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Pilot methodology for mapping Sustainable Development Goals in the context of Smart Specialisation Strategies

Joint Research Centre

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Contact information
Monika Matusiak
Joint Research Centre, European Commission
monika.matusiak@ec.europa.eu

EU Science Hub
https://ec.europa.eu/jrc

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Pilot methodology for mapping Sustainable Development Goals in the context of Smart Specialisation Strategies

EDITORS

Matusiak, M., Fuster Martí, E.***

AUTHORS

*Enric Fuster Martí**, Massucci F.**, Matusiak, M.*, Quinquillà A.**, Bosch J.**, Duran N.**, Amador R.**, Multari F.**, Iriarte M.***

** European Commission, Joint Research Centre*
*** SIRIS Academic*

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ABSTRACT

This report has been developed as a part of the Joint Research Centre's contribution to the United Nation's Global Pilot Programme on Science, Technology and Innovation (STI) for Sustainable Development Goals (SDGs) Roadmaps. It develops and tests a novel methodology to analyse the challenges resulting from the commitment to SDGs and the STI potential available to respond to them as part of the mapping (diagnostic) exercise within Smart Specialisation Strategies. The report combines the analysis of policy mandates, statistical indicators and scientometrics to propose a new approach for the inclusion of the sustainability dimension in the design phase of Smart Specialisation Strategies. This approach has been piloted and validated by Serbian stakeholders as a part of Serbia's participation in the Global Pilot Programme on STI for SDGs Roadmaps. The wider ambition of this paper is however to propose a tested methodological approach that will be universal and applicable in other territories both in Europe and beyond.

ACKNOWLEDGMENTS

This report builds on the continuous learning process we experienced working with the United Nation's Inter-Agency Task Team on STI for SDGs Roadmaps, including discussions and feedback from our colleagues from UN-DESA, UNESCO, UNIDO, UNCTAD and the World Bank, but also from the insights of our Serbian partners. We would like to extend our warmest thanks to the Serbian Smart Specialisation Team, in particular Viktor Nedovic and Tijana Knezevic, for their commitment and contributions to this project. The report benefited from comments from Fernando Santiago Rodriguez from the United Nations Industrial Development Organization (UNIDO) and the continuous support of Alessandro Rainoldi, the Head of the Territorial Development Unit at the Joint Research Centre of the European Commission.

DISCLAIMER

EXECUTIVE SUMMARY

The United Nation's Addis Ababa Action Agenda[1] recognizes the key role of science, technology and innovation in achieving the Sustainable Development Goals (SDGs). The European Union (EU) is strongly committed to the SDGs, which are applied throughout all EU policies, including those on research and innovation. Following this direction, in 2018 Joint Research Centre (JRC) joined the United Nation's Inter-Agency Task Team on Science, Technology and Innovation for Sustainable Development Goals Roadmaps (STI for SDGs Roadmaps) and launched a reflection on how to embed the SDGs in Smart Specialisation Strategies – place-based research and innovation agendas defined and implemented in regions and member states, and increasingly adopted by countries outside of the EU[2]. The first methodological efforts on Smart Specialisation for SDGs were tested in United Nation's Global Pilot Programme, where JRC cooperated with UNIDO and Serbia to include the SDGs in the Serbia's Smart Specialisation Strategy (4S), adopted in 2020 and followed by an Action Plan in 2021. The 4S Action Plan has been designed as the STI for SDGs Roadmap of Serbia and presented at the United Nation's Science, Technology and Innovation Forum and the High Level Political Forum in 2021 as a first document of this kind adopted globally.

The purpose of this report is to develop a methodology, available to interested countries and regions, which allows to 1) identify the key challenges resulting from the SDGs in a given territory, 2) map the scientific, innovative and technological potential, including relevant cooperation networks, that can be mobilised to address these challenges and 3) find out how different Smart Specialisation priority domains contribute to the SDGs.

The proposed methodology has been tested with the Serbian partners, including the government representatives, members of the inter-ministerial Smart Specialisation Team of Serbia and the stakeholders – members of the S3 working groups composed of business, academia, public sector and civic society. Lessons learnt from this pilot exercise form a part of the methodological approach for Smart Specialisation Strategies for Sustainable Development Goals. Thus, they are also relevant for EU countries and regions interested in including sustainability challenges in their place-based innovation strategies.

The research procedure is based on six main research questions, for each of which a specific analytical approach has been proposed. They also provide the structure of this report. The first two questions focus on priority-setting by identifying key challenges in Serbia within the framework of the SDGs. The remaining four questions analyse the Serbian SDG-oriented STI ecosystems and external collaborations, and are aimed at supporting the implementation of Smart Specialisation Strategy and the design of STI roadmaps for SDGs. The list of the research questions is presented below.

1. What are the current national priorities to achieve the Agenda 2030 in Serbia?
2. Which challenges resulting from SDG goals and targets are most important in statistical terms?
3. What are the areas of specialisation and excellence of the Serbian STI ecosystem that can be mobilised to respond to the challenges resulting from the SDGs?
4. What are the knowledge gaps between the identified SDG challenges and STI potentials?
5. Which international STI collaboration networks and partnerships match the identified knowledge gaps and potentials?
6. How do the identified challenges, potentials and knowledge gaps relate to Smart Specialisation priority domains in Serbia?

1 *United Nations, 2015. Retrieved 15 December 2019 from* ***https://sustainabledevelopment.un.org/index.php?page=view&type=400&nr=2051&menu=35***

2 *For further information, see: European Commission, S3 Platform – 'S3 Beyond EU'. Retrieved 1 April 2020 from* ***https://s3platform.jrc.ec.europa.eu/s3-beyond-eu****.*

The first two research questions have been answered based on the documentary analysis of the national SDG policy framework in Serbia, including the main challenges indicated in official documents and the statistical assessment of the key challenges resulting from the SDGs at target level. The results were validated by the stakeholders and policy-makers during dedicated workshops.

The second set of questions has been addressed by analysing data on research and innovation activities, that have been classified into the SDGs. Relevant indicators, insights and visualisations have been developed to support the identification of the scientific, technological and innovative potential which can be used to address the main SDG-related challenges in Serbia. Data sources included scientific publications, research and innovation projects supported by Horizon 2020, research and innovation projects funded by the Serbian Innovation Fund and Serbian patents. These four data sources offer complementary insights into the SDG-related STI activities and outputs, and, thus, Serbian capacities matching the relevant SDGs.

The analysis of the data sources was based on Natural Language Processing (NLP) techniques in order to automatically parse the text of each STI record (titles, abstracts, descriptions) and, through machine learning, extract relevant information used to link the records to the SDGs. A controlled vocabulary of key terms specifying the semantic content of each goal has been used to identify pertinent terms in the analysed texts and to classify the records as thematically related to the SDGs.

As a result of the analysis, a set of priority SDGs has been identified. They include goals 1, 3, 4, 8, 9 and 10 and two goals with distinctive STI potential within the framework of Smart Specialisation: 2 and 7. While all the SDGs have been analysed in the context of the most relevant science, technology and innovation potentials and gaps, the six higher-priority SDGs have benefited from more detailed analysis. Finally, the findings have been mapped into the Smart Specialisation priorities of Serbia to show their potential contribution to the SDGs.

The conclusions of the research indicate the areas of possible policy interventions both in the design and during the implementation phase of Smart Specialisation Strategy so it can more meaningfully address the SDG challenges. First, where the local STI capacity exists, the stakeholders can be mobilised and encouraged to propose innovations for sustainability in the identified S3 priority domains. The Entrepreneurial Discovery Process, reoriented and opened to the new groups of stakeholders can be a powerful vehicle for this. Appropriate policy instruments and programmes can further support the implementation of the best ideas. Second, in a wider process, the expertise of the knowledge sector, the public sector and NGOs can contribute more generally to better public policy, social innovation and social, economic and sustainability transformations.

There are some sustainability challenges, where there are STI knowledge or competence gaps in the local ecosystem. These can be addressed by building capacities in the public, private and third sector, which requires longer-term science and innovation policy oriented towards SDGs. In the short term, the international partnerships can be mobilised to import skills and accelerate the capacity-building of local actors. Finally, the SDG-related assessments and policy design can be used to advance scientific knowledge and build linkages between the existing actors.

MAIN RESULTS AND INSIGHTS

The main results and insights of the study are summarised here, structured following the six key research questions.

1 What are the current national priorities to achieve the Agenda 2030 in Serbia?

2 Which challenges resulting from SDG goals and targets are most important in statistical terms?

Chapter 2 of the report addresses these first two questions, which have the objective of establishing a base for priority-setting within the framework

of the SDGs. This belongs to the realm of national policy; as such, the set of higher-priority goals and targets listed below, resulting from a documentary analysis (official Serbian SDG assessments and policies) and a statistical assessment (based on UN SDG indicators), is simply an input for national discussion and decision-making. The ranking of goals, validated with national stakeholders, results from the combination of these two methodologies, which offer complementary qualitative and quantitative information for identifying the main challenges within the framework of the SDGs in Serbia.

SDG targets are assessed within this goal prioritisation and relative priorities are also established. To obtain a finer-grained understanding of the specific key challenges at target level, in all goals, please see Additional material: SDG indicators at target level – Statistical assessment of the challenges resulting from the SDGs in Serbia.

Globally, it appears that social (particularly welfare-related) and **economic-related** Sustainable Development Goals are a more pressing challenge for Serbia. On the contrary, environmental and climate-related goals are generally understood as being lower priority in the analysed documentation, and Serbia is in a better position in comparison to EU leaders in the statistical assessment. In this context, social innovation and transformative public policy for a better provision of public goods in a more inclusive society are key levers from improvement, while technological development may not be enough to achieve the SDGs in Serbia.

3 What are the areas of specialisation and excellence of the Serbian STI ecosystem that can be mobilised to respond to the challenges resulting from the SDGs?

4 What are the knowledge gaps between the identified SDG challenges and STI potentials?

Chapter 3 and *Chapter 4* of the report address these questions. In Serbia, 21% of publications, 55% of Horizon 2020 projects, 41% of Innovation Fund projects and 18% of patents are thematically related to the SDGs. The share of publications is very similar to that of EU-13 and EU-27 countries, meaning that the aggregate specialisation of the Serbian scientific community does not significantly differ from that of the benchmarks in terms of SDG orientation.

An initial observation is that, so far, there is no clear alignment between the superiority of the SDG-related priorities and the rank of the related STI communities.

Higher-priority goals in Serbia are clustered within the social and economic domains. The three more socially oriented higher-priority challenges (Goal 1. No Poverty, Goal 4. Quality Education, Goal 10. Reduced Inequalities) are researched by small scientific communities and, due to their non-technical nature, are not related to a single Serbian patent. Furthermore, these goals do not receive much attention from research and innovation funding agencies, which may limit the consolidation of the scientific communities and the transformative impact of science and innovation in Serbia. In this sense, it is noteworthy that these goals all have a percentage of publications in the TOP10% journals below the Serbian average. While there may be a trade-off between international relevance and local impact, at face value these indicators are not encouraging. Transversally, Serbia presents a lower specialisation index in Social Sciences and Arts and Humanities that could be related to these gaps. Pockets of distinctive capacity can be found in digital education (Goal 4.) and in technologies and devices supporting the inclusion of people with disabilities (Goal 10.). The presence of these two goals in the Innovation Fund is unexpectedly high: with four and five projects, respectively.

Higher-priority, socio-economic oriented Goal 8. Decent Work and Economic Growth and Goal 9. Industry, Innovation and Infrastructure are subject of sizable scientific communities, as shown by the number of related publications. The scientific communities relating to Goals 8 and 9 are notably smaller than in EU-13 countries. This may represent an important knowledge gap in relation to countries facing, or which have faced, comparable Goal 8 and 9-related challenges. Furthermore, in

these cases the challenge remains how to connect these scientific capacities to better policymaking and widespread social transformation.

Higher-priority Goal 3. Good Health and Well-being presents a large STI-related ecosystem. The Goal 3-related scientific community is relatively smaller than in the EU-13 countries, which may point at an insufficient critical mass, and has a difficulty in obtaining Horizon 2020 funding – unlike other Serbian goal-related communities. Notable knowledge gaps in Goal 3-related topics can be found in the scientific disciplines of Immunology and Microbiology, Neuroscience and Psychology. Pockets of distinctive innovative capacity can be found in medical devices (diagnostic and therapeutic, particularly related to heart conditions), implants and dermatological products.

Beyond the higher-priority goals, Goal 2. Zero Hunger and Goal 7. Affordable and Clean Energy showcase noteworthy STI capacities and opportunities for mobilisation and SDG-oriented development pathways.

Goal 2 is strongly connected to the Serbian S3 priority Food for Future, particularly regarding the topic 'Sustainable Agri-food Production'. Goal 2-related STI ecosystems have a critical mass, gain significant attention from the private sector (ranking 1st in the Innovation Fund and 3rd in Patents) and are internationally connected (ranking 4th in H2020). Nevertheless, the scientific community is relatively small (particularly in relation to EU-13 countries) and presents a lower scientific impact than the Serbian average. The share of publications across subject areas shows a relative lack of contribution to Environmental Science and the Social Sciences, pointing to a knowledge gap, with a greater contribution to Engineering and Chemistry, pointing at an STI potential.

Goal 7 is strongly connected to one of the Serbian Smart Specialisation priorities: Energy Efficient and Eco-Smart Solutions and provides transversal value in Food for Future and Future Machines and Manufacturing Systems. The Goal 7-related STI community has a large critical mass (ranking 2nd in publications and Horizon 2020 projects), gains

TABLE 1 *SDG prioritisation from the documentary analysis and the statistical assessment*

Higher-priority challenges	Medium-priority challenges	Lower-priority challenges
1 No Poverty	5 Gender Equality	2 Zero Hunger
3 Good Health and Well-being	6 Clean Water and Sanitation	12 Responsible Consumption and Production
4 Quality Education	7 Affordable and Clean Energy	13 Climate Action
8 Decent Work and Economic Growth	11 Sustainable Cities and Communities	14 Life Below Water
9 Industry, Innovation and Infrastructure	17 Partnerships for the Goals	15 Life on Land
10 Reduced Inequalities		16 Peace, Justice and Strong Institutions

Source: Authors', based on selected documentation and the United Nations' Global SDG Indicators Database.

significant attention from the private sector (ranking 2nd in the Innovation Fund and 1st in Patents). It also presents a high scientific impact, with the largest percentage (24%) of publications in the TOP10% international journals in Serbia. Nevertheless, the Goal 7-related scientific community is notably smaller in relative terms than the corresponding communities in EU-27 and EU-13 countries. Serbia presents reduced specialisation in the scientific disciplines of Physics, Materials Science, Computer Science (compared to the EU-27) and Agricultural and Biological Sciences (compared to the EU-13), which may indicate relative knowledge and competence gaps. Conversely, Serbia presents pockets of innovative capacity related to renewable energies (wind, solar, hydro, wave) for electricity and hot water production, energy efficiency, thermal-electrical machines, smart grids and the impact of these developments on a reduced footprint and fewer greenhouse gas emissions.

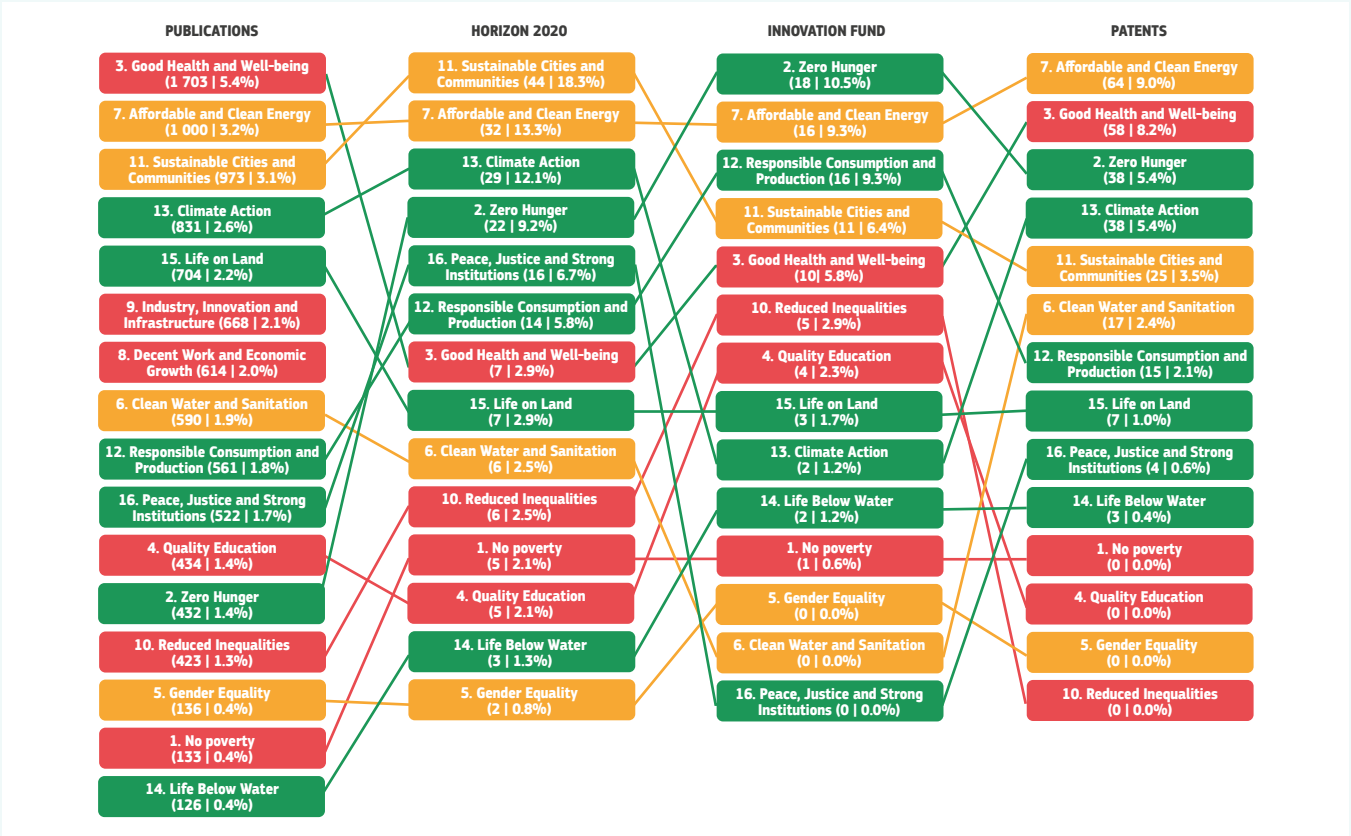
Goal 11. Sustainable Cities and Communities and Goal 12. Responsible Consumption and Production also show important STI capacities, as demonstrated by an active community in Horizon 2020 and the Innovation Fund as well as a notable number of related patents.

Across all goals, Serbia tends to present a critical mass in relative terms – and thus greater STI potential – in the scientific disciplines of Medicine and the Health professions, Engineering, Chemistry, Chemical Engineering and Economics, Econometrics and Finance.

Lastly, three transversal knowledge-competence gaps can be identified across all of the goals:

- Serbia presents relative weaknesses (lower specialisation index) in the Social Sciences, Arts and Humanities (which includes Design, Fine Arts and Applied Arts) and in goals with related applications in Psychology, Business, Management

FIGURE 1 *Distribution of STI activities by goal (coded by priority level) and data source*



Source: Authors based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO

and Accounting. In that regard, the 'softer' scientific disciplines are usually lacking, which can have a limiting effect on the necessary SDG-oriented social, cultural and policy transformations, particularly in society and economy-related higher-priority goals[3];

- Serbia presents relative weaknesses (as expressed by a lower specialisation index, relatively low citation impact and difficulties in competing in Excellent Science and Industrial Leadership calls in Horizon 2020) in basic and applied sciences disciplines (such as Physics, Materials Science, Computer Science, Mathematics, Biochemistry, Genetics and Molecular Biology, Immunology and Microbiology). Thus, it may be difficult to play an active role in the development of most advanced technological solutions addressing the SDGs in comparison to international leaders;

- Horizon 2020 is structured with three main pillars: Excellent Science, Industrial Leadership and Societal Challenges – rom the rather non-oriented nature of Excellent Science, to the clearly thematically-oriented Societal Challenges. Serbia, similar to EU-13 countries, has great difficulties in competing and obtaining funding under the Excellent Science and Industrial Leadership pillars. This manifests as a relative gap in scientific excellence across all disciplines in comparison to EU-13 countries, and, as expressed in the previous point, difficulties in leading SDG-oriented technological and industrial innovations at the frontier.

5 Which international STI collaboration networks and partnerships match the identified knowledge gaps and potentials?

The study identifies national and international STI collaboration networks that can be mobilised to respond to the challenges resulting from the SDGs based on co-publishing, co-patenting and joint projects. This is an exploratory rather than analytical effort. Thus, two information resources have been produced (available in Additional material: Main Serbian actors and international partners collaborating in SDG-oriented STI activities) for the use of policy-makers, experts and stakeholders aiming to mobilise and build connections in the ecosystem, as well as to increase linkages and presence at international level:

- a visual depiction of the national and international collaboration networks in SDG-oriented STI activities,

- a list of the main Serbian actors and international partners collaborating in SDG-oriented STI activities.

For higher-priority goals (1, 3, 4, 8, 9, 10) and the two goals connected to the Serbian S3 with high STI potential (2 and 7), an interpretation of this material is provided in ***Chapter 5*** of this report.

Some transversal insights emerge, as follows.

- Serbian universities have a central role in all SDG-oriented STI networks. The University of Belgrade, followed by Novi Sad, Nis, Kragujevac and several 'specialised' universities, act as national and international collaboration hubs.

- There is a small presence of 'other' actors – NGOs, not-for-profits, foundations, etc. – which should play a key role in mobilising civil society and in spreading innovations throughout social groups and geographies. This weakness is particularly visible in humanitarian, social and environment-oriented goals.

- The presence of private companies is unequal across goals. Where private enterprise is naturally oriented to SDG-related topics (agri-food, health, energy, consumer-goods production), companies are indeed actively contributing to SDG-oriented innovations, primarily of a technological nature. On the contrary, the presence of private companies is very sparse in the society and environment-related goals, which are dominated by academic institutions. The cur-

3 *Nevertheless, as presented in the first chapter of the report and in the methodological annex, one limitation of the STI analysis is the lower propensity of Social Sciences and Humanities communities to publish in international and/or English-speaking journals.*

rent situation is that Serbian private companies therefore do not yet seem to have found entrepreneurial opportunities in non-technological SDG-related areas.

- Public administrations have some presence within the networks, but this is probably smaller than may be necessary considering the nature of the SDGs, and not central enough. National and subnational administrations appear within the networks in a haphazard way, and there does not seem to be any direct alignment between the topic of the goal and the active ministries or public bodies in the related STI networks.

- Specialised research institutes are present within most SDG-oriented STI networks, complementing the universities in their disciplines of activity, generally rather applied in nature.

- Serbian SDG-oriented STI communities are connected internationally. There is very strong collaboration in the region (both with EU and non-EU countries, mainly to the north, west and south: Croatia, Greece, Bosnia and Herzegovina, Slovenia), with more distant EU countries (Germany, Italy, Spain, the Netherlands, France, Belgium) with the United Kingdom and, to a lesser degree, the United States of America. In specific goals (Goal 1. No Poverty, Goal 7. Affordable and Clean Energy, Goal 3. Good Health and Well-being), collaborations emerge with some Asian countries, in particular: Malaysia, Iran, China and India. These linkages could act as a basis for collaborative activity in the framework of Goal 17. Partnerships for the goals.

- In Horizon 2020, Serbian actors are capable of obtaining funding, and, thus, are well-connected within the Societal Challenges pillar. On the contrary, they have a hard time, and are therefore rather disconnected from Excellent Science and Industrial Leadership collaborative efforts.

Additionally, in ***Chapter 5***, for higher-priority goals (1, 3, 4, 8, 9, 10) and the two goals connected to the Serbian S3 with high STI potential (2 and 7), specific venues for international collaboration have been identified, in particular:

- Serbian clusters present in the Custer Mapping Tool provided by the European Cluster Collaboration Network,

- health-related projects financed by the EU Health Programme, available in the EU's Consumers, Health, Agriculture and Food Executive Agency (CHAFEA) database,

- JRC-promoted S3 Thematic Platforms.

6 How do the identified challenges, potentials and knowledge gaps relate to Smart Specialisation priority domains in Serbia?

As confirmed during the Smart Specialisation for Sustainable Development Goals pilot activity workshop in Serbia, Belgrade, on 27 February 2020, all Serbian Smart Specialisation priority domains can find opportunities and have the potential to tackle the Sustainable Development Goals. The specific STI potential and opportunities, gaps and risks are detailed for each vertical and transversal S3 priority in ***Chapter 6*** of this study: 'Relationship between the identified challenges, potentials and knowledge gaps and the Smart Specialisation priority domains in Serbia'.

There is direct taxonomical alignment between:

- Food for Future (particularly the sub-priority Sustainable Agri-food Production) with Goal 2. Zero Hunger. Specific STI capacities can be found in agricultural and food industry machinery, improved production processes and new food products, with contributions from Mechanical Engineering, Chemistry and Biotechnology. Indirectly, it can generate positive externalities on poverty and inequality (Goals 1 and 10), better health (Goal 3) and reduce impacts exploring more sustainable development pathways (Goals 6, 11, 12, 13, 14, 15);

- Energy Efficient and Eco-Smart Solutions are directly connected to Goal 7. Affordable and clean energy, and more loosely connected to Goals 11 and 12, which all present strong and entrepreneurial STI ecosystems. Energy Efficient

and Eco-Smart Solutions can have an indirect positive impact on most social and environmental goals, in particular 9, 13 and 15.

As discussed, all remaining priority domains have strong potentials for achieving the SDGs.

- Information and Communication Technologies can play a horizontal role in supporting technification and innovation (Goal 9) and improving employment (Goal 8). By tackling the digital divide, with adequate education, training and labour policies, ICT can produce significant economic traction and employment opportunities addressing poverty (Goal 1) and inequality-inclusion (Goal 10) challenges for minorities, populations with disabilities and women (Goal 5). A large area of opportunity lies in Good Health and Well-being (Goal 3), through medical devices, e-health and digital health. Similarly, the medium-priority challenges Goal 7. Affordable and Clean Energy and 11. Sustainable Cities and Communities offer great opportunities for ICT, particularly in the domains of energy efficiency, smart grids, smart cities and sustainable and efficient transportation.

- The Creative Industries have two direct connections to Sustainable Development Goals:

  - The sub-priorities 'Creative Audio-Visual Production' and 'Video Games and Interactive Content' can have a key impact on higher-priority Goal 4. Quality Education through digital education – a fertile domain for Serbian innovation;

  - the sub-priority 'Smart Packaging' directly contributes to Goal 12. Responsible Consumption and Production;

  - additionally, similar to ICT, as a horizontal capacity in design and creativity, and as a sector prone to entrepreneurship, it can provide opportunities in Goals 1, 5, 8, 9 and 10.

- Future Machines and Manufacturing Systems play a horizontal role in supporting technification in industry and innovation (Goal 9) and improving employment (Goal 8). Vertically, it can provide new products and innovation in production processes in industries contributing to Goals 2, 11 and 12.

- The Key Enabling Technologies can play an important role in addressing Goals 2, 3, 6, 7, 9, 11, 12 and 13. Serbia presents relative strength in Engineering, Chemistry and Chemical Engineering but as presented above, presents knowledge/competence gaps in comparison to EU-27 countries in basic and applied science fields.

The main knowledge and competence gaps affecting the SDG-oriented STI capacities in the context of the Smart Specialisation domains have been discussed in detail in ***Chapter 6***, and summarised in the section above.

In ***Chapter 6*** there is also a short qualitative discussion of the SDG-related risks in the S3 priority domains which gathers displacement and directionality issues, notably:

- automation and its impact on employment and equality,

- the growing divide between internationalised and innovative sub-sectors and the rest of the economy,

- the lack of inclusion in the development of minorities and disadvantaged populations,

- the concentration of activity and territorial inequality, affecting the rural areas in particular,

- environmental impacts of growth-oriented development.

These risks should be taken into account when exploring STI opportunities in the context of S3. Responsible research and innovation, social innovation, transparency and challenge-oriented R&I policy can provide useful frameworks for managing the trade-offs between risks, indirect effects and opportunities.

As a summary of these insights, the potential impacts of the Smart Specialisation priority domains on the main challenges resulting from the SDGs in Serbia a synthetically listed below. Potential and opportunities are classified into direct and indi-

rect. Direct potential and opportunities correspond to specific areas of innovation or application in the priority domains that tackle challenges within the SDGs directly, through science, technology and innovation, in most cases with economic or market potential for private stakeholders. Indirect potential and opportunities correspond to positive societal or environmental externalities which can be produced by the direct ones, and/or to wider developments and improvements in the practices of the priority domains that help tackle ingrained challenges within the SDGs.

Table 2 detail the potential, gaps and opportunities emerging from the Smart Specialisation priority domains in connection with the SDGs. To facilitate the reverse analysis – that is, the main S3-related capabilities that can support innovation and development pathways in the SDGs – the following table presents the top 3 S3 priority domains most closely related to each goal. It is primarily based on the nature and orientation of the goal's targets, and on the finer-grained STI potential and knowledge/competence gap analysis.

STRUCTURE OF THE REPORT AND ADDITIONAL MATERIAL

Structure of the report

Chapter 1 Presentation and approach provides the context, objectives and methodological approach; how STI potential and knowledge/competence gaps are assessed, quantitatively and qualitatively, in the study; and offers guidance on how to interpret the data and results.

Chapter 2 Analysis of the challenges resulting from the SDGs in Serbia addresses the first two research questions:

1. What are the current national priorities to achieve the Agenda 2030 in Serbia?

2. Which challenges resulting from SDG goals and targets are most important in statistical terms?

It includes the main conclusions from the documentary analysis and the statistical assessment of the main challenges at SDG goal and target level.

Chapter 3 General analysis of the SDG-related STI potential and knowledge- competence gaps addresses the main questions:

3. What are the areas of specialisation and excellence of the Serbian STI system that can be mobilised to respond to the challenges resulting from the SDGs?

4. What are the knowledge gaps between the identified SDG challenges and STI potentials?

This also includes a transversal STI analysis of all goals and all data sources.

Chapter 4 Finer-grained STI potential and knowledge/competence gap analysis in selected goals digs deeper into the two questions above, providing substantial detail supporting a finer mobilisation of Serbian STI actors and future policy decisions in a set of eight key goals.

Chapter 5 Identification of national and international SDG-oriented STI collaboration networks addresses the question:

5. Which international STI collaboration networks and partnerships match the identified knowledge gaps and potentials?

This is supported by quantitative indicators, a visual interpretation of the collaboration networks depicting the main actors engaged in each goal and international venues and networks that could support further international STI collaboration within the SDGs.

Chapter 6 Relationship between the identified challenges, potentials and knowledge gaps and the Smart Specialisation priority domains in Serbia addresses the question:

6. How do the identified challenges, potentials and knowledge gaps relate to Smart Specialisation priority domains in Serbia?

It is based on a qualitative curation of the documentary, quantitative and semantic evidence presented in the previous chapters, and also integrates several opportunities identified by representatives of the S3 working groups corresponding to the four S3 priorities during the Smart Specialisation for Sustainable Development Goals pilot activity workshop in Serbia, Belgrade, on 27 February 2020.

"Chapter 7 Conclusions and proposed next steps provides a summary of the main insights of the report and presents a few guidelines for future interpretation and action.

TABLE 2 *Summary of the potential impact of the S3 priorities on the main challenges resulting from the SDGs in Serbia*

	Information and communication technologies	Food for Future	Creative Industries	Future Machines and Manufacturing Systems	Energy Efficient and Eco-Smart Solutions	Key Enabling Technologies
Goal 1. No Poverty	Indirect	Indirect				
Goal 2. Zero Hunger		Direct	Indirect	Indirect	Indirect	Indirect
Goal 3. Good Health and Well-being	Direct		Indirect		Indirect	Indirect
Goal 4. Quality Education	Direct		Direct			
Goal 5. Gender Equality	Indirect		Indirect			
Goal 6. Clean Water and Sanitation		Indirect		Indirect		Indirect
Goal 7. Affordable and Clean Energy	Direct	Indirect	Indirect	Indirect	Direct	Indirect
Goal 8. Decent Work and Economic Growth	Indirect	Indirect	Indirect	Indirect	Indirect	Indirect
Goal 9. Industry, Innovation and Infrastructure	Direct	Indirect	Indirect	Direct	Indirect	Direct
Goal 10. Reduced Inequalities	Indirect		Indirect			
Goal 11. Sustainable Cities and Communities	Indirect			Indirect	Indirect	Indirect
Goal 12. Responsible Consumption and Production		Indirect	Direct		Indirect	Indirect
Goal 13. Climate Action		Indirect	Indirect	Indirect	Indirect	Indirect
Goal 14. Life Below Water		Indirect	Indirect	Indirect		
Goal 15. Life on Land		Indirect	Indirect	Indirect	Indirect	
Goal 16. Peace, Justice and Strong Institutions						

Source: Authors', based on the Agenda 2030, the STI analysis and the Smart Specialisation for Sustainable Development Goals pilot activity workshop in Serbia, Belgrade, on 27 February 2020.

ADDITIONAL MATERIAL

Only a fraction of the data gathered and analysed in the project is presented in this report. To open up the wealth of information produced to policy-makers, experts and stakeholders, a series of carefully crafted files has been prepared. They gather and summarise information in different forms and provide granular results from the entire analysis. See below a visual guide to this additional material.

TABLE 3 *S3 priority domains most closely related to the Sustainable Development Goals*

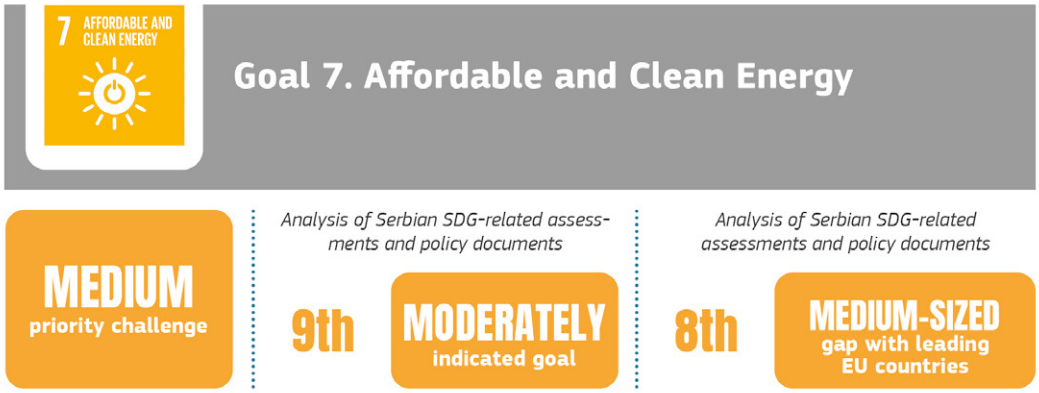
Goal	Most closely related S3 priority domains
1. No Poverty	Food for Future Information and Communication Technologies
2. Zero Hunger	Food for Future Energy Efficient and Eco-Smart Solutions
3. Good Health and Well-being	Information and Communication Technologies Food for Future
4. Quality Education	Information and Communication Technologies Creative Industries (Education and training is transversal to all)
5. Gender Equality	Information and Communication Technologies Creative Industries (Gender equality is transversal to all)
6. Clean Water and Sanitation	Food for Future (Sustainable Agri-food Production) Key Enabling Technologies (Biotechnology)
7. Affordable and Clean Energy	Energy Efficient and Eco-Smart Solutions Food for Future
8. Decent Work and Economic Growth	*Transversal to all S3 priority domains*
9. Industry, Innovation and Infrastructure	*Transversal to all S3 priority domains* Information and Communication Technologies
10. Reduced Inequalities	Food for Future Information and Communication Technologies
11. Sustainable Cities and Communities	Energy Efficient and Eco-Smart Solutions Information and Communication Technologies
12. Responsible Consumption and Production	Creative Industries (Smart Packaging) Food for Future (Sustainable Agri-food Production)
13. Climate Action	Energy Efficient and Eco-Smart Solutions Food for Future
14. Life Below Water	Creative Industries (Smart Packaging) Food for Future (Sustainable Agri-food Production)
15. Life on Land	Food for Future (Sustainable Agri-food Production) Creative Industries (Smart Packaging)
16. Peace, Justice and Strong Institutions	*Transversal to all S3 priority domains*

Source: Authors', based on the Agenda 2030, the STI analysis and the Smart Specialisation for Sustainable Development Goals pilot activity workshop in Serbia, Belgrade, on 27 February 2020.

01

Science, technology and innovation potential to address SDGs

Science, technology and innovation potential to address SDGs presents, in a one-page visual summary, the main indicators and results of the analysis for each Sustainable Development Goal.



Goal 7 rank and share in the STI analysis

This table presents the rank of Goal 7-related STI activities in relation to the rest of the goals. For publications and H2020 projects, the share vs the EU-27 provides a notion of relative specialisation.

Publications (out of 16 goals)		Horizon 2020 (out of 14 goals)		Innovation Fund (out of 11 goals)	Patents (out of 10 goals)
2nd	2nd	2nd	1st	2nd	1st
3.2% Serbia	3.8% EU-27	13.3% Serbia	12.2% EU-27	9.3% Serbia	9.0% Serbia

Scientific impact of Goal 7-related publications

% of publications in TOP10% journals	*Normalised citation impact (vs Serbian pubs.)*
24.0 % Serbian average = 10.2%	**1.4** Serbia = 1

Active organisations in Goal 7-related STI activities

This table presents the number of organisations engaged in Goal 7-related STI activities, providing a notion of critical mass and international linkages.

