> CHAPTER 7

Future STI priorities

Stakeholders' views on how science, technology and innovation can help achieve the SDGs

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OVERVIEW

- This chapter presents the results of a global survey of stakeholders.
- Survey respondents proposed the STI areas and activities that they believe could help to achieve the SDGs by 2030.
- Their responses highlighted a range of STI areas, including policy-oriented, social and grassroots innovations, which are often overlooked in the existing STI system.
- Several STI areas were identified as potentially having a positive influence on the achievement of multiple SDGs.
- The survey results also highlighted that some STI activities may support one particular SDG target at the same time as impeding progress towards another.

Footnotes for this chapter are on page 86. A full list of references can be found on page 140.

To understand the relationships between science, technology and innovation (STI) and the Sustainable Development Goals (SDGs), we can learn by looking forwards as well as backwards in time. Retrospective observations can locate STI areas that have been privileged or under-supported in the past (see Chapters 4 and 5 for such mappings). However, looking backwards misses emerging ideas and current understandings about how STI can help achieve the SDGs.

By capturing different stakeholders' understandings of STI and the SDGs, we can explore how insights around future STI-SDG influences align with current activities. To this end, we undertook a survey in 2021 to gather a range of perspectives about the types of STI activity needed to achieve the SDGs. This chapter reports on these findings, considering the following key themes:

- **Diversity** of future STI influences
- **Synergies** between multiple SDGs
- **Nature** of influences
- **Degree of consensus** between stakeholders
- **Similarities and differences** between proposed future STI influences and current research and innovation patterns

Figure 7.1 / A snapshot of survey responses about STI for the SDGs

This word cloud depicts the 60 most frequently used words across the 1,351 survey responses. The size of words reflects their relative occurrence, with the largest words being the most common. Word colour intensity decreases with proportional word occurrence in survey responses.

Diversity of proposed STI influences

Future STI influences identified in the STRINGS survey ranged widely (see Figure 7.3) and included:

- propositions for new, or further development of, **research areas**, for example, research on the value of biodiversity
- adoption of **existing technologies** such as carbon capture and storage technology
- system-wide principles to set **directions and values** guiding STI development (such as circular economies)

Respondents highlighted various types of innovation that could influence SDG attainment, including:

- **Market-oriented innovation** (16% of respondents), which aims to improve a product or process. This type of innovation can help to create capabilities, and often involves capturing the resultant revenues, including through the use of patents (see Chapter 5). Innovators range from farmers to multinational corporations and public laboratories.
- **Social innovation** (11% of respondents), which aims to meet social needs not provided for by the market.[1]
- **Adaptive, inclusive and grassroots innovation** (6% of respondents), which uses local inclusion and control to improve technology development and social organization.[2]
- **Policy innovation** (37% of respondents),[3] including changes to the instruments and processes of public administration.

20% of responses focused on the need for values and direction-setting to support the SDGs, for example, by developing circular economy principles to guide STI development.

The results suggest that stakeholders, including scientists, researchers, and technology developers (who between them comprised 69% of survey respondents) believe that traditional scientific and technological developments alone are not sufficient to achieve the SDGs. Authors of academic papers responded to open-ended questions with more diverse STI types than those covered in their collective publications.

The STRINGS survey

The STRINGS survey captured views from more than 1,350 individuals worldwide about the influences of STI on the SDGs. Figure 7.2 summarizes the survey's approach.

How the survey worked

- The survey employed the Delphi technique – a structured method used in policy analysis. It involves relaying ideas and beliefs from other respondents to better inform individual reflection.
- First, respondents were asked to imagine a world in 2030 in which the SDGs have been achieved. They were asked for their views on which STI areas would have been influential in achieving specific SDG targets. To remain open to diverse and plural ideas, the survey imposed no strict constraints on the types of ideas that could be submitted.
- Next, respondents used a five-point scale to indicate whether the proposed STI area would have a positive, neutral or negative influence on SDG achievement.
- From the survey responses, we calculated a consensus score for each proposed STI-SDG relationship.
- Respondents had the option to add comments to contextualize their ratings. They could see the ideas and comments of other survey participants and were free to amend their own contributions at any point.

Who responded to the survey?

