Bioeconomy Sustainability Indicator Model (BSIM)

Supergen Bioenergy

Supergen Bioenergy Hub

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Guidance Manual

Authors

Andrew Welfle, Mirjam Röder

The University of Manchester · Aston University Birmingham UK · EBRI Energy & Bioproducts Research Institute · UKRI Biotechnology and Biological Sciences Research Council · UKRI Engineering and Physical Sciences Research Council

Please use the following references:

BSIM:
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All enquiries related to this publication should be sent to:
andrew.welfle@manchester.ac.uk

Table of Contents

1. Introducing the Bioeconomy Sustainability Indicator Model

The Bioeconomy Sustainability Indicator Model (BSIM) was developed by the UK Supergen Bioenergy Hub (SBH) to provide a flexible tool to map the sustainability of bioeconomy projects. The BSIM can analyse individual elements within bioeconomy projects from specific biomass resources, supply chains, technologies, or whole bioeconomy project value chains. This Manual has been developed to introduce, explain and provide a step-by-step guide for using the BSIM.

The BSIM can be freely accessed online [1], and demonstration of its application can be found in research literature [2].

1.1. BSIM Approach

A schematic illustrating the architecture and overall approach of the BSIM is presented in Figure 1 and described below:

1) The model was developed around the concept that there will be both sustainability risks and benefits attributed to each life cycle step within any bioeconomy project and each value chain, and sustainability can be mapped to identify and analyse these risks and benefits.

2) A comprehensive list of sustainability issues was identified, covering each potential life cycle stage for any given project or value chain.

3) These issues are structured within a sustainability assessment framework following a hierarchy of:

    - High-level sustainability *categories* (e.g. climate change),
    - Sustainability *themes* (e.g. emissions),
    - Sustainability *indicators* (e.g. land-use change),
    - Individual sustainability *issues* (e.g. direct land-use change).

    The BSIM is calibrated by selecting the sustainability issues relevant to a project and identifying the potential occurrence of a sustainability risk or benefit by scoring the level of impact from very low to very high. Additionally, each sustainability *issue* has a *weighting* value to account for the greater or lesser potential influence within the whole system compared to all other issues considered.

4) The BSIM generates outputs mapping the sustainability risks and benefits and calculating an overall sustainability score for the project based on the combined individual *indicator* scores and *weightings*. Sustainability scores for a given project provide an index value to allow comparison between projects.

5) The BSIM is also designed to map the potential influence of bioeconomy projects on the United Nation's Sustainable Development Goals (SDGs). Identifying where a project may generate risk or benefits for achieving each of the 17 SDGs.

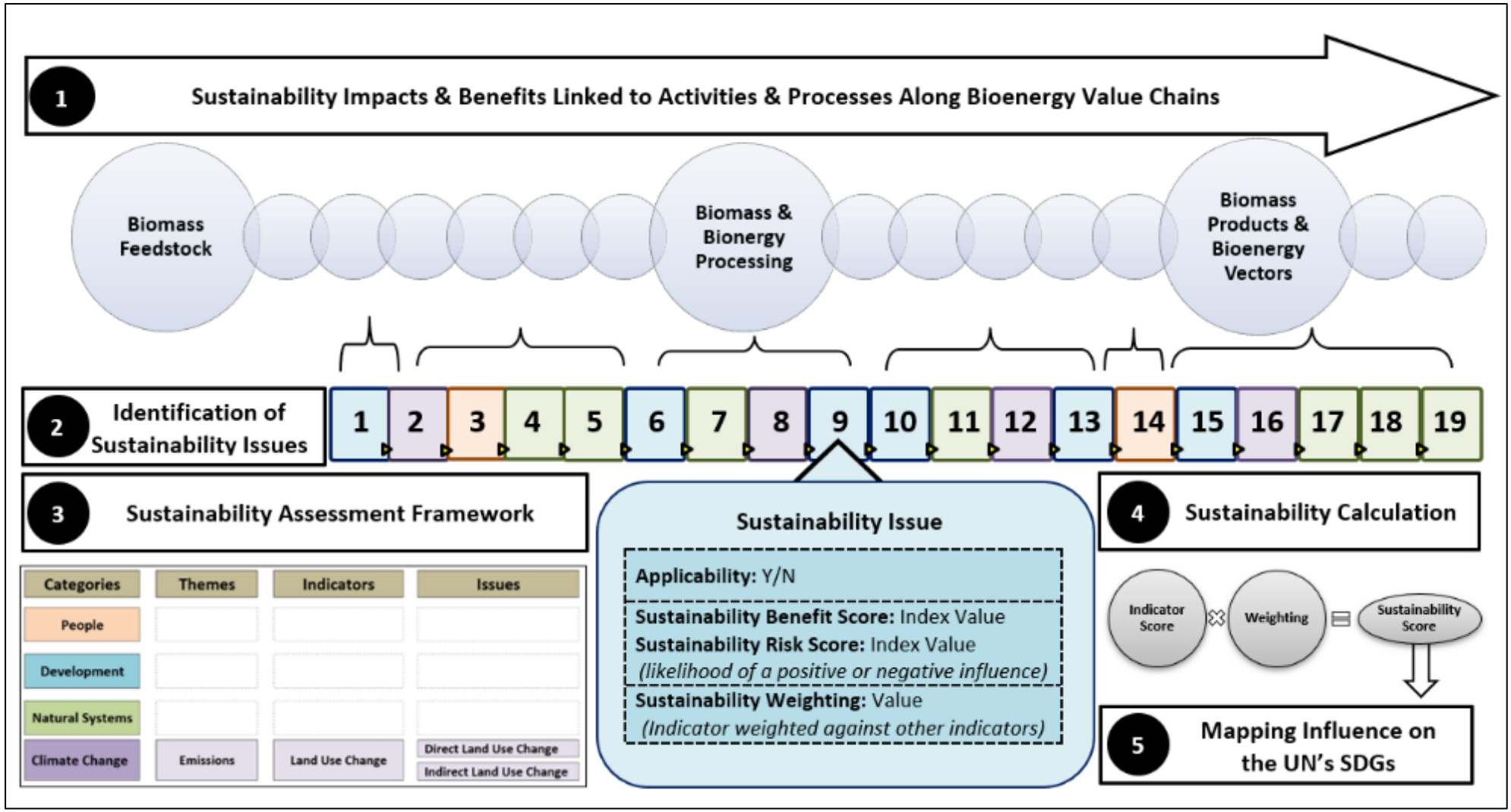


Figure 1: Bioeconomy Sustainability Indicator Model Architecture

2. BSIM Development

2.1. Stakeholder Engagement

The BSIM was developed by the UK Supergen Bioenergy Hub [3] through active engagement with bioenergy stakeholders. During a series of workshops, stakeholders from academia, industry, and policy discussed and informed the BSIM's overarching concepts, the list of sustainability issues, the sustainability assessment framework, the calculation mechanics and the weightings of sustainability issues. Stakeholders from academia also tested and validated the BSIM by mapping the sustainability of bioenergy case studies. Engagement was facilitated by individual discussions with bioeconomy specialists, five 'Bioeconomy Sustainability Expert Workshops', and model development sessions at Supergen's Researchers Day 2021 and with the Supergen Core Management Group and Advisory Groups.

2.2. Individual Conversations with Bioenergy Stakeholders

Meetings were organised before the BSIM was developed to identify the boundaries of the methodology and develop concepts drawing on the similar experiences of stakeholder groups:

- Roundtable on Sustainable Biomaterials, 8th June 2020.
- International Maritime Organisation's Sustainable Shipping Initiative, 13th August 2020.

2.3. Bioeconomy Sustainability Expert Workshops

Workshops were organised to focus on each of the sustainability *themes* of the BSIM. Expert stakeholders from the following organisation contributed to these workshops:

- Aston University
- Consult-Meridian
- Drax Group Ltd
- Imperial College London
- Innovate UK
- Renewable Energy Association
- Royal Dutch Shell
- Tyndall Centre for Climate Change Research
- UK Centre for Ecology & Hydrology
- UK Department for Transport
- Uniper
- University of Aberystwyth
- University of Bath
- University of East Anglia
- University of Edinburgh
- University of Manchester
- University of Nottingham
- University of Southampton

The workshops were facilitated virtually via 'Zoom' conferencing software [4], with attendants asked to provide feedback and information facilitated by 'Poll Everywhere' polling software [5]:

- Climate Change & Emissions: 15th October 2020,
- People, Food & Society: 3rd November 2020,
- Development - Technology, Infrastructure & Economics: 5th November 2020,
- Land & Water: 11th November 2020,
- Air Particulates & Pollutants: 12th November 2020

2.4. Engagement Activities

Presentations were delivered at the following events to introduce the BSIM and gain feedback on its design and approach:

- Energy & Bioproducts Research Institute, Aston University, 14th April 2021
- European Bioenergy Conference & Exhibition, 29th April 2021
- UK Supergen Bioenergy Hub Researchers Day, 7th May 2021
- Sustainable Futures Event, University of Manchester, virtual event: 8th June 2021

2.5. Validation of the BSIM

The BSIM was validated through further individual workshops with academics who tested the model through its application to specific research case studies. The allowed validation of the models base assumptions, the weightings of individual sustainability issues. Through testing the model the academics also provided feedback on the model's functionality.

2.6. Software

The BSIM was developed within Microsoft Excel [6] using macros to enable functionality and scenarios development.

3. Sustainability Assessment Framework

The choice of sustainability *issues* included in the BSIM was influenced by the large body of existing work that focuses on bioenergy and bioeconomy sustainability assessment schemes. Sources used included the EU RED II criteria [7], Global Bioenergy Partnership's sustainability indicator framework [8], the Roundtable on Sustainable Biomaterials assessment criteria [9] and the many individual targets of the United Nation's Sustainable Development Goals [10]. The final choice of *issues* included in the BSIM and the structuring of a sustainability assessment framework was developed through the stakeholder engagement activities.

The resulting sustainability assessment framework includes coverage of 126 different sustainability *issues*. These are structured in 38 sustainability *indicators*, 16 sustainability *themes* and 4 sustainability *categories*. Table 1 provides a summary of the *categories, themes* and *indicators* covered by the BSIM, and a discussion of each sustainability *issue* is provided below.

Table 1: Sustainability Indicator Assessment Framework

Sustainability Assessment Framework		
Categories	**Themes**	**Indicators**
People	Health	*Health & Wellbeing*
		Food Systems
		Land Management
	Livelihoods	*Decent Work*
		Jobs & Skills
		Change in income
	Society	*Equality*
		Peace, Justice & Strong Institutions
		Partnerships
		Energy Access
Development	Economy	*Economic Performance*
		Economic Stimulation
	Infrastructure	*Infrastructure Requirements*
	Feedstocks	*Production Processes*
		Mobilisation
		Distribution
	Technology	*Innovation*
		Efficiencies
		Techno-Economics
	Energy Sector	*Bioenergy*
		Energy System Performances
	Bioeconomy	*Added Value Products*
		Bioenergy Complementing Wider Sectors
	Land Utilisation	*Land Characteristics*
Natural Systems	Land	*Soil*
		Ecosystems
	Air	*PM Pollutants*
		Oxide Pollutants
		Heavy Metal
	Water	*Water Use & Efficiency*
		Water Quality
		Water Systems
Climate Change	Governance	*Climate Action*
		Standards
	Carbon & Emissions	*Whole Life Cycle Emissions*
		Land & Carbon Stocks
		Counterfactual Considerations
	Energy System	*Replaced Fuels*

3.1. Bioeconomy Sustainability - People

Within the sustainability *category* People the BSIM covers three core *themes*: Health, Livelihoods and Society.

Potential influence on Health includes *issues* such as possible changes in mortality rate and disease burden, for example, due to disease attributable to contaminants and air pollution [11]. Also influences to occupational risks and safety hazards linked to incidences of injury, illness or fatalities due to bioeconomy activities [12]. Influence on food systems, include changes in food commodity production, supply, prices, and influences on the productivity and resilience of agriculture [13].

Bioeconomy sustainability *issues* related to the Livelihoods *theme* include potential influences on land management, ownership and access [14], working conditions [15], jobs and changes in income [16].

The Society *theme* is developed to map the potential influence on wider society including issues of diversity and equality, institutions and legal systems, and its influence through partnerships with community groups [17], with industry and government organisations [18]. Changes in energy access due to bioeconomy projects is a further crucial societal issue that may provide wider sustainability influences for both households and industry [19].

3.1.1. Health

3.1.1.1. Health & Wellbeing

Mortality Rate & Disease Burden	There are many ways how bioeconomy can influence health. For example, the transformation of land, including for agriculture, forestry, wetlands, and bioenergy can provide both potential benefits gained by providing clean energy, and potential risks where there are occurrences of unsustainable practices or activities [20]. ○ *Are there any risks and/ or benefits to health and wellbeing that may influence mortality or disease as a consequence of the project?*
Exposure to Occupational Health & Safety Hazards	Many activities and processes of the bioeconomy have known hazards that need to be managed. For example, health risks associated with industrial processes, the use or production of hazardous fuels, chemicals or products. Products of the bioeconomy such as low carbon fuels and chemicals can also provide cleaner options that may provide broader health and safety benefits [21]. ○ *Are there any risks and/ or benefits to health and wellbeing linked to occupational health and safety as a consequence of the project?*

3.1.1.2. Food Systems

Food Commodity Supply	Biomass cropping land use decisions will influence the food sector where land is used for production of feedstocks instead of food. Reducing or displacing food production may influence the supply of food commodities at both local and regional scales [22]. ○ *Are there any risks and/ or benefits for food commodity supply as a consequence of the project?*
Food Commodity Imports & Exports	Reducing or displacing food production may also influence the levels of food commodities available to export from certain regions, and in turn may influence food commodity import activity [22]. ○ *Are there any risks and/ or benefits for food commodity imports and exports as a consequence of the project?*

Climate Change Resilience	The bioeconomy can directly influence the climate change resilience of the food sector. Robust empirical literature demonstrates how implementation of best management practices can increase the resilience of land, productivity and the sector more broadly. In contrast where best practices are not deployed, bioeconomy activities may reduce the resilience of natural systems to climate change [23]. ○ *Is there potential for the project to generate risks and/ or benefits for the food sector and its ability to resist climate change?*
Changes in Costs of Agricultural Products	The bioeconomy is intrinsically linked with the land and agricultural process and has the potential to both provide a benefit and impact for costs. For example, developing the bioeconomy may provide advances such as improved infrastructure that may reduce costs of agricultural products. Although sectors of the bioeconomy may also compete for land, feedstocks, agricultural inputs etc that may result in increased costs [24]. ○ *Are there any risks and/ or benefits for the costs of agricultural products as a consequence of the project?*
Food Prices	The bioeconomy may have direct influences on food prices where there are impacts on food commodity supply-demand trends. Increased efficiencies translated to the food sector may provide benefits in reducing food prices. Whilst any changes to the availability of food commodities may increase food prices at the local, regional or national scale [24]. ○ *Are there any risks and/ or benefits for food commodity prices as a consequence of the project?*
Food Security	Where food production is reduced or displaced, there is potential for the rise in food security concerns and impacts arising from reduced self-sufficiency and reliance on imports at the local, regional and national scales [22]. ○ *Are there any food security risks and/ or benefits as a consequence of the project?*

3.1.2. Livelihoods

3.1.2.1. Land Management

Land Ownership	Growth of the bioeconomy and the changing demands for biomass resource will influence how land is managed – the value and use of lands will change as demands for specific feedstocks change. Where external actors become interested in the control of resources, there will be both potential of risks and benefits for landowners. Land becoming more valuable but there is also a growing phenomenon of 'land grabbing' in some regions where organisations work to overtly or subtlety control lands and its resource potential [25]. ○ *Is there potential for changing land ownership structures leading to sustainability risks and/ or benefits as a consequence of the project?*
Land Access	Changing land ownership and management practices may also result in changes to how lands are accessed. This may be beneficial, for example where access is potentially increased through new management and/ or infrastructure. Also potential impacts where new management practices restrict previous access options [25]. ○ *Is there potential for changing land access dynamics that may lead to sustainability risks and/ or benefits as a consequence of the project?*

3.1.2.2. Decent Work

Rights	The bioeconomy provides jobs with broad ranging work specialisms. Providing decent working conditions that adheres to high standards is a mandatory criterion for the sustainability of any projects. As activities of the bioeconomy cross international borders, laws and standards that set minimum requirements for working conditions will also change - projects within the bioeconomy adhere to these standards and can provide a mechanism for raising standards. It is also vital that projects are managed in the knowledge that the monitoring and enforcement of working standards is not uniform across all regions, so there is always risk to sustainability that needs constant attention [26]. ○ *Is there potential that the project may result in sustainability risks and/ or benefits for working rights?*
Child Labour	Projects are not sustainable where there is any risk of child labour! ○ *Is there potential risks of child labour as a consequence of the project?*
Slave Labour	Projects are not sustainable where there is any risk of slave labour! ○ *Is there potential risks of slave labour as a consequence of the project?*
International Labour Standards	Projects that do not adhere to international labour standard are not sustainable! ○ *Is there potential risks that the projects will not adhere to international labour standards?*

3.1.2.3. Jobs & Skills

Skilled Jobs	The bioeconomy provides jobs, skills and training covering the full spectrum of work activities. A leading benefit of any project will be the jobs it creates, and training, skills and experiences it provides. There is also potential for risks where livelihoods are lost as consequence of transitions, for example traditional bioenergy jobs lost as the energy sector modernises. Creation of permanent skilled jobs is a key driver of sustainable development [27]. ○ *Are there any risks and/ or benefits resulting from the skilled jobs created as a consequence of the project?*
Unskilled Jobs	Many activities of the bioeconomy will be reliant on unskilled labour. Providing new jobs and benefits will provide clear benefits, although there are also risks for society where there is large imbalance between skilled and unskilled workforce [27]. ○ *Are there any risks and/ or benefits resulting from the unskilled jobs created as a consequence of the project?*
Permanent Jobs	Creation of permanent skilled jobs will be a key driver of sustainable development [27]. ○ *Are there any risks and/ or benefits resulting from creation of permanent jobs as a consequence of the project?*

Temporary Jobs	Many activities of the bioeconomy are reliant on temporary and seasonal work, for example biomass jobs to help establish or harvest crops. These can provide valuable income and benefit, but also a sustainability risk when work is not available [27]. ○ *Are there any risks and/ or benefits resulting from creation of temporary jobs as a consequence of the project?*
Regional Job Distribution	Sectors of the bioeconomy can be highly concentrated in specific regions where feedstocks are grown, processed and where products are eventually sold. This can provide clear benefits for the regions with activities, but also risks where this activity may result in imbalances in the economy or available workforce [27]. ○ *Are there any risks and/ or benefits resulting from the regional distribution of jobs as a consequence of the project?*
Career Development	A leading benefit of any project will be the jobs it creates, and training, skills and experiences provided. The bioeconomy will be a key driving force for sustainable development where it provides attractive careers. Where projects offer limited opportunities for career development the net contribution of the project to society and wider sustainability may also be limited [27]. ○ *Are there any risks and/ or benefits resulting from the career development opportunities provided by the project?*