No. of **organisations** in **publications**		No. of **organisations** in **Horizon 2020**		No. of **organisations** in **Innovation Fund**	No. of **organisations** in **patents**
103 National	330 International	25 National	377 International	18 National	4 National

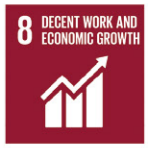
Relationship with other goals and Smart Specialisation

MOST CLOSELY RELATED GOALS				*MOST CLOSELY RELATED SMART SPECIALISATION PRIORITY DOMAINS*
13 CLIMATE ACTION	**14%** Similarity	11 SUSTAINABLE CITIES AND COMMUNITIES	**11%** Similarity	**Energy Efficient and Eco-Smart Solutions** **Food for Future** **Key Enabling Technologies**

02

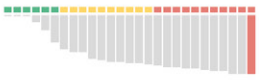
SDG indicators at target level –

Statistical assessment of the challenges resulting from the SDGs in Serbia



Goal 8. Decent Work and Economic Growth

Analysis of the main challenges at target level

	Target	Priority	Distance to frontier	
		In Serbian SDG-related assessments and policy documents	Statistical assessment of the gap in the SDG indicators with EU countries, 100 = wider gap. *Serbia is represented by the coloured bar*	
8.1	Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries	Low	77	
8.2	Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors	Medium	100	
8.3	Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services	High	-	
8.4	Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead	Low	58	
8.5	By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value	Medium	100	
8.6	By 2020, substantially reduce the proportion of youth not in employment, education or training	High	100	

03

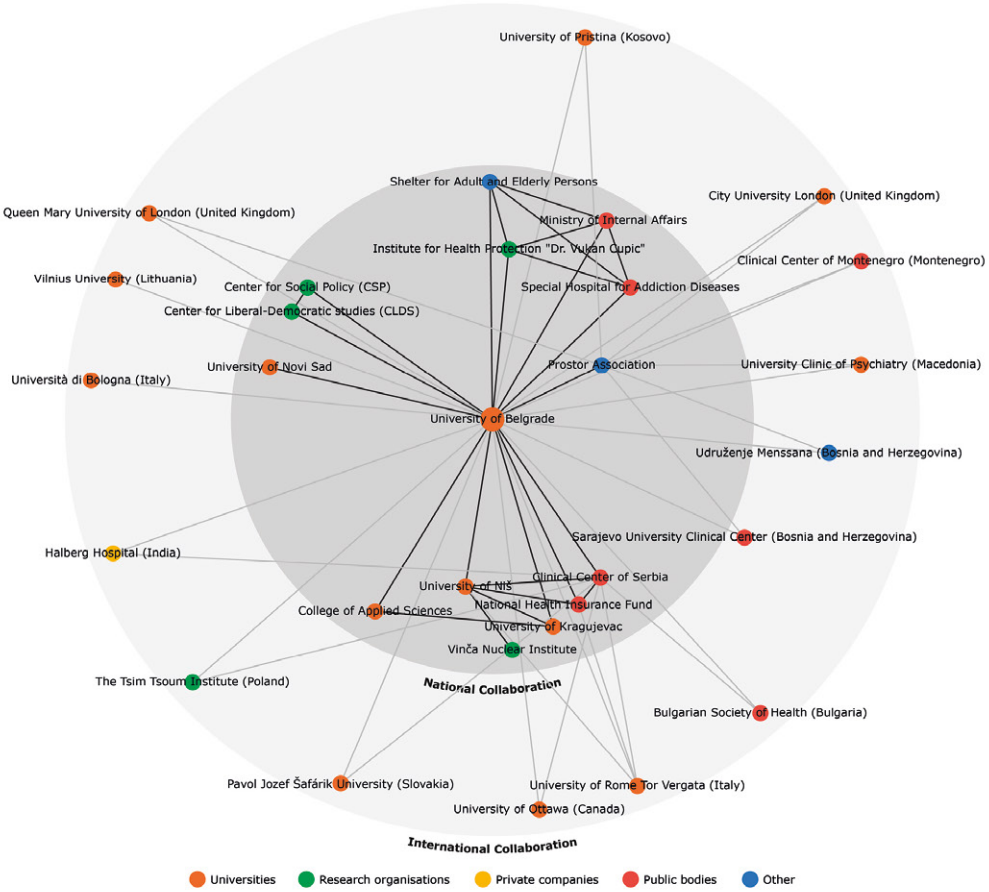
Main Serbian actors and international partners collaborating in SDG-oriented STI activities

(networks)

Goal 1. No Poverty

SDG-oriented STI collaboration networks

The following schema presents the collaboration network of the top 15 national and top 15 international actors engaged in Goal 1, classified by typology of organisation.



04

Main Serbian actors and international partners collaborating in SDG-oriented STI activities

(list of actors)

Main Serbian actors and international partners engaged in SDG-oriented STI activities

The following tables present the top 10 Serbian and international actors engaged in each Goal 1-oriented STI activity in the different data sources. For more information on entrepreneurial innovation, the last table presents the top 10 Serbian companies participating in R&D projects.

PUBLICATIONS			
TOP 10 National organisations	**TOP 10 International orgs.**	**TOP 10 Countries**	
University of Belgrade [31]	Vilniaus universitetas (Lithuania) [3]	IT	Italy [7]
University of Kragujevac [11]	University of Ottawa, Canada (Canada) [3]	US	United States [6]
University of Novi Sad [6]	Halberg Hospital and Research Institute (India) [3]	GB	United Kingdom [5]
University of Niš [5]	Alma Mater Studiorum Università di Bologna (Italy) [3]	FI	Finland [4]
Clinical Center of Serbia [3]	The Tsim Tsoum Institute (Poland) [3]	SK	Slovakia [4]
Vinča Nuclear Institute [2]	Bulgarian Society of Health (Bulgaria) [3]	IN	India [4]
Serbian Academy of Sciences and Arts [2]	Pavol Jozef Safarik University in Kosice (Slovakia) [3]	BG	Bulgaria [3]
Center liberalno-demokratske studije [1]	Universidade de Pernambuco (Brazil) [2]	CA	Canada [3]
Centar za Socijalnu Politiku [1]	Heriot-Watt University, Edinburgh (United Kingdom) [2]	JP	Japan [3]
Institute for Mother and Child Health Care [1]	Taiyo Kagaku Co., Ltd. (Japan) [2]	LT	Lithuania [3]

HORIZON 2020			
TOP 10 National organisations	**TOP 10 International orgs.**	**TOP 10 Countries**	
University of Belgrade [2]	ZURCHER HOCHSCHULE FUR ANGEWANDTE WISSENSCHAFTEN (Switzerland) [1]	GB	United Kingdom [5]
Republic Hydrometeorological Service of Serbia [1]	Finnish Meteorological Institute (Finland) [1]	FR	France [4]
PROSTOR ASSOCIATION [1]	EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS (United Kingdom) [1]	DE	Germany [4]
ELEKTROTEHNICKI INSTITUT NIKOLA TESLA AKCIONARSKO DRUSTVO BEOGRAD SAVSKI VENEC [1]	Euro-Mediterranean Center on Climate Change (CMCC) (Italy) [1]	IT	Italy [4]
Bitgear Wireless Design Services d.o.o. [1]	FIZIKALAS ENERGETIKAS INSTITUTS (Latvia) [1]	BE	Belgium [3]
	Institut du développement durable et des relations internationales (France) [1]	ES	Spain [3]

1. Introduction

1.1. Context, objectives and approach

In 2015, the United Nations General Assembly ratified the 2030 Agenda for Sustainable Development[4] as a plan for 'action to end poverty, protect the planet and improve the lives and prospects of everyone, everywhere'. The Agenda establishes 17 Sustainable Development Goals (SDGs)[5] – a 'blueprint to achieve a better and more sustainable future for all' and 'positioned Science, Technology and Innovation (STI) as key means of implementation of the SDGs[6]', and is developing policy guidance for the development of Science, Technology and Innovation roadmaps for Sustainable Development Goals[7] in partnership with numerous institutions, particularly the European Commission.

In parallel, the European Union's strategy towards smart, inclusive and sustainable growth is supported by territorial growth-oriented Research and Innovation Strategies for Smart Specialisation (S3)[8], defined and implemented in regions and Member States, and increasingly adopted by countries outside of the EU[9]. Serbia approved the Serbia Smart Specialisation Strategy (4S) in 2020.

Serbia, strongly committed to the Agenda 2030 and to Smart Specialisation, has entered the Global Pilot Programme on STI for SDGs Roadmaps. With dedicated support from the Joint Research Centre and UNIDO, Serbia based the establishment of the national STI roadmap for SDGs on an adapted Smart Specialisation methodology – with an increased focus on the SDGs as a key framework for the strategy – and gave further attention to societal and environmental issues, adding to the economic, innovation, scientific and technological dimensions.

This report aims to contribute to the integration of these two STI-based policy-making models and methodologies: the EU's Smart Specialisation Strategies (S3) and the UN's Science, Technology and Innovation roadmaps for Sustainable Development Goals[10]. Both models share a common set

4 *United Nations,* General Assembly, *21 October 2015. Retrieved 15 December 2019 from* ***https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E****.*

5 *United Nations, 'Take Action for the Sustainable Development Goals'. Retrieved 15 December 2019 from* ***https://www.un.org/sustainabledevelopment/sustainable-development-goals/****.*

6 *United Nations Interagency Task Team on Science, Technology and Innovation for the SDGs (IATT),* Science, Technology and Innovation for SDGs Roadmaps, *June 2018. Retrieved 15 December 2019 from* ***https://sustainabledevelopment.un.org/content/documents/19009STI_Roadmap_Background_Paper_pre_STI_Forum_Final_Draft.pdf****.*

7 *United Nations,* Global Pilot Programme on STI for SDGs Roadmaps. *Retrieved 15 December 2019 from* ***https://sustainabledevelopment.un.org/partnership/?p=33852****.*

8 *For further information, see: European Commission, S3 Platform – 'What is Smart Specialisation?'. Retrieved 1 April 2020 from* ***https://s3platform.jrc.ec.europa.eu/what-we-do****.*

9 *For further information, see: European Commission. S3 Platform – 'S3 Beyond EU'. Retrieved 1 April 2020 from* ***https://s3platform.jrc.ec.europa.eu/s3-beyond-eu****.*

10 *For further information, see: United Nations,* Sustainable Development – STI Roadmaps, *Retrieved 1 April 2020 from* ***https://sustainabledevelopment.un.org/tfm#roadmaps****.*

of principles and methodological approaches that facilitate this integration, notably:

- a reliance on participation and stakeholder consultation, data analysis and domain expertise to build a shared evidence base for policymaking
- a sequential prioritisation process
  - in Smart Specialisation, territories aim at excelling in a 'limited number of innovation and research priorities in line with the potential for smart specialisation detected in the analysis phase that is anchored in entrepreneurial discoveries[11]',
  - in STI for SDGs roadmapping, 'because the 17 SDG goals are so broad and cover so many targets it is important for countries to think carefully on which they will prioritize[12].'

In this context, the objective of this study is to identify a set of main challenges connected with Sustainable Development Goals (SDG) in Serbia, and to identify the scientific, technological and innovative potential (STI) that can be mobilised to respond to these challenges as a part of the Smart Specialisation Strategy. The wider ambition of this paper is however to propose a tested methodological approach that will be universal and applicable in other territories both in Europe and beyond.

In this way, the analysis contributes to the analytical phase of the Smart Specialisation process (mapping). Originally developed to support Smart Specialisation as a knowledge-based economic transformation agenda, the guidance for the non-EU countries focused on the analysis of economic, innovative and scientific potential. The new approach, focused on the sustainability dimension and the SDGs, requires increased attention to the environmental and societal aspects of developmental challenges. This study adds these dimensions, as expressed in the SDGs, to the Smart Specialisation development process. The lessons learnt from the pilot exercise will be used to further consolidate the methodological approach for Smart Specialisation Strategies for SDGs.

As such, the study aims to build an evidence-base for:

1. assessing the main challenges faced by the country, in order to identify areas for priority-setting within the framework of the SDGs;
2. assessing the SDG-oriented capacities of the Serbian STI ecosystem;
3. identifying STI-based opportunities to address the SDG-related challenges of the country; and
4. identifying national and international actors with SDG-oriented capacities within the framework of the Serbian S3 priority domains, to pursue these opportunities and support the design and implementation of the STI roadmap for the SDGs.

The project is an important step in a sustained effort by the European Commission's Joint Research Centre to better adapt S3 to countries beyond the EU. Furthermore, the approach and methodology can also be of relevance and value for EU Member States and regions in view of the strategic pre-eminence of the Agenda 2030 Sustainable Development Goals in the 2021-2027[13] programming period.

11 *Foray, D. et al.,* Guide to Research and Innovation Strategies for Smart Specialisations (RIS 3), *May 2012. Retrieved 15 December 2019 from* ***https://ec.europa.eu/regional_policy/sources/docgener/presenta/smart_specialisation/smart_ris3_2012.pdf****.*

12 *United Nations Interagency Task Team on Science, Technology and Innovation for the SDGs (IATT),* A Guidebook for the Preparation of STI for SDGs Roadmaps, *December 2019. Retrieved 24 November 2021 from* ***https://sdgs.un.org/sites/default/files/2021-06/GUIDEBOOK_COMPLETE_V03.pdf***

13 *For further information see:*

- ***Reflection Paper: Towards a Sustainable Europe by 2030****, where Cohesion Policy is presented as 'one of the most transversal and cross-cutting policies, which contributes to most, if not all 17 SDGs',*
- *Horizon Europe documentation (see* ***A new horizon for Europe****), where SDGs set the stage for 'Clusters in the Global Challenges and Industrial Competitiveness pillar' and the 'Research and Innovation Missions',*
- *Bottom-up alignments, since regions, member states and stakeholders are already integrating or calling to integrate SDGs in the next Cohesion Policy efforts – particularly S3.*

Setting the thematic perimeter of the project, as presented in the schemas below, the Agenda 2030 is composed of 17 goals (broken down into 169 targets) and Serbia's Smart Specialisation composed of four vertical priorities (declined in 11 sub-priorities) and two transversal priorities.

Serbia Smart Specialisation Strategy (4S) priority domains[14]

- Information and Communication Technologies
  - Custom Software Development
  - Software Solutions Development
- Food for Future
  - High Tech Agriculture
  - Value Added Food products
  - Sustainable Agri-food Production
- Creative Industries
  - Creative Audio-Visual Production
  - Video Games and Interactive Content
  - Smart Packaging
- Future Machines and Manufacturing Systems
  - General and specific purpose machines
  - Information in the Smart Management Service – Industry 4.0
  - Smart Components and Tools
- Energy Efficient and Eco-Smart Solutions
- Key Enabling Technologies

FIGURE 2 *Agenda 2030's 17 Sustainable Development Goals*

14 *Knežević, T. & Nedović, V.,* S3 contribution to national STI roadmap for SDGs, *December 2020. Retrieved 1 April 2020 from* ***https://sustainabledevelopment.un.org/content/documents/29188Special_Mr._Tijana_knezevic.pdf****.*

To achieve the objectives of the project, six main research questions guide the methodology and broadly define the structure of this document. The first two questions establish the framework for priority-setting by identifying main challenges in Serbia within the framework of the SDGs. The remaining four questions analyse the Serbian SDG-oriented STI ecosystems and external collaborations in support of Smart Specialisation implementation and the design of STI roadmaps for the SDGs.

1. What are the current national priorities to achieve the Agenda 2030 in Serbia?
2. Which challenges resulting from SDG goals and targets are most important in statistical terms?
3. What are the areas of specialisation and excellence of the Serbian STI ecosystem that can be mobilised to respond to the challenges resulting from the SDGs?
4. What are the knowledge gaps between the identified SDG challenges and STI potentials?
5. Which international STI collaboration networks and partnerships match the identified knowledge gaps and potentials?
6. How do the identified challenges, potentials and knowledge gaps relate to Smart Specialisation priority domains in Serbia?

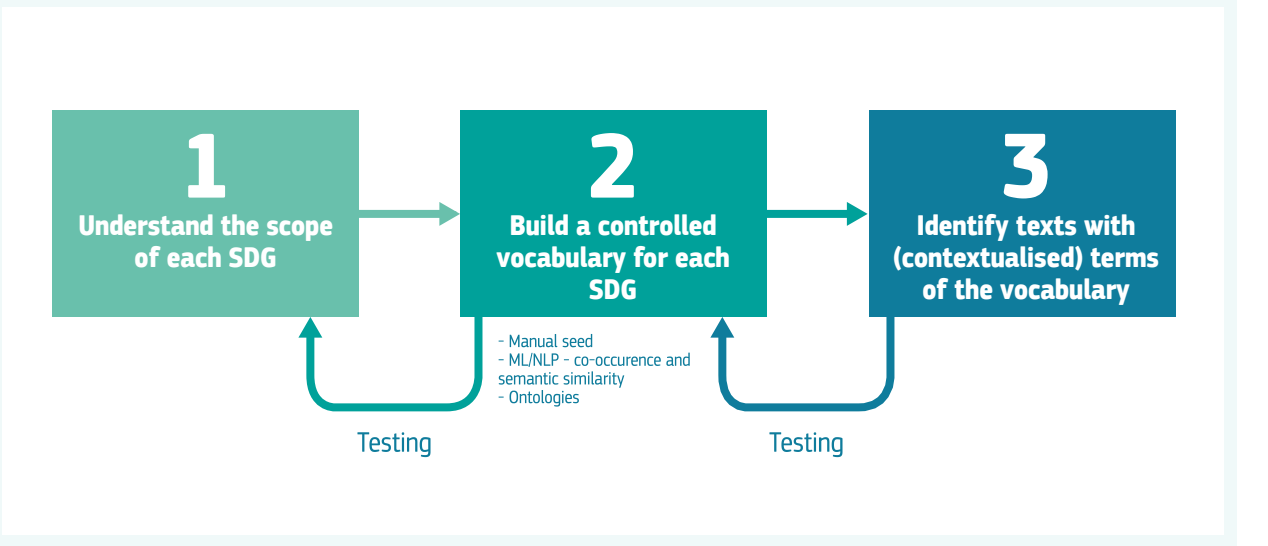
It must be noted that the first research question cannot be formally answered, since the country has not yet established a single official assessment, set of priorities or action plan for achieving the objectives of the Agenda 2030 in Serbia. For this reason, an ex-novo set of priorities, at SDG goal and SDG target level, have been identified and validated with national stakeholders, based on:

- documentary analysis of the national SDG policy framework in Serbia, including the main challenges indicated in official documents,
- statistical assessment of the key challenges resulting from the SDGs at target level, from the UN's Global SDG Indicators Database.

Thus, the 17 Sustainable Development Goals have been classified in three levels:

- higher-priority goals
- medium-priority goals
- lower-priority goals.

FIGURE 3 *Summary of the process and method for identifying SDG-related STI records*



Source: Authors.

TABLE 4 *Examples of STI records thematically related to the SDGs*

Type of record	Title of the record	Thematically related to goal(s)
Scientific publication	Review of technological methods and experimental determination of thermodynamic and transport properties of reagents for carbon dioxide removal from fuel gases	Goal 7. Affordable and Clean Energy Goal 13. Climate Action
H2020 project	Behavioural, Ecological and Socio-economic Tools for Modelling Agricultural Policy	Goal 2. Zero Hunger Goal 15. Life on Land
Innovation Fund project	RAVIP – Radar for Visually Impaired Persons	Goal 10. Reduced Inequalities
Patent	Methods and apparatuses, including devices and systems, for remote detection and/or diagnosis of acute myocardial infarction (AMI)	Goal 3. Good Health and Well-being

Additionally, higher-priority targets have also been identified within the goals when there was enough evidence for the assessment.

The second set of questions has been addressed by analysing data sources recording activities and results of research and innovation, classifying them into the SDGs and providing indicators, insights and visualisations to support the identification of the scientific, technological and innovative potential addressing the main SDG-related challenges in Serbia. Four main data sources have been used:

- scientific publications, from Scopus (Elsevier),
- research and innovation projects supported by Horizon 2020,
- research and innovation projects funded by the Serbian Innovation Fund,
- Serbian patents filed in any office included in the EPO's Open Patent Services database, particularly the Intellectual Property Office of the Republic of Serbia.

These four science, technology and innovation data sources provide a complementary view of SDG-related STI activities and products and, thus, Serbian ecosystem capacities under the corresponding SDG topics. Scientific publications provide a view of the scientific communities and disciplines related to each goal. Horizon 2020 projects support top science and innovation activities, usually cooperative, while the Innovation Fund supports innovative activities, of private companies in particular. Lastly, patents are an indicator of technological development and assets in the country.

Natural Language Processing (NLP) techniques have been employed to automatically parse the text of each STI record (titles, abstracts, descriptions) and to extract relevant information used to link the records to SDGs. A controlled vocabulary of key terms specifying the semantic content of each goal has been used to identify pertinent terms in the analysed texts and to classify the records as thematically related to the SDGs. The SDG controlled vocabulary, which is openly available in the Zenodo[15] repository, crafted by SIRIS Academic during 2019.

For more detail on the methodology and data sources, please see ***Annex II***.

15 *Duran-Silva, N., Fuster, E., Massucci, F. A. & Quinquillà, A.,* A controlled vocabulary defining the semantic perimeter of Sustainable Development Goals, *Version 1.2 [Data set], Zenodo, 2019. https://doi.org/10.5281/ZENODO.3567769.*

1.2. Assessing STI potential and knowledge/competence gaps

The methods and data described in the previous section have been used to link research efforts carried out by Serbian actors to the SDGs and, in turn, to measure the Serbian STI potential to tackle the challenges resulting from the Sustainable Development Goals. Complementally, knowledge and competence gaps have also been identified by comparing two benchmark geographies – EU-27 and EU-13 countries – which serve as indicator baselines.

Gaps and potentials are, by definition, relative: relative between SDG-oriented disciplines, technologies and sectors in Serbia, and/or relative between Serbia and international partners and competitors. According to the availability of national and international data (for publications, projects and patents), and the coverage and quality of this data, different approaches to measuring potential and gaps have been used in this analysis.

When data is available for Serbia and other countries, the gap and potential analysis is performed by comparing Serbia with EU-27 and EU-13 countries. This gap and potential analysis will rely on the computation of the specialisation index[16] – assuming there is a knowledge gap for SDG goals where Serbia presents a lower specialisation index with respect to the EU baselines, and a knowledge potential when Serbia presents a higher or comparable specialisation index with respect to the EU baselines.

Gaps and potentials should be read in relation to the main challenges resulting from the SDGs in Serbia, previously identified via the documentary analysis and the statistical indicator assessment of this study. In this sense, a Serbian STI not sufficiently active in higher-priority goals (as indicated by lower specialisation indexes) may be an indication of a need for international collaboration and/or policy measures supporting the development and use of STI for the achievement of the SDGs.

When data is sparse (i.e. when the total outputs produced by the entity of interest is too low), the specialisation index may suffer from considerable fluctuations. For this reason, in some cases the gap and potential analysis will rely on rankings and the distribution of activities by goal and by other taxonomies such as scientific disciplines (subject areas) or Horizon 2020 programmes. As an illustration, Serbian publications in Goal 16. Peace, Justice and Strong Institutions' represent 1.7% of all publications in Serbia, this goal ranking 10th among the 17 SDG goals. In comparison, Goal 16-related publications represent 2.0% of the total in EU-27 countries, ranking 7th, which indicates a probable knowledge gap in relation to the EU in topics related to this goal.

Lastly, the notion of potentials and gaps goes hand in hand with that of excellence. The question here is, in fact, not only to understand whether there exists critical mass to tackle the most pressing SDG challenges within the Serbian STI ecosystem, but also whether the ecosystem possesses the necessary capacities to address them. Excellence is, however, an even more elusive concept than potential/gaps, one which in the current context can only be indirectly related to bibliometric impact, for publications, and to the capacity of Serbian actors to obtain Horizon 2020 funding – a high-quality threshold for any organisation.

16 *The specialisation index, also known as the 'location quotient', measures how much a certain entity of interest (either a specific institution or a geographical aggregation) is specialised in a given domain with respect to a given baseline. The specialisation is computed by normalising the share of output produced in the domain of interest by the entity over the share of output of the baseline (usually a larger geography).*

1.3. Interpretation and orientations

Addressing societal challenges is an effort grounded on the social, economic and cultural context of societies[17]. SDG-related STI capacities may be available, and actors may promote the development and adoption of SDG-oriented advancements resulting from science and innovation, but the existence of dysfunctional social realities (such as inequality, discrimination or an ineffective public sector) could very well hamper the adoption or widespread dissemination of such solutions. One example would be the lower health outcomes, educational attainment and employment levels of ethnic minority populations in many countries.

SDGs need to be translated into local realities. The strong effort by the EU[18], the UN and other organisations in supporting the 'localisation' of the SDGs, as read on the Local2030 platform[19], demonstrates that 'The success of the 2030 Agenda for Sustainable Development hinges on effective collaboration between all relevant actors. Knowledge, resources, skills and partnerships will need to be mobilized on an unprecedented scale to implement all of the 17 Sustainable Development Goals (SDGs).'

SDG improvement opportunities and development pathways may very well stem from STI capacities, but an orchestrated societal effort will be necessary to adopt and deploy them at scale. Smart specialisation, with its participatory and bottom-up approach, can be a good methodology for the engagement of STI actors, as well as public administration and citizenship, in SDG-oriented innovations and transformations.

Smart specialisation and the STI for SDG roadmapping are, above all, collective human efforts to connect and mobilise actors in the exploration, discovery and exploitation of innovation opportunities and sustainable development pathways, within the knowledge economy.

Data, analytical reports, and experts' insights are only a foundation to optimise stakeholder engagement in the entrepreneurial discovery process, a continuous activity that spans the establishment of the strategies, but also their implementation, refinement and participatory monitoring.

In this framework, the outputs of this project are designed to facilitate empowerment and appropriation by the Serbian and international quadruple helix stakeholders that will establish and implement S3 strategies and STI roadmaps, and, more generally, economic, innovation ecosystem and policy transformations.

17 *See* ***Social Development for Sustainable Development****, Department of Economic and Social Affairs, United Nations, for further material on this question.*

18 *For instance, with the recently published* European Handbook for SDG Voluntary Local Reviews.

19 ***https://www.local2030.org/***

2. Analysis of the challenges resulting from the SDGs in Serbia

This chapter aims at answering two main research questions:

- What are the current national priorities to achieve the Agenda 2030 in Serbia?
- Which challenges resulting from SDG goals and targets are most important in statistical terms?

To answer them, two complementary analyses have been performed:

1. a documentary analysis of authoritative SDG-related assessments, policy and strategy documents[20] in Serbia, and
2. a statistical assessment of the key challenges resulting from the SDGs[21].

Both analyses are presented in the following two sections, respectively, while the interpretation of both collectively constitutes the final section of this chapter.

2.1. Results of the overview of national priorities for the implementation of the Agenda 2030 indicated in policy documents, strategies and other relevant documents

The main objective of this analysis is a qualitative identification of the main (highest-priority) challenges in Serbia as expressed by authoritative sources agreed with the Serbian Ministry of Education, Science and Technological Development. Nevertheless, at the time of writing this study, the Republic of Serbia had not published any document establishing an official prioritisation of challenges resulting from the SDGs in Serbia. With this in mind, a methodology has been designed to identify those challenges which gained higher attention in documents issued by national and external authoritative and expert sources – i.e. State agencies, agencies of the United Nations or specialised think tanks. This four-step methodology is presented hereunder.

1. **Selection of pertinent documents.** After a thorough revision of candidate documents, the final selection is made of those which match the following criteria:

20 *The selection of documents has been performed and validated with national representatives.*

21 *United Nations,* Global indicator framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development, *Retrieved 15 December 2019 from* ***https://unstats.un.org/sdgs/indicators/indicators-list/****.*

a. have an encompassing perspective of the SDGs[22]; and

b. are authored by an authoritative source.

The final selection of documents is presented in the *Table 5.*

2 Review of the selected documents by identifying the main topics and challenges connected to SDGs, as indicated in key sections of the document (i.e. introductory chapter, executive summary or conclusions) in order to confirm their priority status (also verified by the government representatives).

3 Matching of the challenges identified in the previous step with specific SDG targets and goals.

One challenge is considered to match an SDG target if they are connected conceptually by a broad or specific relation. It was achieved by the expert assessment as a degree of interpretation is required in each case.

4 Aggregation into a single indicator of the results of the analysis for the three documents. To do so, for each SDG and each selected document, we computed the ratio between the number of targets indicated as a priority for the policy document and the total number of targets of that SDG (to control for the upward bias that could be generated by the SDG with more targets). This ratio provides the relative indication for each SDG in each document analysed. Lastly, an average indication rate is computed for each SDG so that SDGs can be ranked according to their level of indication in the three documents.

TABLE 5 *Selection of documents*

Year	Document	Authored by
2019	Voluntary National Review of the Republic of Serbia on the Implementation of the 2030 Agenda for Sustainable Development	Inter-Ministerial Working Group for the Implementation of the 2030 Agenda in Serbia (IMWG)
2019	Policy Support for Advancing SDG Progress in Serbia – Promoting Inclusive and Sustainable Growth 'Leaving no-one Behind'	Inter-agency UN MAPS team[23]
2018	Serbia Sustainable Development Issues: A Baseline Review	Center for Advanced Economic Studies (CEVES)[24] and the Swiss Agency for Development and Cooperation (SDC)[25]

22 *This leaves out numerous 'vertical' Republic of Serbia strategies and policy documents, which, although covering areas related to the SDGs (such as education, infrastructures or agriculture), cannot provide a transversal view of the Serbian challenges due to their thematically-limited scope.*

23 *The Inter-agency UN MAPS team gathered 21 international experts from UN agencies, funds and programmes, regional or HQ offices including the UNDP, UNICEF, UNESCO, UNECE, UNFPA, ILO, OHCHR, UNHCR, WHO, Delegation of the European Union to Serbia and the World Bank Country Office in the Republic of Serbia, under the leadership of the UNDP and the UN Economic Commission for Europe in Geneva.*

24 *CEVES is an independent think-and-do-tank dedicated to the sustainable socio-economic development of Serbia and the Western Balkans.*

25 *SDC is the agency for international cooperation of the Federal Department of Foreign Affairs. The SDC is responsible for the overall coordination with other federal authorities of development and cooperation within Eastern Europe.*

Table 6 presents the indication rate of each SDG for each reviewed document, and the average for the three.

A highly indicated target and, therefore, a highly indicated SDG has been assessed as more pressing or important challenges by the authors of the specified documents. The analysed policy reports allow us to classify the SDG goals into three levels: highly-indicated (an average indication equal to or above 50%), moderately indicated (between 25% and 50%) and minimally indicated SDGs (below 25% of the average indication). The SDG distribution across the above-mentioned categories is as follows.

TABLE 6 *SDG indication rate by reviewed document*

	Average	Serbian Voluntary National Review	UN Policy Support for Advancing SDG Progress in Serbia	Serbia Sustainable Development Issues: A Baseline Review
1. No Poverty	71%	100%	29%	86%
9. Industry, Innovation and Infrastructure	54%	63%	50%	50%
3. Good Health and Well-being	46%	38%	46%	54%
8. Decent Work and Economic Growth	44%	33%	42%	58%
4. Quality Education	43%	50%	50%	30%
5. Gender Equality	41%	56%	33%	33%
10. Reduced Inequalities	37%	40%	40%	30%
13. Climate Action	33%	0%	60%	40%
7. Affordable and Clean Energy	27%	0%	20%	60%
11. Sustainable Cities and Communities	17%	10%	10%	30%
2. Zero Hunger	13%	13%	0%	25%
6. Clean Water and Sanitation	13%	13%	25%	0%
16. Peace, Justice and Strong Institutions	11%	0%	17%	17%
17. Partnerships for the Goals	11%	26%	5%	0%
15. Life on Land	6%	17%	0%	0%
12. Responsible Consumption and Production	3%	0%	0%	9%
14. Life Below Water	0%	0%	0%	0%

Source: Authors', based on the Agenda 2030 and selected documentation.

Highly-indicated SDGs

Average indication rate between 100% and 50%

The only two SDGs that are highly indicated by the three examined policy reports are SDG 1. No Poverty and SDG 9. Industry, Innovation and Infrastructure. The SDG with a higher average indication ratio in the analysed papers is SDG 1, dealing with a central topic among social issues: poverty. For Serbia, in particular, one of the documents highlights that '10-20% of Serbia's population has been living in income poverty during the past 15 years. Also worrisome is the absolute poverty line, where trends (...) indicate that, in 2017, approximately half a million or 7.2% Serbian citizens could not meet their daily needs' (UN Policy Support for Advancing SDG Progress in Serbia, pp. 29-30).

For SDG 1, the policy documents specifically underline the SDG **Targets 1.2** 'By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions' and **1.3** 'Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable'.

The other SDG in the highly indicated category, SDG 9, tackles the areas of industry, innovation and infrastructure. With regard to innovation, according to the policy documents, 'Complete[ing] the transition to a more competitive financing model for R&D / scientific projects should be a strong priority, including a new call for proposals for scientific projects' (UN Policy Support for Advancing SDG Progress in Serbia, p. 68). With regards to infrastructure, the reviewed documents state that 'Serbia's transport infrastructure is neither the generator of transit income that it once was, nor the facilitator of quality growth that it could and should be' (Serbia Sustainable Development Issues: A Baseline Review, p. 39).

Among the SDG 9 targets, those that receive more attention from the analysed documents are **SDG Target 9.3** 'Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets' and **9.4** 'By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities'. In fact, they are the only targets that can be clearly matched with the identified challenges for all of the analysed policy documents.

Moderately indicated SDGs

Average indication rate between 50% and 25%

The SDGs in the 'moderate' category indicate a diversity of topics, from social issues such as education, health, income and gender inequality to climate action and sustainable energy. However, those dealing with social problems (SDGs 3, 8, 4, 5 and 10) have, within the group, a higher policy indication than the two dealing with environmen-

tal sustainability (SDG 13. Climate Action and SDG 7. Affordable and Clean Energy).

Among these moderately indicated SDGs, the targets that stand out the most in the reviewed policy documents are the following. For SDG 3, SDG **Target 3.2** 'By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births' and **3.7** 'By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes'.

For SDG 8, **Targets 8.3** 'Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services'; **8.5** 'By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value'; and **8.6** 'By 2020, substantially reduce the proportion of youth not in employment, education or training'.

For SDG 4, **Targets 4.2** 'By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education'; **4.3** 'By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university'; and **4.4** 'By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship'.

For SDG 5, **Targets 5.3** 'Eliminate all harmful practices, such as child, early and forced marriage and female genital mutilation' and **5.6** 'Ensure universal access to sexual and reproductive health and reproductive rights as agreed in accordance with the Programme of Action of the International Conference on Population and Development and the Beijing Platform for Action and the outcome documents of their review conferences'.

For SDG 10 **Targets 10.2** 'By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status'; **10.3** 'Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and action in this regard'; and **10.4** 'Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality'.

Lastly, for SDGs 13 and 7 there are no other specific SDG targets more frequently indicated by the three analysed policy documents.

Minimally indicated SDGs

Average indication rate between 25% and 0%

Lastly, the group of minimally indicated SDGs is also very heterogeneous, including SDGs related to sustainability (Sustainable Cities and Communities, Life on Land, Life Below Water), but also other topics such as Zero Hunger; Peace, Justice and Strong Institutions; and Partnerships for the Goals.

Non - indicated SDGs

None of the analysed documents underline SDG 14. Life Below Water. The fact that Serbia is a landlocked country could be an explanation for it, as highlighted in other works such as 'Serbia and Agenda 2030'.

2.2. Results of the statistical assessment of the key challenges resulting from the SDGs on the basis of international and national data sources covering the indicators for SDG goals and targets

The construction of a dataset of SDG goal- and target-level statistical indicators has enabled the quantification of Serbia's statistically measurable social, environmental and institutional challenges. To discern which indicators/targets/goals may need special attention (gap analysis), in identifying the main challenges resulting from the SDGs in statistical terms, each indicator has been compared to a reference value integrating the EU-27 benchmarks. The data on the official indicators as defined in the UN Agenda 2030 has been obtained from the United Nations' Global SDG Indicators Database[26]. The result has been the creation of a database of available UN SDG indicators for Serbia and the EU-27 countries for the 2014-2017 period, inclusive of both[27].

The distance to frontier score has been selected to characterise the distance of a country to the 'frontier', which represents the best performance observed on a dataset – in this case, the best performing EU-27 countries[28] in any given SDG target indicator. Proceeding in this manner, it is possible to assess how far Serbia is from achieving each of the SDGs, in comparison to the leading EU countries[29].

The following figure shows the median distance in the statistical indicators of each SDG goal compared to the EU-27 frontier (TOP10% countries). The median distance is bounded into a range from 0 to 100: 100 being the maximum gap between the EU-27 frontier and Serbia, and 0 an equal performance in the SDG between TOP10% EU-27 performers and Serbia (0 means the absence of a gap). The results of this analysis are contained in the table below.

From *Table 7*[30] we can classify the SDGs into three categories: those with a larger gap between the leading EU countries (a distance to frontier from 85 to 100), those with a medium-sized gap (from 56 to 84) and those with a smaller gap (from 0 to 55). In the following figures we show the distribution of the SDGs across the three categories.

26 *United Nations, United Nations Global SDG Indicators Database. Retrieved 15 December 2019 from* ***https://unstats.un.org/sdgs/indicators/database/****.*

27 *For further details on data availability and processing, see* ***Annex 2****.*

28 *The frontier value has been established as a value marking the 10th percentile of the indicator's distribution for the EU-27 countries.*

29 *For further details on the methodology, see* ***Annex 2****.*

30 *For further details, a table with the distance to frontier values at target level is provided in Additional material: SDG indicators at target level – Statistical assessment of the challenges resulting from the SDGs in Serbia.*

TABLE 7 *Median distance to frontier (TOP10%) compared to the EU-27 by goal*

↑ SDGs presenting a wider statistical gap between Serbia and leading EU countries	10. Reduced Inequalities	100
	6. Clean Water and Sanitation	98
	3. Good Health and Well-being	97
	8. Decent Work and Economic Growth	95
	9. Industry, Innovation and Infrastructure	88
	17. Partnerships for the Goals	82
	4. Quality Education	82
	7. Affordable and Clean Energy	79
	1. No Poverty	77
	11. Sustainable Cities and Communities	69
	2. Zero Hunger	52
	16. Peace, Justice and Strong Institutions	51
	5. Gender Equality	39
	15. Life on Land	32
	13. Climate Action	26
	12. Responsible Consumption and Production	21
	14. Life Below Water	Not indicated

Source: Authors', based on the United Nations' Global SDG Indicators Database.

Attention: A wide relative gap to EU leaders does not necessarily mean a worrying situation in absolute terms (and vice versa). That is the case for Target 16.9 ('By 2030, provide legal identity for all, including birth registration'), in which Serbia is in the last position in comparison to the EU-27, but in absolute value the situation is not particularly adverse. In particular, 99.4% of Serbian births were registered with a civil authority in 2014, close to the 100% of birth registration in all EU-27 countries in the same year.

Larger gap between leading EU countries

Distance to frontier between 100 and 85

In the figure above we list the SDGs in which Serbia is, in relative terms, further from the EU-27 frontier. We see that most of them are related to different dimensions of well-being (reduced inequalities, access to clean water and sanitation, good health and decent work), and also includes SDG 9. Industry, Innovation and Infrastructure.