- The survey was open to individuals from various backgrounds, with invitations circulated across a wide range of STI and SDG channels and networks
- One-fifth (20%) of respondents contributed to the making of public funding decisions and 8% to private funding decisions
- Most respondents (63%) were male
- Most were in the 35-44 age group (31%), followed by 45-54 (25%), 55-65 (20%), 18-34 (15%) and 65 or older (8%)
- The vast majority (85%) were primarily employed at a university or similar research institution
- Others described their primary employment as the public sector (5%), private sector (3%) or not-for-profit sector (3%)
- 20-30% of participants had expertise in either Europe or North America
- Fewer had expertise in Latin America, South-eastern Asia and Oceania (each between 10-20%), or in North Africa, or Central and Western Asia (less than 5% each)

Further respondent background details are provided in Appendix 5.

An exploratory approach

The combination of 169 SDG targets with thousands of possible STI areas could potentially generate hundreds of thousands of STI-SDG relationships to be appraised. Our study takes an exploratory approach, and concentrates only on the possible relationships proposed by respondents.

Figure 7.2 / A summary of how the survey employed the Delphi technique

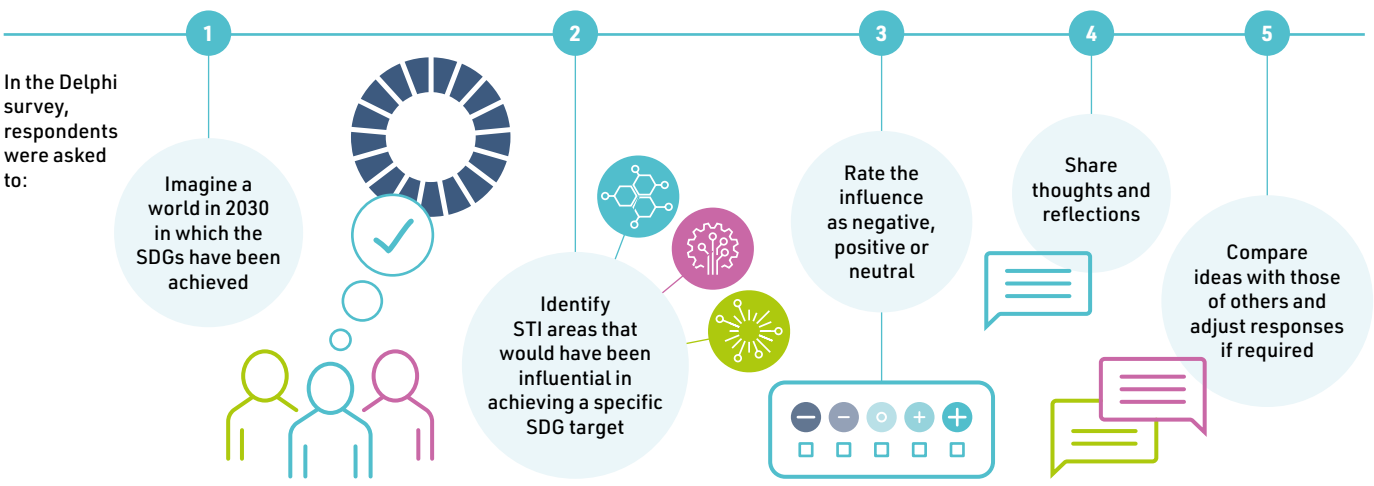
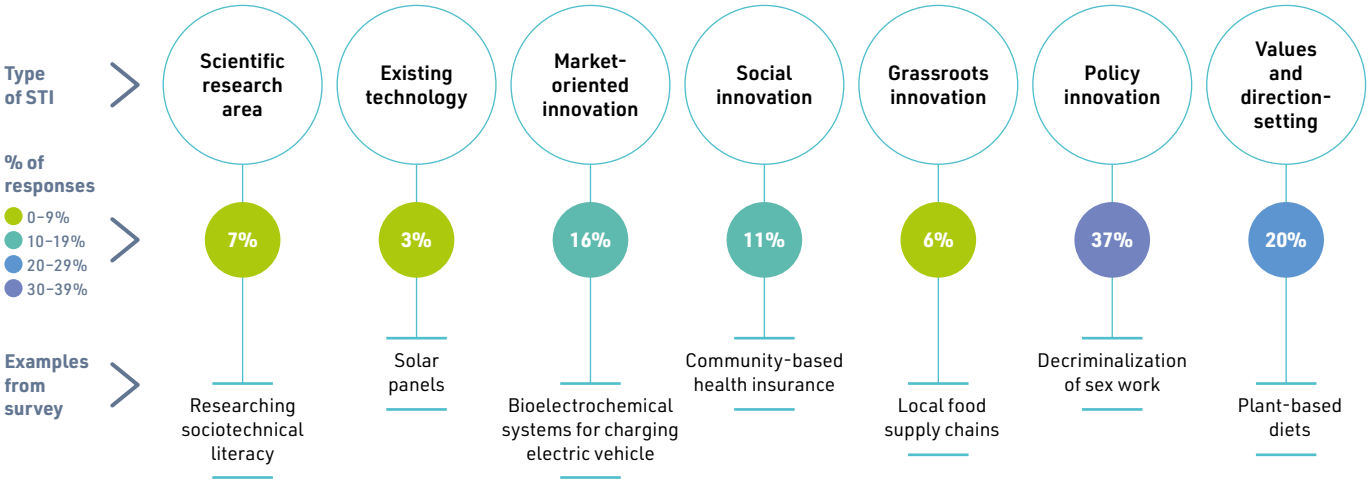