3.1.2.4. Change in Income

Wages from Bioeconomy	The bioeconomy can be a valuable sector of any economy, providing jobs and income. Regular wages being a key driver of sustainable development [28]. ○ *Are there any risks and/ or benefits resulting from the wages potentially provided by the project?*
Net Income from Bioeconomy	The bioeconomy can be a valuable sector within wider economies and a major source of income and contributor to GDP. Net income providing a driver of sustainable development and mechanism for improving infrastructure, industry, human services etc [29]. ○ *Are there any risks and/ or benefits resulting from the changes in net income potentially provided by the project?*

3.1.3. Society

3.1.3.1. Equality

Diversity through Supply Chain Participation	Bioeconomy industries can be significant employers at each stage of value chains where the required skills and occupations can be highly diverse. This places bioeconomy industries in a unique position, having the potential to influence equality and diversity cutting across regions and segments of society. Where a project focuses on enhancing diversity through supply chains there is great potential for having a positive influence for equality through society [30]. ○ *Are there any risks and/ or benefits for diversity through the project's approach to supply chains participation?*

Diversity & End Use	Bioeconomy projects may also influence equality and diversity through the end use of biofuels and bioproducts. For example, where modern bioenergy technologies are deployed to replace traditional bioenergy, there may be a mitigation of time intensive activities such as collection of wood fuels that have been found to be a gender specific role in many regions – this potentially freeing time of individuals, providing new opportunities [19]. ○ *Are there any risks and/ or benefits for diversity through the end use of products generated by the project?*

3.1.3.2. Peace, Justice & Strong Institutions

Legality	The bioeconomy is unique from many sectors as there is potential for extensive value chains that cross regions and international borders. Within a given value chain there may be different legal frameworks, cultures and methods of operation. For any bioeconomy project to be sustainable it is vital to stay within the bounds of legality and should ensure the highest standards are adhered throughout [31]. ○ *Is there potential legality risks at any stage of the project's value chains?*
Monitoring	The monitoring of a project's activities and adherence to standards is a further prerequisite for sustainability. There should a robust strategy and mechanisms to ensure that adherence to standards is maintained at each stage of a project's value chains [31]. ○ *Is there potential risks from the project's strategy for monitoring adherence to working standards?*
Bribery & Conflict of Business	Bribery and corruption is a further activity that should have no role in sustainable projects [31]. Where there is risk of conflict, measures should be implemented to ensure the continued monitoring and prevention of bribery and corruption through value chains [31]. ○ *Is there potential risks of bribery and corruption through the project's value chains?*

3.1.3.3. Partnerships

Community Partnerships	The bioeconomy encompasses many sectors, and its activities are intrinsically linked to people, land, industry etc. Partnerships are key for the success of the bioeconomy, potentially enabling and enhancing the benefits for people, the economy and natural systems. Lack of partnerships presents a potential risk for the success of any project and a potential barrier to maximising benefits. For example, partnerships with community groups can be key for gaining acceptance of a project and ensuring benefits gained such as new infrastructure are maximised [32]. ○ *Are there any sustainability risks and/ or benefits resulting from the project's community partnerships?*
Industry Partnerships	Industry partnerships are essential to drive the innovation, development and successful implementation of bioeconomy projects. The success of bioeconomy industries providing a positive influence and driver of sustainable development [32]. ○ *Are there any sustainability risks and/ or benefits resulting from the project's industry partnerships?*

Government Partnerships	Partnerships with government are crucial to set the direction and drive development of the bioeconomy. For example, government partnerships with industry that provide support for emerging technologies is essential for the sector potentially providing long-term sustainability benefits [32]. ○ *Are there any sustainability risks and/ or benefits resulting from the project's government partnerships?*
Specialist Bioenergy Partnerships	Bioenergy is an industry within the bioeconomy where there are strong links with people, industry, government etc; a successful bioenergy value chain having to complement and adapt to the requirements and realities of numerous actors. Partnerships focused on the promotion and deployment of bioenergy technologies are crucial for the sustainability and growth of the sector [32]. ○ *Are there any sustainability risks and/ or benefits resulting from the project's bioenergy partnerships?*

3.1.3.4. Energy Access

Households using Bioenergy	Increasing access to secure, low carbon renewable energy has been demonstrated to be a leading driver of sustainable development. Renewable sources such as bioenergy can reduce reliance on conventional energy and depending on the technologies deployed may reduce reliance on the grid. Increased use of bioenergy may also provide benefits for individual households, for example there may be air quality and health benefits gained where modern bioenergy technologies replace traditional bioenergy. There is also potential risks as feedstock supply chains need to ensure sufficient sustainable supply to balance any increased in demands [33]. ○ *Are there any sustainability risks and/ or benefits achieved through the project increasing access to bioenergy for households?*
Industry using Bioenergy	Sustainability risks and benefits may also be realised where there is increased use of bioenergy by industry, given there is sufficient supply of sustainable feedstocks to balance demands [33]. ○ *Are there any sustainability risks and/ or benefits achieved through the project increasing access to bioenergy for industry?*

3.2. Bioeconomy Sustainability - Development

The Development sustainability *category* covers seven *themes*. This includes mapping potential bioeconomy project's influences on the Economy and Infrastructure. For example, potential risks or benefits for GDP, trade and the economic performance of wider sectors, and the broader influences of increasing renewable energy generation albeit at the cost of required economic support mechanisms [34,35]. The Development *category* also includes the potential risks and benefits resulting from the use of existing and new infrastructure [36]. The production, mobilisation or harvesting of Feedstocks may also generate both risks and benefits resulting from varying production methods and wider strategies that may change the productivity of land and processes [37]. Factors such as the spatial distribution of and existing competition for feedstocks potential may have widespread sustainability implications [38].

Bioeconomy projects may also develop new Technologies and intellectual property that may have sustainability implications such as improving efficiencies or economic performances [39]. Increased bioeconomy activities such as bioenergy can also have sustainability implications for the broader Energy Sector [22], specifically for the Bioeconomy [40] and for Land Utilisation [41].

3.2.1. Economy

3.2.1.1. Economic Performance

Gross Domestic Product	The bioeconomy can be a valuable sector within economies and a major contributor of revenues. Bioeconomy activities potentially contributing to GDP and decisions influencing the bioeconomy may in return be influenced by wider economic performances that determine factor such as available funds [42]. ○ *Are there any risks and/ or benefits for GDP that may result as a consequence of the project?*
Influence on Wider Sectors	The bioeconomy encompasses many sectors and its activities such as bioenergy are intrinsically linked to people, land, industry etc. Bioeconomy activities thus have the potential to influence many sectors across economies [42]. ○ *Are there any risks and/ or benefits for wider sectors of the economy as a consequence of the project?*
International Trade	The bioeconomy is intrinsically linked to trade, as products, materials and feedstocks are imported and exported to balance demands. This can be beneficial where the production of added-value products or feedstocks are exported. There may also be risks where reliance is placed on imports to balance demands [35]. ○ *Are there any sustainability risks and/ or benefits from changes in international trade as a consequence of the project?*
Financial Capacity to Adopt Bioenergy	Bioenergy projects can require significant capital expenditure to install facilities, establish cropping and feedstock mobilisation, develop supply chains etc. The financial capacity to provide initial support for such activities can be a leading factor determining whether a project can proceed and ultimately whether the project is economically sustainable [43]. ○ *Are there financial capacity considerations that provide potential risks and/ or benefits for the ongoing economic sustainability of the project?*

3.2.1.2. Economic Stimulation

Increased Sustainable Energy Generation	Bioeconomy projects such bioenergy activities that provide sustainable energy can stimulate widespread benefits. For example, providing secure local energy sources may reduce reliance on the grid or imported energy. These benefits should be weighed against factors such as the costs of establishing and maintaining the bioenergy project [34]. ○ *Are there any risks and/ or benefits provided by the increased generation of sustainable energy as a consequence of the project?*
Economic Support Measures	Economic support measures can be vital for the economic viability of many bioeconomy projects. The availability and scale of support needed to establish and ensure economic viability needs to be balanced to ensure there is long term the economic capacity to maintain the support [34]. ○ *Are there any risks and/ or benefits provided by the economic support measures that are required to sustain the viability of the project?*

3.2.2. Infrastructure

3.2.2.1. Infrastructure Requirements

Existing Infrastructure – Availability	The viability and long-term sustainability of bioeconomy projects may be determined by the availability of existing infrastructure to enable activities intrinsic to the project. For example, availability of existing roads or pipelines to facilitate the transport of feedstocks or products. Use of existing infrastructure may be beneficial as it will mitigate the need for building new works but may also place new strains on the existing infrastructure [44]. ○ *Are there any sustainability risks and/ or benefits resulting from the availability of existing infrastructure as to be used by the project?*
Existing Infrastructure – Capacity	Bioeconomy projects may also have impacts on the capacity of existing infrastructure. Increased use of roads and pipelines etc, potentially providing benefits as increased capacity may enhance the economic performance of infrastructure assets. There may also be impacts where new demands exceed capacity limits of existing infrastructure [44]. ○ *Are there any risks and/ or benefits resulting from changes in the capacity of existing infrastructure as a consequence of the project?*
New Infrastructure Capacity	Where projects require new infrastructure the capacity for activities such as movement and transport of products will increase. This may drive wider economic benefits for broad sectors, for example growth of transportation sectors. However there may also be substantial sustainability risks not least the new cost burden required to construction new infrastructure [44]. ○ *Are there any risks and/ or benefits for sustainable development resulting from new infrastructure constructed to increase capacity as required by the project?*

3.2.3. Feedstock Production/ Mobilisation/ Distribution

3.2.3.1. Production Processes

Agro-Chemicals (Fertiliser & Pesticide)	Agriculture is intrinsically linked to the bioeconomy as provides resources either grown specifically in the case of energy crops or indirectly through the utilisation of agricultural residues. The use of agro-chemicals such as fertilisers and pesticides can maximise crop yields, thus having sustainable development benefits for people and the economy etc. However inappropriate fertilisation and/or the use of pesticides can have adverse effects on crop productivity and quality, can be a cost burden, will be an additional source of net emissions and risks environmental impacts such as to water systems. Thus the potential risks and benefits of agro-chemicals use need to be balanced [45]. ○ *Are there any risks and/ or benefits resulting from use of agro-chemicals through the project?*

Use of Genetically Modified Materials	Genetical modification of materials is a strategy that may provide large benefits for the performances of bioeconomy activities. For example, modification of crops to enhance productivity or resilience would provide clear sustainable development benefits. These benefits need to be weighed against the potential risks. There are known risks such as the potential for crops to pass traits to 'wild' relatives leadingly to increases their invasiveness, also unknown risks such as the potential for traits to negatively impact non-target organisms in the environment [46]. ○ *Are there any sustainability risks and/ or benefits for the project resulting the use of genetically modified materials?*
Feedstock Production Strategy	The feedstock production strategy will influence what and how feedstocks are grown/ harvested/ collected and can be highly influential on the sustainability of a project. Strategies that are too intensive in the crops they grow or resources they extract may result in impacts that influence long-term sustainability and ability to continue to grow/ extract resources. For example, excessive application of agro-chemicals or removal of crop residues from the land may have long term impacts on soil health and subsequent land productivity. Where a sustainable feedstock production strategy is implemented that prevents excesses, there is increased potential for long sustainable production and contribution to development [37]. ○ *Are there any risks and/ or benefits for sustainable development resulting from the project's feedstock production strategy?*
Land Use Productivity	Productivity of the land is essential for the bioeconomy. Where projects increase productivity of the land there will be benefits for the bioeconomy, for people and thus for wider sustainable development. This productivity needs to be balanced against potential risks for environmental systems and activities such as direct or indirect land use change [47]. ○ *Are there any sustainability risks and/ or benefits resulting from changing land use productivity as a consequence of the project?*

3.2.3.2. Mobilisation

Resource Mobilisation	The mobilisation of resources for the bioeconomy has the potential for generating both risks and benefits for development and sustainability. Resource mobilisation may generate new markets and has the potential to transform materials that had limited previous value into commodities with value, for example wastes. Depending on the resources targeted there many also be risks, for example the overextraction of resource may have environmental impacts; or depending on the characteristics of resource there may be hazards that need management, for example where feedstocks may contain hazardous materials [48]. ○ *Are there any sustainability risks and/ or benefits resulting from the project's resource mobilisation activities?*
Competition for Resources	Bioeconomy activities are reliant on a broad range of biomass resources, and as the sector grows there will be a corresponding increase in demand for resource. There may be competition for resources between industries within the bioeconomy and with industries of wider sectors. This has the potential benefit of driving the growth of supply chains and maturing markets, albeit at the risk of also driving up commodity prices which may have detrimental impacts for sustainable development [35]. ○ *Are there any sustainability risks and/ or benefits resulting from the increased competition for resources as a consequence of the project?*

3.2.3.3. Distribution

Spatial Distribution of Resources	The spatial distribution of lands, resources and bioeconomy facilities is a key factor that will determine the overall viability and success of projects. Projects reliant on high concentrations of available feedstocks and/ or established connecting infrastructure will be more sustainable as they will have secure supply chains with likely better in techno-economic and environmental performances. Where projects are reliant of dispersed or long supply chains and/ or with underdeveloped connecting infrastructure will have reduced sustainability linked to the risks of potential supply [38]. ○ *Are there any risks and/ or benefits for the project resulting from the spatial distribution of required resources and/ or availability of connecting infrastructure?*
Resource Transportation	The transportation of feedstocks, products and fuels is a fundamental activity for any project within the bioeconomy, in addition to being a key business activity of the transport sector. Feedstocks are often harvested from a relatively large area and are not always near processing or end use facilities. As feedstock supply chains become increasing long, complex and potentially cross borders, infrastructure and an efficient transport strategy is vital for the growth and sustainability of the bioeconomy. Transport is enabled by networks of road, rail, maritime and pipeline infrastructure – the development of such infrastructure may bring widespread sustainable development benefits as well as environmental risks [49]. ○ *Are there any risks and/ or benefits for sustainable development resulting from the resource transportation strategy of the project?*

3.2.4. Technology

3.2.4.1. Innovation

TRL Development	The bioeconomy includes broad ranging technologies at varying levels of maturity. The 'technology readiness level' can present a risk to any project, for example even where technologies with high potential are deployed prematurely there is a risk they may fail or deliver poor performances that may be detrimental to the sustainability of the project. Although where projects lead to the advancement of a technology, such as providing the opportunity to improve designs through testing, there may be gains in performance and long term wider benefits for the environment, economy etc [50]. ○ *Are there any risks and/ or benefits from the TRL of technologies deployed as a consequence of the project?*
Intellectual Property	Intellectual property can be both a risk and benefit for sectors such as those of the bioeconomy. Intellectual property is indicative of a sustainable competitive advantage, well-managed companies, good growth prospects and operation in niche markets. There will be economic benefits where protected technologies and approaches are deployed effectively and stimulate subsequent commercial value. There are also potential risks where the protection of technologies restricts the broader deployment of successful technologies or restricts its further development by external actors – potentially limiting the full gains that may otherwise be realised. A further risk of having no intellectual property protection is the potential for creating a lack of credibility, at least from an investor's point of view [51]. ○ *Are there any risks and/ or benefits from the intellectual property status of technologies or approaches deployed through the project?*

3.2.4.2. Efficiencies

Processing Efficiencies	Efficiencies are important for each stage within bioeconomy value chains, from how lands are used through to the final generation of products and/or energy. The efficiencies of processing technologies and that of all activities are vital in determining the overall performance and sustainability of projects – efficiencies influencing productivities, land used, levels of waste generated, water and energy uses, and amount of product/ energy produced [37]. ○ *Are there any risks and/ or benefits for the project resulting from the processing efficiencies?*
Supply Chain Efficiencies	The efficiency of bioeconomy supply chains is a further key factor that will determine the overall sustainability performance of projects. The efficient production/ collection/ mobilisation of feedstocks and their onward movement for processing and to their end uses has implications for the environment, economics etc. The viability of bioeconomy projects will be much increased where there is efficient and reliable movement through supply chains [37]. ○ *Are there any risks and/ or benefits for the project resulting from supply chain efficiencies?*

3.2.4.3. Techno-Economics

CAPEX – Direct Fixed Capital Costs	Bioeconomy projects will only be sustainable where they are economically viable. A project's direct fixed capital costs are those that are directly linked to the establishment of the project such as the purchase of equipment or raw materials [52]. ○ *Are there any risks and/ or benefits resulting from the project's direct capital costs?*
CAPEX – Indirect Fixed Capital Costs	A project's indirect fixed capital costs are those that are indirectly linked to the establishment of the project such as administration or consultancy costs [52]. ○ *Are there any risks and/ or benefits resulting from the project's indirect capital costs?*
OPEX – Fixed Operational Costs	A project's fixed operational costs are those that do not change with either an increase or decrease in productivity and must be paid regardless of performances, for example rents and employee salaries [52]. ○ *Are there any risks and/ or benefits resulting from the project's fixed operational costs?*
OPEX – Variable Operational Costs	A project's variable operational costs are those that will change with either an increase or decrease in productivity, for example taxes, energy utilities [52]. ○ *Are there any risks and/ or benefits resulting from the project's variable operational costs?*

Biomass Feedstock Costs	The cost of feedstocks is a fundamental factor that will determine the economic viability of a project. Where feedstock costs are high or subject to fluctuations there will be ongoing risks for any project. Also where bioeconomy projects target the use of specific feedstocks there may be the additional risk of influencing the prices of that feedstock, which may impact wider sector competing for the resource [34]. ○ *Are there any risks and/ or benefits resulting from the project's biomass feedstock costs?*
Reliance on Economic Support Measures	Many bioeconomy projects are reliant on economic support measures to enable the establishment or the ongoing operation of activities. This support is often vital to ensure the economic viability of projects and to allow it to compete with established technologies. The availability of economic support will likely be a benefit for any bioeconomy project. However reliance on economic support measures may represents a key sustainability risk for any project, given there may be no guarantees that the support will remain over longer timeframes [34]. ○ *Are there any risks and/ or benefits resulting from the project's reliance on economic support measures?*