Among these SDGs, the targets with a larger gap compared to the top EU-27 performers, which we will define as a distance to frontier of 75 or higher[31], are the following. For SDG 10. Reduced Inequalities, the targets with a larger distance to frontier are:

- **10.4** 'Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality';
- **10.6** 'Ensure enhanced representation and voice for developing countries in decision-making in global international economic and financial institutions in order to deliver more effective, credible, accountable and legitimate institutions';
- **10.a** 'Implement the principle of special and differential treatment for developing countries, in particular least developed countries, in accordance with World Trade Organization agreements';
- **10.c** 'By 2030, reduce to less than 3 per cent the transaction costs of migrant remittances and eliminate remittance corridors with costs higher than 5 per cent'.

For SDG 6. Clean Water and Sanitation, the targets with a larger distance to frontier are:

- **6.1** 'By 2030, achieve universal and equitable access to safe and affordable drinking water for all';
- **6.2** 'By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations';
- **6.6** 'By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes'.

In this context, indicator **6.3.1** 'Proportion of domestic and industrial wastewater flows safely treated' under Target **6.3**[32], currently in the SDG database of the Statistical Office of the Republic of Serbia[33] but not in this study due to the lack of enough benchmark values, provides a concrete example of the current situation of SDG 6 in Serbia: in 2017, only 12.6% of the population was connected to wastewater treatment with at least secondary treatment. On the other hand, it should be noted that even if Serbia has the highest proportion of the population practising open defecation in rural areas (indicator **6.2.1**) compared with EU-27 countries – leading to a distance to frontier of 100- – in absolute value it is notably close to the latter. In particular, 0.18% of the Serbian population in rural areas practised open defecation in 2017, arguably as close to its eradication as it is in all EU-27 countries.

31 *The 75 threshold lies in the fact that it corresponds to the median distance to frontier, so we only consider those targets which have a distance to frontier above the median.*

32 *Which states 'By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally'.*

33 *Statistical Office of the Republic of Serbia, SDG Database indicator 6.3.1 Proportion of wastewater safely treated, 2017. Retrieved 2 April 2020 from* ***https://data.stat.gov.rs/Home/Result/SDGUN060301?languageCode=en-US****.*

For SDG 3. Good Health and Well-being, the targets with a larger distance to frontier are:

- **3.1** 'By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births';
- **3.2** 'By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births';
- **3.4** 'By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being';
- **3.8** 'Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all';
- **3.9** 'By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination';
- **3.a** 'Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries, as appropriate';
- **3.c** 'Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing States';
- **3.d** 'Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks'.
- Indicator **3.1.1** provides a more precise picture of the current situation in Serbia regarding SDG 3. In 2015, the maternal mortality ratio in Serbia was 17 per 100 000 live births, being the highest compared to EU-27 countries – which have an average mortality of 8.8 per 100 000 live births in the same year. It should be noted that even if Serbia is at the bottom of the pile in the proportion of births attended by skilled health personnel (indicator **3.1.2**) with a distance to frontier of 94, in absolute value it is notably close to that of EU-27 countries. In particular, 98.4% of Serbian births were attended by skilled health personnel in 2014, compared to 99.1% of births attended on average in EU-27 countries in the same year.

For SDG 8. Decent Work and Economic Growth, these targets are:

- **8.2** 'Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors';
- **8.5** 'By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value';
- **8.6** 'By 2020, substantially reduce the proportion of youth not in employment, education or training';
- **8.10** 'Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all'.

In this context, indicator **8.6.1** provides an example of the current situation in Serbia. In 2017, 17.6% of Serbian youth was not in education, employment or training, being the highest proportion compared with EU-27 countries – having an average of 10.16% for the same indicator.

Lastly, for SDG 9. Industry, Innovation and Infrastructure, the targets with a larger distance to frontier are:

- **9.1** 'Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic

development and human well-being, with a focus on affordable and equitable access for all';

- **9.4** 'By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities';

- **9.5** 'Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending';

- **9.b** 'Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities'.

- It must be noted that there is room for improvement for the Serbian economy in its transition towards a low carbon economy. In 2016 in particular, Serbia emitted 0.49 kilograms of CO2 per unit of GDP compared with an average of 0.2 kilograms emitted by EU-27 countries. This measurement corresponds to indicator **9.4.1**, which has a distance to frontier of 100.

Medium-sized gap between leading EU countries

Distance to frontier between 84 and 56

The group of topics where Serbia's gap compared to EU leading countries is classified as medium-sized is the most diverse, including education, poverty, strong institutions, affordable and clean energy or sustainable cities and communities.

Among these SDGs, the following targets present a larger distance to the frontier compared to the EU-27 leading countries. For SDG 4. Quality Education, Targets **4.3** 'By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university' and **4.4** 'By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship'. Indicator **4.3.1** provides further details of the current situation in Serbia concerning SDG 4. In 2016 in particular, the participation rate in formal and non-formal education and training by both sexes in Serbia was 19.8%, being the highest compared to EU-27 countries – which have an average of 43% for the same indicator.

For SDG 17. Partnerships for the Goals, the targets with a larger distance to frontier are **17.6** 'Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge-sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism'; **17.8** 'Fully operationalize the technology bank and science, technology and innovation capacity-building mechanism for least developed countries by 2017 and enhance the use of enabling technology, in particular information and communications technology'; and **17.19** 'By 2030, build on existing initiatives to develop measurements of progress on sustainable development that complement gross domestic product, and support statistical capacity-building in developing countries'.

For SDG 7. Affordable and Clean Energy, the target with a larger gap compared to EU-27 leading countries is **7.3** 'By 2030, double the global rate of improvement in energy efficiency'.

For SDG 1. No Poverty, the targets facing a larger gap are **1.2** 'By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions' and **1.a** 'Ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation, in order to provide adequate and predictable means for developing countries, in particular least developed countries, to implement programmes and policies to end poverty in all its dimensions'.

Lastly, for SDG 11. Sustainable Cities and Communities, the targets with a larger distance to the frontier are **11.1** 'By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums' and **11.6** 'By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management'. Indicator **11.1.1** provides a more precise picture of the current situation in Serbia concerning the sustainability of its cities and communities. In 2016 in particular, 3.6% of the urban population was living in slums, compared to no population living in this condition in the leading EU-27 countries.

Smaller gap between leading EU countries

Distance to frontier between 55 and 0

The goals for which Serbia's performance converges the most with the leading EU countries are environment-oriented are as follows: Life on Land, Climate Action and Responsible Consumption and Production patterns. In terms of social-related topics, the SDGs for which Serbia is closer to the leading EU countries are Gender Equality; Peace, Justice and Strong Institutions and Zero Hunger.

Among these SDGs, the targets under SDG 16. Peace, Justice and Strong Institutions present a larger distance to the frontier in comparison to the EU-27 leading countries. In particular, these targets are **16.8** 'Broaden and strengthen the participation of developing countries in the institutions of global governance' and **16.9** 'By 2030, provide legal identity for all, including birth registration'.

2.3. Comparison of the two analyses and identification of a single set of key challenges

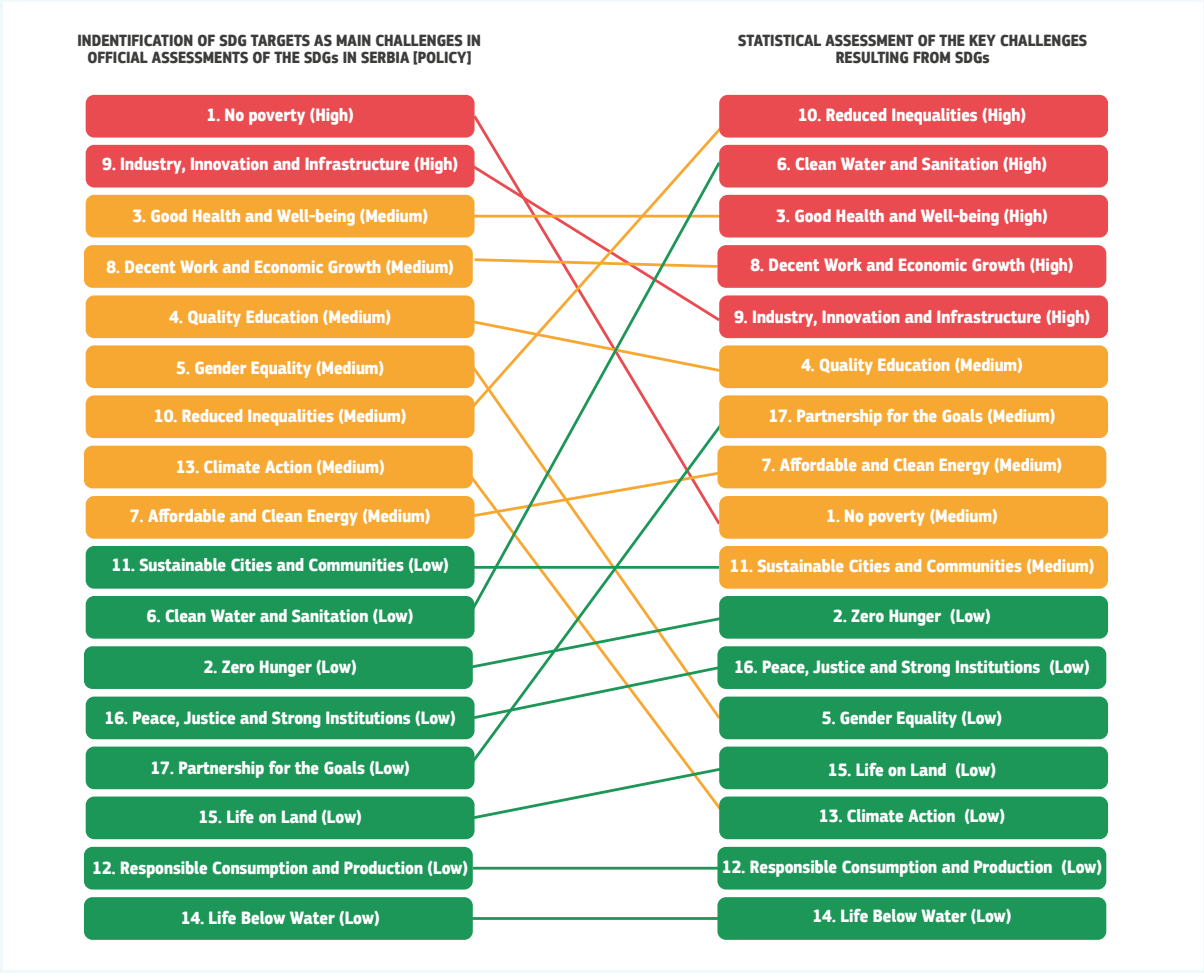
As a summary of the results of the analysis, ***Figure 4*** presents, in parallel, the SDGs identified as key challenges in official assessments of SDGs in Serbia and those resulting from the statistical analysis (the SDGs where Serbia is in a worse relative position).

A single ranking to support the prioritisation emerging from the two analyses is based on the following composite indicators:

- the average rank of each SDG in both analyses,
- the direct sum of the average indication in policy documents and the distance to frontier in the statistical assessment,
- the weighted sum of the average indication in policy documents and the distance to frontier in the statistical assessment.

According to the distribution of the SDGs in each of these three composite indicators, the goals have been qualitatively categorised into the three priority levels based on the aggregate quantitative results of the previous analyses, as shown in the ***Table 8***. Please note that the order of the individual goals within a priority level is not indicative; it only responds to the ordinal in the SDG list.

FIGURE 4 *Distribution of the goal priority ranking between the official documents and the statistical assessment*



Source: Authors', based on selected documentation and the United Nations' Global SDG Indicators Database.

Figure 4 (a parallel chart) shows rather good alignment between the two analyses for 11 out of 17 SDGs – those where the rank in both columns remains constant or changes by up to three positions. At the higher end of the distribution, this is the case for SDGs 3, 4, 8 and 9, which are in high positions in both rankings, presenting consistency between the analysed documentation and the statistical assessment.

Summarizing the results with the focus on the coherence of the documentary and statistical analyses, it can be concluded that the following goals are key challenges resulting from the SDGs in Serbia:

- SDG 3. Good Health and Well-being
- SDG 4. Quality Education
- SDG 8. Decent Work and Economic Growth
- SDG 9. Industry, Innovation and Infrastructure.

On the contrary, there are six SDGs with rather poor alignment between the two analyses carried out: SDGs 1, 5, 6, 10 and 17. Out of these six, only three – SDG 1, SDG 6 and SDG 10 – appear in top-ranking positions in either analysis, and only 1 and 10 are in the top 5 in the second figure. SDG 1. No Poverty appears in top position in the assessment of policy reports, and SDG 10. Reduced Inequalities in the statistical assessment. When inspecting the description of the targets for these

two goals, it is considered that SDG 1 and SDG 10 are closely related, both of them covering the threat of social exclusion from complementary angles: SDG 1 deals with absolute and relative economic poverty, social inclusion policies and equal access to economic resources. SDG 10 focuses on economic inequality, policies promoting social protection and fighting against discrimination. They are indeed highly interrelated SDGs, and while SDG 1 is not amongst the SDGs with the larger gap and SDG 10 is not highly indicated, together they tackle a challenge where Serbia faces a large gap in comparison to EU-27 leaders and which, at the same time, appears to be highly indicated by the reviewed policy reports.

TABLE 8 *SDG prioritisation from the documentary analysis and the statistical assessment*

HIGHER-PRIORITY CHALLENGES	1 No Poverty
	3 Good Health and Well-being
	4 Quality Education
	8 Decent Work and Economic Growth
	9 Industry, Innovation and Infrastructure
	10 Reduced Inequalities
MEDIUM-PRIORITY CHALLENGES	5 Gender Equality
	6 Clean Water and Sanitation
	7 Affordable and Clean Energy
	11 Sustainable Cities and Communities
	17 Partnerships for the Goals
LOWER-PRIORITY CHALLENGES	2 Zero Hunger
	12 Responsible Consumption and Production
	13 Climate Action
	14 Life Below Water
	15 Life on Land
	16 Peace, Justice and Strong Institutions

Source: Authors', based on selected documentation and the UN Global SDG Indicators Database.

Thus, it is concluded that SDG 1. No Poverty and SDG 10. Reduced Inequalities are both key challenges resulting from the SDGs in Serbia, and are highly interconnected.

For the higher-priority SDGs (1, 3, 4, 8, 9, 10) identified above, ***Table 9*** presents the targets which have been highly indicated in the documentation and also present a high statistical distance to frontier vis-à-vis the EU-27 leaders. This list gives a more granular view of the specific challenges resulting from the SDGs in Serbia in the higher-priority SDGs. Nevertheless, it must be noted that major targets may be missing from this priority list due to the lack of indicators to perform the

TABLE 9 *Highly-indicated SDG targets by both the documents and the statistical assessment*

SDG	Target ID	Target name
1	1.2	By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions
3	3.2	By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births
4	4.3	By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university
	4.4	By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship
8	8.5	By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value
	8.6	By 2020, substantially reduce the proportion of youth not in employment, education or training
9	9.4	By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities
10	10.4	Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality

Source: Authors', based on selected documentation and the UN Global SDG Indicators Database.

statistical assessment[34]. To complement this information and for further detail, the collaboration networks and lists of main actors can be found as stand-alone documents; please see the section 'Structure of the report and additional material' in ***Chapter 1***.

Beyond the higher-priority goals, SDG 6. Clean Water and Sanitation ranks 2nd in the statistical assessment as a goal where Serbia is very far behind the EU-27 leaders. Nevertheless, in the analysis of policy documents, it appears as a minimally indicated SDG. However, from the aggregate analysis it cannot be concluded that this is currently a key challenge for the country. In three SDG 6 targets, Serbia is faring worse in comparison to the EU-27 leaders: Target 6.1 'By 2030, achieve universal and equitable access to safe and affordable drinking water for all'; Target 6.2 'By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations'; and Target 6.6 'By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes'.

The statistical assessment also shows challenges in social-related topics within goals that are not classified as high-priority. These topics range from housing rights and basic services provision (Goal 11) to the provision of legal identity for all citizens (Goal 16). As an illustration of these challenges, in 2016, 3.6% of the urban population in Serbia was living in slums, compared with no population living in this condition in the leading EU-27 countries. These findings are reinforced by the policy assessment, where social challenges within Goal 5 – tackling topics in the field of gender equality such as early and forced marriage or reproductive rights – are identified as highly indicated.

Two other challenges presenting a wide statistical gap in comparison to EU-27 leading countries, and emerging from goals not classified as high-priority are: Goal 7. Affordable and Clean Energy and Goal 11. Sustainable Cities and Communities.

Globally, it appears that social (particularly welfare-related) and economic-related Sustainable Development Goals are a more pressing challenge for Serbia. On the contrary, environmental and climate-related goals are generally understood as being lower priority, in the documentation, while Serbia is in a better position in comparison to EU leaders in the statistical assessment.

Nevertheless, individual targets presenting significant challenges in non-higher-priority SDGs may also be the subject of STI policy responses and current opportunities for Smart Specialisation. All of them have been identified in Additional material: SDG indicators at target level – Statistical assessment of the challenges resulting from the SDGs in Serbia.

34 *For further details on the target coverage in the available indicators by goal, see* ***Annex II*** *and Additional material: SDG indicators at target level – Statistical assessment of the challenges resulting from the SDGs in Serbia.*

3. General analysis of the SDG-related STI potential and knowledge/competence gaps

3.1. Transversal analysis

Table 10 presents the size of the analysed data for Serbia and the two baseline geographies (EU-27 and EU-13 countries), as well as the number and share of records that have been classified as thematically related to the SDGs (at least one goal).

In Serbia, 21% of publications, 55% of Horizon 2020 projects, 41% of Innovation Fund projects and 18% of patents are thematically related to the SDGs. The share of publications is very similar to that of EU-13 and EU-27 countries, meaning that the aggregate specialisation of the Serbian scientific community does not differ from that of the benchmarks in terms of SDG orientation.

TABLE 10 *Descriptive statistics by data source and geography of interest*

		Publications[35]	Horizon 2020 projects[36]	Innovation Fund projects[37]	Patents[38]
Serbia	**Total**	31 404	240	172	708
	SDG-related	6 625 (21%)	131 (55%)	70 (41%)	129 (18%)
EU-13	**Total**	506 217	3 985		
	SDG-related	102 149 (20%)	1 927 (48%)		
EU-27	**Total**	3 050 545	19 152		
	SDG-related	651 487 (21%)	7 230 (38%)		

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

35 *Does not include Goal 17. Timeframe 2014-2017.*

36 *Does not include Goals 8, 9 and 17. Timeframe 2014-2019.*

37 *Does not include Goals 8, 9 and 17. Timeframe 2012-2019.*

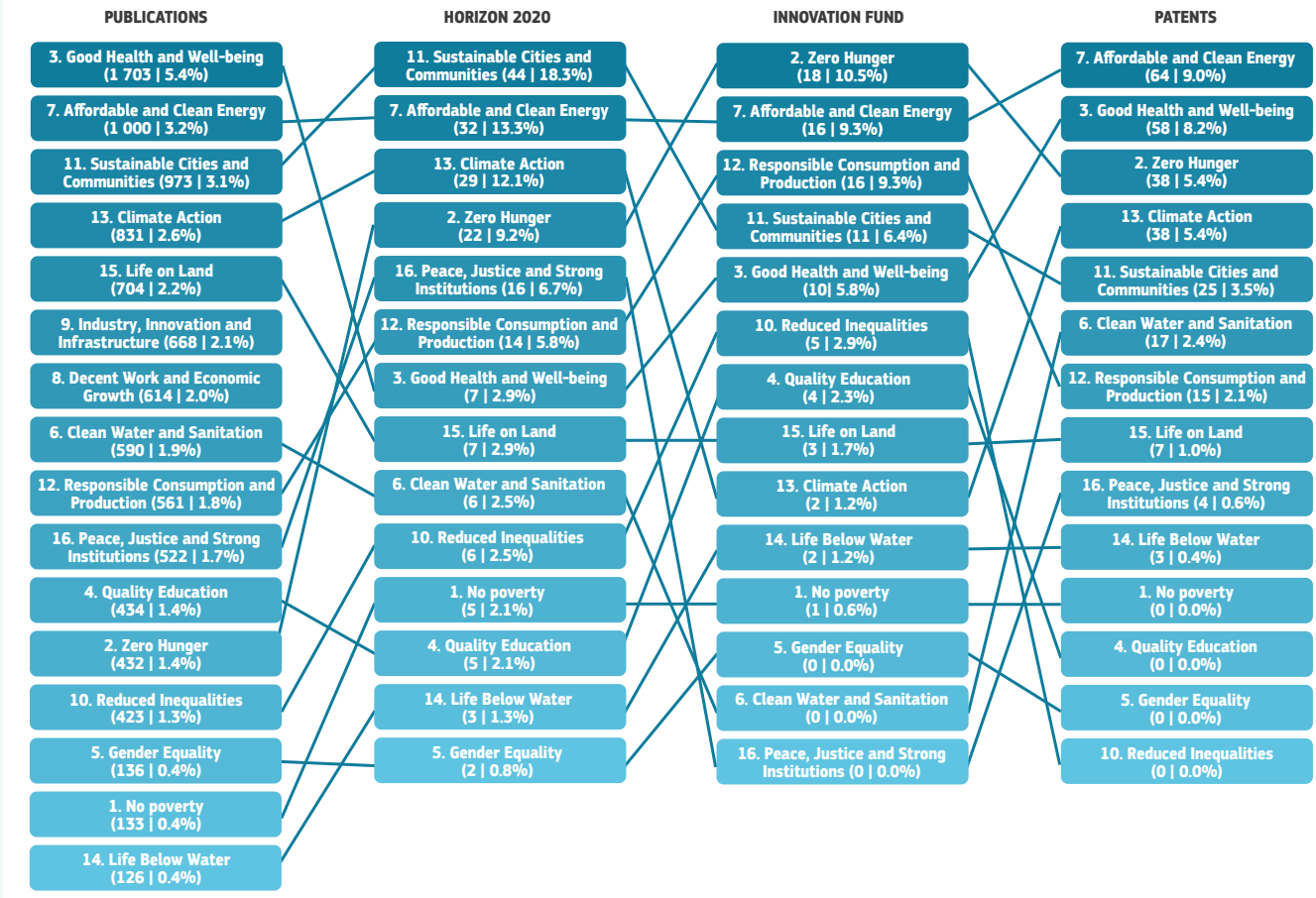
38 *Does not include Goals 8, 9 and 17. Timeframe 2014-2017.*

The share of SDG-related Horizon 2020 projects (55%) is higher than in the EU-13 (48%), and significantly higher than in the EU-27 (38%). This is due to two main reasons: reduced competitivity in the Excellent Science (particularly at the European Research Council, but also in Marie Skłodowska-Curie Actions) and Industrial Leadership pillar calls, and the easier accessibility to the large consortia of Societal Challenges pillar calls. Overall, the orientation of Horizon 2020 to the Sustainable Development Goals is notably high. Horizon 2020 is clearly supportive of STI communities engaged in topics related to the SDGs.

With regard to Innovation Fund projects, 41% have a thematic relation to at least one goal, a high figure, considering that the focus of the funding is to support enterprise and market-oriented innovation.

An initial view of the distribution of STI activities and products thematically related to the Sustainable Development Goals is provided in ***Figure 5***, which ranks the number of documents from the four analysed STI data sources thematically related to each goal.

FIGURE 5 *Distribution of STI activities by goal and data source*



Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

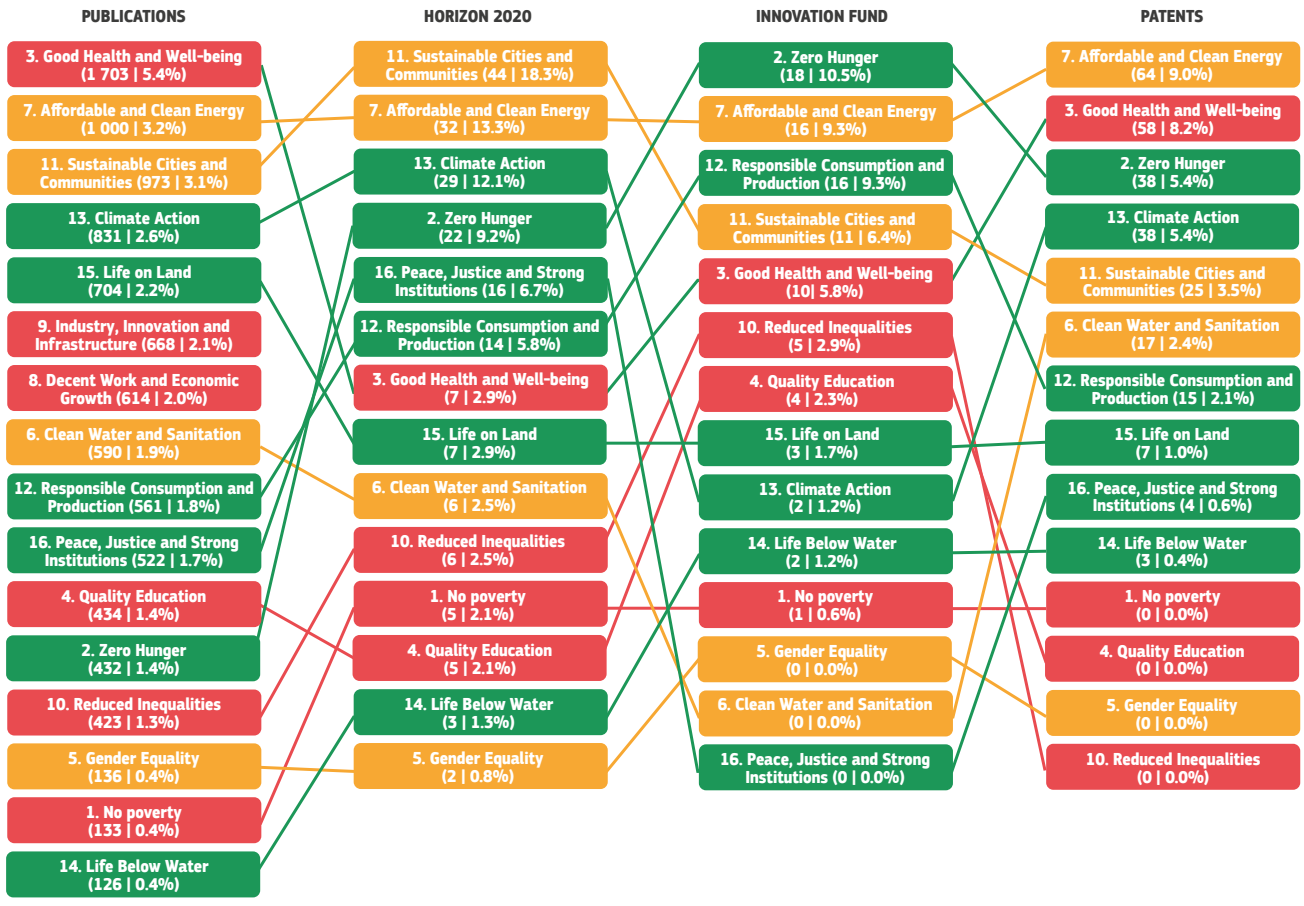
The initial observation is the lack of clear consistency in the ranking of goals between data sources, pointing at different orientations and specialisations. Nevertheless, the top positions tend to be captured by the same goals. It must be noted, however, that some goals have a wider and more varied nature, and not all are equally impacted by science, technology and innovation capacities and developments.

Publications and patents are the best indicator of Serbia's 'bottom-up' scientific and technological SDG-oriented profile. The two top goals in publications and patents are:

- Goal 3. Good Health and Well-being, which is a higher-priority challenge;
- Goal 7. Affordable and Clean Energy, which is a medium-priority challenge.

Beyond publications and patents, Goal 7. Affordable and Clean Energy presents strong STI competitiveness in Horizon 2020 (ranking 2nd) and in enterprise innovation dynamism, ranking 2nd in Innovation Fund grants with 16 projects. Goal 3. Good Health and Well-being ranks quite low in H2020. Goal 2. Zero Hunger ranks at the top of Innovation Fund grants, and is also rather high

FIGURE 6 *Distribution of STI activities by goal (coded by priority level) and data source*



Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

up in patents, ranking 3rd. Lastly, in the top position, Goal 11. Sustainable Cities and Communities ranks 1st in Horizon 2020, and relatively highly in publications and the Innovation Fund (3rd in both).

The parallel chart in ***Figure 6*** presents the same information, but with the goals colour-coded according to their priority level as key challenges in Serbia resulting from the SDGs, as concluded from the assessment of documents and statistical indicators.

Within the higher-priority challenges, Goal 1. No Poverty, Goal 4. Quality Education and Goal 10. Reduced Inequalities present very small publication counts and, due to their non-technical nature, are not related to a single Serbian patent. These goals receive little attention from research and innovation funding agencies: Horizon 2020 supports a few projects (5, 5, 6, respectively) and the Innovation Fund has financed 4 projects related to Goal 4. Quality Education, 5 related to Goal 10 and 1 related to Goal 1.

As such, rather than classical research and innovation policy approaches, to address Goals 1, 4 and 10, new transformative policy frameworks could be explored based on social innovation and policy reform. The scientific communities active working on these topics is rather small, so a larger critical mass and international collaboration may be required to instigate the necessary innovation and policy transformations.

On the contrary, higher-priority socio-economic-oriented Goal 8. Decent Work and Economic Growth and Goal 9. Industry, Innovation and Infrastructure are the subject of sizable scientific activity, as shown by the number of related publications. Due to their socio-economic and policy orientation, not technological in nature, no Horizon 2020 and Innovation Fund projects nor patents have been classified into Goals 8 and 9.

Medium-priority Goal 11. Sustainable Cities and Communities ranks highly in all STI data sources, 3rd in publications, 1st in Horizon 2020 (showcasing the interest of EU funding in this area and the competitive capacity of Serbian actors), 4th in the Innovation Fund (showcasing an active entrepreneurial ecosystem) and 5th in Patents.

Goal 6. Clean Water and Sanitation, also a medium-priority challenge, presents a relatively weak STI ecosystem, with few Horizon 2020 projects and no Innovation Fund grants. Given the priority level of this challenge, and the scientific and patenting activity, more could be expected in terms of R&D funding.

For further detail, the next sections analyse the goals collectively within each of the data sources. Afterwards, a finer-grained STI potential and gap analysis is provided for the six high-priority goals and for Goals 2 and 7, which manifest strong entrepreneurial STI ecosystems and are directly linked to Serbian Smart Specialisation priorities.

3.2. Scientific publications and impact

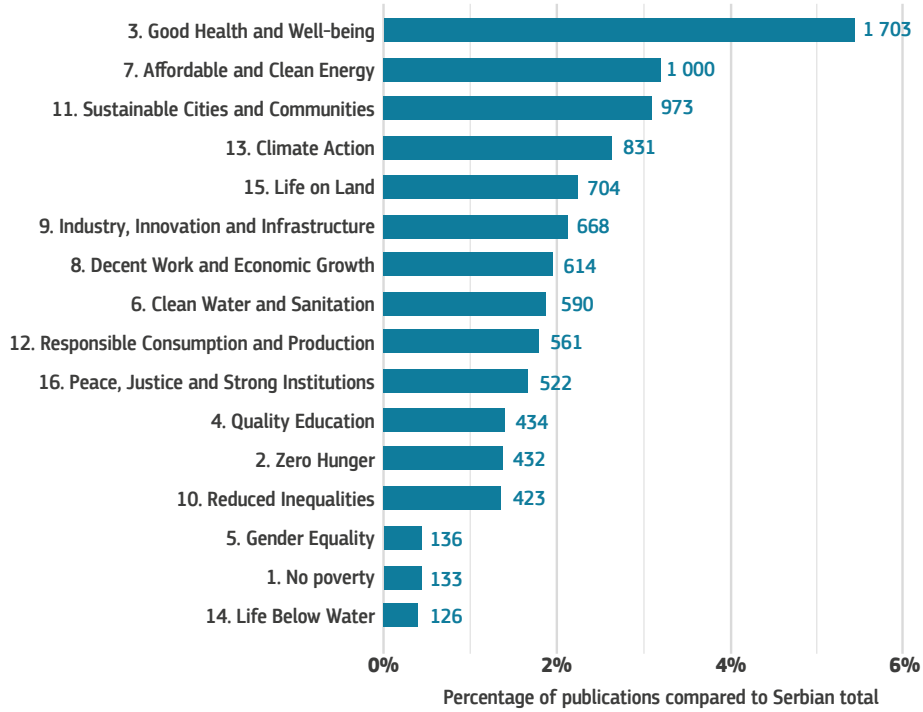
Figure 7 presents the raw number of publications thematically related to each goal in the analysed period, 2014-2017, to provide an initial view of the critical mass of the related scientific communities.

Scientific communities have different sizes and productivity due to historical reasons and different practices. Thus, beyond the number or share of goal-related publications, it is necessary to analyse Serbia's relative specialisation in the SDGs. The following figure presents Serbia's scientific specialisation index ,compared to EU-27 and EU-13 countries, in publications.

Serbia is specialised in comparison to both the EU-27 and EU-13 in seven goals, displaying relative scientific potential in:

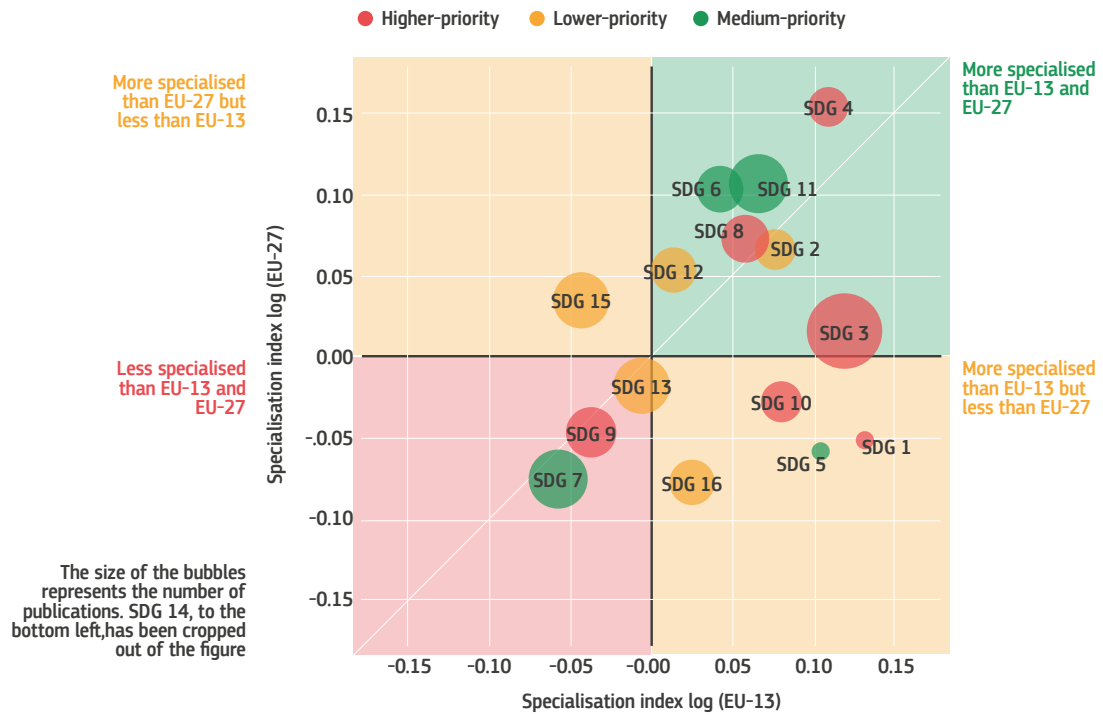
- Goal 2. Zero Hunger
- Goal 3. Good Health and Well-being
- Goal 4. Quality Education
- Goal 6. Clean Water and Sanitation
- Goal 8. Decent Work and Economic Growth

FIGURE 7 *Absolute and relative number of Serbian publications by SDG*



Source: Authors', based on Scopus (Elsevier).

FIGURE 8 *Serbia's specialisation index in publications in comparison to EU-13 and EU-27 by goal*



Source: Authors', based on Scopus (Elsevier).

- Goal 11. Sustainable Cities and Communities
- Goal 12. Responsible Consumption and Production.

Serbia is more specialised than the EU-13, but less so than the EU-27, in four goals, displaying relative scientific potential in comparison to the EU-13 in:

- Goal 1. No Poverty
- Goal 5. Gender Equality
- Goal 10. Reduced Inequalities
- Goal 16. Peace, Justice and Strong Institutions.

It is noteworthy that the relative number of publications related to Goal 16. Peace, Justice and Strong Institutions is very small – the furthest from EU levels of all of the goals.

Serbia is more specialised than the EU-27, but less so than the EU-13, in Goal 15. Life on Land, displaying an STI potential relative to the EU but not to EU-13 countries, which is more similar in socio-economic terms.

Lastly, Serbia is less specialised than the EU-27 and EU-13 baselines in four goals, showcasing a relative scientific activity gap in:

- Goal 7. Affordable and Clean Energy
- Goal 9. Industry, Innovation and Infrastructure
- Goal 13. Climate Action
- Goal 14. Life Below Water.

To gain a perspective of the underlying scientific excellence, two impact indicators have been computed for SDG-related publications, which provide complementary views.

- The % of publications in TOP10% journals, showcasing the share of publications in the best international journals. The average for this indicator for all Serbian publications is 10.2%.
- The normalised citation impact (NCI) of SDG-related publications in comparison to non-SDG-related publications in the same disciplines, which:
  - is above 1 if SDG-related publications are cited more than Serbian publications of the same discipline (subject area);
  - is below 1 if SDG-related publications are cited less than Serbian publications of the same discipline (subject area).

Figure 9 shows that for all but three goals, the NCI is above 1, so Serbian researchers actively working on SDG-related topics are comparatively cited more than their colleagues working in similar areas.

In particular, scientific publications in Goal 3. Good Health and Well-being are much better cited than similar publications not aimed at SDG-related topics. In that sense, steering more health-related scientific activity towards SDG-relevant issues would not, in principle, diminish the impact of Serbian research.