Figure 7.3 / STI priorities identified in the STRINGS survey



The figure shows what percentage of survey responses suggested each type of STI, together with some examples of each type, drawn from the responses. For analysis purposes, we assigned only one STI type for each response. In practice, an activity can fit multiple innovation types.

The misalignment between respondents' perspectives and their own research focus can be explained partially by the constraints of research support and incentive systems that favour publication in specific technical domains. These factors tend to result in research that is less interdisciplinary,[4] less likely to be grounded in a local context,[5] and less risky.[6]

Only 19% of survey responses could be categorized using International Patent Classification codes (most of these were categorized as 'market-oriented' innovations). This relatively low percentage indicates that most STI areas proposed by survey respondents are different from those mapped using typical patent-focused methodologies (see Chapter 5).

Synergies and trade-offs

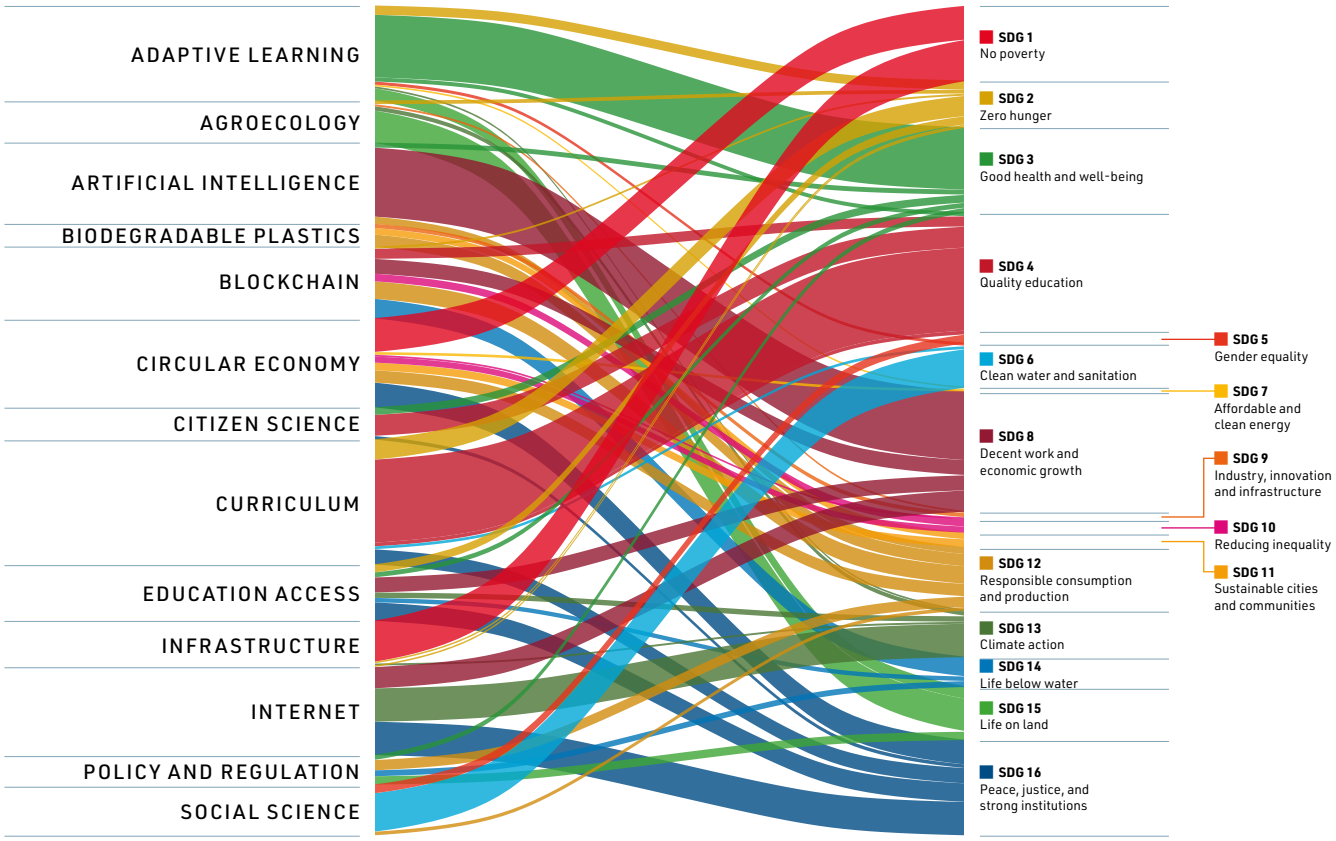
Where one area of STI supports the achievement of multiple SDG targets, a **synergy** exists across these targets.[7] However, links between the SDGs are not always positive. For example, a development in one STI area may support one SDG target, while inhibiting progress towards another. Such 'negative synergies' are also known as **trade-offs**.[8] Figure 7.4 illustrates the positive and negative influences identified in the STRINGS survey for one example STI area – blockchain technology.