3.2.5. Energy Sector

3.2.5.1. <u>Bioenergy</u>

Infrastructure Alignment	Infrastructure is vital for the sustainable growth of the bioeconomy. For example, the compatibility with existing infrastructure is one of the primary reasons why bioenergy is heavily targeted within many country's renewable energy and decarbonisation strategies. There may be large benefits for bioenergy projects can take advantage of existing infrastructure, for example roads that enable the mobilisation and transport of biomass to processing and conversion sites. Where there is limited infrastructure alignment there will be sustainability risks, for example construction of new pipelines, roads or rail will be expensive and may lead to direct environmental impacts [53]. ○ *Are there any risks and/ or benefits as a result of the projects alignment with existing infrastructure?*
Bio-Product Flexibility (energy)	The flexibility provided by bioenergy makes it a valuable contributor to energy strategies, projects ideally being developed to produce bioenergy vectors that balance specific demands whether that is bioheat, biopower or biofuels. Where a project generates fuels and energy, the flexibility of the energy vector and its compatibility with existing energy infrastructure will contribute to its sustainability performance [54]. ○ *Does the flexibility of the bioenergy vectors generated by the project provide risks and/ or benefits for its sustainability?*
Bio-Product Flexibility (non-energy)	The bioeconomy is extremely broad in the bio-products it generates. The flexibility of these products, their compatibility with existing infrastructure and the extent that they can provide viable alternatives to balance demand will contribute to a project's sustainability [54]. ○ *Does the flexibility of the bio-products generated by the project provide risks and/ or benefits for its sustainability?*

Bioenergy Vector Distribution	The spatial distribution of biomass resources, processing facilities and their ideal end use locations are seldom aligned, meaning infrastructure and supply chains are required for to move resources, products, fuels and energy. The availability of infrastructure such as roads, pipelines and rail is essential to facilitate the distribution of bioenergy vectors. A sustainable distribution strategy will also likely require established and efficient technologies to facilitate movement of vectors [38]. ○ *Does the project's bioenergy vector distribution strategy present potential risks and/ or benefits for sustainability?*
Bioenergy Vector Affordability	A project will not be economically viable if it cannot produce bioenergy vectors that are affordable. The long term sustainability of any bioenergy project will be dependent on the ability to produce low carbon energy that can compete with conventional energy [54]. ○ *Are there sustainability risks and/ or benefits for project based on the affordability of the bioenergy vectors it generates?*

3.2.5.2. Energy System Performances

Input Energy Requirements	Energy is required to enable the bioeconomy, even where a project generates biofuels or bioenergy, input energy may be required at each stage along value chains. For example, fuel energy to collect, process and transport feedstocks. The type and extent of energy required to enable bioeconomy activities will influence the sustainability of a project. Where there are large energy demands there will be cost implications and depending on the source of the energy there may also be emission and climate change implications. Bioeconomy activities that have low input energy requirement will be more sustainable [55]. ○ *Are there sustainability risks and/ or benefits based on the input energy required to enable the project?*
Influences on Energy System Resilience	Bioeconomy activities both require energy to enable processes and may generate energy where bioenergy or biofuels are produced. This supply and demand of energy will have direct influence on the resilience of energy systems. The production of bioenergy and biofuels will increase the resilience of energy systems by providing additional sustainable low carbon energy that may reduce reliance on energy imports and/ or conventional energy sources and may also reduce reliance on the grid where used locally. There may also be risks, for example where energy demanding bioeconomy activities take place in locations where there is limited energy infrastructure, placing greater pressure on that available [56]. ○ *Are there sustainability risks and/ or benefits for energy system resilience as a consequence of the project?*
Accessibility to Wider Input Energy	Where bioeconomy activities are reliant on input energy to enable processes, access to the energy will influence the sustainability of projects. Bioeconomy activities and supply chains can take place far from established infrastructure, for example when producing/ sourcing feedstocks in rural regions. Secure access to energy such as fuels to operate machinery or transport is essential to the viability of the project. Projects will not be sustainable where there are potential risks to the access of energy or where the available energy is limited to unsustainable sources [56]. ○ *Are there sustainability risks and/ or benefits based on the access to input required to enable the project?*

3.2.6. Bioeconomy

3.2.6.1. Added Value Products

Bio-Chemicals	The bioeconomy has the potential to transform all forms of biomass materials into value-added products. Resulting in a product portfolio that consist of a wide spectrum products to address societal and consumer needs. The production of value-added products from materials such as wastes can provide wide benefits for the economy, people, environment and for climate change. For example, bio-chemical products such as bio-plastics can be sustainable low carbon alternatives that may replace fossil fuel derived chemicals. There are also potential risks such as the costs and affordability of such products - bio-chemical processes may currently cost more than the long established conventional processes that they are aiming to replace [32]. ○ *Are there any sustainability risks and/ or benefits from the production value-added bio-chemicals as a consequence of the project?*
Bio-Products	The bioeconomy can also produce a wide range of non-chemical products that can provide alternative options for industry and consumers. For example, bio-based insulation produced from resources such as wool can provide alternative options for the construction sector [32]. ○ *Are there any sustainability risks and/ or benefits from the production of value-added bio-products as a consequence of the project?*

3.2.6.2. Bioeconomy Complementing Wider Sectors

Agriculture & Forestry	The bioeconomy is intrinsically linked to broad economic sectors that may both provide and compete for resources. For example, the agriculture and forestry sectors are key sources of biomass. Where biomass is sourced sustainably this can provide many benefits for these sectors such as the diversification of revenue streams. Unsustainable practices such as over extraction of agricultural residues may also provide risks of the log terms sustainability of the sector [57]. ○ *Are there any risks and/ or benefits for the agriculture and/ or forestry sector as a consequence of the project?*
Chemical	The bioeconomy may provide many opportunities for the chemical sector, for example by providing low carbon feedstocks for bio-chemical production. There may also be risks for and generated by the chemical sector where there is increased competition for feedstocks [57]. ○ *Are there any risks and/ or benefits for the chemical sector as a consequence of the project?*
Waste	The waste sector may also represent a key source of feedstock material for the bioeconomy. For example, bioenergy potentially providing an opportunity for generating energy from wastes that may otherwise be diverted to landfill. There are also many risks associated with the processing and management of certain waste streams that need to be managed [57]. ○ *Are there any risks and/ or benefits for the waste sector as a consequence of the project?*

Construction	The construction sector is itself a major source of waste material that may provide feedstock opportunities for the bioeconomy. The construction sector may also compete for certain resources with sectors of the bioeconomy [57]. ○ *Are there any risks and/ or benefits for the construction sector as a consequence of the project?*
Transport	The transportation of feedstock, products and fuels is fundamental to the bioeconomy and a key business activity of the transport sector. As feedstock supply chains become increasing long, complex and potentially cross borders, the transport sector is vital for the sustainable growth of the bioeconomy. The bioeconomy also produces low carbon biofuels that are heavily targeted as part of the decarbonisation strategies for the transport sector [57]. ○ *Are there any risks and/ or benefits for the transport sector as a consequence of the project?*
Services	The bioeconomy generates jobs across all sectors, including providing opportunities for the services industry. The service sector is also vital for creating the frameworks, partnerships and economic support and investment to enable the sustainable growth of the bioeconomy [57]. ○ *Are there any risks and/ or benefits for the service as a consequence of the project?*
Manufacturing	The manufacturing sector is also a major source of waste material that may provide feedstock opportunities for the bioeconomy. Manufacturing industries may also compete for certain resources with sectors of the bioeconomy [57]. ○ *Are there any risks and/ or benefits for the manufacturing sector as a consequence of the project?*

3.2.7. Land Utilisation

3.2.7.1. <u>Land Characteristics</u>

Topography – Influencing Access	Topography can represent a key risk to the sustainability of a projects, as may determine the extent that lands may be used within biomass cropping activities. Factors such as gradient determining whether lands are accessible and whether equipment can effectively deployed at the site [58]. ○ *Are there any risks and/ or benefits for the project resulting from the topography of the land and its influence on access?*
Location – Influencing Distribution & Connectivity	The spatial distribution of lands, resources and bioeconomy facilities and the connecting infrastructure is a key factor that will determine the overall viability and success of projects. Projects reliant on high concentrations of available feedstocks and/ or established connecting infrastructure will be more sustainable as they will have secure supply chains with likely achieve better in techno-economic, environmental performances. Where projects are reliant of dispersed or long supply chains and/ or with underdeveloped connecting infrastructure there may be reduced sustainability due to the increased risks to supply [59]. ○ *Are there any risks and/ or benefits for the project resulting from the distribution of required resource and the connecting infrastructure?*

Use of Contaminated Lands	Bioeconomy projects that utilise contaminated lands can provide risks and benefits for sustainability. The practice of producing biomass crops on contaminated lands may require specialist equipment and practices to manage and minimise risk, in addition specialist technologies and procedures may be required to facilitate the onward use of the crops. There is also potential sustainability benefits - contaminated lands are not suitable for food production, production of feedstocks provides an option to use and gain value from otherwise unusable lands, in addition to potentially providing a mechanism to remediation [60]. ○ *Are there any sustainability risks and/ or benefits through the use of contaminated lands as a consequence of the project?*
Potential for Phytoremediation	Activities to decontaminate lands are typically expensive. Phytoremediation where production of biomass crops is used as a mechanism to remove contaminants from soils may provide a much more affordable option where over time lands are decontaminated. Where a biomass cropping strategy provides a phytoremediation mechanism there will be long term sustainability benefits gained, such as increasing the value of lands and removing the risk to people, flora and fauna. There are also sustainability risks associated with working on contaminated lands and the handing, processing and onward use of the produced crops [60]. ○ *Are there any sustainability risks and/ or benefits through the phytoremediation of lands achieved as a consequence of the project?*

3.3. Bioeconomy Sustainability - Natural Systems

The Natural Systems sustainability category covers three broad *themes*: Land, Air and Water. Bioeconomy projects may have potential influences on the Land, such to the health and productivity of soils [61], to ecosystems and biodiversity [62,63] and they may also change land uses and classifications [64]. Potential influences on the Air include changes in pollutants [65] and particulate emissions [66]; and influences to Water include changes in heavy metal pollutants [67,68] use of fertilisers and pesticides [69], use of water resource that may have impact on water availability [70], flooding [71] and water stresses [72].

3.3.1. Land

3.3.1.1. Soil

Impact on Soil Organic Carbon	Biomass cropping and production and the extent that biomass materials are harvested from/ returned to the soil will influence soil organic carbon (SOC) [73]. ○ *Are there any risks and/ or benefits to SOC as a consequence of the project?*
Soil Fertility	Biomass cropping can contribute to the restoration of soil health and fertility, but may also impact fertility where unsustainable harvesting and removal of biomass occurs [74]. ○ *Are there any risks and/ or benefits to soil fertility as a consequence of the project?*
Soil Erosion	A relationship exists between crop residue coverage and soil erosion, the feedstock collection strategy and choices of biomass cropping approaches may have direct influence of soil erosion and health [75]. ○ *Are there any risks and/ or benefits to for soil erosion as a consequence of the project?*

Accumulation of Mineral Salts	Choices of biomass cropping and the production strategy can influence soil characteristics such as through the accumulation of mineral salts through activities such as use of additives [76]. ○ *Are there any risks and/ or benefits resulting from the accumulation of mineral salts in soils as a consequence of the project?*
Drainage Impacts	Choices of biomass cropping and the production strategy can influence soil properties that may influence water management and drainage performances [77]. ○ *Are there any risks and/ or benefits for drainage resulting from changing soil properties as a consequence of the project?*
Soil Compaction	Choices of biomass cropping and the production strategy can influence soil characteristics such as through compacting that will have many onward impacts for soil health, productivity and drainage performance [78]. ○ *Are there any risks and/ or benefits resulting from soil compaction as a consequence of the project?*
Soil Influence on Productivity Yields	Biomass cropping choices and the production strategy can have broad and varying influences on the productivity of soils [73]. ○ *Are there any risks and/ or benefits to soil productivity yields as a consequence of the project?*

3.3.1.2. <u>Ecosystems</u>

Biodiversity	The use of land to produce feedstocks for bioeconomy projects has the potential to directly impact ecosystems and biodiversity. Where land use change takes place there may be risk for biodiversity. Land use and biomass cropping strategies also have the potential to enhance biodiversity in scenarios where new habits are created [79]. ○ *Are there any risks and/ or benefits to ecosystem biodiversity as a consequence of the project?*
Areas of Conservation & High Biodiversity	Projects are not sustainable where there is risk that feedstock production may potentially take place on lands designated areas of conservation and/ or with high biodiversity. Measures should be implemented to prevent biomass cropping or residue collection from such lands. Bioeconomy projects may also provide a benefit for lands with high biodiversity where they provide infrastructure, revenues or increased awareness to aid the protection of such lands [79]. ○ *Are there any risks and/ or benefits to areas of conservation or high biodiversity as a consequence of the project?*
Land Degradation	Land use decisions and biomass cropping strategies may have direct influence on characteristics and properties of the land. There may be risk of degrading lands where land use change takes place, where unsuitable crop choices are implemented or where there are incorrect or excessive use of heavy equipment and/ or chemicals. Application of sustainable biomass cropping approaches may also potentially enhance degraded lands, for example through rebuilding habitats or soil organic carbon [64]. ○ *Are there any risks and/ or benefits for land degradation that may result as a consequence of the project?*

Desertification	Desertification is an extreme example of land degradation that may be accelerated through poor land use and biomass cropping choices. Planting more crops to improve soil properties is the primary strategy for preventing/ reducing desertification, potentially achieved through sustainable biomass cropping projects [64]. ○ *Are there any risks and/ or benefits for the desertification of lands as a consequence of the project?*

3.3.2. Air

3.3.2.1. PM Pollutants

PM10s	Activities of the bioeconomy such as bioenergy may have potential impacts on air quality. Combustion of biomass materials will generate pollutants such as particulate matter that if not managed appropriately may pose risk for air quality. Modern bioenergy technologies can be designed with strict specifications that limit release of pollutants to the atmosphere, and where deployed to replace conventional fossil fuel or traditional bioenergy systems can improve air quality. PM10s are a risk to health as these materials can deposit on the surfaces of airways if inhaled. [80]. ○ *Are there any risks and/ or benefits to air quality through the generation or prevention of PM10 pollution as a consequence of the project?*
PM2.5s	PM2.5s are a risk to health as these small materials can deposit deep within lungs [80]. ○ *Are there any risks and/ or benefits to air quality through the generation or prevention of PM2.5 pollution as a consequence of the project?*

3.3.2.2. Oxide Pollutants

Sulphur Oxides	Sulphur oxides such as sulphur dioxide are corrosive, acidic gases that are predominantly produced from the combustion of material such as coal. Replacing conventional energy technologies with modern bioenergy may provide an opportunity to reduce air pollution from sulphur oxides [81]. ○ *Are there any risks and/ or benefits to air quality through the generation or prevention of sulphur oxides as a consequence of the project?*
Nitrogen Oxides	Nitrogen oxides such as nitrogen dioxide are poisonous, highly reactive gases that form when fuels are combusted at high temperatures [81]. ○ *Are there any risks and/ or benefits to air quality through the generation or prevention of nitrogen oxides as a consequence of the project?*
Carbon Monoxide	Carbon monoxide is a toxic air pollutant produced through the incomplete combustion of carbon based fuels [81]. ○ *Are there any risks and/ or benefits to air quality through the generation or prevention of carbon monoxide as a consequence of the project?*

3.3.2.3. Heavy Metals

Cadmium	Heavy metal pollutants such as cadmium, lead and mercury are common air pollutants generated through activities such as combustion. Heavy metals pose a risk even at low atmospheric concentrations, as any accumulation in soils will persist in the environment and may accumulate in food chains and on both land and water [81]. ○ *Are there any risks and/ or benefits to air quality through the generation cadmium as a consequence of the project?*
Lead	See Cadmium ○ *Are there any risks and/ or benefits to air quality through the generation lead as a consequence of the project?*
Mercury	See Cadmium ○ *Are there any risks and/ or benefits to air quality through the generation mercury as a consequence of the project?*

3.3.3. Water

3.3.3.1. Water Use & Efficiency

Water Withdrawn	Production of biomass crops has the potential to directly influence water systems as will both require water and will directly influence how water is managed. Bioeconomy projects will have water demands that may be drawn from either local or distant sources. Choices of biomass crops will influence the levels of water required, these should be compatible with the available water and the water infrastructure. Unsustainable withdrawal of water from aquifers will result in broad and potentially long lasting environmental impacts [82]. ○ *Are there any sustainable risks and/ or benefits for water systems resulting from the water withdrawn from aquifers as a consequence of the project?*
Water Consumed	The levels of water consumed by a given bioeconomy projects will be influenced by choices such as the technical equipment used, locations, land use, land management choices and selection of biomass crops. These will influence the water use efficiency and resulting water demands of the project. Project's designed with water efficiency measures will be more sustainable to those will poorer water consumption performances [82]. ○ *Are there any sustainable risks and/ or benefits for water systems resulting from the water consumption of the projects?*
Non-renewable Water Resources	Non-renewable water resources are those that cannot be replenished naturally within short timeframes. Bioeconomy projects that use or are reliant on non-renewable water aquifers will not be sustainable and may result in broad long lasting environmental impacts [83]. ○ *Are there any sustainable risks and/ or benefits for non-renewable water resources as a consequence of the project?*

Renewable Water Resources	Renewable water resources are those that can replenished naturally within short timeframes. The water sustainability of bioeconomy projects will be increased where demand is balanced from renewable water aquifers. Although measures should always be implemented to ensure efficient use and management of water systems [83]. ○ *Are there any sustainable risks and/ or benefits for renewable water resources as a consequence of the project?*

3.3.3.2. Water Quality

Fertiliser & Pesticide Loadings	Use of fertiliser and pesticides is routinely used in the production of many biomass crops. These provide the benefit of improving productivity yields. The use of these chemicals should be balanced against their carbon and economic costs, and excessive use may present risks to water systems as increased leading may lead to impacts such as eutrophication [84]. ○ *Are there any risks and/or benefits for water systems from increased fertiliser and pesticide loadings as a consequence of the project?*
Pollution from Feedstock Processing	Chemicals are sometimes used in the processing and pre-treatment of raw biomass resource to produce the uniform feedstocks that required to be compatible with onward activities. Use of such chemical may pose risks for water systems if not managed appropriately [84]. ○ *Are there any risks and/or benefits for water systems from pollution generated through the processing of feedstocks as a consequence of the project?*
Pollution from Feedstock Conversion	The conversion of feedstocks to energy or into bioproducts will generate by-products and waste materials that may pose a pollution risk if not managed appropriately [84]. ○ *Are there any risks and/or benefits for water systems from pollution generated through the conversion of feedstocks as a consequence of the project?*

3.3.3.3. Water Systems

Flooding	Production of biomass crops has the potential to influence water systems such through managing the flow of water. Biomass cropping can provide additional ecosystem service benefits such as providing mechanisms to slow the flow of water from/ through land to reduce flood risks. Although where a biomass project results in direct or risk of indirect land use change, there is also the potential for increased flood risks where land's water management characteristics are impacted [85]. ○ *Are there any risks and/or benefits for flood risk as a consequence of the project?*
Local Water Stresses	Where bioeconomy projects require water drawn from local aquifers there may be both potential impacts and/ or benefits for water stresses. Influencing the flow and management of water may provide the benefit of better control of water. There may also be risks to the local availability of water if not managed well or drawn from aquifers at an unsustainable rate [85]. ○ *Are there any risks and/or benefits for local water stresses as a consequence of the project?*

3.4. Bioeconomy Sustainability - Climate Change

The Climate Change sustainability *category* covers three *themes*: Governance, Carbon and Emissions and Energy System. Bioeconomy project's potential influence on/ by climate change Governance may be the direct contributions to achieving climate change and sustainability targets, legislation and regulations [34], raising awareness to climate change issues [86]. Standards are also important for driving the effectiveness of projects in their ability to deliver low carbon sustainable energy [87].