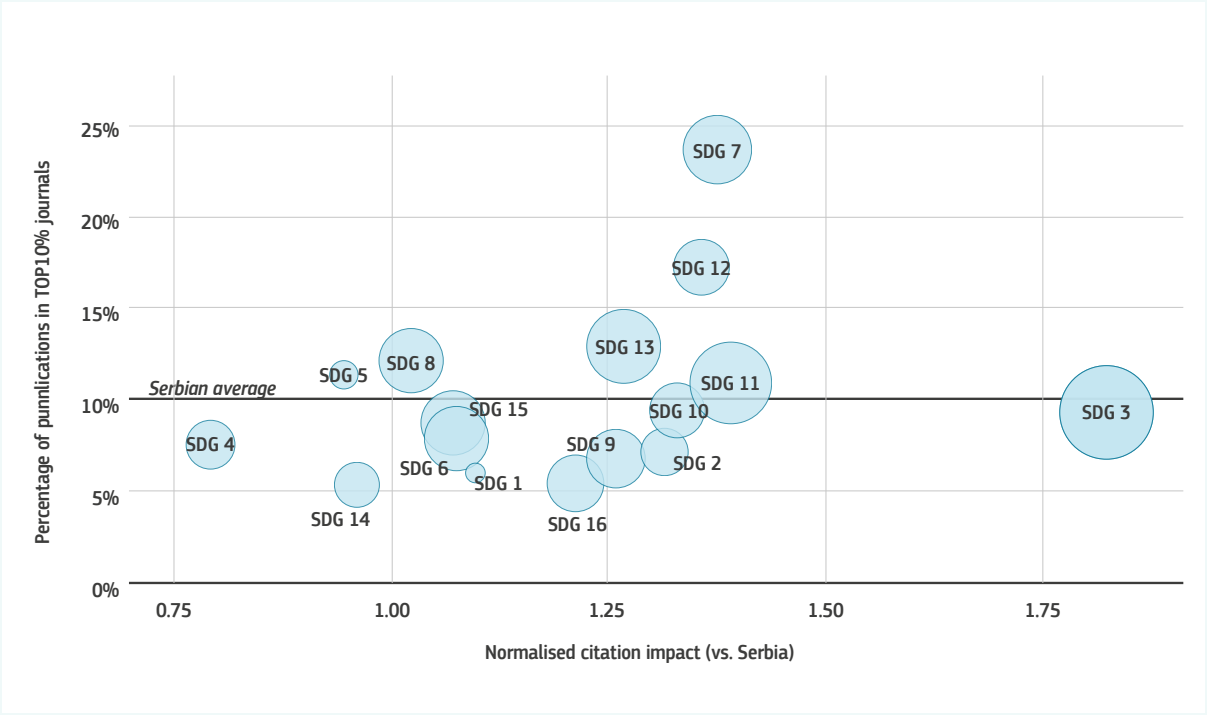
On the contrary, only six goals present a share of publications in TOP10% international journals above the Serbian average of 10.2%, revealing a lack of interest or capacity to publish in the most cited international venues. These above par scientific communities are related to:

- Goal 7. Affordable and Clean Energy
- Goal 12. Responsible Consumption and Production
- Goal 13. Climate Action
- Goal 8. Decent Work and Economic Growth
- Goal 5. Gender Equality
- Goal 11. Sustainable Cities and Communities.

Goal 7 and Goal 12-related publications are very well published, demonstrating excellent scientific communities in the Serbian context.

FIGURE 9

Normalised citation impact (vs Serbia average) compared to the percentage of publications in the TOP10% journals, by goal



Source: Authors', based on Scopus (Elsevier) and the SCImago Journal Rank.

See ***Figure 10*** with the different goals colour-coded according to the priority level of the key challenges.

A rapid glimpse demonstrates that there is no correlation between scientific impact and the goal's priority levels. What is particularly concerning is the low NCI (0.79) of Goal 4-related publications, which means that SDG-oriented scientific activity is worse-cited than similar SDG-unrelated publications. In fact, all high-priority goals, bar Goal 8, present a lower-than-average share of publications in TOP10% journals.

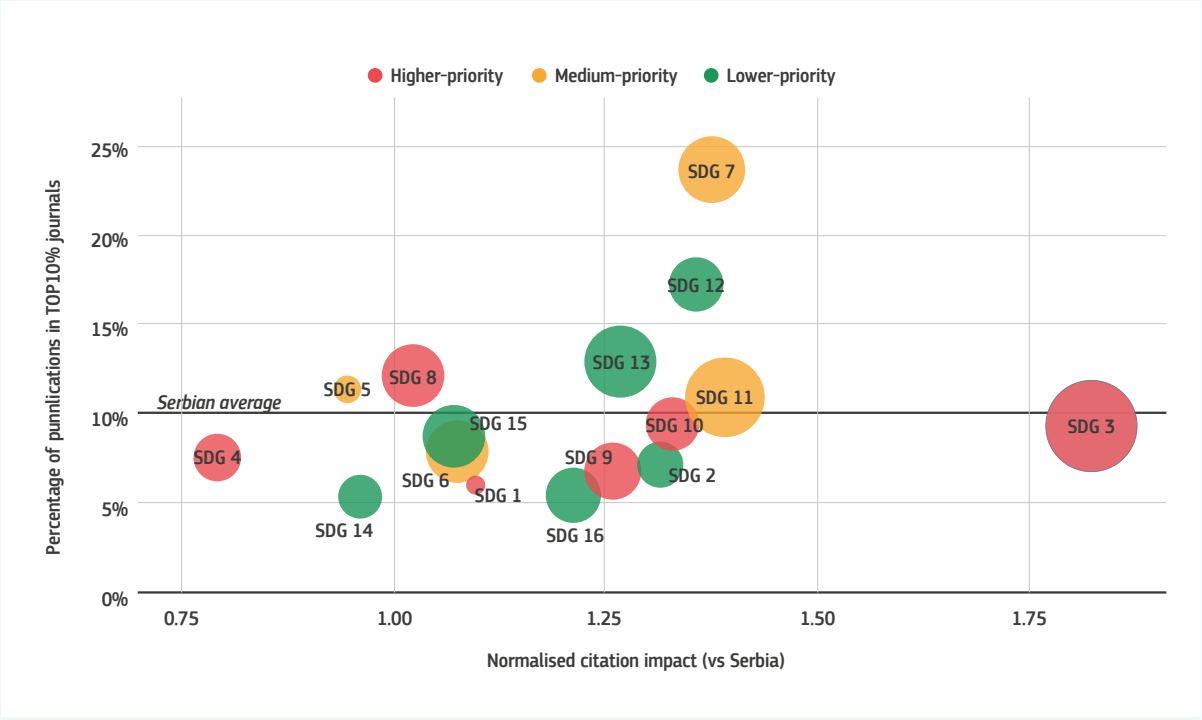
The figures on critical mass, relative specialisation and the impact of scientific publications provide complementary insights on the potentials and gaps in the Serbian SDG-oriented scientific community, supporting long-term science policy decision-making and shorter- and medium-term mobilisation of national and international actors.

3.3. Funding for research and innovation – Horizon 2020 and the Innovation Fund

In this section, STI potential and gaps will be derived from the relative share of SDG-related activities in science and innovation calls for proposals from Horizon 2020 and the Serbian Innovation Fund. As such, the results of the analysis fundamentally depend upon the thematic prioritisation of the funding programmes and on the conditions to access the calls, the following in particular.

- Horizon 2020 is structured under three main pillars: Excellent Science, Industrial Leadership and Societal Challenges. From the rather non-oriented nature of Excellent Science to the clearly thematically-oriented Societal Challenges, actors respond to defined funding priorities, so activities will tend to cluster in areas of European interest and concern. Nevertheless, Horizon 2020 is highly competitive so the fact that Serbian actors have been able to obtain funding

FIGURE 10 *Normalised citation impact compared to the percentage of publications in the TOP10% journals by goal (coded by priority level)*



Source: Authors', based on Scopus (Elsevier) and the SCImago Journal Rank.

demonstrates clear STI capacities as well as international relevance and connections.

- The Innovation Fund is not strongly thematically oriented, but it is aimed at R&D and private innovation. Projects are expected to have a long-term return on investment and support the economic competitiveness of the country. Thus, it can be expected that certain areas of concern of the Sustainable Development Goals with little market pull capacity will be the subject of few Innovation Fund projects.

These caveats must be taken into account when analysing the results of the classification of funded projects into the SDGs. The following parallel chart presents the distribution of Horizon 2020 projects across the goals[39].

It is noteworthy that Serbia has a larger share of Horizon 2020 projects classified into the SDGs than the EU-27 and EU-13 baselines. As will be shown later, this is in part due to the difficulty encountered by Serbian actors (and, notably, EU-13 countries too) in accessing the less-oriented, highly competitive Excellent Science calls.

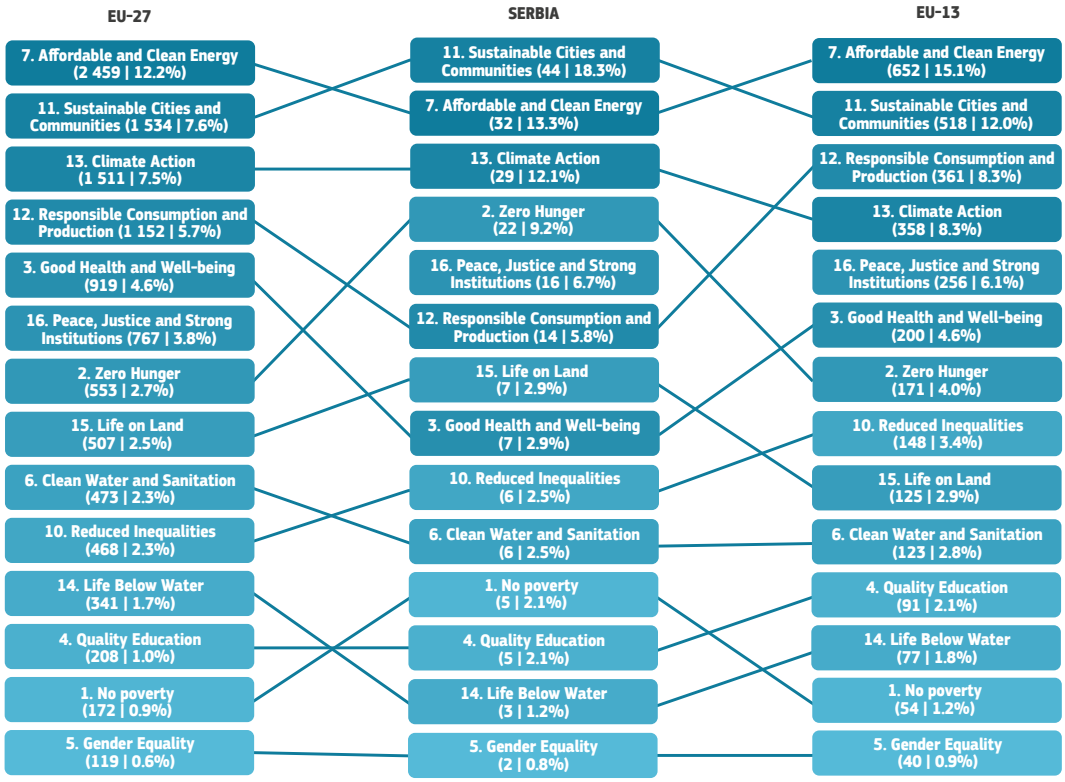
The concentration of Horizon 2020 funding into sustainability challenges is very clear from the overall ranking of SDG-classified projects, with Goals 7, 11, 12 and 13 concentrating the largest share of projects.

The ranking of the different goals across the three geographical areas is quite consistent. Nevertheless, some goals in Serbia are positive outliers, notably:

- Goal 2. Zero Hunger concentrates a very high share of projects in Serbia. This manifests a national orientation and interest, as well as a pocket of excellence, with Serbian actors capable of competing at international level. These capacities are aligned with the Smart Specialisation priority Food for Future, particularly the sub-domain Sustainable Agri-food Production;

39 *Excluding goals 8, 9 and 17.*

FIGURE 11 *Distribution of H2020 projects by goal in each geography of interest*



Source: Authors', based on CORDIS.

- Goal 11. Sustainable Cities and Communities also concentrates funding, within EU-13 countries, in line with the S3 horizontal priority Energy Efficient and Eco Smart Solutions;
- socially-oriented high-priority Goals 1 and 4 relate to a larger share of projects than in the EU-27.

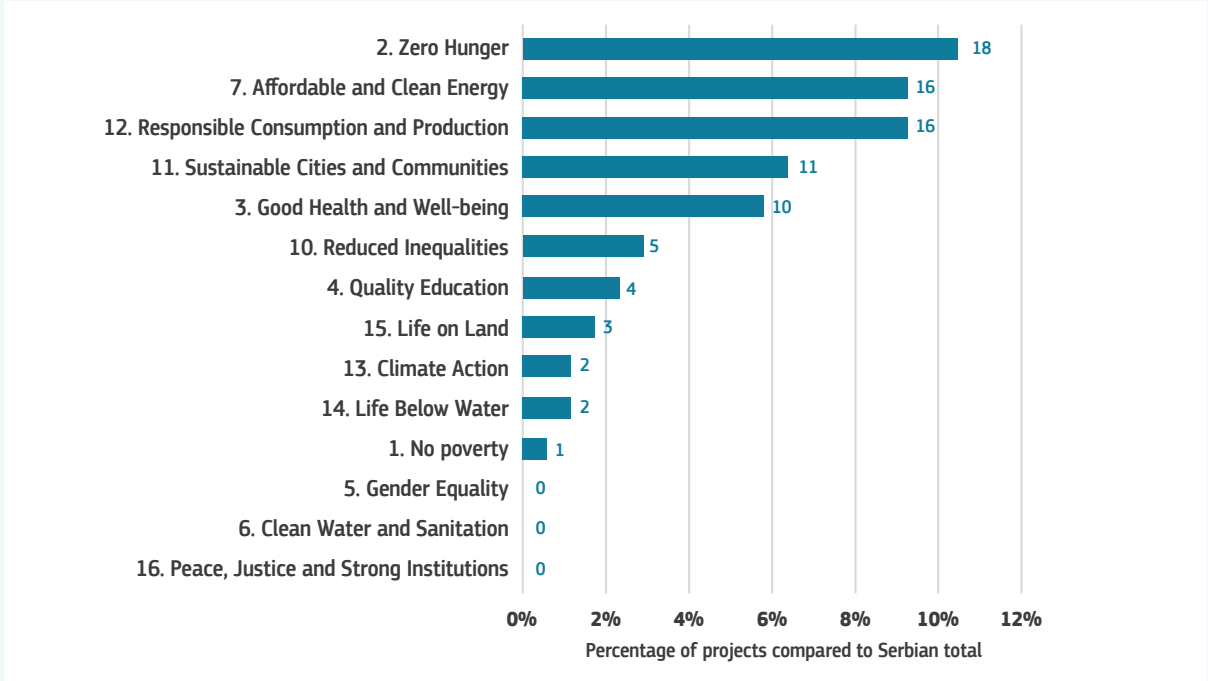
On the contrary, the share of projects in Goal 3. Good Health and Well-being is particularly small (almost 50% of that of the EU-27 and EU-13 baselines). Given the importance of the goal, such a lack of interest or competitiveness by Serbian actors could be a reason for dedicated policy action.

With regard to the Innovation Fund, the following image presents the distribution of projects across the Sustainable Development Goals.

The top three goals by share of projects in the Innovation Fund manifesting entrepreneurial innovation capacity are:

- Goal 2. Zero Hunger
- Goal 7. Affordable and Clean Energy
- Goal 12. Responsible Consumption and Production.

FIGURE 12 *Absolute and relative number of Innovation Fund projects by goal*



Source: Authors', based on Innovation Fund data.

These leading goals are highly aligned with the top SDGs in Horizon 2020, showing consistency. Two of them are also connected to Smart Specialisation priorities: Food for Future and Energy Efficient and Eco-Smart Solutions.

While Goal 2-related projects are concentrated in the agri-food sector, Goal 7 and Goal 12 projects are spread across many sectors, including not only vertical contributions (such as green energy projects in Goal 7 or green packaging in Goal 12), but also the positive impacts in terms of energy efficiency and waste reduction of the innovations in several industries, contributing to the circular economy.

The number of projects in higher-priority Goal 10. Reduced Inequalities points at an interesting area of technological innovation supporting the inclusion of people with disabilities, related to impaired vision, in particular.

The number of projects in Goal 4. Quality Education is also notable, given the social orientation of the goal. The four projects are connected to digital education (interactive platforms, virtual learning environments) showcasing a relationship with Smart Specialisation priorities Information and Communication Technologies and Creative Industries (Video Games and Interactive Content).

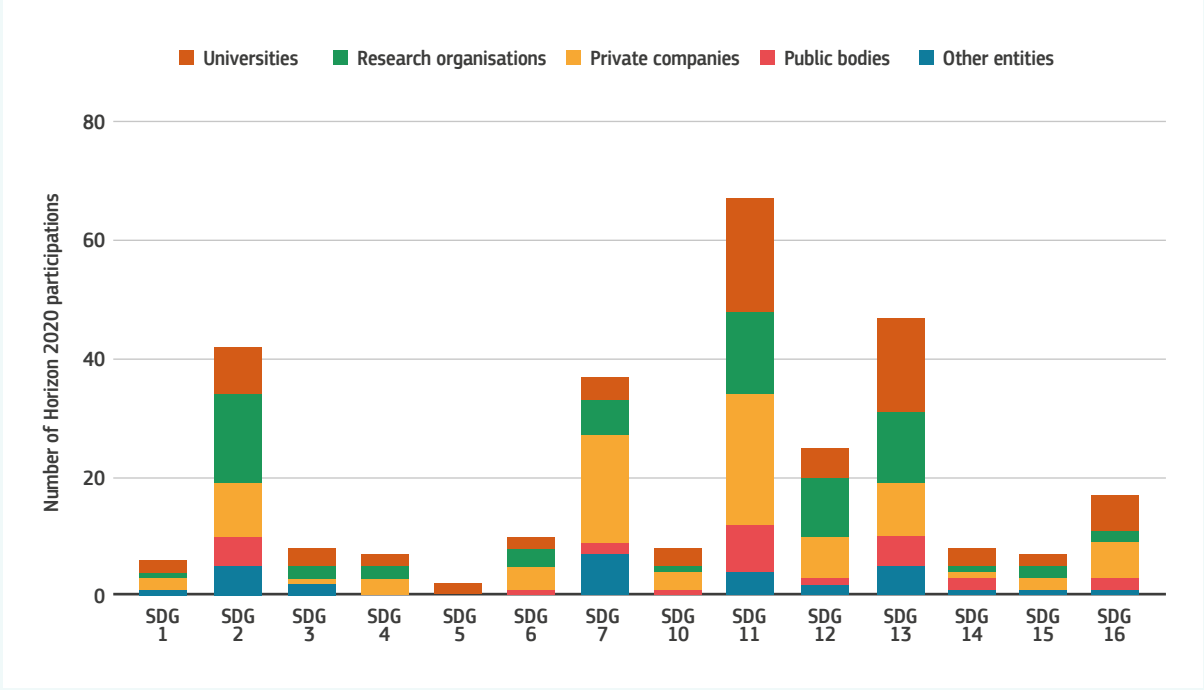
On the contrary, Goal 6. Clean Water and Sanitation and Goal 13. Climate Action, given the size of the underlying STI ecosystems and the scientific and technological development opportunities, would be expected to be part of a higher number of Innovation Fund projects.

Lastly, the typology of institutions participating in SDG-oriented science and innovation projects provides clear information on entrepreneurial opportunities and, thus, their potential connection to Smart Specialisation. ***Figure 13*** presents the distribution of institutional typologies in Horizon 2020 projects across the goals.

It is very clear that private companies cluster in several goals:

- Goal 2. Zero Hunger
- Goal 7. Affordable and Clean Energy
- Goal 11. Sustainable Cities and Communities.

FIGURE 13 *Number of H2020 participations by goal and type of organisation*



Source: Authors', based on CORDIS.

Again, this list of goals, strongly connected to Smart Specialisation priorities, seems to be a fertile ground for entrepreneurial innovation.

This pattern is consistent with the distribution of company activity in the Innovation Fund programmes, as shown in the ***Figure 14***.

Thus, Goals 2, 7, 11 and 12 present private sector SDG-oriented innovation, and could be a source of opportunity in the Smart Specialisation implementation process.

The number of projects and the pattern of activity of the different typologies of actors provide information on the apparent specialisation of the most active stakeholders, and on the orientation of the funding. In that sense, the goals which concentrate more activity are clear (2, 7, 11, 12 and, to a lesser degree, 3), all of them with the key participation of private companies. On the other hand, the relative lack of projects in social-oriented higher-priority goals such as 1, 4 and 10 demonstrates the lower predisposition of funding programmes to support social innovation and innovations in policy and the provision of public goods.

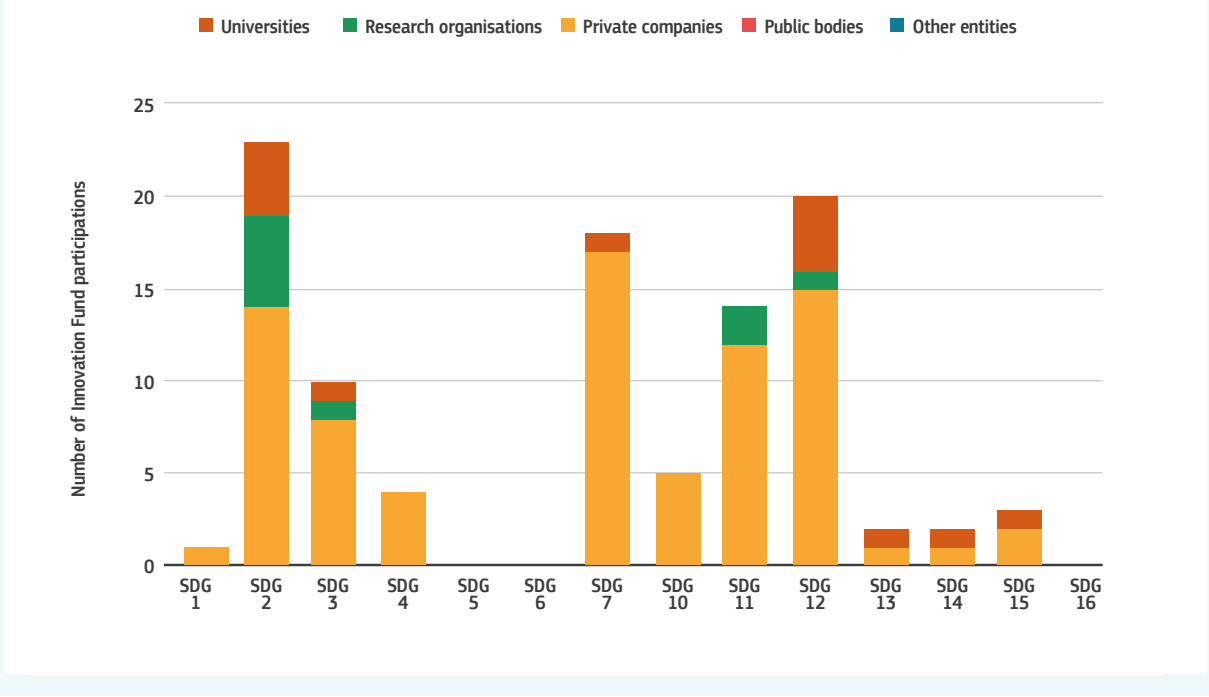
3.4. Technological development – patent analysis

Patent applications are a measure of technological development capacities and assets. Nevertheless, it must be acknowledged that technological innovation plays a clear role in some Sustainable Development Goals, despite being farther from some others. In addition, technological development is not positive nor negative per se, and the directionality and application of innovation must be taken into account, since specific developments can have negative environmental or social effects. For this reason, the analysis realised in the current study takes into account elements of directionality, classifying as SDG-relevant these technological innovations that are related to positive outcomes, such as 'food safety', 'water purification' or 'renewable resource'.

Figure 15 presents the number and share of Serbian patent families thematically related to the different goals.

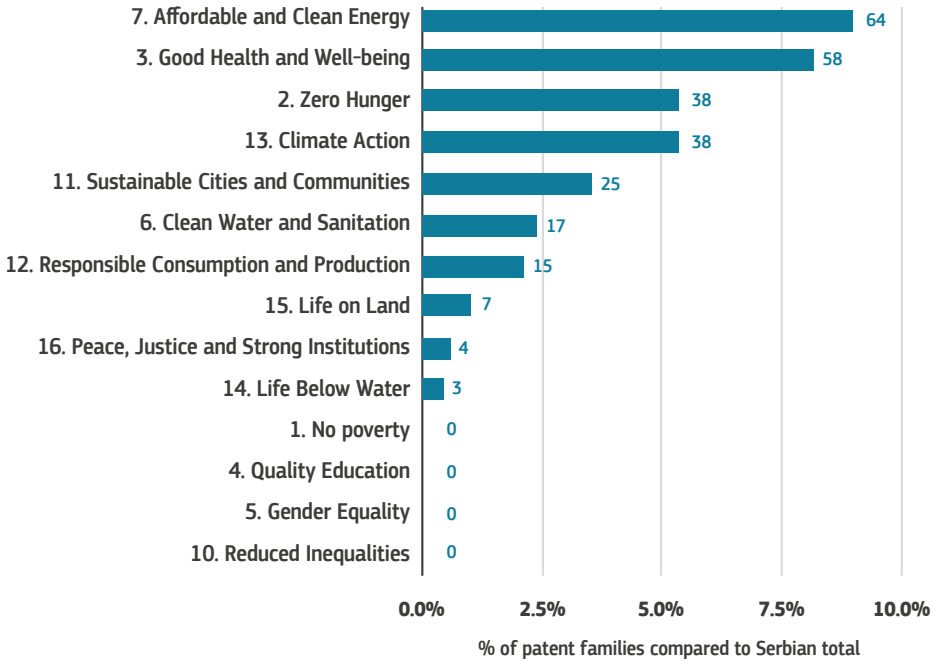
Unsurprisingly, the goals which can be addressed by technological innovations cluster at the top.

FIGURE 14 *Number of Innovation Fund participations by goal and type of organisation*



Source: Authors', based on Innovation Fund data.

FIGURE 15 *Absolute and relative number of patents by goal*



Source: Authors', based on the EPO.

- Goal 7. Affordable and Clean Energy, with innovations related to renewable energies (wind, solar, hydro, wave) for electricity and hot water production, energy efficiency, thermal-electrical machines, smart grids and the impact of these developments on a reduced footprint and fewer greenhouse gas emissions. These technological assets are aligned with the Smart Specialisation priority domain Energy Efficient and Eco-Smart Solutions.

- Goal 3. Good Health and Well-being leading the table, with many innovations related to medical devices and implants, and a few to dermatological products.

- Goal 2. Zero Hunger, with innovations related to agricultural and food industry machinery, improved production processes and new food products, with contributions from Mechanical Engineering, Chemistry and Biotechnology. These technological assets are aligned with the Smart Specialisation priority domain Food for Future.

- Goal 13. Climate Action, with innovations related to energy efficiency, green energy production, better heating and cooling systems and carbon footprint reduction measures. These technological assets are aligned with the Smart Specialisation priority domain Energy Efficient and Eco-Smart Solutions.

- Goal 11. Sustainable Cities and Communities, with innovations related to smart cities, sustainable and efficient transportation, urban power generation and cooling/heating systems, built environment insulation and efficiency. These technological assets are aligned with the Smart Specialisation priority domain Energy Efficient and Eco-Smart Solutions.

With regard to the typologies of actors applying for these patents, it is important to note that there is a very large number of individual patent applicants in Serbia. Some of these can be actual individual inventors, but a significant number are academic professors and researchers. As such, with different intellectual property legislation and institutional regulations, the distribution of typologies of actors would certainly change.

In any case, ***Figure 16*** presents said distribution of actors patenting in the different Sustainable Development Goals.

Private companies are mainly active in goals 3, 6, 7, 11 and 13, manifesting in technological capacity and developments in these domains.

Universities and research organisations are more active in Goal 2. Zero Hunger, demonstrating a relative specialisation of the research sector and a capacity to contribute locally to the agricultural and food industry value chains.

3.5. Relationship between goals – tackling similar challenges together

The Sustainable Development Goals are a cohesive agenda. Goals and targets are interrelated, and development pathways addressing a goal can have positive, as well as negative, consequences for other goals. This final section presents an analysis of the overlap between the STI activities, results and capacities in the different goals.

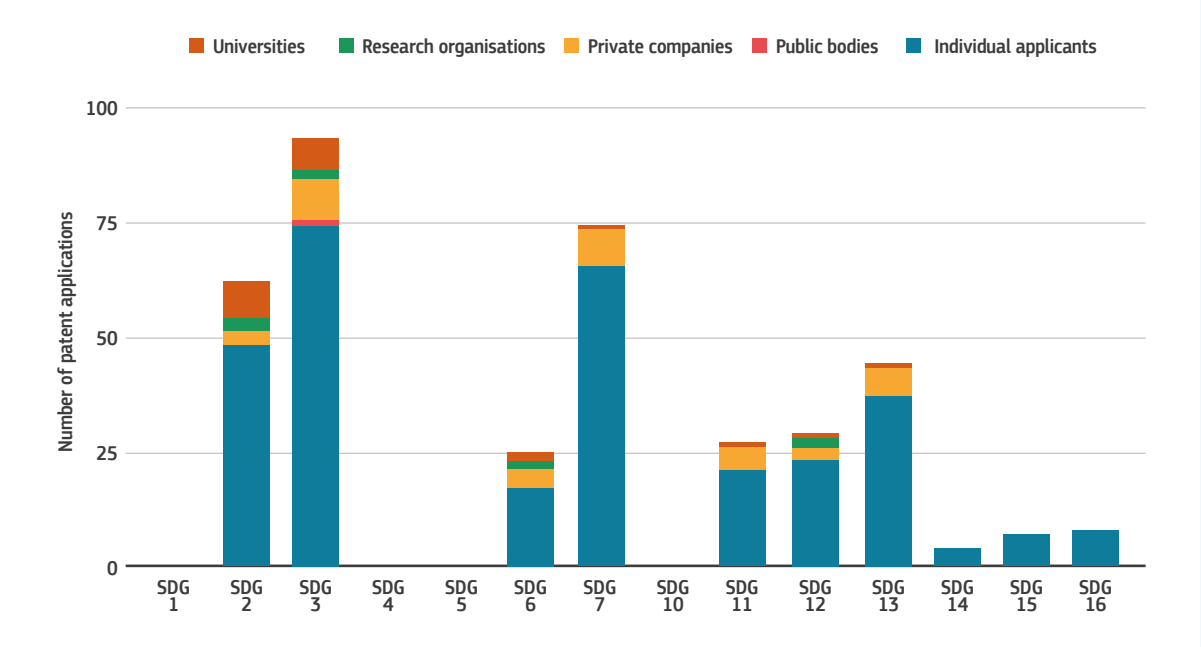
The heat map in ***Table 11*** shows the share of STI records which have been classified as thematically related to more than one goal. In particular, the table provides the percentage of STI activities related to the SDGs in rows which are also related to the SDGs in columns. Cells with a higher percentage reveal pairs of goals which share a common scientific, technological or innovative ground. Goals 8, 9 and 17 have been excluded due to their transversal nature.

The main STI links between goals are described below:

- 28% of STI records thematically related to Goal 1. No Poverty are also related to Goal 10. Reduced Inequalities;

- or, 26% of STI records thematically related to Goal 12. Responsible Consumption and Production are also related to Goal 11. Sustainable Cities and Communities;

FIGURE 16 *Number of patent families by goal and type of organisation*



Source: Authors', based on the EPO.

- Goal 2. Zero Hunger is linked to Goal 15. Life on Land, since the development of sustainable agriculture can have positive impacts on land ecosystems;

- Goal 5. Gender Equality is closely connected to Goal 3. Good Health and Well-being and Goal 16. Peace, Justice and Strong Institutions, and to a lesser extent to Goal 10. Reduced Inequalities. The first link is due to the area of women's health, a subject of attention in Goals 5 and 3. The other relationships are related to increasing inclusiveness and participation and reducing discrimination;

- the goals that link human industry and settlement to environmental impacts cluster together in binomials or trinomials, in concentric circles from the activity to the impact, notably:

  - Goal 6. Clean Water and Sanitation is fairly connected to Goal 12. Responsible Consumption and Production and Goal 13. Climate Action;

  - Goal 11. Sustainable Cities and Communities is fairly connected to Goal 12. Responsible Consumption and Production and Goal 13. Climate Action;

  - Goal 12. Responsible Consumption and Production is reasonably linked to Goal 6. Clean Water and Sanitation and strongly connected to Goal 11. Sustainable Cities and Communities;

  - Goal 13. Climate Action is considerably linked to Goal 7. Affordable and Clean Energy and Goal 11. Sustainable Cities and Communities;

- Goal 14. Life Below Water is closely connected to Goal 15. Life on Land, connecting the ecosystem-minded goals which share scientific disciplines, activities and impacts.

Figure 17 summarises these relationships, for the pairs of goals above a threshold.

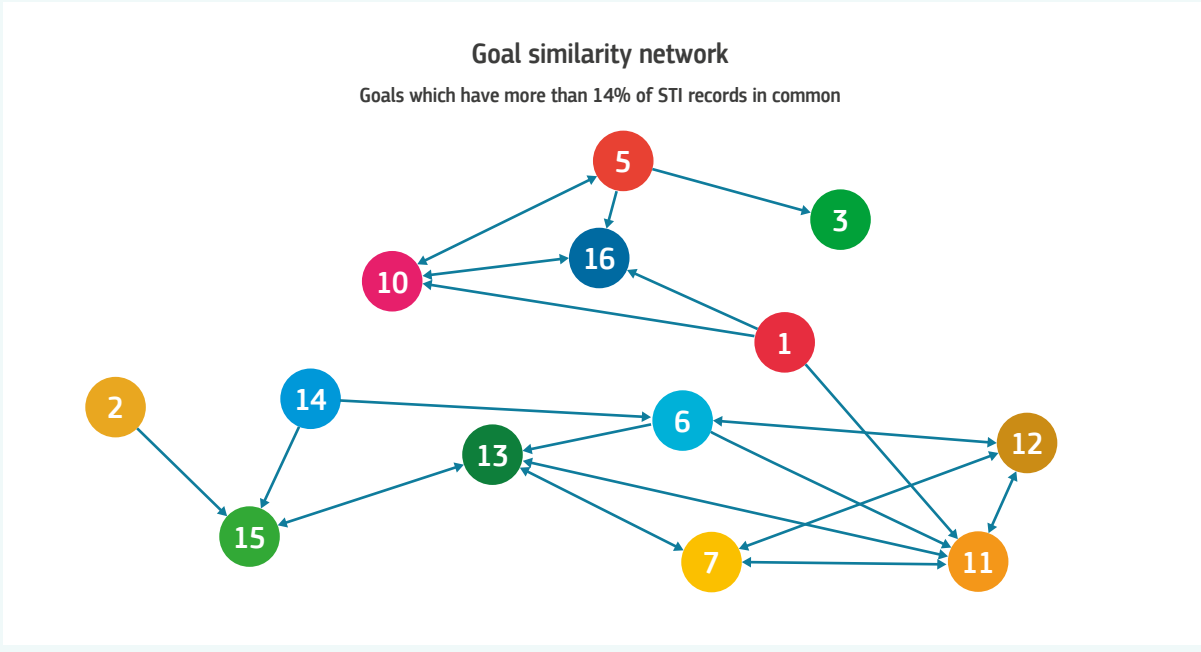
These connections can allow stakeholders to understand the SDG-oriented opportunities upstream and downstream of their concrete area of activity or expertise. For policy-makers it allows areas and topics, which can tackle more than one challenge, to be identified and to characterise and exploit the transversal relationships to increase the impact of policies and actions.

TABLE 11 *Share of STI records which have been classified as thematically related to more than one goal*

	SDG 1	SDG 2	SDG 3	SDG 4	SDG 5	SDG 6	SDG 7	SDG 10	SDG 11	SDG 12	SDG 13	SDG 14	SDG 15	SDG 16
1		10%	13%	7%	1%	3%	4%	28%	14%	-	11%	1%	4%	14%
2	2%		4%	1%	1%	8%	5%	3%	6%	8%	9%	2%	17%	1%
3	1%	2%		1%	2%	4%	2%	3%	10%	2%	6%	-	2%	3%
4	2%	1%	4%		2%	-	-	9%	4%	2%	3%	-	1%	6%
5	1%	4%	21%	8%		-	-	18%	4%	-	-	-	-	26%
6	1%	6%	7%	-	-		7%	1%	14%	17%	16%	3%	10%	-
7	-	2%	2%	-	-	3%		1%	11%	7%	14%	-	3%	1%
10	7%	3%	8%	8%	5%	1%	3%		8%	1%	2%	1%	3%	14%
11	1%	3%	11%	1%	-	8%	14%	3%		15%	18%	1%	6%	4%
12	-	6%	3%	1%	-	16%	14%	1%	26%		13%	1%	6%	1%
13	1%	5%	9%	1%	-	12%	23%	1%	23%	9%		2%	14%	1%
14	1%	8%	1%	-	-	15%	1%	3%	10%	5%	11%		25%	-
15	1%	10%	2%	1%	-	8%	4%	2%	8%	5%	14%	4%		1%
16	3%	1%	8%	5%	6%	-	3%	14%	9%	1%	2%	-	1%	

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

FIGURE 17 *Relationship between the goals visualised as a graph*



Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

4. Finer-grained STI potential and knowledge/ competence gap analysis in selected goals

To continue addressing the research question 'What are the knowledge gaps between the identified SDG challenges and STI potentials?', in this chapter, a finer-grained STI potential and knowledge/competence gap analysis is provided for the higher-priority goals and for two goals with higher STI potential in the context of Smart Specialisation, as follows.

Higher-priority goals

- **Goal 1.** No Poverty
- **Goal 3.** Good Health and Well-being
- **Goal 4.** Quality Education
- **Goal 8.** Decent Work and Economic Growth
- **Goal 9.** Industry, Innovation and Infrastructure
- **Goal 10.** Reduced Inequalities

Goals with higher STI potential in the context of Smart Specialisation

- **Goal 2. Zero Hunger.** Goal 2 is strongly connected to one of the Serbian Smart Specialisation priorities – Food for Future – with particular regard to the topic Sustainable Agri-food Production. Goal 2-related STI contributions have a critical mass, gain significant attention from the private sector (ranking 1st in the Innovation Fund and 3rd in Patents) and are internationally connected (ranking 4th in H2020).
- **Goal 7. Affordable and Clean Energy.** Goal 7 is strongly connected to one of the Serbian Smart Specialisation priorities – Energy Efficient and Eco-Smart Solutions – and provides transversal value in Food for Future and Future Machines and Manufacturing Systems. Goal 7-related STI ecosystems have a very large critical mass (ranking 2nd in publications and Horizon 2020 projects), gain significant attention from the private sector (ranking 2nd in the Innovation Fund and 1st in Patents).It also presents a high scientific impact, with the largest percentage (24%) of publications in TOP10% international journals.

4.1. Goal 1. End poverty in all its forms everywhere

Table 12 presents the main challenges identified in the policy document analysis and the statistical assessment at target level. This provides further detail on the topics to be addressed by STI actors and activities in Goal 1.