The survey identified 13 STI areas as synergistic, linking to three or more SDGs[9] (see Figure 7.5). These include areas of research, such as social science; market-oriented innovations, such as biodegradable plastics; existing technologies, such as the internet; and policy innovations, such as enhanced monitoring and evaluation.

Figure 7.4 / Synergies and trade-offs for one STI area

Example of an STI area	SDG targets	Survey descriptions of STI influence on SDG achievement
BLOCKCHAIN TECHNOLOGY	**SDG 5.1** End of discrimination against women and girls	INFLUENCE: NEGATIVE Blockchain cryptocurrencies are used as payments for sexual abuse of women and girls, bypassing regulated banks
	SDG 8.10 Expand access to financial services	INFLUENCE: POSITIVE Blockchain enables payment systems for people excluded from mainstream banking services
	SDG 12.2 Sustainable management of natural resources	INFLUENCE: NEGATIVE Blockchain cryptocurrencies can be more energy-intensive than the resource management benefits they support
	SDG 12.5 Waste	INFLUENCE: POSITIVE Transparent blockchain ledgers improve accuracy in tracing feedstock provenance and quality for plastics recycling
	SDG 14.1 Marine pollution	INFLUENCE: POSITIVE Tamper-proof ledgers of pollution levels encourage polluter responsibility

Figure 7.5 / STI synergies across the SDGs



The figure shows the links to various SDGs for the STI areas that are positively linked to three or more SDGs. Line colours reflect a specific STI area. Line thickness is proportional to the number of survey responses that identified a specific STI-SDG link.

It is unsurprising that respondents identified more than one potential use for several STI areas. Technological innovation arises from this type of flexibility – for example, repurposing or adapting existing components into new and very different applications[10] or contexts.[11]

Many of the synergistic STI areas identified by the survey relate to general processes and systems that can strengthen other areas of STI, and improve the capacity of people, organizations and society to achieve the SDGs.[12] For example, artificial intelligence algorithms applied to publicly accessible data about household waste levels and stored on ***blockchain*** ledgers can be used to implement ***adaptive learning*** to identify missed waste reuse opportunities for local businesses. This information can be used to learn about existing policy or regulation barriers to domestic waste reuse, and monitor the impact of their adjustment.