Carbon and Emissions represents a key environmental issue for any bioeconomy project. In the case of bioenergy projects there is potential for the storage or release emissions at each life cycle stage of a given value chain, including from the production/ mobilisation/ harvesting of feedstocks, resource transportation, processing and pre-treatment activities and the conversion of feedstocks [88]. Biomass production strategies may also have large implications for land and carbon stocks as can drive large fluxes of carbon between the atmosphere and terrestrial carbon sinks. It is important to also account counterfactual considerations that describe what may otherwise have happened. For example, if waste materials are used for bioenergy that would otherwise be managed through a potentially high environmental impact pathway such as being sent to landfill, using the wastes for bioenergy could result in the mitigation of large environmental impacts associated with landfilling [89].

Projects may also influence the sustainability of broader Energy Systems, for example bioenergy will be beneficial where it replaces fuels with higher GHG intensities. Bioenergy schemes that substitute use of fossil fuels or traditional bioenergy technologies may also generate broader sustainability benefits beyond reduced emissions [19].

3.4.1. Governance

3.4.1.1. Climate Action

Targets, Legislation & Regulations	The bioeconomy can provide a mechanism to reduce GHG emissions across economies. Producing bioproducts such as biochemicals to provide low carbon alternatives to those produced from fossil fuels, also through bioenergy to provide sources of low carbon heat, power, fuels to replace conventional energy. The bioeconomy is already included in the renewable energy, decarbonisation and broader climate change strategies of countries globally – bioproducts, biomaterials, biochemicals, biofuels and bioenergy all targeted to reduce emissions [34]. ○ *Are there any risks and/or benefits for climate change targets, legislation or regulations as a consequence of the project?*
Awareness	Bioeconomy activities can also be highly visual with opportunities to raise awareness of the technologies and climate change at each stage through value chains. For example, the growth of energy crops in fields, the labelling bioproducts on shelves, or highlighting the biofuel content of transport fuels at filling stations. Benefits may be gained where projects and activities are designed and communicated to raise awareness of climate change issues. There may also be risks, such as the acceptance of projects where there is limited transparency or communication of the benefits for issues such as climate change [86]. ○ *Are there any risks and/or benefits for awareness of climate change as a consequence of the project?*

3.4.1.2. Standards

Fuel Standards	Fuel standards are important for the sustainability and viability of bioenergy projects and safety of using these products. Standards ensure that raw biomass materials are processed into fuels compatible with bioenergy conversion technologies. Also ensuring the sustainability and whole life cycle GHG performance of fuels adhere to prescribed standards. Where fuel standards are not applied there may be risk for climate change and for the long-term operational viability of projects [90]. ○ *Are there any sustainability risks and/or benefits resulting from the fuel standards applicable to the projects?*
Technical Standards	Technical standards ensure use of standardised components and processes that can lead to increased productivity. Availability of technical standards would increase the sustainability of bioeconomy projects and increase the success of expanding activities. Where there are no technical standard there may be risks to productivity, for example maintenance activities may be more complex where there is lack of available compatible components [91]. ○ *Are there any sustainability risks and/or benefits resulting from the technical standards applicable to the projects?*
Supply Chain of Custody Processes	Given the complexity of bioeconomy processes and the potential for a project's activities to cross borders, chain of custody is a valuable tool for evidencing performances along supply chains. Supply chain of custody processes can be used to certify and increase transparency of the activities at each stage through supply chains, ensuring performance across broad ranging issues from diversity in employment through to protection of designated lands and ecosystems. There are also potential risks as chain of custody processes will likely require costs and may lead to the exclusion of certain actors along supply chains - although at the benefit of raising standards and reducing impacts [9]. ○ *Are there any sustainability risks and/or benefits resulting from the supply chain of custody processes implemented through the project?*

3.4.2. Carbon & Emissions

3.4.2.1. Whole Life Cycle Emissions

Energy Conversion	The GHG emission profile of any given project will be reflective of the net emissions attributed to each activity and process across the whole life cycle. There may be flux of emissions to and from the atmosphere at each life cycle step. From a climate change perspective the sustainability of a project will only be viable if it delivers a reduction in emissions when compared to comparators, for example the GHG emissions resulting from the combustion of a biofuel should be less compared to that of fuel being replaced [89]. At the life cycle step where fuels are converted to energy, the choice and design of energy conversion technologies will be a key factor determining the efficiency of energy conversion - influencing the overall GHG emission performance of the project [92]. ○ *Are there potential climate change risks and/or benefits resulting from the project's energy conversion technologies?*

Feedstock Sources	Feedstock choices and the activities and processes of their growth/ collection/ mobilisation will be a leading factor determining the overall whole life cycle emission of a value chain. Sustainable sourcing of feedstocks should protect or enhance land carbon dynamics and biogenic carbon stored within the feedstocks should be close to the net emissions released to the atmosphere as a consequence of the project [92]. ○ *Are there potential climate change risks and/or benefits resulting from the project's feedstock production/ collection/ mobilisation strategy?*
Transport	The transport of feedstocks and products is an essential activity for the majority of industries of the bioeconomy. Emissions generated through transport activities are not typically the defining factor determining the whole life cycle emission performance of a project. However transport within projects should be optimised to reduce its impact, including optimised siting of facilities and activities, and smart selection of transport modes [92]. ○ *Are there potential climate change risks and/or benefits resulting from transport activities as a consequence of the project?*
Processing & Pre-treatment	Processing and pre-treatment activities are often essential for many industries of the bioeconomy. For example, the processing of raw feedstocks to produce advanced fuels that are more compatible with transport infrastructure, onward processing and conversion activities. The choice and design of processing and pre-treatment technologies will be a key factor determining the efficiency of the whole value chain, the properties and compatibility of fuels and products and consequently the overall GHG emission performance of the project [92]. ○ *Are there potential climate change risks and/or benefits resulting from the project's processing and pre-treatment technologies?*

3.4.2.2. Land & Carbon Stocks

Direct Land Use Change	The bioeconomy is intrinsically linked to the land as many activities require feedstocks that are either grown specifically such as energy crops, or are residues of land activities such as agriculture. Dedication of lands to produce feedstocks for the bioeconomy may result in changes in how the land is used and its characteristics. This 'direct land' use change may have sustainability benefits for people and the economy if lands are brought into management, or benefits for climate and natural systems where the growth of feedstocks enhances or protects carbon stocks, biodiversity etc. There may also be risks where direct change impacts the balance of natural systems, for example leading to the release of carbon previously stored within sinks [93]. ○ *Will the project result in direct land use change that may generate potential sustainability risks and/or benefits for natural systems, climate, land and carbon stocks?*

Indirect Land Use Change	Indirect land use change may take place due to bioeconomy activities where land is repurposed for the production of feedstocks, resulting in the displacement of previous land activities. For example, if arable land is repurposed to produce energy crops, there will likely still be a demand for arable crops but the production will have to take place elsewhere. Thus the production of energy crops may result in other lands having to be repurposed to produce arable crops – this indirect land use change potentially generating sustainability impacts far away and not directly identifiable with the project [93]. ○ *Is there potential for the project to cause indirect land use change that may generate sustainability risks and/or benefits for natural systems, climate, land and carbon stocks?*
Changes in Carbon Stocks	Protection and good management of land and carbon stocks is essential for the sustainability of all activities of the bioeconomy. Where carbon stocks are not maintained or where carbon is released from sinks as result of activities, the whole life cycle emission profile of projects may be (potentially drastically) impacted. Projects or activities that potentially risk land and carbon stocks represent a high sustainability risk, and measures should be implemented to reduce this risk. Although there is also potential for bioeconomy projects to enhance or protect carbon stocks, for example though increasing the organic carbon content of soils by implementing sustainable biomass cropping and land management activities [94]. ○ *Are there potential risks and/or benefits for land and carbon stocks as a consequence of the project and all its activities?*

3.4.2.3. Counterfactual Considerations

Land & Carbon Stocks	How land and resources would otherwise have been used should be considered when evaluating the sustainability of a projects. For example, in the case of an energy crops, consideration of the counterfactual land characteristics is essential. Energy crops may provide a net benefit for carbon stocks and biodiversity etc, compared to scenarios where the counterfactual land use was certain forms of intensive arable agriculture. In contrast there may be net impacts for climate change where energy crops are produced on lands that would otherwise have larger carbon stocks, such as forested land [89]. ○ *Are there potential risks and/or benefits as a consequence of the project when compared to the counterfactual land and carbon stock conditions?*
Counterfactual Considerations	It is important to consider all the different counterfactual scenarios related to land and resources to allow true assessment of the sustainability impacts of a given projects. For example, in the case of an energy from waste project - the waste material may otherwise have been sent to landfill or it may have been reused or recycled. If it were sent to landfill there would likely have been emissions and sustainability risks associated with that counterfactual waste management activity – use of the waste to produce energy, not only provides energy but also prevents any impact from the alternative landfill process. If the counterfactual waste management activity was the reuse or recycling of the material, there is a risk that its use as a source of energy may generate more emissions and sustainability risks [89]. ○ *When considering counterfactual activities relevant to the project, are there any potential risks and/or benefits for emissions and sustainability as a consequence of the project?*

3.4.3. Energy System

3.4.3.1. <u>Replaced Fuels</u>

Substitution of Fossil Fuels	Where a projects generates energy or fuels that lead to the substitution of fossil fuel energy there will likely be broad sustainability benefits given there is a net reduction in life cycle GHG emissions [19]. ○ *Will the project lead to the substitution of fossil fuel energy providing sustainability benefits and/ or risks?*
Substitution of Traditional Bioenergy	Where a projects generates energy or fuels that lead to the substitution of traditional bioenergy there will likely be broad sustainability benefits given there is a net reduction in life cycle GHG emissions [19]. ○ *Will the project lead to the substitution of traditional bioenergy providing sustainability benefits and/ or risks?*

4. Mapping Links between Bioeconomy Projects & the UN SDGs

The BSIM has also been developed to provide an assessment of how bioeconomy projects may influence the UN's Sustainable Development Goals (SDG). Each of the 17 SDGs are built on a large number of individual targets (listed in Appendix Section B) that characterise broad ranging sustainability issues. Through stakeholder engagement activities during the BSIM development process, potential links were identified between each of the BSIM's 126 sustainability issues and the individual targets of the 17 SDGs.

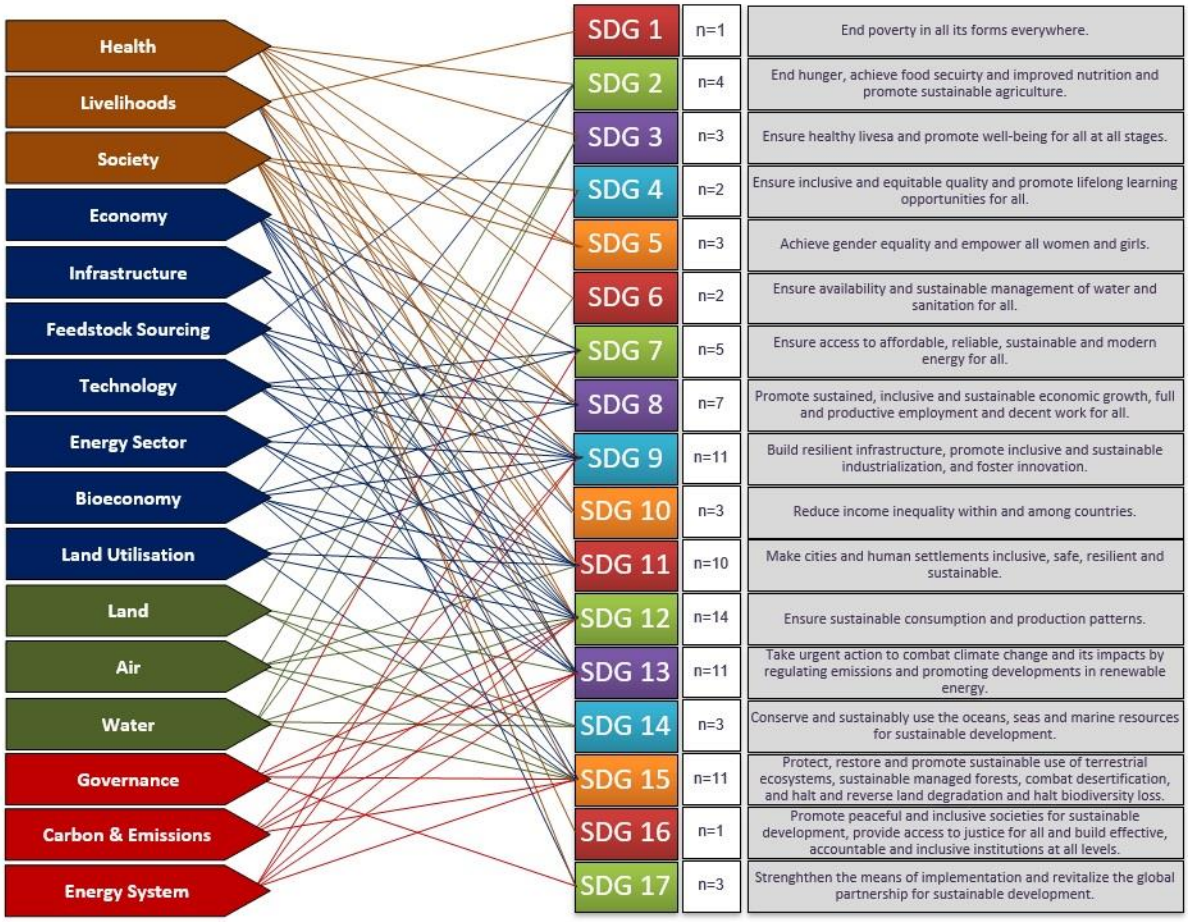


Figure 2: Linkages between the BSIM Sustainability Assessment Framework & the SDGs

An overview of the breadth of potential links between the sustainability of bioeconomy projects and the SDGs are demonstrated in Figure 2. Bioeconomy projects are shown to have potential to influence on every SDG. The n-values within Figure 2 denote the number of linkages identified between the many sustainability issues that make up each of the BSIM's themes and the targets of each SDG. However, as the SDGs are also intrinsically linked and influence each other, the true potential influence of bioeconomy projects on the SDGs may be significantly larger than highlighted. Where the sustainability risks of bioeconomy projects are mitigated and the benefits maximised, bioenergy may provide a valuable mechanism for countries to drive their progress towards sustainable development.

5. BSIM Modelling Mechanics

The BSIM is designed to calculate a series of 'sustainability performance scores' (SPS) at each level of the sustainability assessment framework – a score for each *issue, indicator, theme, category* and an overall score for the project. This allows the mapping of the sustainability performances between different aspects of a project, identifying *issues, indicators, themes* or *categories* where there may be a risk or benefit to sustainability and mapping the trade-off within the system. Additionally, this allows a harmonised comparison and benchmarking of performances where more than one project is assessed.

The SPS scores are index values that are calculated as a function of the *issue* scores (IS)[1] and the *issue* weighting (IW)[2] for each individual sustainability *issue* within the BSIM (**Equation 1**). This 'likelihood x magnitude' approach is the standard method for calculating risk assessments in science and technology, ensuring that risks of catastrophic impact or high benefit are not neglected or dismissed due to low probability [95].

5.1. Issue Scores (IS)

The user calibrates the BSIM to develop bespoke *issue* scores (IS) to reflect the bioeconomy project modelled. Users are required to assign two 'Likelihood Index' (LI)[3] scores for each sustainability *issue*, to reflect the likelihood that a sustainability risk and/ or benefit will occur as a consequence of the project.

The LI score options are:

- 'none' (score 0),
- 'very low' (score 1),
- 'low' (score 2),
- 'medium' (score 3),
- 'high' (score 4),
- 'very high' (score 5).

Users also have the option to apply a 'boost index' (BI)[4] to these scores where the user believes a given sustainability *issue* is particularly relevant or irrelevant to the project.

The BI options are:

- 'low' (multiplier 1),
- 'standard' (multiplier 2)
- 'high' (multiplier 3).

The IS scores are calculated as a function of the likelihood index (LI) and the multiplying boost index (BI) (

Equation **2**). For example, a project's IS for a prominent sustainability *issue* assigned with a 'high' likelihood for generating a risk (score 4) with an addition 'high' boost (multiplier 3) would be 12.

5.2. Issue Weightings (IW)

Weightings are used within the BSIM to take account of the varying influence of different sustainability *issues*, each potentially having greater or lesser importance in determining overall sustainability. For example, GHG emission performances are a fundamental factor influencing the overall sustainability performance of a given project [89].

The method for calculating weightings within the BSIM draws influence from comparable assessment schemes, including industry sustainability assessment schemes [96], broad environmental impact assessment schemes [97] and existing bioenergy assessment methods [98]. The BSIM can be calibrated to either use default *issue* weightings or have custom *issue* weightings to be decided by the

[1] Issue Scores (IS) - Two scores attributed to each sustainability issue, determining the potential sustainability benefit (IS^b) and sustainability risk (IS^r). These values are calculated within the BSIM as a function of the LI and BI scores.

[2] Issue Weighting (IW) – Two scores attributed to each sustainability issue, determining the influence of each issue on overall sustainability compared to the comparative influence of all sustainability issues within the BSIM. Default values for the sustainability benefit issue weighting (IW^b) and sustainability risk issue weighting (IW^r) are built into the BSIM as informed by stakeholder engagement. Although the BSIM user can also opt to use custom IW values.

[3] Likelihood Index (LI) - Two scores attributed to each sustainability issue, determining the perceived likelihood that there will be a sustainability benefit (LI^b) and/ or sustainability risk (LI^r) as a consequence of the project. These values are determined by the BSIM user to reflect the bioenergy project being modelled.