For a finer-grained view of the content of the goal-oriented STI activities, the keyword cloud

TABLE 12 *Analysis of the main challenges at target level*

Target		Priority	Distance to frontier	
		In Serbian SDG-related assessments and policy documents	Statistical assessment of the gap in the SDG indicators with EU countries, 100 = wider gap. *Serbia is represented by the coloured bar*	
1.1	By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day	Medium	8	
1.2	By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions	High	100	
1.3	Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable	High	-	
1.4	By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance	Medium	77	
1.5	By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters	Low	58	
1.a	Ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation, in order to provide adequate and predictable means for developing countries, in particular least developed countries, to implement programmes and policies to end poverty in all its dimensions	Medium	100	
1.b	Create sound policy frameworks at the national, regional and international levels, based on pro-poor and gender-sensitive development strategies, to support accelerated investment in poverty eradication actions	Medium	-	

Source: Authors', based on selected documentation and the UN Global SDG Indicators Database.

in ***Figure 18*** presents the most frequent Goal 1 SDG-related keywords in Serbian STI activities and results across the four analysed data sources. This offers a glimpse into the topics where STI actors are currently active and engaged, as well as an understanding of the diversity of challenges and disciplines involved.

Table 13 presents the rank of Goal 1-related STI activities in relation to the rest of the goals. For publications and H2020 projects, the rank and share in the EU-27 provide a notion of relative specialisation.

Goal 1. No Poverty remains a key challenge for Serbia, but the STI analysis shows a slight lack of scientific specialisation in a topic with an already small volume of publications (for further information, see analyses and results in ***Chapter 3***).

With regard to the scientific impact, Goal 1-related publications have a normalised citation impact (NCI, vs the aggregate Serbian scientific production) of 1.10, slightly above par, but modest in relation to the contributions to other Goals. Notably, only 6% of Serbian Goal 1-related publications have been published in TOP10% journals, a less-than-excellent record.

The discipline of Medicine concentrates most publications in Goal 1-related topics in Serbia, which produces relatively lower specialisation in other disciplines found to be relevant for Goal-1 in the benchmarks. As a consequence, significant knowledge gaps, as expressed by the disciplinary specialisation index, are present in the Social Sciences[40], Environmental Science and Agricultural and Biological Sciences.

While small in number, the share of Serbian participation in Goal 1-related Horizon 2020 projects is relatively higher than that of EU-27 and EU-13 countries, showing a higher propensity or capacity to obtain funding in these topics. With regard to technological and entrepreneurial capacities, the Innovation Fund is only supporting one Goal-1 related project, and no patents have been classified into this goal.

40 *Nevertheless, as presented in the first chapter of the report and in the methodological annex, a limitation of the STI analysis is the lower propensity of Social Sciences and Humanities communities to publish in international and/or English-speaking journals.*

FIGURE 18 ***Goal 1*** *most frequent SDG-related keywords across all data sources*

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

TABLE 13

Goal 1 rank and share in the STI analysis

Publications *(out of 16 goals)*		Horizon 2020 *(out of 14 goals)*		Innovation Fund *(out of 11 goals)*	Patents *(out of 10 goals)*
15th	16th	12th	13th	11th	-
0.4% Serbia	0.5% EU-27	2.1% Serbia	0.9% EU-27	1% Serbia	0% Serbia

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

TABLE 14 *STI analysis of **Goal 1** by data source*

		Distinctive STI potential	Relevant knowledge gaps
In scientific publications		The discipline with the highest contribution to Goal 1 in Serbia is Medicine. The size and tradition of the medical research community in the country may have given it a relative advantage in this topic. Engineering is also a discipline with a slight comparative specialisation vs the EU-27. Other life sciences and healthcare-related disciplines present a contribution on par with EU-27: Nursing and Immunology and Microbiology.	In both the EU-27 and EU-13, Social Sciences are the top contributor to this topic; Serbia presents a lower specialisation in Social Sciences, ranking 2nd after Medicine. The discipline of Medicine concentrates most publications in Goal-1 related topics in Serbia, which produces a relatively lower specialisation in other disciplines found to be relevant for Goal-1 topics in the benchmarks, in particular: ■ Environmental Science ■ Business Management and Accounting ■ Agricultural and Biological Sciences (-50%) ■ Arts and Humanities - Psychology ■ Earth and Planetary Sciences ■ Biochemistry, Genetics and Molecular Biology ■ Computer Science.
In patents		No patents have been classified into Goal 1.	
In nationally-funded R&I projects (Innovation Fund)		Only one Innovation Fund project has been classified into Goal 1, related to disaster resilience (seismic protection of buildings during earthquakes).	

In EU-funded R&I projects (Horizon 2020)		There are only three H2020 projects related to Goal 1 in Serbia, all in Societal Challenges, particularly in the programmes 'Energy', 'Health' and 'Secure Societies'. Projects are related to 'Sustainable finance for sustainable agriculture and fisheries', climate/disaster resilience, treatment of patients with severe mental disorders and energy efficiency policy (including energy poverty).	The top 4 H2020 programmes in Europe with projects related to Goal 1 are: ■ Marie Sklodowska Curie Actions ■ Innovation in SMEs ■ European Research Council ■ SC 'Europe in a changing world'. The lack of projects in Serbia may be due to the small size of the goal-related activities in H2020, but may also show a lack of innovative capacity in SMEs and excellent research capable of competing with EU-27 academic actors.

4.2. Goal 3. Ensure healthy lives and promote well-being for all at all ages

Table 15 presents the main challenges identified in the policy document analysis and the statistical assessment at target level. This provides further detail on the topics to be addressed by STI actors and activities in Goal 3.

For a finer-grained view of the content of the goal-oriented STI activities, the keyword cloud in *Figure 19* presents the most frequent Goal 3 SDG-related keywords in Serbian STI activities and results across the four analysed data sources. This offers a glimpse into the topics where STI actors are currently active and engaged, as well as an understanding of the diversity of challenges and disciplines involved.

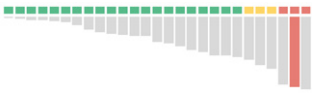
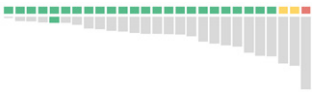
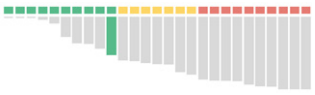
Table 16 presents the rank of Goal 3-related STI activities in relation to the rest of the goals. For publications and H2020 projects, the rank and share in the EU-27 provide a notion of relative specialisation.

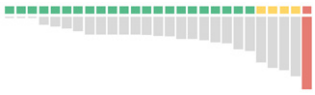
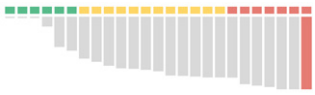
Due to the large scientific communities and high productivity of the life sciences and healthcare disciplines, Goal 3. Good Health and Well-being presents the largest share of SDG-related scientific publications in Serbia, the EU-27 and EU-13. Nevertheless, Serbia presents a smaller share (5.4%) than the EU-13 (8.2%), showing smaller specialisation in comparison to nearby countries.

With regard to the scientific impact, 9% of Goal 3-related publications have been published in the TOP10% journals, a slightly lower-than-average share. However, these publications have a normalised citation impact (vs the aggregate Serbian scientific production) of 1.82, the highest of all the goals, so there is a quality community contributing to Goal 3 topics.

Notable knowledge gaps in Goal 3-related topics can be found in Immunology and Microbiology, Neuroscience and Psychology. Serbian actors are not very competitive in obtaining Goal 3-related H2020 funding, which, given the size of the scientific community and the importance of the goal, is a challenge to be addressed. The Innovation Fund is supporting 10 Goal 3-related projects; this is only a fraction of all health-related funded projects, which spread to areas that lie outside of the specific domain of the SDG. Lastly, a large number of patents are classified into Goal 3, ranking 2nd after Goal 7. Most of these patents protect medical devices and implants, while several are related to dermatological products.

TABLE 15 *Analysis of the main challenges at target level*

	Target	Priority	Distance to frontier	
		In Serbian SDG-related assessments and policy documents	Statistical assessment of the gap in the SDG indicators with EU countries, 100 = wider gap. *Serbia is represented by the coloured bar*	
3.1	By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births	**Medium**	**97**	
3.2	By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births	**High**	**96**	
3.3	By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases	**Medium**	**7**	
3.4	By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being	**Medium**	**85**	
3.5	Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol	**Medium**	**52**	
3.6	By 2020, halve the number of global deaths and injuries from road traffic accidents	-	-	
3.7	By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes	**High**	**53**	
3.8	Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all	**Medium**	**100**	

3.9	By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination	-	98	
3.a	Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries, as appropriate	-	100	
3.b	Support the research and development of vaccines and medicines for the communicable and non-communicable diseases that primarily affect developing countries, provide access to affordable essential medicines and vaccines, in accordance with the Doha Declaration on the TRIPS Agreement and Public Health, which affirms the right of developing countries to use to the full the provisions in the Agreement on Trade-Related Aspects of Intellectual Property Rights regarding flexibilities to protect public health, and, in particular, provide access to medicines for all	Low	40	
3.c	Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing States	-	100	
3.d	Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks	Low	100	

Source: Authors', based on selected documentation and the UN Global SDG Indicators Database.

FIGURE 19 **Goal 3** *main SDG-related keywords across all data sources*

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

TABLE 16

Goal 3 rank and share in the STI analysis

Publications (out of 16 goals)		Horizon 2020 (out of 14 goals)		Innovation Fund (out of 11 goals)	Patents (out of 10 goals)
1st	1st	7th	5th	5th	2nd
5.4% Serbia	5.2% EU-27	2.9% Serbia	4.6% EU-27	1% Serbia	8.2% Serbia

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

TABLE 17 *STI analysis of **Goal 3** by data source*

		Distinctive STI potential	Relevant knowledge gaps
In scientific publications		Serbia presents relative specialisation vs the EU-27 in Goal 3-related disciplines in: ■ Environmental Science ■ Pharmacology, Toxicology and Pharmaceutics ■ Social Sciences ■ Engineering. Important disciplines in Goal 3 – Biochemistry, Genetics and Molecular Biology, and Agricultural and Biological Sciences – present a specialisation on par with the EU-27.	The clearest knowledge gap, as shown by a smaller relative contribution, is in Immunology and Microbiology. The gap is very significant with the EU-27, while small with the EU-13. Neuroscience and Psychology show important specialisation gaps vs the EU-27 and EU-13 countries. Medicine is by far the largest discipline contributing to Goal 3 (62% of publications). The EU-27 is slightly more specialised than Serbia (67%), while Serbia presents a slight regional specialisation vs the EU-13 (57%)
		Serbia has a relative specialisation in comparison to the EU-27 in Chemistry and Chemical Engineering, but not in comparison to the EU-13, which present a higher contribution to Goal 3 in these disciplines.	
In patents		58 patents filed by Serbian actors have been classified into Goal 3. Good Health and Well-being, or 8.2% of the total. As such, Goal 3 ranks 2nd after Goal 7. Affordable and Clean Energy, showcasing a concentration of the apparent technological capacity of the country. Most of these patents protect medical devices and implants, while several are related to dermatological products.	

In nationally-funded R&I projects (Innovation Fund)		10 Innovation Fund projects have been classified into Goal 3, related to digital health, medical devices for heart conditions (3 projects), mosquito biocides, neurorehabilitation, environmental pollution and pharmacological innovation. The Innovation Fund has supported a larger number of health-related projects in diagnostic and therapeutical devices and in life sciences, not in specific topics covered in Goal 3 targets.
In EU-funded R&I projects (Horizon 2020)		Serbia presents the largest gap in comparison to the EU-27 in Innovation in SMEs and the European Research Council. Nevertheless, it must be noted that EU-13 countries also fail to obtain funding in Goal 3-related topics in these two highly competitive programmes. Most projects are related to infectious diseases and vaccination, while three are related to life quality, environmental pollution and non-communicable diseases (including cancer).

4.3. Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Table 18 presents the main challenges identified in the policy document analysis and the statistical assessment at target level. This provides further detail on the topics to be addressed by STI actors and activities in Goal 4.

For a finer grained view of the content of the goal-oriented STI activities, the keyword cloud in *Figure 20* presents the most frequent Goal 4 SDG-related keywords in Serbian STI activities and results across the four analysed data sources. This offers an insight into the topics where STI actors are currently active and engaged, as well as an understanding of the diversity of challenges and disciplines involved.

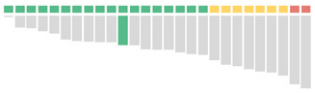
Table 19 presents the rank of Goal 4-related STI activities in relation to the rest of the goals. For publications and H2020 projects, the rank and share in the EU-27 provide a notion of relative specialisation.

While, in absolute numbers, Goal 4. Quality Education ranks quite low, in relative terms Serbia presents a clear specialisation in scientific publications and H2020 projects in comparison to the EU-27. In comparison to the EU-13, Serbia presents a major gap in scientific publications, while being on par in H2020 projects. Four Innovation Fund projects, a significant share of the total (ranking 4th), have been classified into Goal 4 in topics related to digital education in primary schools and more advanced education levels.

With regard to the scientific impact, 8% of Goal 4-related publications have been published in the TOP10% journals, a lower-than-average share. As these publications have an NCI (vs the aggregate Serbian scientific production) of 1.82, the lowest of all goals, there is therefore an excellence gap in the Serbian scientific contribution to Goal 4 topics.

In Social Sciences, the largest scientific discipline in Goal 4, Serbia presents a small specialisation gap in comparison to the EU-27 and EU-13. Notable specialisation gaps are present in Computer Science, Psychology (only vs the EU-27), Arts and Humanities and in Business, Management and Accounting. In Medicine and Environmental Science, Serbia presents a specialisation advantage.

TABLE 18 *Analysis of the main challenges at target level*

	Target	Priority	Distance to frontier	
		In Serbian SDG-related assessments and policy documents	Statistical assessment of the gap in the SDG indicators with EU countries, 100 = wider gap. *Serbia is represented by the coloured bar*	
4.1	By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes	-	-	
4.2	By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education	**High**	**63**	
4.3	By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university	**High**	**100**	
4.4	By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship	**High**	**100**	
4.5	By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations	**Low**	**37**	
4.6	By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy	-	-	
4.7	By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development	**Medium**	-	

4.a	Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all	–	–	
4.b	By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training and information and communications technology, technical, engineering and scientific programmes, in developed countries and other developing countries	–	–	
4.c	By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing States	**Low**	–	

Source: Authors', based on selected documentation and the UN Global SDG Indicators Database.

FIGURE 20 ***Goal 4*** *main SDG-related keywords across all data sources*

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

TABLE 19

Goal 4 rank and share in the STI analysis

Publications *(out of 16 goals)*		Horizon 2020 *(out of 14 goals)*		Innovation Fund *(out of 11 goals)*	Patents *(out of 10 goals)*
11th	13th	11th	12th	7th	-
1.4% Serbia	1.0% EU-27	2.1% Serbia	1.0% EU-27	2.3% Serbia	0% Serbia

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

TABLE 20 *STI analysis of **SDG 4** by data source*

		Distinctive STI potential	Relevant knowledge gaps
In scientific publications		Medicine presents a higher share of Goal 4-related publications in Serbia than in the EU-27 and EU-13. Environmental Science and Engineering (vs the EU-27, but not vs the EU-13) present relative potential.	The largest discipline in Goal 4 are Social Sciences, where Serbia presents a small specialisation gap vs the EU-27 and EU-13. Notable specialisation gaps are present in Computer Science, Psychology (only vs the EU-27), Arts and Humanities and in Business, Management and Accounting.
In patents		No patents have been classified into Goal 4.	
In nationally-funded R&I projects (Innovation Fund)		Four Innovation Fund projects, a significant share of the total, have been classified into Goal 4 in topics related to digital education (software and hardware) in primary schools and more advanced education levels.	
In EU-funded R&I projects (Horizon 2020)		The small number of H2020 projects classified into Goal 4, both in Serbia and in the EU, makes it hard to identify relative knowledge advantages and gaps. Projects are related to 'OpenCourseWare authoring, multiplatform delivery and Learning Analytics', 'Entrepreneurial skills for young social innovators in an open digital world', training in Open Data and Big Data technologies and researcher mobility.	

4.4. Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Table 21 presents the main challenges identified in the policy document analysis and the statistical assessment at target level. This provides further detail on the topics to be addressed by STI actors and activities in Goal 8.

For a finer-grained view of the content of the goal-oriented STI activities, the keyword cloud in *Figure 21* presents the most frequent Goal 8 SDG-related keywords in Serbian scientific publications. This offers an insight into the topics where STI actors are currently active and engaged, as well as an understanding of the diversity of challenges and disciplines involved.

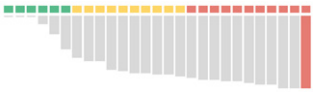
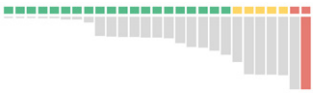
Table 22 presents the rank of Goal 8-related STI activities in relation to the rest of the goals. For publications, the rank and share in the EU-27 provide a notion of relative specialisation. Due to their intrinsic nature, and their relationship with Smart Specialisation, all research and innovation projects, as well as all patents (as innovative products or processes), share with Goal 8 the objective of promoting 'sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all'. Thus, as presented in *Chapter 1*, neither projects nor patents have been individually classified in the Goal 8. Unlike for the rest of the goals, the table below presents the total number of Horizon 2020 and Innovation Fund patents in Serbia as a means to showcase activities supporting the aims of Goal 8.

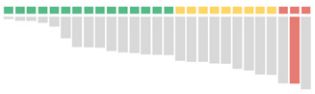
The share of scientific publications thematically related to Goal 8 is slightly larger than in the EU-27, but notably smaller than in EU-13 countries. This may represent a major knowledge gap in relation to countries facing, or which have faced, comparable Goal 8-related challenges.

With regard to the scientific impact, 12% of Goal 8-related publications have been published in the TOP10% journals, and they have an NCI of 1.02; both indicators are slightly higher than average.

In disciplinary terms, Serbia presents a scientific specialisation gap in Social Sciences, in Business, Management and Accounting and Computer Science. Meanwhile, Serbia presents relative potential in three applied science disciplines: Energy, Chemical Engineering and Chemistry.

TABLE 21 *Analysis of the main challenges at target level*

Target		Priority	Distance to frontier	
		In Serbian SDG-related assessments and policy documents	Statistical assessment of the gap in the SDG indicators with EU countries, 100 = wider gap. *Serbia is represented by the coloured bar*	
8.1	Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries	Low	77	
8.2	Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors	Medium	100	
8.3	Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services	High	-	
8.4	Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead	Low	58	
8.5	By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value	Medium	100	
8.6	By 2020, substantially reduce the proportion of youth not in employment, education or training	High	100	
8.7	Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms	Low	-	

8.8	Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment	**Low**	-	
8.9	By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products	**Low**	-	
8.10	Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all	-	**90**	
8.a	Increase Aid for Trade support for developing countries, in particular least developed countries, including through the Enhanced Integrated Framework for Trade-related Technical Assistance to Least Developed Countries	-	-	
8.b	By 2020, develop and operationalize a global strategy for youth employment and implement the Global Jobs Pact of the International Labour Organization	**Low**	-	

Source: Authors', based on selected documentation and the UN Global SDG Indicators Database.

FIGURE 21 ***Goal 8*** *main SDG-related keywords across all data sources*

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

TABLE 22

Rank and share (for publications) and total number (for projects and patents) of **Goal 8**-related activities in the STI analysis

Publications *(out of 16 goals)*		Horizon 2020 *(total number in Serbia)*	Innovation Fund *(total number in Serbia)*	Patents *(total number in Serbia)*
7th 2.0% Serbia	**8th** 1.7% EU-27	**240**	**172**	**708**

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

TABLE 23 *STI analysis of **Goal 8** by data source*

		Distinctive STI potential	Relevant knowledge gaps
In scientific publications		The top 3 disciplines with STI activities thematically related to Goal 8 are: ■ Environmental Science, where Serbia is almost on par with the EU-27 while there's a narrow specialisation advantage vs the EU-13; ■ Social Sciences, where Serbia presents a specialisation gap vs both the EU-27 (quite large) and the EU-13 (smaller); ■ Engineering, where Serbia is more specialised than the EU-27 but less than the EU-13.	
		Serbia presents relative potential in applied science disciplines: Energy, Chemical Engineering and Chemistry.	Serbia presents a relevant knowledge gap in Business, Management and Accounting and Computer Science.
In patents		Patents have not been classified into Goal 8 since the nature of intellectual property and the content of Goal 8 are closely related. In total, during the period, Serbian organisations filed applications for 708 patents.	
In nationally-funded R&I projects (Innovation Fund)		Innovation Fund projects have not been classified into Goal 8 since the nature of research and innovation projects and the content of Goal 8 are closely related. In total, during the period, Serbian organisations participated in 172 Innovation Fund projects.	
In EU-funded R&I projects (Horizon 2020)		Horizon 2020 projects have not been classified into Goal 8 since the nature of research and innovation projects and the content of Goal 8 are closely related. In total, during the period, Serbian organisations participated in 240 Horizon 2020 projects.	

4.5. Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation

Table 24 presents the main challenges identified in the policy document analysis and the statistical assessment at target level. This provides further detail on the topics to be addressed by STI actors and activities in Goal 9.

For a finer-grained view of the content of the goal-oriented STI activities, the keyword cloud in *Figure 22* presents the most frequent Goal 9 SDG-related keywords in Serbian scientific publications. This offers a sample of the topics where STI actors are currently active and engaged, as well as an understanding of the diversity of challenges and disciplines involved.

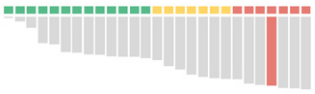
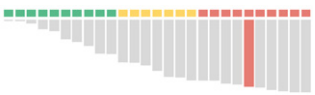
Table 25 presents the rank of Goal 9-related STI activities in relation to the rest of the goals. For publications, the rank and share in the EU-27 provide a notion of relative specialisation. Due to their intrinsic nature, and their relationship with Smart Specialisation, all research and innovation projects, as well as all patents (as innovative products or processes), share with Goal 9 the objective to '[...] promote inclusive and sustainable industrialization, and foster innovation'. Thus, as presented in *Chapter 1*, neither projects nor patents have been individually classified into Goal 9. Unlike for the rest of the goals, the table below presents the total number of Horizon 2020 and Innovation Fund patents in Serbia as a means to showcase activities supporting the aims of Goal 8.

The share of scientific publications thematically related to Goal 9 is slightly smaller than in the EU-27, and notably smaller than in EU-13 countries. This may represent a major knowledge gap in relation to countries facing, or which have faced, comparable Goal 9-related challenges.

With regard to the scientific impact, only 7% of Goal 9-related publications have been published in the TOP10% journals, a lower-than-average share. On the contrary, within their disciplines, Goal-9 related topics are relatively well-cited, with an NCI of 1.26.

In disciplinary terms, Serbia is on par with the EU-27 and EU-13 in Engineering – the most relevant discipline in Goal 9. Serbia presents a relevant scientific specialisation gap in Computer Science and Mathematics, while showing an advantage in Economics, Econometrics and Finance and in Agricultural and Biological Sciences. Horizon 2020 projects, Innovation Fund projects and patents have not been classified into Goal 9, since their nature and the content of Goal 9 are closely related, which yields haphazard results.

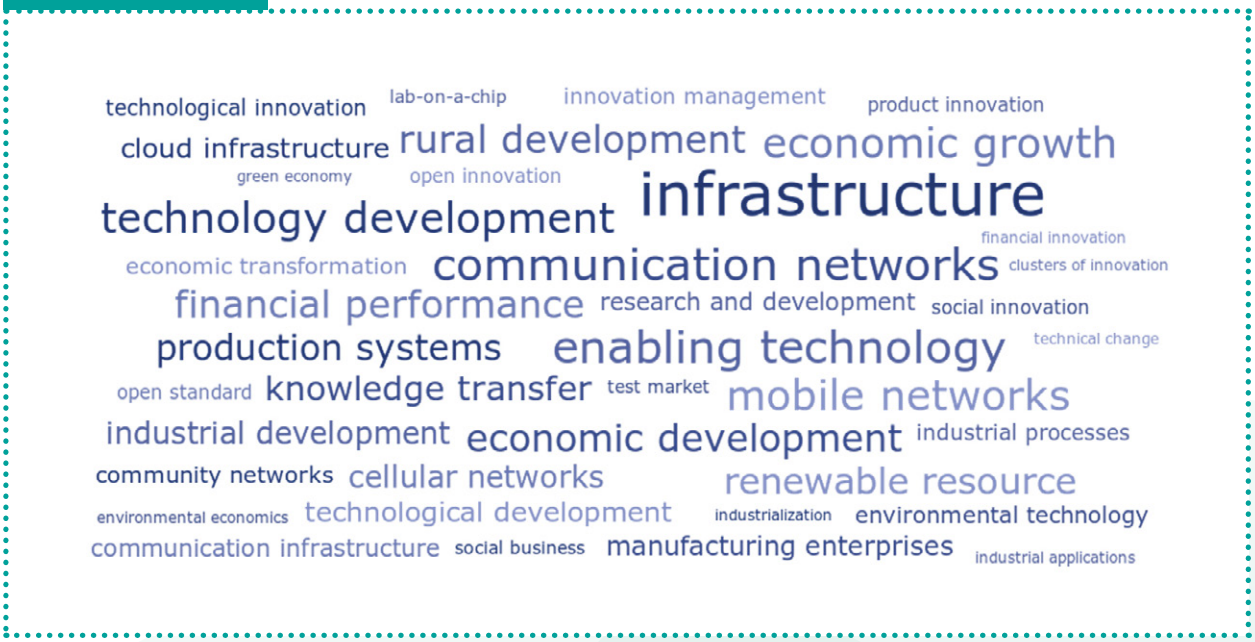
TABLE 24 *Analysis of the main challenges at target level*

Target		Priority	Distance to frontier	
		In Serbian SDG-related assessments and policy documents	Statistical assessment of the gap in the SDG indicators with EU countries, 100 = wider gap. *Serbia is represented by the coloured bar*	
9.1	Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	**Low**	**93**	
9.2	Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries	**Medium**	**62**	
9.3	Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets	**High**	**–**	
9.4	By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities	**High**	**83**	
9.5	Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending	**Medium**	**93**	

9.a	Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States	-	-	
9.b	Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities	**Low**	**93**	
9.c	Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020	**Low**	**53**	

Source: Authors', based on selected documentation and the UN Global SDG Indicators Database.

FIGURE 22 ***Goal 9*** *main SDG-related keywords across all data sources*



Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

TABLE 25

Rank and share (for publications) and total number (for projects and patents) of **Goal 9**-related activities in the STI analysis

Publications *(out of 16 goals)*		Horizon 2020 *(total number in Serbia)*	Innovation Fund *(total number in Serbia)*	Patents *(total number in Serbia)*
6th 2.1% Serbia	**5th** 2.4% EU-27	**240**	**172**	**708**

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

TABLE 26 *STI analysis of **Goal 9** by data source*

		Distinctive STI potential	Relevant knowledge gaps
In scientific publications		The top discipline contributing scientific articles thematically related to Goal 9 is Engineering, where Serbia presents a specialisation on par with the EU-27 and EU-13.	
		Serbia presents a relevant scientific specialisation advantage in Economics, Econometrics and Finance and in Agricultural and Biological Sciences.	Serbia presents a relevant scientific specialisation gap in Computer Science and Mathematics.
In patents		Patents have not been classified into Goal 9 since the nature of intellectual property and the content of Goal 9 are closely related. In total, during the period, Serbian organisations filed applications for 708 patents.	
In nationally-funded R&I projects (Innovation Fund)		Innovation Fund projects have not been classified into Goal 8 since the nature of research and innovation projects and the content of Goal 9 are closely related. In total, during the period, Serbian organisations participated in 172 Innovation Fund projects.	
In EU-funded R&I projects (Horizon 2020)		Horizon 2020 projects have not been classified into Goal 8 since the nature of research and innovation projects and the content of Goal 9 are closely related. In total, during the period, Serbian organisations participated in 240 Horizon 2020 projects.	

4.6. Goal 10. Reduce income inequality within and among countries

Table 27 presents the main challenges identified in the policy document analysis and the statistical assessment at target level. This provides further detail on the topics to be addressed by STI actors and activities in Goal 10.

For a finer-grained view of the content of the goal-oriented STI activities, the keyword cloud in *Figure 23* presents the most frequent Goal 10 SDG-related keywords in Serbian STI activities and results across the four analysed data sources. This offers an insight into the topics where STI actors are currently active and engaged, as well as an understanding of the diversity of challenges and disciplines involved.

Table 28 presents the rank of Goal 10-related STI activities in relation to the rest of the goals. For publications and H2020 projects, the rank and share in the EU-27 provide a notion of relative specialisation.

The share of scientific publications thematically related to Goal 10 is similar to that of EU-27 countries, but significantly smaller than in EU-13 countries. For this higher-priority challenge, the share of thematically related Horizon 2020 projects (6, or 2.5%) is smaller than in the EU-13 (3.4%).

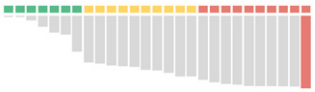
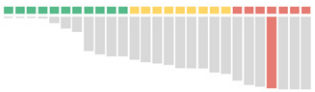
With regard to the scientific impact, 10% of Goal 10-related publications have been published in the TOP10% journals, on par with the rest of the goals. On the contrary, within their disciplines, Goal-10 related topics are relatively well-cited, with an NCI of 1.33.

The presence of Goal 10 in the Innovation Fund is unexpectedly high; with five projects, the programme has funded the development of technological innovations supporting the inclusion of people with disabilities, related to impaired vision in particular.

Six Serbian H2020 projects have been classified into Goal 10, a number too small to infer specific relative potential or knowledge gaps. Overall, the top 2 H2020 programmes with projects related to Goal 10 in the EU are the MSCA and ERC. Serbia has not been able to obtain funding for Excellent Science in these programmes but, notably, no EU-13 country has obtained an ERC grant either.

No Serbian patents have been classified into Goal 10.

TABLE 27 *Analysis of the main challenges at target level*

Target		Priority	Distance to frontier	
		In Serbian SDG-related assessments and policy documents	Statistical assessment of the gap in the SDG indicators with EU countries, 100 = wider gap. *Serbia is represented by the coloured bar*	
10.1	By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average	**Medium**	–	
10.2	By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status	**High**	–	
10.3	Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and action in this regard	**High**	–	
10.4	Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality	**High**	**100**	
10.5	Improve the regulation and monitoring of global financial markets and institutions and strengthen the implementation of such regulations	–	–	
10.6	Ensure enhanced representation and voice for developing countries in decision-making in global international economic and financial institutions in order to deliver more effective, credible, accountable and legitimate institutions	–	**100**	
10.7	Facilitate orderly, safe, regular and responsible migration and mobility of people, including through the implementation of planned and well-managed migration policies	–	–	
10.a	Implement the principle of special and differential treatment for developing countries, in particular least developed countries, in accordance with World Trade Organization agreements	–	**99**	

10.b	Encourage official development assistance and financial flows, including foreign direct investment, to States where the need is greatest, in particular least developed countries, African countries, small island developing States and landlocked developing countries, in accordance with their national plans and programmes	-	-	
10.c	By 2030, reduce to less than 3 per cent the transaction costs of migrant remittances and eliminate remittance corridors with costs higher than 5 per cent	-	69	

Source: Authors', based on selected documentation and the UN Global SDG Indicators Database.

FIGURE 23 ***Goal 10*** *main SDG-related keywords across all data sources*

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

TABLE 28

Rank and share of **Goal 10** in the STI analysis

Publications *(out of 16 goals)*		Horizon 2020 *(out of 14 goals)*		Innovation Fund *(out of 11 goals)*	Patents *(out of 10 goals)*
13th	11th	9th	10th	6th	-
1.3% Serbia	1.4% EU-27	2.5% Serbia	2.3% EU-27	2.9% Serbia	0% Serbia

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

TABLE 29 *STI analysis of **SDG 10** by data source*

		Distinctive STI potential	Relevant knowledge gaps
In scientific publications		The top 3 disciplines producing research thematically related to Goal 10 are Medicine, Social Sciences and Economics, Econometrics and Finance. In these three disciplines, the share of publications in Serbia is very similar to that of EU-27 and EU-13 countries, so no specific gap or advantage can be observed.	
		Below the top three Serbia presents a higher specialisation, showing relative STI potential in: ■ Agricultural and Biological Sciences	Serbia presents a lower specialisation, showing a relative gap, in: ■ Arts and Humanities ■ Psychology ■ vs the EU-13, Engineering.
In patents		No patents have been classified into Goal 10.	
In nationally-funded R&I projects (Innovation Fund)		Considering the social orientation of Goal 10, the programme has funded the development of five technological innovations supporting the inclusion of people with disabilities, particularly related to impaired vision – a very notable amount.	
In EU-funded R&I projects (Horizon 2020)		Only 6 Serbian H2020 projects have been classified into Goal 10, a number too small to infer specific relative potential or knowledge gaps. Overall, the top 2 H2020 programmes with projects related to Goal 10 in the EU are the MSCA and ERC. Serbia has not been able to obtain funding for Excellent Science in these programmes but, notably, no EU-13 country has obtained an ERC grant either. Projects are related to energy inequality, rural strategies based on agricultural technology, gender equality, female inclusion in transportation systems and 'Smart strategies for the transition in coal intensive regions'.	

4.7. Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Table 30 presents the main challenges identified in the policy document analysis and the statistical assessment at target level. This provides further detail on the topics to be addressed by STI actors and activities in Goal 2.

For a finer-grained view of the content of the goal-oriented STI activities, the keyword cloud in *Figure 24* presents the most frequent Goal 2 SDG-related keywords in Serbian STI activities and results across the four analysed data sources. This offers an insight into the topics where STI actors are currently active and engaged, as well as an understanding of the diversity of challenges and disciplines involved.

Table 31 presents the rank of Goal 2-related STI activities in relation to the rest of the goals. For publications and H2020 projects, the rank and share in the EU-27 provide a notion of relative specialisation.

The share of Goal 2-related scientific publications (1.4%) is similar to that of EU-27 countries (1.2%), but relatively smaller than in EU-13 countries (2.3%), which points at a lack of critical mass in relation to neighbouring societies. With regard to the scientific impact, 7% of Goal 2-related publications have been published in the TOP10% journals, below the average for the rest of the goals (10.2%), manifesting a potential lack of international relevance. On the contrary, within their disciplines, Goal-2 related topics are relatively well-cited, with an NCI of 1.3.

In relative terms, Goal 2-related actors are very active in R&I European funding – proof of international competitiveness and relevance. In addition, entrepreneurial innovation capacity is very high, with Goal 2 ranking 1st in Innovation Fund projects and 3rd in patenting.

With regard to the disciplinary distribution, the share of publications across subject areas shows a relative lack of contribution in Environmental Science and Social Sciences, pointing to a knowledge gap, with a higher contribution in Engineering and Chemistry, pointing at STI potential.

In H2020 funding, as across all sectors in Serbia, Goal 2-related actors have a harder time obtaining MSCA, Innovation in SMEs and ERC funding in particular.

TABLE 30 *Analysis of the main challenges at target level*

Target		Priority	Distance to frontier	
		In Serbian SDG-related assessments and policy documents	Statistical assessment of the gap in the SDG indicators with EU countries, 100 = wider gap. *Serbia is represented by the coloured bar*	
2.1	By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round	**Low**	**63**	
2.2	By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons	**Medium**	–	
2.3	By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment	–	–	
2.4	By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	–	–	
2.5	By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed	–	**52**	

2.a	Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries	-	-	
2.b	Correct and prevent trade restrictions and distortions in world agricultural markets, including through the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in accordance with the mandate of the Doha Development Round	-	-	
2.c	Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility	-	46	

Source: Authors', based on selected documentation and the UN Global SDG Indicators Database.

FIGURE 24 ***Goal 2** main SDG-related keywords across all data sources*

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

TABLE 31

Goal 2 rank and share in the STI analysis

Publications (out of 16 goals)		Horizon 2020 (out of 14 goals)		Innovation Fund (out of 11 goals)	Patents (out of 10 goals)
12th	12th	4th	7th	1st	3rd
1.4% Serbia	1.2% EU-27	9.2% Serbia	2.7% EU-27	10.5% Serbia	5.4% Serbia

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

TABLE 32 *STI analysis of **Goal 2** by data source*

		Distinctive STI potential	Relevant knowledge gaps
In scientific publications		The top 3 disciplines producing research thematically related to Goal 2 are Agricultural and Biological Sciences, Environmental Science and Medicine. In Agricultural and Biological Sciences, the share of publications in Serbia is very similar to that of EU-27 and EU-13 countries, so no specific gap or advantage can be observed. Meanwhile	
		Serbia presents a higher specialisation, showing relative STI potential in: ■ Medicine (vs the EU-13) ■ Engineering ■ Chemistry ■ Chemical Engineering.	Serbia presents a lower specialisation, showing a relative gap, in: ■ Environmental Science ■ Social Sciences ■ Immunology and Microbiology ■ Computer Science.
In patents		The patents classified into Goal 2 present capacities related to agricultural and food industry machinery, improved production processes and new food products, with contributions from Mechanical Engineering, Chemistry and Biotechnology. Actually, the patent class 'Chemistry, metallurgy' is the most present in Serbian patents, with a proportion much higher than in EU-27 countries.	
In nationally-funded R&I projects (Innovation Fund)		The large number of Goal 2-related Innovation Fund projects address topics, and thus show entrepreneurial innovative potential in sustainable agriculture, functional and healthy food, chemistry for food safety, food quality and better and more efficient agricultural production techniques, for instance 'smart planning of sowing' or 'new system for cultivating organic plants and mini-vegetables in urban home conditions'.	
In EU-funded R&I projects (Horizon 2020)		Serbian institutions have obtained 22 Goal 2-related H2020 projects – a significant number. STI actors have a harder time obtaining MSCA, Innovation in SMEs and ERC funding in particular. Projects cover the entire value chain, from crop yield, ecological farming and sustainable agriculture to food production, nutrition security and safe and healthy food.	

4.8. Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all

Table 33 presents the main challenges identified in the policy document analysis and the statistical assessment at target level. This provides further detail on the topics to be addressed by STI actors and activities in Goal 7.

For a finer-grained view of the content of the goal-oriented STI activities, the keyword cloud in *Figure 25* presents the most frequent Goal 7 SDG-related keywords in Serbian STI activities and results across the four analysed data sources. This offers an insight into the topics where STI actors are currently active and engaged, as well as an understanding of the diversity of challenges and disciplines involved.

Table 34 presents the rank of Goal 7-related STI activities in relation to the rest of the goals. For publications and H2020 projects, the rank and share in the EU-27 provide a notion of relative specialisation.