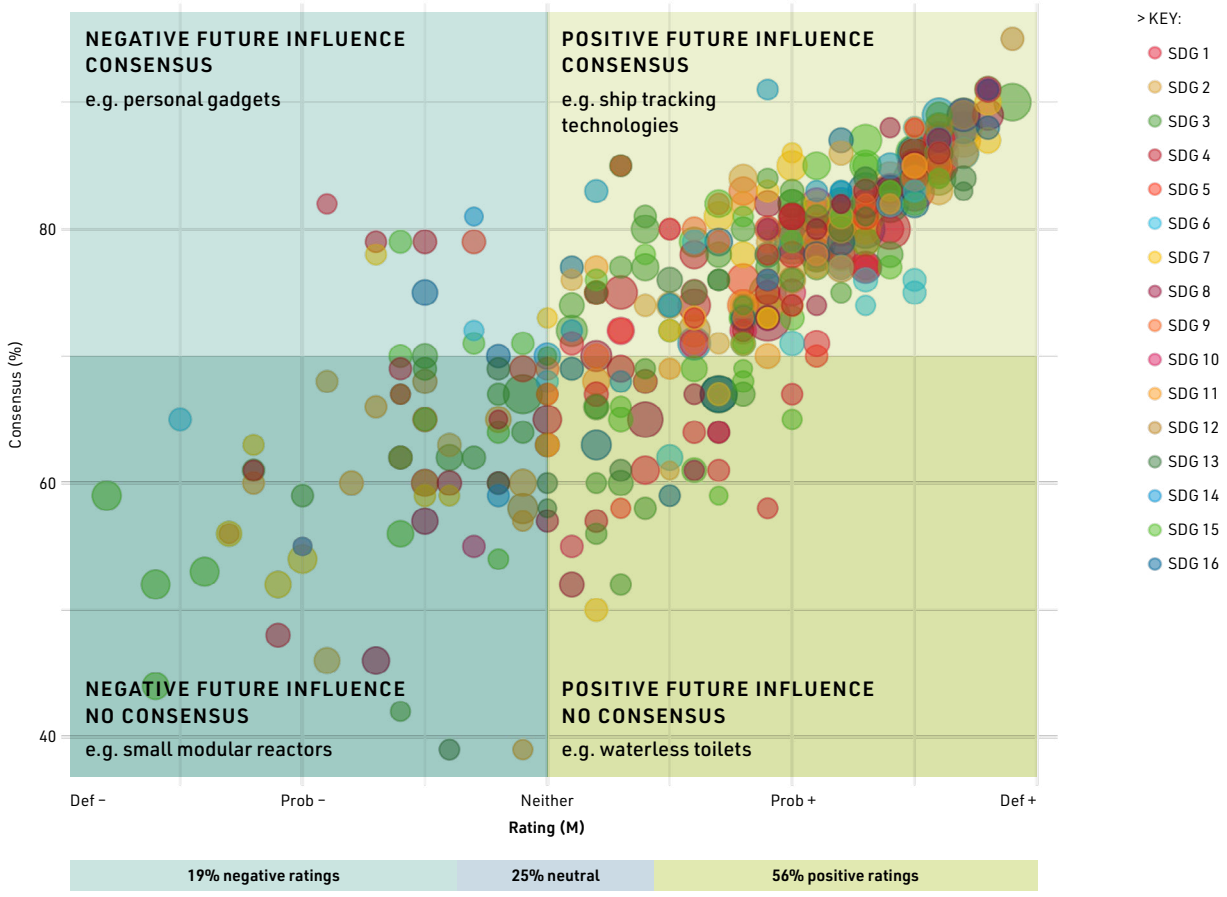
While the role of STI in developing mutually beneficial synergies for local and global capacity-building is recognized in global SDG action, STI capacity-building in low-income countries is almost absent from published research and inventions (see Chapters 4 and 5).[13]

Nature of influence and degree of consensus

Survey respondents rated each of their proposed STI areas according to the expected **future nature of influence** (positive or negative) and the **likelihood** (probable or definite) of its impacting on the SDGs. We also measured the **degree of consensus** (a measurement of agreement between stakeholders).[14,15]

The permutations of the nature of influence and consensus form a framework to explore future significance.[16] We can identify where there is strong consensus that particular STIs will have a positive future influence on SDG attainment, and also those STI-SDG relationships for which there is much less agreement. Figure 7.6 uses four examples from the survey responses to illustrate areas with and without consensus about positive or negative future STI influences on SDG attainment.

Figure 7.6 / Survey perspectives on the future influence of STI on SDG attainment



Rating (M) is a measure of likely STI influence on SDG attainment using a scale from definitely negative, to probably negative, to a neutral midpoint, to probably positive, to definitely positive. Consensus (%) is a measure of relative agreement across survey respondents.[18]

Every survey response is represented by a dot. Responses are distributed according to the degree of consensus on likely future direction. Most survey responses described STI areas with **positive** future influence on SDG achievement and are therefore on the right-hand side of the chart.