[4] Boost Index (BI) - Two additional scores that the BSIM user may decide to attribute to each sustainability issue, providing an increase or reduction in the sustainability benefit (BI^b) and/ or sustainability risk (BI^r) based on the specific project being modelled.

BSIM user. The default weightings were informed by the research's stakeholder engagement exercises (Section 2.1) and are listed in Appendix A. Stakeholders compared and discussed sustainability performance considerations for a large number of biomass feedstocks, conversion technologies, products and energy vectors, identifying on an index scale of 1 to 5 (1 very low, 2 low, 3 medium, 4 high, 5 very high) the extent that a given issue may generate a sustainability benefit and/ or a sustainability risk. For example, stakeholders identified that bioenergy substituting use of fossil fuels would potentially generate a 'high to very high' sustainability benefit (averaged score 4.50) and a 'very low to low' sustainability risk (averaged score 1.5).

Although the weightings calculated for each sustainability *issue* can be changed within BSIM, these should remain fixed when undertaking studies to compare sustainability performances across different projects.

Equation 1: Calculating the Sustainability Performance Scores (SPS) within the BSIM

$$i) \quad SPS^{b} = IS^{b} \times IW^{b}$$

$$ii) \quad SPS^{r} = IS^{r} \times IW^{r}$$

$$iii) \quad SPS^{issue} = Mean\,[SPS^{b} + SPS^{r}]$$

$$iv) \quad SPS^{indicator} = Mean\,[SPS^{issue}]^{n}$$

$$v) \quad SPS^{theme} = Mean\,[SPS^{indicator}]^{n}$$

$$vi) \quad SPS^{category} = Mean\,[SPS^{theme}]^{n}$$

$$vii) \quad SPS^{overall} = Mean\,[SPS^{category}]^{n}$$

Equation 2: Calculating the Sustainability Issue Scores (IS) within the BSIM

$$i) \quad IS^{b} = LI^{b}\ x\ BI^{b}$$

$$ii) \quad IS^{r} = LI^{r}\ x\ BI^{r}$$

Key

IS^{b}	– Issue Score, sustainability benefit calculated within the BSIM as a function of the LI^{b} and Bi^{b} values.
IS^{r}	– Issue Score, sustainability benefit calculated within the BSIM as a function of the LI^{r} and Bi^{r} values.
IW^{b}	– Issue Weighting, sustainability benefit weighting. Either default value within BSIM or a custom value.
IW^{r}	– Issue Weighting, sustainability risk weighting. Either default value within BSIM or a custom value.
SPS^{b}	– Sustainability Performance Score, calculated benefit for each sustainability issue within the BSIM.
SPS^{r}	– Sustainability Performance Score, calculated risk for each sustainability issue within the BSIM.
SPS^{issue}	– Sustainability Performance Score, calculated for each sustainability issue within the BSIM.
$SPS^{indicator}$	– Sustainability Performance Score, calculated for each sustainability indicator within the BSIM.
SPS^{theme}	– Sustainability Performance Score, calculated for each sustainability theme within the BSIM.
$SPS^{category}$	– Sustainability Performance Score, calculated for each sustainability category within the BSIM.
SPS overall	– Sustainability Performance Score, calculated for the overall project.
LI^{b}	– Likelihood Index, value selected by the BSIM user to determine likelihood of a sustainability benefit.
LI^{r}	– Likelihood Index, value selected by the BSIM user to determine likelihood of a sustainability risk.
BI^{b}	– Boost Index, optional benefit amplification value selected by the user to increase/decrease influence.
BI^{r}	– Boost Index, optional risk amplification value selected by the user to increase/decrease influence.

6. Tour of the BSIM & Example

The following section provides a tour of the BSIM through a series of screenshots of the BSIM interface. Explanations are provided alongside a worked example to demonstrate how to operate and interpret outputs from the BSIM.

6.1. BSIM Title Page

Opening the BSIM takes the user to the Title Page (Figure 3). This page presents introductory information describing the model, highlights the model version and provides details for how to find the BSIM and supporting information.

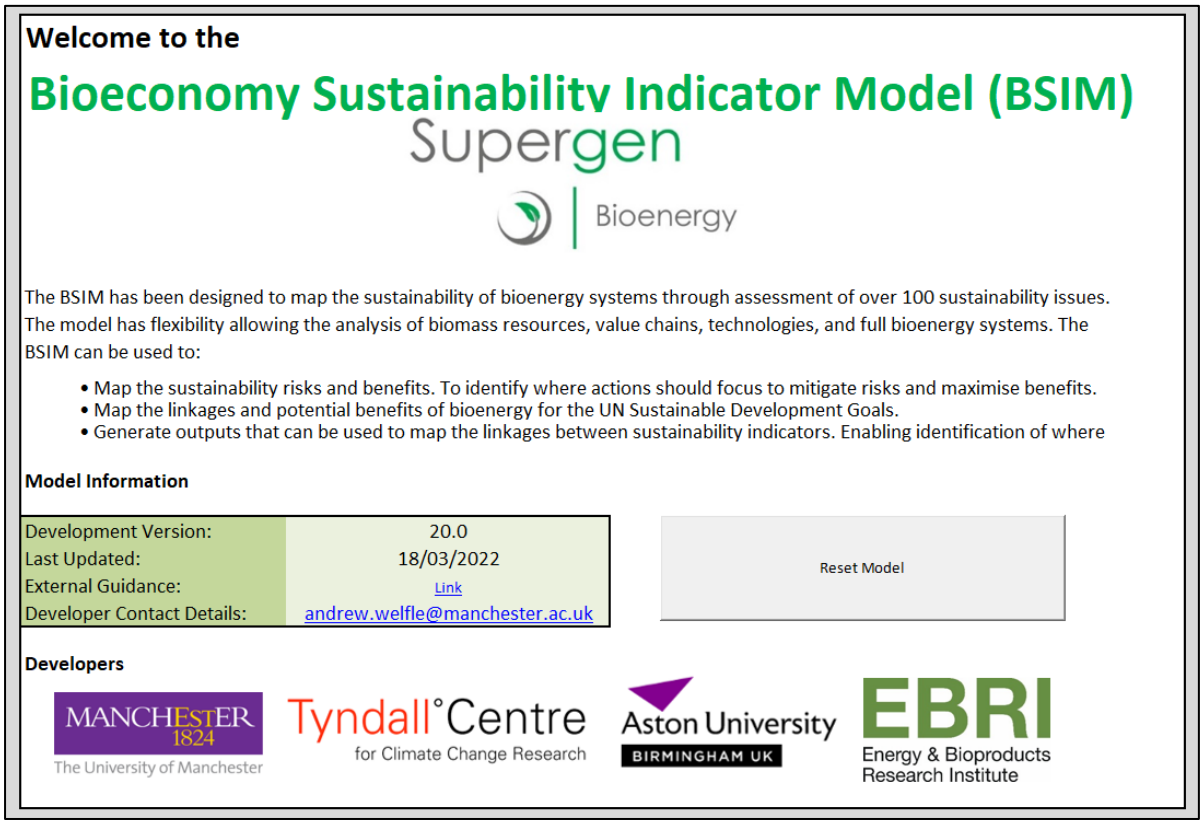


Figure 3: BSIM Title Page

1) **Reset Model** – This button will reset the BSIM to default settings to allow assessment of a new case study. **Please note all unsaved changes will be lost by resetting the BSIM.** If the user wants to save changes and model another project, please name and save the model and open a new model document. The model will not allow you to save more than one project per MS Excel document.

Example

- ✓ Open the BSIM and select the Reset Model button to ensure the setting revert to the default.
- ✓ Save the BSIM with a file name describing the case study to be modelled by the BSIM.

6.2. BSIM Case Study Control Panel

The Case Study Control Panel (Figure 4) is the primary page that controls the calculations throughout the BSIM. The Control Panel is where the BSIM is calibrated to reflect the specific project being modelled. The model is calibrated and sustainability is mapped at issue level.

1) **Sustainability Ranges** – these provide a visual indication of balance between sustainability risk and benefits for each sustainability *issues*, also allowing comparison between *issues*. As the control panel is calibrated the sustainability ranges will recalculate accordingly.

2) **Applicability** – by selecting 'Yes' or 'No' individual sustainability *issues* will be included or excluded from the analyses. Where a given *issue* is excluded (No) the *issue* will not be included in any of the BSIM calculations or output results. The BSIM changes the colour of excluded sustainability *issues*.

3) **Sustainability Risk Likelihood –** User indicates the likelihood of sustainability risk (LI^r) that may result for a given sustainability *issues*. Options include 'none', 'very low', 'low', 'medium', 'high', 'very high'.

4) **Sustainability Risk Boost –** allows the user to boost (Bi^r) the sustainability risk calculations where a given sustainability *issue* may have a particularly low or high influence. Options include 'Low', 'Standard' and 'High'. Where 'Standard' is selected no boost is applied to the calculations.

5) **Sustainability Benefit Likelihood –** User indicates the likelihood of sustainability benefit (LI^b) that may result for a given sustainability *issues*. Options include 'none', 'very low', 'low', 'medium', 'high', 'very high'.

6) **Sustainability Benefit Boost –** allows the user to boost (Bi^b) the sustainability benefit calculations where a given sustainability *issue* may have a particularly low or high influence. Options include 'Low', 'Standard' and 'High'. Where 'Standard' is selected no boost is applied to the calculations.

7) **Notes** - can be added within this column, for example to provide justification for how the BSIM has been calibrated.

Example – Control Panel

- The control panel configuration in Figure 4 presents a modelled case study focusing on the Climate Change Category Sustainability Issues.
- The 'Standards' sustainability *issues* and 'Substitution of Traditional Bioenergy' *issue* have been selected as not applicable ("No") for the case study modelled and can be seen to be shaded-out. These do not contribute to the sustainability score calculations. All other climate change sustainability *issues* are selected ("Yes") and are contributing to the BSIM calculations.
- Sustainability Risk likelihood scores have been selected for all applicable *issues*. Within the presented case study, 'Whole Life Cycle Emissions' and 'Land and Carbon Stocks' are shown to present the highest risks. 'Very High' risk is selected for the 'Feedstock Sources' *issue*, and a 'boost' is applied to the 'Changes in Carbon Stock' *issue* to reflect the potentially high risk this may generate. The potential risk to Climate Action for 'Targets, Legislation & Regulations' and 'Awareness' are both selected as 'Very Low', and the potential risk related to 'Substitution of Fossil Fuels' is deemed to be 'None' for this given case study.
- Sustainability Benefit likelihood scores are shown to be highest for 'Targets, Legislation & Regulations' and 'Substitution of Fossil Fuels". The potential sustainability benefits for 'Transport' and 'Processing & Pre-treatment' emissions and Direct Land Use Change' and 'Indirect Land Use Change' are deemed to be 'Low' for this given case study.
- The Sustainability Range scores demonstrate where the leading risks and benefits are for climate change sustainability for this given case study. The potential leading sustainability risks are shown to be 'Changes in Carbon Stock', whilst 'Substitution of Fossil Fuels' may provide the leading sustainability benefit.

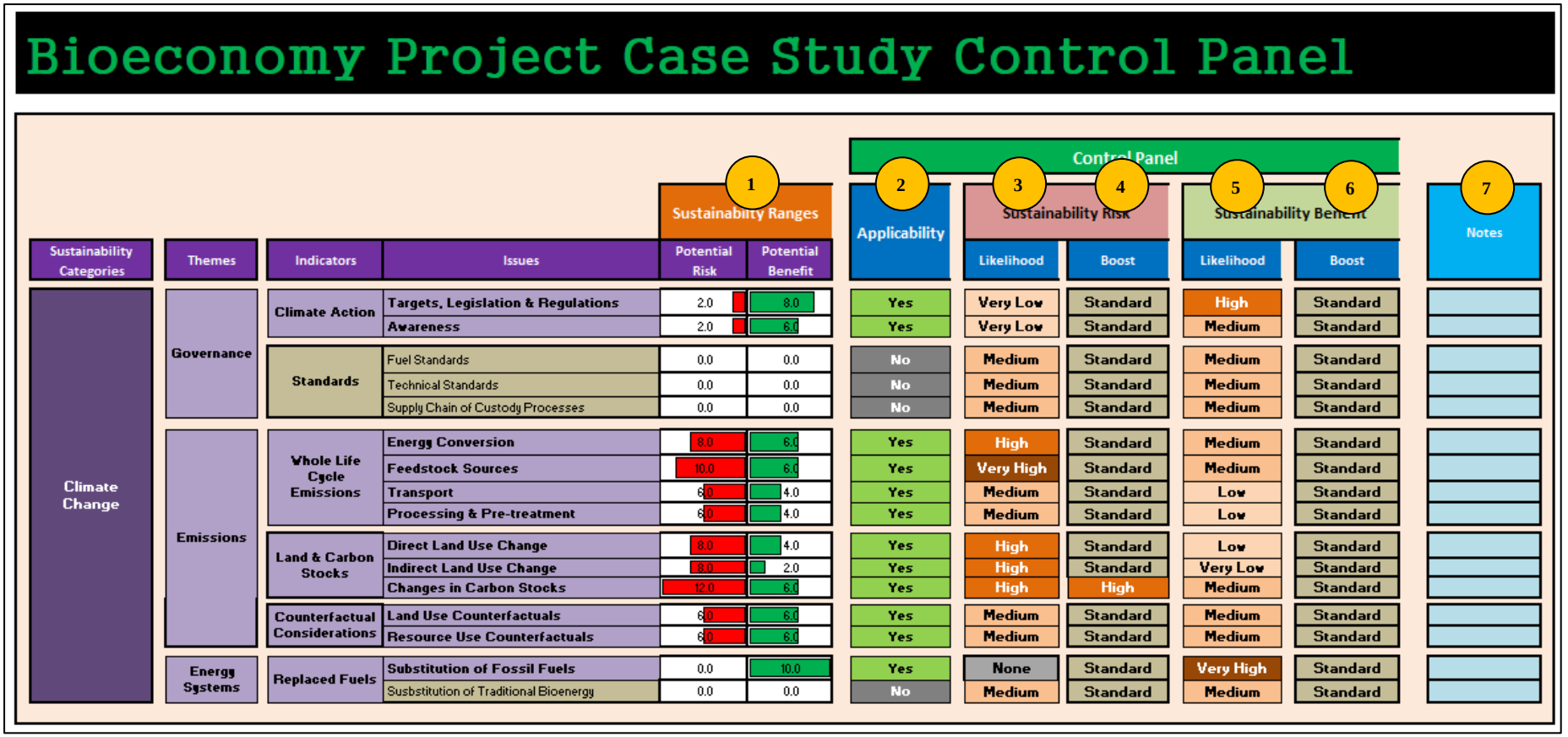


Figure 4: BSIM Control Panel

6.3. BSIM Sustainability Dashboard

The Sustainability Dashboard (Figure 5) within the BSIM presents the sustainability assessment outputs results for the assessed project. Sustainability Performance Scores (SPS) are presented at each level of the sustainability assessment framework, individual scores for each issue and collective scores for each indicator, theme and category.

1) **Category SPS –** Sustainability Performance Scores at the sustainability *category* resolution.
2) **Theme SPS –** Sustainability Performance Scores at the sustainability *theme* resolution.
3) **Indicator SPS –** Sustainability Performance Scores at the sustainability *indicator* resolution.
4) **Issue SPS –** Sustainability Performance Scores at the sustainability *issue* resolution.

Example – Sustainability Dashboard

- The sustainability dashboard presents outputs for the worked example, providing both a visual map of the sustainability for the case study in addition to SPS index scores to allow analysis and comparison.
- The SPS at the Sustainability *Category* resolution shows that overall, the case study provides a potential sustainability benefit for climate change.
- Analysis of the SPS scores at finer resolution highlights that despite the overall benefit for climate changes, there are also specific themes where there is potential risk.
- Analysis of the case study is shown to provide potential benefits for ‘Governance’ and ‘Energy Systems’ *themes*, although potential risks linked to ‘Emissions’. Analyses of the SPS at the Sustainability *Issue* resolution highlights that the leading risks are ‘Changes in Carbon Stocks’, ‘Indirect Land Use Change’ and whole life cycle emission associated with ‘Feedstock Sources’.