The share of Goal 7-related scientific publications (3.2%) is smaller than that of EU-27 countries (3.8%) and significantly smaller than in EU-13 countries (7.3%), which points at a lack of scientific critical mass in relation to neighbouring societies. With regard to the scientific impact, 24% of Goal 7-related publications have been published in the TOP10% journals – the highest of all goal-related STI ecosystems. Thus, Serbia has a great scientific base supporting Goal 7-oriented transformations, but this base has ample room to grow in size.

With regard to the disciplinary distribution, the share of publications across the top subject areas (Engineering, Energy, Environmental Science) is quite similar to that of the EU-27 and EU-13 countries. Below this, Serbia presents a lower specialisation in Physics, Materials Science, Computer Science (compared to the EU-27) and Agricultural and Biological Sciences (compared to the EU-13).

The share of H2020 projects is similar to that of the EU-27 and EU-13 baselines, pointing at a targeted STI ecosystem capable of partnering and competing internationally, most projects clustering under the Societal Challenges pillar - Energy programme. In H2020 funding, as across all sectors in Serbia, Goal 2-related actors have a harder time obtaining MSCA, Innovation in SMEs and ERC funding in particular.

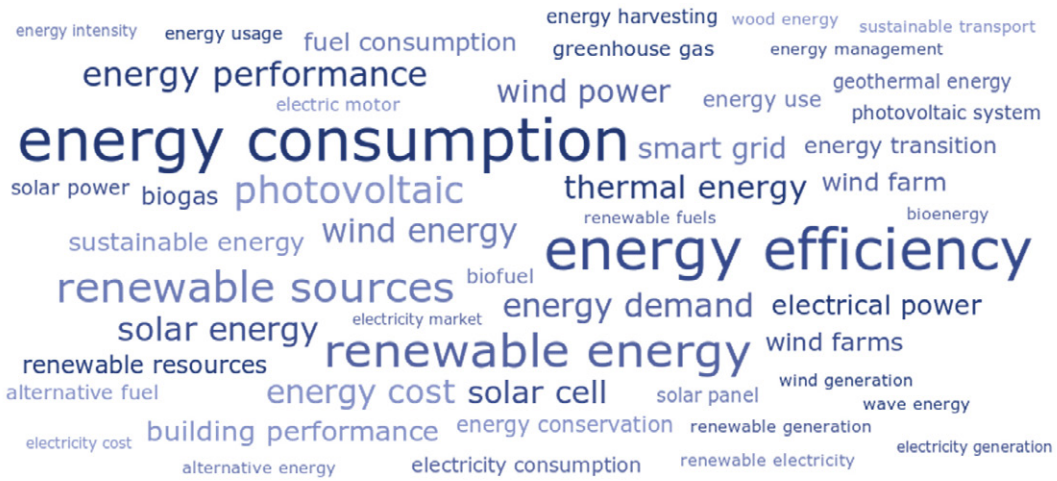
Goal 7 ranks 2nd across all SDGs in number of related Innovation Fund projects (9.3% of the total) and 1st in patents (9% of the total). The entrepreneurial innovation and technological capacity is unparalleled.

TABLE 33 *Analysis of the main challenges at target level*

Target		Priority	Distance to frontier	
		In Serbian SDG-related assessments and policy documents	Statistical assessment of the gap in the SDG indicators with EU countries, 100 = wider gap. *Serbia is represented by the coloured bar*	
7.1	By 2030, ensure universal access to affordable, reliable and modern energy services	**Low**	-	
7.2	By 2030, increase substantially the share of renewable energy in the global energy mix	**Low**	**57**	
7.3	By 2030, double the global rate of improvement in energy efficiency	**Low**	**100**	
7.a	By 2030, enhance international co-operation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology	**Low**	-	
7.b	By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support	-	-	

Source: Authors', based on selected documentation and the UN Global SDG Indicators Database.

FIGURE 25 ***Goal 7*** *main SDG-related keywords across all data sources*



Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

TABLE 34

Goal 7 rank and share in the STI analysis

Publications (out of 16 goals)		Horizon 2020 (out of 14 goals)		Innovation Fund (out of 11 goals)	Patents (out of 10 goals)
2nd	2nd	2nd	1st	2nd	1st
3.2% Serbia	3.8% EU-27	13.3% Serbia	12.2% EU-27	9.3% Serbia	9.0% Serbia

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

TABLE 35 *STI analysis of **Goal 7** by data source*

		Distinctive STI potential	Relevant knowledge gaps
In scientific publications		With regard to the disciplinary distribution, the share of publications across the top subject areas (Engineering, Energy, Environmental Science) is quite similar to that of the EU-27 and EU-13 countries.	
		Serbia does not present specialisation in any scientific discipline, probably due to the smaller relative size of the scientific ecosystem.	Serbia presents a lower specialisation, showing a relative gap, in: ■ Physics and Astronomy ■ Materials Science ■ Computer Science (vs the EU-27) ■ Agricultural and Biological Sciences (vs the EU-13).
In patents		The patents classified in Goal 7 present capacities related to renewable energies (wind, solar, hydro, wave) for electricity and hot water production, energy efficiency, thermal-electrical machines, smart grids and the impact of these developments on a reduced footprint and fewer greenhouse gas emissions.	
In nationally-funded R&I projects (Innovation Fund)		Goal 2-related Innovation Fund projects address topics, and thus show entrepreneurial innovative potential in renewable and greener energy (from production to consumption), thermal machines and in a diverse set of solutions energy efficiency / reduction in energy consumption in different technologies and sectors, notably agri-food, heavy industries and ICT.	
In EU-funded R&I projects (Horizon 2020)		Serbian institutions have obtained 32 Goal 7-related H2020 projects. In H2020 funding, as across all sectors in Serbia, Goal 2-related actors have a harder time obtaining MSCA, Innovation in SMEs and ERC funding in particular. Projects cover the whole energy sector and consumption chain, including: renewable production, smarter and more efficient grids, energy efficiency and consumption reduction and greener transport.	

5. Identification of national and international SDG-oriented STI collaboration networks

Research and innovation ecosystems are collaborative in nature. Addressing the SDGs requires collaboration, co-mobilisation and transformative policy reforms, well beyond the strict R&I systems: the quadruple helix is key. In coherence with this, Goal 17. Partnerships for the Goals aims to 'Strengthen the means of implementation and revitalize the global partnership for sustainable development'.

One of the key research questions of the project is 'Which international STI collaboration networks and partnerships match the identified knowledge gaps and potentials?'. To tackle this question, three main elements will be combined for each goal:

- a quantitative analysis of the relative size of the SDG-oriented STI communities (based on the specialisation index), as well as the absolute number of engaged actors, to assess the critical mass and the potential need for international collaboration;
- a visual interpretation of the collaboration networks depicting the main actors engaged in each goal, and their typology within the quadruple-helix. Collaborations are as follows:
  - co-authorship of publications
  - co-participation in an H2020 or Innovation Fund project
  - co-patenting.

Collaborations have been weighted across the data sources to offset the different size of the datasets;

- additional information on international projects and venues where Serbian actors participate and existing platforms that could support international collaboration on the SDGs.

For further information, and to support actor mobilisation in the context of STI roadmaps for the SDGs, as well as in the Smart Specialisation entrepreneurial discovery process, additional material in the final report provides a comprehensive list of the top national and international actors engaged in each goal, and a separate focus on private companies.

5.1. Goal 1. End poverty in all its forms everywhere

With only 133 publications and 5 H2020 projects, the Goal 1 STI community is rather small. The scientific specialisation index is slightly below EU-27 and EU-13 baselines, so more local actors could be mobilised, and there is ample room for international collaboration. In addition, the percentage of Goal 1-related publications in TOP10% journals is well below the national average, revealing a potential need for international scientific collaborations and contributions to the topic.

In this goal, as in other society-oriented goals, local engagement and quadruple-helix collaboration in transformative change is key. The following collaboration network presents the actors most engaged in STI activities and results related to Goal 1 (by volume). The inner circle corresponds to Serbian institutions (top 15), the outer to international institutions (top 15). The colour of the nodes represents the typology of actors.

The network is mainly populated by universities, research organisations and the public sector (both public administration and public healthcare institutions). Given the nature of the goal, the small presence of relevant 'Other' actors (NGOs, not-for-profits, foundations, etc.) as well as private companies may limit the impact and engagement of Goal 1-oriented activities and a path of entrepreneurial innovation addressing poverty issues. How to support private actors in engaging in science and innovation activities oriented towards social goals is a key element of discussion. In this regard, the Prostor Association and the Shelter for Adult and Elderly Persons could be interesting case studies.

In addition, the similar relative size of the nodes manifests a rather 'horizontal' network, not dominated by volume by any institution.

To support international collaboration, further efforts should be made to access Goal 1-related Horizon 2020 / Horizon Europe funding, targeting the programmes with a larger number of projects in Goal 1: MSCA, Innovation in SMEs, the ERC and the Societal Challenges Pillar.

The 'Social Economy' working area, within the JRC-promoted S3 Thematic Platform 'Industrial Modernisation', would be a good venue to foster Goal 1 international collaboration in Smart Specialisation.

TABLE 36

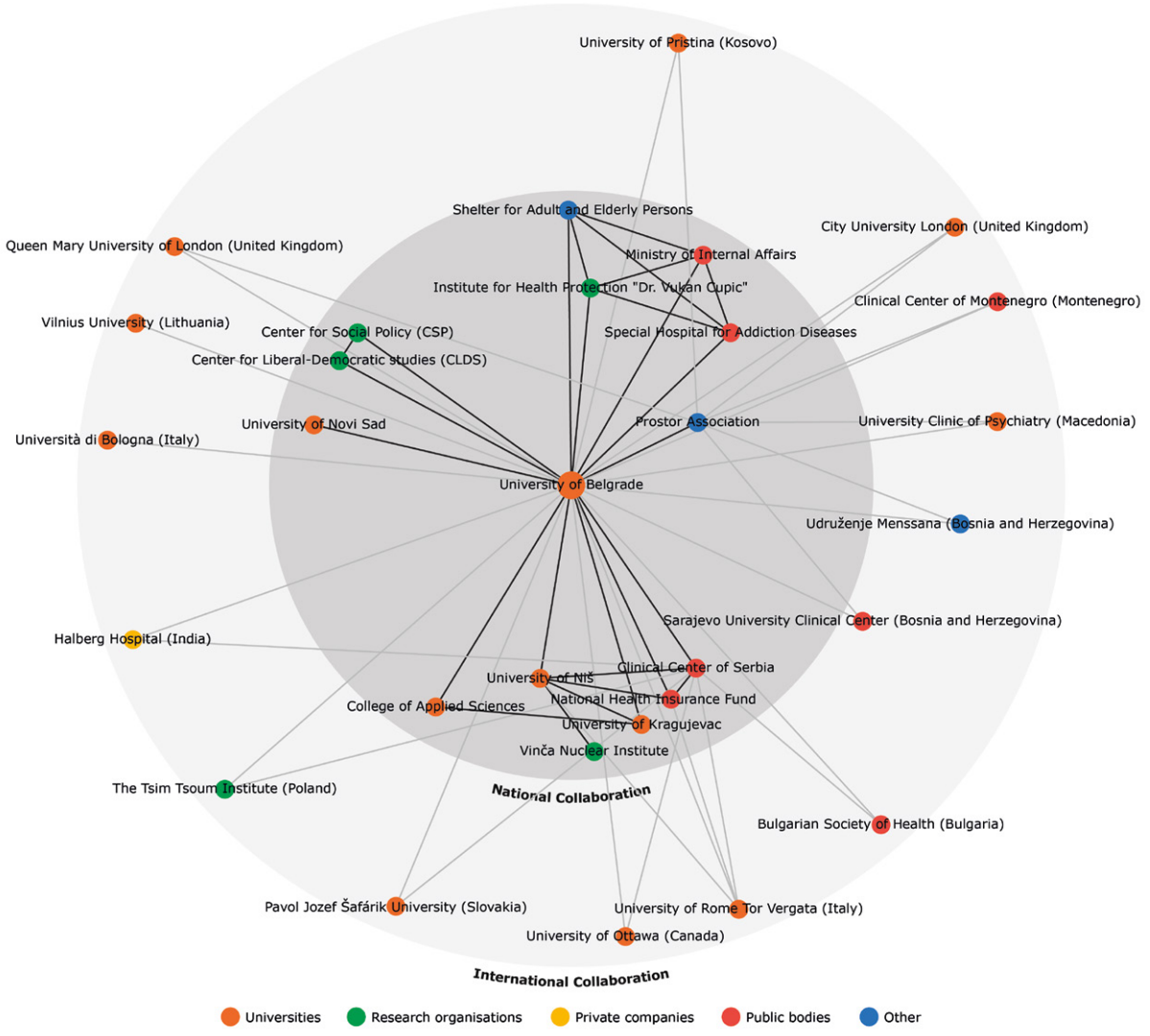
Active organisations in **Goal 1**-related STI activities

No. of **organisations** in **publications**		No. of **organisations** in **Horizon 2020**		No. of **organisations** in **Innovation Fund**	No. of **organisations** in **patents**
31	**61**	**5**	**85**	**1**	**-**
National	International	National	International	National	National

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

FIGURE 26

***Goal 1**-related STI collaboration network presenting the TOP 15 Serbian institutions and TOP 15 international partners*



Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

5.2. Goal 3. Ensure healthy lives and promote well-being for all at all ages

The national STI ecosystem addressing Goal 3-related topics is relatively large, producing 1 703 publications and 58 patents, although relatively smaller in funded R&D projects, as expressed by a small specialisation index in H2020 and a modest share of projects in the Innovation Fund. The percentage of Goal 3-related publications in TOP10% journals is below the national average, revealing a potential need for international scientific collaborations and contributions. At the same time, the NCI is very high, so Serbian life science and healthcare actors engaged in SDG-related topics are comparatively well-cited in their disciplines – a good base for further activity and growth.

The national collaboration network is strongly connected, with selected universities and the Clinical Center of Serbia acting as clear hubs.

This 'academic-clinical' orientation of the national network is also observed in the international collaborations, mainly populated by universities and hospitals.

The presence of private companies is small, with Protech Integra as the most active company in the ecosystem. As in Goal 1, further efforts could be necessary to foster the diversification of the typologies of actors engaged in Goal 3-oriented innovation. The Serbian Cluster of Medical and Health Tourism and the Center for organic production Selenča could engage in and support this process.

As previously commented, given the size of the STI ecosystem, Serbia is not very active in Horizon 2020. Serbia has difficulty in obtaining funding from the MSCA, the Innovation in SMEs and the ERC programmes, which support a large number of Goal 3-related projects in Europe, but not in Serbia. Fostering participation of the Serbian life sciences and healthcare-oriented institutions in these programmes would increase connections, and most probably scientific excellence and the capacity to lead local transformation processes.

Several JRC Thematic Platforms could be good venues to support international cooperation in Goal 3-related Smart Specialisation: 'Medical Technologies', 'Personalised Medicine' and 'Social Economy'.

The EU's Consumers, Health, Agriculture and Food Executive Agency supports international collaboration projects with an innovative dimension through the Health Programme, 'a funding instrument to support cooperation among EU countries and underpin and develop EU health activities'. Serbia participates in some of these projects, which can serve as a nucleus for further collaboration and actor mobilisation in Goal 3-related topics, the following in particular.

TABLE 37

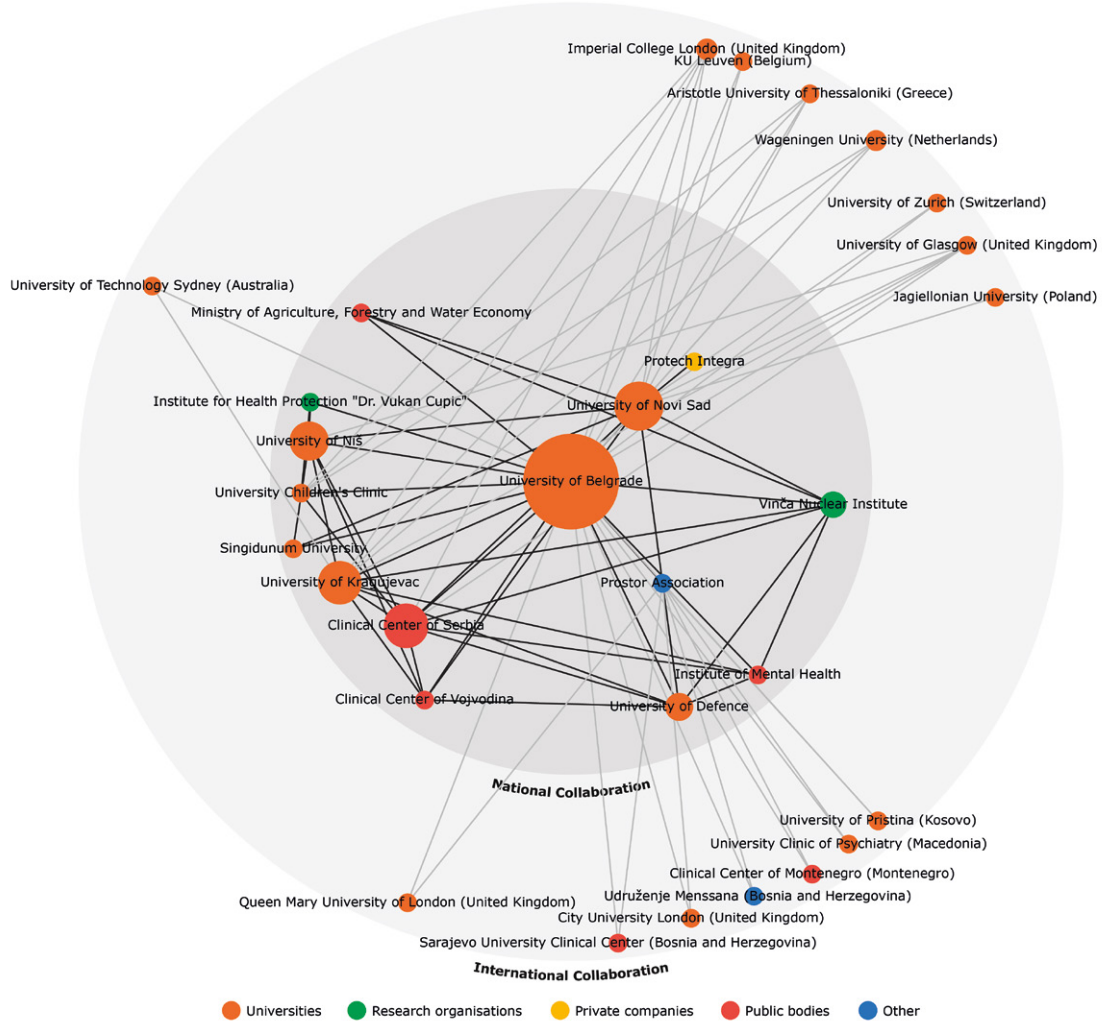
Active organisations in **Goal 3**-related STI activities

No. of **organisations** in **publications**		No. of **organisations** in **Horizon 2020**		No. of **organisations** in **Innovation Fund**	No. of **organisations** in **patents**
167	**2 380**	**6**	**96**	**9**	**4**
National	International	National	International	National	National

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

FIGURE 27

***Goal 3**-related STI collaboration network presenting the TOP 15 Serbian institutions and TOP 15 international partners*



Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

TABLE 38

Identifier	Title
848096	Strengthened International HeAlth Regulations and Preparedness in the EU - Joint Action
801495	European Joint Action on Vaccination
801600	Joint Action Health Equity Europe
801558	Joint Action supporting the eHealth Network
801493	Preparedness and action at points of entry
801520	Innovative Partnership for Action Against Cancer
801553	Information for Action
761297	Joint Action on Tobacco Control
761319	Joint Action on integrating prevention, testing and linkage to care strategies across HIV, viral hepatitis, TB and STIs in Europe (INTEGRATE)
761307	CHRODIS PLUS – Implementing good practices for chronic diseases

Source: Authors', based on CHAFEA data.

5.3. Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

The scientific community oriented towards Goal 4 is not small, with 434 publications in the period. While small in number (5 and 4), given the social orientation of the goal, the share of H2020 and Innovation Fund projects demonstrate an active ecosystem.

The percentage of Goal 4-related publications in TOP10% journals is below the national average, and the NCI, at 0.79, is the lowest of the SDG goals, revealing:

- a possible need for international scientific collaborations and contributions;
- a possible need to steer Serbian scientific disciplinary leaders towards SDG-related research topics.

The universities dominate the collaboration network, although the large number of private companies, both within the national ecosystem and external partners, must be noted. Given the social orientation of Goal 4, a higher presence of 'Other' actors (NGOs, not-for-profits, foundations, etc.) could be desirable to increase the local reach, engagement and impact of the STI activities.

At European level, Erasmus+ is the main programme fostering educational activities and exchange. Serbia is fairly active in the programme, with 2 583 *projects* in the 2014-2019 period; this wealth of activities could catalyse local and international collaborations addressing Goal 4.

TABLE 39

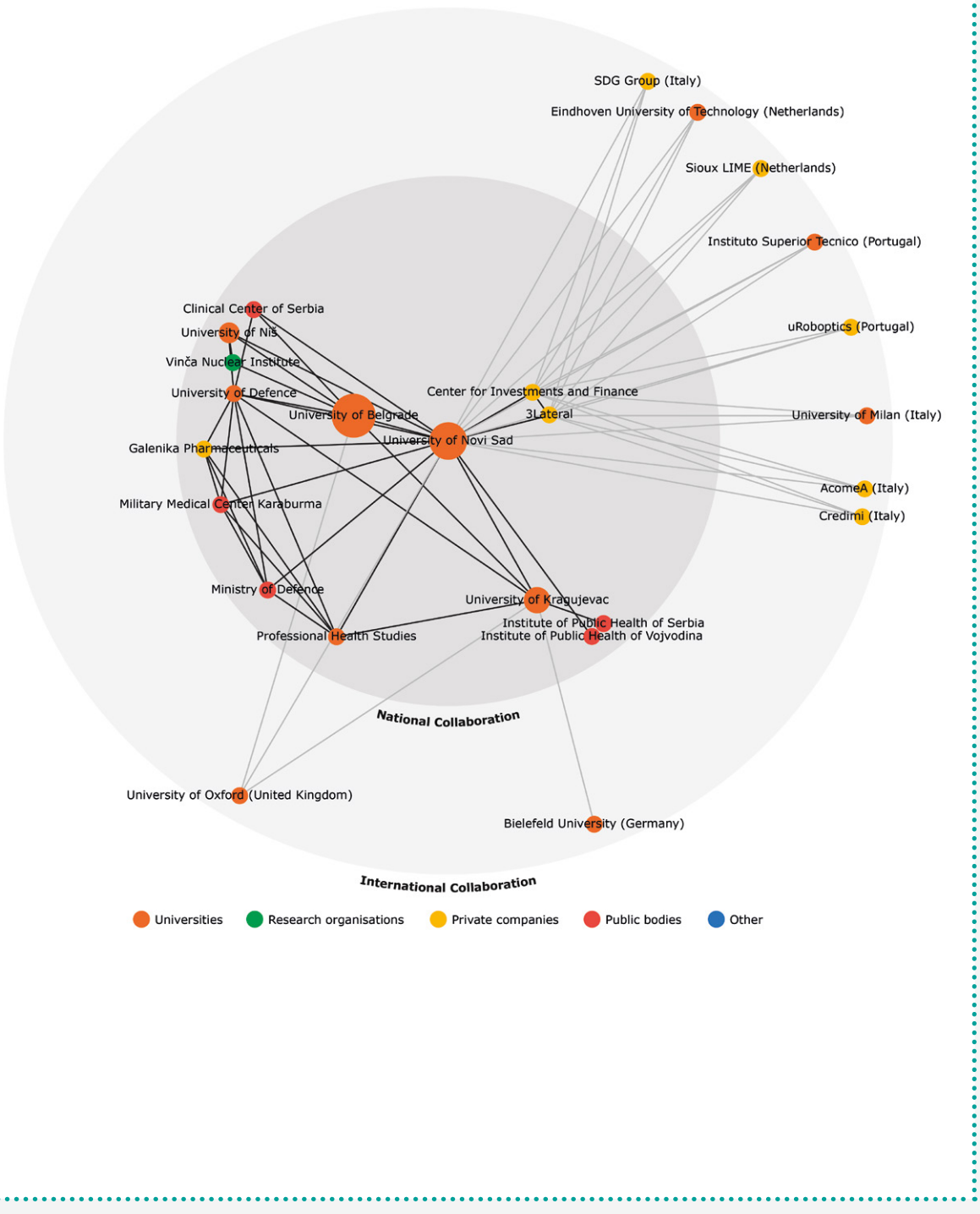
Active organisations in **Goal 4**-related STI activities

No. of **organisations** in **publications**		No. of **organisations** in **Horizon 2020**		No. of **organisations** in **Innovation Fund**	No. of **organisations** in **patents**
71	**283**	**6**	**46**	**3**	**-**
National	International	National	International	National	National

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

FIGURE 28

***Goal 4**-related STI collaboration network presenting the TOP 15 Serbian institutions and TOP 15 international partners*



Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

5.4. Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

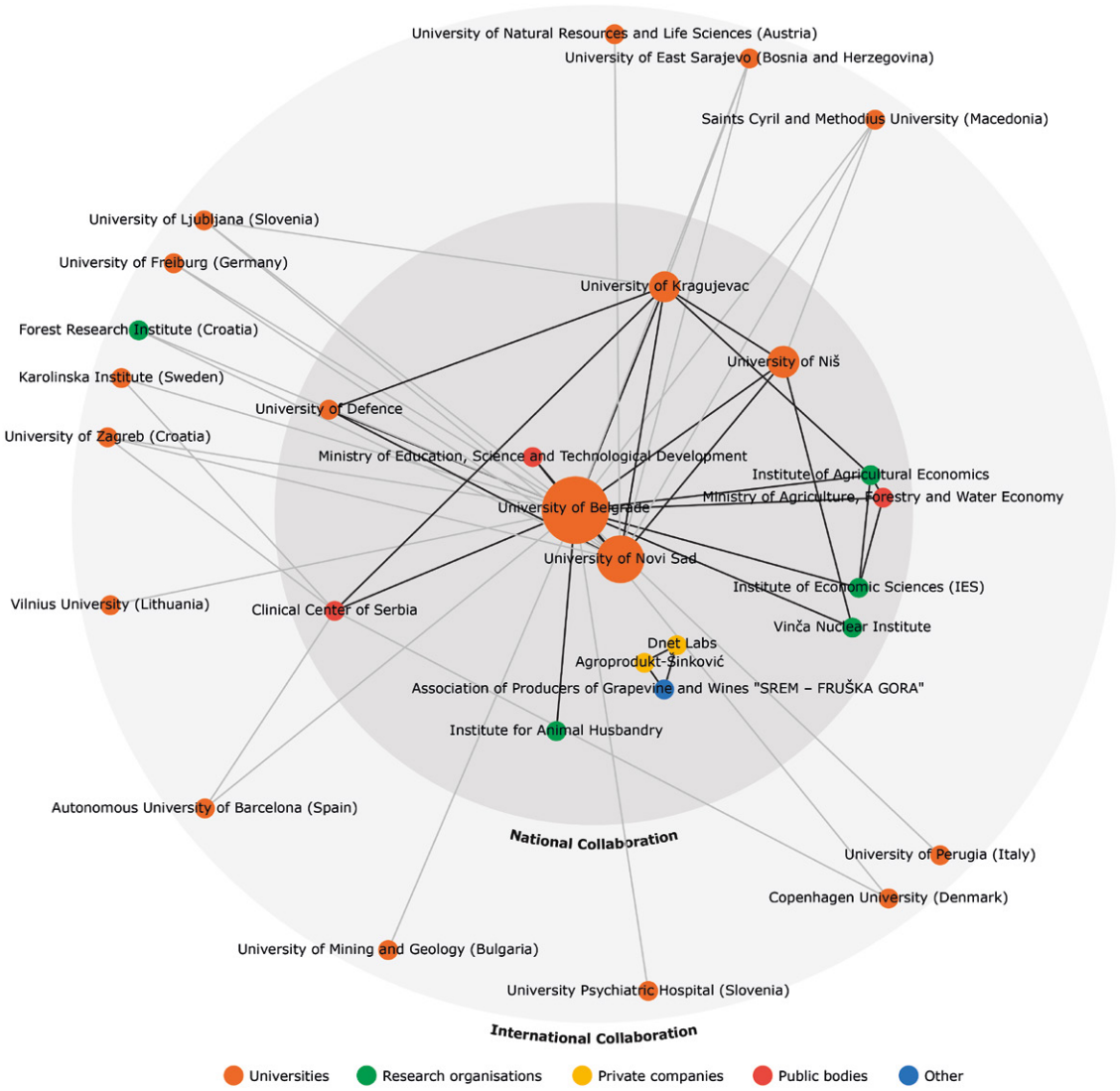
The scientific community oriented towards Goal 8 is mid-sized, with 614 publications in the period. The specialisation index is on par with the EU-27, but smaller than in the EU-13. This could point to a need for further activity, and thus potential for collaboration with neighbouring countries in Goal 8-related research and innovation.

Horizon 2020 projects, Innovation Fund projects and patents have not been classified into Goal 8 since their nature and the content of the goal are closely related, which yields haphazard results. Thus, the following collaboration network only corresponds to co-authorships in scientific publications, and is therefore biased towards academic research rather than other types of STI capacities and activities. The networks presented in the other goals analysed in the current chapter contribute to the identification of national and international partners and linkages that can indirectly 'Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all' – the aim of Goal 8.

The national collaboration network is dominated by academic institutions (predominantly universities, and research institutes) but there is a relevant presence of public administrations (competent ministries), business associations and companies. Strong international links are present with Croatia, Italy, Spain, Slovenia and Germany.

FIGURE 29

***Goal 8**-related STI collaboration network presenting the TOP 15 Serbian institutions and TOP 15 international partners*



Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

5.5. Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation

The specialisation index of Goal 9-related scientific publications is 0.9 in comparison to the EU-27 and the EU-13 and the percentage of TOP10% journals is below the national average, revealing a possible need for further scientific international connections and contributions from foreign partners.

Horizon 2020 projects, Innovation Fund projects and patents have not been classified into Goal 9 since their nature and the content of the goal are closely related, which yields haphazard results. Thus, the following collaboration network only corresponds to co-authorships in scientific publications, and is therefore biased towards academic research rather than other types of STI capacities and activities. The networks presented in the other goals analysed in the current chapter contribute to the identification of national and international partners and linkages that can '[...] promote inclusive and sustainable industrialization, and foster innovation' – the aims of Goal 9.

The University of Belgrade and the University of Novi Sad are the prominent actors in the national collaboration network. Thematic institutes such as the Vinča Nuclear Institute, RT-RK Institute For Computer Based Systems or the Institute of Agricultural Economics also play a relevant role. An appropriate number of private companies emerge within the ecosystem, connected to the universities of Kragujevac, Nis and Belgrade.

The presence of development and intermediate institutions – key in fostering innovation – such as the Serbian Chamber of Commerce, Business Incubator Novi Sad or the Development Agency of Serbia, is also noteworthy.

At international level, the top partner institutions are in Montenegro, Bosnia and Herzegovina, Croatia, North Macedonia and Slovenia; however, in aggregate, the largest number of Goal 9-related co-authored publications are within the United Kingdom and the United States.

As will be discussed in the next chapter 'Relation between the identified challenges, potentials and knowledge gaps and the Smart Specialisation priority domains in Serbia', actors in the S3 priorities ICT and Future Machines and Manufacturing Systems can be engaged and mobilised to support advances in Goal 9 and, transversally, to support technification and innovative pathways in all sectors.

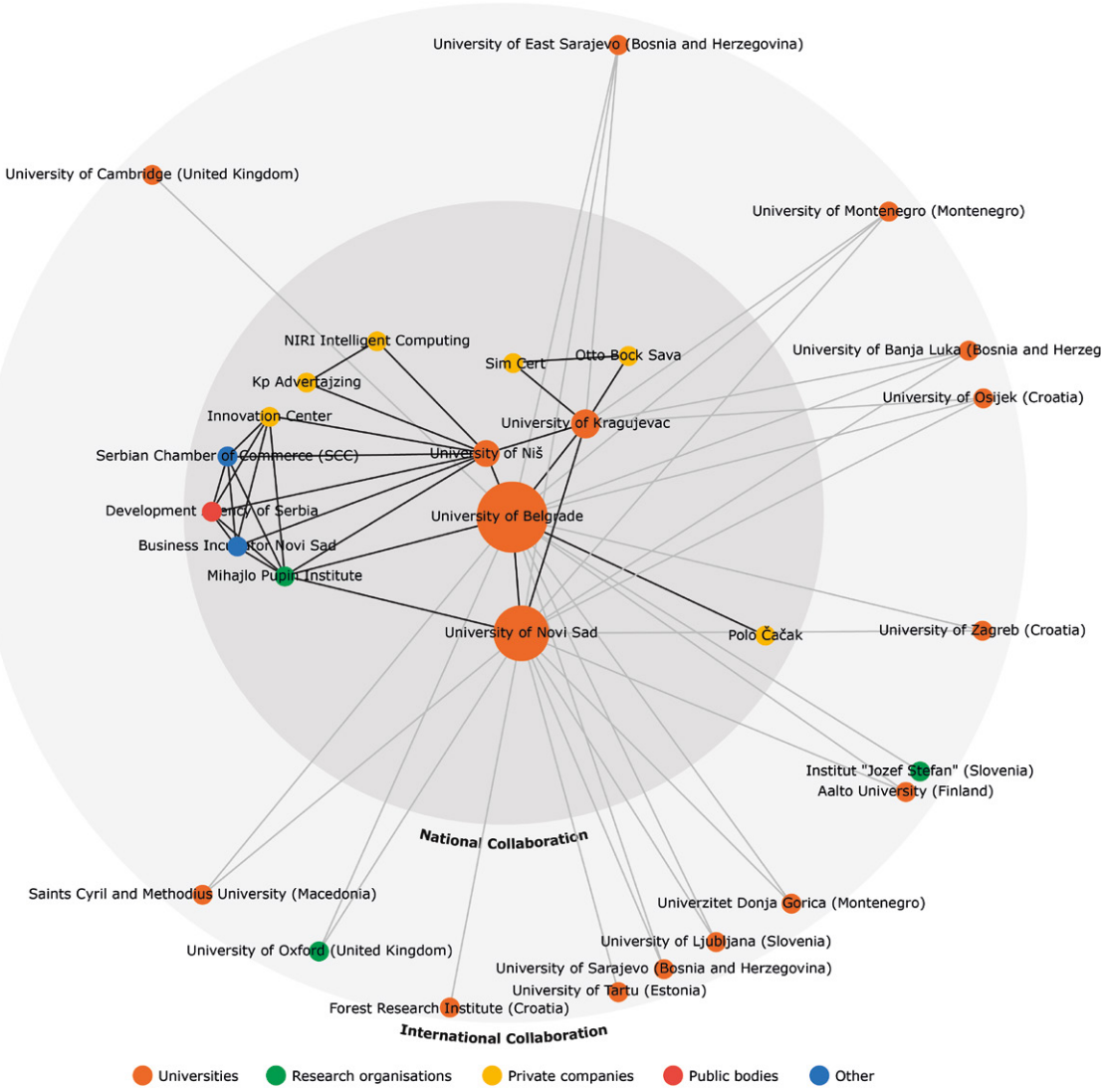
At European level, many working areas of the JRC-promoted S3 Thematic Platform 'Industrial Modernisation' would be suitable venues for international Goal 9-oriented Smart Specialisation collaboration, in particular:

- Artificial Intelligence and Human Machine Interface
- Efficient and Sustainable Manufacturing
- High Performance Production through 3D-Printing
- SME integration to Industry 4.0
- Social Economy
- Advanced manufacturing for energy applications
- New Nano-Enabled Products
- Safe and sustainable mobility.

Serbian actors have difficulty in accessing H2020 funding in the closely related 'Industrial Leadership' pillar. Supporting further participation in these programmes would reinforce the national ecosystem and build links with European and international leading partners.

FIGURE 30

***Goal 9**-related STI collaboration network presenting the TOP 15 Serbian institutions and TOP 15 international partners*



Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

5.6. Goal 10. Reduce income inequality within and among countries

The scientific community oriented towards Goal 10 is not small, with 423 publications in the period and 7 Horizon 2020 projects with Serbian actors.

The share of Goal 10-related H2020 projects (2.5%) is smaller than in EU-13 countries (3.4%), which points at a potential for increased Serbian participation in EU-funded R&I calls, and thus stronger international linkages. Similarly, the share of publications (1.3%) is smaller than the EU-13's (2.2%), so, in comparison with countries with similar socio-economic challenges, there may be a need for increased scientific critical mass.

The international collaboration network in scientific publications is vast, with 1 124 institutions that could connect with and engage in SDG-oriented knowledge sharing and local transformations.

As depicted in the following collaboration network of top national and international actors in Goal 10, the typologies of actors is diverse, with the key participation of two universities (Belgrade and Novi Sad), a series of public administrations and private companies. Given the social orientation of the goal – to support social innovation and transformations – further 'Other' organisations (NGOs, not-for-profits, foundations, etc.) should be engaged and mobilised, as happens in international partnerships.

The 'Social Economy' working area, within the JRC-promoted S3 Thematic Platform 'Industrial Modernisation', would be a good venue to foster Goal 1 international collaboration in Smart Specialisation.