Most responses identified a positive or neutral STI influence on target SDGs:

- 56% of the identified STI-SDG relationships were perceived to have a positive and supportive influence on SDG attainment
- 25% were rated neither positive nor negative
- 19% were described as having a negative future influence

The higher proportion of positive results may be due to the 'goal framing' effect, whereby an issue is framed positively within a question.[17] The STRINGS survey asked respondents to identify STI influences in the context of the successful attainment of 2030 SDGs, which could have led to more positive responses. This effect should be accounted for in future analyses exploring STI-SDG relationships.

In some cases, survey respondents had highly polarized perspectives about an STI-SDG relationship. For example, the use of blockchain technology was rated by some responses as a definite positive influence towards meeting Target 11.6: 'reduce adverse environmental impact of cities, by paying special attention to air quality and municipal and other waste management'. An equal number of responses rated its influence as definitively negative towards SDG achievement. This results in an average 'neither' rating along the centre line of Figure 7.6.

We found the greatest consensus about the positive scoring STIs. This phenomenon – known as the desirability effect (where there is greater consensus about the likelihood of good things in the future than about bad things) is often encountered in similar studies.[19]

Table 7.1 / Highest- and lowest-rated STI types across all SDG targets

HIGHEST RATED

SDG target	STI	Type	Mean rating	Consensus %	Responses %
SDG 12.3 Food waste	Education and marketing to change consumer behaviour	Social innovation	4.94	95	16
SDG 3.2 Newborn and child death	Public health	Policy innovation	4.88	90	196
SDG 7.1 Energy access	Renewable energy	Market-oriented innovation	4.85	91	227
SDG 10.2 and 10.3 Inclusivity	Social justice	Values and direction-setting	4.85	91	33
SDG 15.8 Invasive species	Regulations and controls on invasive species	Policy innovation	4.81	91	42
SDG 7.2 Renewable energy	Solar energy	Market-oriented innovation	4.78	87	32
SDG 16.7 Decision-making	Protection of voter rights	Values and direction-setting	4.76	88	17
SDG 11.3 Urbanization	Affordable housing	Policy innovation	4.76	91	21
SDG 8.7 and 8.8 Labour	Education	Social innovation	4.75	89	92
SDG 7.3 Energy efficiency	Building energy efficiency	Market-oriented innovation	4.75	90	40

STI influences rated by at least 10 respondents were ranked by highest mean rating and highest consensus to identify the ten highest rated STI areas

LOWEST RATED

SDG target	STI	Type	Mean rating	Consensus %	Responses %
SDG 15.5 Biodiversity	Conversion of natural areas for agriculture and livestock	Values and direction-setting	1.25	60	69
SDG 2.1 Food access	Genetically modified crops	Existing technology	1.50	65	12
SDG 15.3 Desertification	Heavy agricultural mechanization	Existing technology	1.65	54	65
SDG 7.1 Energy access	Natural gas exploitation	Market-oriented innovation	1.68	55	31
SDG 3.2 Newborn and child death	Population control	Values and direction-setting	1.79	61	14
SDG 11.1 Housing	Abolish private property rights	Values and direction-setting	1.83	61	12
SDG 7.1 Energy access	Small modular reactors	Market-oriented innovation	1.87	52	38
SDG 7.3 Energy efficiency	Next-generation nuclear	Market-oriented innovation	1.95	53	63
SDG 3.4: Non-communicable diseases	Augmented reality	Market-oriented innovation	2.00	59	13
SDG 2.1: Food access	Organic agriculture	Market-oriented innovation	2.09	66	11

STI influences rated by at least 10 respondents were ranked by the lowest mean rating and a consensus of more than 50% to identify the lowest 10 rated STI areas

Rating of future STI-SDG influences

The STI areas with a high consensus about their positive future influence towards SDG achievement (see upper-right-quadrant in Figure 7.7) include a diversity of STI types. On average, social innovations were the highest-scoring influences, and market-oriented innovations were the lowest.