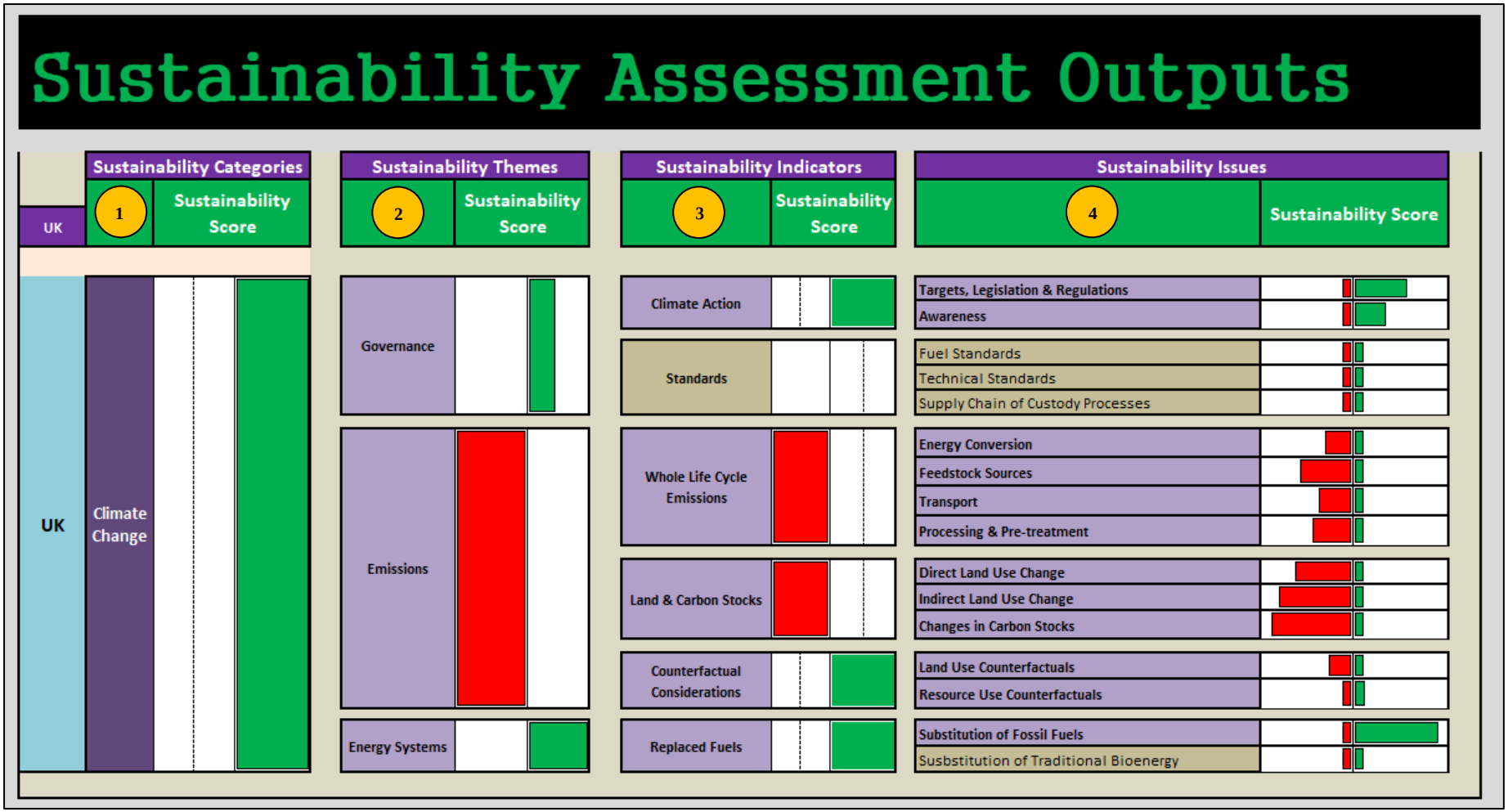


Figure 5: BSIM Sustainability Dashboard

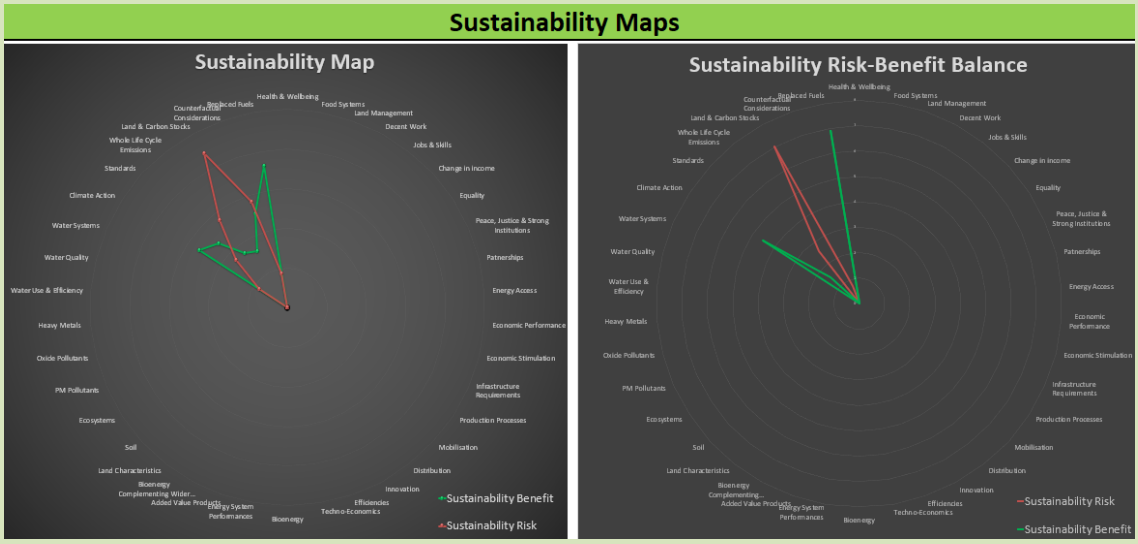
6.4. BSIM Output – Sustainability Map

Sustainability Maps (Figure 6) are a primary output generated by the BSIM. These allow clear visual analysis of the leading potential sustainability risks and benefits for case studies.

1) **Sustainability Map –** Presentation of SPS index values at the Sustainability *Indicator* resolution. Both sustainability risk and benefit scores are presented for each *indicator* to allow a visual assessment of the leading areas of sustainability risk and benefits.

2) **Sustainability Balance –** Presentation of the balance of SPS scores at the Sustainability *Indicator* resolution. The Risk-Benefit Balance sustainability map allows visual assessment of where there may be overwhelming sustainability risks or benefits. Although where both a 'high' sustainability risk and benefit are calculated for a given indicator the overall sustainability balance will be shown to be small, therefore the sustainability maps should be used together to ensure accurate interpretation of BSIM outputs.

Example – Sustainability Maps



- Sustainability Maps for the case study are presented above. As the case study focuses of the sustainability *issues* within the Climate Change Category, the maps are restricted to only present outputs for the climate change *indicators*.
- The Sustainability Map on the left presents both sustainability risk and benefit values for the case study at the Sustainability *Indicator* resolution. Sustainability benefits are shown to far exceed the risks for the 'Replaced Fossil Fuels' and 'Climate Action' *indicators*. Sustainability risks are shown to exceed and far exceed the benefits for the 'Whole Life Cycle Emissions' and 'Land & Carbon Stocks' indicators respectively. There is close to parity in sustainability risk and benefits for the 'Counterfactual Considerations' *indicator*.
- The Risk-Benefit Balance Sustainability Map on the right provides a further visual demonstration of the leading risks and benefits for the case study. In balance the potential sustainability benefits far exceeds the potential risk for the 'Replaced Fossil Fuels' and 'Climate Action' indicators, and the opposite is shown for the 'Land & Carbon Stocks' indicator. The balance for the 'Counterfactual Considerations' indicator is shown to be negligible reflecting the close parity in SPS scores – highlighting the importance of using both maps when analysing the sustainability performances.

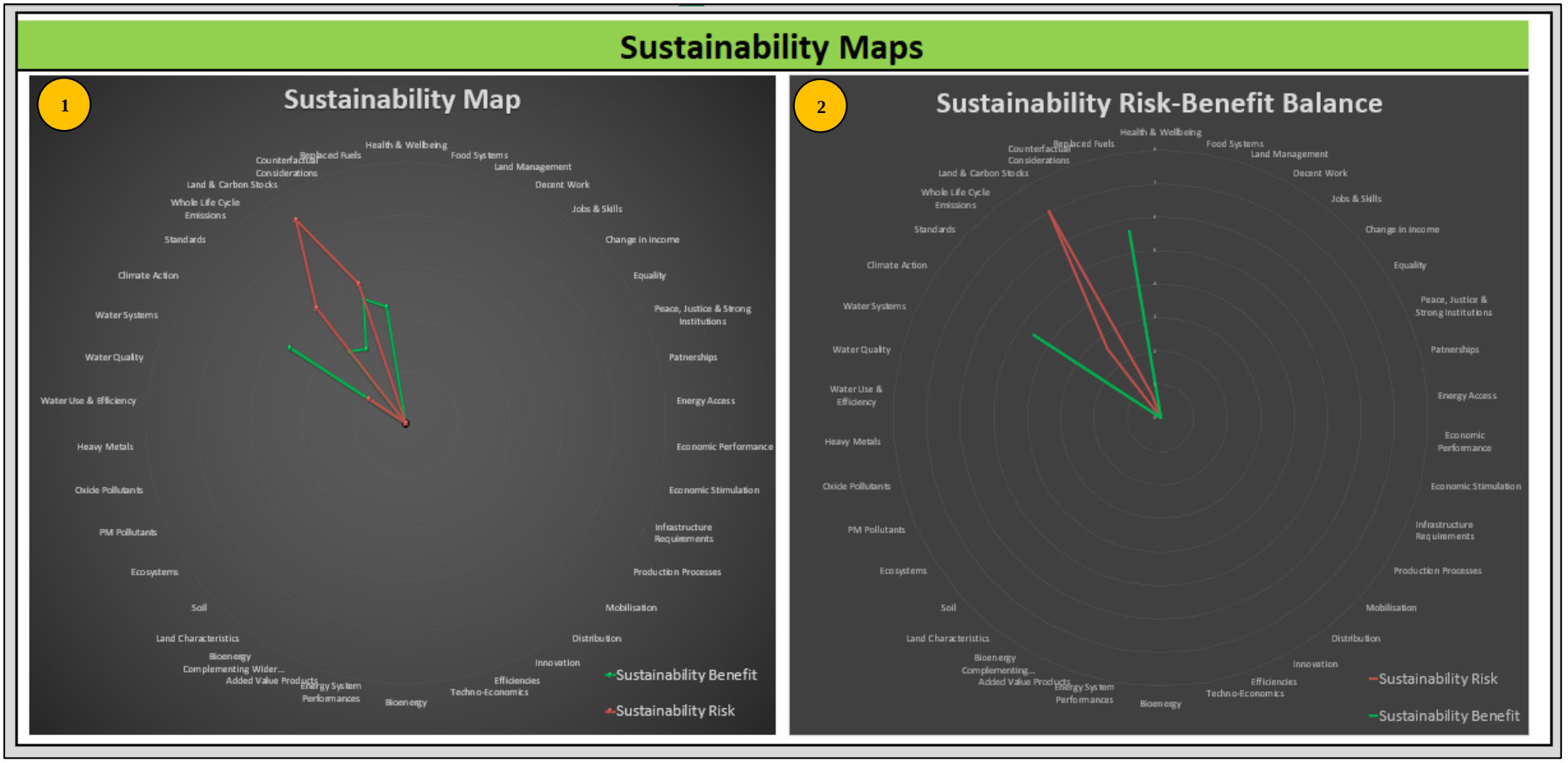


Figure 6: BSIM Sustainability Maps

BSIM Output SDGs Map

The BSIM generates SDG Maps (Figure 7) that provide visual analyses of how case studies may influence the United Nation's Sustainable Development Goals.

1) **Mapping Choice –** The BSIM's SDG Map can presents 3 sets of outputs. The user choosing between 'Balance', 'Risks' and 'Benefits' options. As each of the SDGs consist of a long list of individual targets, there is potential that a given project may provide both risks and benefits for each SDG. Where 'Balance' is selected, the SDG Map will highlight the overall balance of risks and benefit that the project may have on each of the 17 SDGs. Selecting 'Risks' will generate a map that highlights where the project has the potential to generate a risk for each given SDG. In contrast selecting 'Benefit' will generate a map that highlights where the project has potential to generate a benefit for each given SDG.

2) **SDG Map –** Provides a visual assessment of where the project has the potential for generating a risk or benefit for each of the SDGs. Where an SDG label is shaded 'green' there is a potential benefit for the SDG, and where the label is shaded 'red' there is a potential risk.

3) **SDG Radar Map –** Similar to the BSIM's Sustainability Map, the SDG Radar Map provides a visual assessment of whether and to what extent the assessed project may provide either a risk or benefit for achieving each SDG.

Example – SDG Mapping

- The SDG Map demonstrated in Figure 7 shows that on balance the project may have a beneficial influence on progress towards achieving SDGs 6, 9, 10, 11, 15, 16 and 17. In contrast the project may pose a risk on progress towards achieving SDGs 1, 2, 3, 7, 8, 12 and 13. There is no net positive or negative influence calculated for SDGs 4, 5 and 14.
- As each of the SDGs consists of a large number of individual targets there is potential for a project to have a positive influence on some targets and a negative influence on others. The SDG Map above presents the calculated balance of influence, for example the BSIM calculates the project may have a net positive influence on potentially achieving SDG 6.
- The SDG Radar Map provides further demonstration of these trade-offs, visually highlighting the extent that a project may influence the individual targets of a given SDG. For example, the Radar Map shows that the project will result in large net negative impacts on potentially achieving SDG8. This means there are negative influences on far more individual targets within SDG 8 than positive influences. SDG 9 provides an example where there will be an overall net positive influence, although there is near parity in how the project may benefit and impact the individual targets that construct SDG 9.

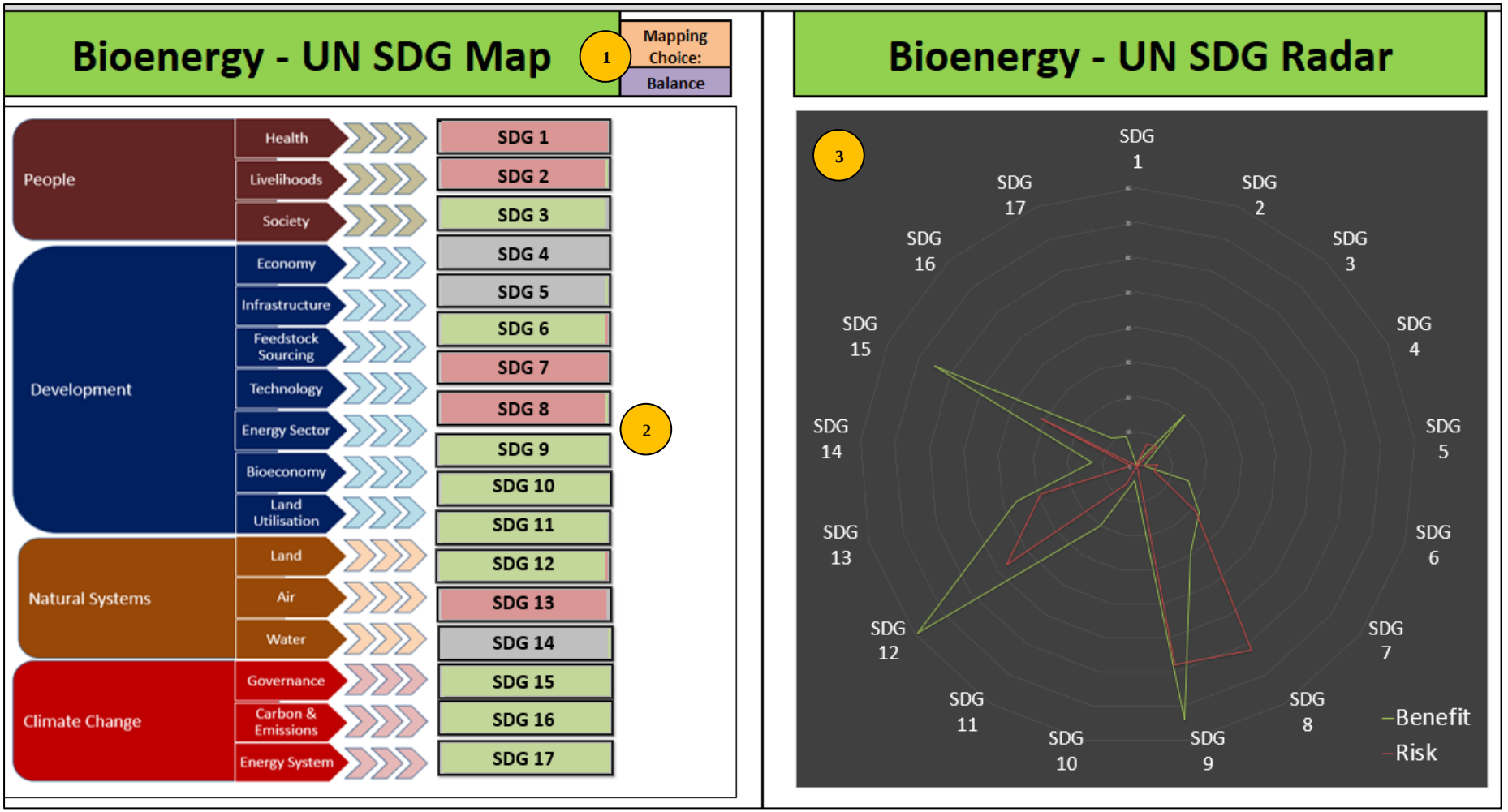


Figure 7: BSIM SDG Maps

6.5. BSIM Weightings Control Panel

The weighting of sustainability issues is a key variable influencing the BSIM's calculations. The BSIM's Weightings Control Panel (Figure 8) can be used to view the weighting assumptions. The default weightings built within the BSIM have been calibrated working with bioeconomy stakeholders as described in Section 2.1.

1) **Weighting Balance –** Provides a visual assessment of whether there is an overall risk or benefit weighting for each sustainability *issue*. Where a given *issue* has a negative weighting (indicating it may be a potential leading risk), case study risk scores will be amplified within the calculations. For example, in Figure 8, 'Changes in Carbon Stock' are shown to have a 'negative weighting' – if a potential risk for carbon stocks if identified for a given project, the calculated SPS risk score will be amplified by the weighting value. In contrast Figure 8 shows that 'Substitution of Traditional Bioenergy' has a significant 'benefit weighting' – if a project is identified to potentially lead to the replacement of traditional bioenergy, the calculated SPS benefit score will be amplified by the weighting.

2) **Sustainability Benefit Weightings –** Visual presentation of the active benefit weighing scores (IW^b) applied within the SPS calculations.

3) **Sustainability Risk Weightings –** Visual presentation of the active risk weighing scores (IW^r) applied within the SPS calculations.

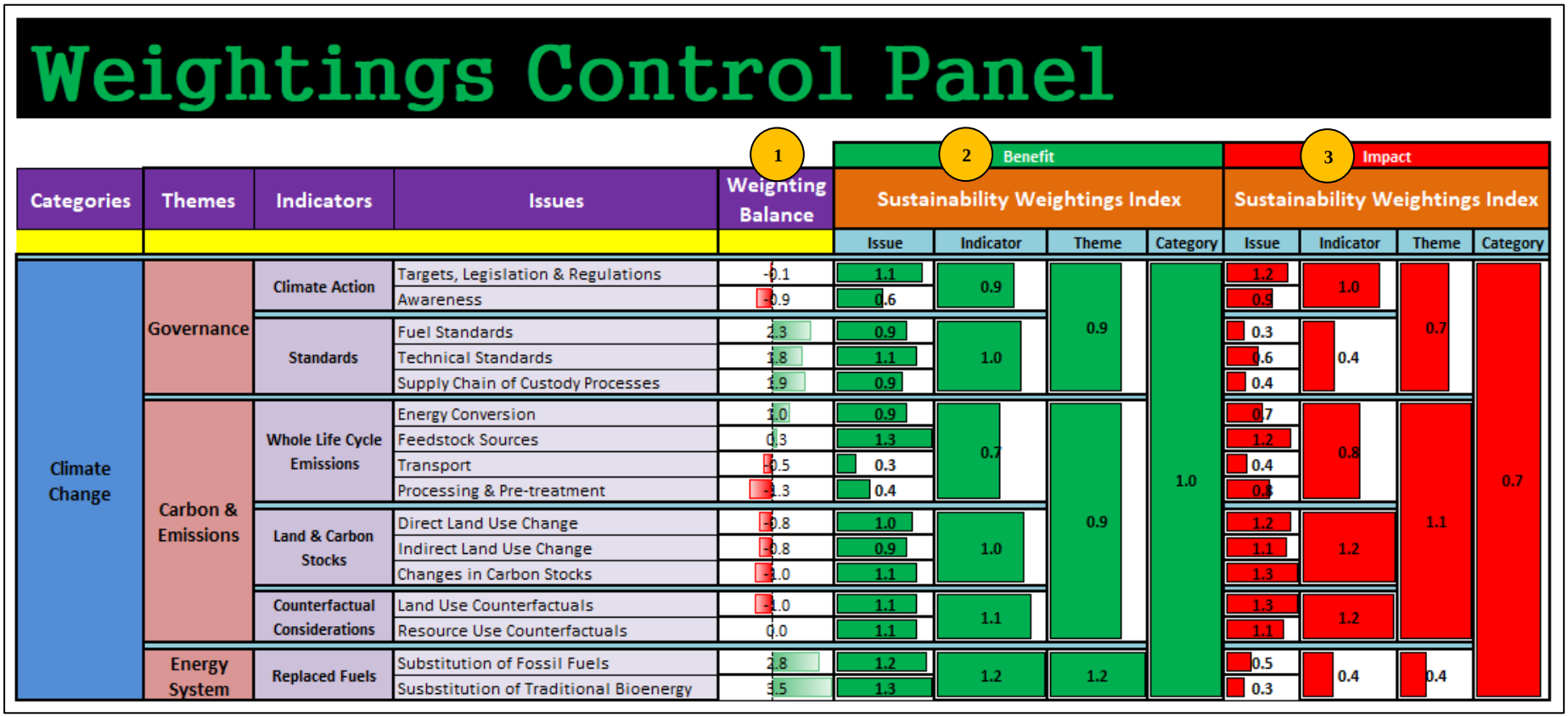


Figure 8: BSIM Weighting Control Panel

6.6. BSIM Sustainability Indicators List

The Sustainability Indicators List (Figure 9) within the BSIM is a reference source, providing a brief description of each sustainability *issue* and an overview of the BSIM's sustainability assessment framework. Users should refer to Section 3 of this Manual for further explanations.