TABLE 40

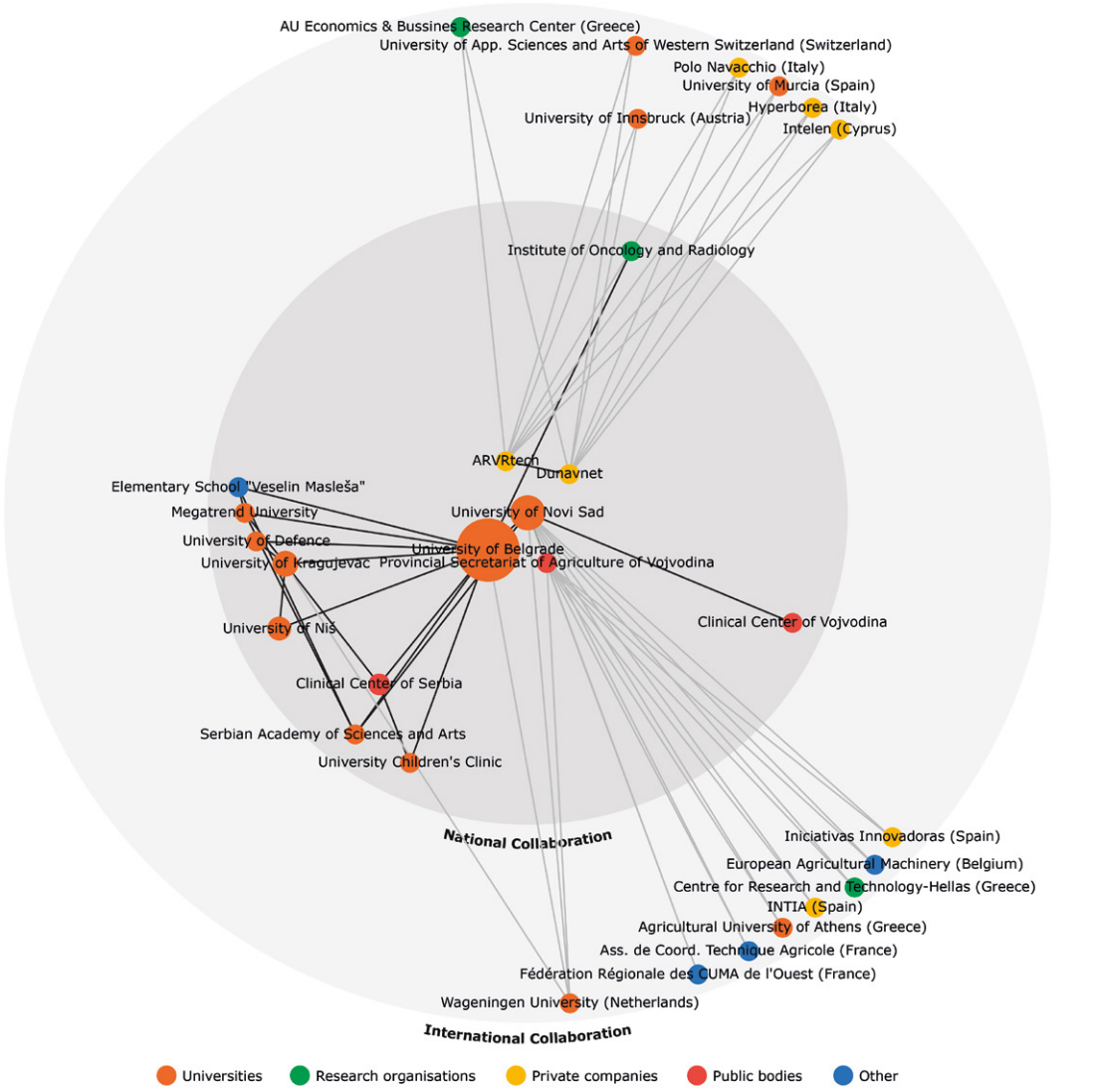
Active organisations in **Goal 10**-related STI activities

No. of **organisations** in **publications**		No. of **organisations** in **Horizon 2020**		No. of **organisations** in **Innovation Fund**	No. of **organisations** in **patents**
83	**1 124**	**7**	**63**	**5**	**-**
National	International	National	International	National	National

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

FIGURE 31

***Goal 10**-related STI collaboration network presenting the TOP 15 Serbian institutions and TOP 15 international partners*



Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

5.7. Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture

The Goal 2-oriented STI ecosystem is mid-sized, producing 432 publications and 38 patents. The scientific research system addressing Goal 2 topics is 40% smaller than in EU-13 countries; there is ample room for growth, given the level of engagement in European projects and the capacity to create patentable innovations, in particular. Due to this small relative size and a lower-than-average percentage of publications in TOP10% journals, international collaborations may be necessary to support Goal 2-oriented STI activities and transformations.

The national collaboration network is rather connected, with Belgrade and Novi Sad universities acting as strong hubs and an interesting number of private companies, research institutions, 'Other' institutions (NGOs, not-for-profits, foundations, etc.) and the presence of the public sector. As evidenced by the selection of Food for Future as one of the Serbian Smart Specialisation priorities, the ecosystem is diverse and entrepreneurial in nature.

The international collaboration networks spread widely, with strong connections to leading western European, eastern and south-eastern European as well as Asian research institutions.

Several Serbian clusters engaged in the agri-food sector could act as catalysts for Goal 2-oriented STI activities and transformations:

- Center for organic production Selenča
- Cluster AGRO START UP
- EUCAAP - European cluster Alpe Adria Pannonia
- Vojvodina organic cluster.

Competitive in H2020, Goal 2-oriented actors are well-embedded in European project networks, counting 22 participations in H2020-funded projects. Furthermore, there is a clear Smart Specialisation collaboration venue in the S3 Thematic Platform 'Agri-Food', which has several lines of relevant activity: Smart Sensor Systems 4 Agri Food, the S3 High Tech Farming Partnership, European Agri-Food Partnership on Nutritional Ingredients, Traceability and Big Data in the agri-food value chain, Consumer Involvement in Agrifood Innovation. The EU's Consumers, Health, Agriculture and Food Executive Agency runs two relevant programmes in this area: Better Training for Safer Food and Promotion of Agricultural Products.

TABLE 41

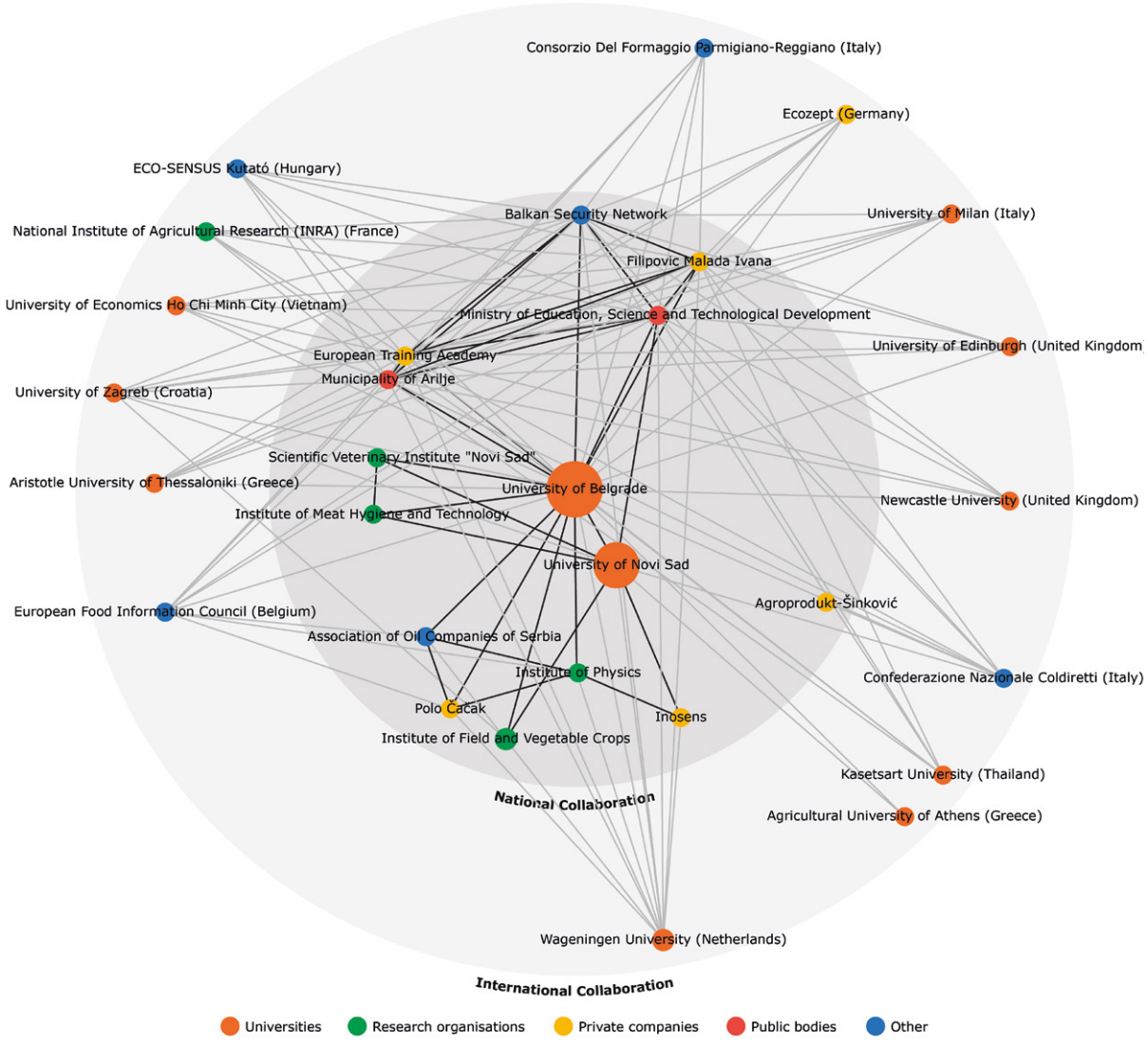
Active organisations in **Goal 2**-related STI activities

No. of **organisations** in **publications**		No. of **organisations** in **Horizon 2020**		No. of **organisations** in **Innovation Fund**	No. of **organisations** in **patents**
58	**927**	**23**	**470**	**20**	**5**
National	International	National	International	National	National

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

FIGURE 32

***Goal 2**-related STI collaboration network presenting the TOP 15 Serbian institutions and TOP 15 international partners*



Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

5.8. Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all

The Goal 7-oriented STI ecosystem is large, producing 1 000 publications (ranking 2nd) and 64 patents (ranking 1st). As previously expressed, Serbian institutions achieve a large scientific impact (24% of publications in the international TOP10% journals – the highest in Serbia), with a smaller specialisation than in EU-27 and EU-13 countries. Thus, the scientific community could and should grow in size.

In the meantime, due to this relatively small size, external collaboration may be necessary to support the SDG-oriented transformations and advance STI opportunities. With 32 Horizon 2020 projects executed by 25 Serbian institutions in partnership with 377 foreign institutions, the international linkages are there.

This is a varied and entrepreneurial ecosystem with many active companies, albeit relatively disconnected from the three universities acting as strong hubs: Belgrade, Novi Sad and Nis. Given the nature of the goal (a transversal input for the economy and a costly utility for final consumers), more public sector and 'Other' institutions (NGOs, not-for-profits, foundations, etc.) could be engaged in STI activities.

The international collaboration network presents clear linkages with nearby countries (Bosnia and Herzegovina, Croatia, Slovenia, Czech Republic, Greece) as well as with more distant European countries (Germany, Italy Spain), Asian countries (notably Malaysia and Iran) and the USA.

Several Serbian clusters engaged in the energy sector could act as catalysts for Goal 7-oriented STI activities and transformations:

- Association 'Cluster for Energy Efficiency'
- Cluster for ecological culture and ecological energy Ecopanonia
- Construction Cluster Dundjer.

There is a clear Smart Specialisation collaboration venue in the S3 Thematic Platform 'Energy', which has several lines of relevant activity: Smart Grids, Solar Energy, Sustainable Buildings, Bioenergy, Marine Renewable Energy, Geothermal Energy.

TABLE 42

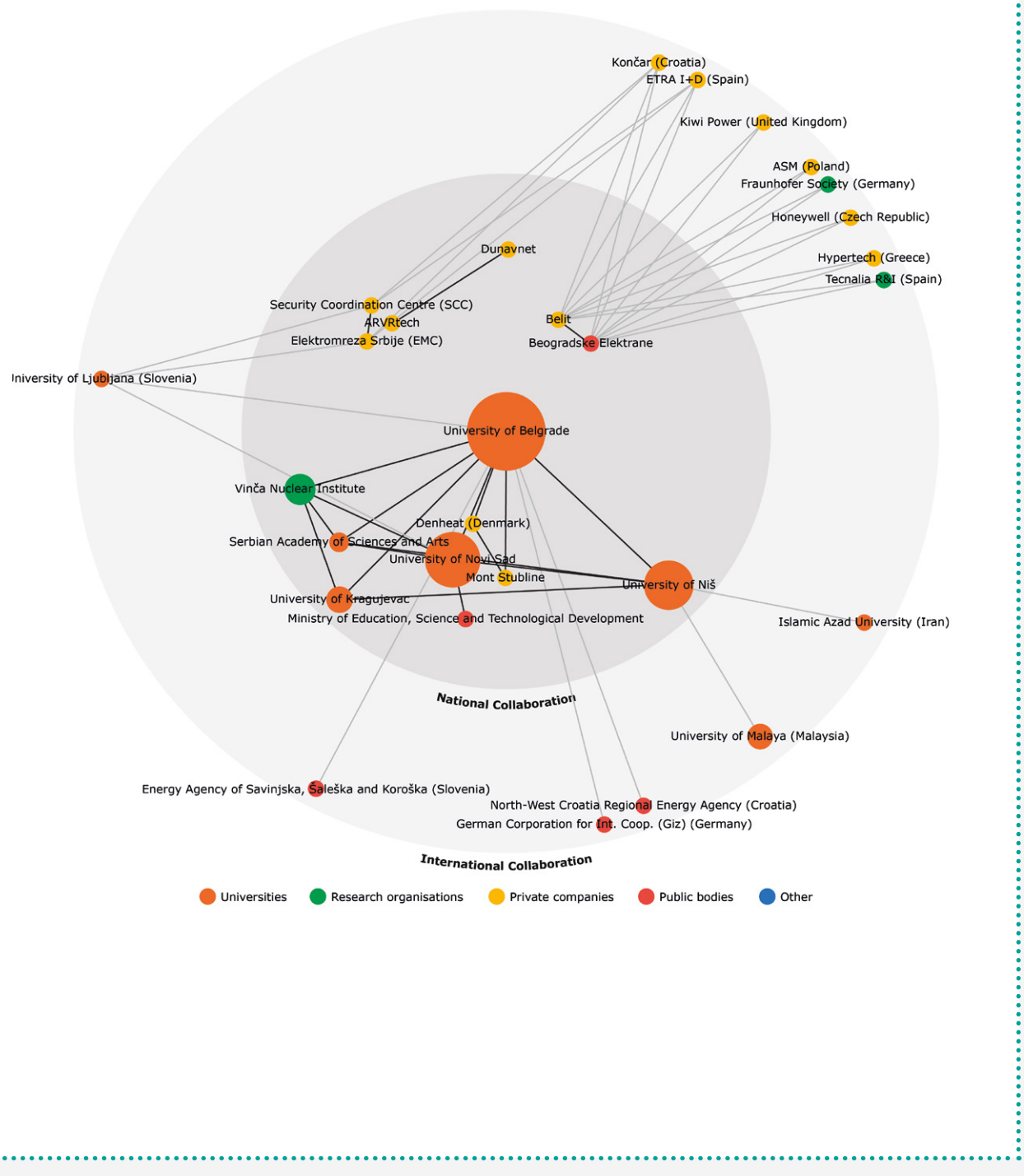
Active organisations in **Goal 7**-related STI activities

No. of **organisations** in **publications**		No. of **organisations** in **Horizon 2020**		No. of **organisations** in **Innovation Fund**	No. of **organisations** in **patents**
103	**330**	**25**	**377**	**18**	**4**
National	International	National	International	National	National

Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

FIGURE 33

***Goal 7**-related STI collaboration network presenting the TOP 15 Serbian institutions and TOP 15 international partners*



Source: Authors', based on Scopus (Elsevier), CORDIS, Innovation Fund and the EPO.

6. Relation between the identified challenges, potentials and knowledge gaps and the Smart Specialisation priority domains in Serbia

This chapter addresses the research question 'How do the identified challenges, potentials and knowledge gaps relate to Smart Specialisation priority domains in Serbia?'.

Firstly, it must be acknowledged that any sector and any technology, through better practices, can make a significant contribution to the Sustainable Development Goals. For instance, better labour practices in the priority areas can have positive impacts on Goals 1, 3, 5, 8, 9 and 11. Better environmental practices can have positive impacts on goals 3, 6, 7, 11, 12, 13, 14, 15.

Beyond these general relationships, which can be true for any sector anywhere, the current analysis will take a narrower look at the identified challenges, potentials and knowledge gaps and the Smart Specialisation priority domains in Serbia, based on the STI analysis.

Generally, the complex nature of the SDG challenges will require formal support and quadruple-helix orchestration since market incentives may be insufficient to steer activities in the desired direction.

Two main directions of action can be identified to address the main challenges within SDGs, and/or to pursue opportunities within the framework of the SDGs from the S3 priority domains:

1. pull capacities from the S3 priorities towards the main challenges in the context of the SDGs;
2. steer and exploit the innovation potential in the S3 priorities towards the SDGs, even if some of these are not priority challenges in Serbia.

In the first case, new investments, new policy measures and new international collaborations can be necessary to address the challenges. In the second case, market incentives (particularly at international level) should be the main driver of new innovations and developments.

Transversally, beyond technological innovation and business development in the context of Smart Specialisation, SDG-oriented transformations must engage in responsible practices (anticipation, reflexivity, inclusion and responsiveness[41]), foster social innovation and be coupled with progressive public policies. This is especially true for higher-priority Goals 1, 4 and 10, which, as shown below, only have an indirect innovative input from the Serbian S3 priorities.

Serbia Smart Specialisation Strategy (4S) priority domains

- Information and Communication Technologies
  - Custom Software Development

41 *Stilgoe, J., Owen, R. & Macnaghten, P., 'Developing a framework for responsible innovation',* Resources Policy, *Vol. 42, 2013, pp. 1568-1580.*

- Software Solutions Development

■ Food for Future

- High Tech Agriculture
- Value Added Food Products
- Sustainable Agri-food Production

■ Creative Industries

- Creative Audio-Visual Production
- Video Games and Interactive Content
- Smart Packaging

■ Future Machines and Manufacturing Systems

- General and specific purpose machines
- Information in the Smart Management Service – Industry 4.0
- Smart Components and Tools

■ Energy Efficient and Eco-Smart Solutions

■ Key Enabling Technologies

Table 43 presents an analysis of the relationship between STI potential and gaps with the four vertical and two horizontal S3 priorities. It also provides a short risk assessment that can help establish principles in the STI roadmaps for the SDGs. It is primarily based on the nature and orientation of the goals' targets, and on the finer-grained STI potential and knowledge/competence gap analysis.

Several of these opportunities were identified by representatives of the S3 working groups corresponding to the four S3 priorities during the Smart Specialisation for Sustainable Development Goals pilot activity workshop in Serbia, Belgrade, on 27 February 2020.

TABLE 43

S3 priority	Potential impact on the main challenges resulting from the SDGs in Serbia
Information and Communication Technologies ■ Custom Software Development ■ Software Solutions Development	**Potential and opportunities** As a transversal priority domain, ICT can play a horizontal role in supporting technification[42] and innovation (Goal 9) and improving employment (Goal 8). During the participatory workshop in Belgrade, representatives of the Smart Specialisation ICT working group cited the following specific SDG-oriented opportunities. Supporting the capacity-building and development of the sections of society which thus far are less digitised, addressing the digital divide. With adequate education, training and labour policies, ICT can produce major economic traction and employment opportunities addressing poverty (Goal 1) and inequality-inclusion (Goal 10) challenges for minorities, population with disabilities and women (Goal 5). Supporting the digitalisation of the public administration, which has a key role in providing common goods and services essential for achieving the SDGs.

42 *The action or fact of making technical; the adoption or imposition of technology or technical methods (Oxford University Press English Dictionary).*

>

Key ICT-related STI opportunities are open, and already being pursued by Serbian companies, in Education (Goal 4) – notably through distant and digitally-enhanced learning (see the finer-grained STI analysis for further details).

A large area of opportunity lies in Good Health and Well-being (Goal 3), through medical devices, e-health and digital health.

Similarly, the medium-priority challenges of Goal 7. Affordable and Clean Energy and 11. Sustainable Cities and Communities, which already present a strong STI ecosystem, offer considerable opportunities for ICT, particularly in the domains of energy efficiency, smart grids, smart cities and sustainable and efficient transportation.

Gaps

As shown in the finer-grained STI analysis, the discipline of Computer Science presents a lower specialisation index in SDG-oriented activities than in the EU-27 and EU-13 countries, in particular. To address this gap, the ICT sector must grow in size and/or focus more attention on SDG-related topics. Nevertheless, this can have an impact on the sector's external competitiveness.

Although many ICT-related projects can be identified in Horizon 2020 and the Innovation Fund programmes, very few of them are related to higher-priority challenges in Goals 1 and 10. From a policy point of view, further support for societal challenge-oriented and social innovation ICT activities could be advisable.

Risks

The main risks associated with ICT in the context of the SDGs are related to automation, potentially leading to unemployment in traditional and lower-added value sectors, low quality employment in some categories, income inequality and the digital divide. Adequate corporate, labour and education policies are necessary to guarantee the positive directionality of ICT development in the context of the SDGs.

Food for Future

- High Tech Agriculture
- Value Added Food Products
- Sustainable Agrifood Production

Potential and opportunities

This is a clear connection between Smart Specialisation priority domain and the STI capacities and opportunities related to the SDGs. Opportunities in Goal 2. Zero Hunger are present in innovations related to agricultural and food industry machinery, improved production processes and new food products, with contributions from Mechanical Engineering, Chemistry and Biotechnology.

During the participatory workshop in Belgrade, representatives of the Smart Specialisation Food for Future working group cited the following specific SDG-oriented opportunities identified during the EDP.

Goal 2 targets 2.3, 2.4 and 2.5 as SDG-oriented development pathways for the sector. The following extractions summarise these pathway opportunities:

- 'By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive re-

sources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment';

- 'By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality';
- 'By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed'.

At the intersection of the Food for Future priority and Goal 2. Good Health and Well-being, safe, healthy and functional food are clear areas of opportunity. In that sense, 'biomedicine' was incorporated into the priority during the EDP.

Climate change (Goal 13.) is seen as a threat, and the sector is aware that it is not technologically prepared to address it.

Responsible consumption and production is also of interest, both as a transversal lever for sectoral improvement as well as to pursue specific market opportunities. In general, through better environmental practices and Sustainable Agri-food Production, this priority can help address challenges in medium-priority goals – 6. Clean Water and Sanitation and 7. Affordable and Clean Energy – as well as having an indirect effect on lower lower-priority challenges Goals 12. Responsible Consumption and Production, 13. Climate Action, 14. Life Below Water and 15. Life on Land.

Through rural development, Food for Future can have a positive impact on higher-priority challenges Goal 1. No Poverty and 10. Reduced Inequalities.

Engineering and Chemistry are the two disciplines where Serbia presents relative strength.

Gaps

The first gap is that, although the Goal 2-related STI ecosystem is active and entrepreneurial, it lacks critical mass in the scientific domain (small specialisation index vs EU-13 countries) and impact: only 7% of Goal 2-related publications have been published in the TOP10% journals, below the average for the rest of the goals (10.2%).

Growth in the Goal 2-related scientific system and increased research collaboration with foreign partners may be necessary to exploit all transformation opportunities.

In particular, there is a gap in Goal 2-related scientific activities in Environmental Science and Social Sciences, which, additionally, could improve the embeddedness and impact of the Food for Future STI activities in the territory.

>

Risks

The main risks associated with Food for Future in the context of the SDGs are related to automation and environmental impact, potentially leading to unemployment in traditional and lower value-added sectors, the destruction of rural livings and income and territorial inequality. Adequate corporate, labour, environmental and cohesion policies are necessary to guarantee the positive directionality of these techno-industrial developments in the context of the SDGs.

Creative Industries

- Creative Audio-Visual Production
- Video Games and Interactive Content
- Smart Packaging

Potential and opportunities

The design and production of interactive content for educational and training purposes can have a crucial impact on higher-priority Goal 4. Quality Education, in the top targets in particular:

- by 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university;
- by 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship.

During the participatory workshop in Belgrade, representatives of the Smart Specialisation Creative Industries working group cited the following specific SDG-oriented opportunities related to:

- measures for a reduction in energy consumption in audio-visual productions, in alignment with Goal 7;
- measures for a reduction in waste production in audio-visual productions (e.g. ***Green Filming***), in alignment with Goal 12;
- Smart and green packaging, in alignment with Goal 12.

There is widespread awareness in the sector of the huge waste production related to packaging. STI activities in smart packaging can bring value in the context of safe and quality food (Goals 2 and 3) as well as a positive environmental impact on lower-priority challenges – Goals 12. Responsible Consumption and Production, 13. Climate Action, 14. Life Below Water and 15. Life on Land. It was commented that adequate legislation could help align actors and accelerate transformations, particularly on the side of the consumer.

As with the ICT sector, the Creative Industries can play a horizontal role in supporting innovation (Goal 9) and improving employment (Goal 8). With adequate training and labour policies, they can produce major economic traction and employment opportunities addressing inequality-inclusion (Goal 10) challenges for minorities, populations with disabilities and women (Goal 5).

Gaps

As shown in the finer-grained STI analysis, the discipline of Arts and Humanities (which includes Design, Fine Arts and Applied Arts) presents a lower specialisation index in SDG-oriented activities than in the EU-13 and EU-27 countries, in particular. To address this gap, the Design and Applied Arts sector must grow in size and/or focus more attention on SDG-related topics. Cultural and social innovation, engaged in local communities and challenges, can be a strong driver in this regard.

>

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Future Machines and Manufacturing Systems

- General and specific purpose machines
- Information in the Smart Management Service – Industry 4.0
- Smart Components and Tools

Potential and opportunities

Future Machines and Manufacturing Systems play a horizontal role in supporting technification in industry and innovation (Goal 9) and improving employment (Goal 8).

STI capacities, activities and technologies related to this priority can contribute to Goal 11. Sustainable Cities and Communities, which already presents a strong STI community. This could be an area of international competitiveness for the economy.

Future Machines and Manufacturing Systems can also support the technification of the agricultural sector, complementing the innovations in Food for Future and contributing to Goal 2. Zero Hunger.

Better production processes and industrial efficiency gains can have positive direct impacts on the environment, particularly in relation to water pollution (Goal 6), energy efficiency (Goal 7) and responsible production (Goal 12), and, indirectly, on the ecosystem (Goals 13, 14 and 15).

To support these transformations, SDG-oriented Engineering capacities in the country appear to be on par with EU-27 and EU-13 countries.

Gaps

The main gap is a notably low scientific specialisation in necessary disciplines such as Computer Science, Mathematics, Materials Science and Physics, as well as in Business and Management.

Furthermore, Serbian institutions have difficulty in competing in H2020's pillars of Excellent Science, Industrial Leadership and Innovation in SMEs, which demonstrates a possible gap in applied sciences and advanced technologies.

For these reasons, this seems to be a domain where investment and further international collaboration are necessary.

Risks

The main risks associated with Future Machines and Manufacturing Systems in the context of the SDGs are related to automation, potentially leading to the destruction of employment in traditional and lower-added value sectors, income inequality and the digital divide between leading companies and the rest of the private sector. Adequate corporate, labour and education policies are necessary to guarantee the positive directionality of these techno-industrial developments in the context of the SDGs.

Energy Efficient and Eco-Smart Solutions

Potential and opportunities

This is a clear connection between Smart Specialisation and the STI capacities and opportunities related to the SDGs. During the participatory workshop in Belgrade, this priority domain was identified by stakeholders as a transversal lever for SDG-oriented transformations in all sectors and vertical priority areas.

This is directly connected to Goal 7. Affordable and Clean Energy, and more loosely connected to Goals 11 and 12, which all present strong and entrepreneurial STI ecosystems.

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The potential is demonstrated by the high impact of related Serbian publications, the capacity to compete in Horizon 2020, the share of Innovation Fund projects and the large number of related patents.

Biotechnology can support the production of energy from agricultural produce and waste. As such, it can provide opportunities related to Goal 2. Zero Hunger.

Energy Efficient and Eco-Smart Solutions can have an indirect positive impact on most social and environmental related goals, in particular Goals 8, 9, 13 and 15.

Gaps

The scientific system related to Goal 7 is particularly small, yet of great quality. Further investment to support the growth of the STI ecosystem, as well as wide collaboration with foreign partners, could be necessary to achieve the desired impact and reach.

Again, Serbia presents a weakness in basic and applied sciences disciplines (Physics, Materials Science, Computer Science, Biochemistry, Genetics and Molecular Biology) that could hamper the efforts.

This gap is further demonstrated by the difficulty in competing in Excellent Science and Industrial Leadership calls in Horizon 2020.

Key Enabling Technologies

Potential and opportunities

Key Enabling Technologies can play an important role in addressing Goals 2, 3, 6, 7, 8, 9, 11, 12 and 13. Serbia presents a relative strength in Engineering, Chemistry and Chemical Engineering.

Gaps

In most goals, Serbia presents weaknesses (lower specialisation index, relatively low impact, difficulty in competing in Excellent Science and Industrial Leadership calls in Horizon 2020) in basic and applied sciences disciplines (Physics, Materials Science, Computer Science, Biochemistry, Genetics and Molecular Biology, Immunology and Microbiology)

Risks

Technology is neutral; it can have positive, negative and unexpected effects on society and the environment. Anticipation and directionality are key to guarantee positive welfare development pathways. Responsible research and innovation practices (inclusiveness, participation, dialogue with representative stakeholders) can help steer technological development in the right direction, and adequate corporate, labour and education policies are necessary to understand, address and mitigate the potential negative effects of technology-based transformations.

As a summary of the previous table, the potential impacts of the Smart Specialisation priority domains in the key challenges in resulting from the SDGs in Serbia are synthetically listed below. Potential and opportunities are classified into direct and indirect. Direct potential and opportunities correspond to specific areas of innovation or application in the priority domains that tackle challenges within the SDGs directly – through science, technology and innovation – in most cases with economic or market potential for private stakeholders. Indirect potential and opportunities correspond to positive societal or environmental externalities which can be produced by the direct ones, and/or to wider developments and improvements in the practices of the priority do-

TABLE 44 *Summary of the potential impact of the S3 priorities on the main challenges resulting from the SDGs in Serbia*

	Information and communication technologies	Food for Future	Creative Industries	Future Machines and Manufacturing Systems	Energy Efficient and Eco-Smart Solutions	Key Enabling Technologies
Goal 1. No Poverty	Indirect	Indirect				
Goal 2. Zero Hunger		Direct	Indirect	Indirect	Indirect	Indirect
Goal 3. Good Health and Well-being	Direct		Indirect		Indirect	Indirect
Goal 4. Quality Education	Direct		Direct			
Goal 5. Gender Equality	Indirect		Indirect			
Goal 6. Clean Water and Sanitation		Indirect		Indirect		Indirect
Goal 7. Affordable and Clean Energy	Direct	Indirect	Indirect	Indirect	Direct	Indirect
Goal 8. Decent Work and Economic Growth	Indirect	Indirect	Indirect	Indirect	Indirect	Indirect
Goal 9. Industry, Innovation and Infrastructure	Direct	Indirect	Indirect	Direct	Indirect	Direct
Goal 10. Reduced Inequalities	Indirect		Indirect			
Goal 11. Sustainable Cities and Communities	Indirect			Indirect	Indirect	Indirect
Goal 12. Responsible Consumption and Production		Indirect	Direct		Indirect	Indirect
Goal 13. Climate Action		Indirect	Indirect	Indirect	Indirect	Indirect
Goal 14. Life Below Water		Indirect	Indirect	Indirect		
Goal 15. Life on Land		Indirect	Indirect	Indirect	Indirect	
Goal 16. Peace, Justice and Strong Institutions						

Source: Authors', based on the Agenda 2030, the STI analysis and the Smart Specialisation for Sustainable Development Goals pilot activity workshop in Serbia, Belgrade, on 27 February 2020.

mains that help tackle ingrained challenges within the SDGs.

Table 44 detail the potential, gaps and opportunities emerging from the Smart Specialisation priority domains in connection with the SDGs. To facilitate the reverse analysis – that is, the main S3-related capabilities that can support innovation and development pathways in the SDGs – *Table 45* presents the top 3 S3 priority domains most closely related to each goal. It is primarily based on the nature and orientation of the goals' targets, and on the finer-grained STI potential and knowledge/competence gap analysis.

TABLE 45 *S3 priority domains most closely related to the Sustainable Development Goals*

Goal	Most closely related S3 priority domains
1. No Poverty	Food for Future Information and communication technologies
2. Zero Hunger	Food for Future Energy Efficient and Eco-Smart Solutions
3. Good Health and Well-being	Information and communication technologies Food for Future
4. Quality Education	Information and communication technologies Creative industries (Education and training is transversal to all)
5. Gender Equality	Information and communication technologies Creative industries (Gender Equality is transversal to all)
6. Clean Water and Sanitation	Food for Future (Sustainable Agrifood Production) Key Enabling Technologies (Biotechnology)
7. Affordable and Clean Energy	Energy Efficient and Eco-Smart Solutions Food for Future
8. Decent Work and Economic Growth	*Transversal to all S3 priority domains*
9. Industry, Innovation and Infrastructure	*Transversal to all S3 priority domains* Information and communication technologies
10. Reduced Inequalities	Food for Future Information and communication technologies
11. Sustainable Cities and Communities	Energy Efficient and Eco-Smart Solutions Information and communication technologies
12. Responsible Consumption and Production	Creative Industries (Smart Packaging) Food for Future (Sustainable Agrifood Production)
13. Climate Action	Energy Efficient and Eco-Smart Solutions Food for Future
14. Life Below Water	Creative Industries (Smart Packaging) Food for Future (Sustainable Agrifood Production)
15. Life on Land	Food for Future (Sustainable Agrifood Production) Creative Industries (Smart Packaging)
16. Peace, Justice and Strong Institutions	*Transversal to all S3 priority domains*

Source: Authors', based on the Agenda 2030, the STI analysis and the Smart Specialisation for Sustainable Development Goals pilot activity workshop in Serbia, Belgrade, 27 February 2020.

7. Conclusions and proposed next steps

In this study, a set of key challenges related to the SDGs in Serbia have been identified at goal and target level. For all of the goals, the most relevant science, technology and innovation potentials and gaps have been described. For the six higher-priority goals (1, 3, 4, 8, 9 and 10), and for two goals with distinctive STI potential within the framework of Smart Specialisation (2 and 7), the STI analysis has been detailed with finer-grained information and insights. Lastly, these findings have been specified for the four vertical and two transversal Smart Specialisation priorities, providing a double entry analysis: from S3 to the SDGs and from the SDGs to S3.

This wealth of evidence allows Serbian policy-makers and stakeholders to mobilise in two main directions to address SDG-related challenges and to pursue innovation and development opportunities within the framework of the SDGs, as follows.

1 In SDG challenges with sufficient capacities in the Serbian STI ecosystem

a. Mobilise the knowledge and private sector in pursuing SDG-oriented innovations, particularly within the framework of the Smart Specialisation priorities, benefiting from the entrepreneurial discovery process and the funding and implementation of support programmes.

b. Mobilise and leverage the expertise of the knowledge sector, the public sector and not-for-profits in localising solutions to the SDG challenges in better public policy, social innovation and social, economic and sustainability transformations.

2 In SDG challenges presenting STI knowledge or competence gaps within the Serbian STI ecosystem

a. Build capacities in the public, private and third sector, which requires longer-term science and innovation policy within the framework of STI roadmaps for the SDGs.

b. Support partnerships with international actors to import skills and accelerate the capacity-building of local actors.

c. Leverage SDG-related assessments and policy design to advance scientific knowledge and build linkages between the existing actors.

Simultaneously, in SDG-related topics which have been found not to be of the highest national priority, Serbian STI actors can still find opportunities for innovation and growth. In these areas, international competitiveness and leadership are essential, in perfect alignment with Smart Specialisation's pursuit of a competitive advantage.

The complex nature of the SDG challenges requires orchestration and a more diverse engagement of quadruple-helix actors. New forms of transformative public policy, with the public sector and civic society leadership role, may be necessary to address the most wicked challenges, particularly in areas where market incentives are missing. For this, sharing experiences and capacities from international partners that are already connected to Serbian actors could be of great value.

In parallel, it must be noted that any sector can make relevant contributions to the Sustainable Development Goals, since all sectors are embedded and have impacts on the economic, social and environmental spheres. As such, beyond specific STI activities and policies, adequate corporate, labour, discrimination, education, environmental policies and regulations (amongst others), as well as key infrastructures, are necessary to advance the SDGs across the board.

Scientific and technological developments are intrinsically neutral. They can be used for good or for bad and produce unplanned positive or negative effects. In the context of the Agenda 2030, science and innovation policy must be attentive to the directionality of innovation[43] for which public debate in a wider social engagement is necessary. Principles and methods of responsible research and innovation, open science and innovation, policy transparency and, above all, diverse participation can help steer innovation towards more inclusive and sustainable development pathways, and make the most of science, technology and innovation to achieve the SDGs.

43 *Schot, J. & Steinmueller, W. E., 'Three frames for innovation policy: R&D, systems of innovation and transformative change',* Resources Policy, *Vol. 47, 2018, pp. 1554-1567.*

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ANNEX.I

Main STI potential and gap analysis indicators

TABLE A.1

Goal	Identification of main challenges resulting from the SDGs in Serbia				Science technology and innovation analysis											
					Publications						Horizon 2020 project		Innovation Fund project		Patent families	
	Goal priority level	Documentary analysis	Gap in statistical indicators vs EU-27 leaders		No.	%	S.I. vs EU-27	S.I. vs EU-13	% in TOP 10% jour-nals	NCI	No.	%	No.	%	No.	%
Goal 1. No Poverty	Higher	Highly indicated	Medium-sized gap		133	0.4%	0.89	1.35	6.1%	1.1	5	2.1%	1	0.6%	0	0.0%
Goal 2. Zero Hunger	Lower	Minimally indicated	Smaller gap		432	1.4%	1.16	1.19	7.2%	1.3	22	9.2%	18	10.5%	38	5.4%
Goal 3. Good Health and Well-being	Higher	Moderately indicated	Larger gap		1 703	5.4%	1.03	1.32	9.4%	1.8	7	2.9%	10	5.8%	58	8.2%
Goal 4. Quality Education	Higher	Moderately indicated	Medium-sized gap		434	1.4%	1.43	1.29	7.6%	0.8	5	2.1%	4	2.3%	0	0.0%
Goal 5. Gender Equality	Medium	Moderately indicated	Smaller gap		136	0.4%	0.87	1.27	11.4%	0.9	2	0.8%	0	0.0%	0	0.0%
Goal 6. Clean Water and Sanitation	Medium	Minimally indicated	Larger gap		590	1.9%	1.27	1.10	7.7%	1.1	6	2.5%	0	0.0%	17	2.4%
Goal 7. Affordable and Clean Energy	Medium	Moderately indicated	Medium-sized gap		1 000	3.2%	0.84	0.88	23.8%	1.4	32	13.3%	16	9.3%	64	9.0%
Goal 8. Decent Work and Economic Growth	Higher	Moderately indicated	Larger gap		614	2.0%	1.18	1.14	12.2%	1						
Goal 9. Industry, Innovation and Infrastructure	Higher	Highly indicated	Larger gap		668	2.1%	0.90	0.92	6.9%	1.3						
Goal 10. Reduced Inequalities	Higher	Moderately indicated	Larger gap		423	1.3%	0.94	1.20	9.5%	1.3	6	2.5%	5	2.9%	0	0.0%
Goal 11. Sustainable Cities and Communities	Medium	Minimally indicated	Medium-sized gap		973	3.1%	1.28	1.16	11.1%	1.4	44	18.3%	11	6.4%	25	3.5%
Goal 12. Responsible Consumption and Produc-tion	Lower	Minimally indicated	Smaller gap		561	1.8%	1.13	1.03	17.4%	1.4	14	5.8%	16	9.3%	15	2.1%
Goal 13. Climate Action	Lower	Moderately indicated	Smaller gap		831	2.6%	0.96	0.99	13.0%	1.3	29	12.1%	2	1.2%	38	5.4%
Goal 14. Life Below Water	Lower	Minimally indicated	Smaller gap		126	0.4%	0.45	0.64	5.4%	1	3	1.3%	2	1.2%	3	0.4%
Goal 15. Life on Land	Lower	Minimally indicated	Smaller gap		704	2.2%	1.08	0.90	8.8%	1.1	7	2.9%	3	1.7%	7	1.0%
Goal 16. Peace, Justice and Strong Institutions	Lower	Minimally indicated	Smaller gap		522	1.7%	0.83	1.06	5.5%	1.2	16	6.7%	0	0.0%	4	0.6%
Goal 17. Partnerships for the Goals	Medium	Minimally indicated	Medium-sized gap													
			Total (SDG-related)		6 625	21%					131	55%	70	41%	129	18%
			Total (all)		31 404	100%	1	1	10.2%	1	240	100%	172	100%	708	100%

ANNEX.II

Detailed methodological explanation of the approach, research procedure and the description of the data sources

As stated in the objective of the project, the aim is to identify a set of key challenges connected to the Sustainable Development Goals (SDG) and to identify the scientific, technological and innovative potential (STI) that can be mobilised to respond to these challenges as part of the Smart Specialisation Strategy.