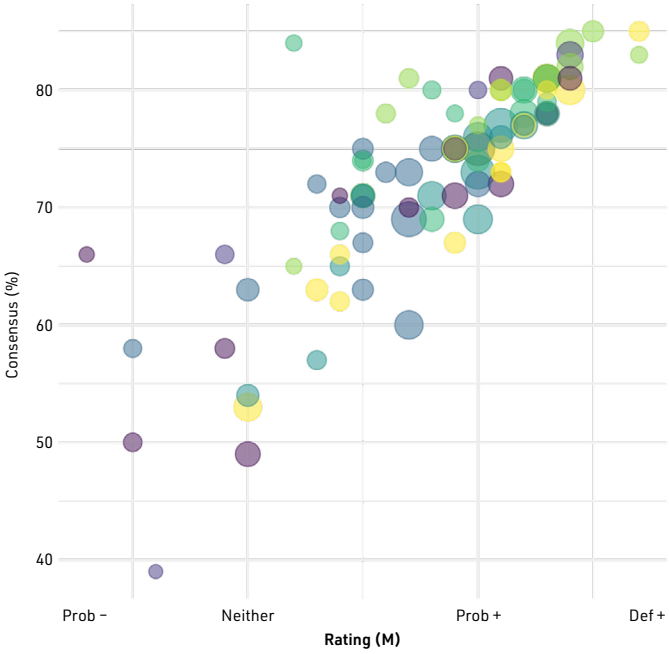
The ten highest-scoring STI influences identified in the survey (see Table 7.1) include only one market-oriented innovation: solar energy for renewable energy. This identification of an energy technology aligns with the data on patent activities: SDG7 (Affordable and clean energy) is the second most common area for SDG-related patent activity, following SDG3 (Good health and well-being).

However, the ratings of future influence provided by our survey participants contrast with the direction of current research and innovation, as mapped in earlier chapters of this report. For example, while the survey responses tend to focus on issues such as social justice, voter rights and affordable housing, we found that research publications relating to societal issues of inequality, education and conflict attract less funding and are more disconnected from research on other SDGs (see Chapter 4).

Several of the STI areas with the lowest mean ratings (see Table 7.1) are existing technology and market-oriented innovations: genetically modified crops, heavy agricultural mechanization, small modules, next-generation nuclear, and augmented reality. However, Chapter 5 shows that there has been recent innovative activity in these areas.

Section 3 (Conclusions and recommendations) of this report addresses ways in which these clear misalignments between current STI activity and the perspectives of expert participants in the STRINGS survey can be addressed.

Figure 7.7 / Consensus-rating plots for STI types across SDGs 1-16



Rating (M) is a measure of likely STI influence on SDG attainment using a scale from definitely negative, to probably negative, to a neutral midpoint, to probably positive, to definitely positive. Consensus (%) is a measure of relative agreement across survey respondents.

Each dot denotes a specific STI type-SDG relationship proposed by STRINGS survey respondents for SDGs 1-16. Each colour represents the type of STI, as elaborated in 'Diversity of proposed STI influences' on page 80. The size of the circle indicates the relative number of responses that rated that STI-SDG relationship.

> KEY:

- Existing technology
- Grassroots innovation
- Market-oriented innovation
- Policy innovation
- Scientific research area
- Social innovation
- Values and direction-setting

Notes

1. OECD/Eurostat, 2018.
2. Kaplinsky, R. et al., 2009.
3. OECD/Eurostat, 2018.
4. Rhoten, D. and A. Parker, 2004.
5. Chavarro, D. et al., 2014.
6. Gewin, V., 2012.
7. Pradhan, P. et al., 2017.
8. Ibid
9. Section 5.3 in Appendix 5 summarizes the identified synergies for STI areas with identified influence on the achievement of three or more SDGs.
10. Arthur, W. Brian, 2009.
11. Kaplinsky, R., 2011.
12. UNDP, 2009.
13. UN-IATT, 2011.
14. Diamond, I. R., et al., 2014.
15. Section 5.4, Apeendix 5 summarizes the STI-SDG relationships with highest consensus and rating, according to respondents' region, expertise, role, disciplinary background, SDG expertise and age.
16. Ramirez, R. and Wilkinson, A., 2014.
17. Cheng, F.-F. and Wu, C.-S., 2010.
18. Two factors were taken into consideration for the measurement of 'consensus': the 'variation' across ratings for a given STI influence on an SDG target (calculated by dividing the standard deviation by the mean of these ratings given by survey responses); and a 'stability' weighted factor, reflecting whether respondents adjusted their initial ratings when they viewed others' scores and reflections.
19. Ecken, P et al., 2011.