Sustainability Indicator List

UK	Sustainability Categories	Themes	Indicators	Issues	Description
UK	Climate Change	Governance	Climate Action	Targets, Legislation & Regulations	*bioenergy scheme will contribute to climate change targets*
				Awareness	*bioenergy scheme will change awareness of climate change issues*
			Standards	Fuel Standards	*fuel standards are in place and are enforced*
				Technical Standards	*technical standards are in place and are enforced*
				Supply Chain of Custody Processes	*processes are in place to ensure strong supply chains*
		Carbon & Emissions	Whole Life Cycle Emissions	Energy Conversion	*emissions linked to conversion of feedstock to energy*
				Feedstock Sources	*emissions linked to feedstock growth/ production/ mobilisation*
				Transport	*emissions linked to processing and pre-treatment activities*
				Processing & Pre-treatment	*emissions linked to processing and pre-treatment activities*
			Land & Carbon Stocks	Direct Land Use Change	*potential for direct land use change*
				Indirect Land Use Change	*potential for indirect land use change*
				Changes in Carbon Stocks	*potential changes in carbon stocks*
			Counterfactual Considerations	Land Use Counterfactuals	*bioenergy scheme performances compared to counterfactual land use scenario*
				Resource Use Counterfactuals	*bioenergy scheme performances compared to counterfactual resource use scenario*
		Energy System	Replaced Fuels	Substitution of Fossil Fuels	*bioenergy scheme will result in the substitution of fossil fuel use*
				Susbstitution of Traditional Bioenergy	*bioenergy scheme will result in the substitution of traditional bioenegry use*

Figure 9: BSIM Sustainability Indicator List

7. References

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Appendices

A. BSIM Weightings

The following tables list the weighting scores allocated to each sustainability issue. Values presented document the 'sustainability ranges', the overall 'weighting balance' and the 'sustainability weighting index' for each sustainability issue, indicator, theme and category.

Weightings for People Sustainability Indicators

			Overall Weight			Sustainability Benefit Weighting				Sustainability Risk Weighting			
Themes	Indicators	Issues	Balance	Range		Sustainability Weightings Index				Sustainability Weightings Index			
				Benefit	Impact	Issue	Indicator	Theme	Category	Issue	Indicator	Theme	Category
Health	Health & Wellbeing	Mortality Rate & Disease Burden	-0.50	2.25	2.75	0.60	0.60	0.65	0.69	0.73	0.73	0.74	0.74
		Exposure to Occupational Health & Safety Hazards	-0.50	2.25	2.75	0.60				0.73			
	Food Systems	Food Commodity Supply	-0.25	2.25	2.50	0.60	0.70			0.67	0.74		
		Food Commodity Imports & Exports	-0.25	2.25	2.50	0.60				0.67			
		Climate Change Resilience	-0.25	2.25	2.50	0.60				0.67			
		Changes in Costs of Agricultural Products	0.00	3.00	3.00	0.80				0.80			
		Food Prices	0.00	3.00	3.00	0.80				0.80			
		Food Security	-0.25	3.00	3.25	0.80				0.87			
Livelihoods	Land Management	Land Ownership	-0.25	3.00	3.25	0.80	0.80	0.66		0.87	0.97	0.76	
		Land Access	-1.00	3.00	4.00	0.80				1.07			
	Decent Work	Rights	-3.00	1.00	4.00	0.27	0.27			1.07	1.07		
		Child Labour	-3.00	1.00	4.00	0.27				1.07			
		Slave Labour	-3.00	1.00	4.00	0.27				1.07			
		International Labour Standards	-3.00	1.00	4.00	0.27				1.07			
	Jobs & Skills	Skilled Jobs	0.81	3.28	2.47	0.87	0.97			0.66	0.53		
		Unskilled Jobs	2.50	4.00	1.50	1.07				0.40			
		Permanent Jobs	1.65	3.64	1.99	0.97				0.53			
		Temporary Jobs	1.65	3.64	1.99	0.97				0.53			
		Regional Job Distribution	1.65	3.64	1.99	0.97				0.53			
		Career Development	1.65	3.64	1.99	0.97				0.53			
	Change in income	Income from Bioenergy	0.50	2.25	1.75	0.60	0.60			0.47	0.47		
		Net Income from Bioenergy	0.50	2.25	1.75	0.60				0.47			
Society	Equality	Diversity through Supply Chain Participation	0.50	2.75	2.25	0.73	0.67	0.75		0.60	0.53	0.72	
		Diversity & End Use	0.50	2.25	1.75	0.60				0.47			
	Peace, Justice & Strong Institutions	Legality	-3.00	1.00	4.00	0.27	0.27			1.07	1.07		
		Monitoring	-3.00	1.00	4.00	0.27				1.07			
		Bribery & Conflicts of Business	-3.00	1.00	4.00	0.27				1.07			
	Partnerships	Community Partnerships	2.00	4.00	2.00	1.07	1.07			0.53	0.53		
		Industry Partnerships	2.00	4.00	2.00	1.07				0.53			
		Government Partnerships	2.00	4.00	2.00	1.07				0.53			
		Specialist Bioenergy Partnerships	2.00	4.00	2.00	1.07				0.53			
	Energy Access	Households using Bioenergy	0.84	3.61	2.77	0.96	0.98			0.74	0.74		
		Industry using Bioenergy	0.99	3.78	2.79	1.01				0.74			

Weightings for Development Sustainability Indicators

Themes	Indicators	Issues	Overall Weight			Sustainability Benefit Weighting				Sustainability Risk Weighting			
			Balance	Range		Sustainability Weightings Index				Sustainability Weightings Index			
				Benefit	Impact	Issue	Indicator	Theme	Category	Issue	Indicator	Theme	Category
Economy	Economic Performance	Gross Domestic Product	0.88	3.49	2.61	0.93	0.83	0.95	0.83	0.70	0.79	0.73	0.81
		Influence on Wider Sectors	0.88	3.49	2.61	0.93				0.70			
		International Trade	0.88	3.49	2.61	0.93				0.70			
		Financial Capacity to Adopt Bioenergy	-2.00	2.00	4.00	0.53				1.07			
	Economic Stimulation	Increased Sustainable Energy Generation	2.00	4.00	2.00	1.07	1.07			0.53	0.67		
		Economic Support Mechanisms	1.00	4.00	3.00	1.07				0.80			
Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability	0.72	3.50	2.78	0.93	0.93	0.93		0.74	0.74	0.74	
		Existing Infrastructure - Capacity	0.72	3.50	2.78	0.93				0.74			
		New Infrastructure Capacity	0.72	3.50	2.78	0.93				0.74			
Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agri-Chemicals (fertiliser + pesticide)	0.00	4.00	4.00	1.07	0.73	0.80		1.07	0.93	0.94	
		Use of Genetically Modified Materials	1.00	4.00	3.00	1.07				0.80			
		Feedstock Production Strategy	-2.00	1.50	3.50	0.40				0.93			
		Land Use Productivity	-2.00	1.50	3.50	0.40				0.93			
	Mobilisation	Resource Mobilisation	0.00	4.00	4.00	1.07	0.87			1.07	0.96		
		Competition for Resources	-0.63	2.56	3.18	0.68				0.85			
	Distribution	Spatial Distribution of Resources	-1.00	3.00	4.00	0.80	0.80			1.07	0.93		
		Resource Transportation	0.00	3.00	3.00	0.80				0.80			
Technology	Innovation	TRL Development	-0.69	2.92	3.62	0.78	0.92	0.65		0.96	0.75	0.86	
		Intellectual Property	2.00	4.00	2.00	1.07				0.53			
	Efficiencies	Processing Efficiencies	-2.00	1.50	3.50	0.40	0.40			0.93	0.93		
		Supply Chain Efficiencies	-2.00	1.50	3.50	0.40				0.93			
	Techno-Economics	CAPEX - Direct Fixed Capital Cost	-1.15	2.40	3.55	0.64	0.63			0.95	0.90		
		CAPEX - Indirect Fixed Capital Cost	-1.15	2.40	3.55	0.64				0.95			
		OPEX - Fixed Operational Costs	-0.92	2.23	3.15	0.59				0.84			
		OPEX - Variable Operational Costs	-0.92	2.23	3.15	0.59				0.84			
		Biomass Feedstock Costs	0.11	2.91	2.80	0.78				0.75			
		Reliance on Economic Support Measures	-2.00	2.00	4.00	0.53				1.07			
Energy Sector	Bioenergy	Infrastructure Alignment	0.72	3.50	2.78	0.93	0.93	0.65		0.74	0.87	0.86	
		Bio-Product Flexibility (energy)	0.61	3.43	2.81	0.91				0.75			
		Bio-Product Flexibility (non-energy)	0.61	3.43	2.81	0.91				0.75			
		Bioenergy Vector Distribution	-1.00	3.00	4.00	0.80				1.07			
		Bioenergy Vector Affordability	0.00	4.00	4.00	1.07				1.07			
	Energy System Performances	Input Energy Requirements	-0.44	2.09	2.53	0.56	0.56			0.67	0.67		
		Influences on Energy System Resilience	-0.44	2.09	2.53	0.56				0.67			
		Accessibility to Wider Input Energy	-0.44	2.09	2.53	0.56				0.67			
Bioeconomy	Added Value Products	Bio-Chemicals	1.19	3.64	2.44	0.97	0.97	0.92		0.65	0.65	0.76	
		Bio-Products	1.19	3.64	2.44	0.97				0.65			
	Bioenergy Complementing Wider Sectors	Agriculture	-0.02	3.26	3.27	0.87	0.87			0.87	0.87		
		Chemical	-0.02	3.26	3.27	0.87				0.87			
		Waste	-0.02	3.26	3.27	0.87				0.87			
		Construction	-0.02	3.26	3.27	0.87				0.87			

		Transport	-0.02	3.26	3.27	0.87				0.87			
		Services	-0.02	3.26	3.27	0.87				0.87			
		Manufacturing	-0.02	3.26	3.27	0.87				0.87			
Land Utilisation	Land Characteristics	Topography - Influencing Access	0.39	3.42	3.03	0.91	0.91	0.91		0.81	0.81	0.81	
		Location - Influencing Distribution & Connectivity	0.39	3.42	3.03	0.91				0.81			
		Use of Contaminated Lands	0.39	3.42	3.03	0.91				0.81			
		Potential for Phytoremediation	0.39	3.42	3.03	0.91				0.81			

Weightings for Natural System Sustainability Indicators

			Overall Weight			Sustainability Benefit Weighting				Sustainability Risk Weighting			
Themes	Indicators	Issues	Balance	Range		Sustainability Weightings Index				Sustainability Weightings Index			
				Benefit	Impact	Issue	Indicator	Theme	Category	Issue	Indicator	Theme	Category
Land	Soil	Impact on Soil Organic Carbon	0.63	3.00	2.38	0.80	0.80	0.70	0.65	0.63	0.54	0.56	0.57
		Soil Fertility	1.13	3.06	1.94	0.82				0.52			
		Soil Erosion	-0.38	2.38	2.75	0.63				0.73			
		Accumulation of Mineral Salts	0.61	2.75	2.14	0.73				0.57			
		Drainage Impacts	1.75	3.00	1.25	0.80				0.33			
		Soil Compaction	0.92	3.25	2.33	0.87				0.62			
		Soli Influence on Productivity Yields	2.00	3.50	1.50	0.93				0.40			
	Ecosystems	Biodiversity	1.13	3.06	1.94	0.82	0.60			0.52	0.58		
		Areas of Conservation & High Biodiversity	-1.00	2.00	3.00	0.53				0.80			
		Land Degradation	1.00	2.25	1.25	0.60				0.33			
		Desertification	-0.75	1.75	2.50	0.47				0.67			
Air	PM Pollutants	PM10s	-1.00	2.00	3.00	0.53	0.53	0.53		0.80	0.80	0.60	
		PM2.5s	-1.00	2.00	3.00	0.53				0.80			
	Oxide Pollutants	Sulphur Oxides	1.00	2.25	1.25	0.60	0.60			0.33	0.33		
		Nitrogen Oxides	1.00	2.25	1.25	0.60				0.33			
		Carbon Monoxide	1.00	2.25	1.25	0.60				0.33			
	Heavy Metal	Cadmium	-0.75	1.75	2.50	0.47	0.47			0.67	0.67		
		Lead	-0.75	1.75	2.50	0.47				0.67			
		Mercury	-0.75	1.75	2.50	0.47				0.67			
Water	Water Use & Efficiency	Water Withdrawn	-0.38	2.38	2.75	0.63	0.63	0.72		0.73	0.73	0.55	
		Water Consumed	-0.38	2.38	2.75	0.63				0.73			
		Non-renewable Water Resources	-0.38	2.38	2.75	0.63				0.73			
		Renewable Water Resources	-0.38	2.38	2.75	0.63				0.73			
	Water Quality	Fertilizer & Pesticide Loadings	0.61	2.75	2.14	0.73	0.73			0.57	0.57		
		Pollution from Feedstock Production	0.61	2.75	2.14	0.73				0.57			
		Pollution from Feedstock Processing	0.61	2.75	2.14	0.73				0.57			
		Pollution from Feedstock Conversion	0.61	2.75	2.14	0.73				0.57			
	Water Systems	Flooding	1.75	3.00	1.25	0.80	0.80			0.33	0.33		
		Local Water Stresses	1.75	3.00	1.25	0.80				0.33			

Weightings for Climate Change Sustainability Indicators

Themes	Indicators	Issues	Overall Weight			Sustainability Benefit Weighting				Sustainability Risk Weighting			
			Balance	Range		Sustainability Weightings Index				Sustainability Weightings Index			
				Benefit	Impact	Issue	Indicator	Theme	Category	Issue	Indicator	Theme	Category
Governance	Climate Action	Targets, Legislation & Regulations	-0.08	4.25	4.33	1.13	0.88	0.92	1.03	1.16	1.01	0.72	0.73
		Awareness	-0.92	2.33	3.25	0.62				0.87			
	Standards	Fuel Standards	2.25	3.50	1.25	0.93	0.96			0.33	0.43		
		Technical Standards	1.75	4.00	2.25	1.07				0.60			
		Supply Chain of Custody Processes	1.92	3.25	1.33	0.87				0.36			
Carbon & Emissions	Whole Life Cycle Emissions	Energy Conversion	1.00	3.50	2.50	0.93	0.73	0.93		0.67	0.77	1.06	
		Feedstock Sources	0.25	4.75	4.50	1.27				1.20			
		Transport	-0.50	1.00	1.50	0.27				0.40			
		Processing & Pre-treatment	-1.33	1.67	3.00	0.44				0.80			
	Land & Carbon Stocks	Direct Land Use Change	-0.75	3.75	4.50	1.00	1.00			1.20	1.22		
		Indirect Land Use Change	-0.75	3.50	4.25	0.93				1.13			
		Changes in Carbon Stocks	-1.00	4.00	5.00	1.07				1.33			
	Counterfactual Considerations	Land Use Counterfactuals	-1.00	4.00	5.00	1.07	1.07			1.33	1.20		
		Resource Use Counterfactuals	0.00	4.00	4.00	1.07				1.07			
Energy System	Replaced Fuels	Substitution of Fossil Fuels	2.75	4.50	1.75	1.20	1.23	1.23		0.47	0.40	0.40	
		Substitution of Traditional Bioenergy	3.50	4.75	1.25	1.27				0.33			

B. Bioenergy Links with the SDGs

The following tables list the links between the BSIM sustainability themes and the United Nation's Sustainable Development Goals. Links have been identified through the research's stakeholder engagement activities. Where a link is identified the BSIM assumes bioenergy can generate a positive influence or risk to achieving the SDGs.