To achieve the above objective, a modular methodology has been proposed by the JRC and further developed in the report and is depicted in detail in the following pages. The proposed methodology comprises the following procedures (covered in the indicated section of this Annex):

A identify the main challenges connected with SDGs in Serbia by means of:

a. an analysis of the national SDG framework in Serbia, including the main challenges indicated in policy documents, strategies and other relevant documents – presented in Section 1 of this Annex,

a. a statistical assessment of the key challenges resulting from the SDGs on the basis of international and national data sources covering the indicators for SDGs – presented in Section 2 of this Annex;

B retrieve Serbian STI records (e.g. publications, research projects, patents) and identify those thematically related to the SDGs – presented in Section 3 of this Annex;

C bridge the two analyses above;

D measure knowledge gaps, identify STI potentials and map the findings with the Serbian S3 priority domains – presented in Section 4 of this Annex.

Thus, this Annex contains the methodology specification for all analyses constituting this study, aimed at answering the following research questions.

TABLE A.2

Analyses	Research questions being answered
A	■ What are the current national priorities to achieve the Agenda 2030 in Serbia? ■ Which challenges resulting from SDG goals and targets are most important in statistical terms?
B-D	■ What are the knowledge gaps between the identified SDG challenges and STI potentials? ■ Which international STI collaboration networks and partnerships match the identified knowledge gaps and potentials? ■ How do the identified challenges, potentials and knowledge gaps relate to Smart Specialisation priority domains in Serbia?

1. Methodology specification of the module 'Overview of national priorities for the implementation of the Agenda 2030 indicated in policy documents, strategies and other relevant documents'

This section presents the detailed methodology carried out for the analysis of the national SDG framework in Serbia, including the main challenges indicated in policy documents, strategies and other relevant documents. The main objective of this module is the qualitative identification of the main (highest-priority) challenges in Serbia. It should be noted that, at the time of writing this study, the Republic of Serbia had not published any document establishing an official prioritisation of challenges resulting from the SDGs in Serbia. Having this is in mind, we designed a methodology able to identify those challenges which gained higher attention in documents issued by national and external authoritative and expert sources – i.e. State agencies, agencies of the United Nations or specialised think tanks. Find below, the four-step methodology followed.

1 **Selection of relevant documents.** The final selection of policy and strategic documents consists of the combination of an initial set prepared by the authors and the selection of documentation provided by Serbian authorities. The documents constituting the final selection are those which match the following criteria:

a. have an encompassing perspective of the SDGs[44], and

b. are authored by an authoritative source.

The final selection of documents is presented in *Table A.3*.

2 **Review of the selected documents by identifying the main topics and challenges connected to SDGs, as indicated in key sections of the document (i.e. introductory chapter, executive summary or conclusions).**

3 **Matching of the challenges identified in the previous step with specific SDG targets and goals.** One challenge is considered to match an SDG target if they are connected conceptually by a broad or specific relation.

4 **Aggregation in a single indicator of the results of the analysis for the three documents.** To do so, for each SDG and each selected document, we computed the ratio between the number of targets indicated as a priority for the policy document and the total number of targets for that SDG (to control for the upward bias that could be generated by the SDG with more targets). This ratio provides the relative indication for each SDG in each document analysed. Lastly, an average indication rate is computed for each SDG, so that SDGs can be ranked according to their level of indication in the three documents.

The results of the described process can be found in *Section 2.1* of this document: 'Results of the overview of national priorities for the implementation of the Agenda 2030 indicated in policy documents, strategies and other relevant documents'.

44 *This leaves out numerous 'vertical' Republic of Serbia strategies and policy documents, which, while covering areas related to the SDGs (such as education, infrastructures or agriculture), cannot provide a transversal view of the Serbian challenges due to their thematically-limited scope.*

TABLE A.3 *Selection of documents*

Year	Document	Authored by
2019	Voluntary National Review of the Republic of Serbia on the Implementation of the 2030 Agenda for Sustainable Development	Inter-Ministerial Working Group for Implementation of the 2030 Agenda in Serbia (IMWG)
2019	Policy Support for Advancing SDG Progress in Serbia Promoting Inclusive and Sustainable Growth 'Leaving no-one Behind'	Inter-agency UN MAPS team[45]
2018	Serbia Sustainable Development Issues: A Baseline Review	Center for Advanced Economic Studies (CEVES)[46] and the Swiss Agency for Development and Cooperation (SDC)[47]

45 *The Inter-agency UN MAPS team gathered 21 international experts from UN agencies, funds and programmes, regional or HQ offices, including the UNDP, UNICEF, UNESCO, UNECE, UNFPA, ILO, OHCHR, UNHCR, WHO, Delegation of the European Union in the Republic of Serbia and the World Bank Country Office in the Republic of Serbia, under the leadership of UNDP and the UN Economic Commission for Europe in Geneva.*

46 *CEVES is an independent think-and-do-tank dedicated to the sustainable socio-economic development of Serbia and the Western Balkans.*

47 *SDC is the agency for international cooperation of the Federal Department of Foreign Affairs. The SDC is responsible for the overall coordination with other federal authorities of development and cooperation within Eastern Europe.*

2. Methodology specification of the module 'Statistical assessment of the key challenges resulting from the SDGs on the basis of international and national data sources covering the indicators for SDGs'

The statistical assessment of the key challenges resulting from the SDGs is divided into two main modules, described in detail below:

1 construction of an SDG goal and target indicators dataset for Serbia,

2 statistical assessment of the key challenges resulting from the SDGs.

2.1. Construction of an SDG goal and target indicators dataset for Serbia

The construction of a dataset of SDG goal and target statistical indicators allows us to quantify Serbia's statistically measurable social, environmental and institutional challenges. The UN Agenda 2030 defines an official list of SDG indicators, which has been used as the statistical framework for the definition of the indicators used in this study. At the time of writing of this report, measuring SDGs achievement by means of the official indicators is not a completely well-established statistical procedure, since[48]:

a. approximately 38% of the official indicators proposed by the UN are conceptually clear, have an internationally established methodology and standards, but the data needed for their calculation is not regularly produced by countries (type Tier II);

b. approximately 15% of the official indicators proposed by the UN do not have an established international methodology or standard which define them (type Tier III).

Conversely, around 45% of the official indicators are both methodologically well established and data is regularly produced by countries (type Tier I). The remaining 2% of indicators have a non-homogeneous level of availability.

The data on the official indicators as defined in the UN Agenda 2030 has been obtained from the United Nations' Global SDG Indicators Database[49]. The result has been the creation of a database of available UN SDG indicators for Serbia and the EU-27 countries for the 2014-2017 period, inclusive of both. After finalising the process of data gathering and processing, the availability of indicators has been assessed based on the criteria that an indicator is well-covered only if there are, at least, six EU-27 countries with available data to permit a proper benchmarking with Serbia. The result of the assessment of the availability of indicators and resulting target coverage for the mentioned geographies and time span is ***Table A.4***[50].

2.2. Statistical assessment of the key challenges resulting from the SDGs

To discern which indicators/targets/goals may need special attention (gap analysis), by identifying the main challenges resulting from the SDGs in statistical terms, each indicator has been compared to a reference value integrating the EU-27 benchmarks.

48 *This assessment is based on* Inter-agency and Expert Group on Sustainable Development Goal Indicators –, *Tier Classification for Global SDG Indicators, 8 August 2019. Retrieved 15 December 2019 from* ***https://unstats.un.org/sdgs/iaeg-sdgs/tier-classification/***.

49 *United Nations,* Statistics –SDG Indicators Database. *Retrieved 15 December 2019 from* ***https://unstats.un.org/sdgs/indicators/database/***.

50 *A complete list of targets not included in the statistical assessment of the key challenges resulting from the SDGs can be found in Additional material: SDG indicators at target level – Statistical assessment of the challenges resulting from the SDGs in Serbia.*

TABLE A.4 *Target coverage in the available indicators by goal*

Goal	Number of targets	Number of targets covered	Percentage of targets covered
1. No Poverty	7	5	71%
2. Zero Hunger	8	3	38%
3. Good Health and Well-being	13	12	92%
4. Quality Education	10	4	40%
5. Gender Equality	9	2	22%
6. Clean Water and Sanitation	8	5	63%
7. Affordable and Clean Energy	5	2	40%
8. Decent Work and Economic Growth	12	6	50%
9. Industry, Innovation and Infrastructure	8	6	75%
10. Reduced Inequalities	10	4	40%
11. Sustainable Cities and Communities	10	4	40%
12. Responsible Consumption and Production	11	3	27%
13. Climate Action	5	1	20%
14. Life Below Water	10	0	0
15. Life on Land	12	7	58%
16. Peace, Justice and Strong Institutions	11	6	55%
17. Partnerships for the Goals	19	4	21%

The distance to frontier score[51] has been selected to characterise the distance of a country to the 'frontier', which represents the best performance observed on a dataset – in this case, the best performing EU-27 countries in any given SDG target indicator.

Proceeding in this manner, it is possible to assess how far Serbia is from achieving each of the SDGs in comparison to the optimal scenario – that of the frontier countries. In particular, the frontier value has been established as value marking the 10th percentile of the indicator's distribution for the EU-27 countries.

Following this procedure, the frontier value is set based on actual national values, defined by systemic conditions which can be further studied and analysed.

51 *See: https://datacatalog.worldbank.org/distance-frontier-score-0lowest-performance-100frontier-0.*

The Serbian degree of achievement (i.e. distance to frontier) for each SDG target and goal has been calculated as a weighted average of the scores obtained for each indicator and underlying target, respectively.

3. Methodological specification of the module 'Retrieval and identification of Serbian STI records thematically related to the SDGs'

This section covers the methodological specifications and limitations that emerged from the process of retrieving, processing and identifying the Serbian STI records related to the SDGs.

3.1. Data sources used in the STI analysis

The current project analyses data sources recording the activities and results of research and innovation to provide key indicators and insights supporting the identification of scientific, technological and innovative potential addressing the main SDG-related challenges in Serbia.

Four main data sources are used in the analysis of the SDG-related STI activities and results:

- **scientific publications from Scopus**, a database of abstracts and citations of peer-reviewed literature, including scientific journals, books and conference proceedings, covering research topics across all scientific and technical disciplines, ranging from Medicine and Social Sciences to Arts and Humanities;
- **EU-funded research and innovation projects from CORDIS** (Community Research and Development Information Service), an open repository of data on projects and beneficiaries of the European Union's Horizon 2020 research and innovation programme;
- **research and innovation projects** funded by the Serbian **Innovation Fund**. Projects from the following programmes[52] have been included in the analysis: Mini Grants Program, Matching Grants Program, Collaborative Grant Scheme Program and Technology Transfer Facility (TTF) Program;
- **Serbian patents filed in any office included in the European Patents Office (EPO) Open Patent Services database.** The EPO's Open Patent Services provide bibliographical and legal status patent data from the main intellectual property offices, including the Intellectual Property Office of the Republic of Serbia.

The four science, technology and innovation data sources provide a complementary view of SDG-related STI activities and products and, thus, of the Serbian ecosystem capacities under the corresponding SDG topics.

Scientific publications offer a view of the scientific communities and disciplines related to each goal. Horizon 2020 projects support the top science and innovation activities, usually cooperative, while the Innovation Fund supports innovative activities, predominantly of private companies. Lastly, patents are an indicator of technological development and assets in the country.

To allow for the publication and priority lag, scientific publications and patents correspond to the 2014-2017 period, inclusive of both. For Horizon 2020, all available projects as of 31 December 2019 have been included, that is 2014-2019. For the Innovation Fund, all projects financed between 2012 and 2019, inclusive of both, have been analysed, since 2012 and 2013 were particularly active years for the fund.

Additional data sources have seldom been used to provide a wider view of research and innovation collaborative activities and organisations. Unlike the four main sources above, these sources correspond to activities and venues in specific thematic

52 *The analysis does not include the Innovation Fund's 'Innovation vouchers' programme because the textual information describing the related projects is too small to allow for a reliable SDG classification.*

TABLE A.5 *Summary of the main data sources used in the STI analysis and number of records*

Scope	Source	Criteria for inclusion	Number of records - Serbia
Scientific publications in internationally indexed journals	*Scopus* (Elsevier)	Publications with at least one author with a Serbian affiliation	**31 404** (2014-2017)
European Commission-funded **research and innovation projects**	*CORDIS* - Community Research and Development Information Service	H2020 projects with at least one Serbian partner	**240** (2014-2019)
Patents	*Open Patent Services* - European Patent Office	At least one Serbian inventor or applicant	**708** (2014-2017) [25 filed in the EPO]
National research and innovation projects	*Innovation Fund*	Projects in the three selected programmes	**172** (2012-2019)

domains. As such, due to the risk of bias, they have not been included in the main analysis of STI potential and gaps. They will serve to provide more detail and relevant venues and actors to mobilise within their related areas of activity, particularly in the identification of national and international SDG-oriented STI collaboration networks. These sources are:

- **Serbian clusters present** in the European Cluster Collaboration Network's Cluster Organisations Mapping Tool,
- **research and innovation** (Thematic Objective 1) **INTERREG projects** in the **Keep database**,
- **health-related projects financed by the EU Health Programme**, available in the EU's Consumers, Health, Agriculture and Food Executive Agency **(CHAFEA) database**,
- **Creative Europe projects**, financed by the European Commission's framework programme to support the culture and audio-visual sectors,
- **LIFE Programme projects available in the COSME data hub**, supported by the EU's fund for the environment, nature and climate action.

3.2. Methodology to identify SDG-related STI records

The taxonomies that characterise the STI documents indexed in the data sources listed in the previous section are not aligned with one another and, most notably, do not allow for an easy linkage of the records to the SDGs[53] to which they

53 *Some mild exceptions given by the H2020 projects funded by some of the Societal Challenges pillar and patents classified via the CPC scheme under the categories Y02 'Technologies or Applications for Mitigation or Adaptation against Climate Change' and Y04S 'Systems Integrating Technologies related to Power Network Operation, Communication or Information Technologies for improving the Electrical Power Generation, Transmission, Distribution, Management or Usage'. The limitations in this case are that the scope of the challenges in H2020 may be wider than that of the related SDG (e.g. H2020 - Health*

TABLE A.6 *Summary of the additional data sources used in the STI analysis and number of records*

Scope	Source	Criteria for inclusion	Number of records - Serbia (2014-2017)
Cluster organisations	*European Cluster Collaboration Network* (ECCN)	Industrial clusters located in Serbia	**24**
Projects supporting **cooperation across borders**	*Keep* - EU projects database - European Commission	Interreg projects with at least one Serbian partner	**52** (All Thematic Objectives) **0** (Thematic Objective 1, 'Strengthening research, technological development and innovation')
Health projects	Consumers, Health, Agriculture and Food Executive Agency (CHAFEA) - *EU Health Programme*	Health projects with at least one Serbian partner	**3**
Cultural and creative projects	*Creative Europe* - European Commission	Creative Europe (and its predecessor programme) projects with at least one Serbian partner	**50**
Environment, nature and climate action projects	Executive Agency for Small and Medium-sized Enterprises (EASME) - *LIFE Programme*	LIFE projects with at least one Serbian partner	**3**

are thematically related. Luckily enough, textual information describing the content, objectives and/or specifications of each STI endeavour is provided for records in the four main data sources. Additionally, in line with the Open Science and Open Innovation principles, for all data except publications (which are retrieved from a proprietary source), this textual information and all other metadata linked to each record is openly available. This wealth of textual information can be exploited to obtain a much deeper understanding of the gathered documents and to categorise them into classification schemes, which are not aligned with their respective original taxonomies.

In this work, Natural Language Processing (NLP) techniques were employed to automatically parse the text of each STI document and to extract relevant information that could be used to link the documents to the SDGs. A controlled vocabulary of key terms specifying the semantic content of each SDG was used to identify pertinent terms in the analysed texts and to classify the records into the SDGs.

The SDG controlled vocabulary, which is openly available in the Zenodo[54] repository, was crafted by SIRIS Academic during 2019. The methodology followed to build the vocabulary is based on three

and SDG 3), that records may be linked to more than the SDG suggested by the respective challenge. On the other hand, the Y symbol for the CPC scheme only covers a narrow section of SDGs and not all patents are classified with the pertinent CPC symbol.

54 *Duran-Silva, N., Fuster, E., Massucci, F. A. & Quinquillà, A., A controlled vocabulary defining the semantic perimeter of Sustainable Development Goals, Version 1.2, [Data set], Zenodo, 2019.* ***https://doi.org/10.5281/ZENODO.3567769****.*

main steps, which combine manual validation with machine learning and Artificial Intelligence techniques:

1 via qualitative research, a manual selection of pertinent terms for each target/goal is performed;

2 different methods based on machine learning and Artificial Intelligence are used to enrich the list of terms;

3 a manual validation of the whole collection of terms is performed.

The terms compiled in the SDG controlled vocabulary were searched within the textual fields of the STI documents to link each record with the respective SDG: the presence of a controlled vocabulary term was assumed to be a positive link between a text and the SDG.

It is relevant to stress here that, within this approach, texts could be linked to more than one SDG. However, because all analysed texts were relatively short abstracts or descriptions of the STI endeavours, which synthesised the respective key aspects, redundancy and noise are kept at bay. To maximise matching between the terms and the analysed texts, a few technical tricks were adopted. First of all, words within terms in the vocabulary were allowed to be separated by up to three words: for instance, the methodology allowed the lexeme 'sustainable development' to match the sequence 'sustainable paths towards development'. Secondly, terms in the vocabulary as well as the analysed texts were lemmatised so that all words were conducted to a canonical and common form, e.g. all plurals to singular and all verbs to the infinitive form. These two features dramatically increased the effectiveness of using the controlled vocabulary to link texts to the SDGs. Lastly, in the case of patents where the applied jargon is highly technical and the presence of the controlled terms is lower, more advanced matching methods between the vocabulary terms and the texts were also applied. These are based on what are known as word-embedding algorithms[55], which allow a looser word-to-text association and which would yield a match for cases where sentences look 'similar' to a given word, but the word per se does not appear. Owing to this less strict protocol, all results were manually assessed in this case.

3.3. STI contributions to the SDGs – limitations, considerations and methodological adaptations to the data

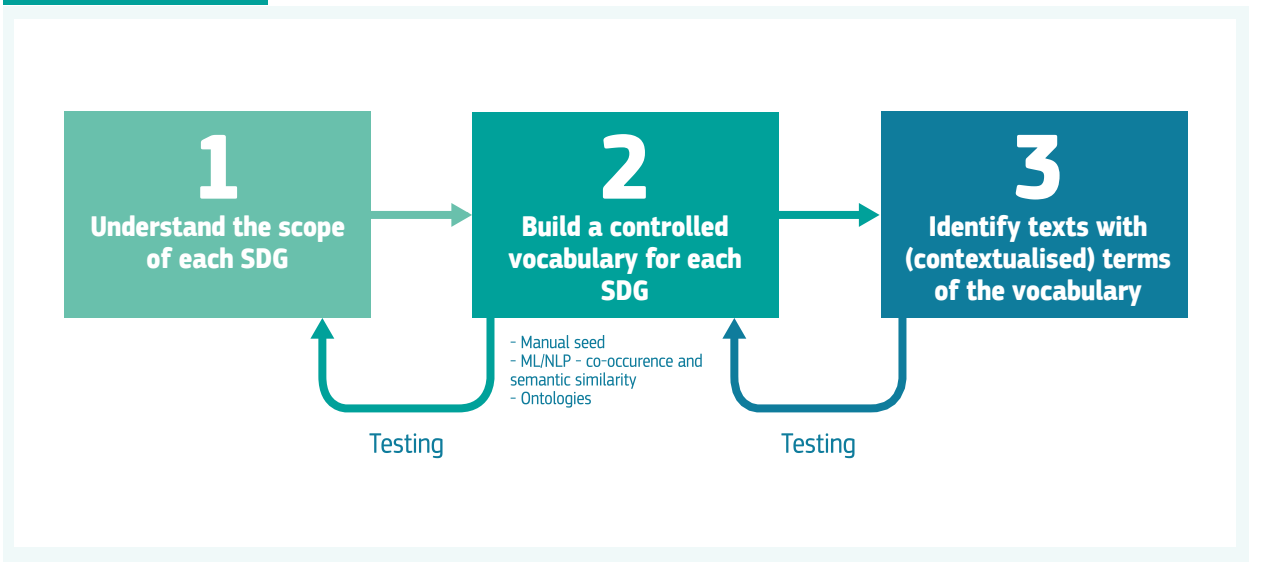
It is necessary to understand that scientometrics-based analyses are particularly sensitive to biases due to the nature and the coverage of the data sources. Data richness is fundamental to analytical reliability and, consequently, to the robustness and the level of detail of the qualitative conclusions extracted from it. The following list presents some of the main limitations and considerations that can fundamentally affect the analysis and policy conclusions of the SDG/S3 analysis and priority-setting exercise using such STI data sources.

1 **Bias against lower-technology sectors, traditional sectors and non-technological innovation.** Several data sources compiled in the table above are biased towards the natural sciences and technological innovations. The relative absence of non-technological research and innovation activities (which can play an essential role in Smart Specialisation as well as in STI roadmaps for the SDGs), and the lower propensity to publish, to protect intellectual property and to participate in R&D projects of lower-technology and traditional sectors, have to be taken into account and weighted in.

2 **2. Trade-off between international impact and local engagement.** In scientific publications, in particular, actors may face a trade-off between pursuing research for international relevance (as demonstrated by publishing in top in-

55 *Mikolov, T., Chen, K., Corrado, G. & Dean, J.,* Efficient Estimation of Word Representations in Vector Space, *2013. Retrieved 14 August 2019 from* ***https://arxiv.org/abs/1301.3781****.*

FIGURE A.1 *Summary of the process and method to identify SDG-related STI records*



ternational journals) and engaging in projects and activities in their vicinity, notably related to non-frontier R&D and social innovation. Traditional scientometric measures (such as the impact factor or the number of citations) may neglect major local contributions to achieving the SDGs.

3 **3. Low number of records hindering a richer / finer-grained characterisation of some goals or SDG-related topics,** particularly for the sparser data sources**.**

4 **4. Goals with especially unspecific vocabulary.** The identification of SDG-related STI records is based on a controlled vocabulary that describes the different goals. Unfortunately, some goals are described by semantics which are very similar to the intrinsic semantics of the science, technology and innovation domain. On these occasions, the SDG classification is unreliable, and may yield haphazard results.

For the reasons above, some adaptations to the general methodology have been necessary, described individually below.

1 The **Innovation Fund** is restricted to Serbia. As such, there cannot be EU-27 or EU-13 baselines to compute specialisation indicators. Consequently, STI potential is identified from Innovation Fund projects when there is a relative critical mass of activities or records related to an SDG, and a gap is identified if there is a relative absence of activities. Thus, the number and share of records, not a specialisation index, was used as an indicator for Innovation Fund projects.

2 The plan was to perform the specialisation analysis on patents filed at the European Patent Office, for Serbian actors and for EU-27 and EU-13 actors, providing homogeneous data perimeters. While numerous patents filed by Serbian actors have been identified (708), most of them correspond to the IP Office of Serbia and only 25 patents were found to be filed at the European Patent Office by Serbian actors – too few to provide reliable indicators on the relative specialisation of the patent portfolios of Serbia and the benchmark geographies. For this reason, the number and share of records, not a specialisation index, will be used as indicators for patents[56].

3 **Goal 8. Decent Work and Economic Growth** aims to 'promote sustained, inclusive and sustainable economic growth, full and productive'.

56 *Nevertheless, absence of evidence is not evidence of absence. As an example, the absence of patents related to SDG 5. Gender Equality is most probably due to the non-technological nature of this goal, rather than a knowledge gap in Serbia.*

Research and innovation funding programmes, on many occasions, also have these objectives. The vocabulary describing Goal 8, and the vocabulary describing R&I projects and intellectual property records can be quite similar, for instance in keywords such as 'technological upgrading', 'innovation' or 'economic growth'. For this reason, the classification of Horizon 2020 and Innovation Fund projects as well as patents has not been performed for Goal 8.

4 **Goal 9. Industry, Innovation and Infrastructure** aims to 'Build resilient infrastructure, promote inclusive and sustainable industrialization'. Research and innovation funding programmes, on many occasions, also have these objectives. The vocabulary describing Goal 9, and the vocabulary describing R&I projects and intellectual property records can be quite similar, for instance in keywords such as 'economic development', 'scientific research' or 'research and development'. For this reason, the classification of Horizon 2020 and Innovation Fund projects and patents has not been performed for Goal 9.

5 **Goal 17. Partnerships for the Goals** is complementary to the rest of the goals, focusing on financing the SDG efforts, enhancing cooperation in science, technology and innovation as well as knowledge sharing, on capacity building and on trade. This transversal and enabling nature renders the automatic identification of goal-related STI records extremely difficult, and would certainly yield a large number of false positives. For this reason, Goal 17 is not included in the STI analysis.

4. Analytical methods and main indicators

4.1. Analytical methods

The methods and data described in the previous sections were used to link research efforts carried out by Serbian actors to the SDGs and, in turn, to measure the Serbian STI potential to tackle the challenges resulting from the Sustainable Development Goals. As well as potential, knowledge/competence gaps have been identified in respect to benchmark geographies (EU-27 and EU-13 countries), which serve as indicator baselines.

Gaps and potentials are, by definition, relative – relative between SDG-oriented disciplines, technologies and sectors in Serbia; and/or relative between Serbia and international partners and competitors. According to the availability of national and international data (for publications, projects and patents), and the coverage and quality of this data, different approaches have been used in this analysis to measure potential and gaps.

When data is available for Serbia and other countries, the gap and potential analysis is performed by comparing Serbia with EU-27 and EU-13 countries. This gap and potential analysis will rely on the computation of the specialisation index[57], assuming there is a knowledge gap for SDG goals where Serbia presents a lower specialisation index with respect to the EU-baselines, and a knowledge potential when Serbia presents a higher or comparable specialisation index with respect to the EU-baselines.

Gaps and potentials should be read in relation to the main challenges resulting from the SDGs in Serbia, previously identified via the documentary analysis and the statistical indicator assessment of this study. In this sense, a Serbian STI not sufficiently active in higher-priority goals (as indicated by lower specialisation indexes) should be a reason for concern in the achievement of the SDGs.

When data is sparse (i.e. when the total outputs produced by the entity of interest is too low), the specialisation index may suffer considerable fluctuations. For this reason, in some cases the gap and potential analysis will rely on rankings and

57 *The specialisation index, also known as the 'location quotient', measures how much a certain entity of interest (either a specific institution or a geographical aggregation) is specialised in a given domain with respect to a given baseline. The specialisation is computed by normalising the share of output produced in the domain of interest by the entity over the share of output of the baseline (usually a larger geography).*

the distribution of activities by goal and by other taxonomies, such as scientific disciplines (subject areas) or Horizon 2020 programmes. As an illustration, Serbian publications in Goal 16. Peace, Justice and Strong Institutions' represent 1.7% of all publications in Serbia, this goal ranking 10th among the 17 SDG goals. In comparison, Goal 16-related publications represent 2.0% of the total in EU-27 countries, ranking 7th, which indicates a probable knowledge gap in relation to the EU in topics related to this goal.

In this case, as an illustration, Serbia has a smaller share (1.7%) and lower rank (10th) of publications related to Goal 16. Peace, Justice and Strong Institutions than the EU-27 countries (2.0%, ranking 7th), which indicates a probable knowledge gap in relation to the EU in topics related to this goal.

All of the analysis and indicators above are performed at SDG goal level. To obtain a finer-grained understanding of the knowledge niches within the SDGs, the original taxonomies of the different data sources have been exploited, indicated in ***Table A.7***.

Lastly, the notion of potentials and gaps goes hand in hand with that of excellence. The question here is, in fact, not only to understand whether there exists within the Serbian STI ecosystem a critical mass to tackle the most pressing SDG challenges, but also whether the ecosystem possesses the necessary capacities to address them.

FIGURE A.2 *[Sample] Distribution of scientific publications by goal and geography of interest (EU-27, Serbia, EU-13)*

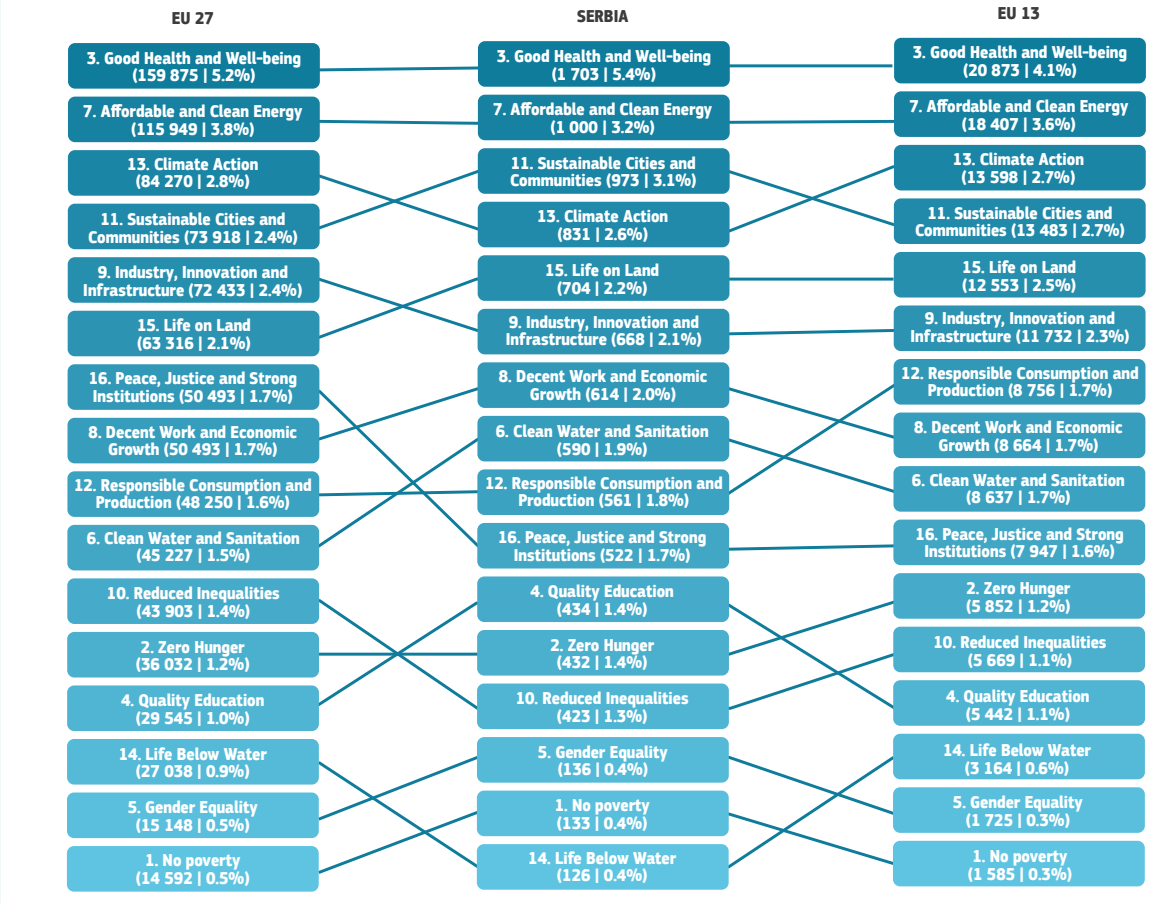


TABLE A.7 *Original taxonomies by data source*

Source	Original taxonomy
Scientific publications	(bibliometric) Subject areas
Patents	Cooperative Patent Classification (CPC)
Horizon 2020 projects	Programmes
Innovation Fund projects	(adapted) Programmes

Excellence is, however, an even more elusive concept than potential/gaps, one which in the current context can only be indirectly related to bibliometric impact, for publications, and to the capacity of Serbian actors to obtain Horizon 2020 funding, a high-quality threshold for any organisation.

4.2. Specialisation index (SI) – definition and computation

The specialisation index indicates the relative publication intensity of a geography of interest (country, region, etc.) in a given domain of knowledge in relation to a typically larger perimeter of comparison (in the case of this study, the EU-13 and EU-27 benchmarks). Within the framework of Smart Specialisation, this indicator provides a comparison of the relative weight of each domain of knowledge in Serbia, in relationship to the benchmarks, to understand whether or not Serbia is specialised in a given domain of knowledge – in this study, the SDG-related research topics.

The specialisation index is the result of a division, composed of:

- **numerator** – percentage of scientific articles in the domain of knowledge (e.g. SDG-related topics) in Serbia with respect to the total number of publications in Serbia,
- **denominator** – percentage of scientific articles in the domain of knowledge in the largest perimeter (the EU-13, EU-27) with respect to the total number of publications in this perimeter.

Thus, a specialisation index greater than 1 implies a relative specialisation of the geography of interest in this domain of knowledge. For example, a SI of 2 means that the geography of interest (i.e. Serbia) publishes twice as much as the largest perimeter (i.e. the EU-13, EU-27).

The specialisation index of a domain of knowledge (e.g. SDG-related topics) can be formalised as follows:

$$SI_i = \frac{n_i^{Serbia} / n_{total}^{Serbia}}{n_i^{EU\text{-}13,EU\text{-}27} / n_{total}^{EU\text{-}13,EU\text{-}27}}$$

where n_i^{Serbia} corresponds to the number of scientific publications in the domain of knowledge i in Serbia, n_{total}^{Serbia} represents the total number of scientific publications in Serbia, $n_i^{EU\text{-}13,EU\text{-}27}$ corresponds to the number of scientific publications in the domain of knowledge i in the largest perimeter (the EU-13 and EU-27) and $n_{total}^{EU\text{-}13,EU\text{-}27}$ represents the total number of scientific publications in the EU-13 and EU-27.

4.3. Normalised citation impact (NCI) – definition and computation

The normalised citation impact NCI^i is a bibliometric measure to assess the impact of the publications of a given entity (which could be a knowledge domain, institution, region, etc.) in comparison to some reference geography. It is normalised since it takes into account the expected impact (i.e. the citations-per-paper) within the relevant fields. Note that NCI^i can also be applied to single publications to measure the impact of a single, specific paper.

To calculate the normalised citation impact (NCI^i) of an entity (e.g. SDG-related topics) for a given time window (T) compared to a reference geography (in the case of this study, Serbia), we need:

- a list of categories $C=\{f=1...N_c\}$
- a time window $T=\{t=y_1...y_n\}$
- the list of publications p^i_{ft} produced by/in entity i, for each category f, in each year t
- the citations received by/in entity i, for each category f, in each year t
- the expected citations-per-paper of the reference geography e_{ft}, for each category f, in each year t. In this study, this corresponds to the average number of citations per paper in Serbia (for each category f, in each year t).

TABLE A.8

Discipline f	PY t	No. of publications p^i_{ft}	Citations c^t_{ft}	Ref. country citation avg. e_{ft}
Physics, Nuclear	2010	40	1 000	24.42
Physics, Nuclear	2011	50	1 005	22.28
Physics, Nuclear	2012	52	1 354	6.06
Physics, Nuclear	2013	73	1 658	14.16
Physics, Nuclear	2014	94	687	9.36
Physics, Nuclear	2015	58	236	2.48

Table A.8 illustrates the citations of some entity which had some publications in the field of Nuclear Physics between 2010 and 2015. The entity is being analysed in the context of a reference country.

Making use of these given data, one can proceed to calculate the NCI^i.

Practical steps to calculate the NCI of an entity i

1. First, calculate the 'Non-normalised' citation impact CI_f^i of the entity i, for each category f:

$$CI_f^i = \sum_{t=y_1}^{y_n} \frac{c_{ft}^i}{e_{ft}}$$

The above quantity tells us how many papers published by/in entity have been cited with respect to what is expected within the field, without normalising the number of papers published by/in the entity. To calculate CI_f^i, we first compute the ratios c_{ft}^i / e_{ft}:

c_{ft}^i / e_{ft} **(Reference geography)**
40.95
45.11
223.43
117.09
73.40
95.16

Then we obtain the citation impact CI_f^i.

Citation impact with respect to the reference country
CI_f^i =595.14

2. Normalise by total amount of papers

$$N^i = \sum_{f=1}^{N_c} \sum_{t=y_1}^{y_n} p_{ft}$$

produced by the entity i in the time window, to finally obtain the NCI^i:

$$NCI^i = \frac{\sum_{f=1}^{N_c} CI_f^i}{\sum_{f=1}^{N_c} \sum_{t=y_1}^{y_n} p_{ft}^i} = \frac{\sum_{f=1}^{N_c} CI_f^i}{N^i}$$

Using this formula, we can normalise the citation impact presented above and finally obtain the NCI of entity i in comparison to a reference country.

Citation impact with respect to the reference country
NCI^i =1.62

Baselines have been obtained from the SCImago Journal & Country Rank [Portal].

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