UN SDG Key

SDG 1	End poverty in all its forms everywhere	1.1	By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day	1.1.1	Proportion of the population living below the international poverty line by sex, age, employment status and geographic location (urban/rural)
		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	1.2.1	Proportion of population living below the national poverty line, by sex and age
				1.2.2	Proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions
		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	1.3.1	Proportion of population covered by social protection floors/systems, by sex, distinguishing children, unemployed persons, older persons, persons with disabilities, pregnant women, newborns, work-injury victims and the poor and the vulnerable
		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	1.4.1	Proportion of population living in households with access to basic services
				1.4.2	Proportion of total adult population with secure tenure rights to land, (a) with legally recognized documentation, and (b) who perceive their rights to land as secure, by sex and type of tenure
		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	1.5.1	Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population
				1.5.2	Direct economic loss attributed to disasters in relation to global gross domestic product (GDP)
				1.5.3	Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030
				1.5.4	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies
		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	1.a.1	Total official development assistance grants from all donors that focus on poverty reduction as a share of the recipient country's gross national income
				1.a.2	Proportion of total government spending on essential services (education, health and social protection)
		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	1.b.1	Pro-poor public social spending

SDG 2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture	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	2.1.1	Prevalence of undernourishment
				2.1.2	Prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale (FIES)
		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	2.2.1	Prevalence of stunting (height for age <-2 standard deviation from the median of the World Health Organization (WHO) Child Growth Standards) among children under 5 years of age
				2.2.2	Prevalence of malnutrition (weight for height >+2 or <-2 standard deviation from the median of the WHO Child Growth Standards) among children under 5 years of age, by type (wasting and overweight)
				2.2.3	Prevalence of anaemia in women aged 15 to 49 years, by pregnancy status (percentage)
		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	2.3.1	Volume of production per labour unit by classes of farming/pastoral/forestry enterprise size
				2.3.2	Average income of small-scale food producers, by sex and indigenous status
		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	2.4.1	Proportion of agricultural area under productive and sustainable agriculture
		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	2.5.1	Number of plant and animal genetic resources for food and agriculture secured in either medium- or long-term conservation facilities
				2.5.2	Proportion of local breeds classified as being at risk of extinction
		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.a.1	The agriculture orientation index for government expenditures
				2.a.2	Total official flows (official development assistance plus other official flows) to the agriculture sector
		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.b.1	Agricultural export subsidies
		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	2.c.1	Indicator of food price anomalies

SDG 3	Ensure healthy lives and promote well-being for all at all ages	3.1	By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births	3.1.1	Maternal mortality ratio
				3.1.2	Proportion of births attended by skilled health personnel
		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	3.2.1	Under-5 mortality rate
				3.2.2	Neonatal mortality rate
		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	3.3.1	Number of new HIV infections per 1,000 uninfected population, by sex, age and key populations
				3.3.2	Tuberculosis incidence per 100,000 population
				3.3.3	Malaria incidence per 1,000 population
				3.3.4	Hepatitis B incidence per 100,000 population
				3.3.5	Number of people requiring interventions against neglected tropical diseases
		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	3.4.1	Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease
				3.4.2	Suicide mortality rate
		3.5	Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol	3.5.1	Coverage of treatment interventions (pharmacological, psychosocial and rehabilitation and aftercare services) for substance use disorders
				3.5.2	Alcohol per capita consumption (aged 15 years and older) within a calendar year in litres of pure alcohol
		3.6	By 2020, halve the number of global deaths and injuries from road traffic accidents	3.6.1	Death rate due to road traffic injuries
		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	3.7.1	Proportion of women of reproductive age (aged 15–49 years) who have their need for family planning satisfied with modern methods
				3.7.2	Adolescent birth rate (aged 10–14 years; aged 15–19 years) per 1,000 women in that age group
		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	3.8.1	Coverage of essential health services
				3.8.2	Proportion of population with large household expenditures on health as a share of total household expenditure or income
		3.9	By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination	3.9.1	Mortality rate attributed to household and ambient air pollution
				3.9.2	Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene (exposure to unsafe Water, Sanitation and Hygiene for All (WASH) services)
				3.9.3	Mortality rate attributed to unintentional poisoning
		3.a	Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries, as appropriate	3.a.1	Age-standardized prevalence of current tobacco use among persons aged 15 years and older
		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	3.b.1	Proportion of the target population covered by all vaccines included in their national programme
				3.b.2	Total net official development assistance to medical research and basic health sectors
				3.b.3	Proportion of health facilities that have a core set of relevant essential medicines available and affordable on a sustainable basis
		3.c S	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.c.1	Health worker density and distribution

		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	3.d.1	International Health Regulations (IHR) capacity and health emergency preparedness
				3.d.2	Percentage of bloodstream infections due to selected antimicrobial-resistant organisms

SDG 5	Achieve gender equality and empower all women and girls	5.1	End all forms of discrimination against all women and girls everywhere	5.1.1	Whether or not legal frameworks are in place to promote, enforce and monitor equality and non-discrimination on the basis of sex
		5.2	Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation	5.2.1	Proportion of ever-partnered women and girls aged 15 years and older subjected to physical, sexual or psychological violence by a current or former intimate partner in the previous 12 months, by form of violence and by age
				5.2.2	Proportion of women and girls aged 15 years and older subjected to sexual violence by persons other than an intimate partner in the previous 12 months, by age and place of occurrence
		5.3	5.3 Eliminate all harmful practices, such as child, early and forced marriage and female genital mutilation	5.3.1	Proportion of women aged 20–24 years who were married or in a union before age 15 and before age 18
				5.3.2	Proportion of girls and women aged 15–49 years who have undergone female genital mutilation/cutting, by age
		5.4	Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate	5.4.1	Proportion of time spent on unpaid domestic and care work, by sex, age and location
		5.5	Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life	5.5.1	Proportion of seats held by women in (a) national parliaments and (b) local governments
				5.5.2	Proportion of women in managerial positions
		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	5.6.1	Proportion of women aged 15–49 years who make their own informed decisions regarding sexual relations, contraceptive use and reproductive health care
				5.6.2	Number of countries with laws and regulations that guarantee full and equal access to women and men aged 15 years and older to sexual and reproductive health care, information and education
		5.a	Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws	5.a.1	(a) Proportion of total agricultural population with ownership or secure rights over agricultural land, by sex; and (b) share of women among owners or rights-bearers of agricultural land, by type of tenure
				5.a.2	Proportion of countries where the legal framework (including customary law) guarantees women's equal rights to land ownership and/or control
		5.b	Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women	5.b.1	Proportion of individuals who own a mobile telephone, by sex
		5.c	Adopt and strengthen sound policies and enforceable legislation for the promotion of gender equality and the empowerment of all women and girls at all levels	5.c.1	Proportion of countries with systems to track and make public allocations for gender equality and women's empowerment

SDG 6	Ensure availability and sustainable management of water and sanitation for all	6.1	By 2030, achieve universal and equitable access to safe and affordable drinking water for all	6.1.1	Proportion of population using safely managed drinking water services
		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	6.2.1	Proportion of population using (a) safely managed sanitation services and (b) a hand-washing facility with soap and water
		6.3	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	6.3.1	Proportion of domestic and industrial wastewater flows safely treated
				6.3.2	Proportion of bodies of water with good ambient water quality
		6.4	By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	6.4.1	Change in water-use efficiency over time
				6.4.2	Level of water stress: freshwater withdrawal as a proportion of available freshwater resources
		6.5	By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate	6.5.1	Degree of integrated water resources management
				6.5.2	Proportion of transboundary basin area with an operational arrangement for water cooperation
		6.6	By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	6.6.1	Change in the extent of water-related ecosystems over time
		6.a	By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies	6.a.1	Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan
		6.b	Support and strengthen the participation of local communities in improving water and sanitation management	6.b.1	Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management

SDG 7	Ensure access to affordable, reliable, sustainable and modern energy for all	7.1	7.1 By 2030, ensure universal access to affordable, reliable and modern energy services	7.1.1	Proportion of population with access to electricity
				7.1.2	Proportion of population with primary reliance on clean fuels and technology
		7.2	7.2 By 2030, increase substantially the share of renewable energy in the global energy mix	7.2.1	Renewable energy share in the total final energy consumption
		7.3	7.3 By 2030, double the global rate of improvement in energy efficiency	7.3.1	Energy intensity measured in terms of primary energy and GDP
		7.a	7.a By 2030, enhance international cooperation 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	7.a.1	International financial flows to developing countries in support of clean energy research and development and renewable energy production, including in hybrid systems
		7.b	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	7.b.1	Installed renewable energy-generating capacity in developing countries (in watts per capita)

SDG 8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	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	8.1.1	Annual growth rate of real GDP per capita
		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	8.2.1	Annual growth rate of real GDP per employed person
		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	8.3.1	Proportion of informal employment in total employment, by sector and sex
		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	8.4.1	Material footprint, material footprint per capita, and material footprint per GDP
				8.4.2	Domestic material consumption, domestic material consumption per capita, and domestic material consumption per GDP
		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	8.5.1	Average hourly earnings of employees, by sex, age, occupation and persons with disabilities
				8.5.2	Unemployment rate, by sex, age and persons with disabilities
		8.6	By 2020, substantially reduce the proportion of youth not in employment, education or training	8.6.1	Proportion of youth (aged 15–24 years) not in education, employment or training
		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	8.7.1	Proportion and number of children aged 5–17 years engaged in child labour, by sex and age
		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	8.8.1	Fatal and non-fatal occupational injuries per 100,000 workers, by sex and migrant status
				8.8.2	Level of national compliance with labour rights (freedom of association and collective bargaining) based on International Labour Organization (ILO) textual sources and national legislation, by sex and migrant status
		8.9	By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products	8.9.1	Tourism direct GDP as a proportion of total GDP and in growth rate
		8.1	Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all	8.10.1	(a) Number of commercial bank branches per 100,000 adults and (b) number of automated teller machines (ATMs) per 100,000 adults
				8.10.2	Proportion of adults (15 years and older) with an account at a bank or other financial institution or with a mobile-money-service provider

SDG 9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	9.1	Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	9.1.1	Proportion of the rural population who live within 2 km of an all-season road
				9.1.2	Passenger and freight volumes, by mode of transport
		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	9.2.1	Manufacturing value added as a proportion of GDP and per capita
				9.2.2	Manufacturing employment as a proportion of total employment
		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	9.3.1	Proportion of small-scale industries in total industry value added
				9.3.2	Proportion of small-scale industries with a loan or line of credit
		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	9.4.1	CO2 emission per unit of value added
		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	9.5.1	Research and development expenditure as a proportion of GDP
				9.5.2	Researchers (in full-time equivalent) per million inhabitants
		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.a.1	Total official international support (official development assistance plus other official flows) to infrastructure
		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	9.b.1	Proportion of medium and high-tech industry value added in total value added
		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	9.c.1	Proportion of population covered by a mobile network, by technology

SDG 10	Reduce inequality within and among countries	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	10.1.1	Growth rates of household expenditure or income per capita among the bottom 40 per cent of the population and the total population
		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	10.2.1	Proportion of people living below 50 per cent of median income, by sex, age and persons with disabilities
		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	10.3.1	Proportion of population reporting having personally felt discriminated against or harassed in the previous 12 months on the basis of a ground of discrimination prohibited under international human rights law
		10.4	Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality	10.4.1	Labour share of GDP
				10.4.2	Redistributive impact of fiscal policy
		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	10.6.1	Proportion of members and voting rights of developing countries in international organizations
		10.7	Facilitate orderly, safe, regular and responsible migration and mobility of people, including through the implementation of planned and well-managed migration policies	10.7.1	Recruitment cost borne by employee as a proportion of monthly income earned in country of destination
				10.7.2	Number of countries with migration policies that facilitate orderly, safe, regular and responsible migration and mobility of people
				10.7.3	Number of people who died or disappeared in the process of migration towards an international destination
				10.7.4	Proportion of the population who are refugees, by country of origin
		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.a.1	Proportion of tariff lines applied to imports from least developed countries and developing countries with zero-tariff
		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.b.1	Total resource flows for development, by recipient and donor countries and type of flow (e.g. official development assistance, foreign direct investment and other flows)
		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	10.c.1	Remittance costs as a proportion of the amount remitted

SDG 11	Make cities and human settlements inclusive, safe, resilient and sustainable	11.1	By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums	11.1.1	Proportion of urban population living in slums, informal settlements or inadequate housing
		11.2	By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons	11.2.1	Proportion of population that has convenient access to public transport, by sex, age and persons with disabilities
		11.3	By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries	11.3.1	Ratio of land consumption rate to population growth rate
				11.3.2	Proportion of cities with a direct participation structure of civil society in urban planning and management that operate regularly and democratically
		11.4	Strengthen efforts to protect and safeguard the world's cultural and natural heritage	11.4.1	Total per capita expenditure on the preservation, protection and conservation of all cultural and natural heritage, by source of funding (public, private), type of heritage (cultural, natural) and level of government (national, regional, and local/municipal)
		11.5	By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations	11.5.1	Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population
				11.5.2	Direct economic loss in relation to global GDP, damage to critical infrastructure and number of disruptions to basic services, attributed to disasters
		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	11.6.1	Proportion of municipal solid waste collected and managed in controlled facilities out of total municipal waste generated, by cities
				11.6.2	Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted)
		11.7	By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities	11.7.1	Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities
				11.7.2	Proportion of persons victim of physical or sexual harassment, by sex, age, disability status and place of occurrence, in the previous 12 months
		11.a	Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning	11.a.1	Number of countries that have national urban policies or regional development plans that (a) respond to population dynamics; (b) ensure balanced territorial development; and (c) increase local fiscal space
		11.b	By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels	11.b.1	Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030
				11.b.2	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies
		11.c	Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials	11.c.1	No suitable replacement indicator was proposed. The global statistical community is encouraged to work to develop an indicator that could be proposed for the 2025 comprehensive review. See E/CN.3/2020/2, paragraph 23.

SDG 12	Ensure sustainable consumption and production patterns	12.1	Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries	12.1.1	Number of countries developing, adopting or implementing policy instruments aimed at supporting the shift to sustainable consumption and production
		12.2	By 2030, achieve the sustainable management and efficient use of natural resources	12.2.1	Material footprint, material footprint per capita, and material footprint per GDP
				12.2.2	Domestic material consumption, domestic material consumption per capita, and domestic material consumption per GDP
		12.3	By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses	12.3.1	(a) Food loss index and (b) food waste index
		12.4	By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment	12.4.1	Number of parties to international multilateral environmental agreements on hazardous waste, and other chemicals that meet their commitments and obligations in transmitting information as required by each relevant agreement
				12.4.2	(a) Hazardous waste generated per capita; and (b) proportion of hazardous waste treated, by type of treatment
		12.5	By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse	12.5.1	National recycling rate, tons of material recycled
		12.6	Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle	12.6.1	Number of companies publishing sustainability reports
		12.7	Promote public procurement practices that are sustainable, in accordance with national policies and priorities	12.7.1	Degree of sustainable public procurement policies and action plan implementation
		12.8	By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature	12.8.1	Extent to which (i) global citizenship education and (ii) education for sustainable development are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment
		12.a	Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production	12.a.1	nstalled renewable energy-generating capacity in developing countries (in watts per capita)
		12.b	Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products	12.b.1	Implementation of standard accounting tools to monitor the economic and environmental aspects of tourism sustainability
		12.c	Rationalize inefficient fossil fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities	12.c.1	Amount of fossil-fuel subsidies per unit of GDP (production and consumption)

SDG 13	Take urgent action to combat climate change and its impacts	13.1	Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	13.1.1	Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population
				13.1.2	Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030
				13.1.3	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies
		13.2	Integrate climate change measures into national policies, strategies and planning	13.2.1	Number of countries with nationally determined contributions, long-term strategies, national adaptation plans, strategies as reported in adaptation communications and national communications
				13.2.2	Total greenhouse gas emissions per year
		13.3	Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	13.3.1	Extent to which (i) global citizenship education and (ii) education for sustainable development are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment
		13.a	Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible	13.a.1	Amounts provided and mobilized in United States dollars per year in relation to the continued existing collective mobilization goal of the $100 billion commitment through to 2025
		13.b	Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities	13.b.1	Number of least developed countries and small island developing States with nationally determined contributions, long-term strategies, national adaptation plans, strategies as reported in adaptation communications and national communications

SDG 14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	14.1	By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution	14.1.1	(a) Index of coastal eutrophication; and (b) plastic debris density
		14.2	By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans	14.2.1	Number of countries using ecosystem-based approaches to managing marine areas
		14.3	Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels	14.3.1	Average marine acidity (pH) measured at agreed suite of representative sampling stations
		14.4	By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics	14.4.1	Proportion of fish stocks within biologically sustainable levels
		14.5	By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information	14.5.1	Coverage of protected areas in relation to marine areas
		14.6	By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation4	14.6.1	Degree of implementation of international instruments aiming to combat illegal, unreported and unregulated fishing
		14.7	By 2030, increase the economic benefits to small island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism	14.7.1	Sustainable fisheries as a proportion of GDP in small island developing States, least developed countries and all countries
		14.a	Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries	14.a.1	Proportion of total research budget allocated to research in the field of marine technology
		14.b	Provide access for small-scale artisanal fishers to marine resources and markets	14.b.1	Degree of application of a legal/regulatory/ policy/institutional framework which recognizes and protects access rights for small-scale fisheries
		14.c	Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in the United Nations Convention on the Law of the Sea, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of “The future we want”	14.c.1	Number of countries making progress in ratifying, accepting and implementing through legal, policy and institutional frameworks, ocean-related instruments that implement international law, as reflected in the United Nations Convention on the Law of the Sea, for the conservation and sustainable use of the oceans and their resources

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SDG 15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	15.1	By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	15.1.1	Forest area as a proportion of total land area
		15.2	By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally	15.1.2	Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type
				15.2.1	Progress towards sustainable forest management
		15.3	By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world	15.3.1	Proportion of land that is degraded over total land area
		15.4	By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development	15.4.1	Coverage by protected areas of important sites for mountain biodiversity
				15.4.2	Mountain Green Cover Index
		15.5	Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species	15.5.1	Red List Index
		15.6	Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed	15.6.1	Number of countries that have adopted legislative, administrative and policy frameworks to ensure fair and equitable sharing of benefits
		15.7	Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products	15.7.1	Proportion of traded wildlife that was poached or illicitly trafficked
		15.8	By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species	15.8.1	Proportion of countries adopting relevant national legislation and adequately resourcing the prevention or control of invasive alien species
		15.9	By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts	15.9.1	(a) Number of countries that have established national targets in accordance with or similar to Aichi Biodiversity Target 2 of the Strategic Plan for Biodiversity 2011–2020 in their national biodiversity strategy and action plans and the progress reported towards these targets; and (b) integration of biodiversity into national accounting and reporting systems, defined as implementation of the System of Environmental-Economic Accounting
		15.a	Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems	15.a.1	(a) Official development assistance on conservation and sustainable use of biodiversity; and (b) revenue generated and finance mobilized from biodiversity-relevant economic instruments
		15.b	Mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation	15.b.1	(a) Official development assistance on conservation and sustainable use of biodiversity; and (b) revenue generated and finance mobilized from biodiversity-relevant economic instruments
		15.c	Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities	15.c.1	Proportion of traded wildlife that was poached or illicitly trafficked

SDG16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	16.1	Significantly reduce all forms of violence and related death rates everywhere	16.1.1	Number of victims of intentional homicide per 100,000 population, by sex and age
				16.1.2	Conflict-related deaths per 100,000 population, by sex, age and cause
				16.1.3	Proportion of population subjected to (a) physical violence, (b) psychological violence and (c) sexual violence in the previous 12 months
				16.1.4	Proportion of population that feel safe walking alone around the area they live
		16.2	End abuse, exploitation, trafficking and all forms of violence against and torture of children	16.2.1	Proportion of children aged 1–17 years who experienced any physical punishment and/or psychological aggression by caregivers in the past month
				16.2.2	Number of victims of human trafficking per 100,000 population, by sex, age and form of exploitation
				16.2.3	Proportion of young women and men aged 18–29 years who experienced sexual violence by age 18
		16.3	Promote the rule of law at the national and international levels and ensure equal access to justice for all	16.3.1	Proportion of victims of violence in the previous 12 months who reported their victimization to competent authorities or other officially recognized conflict resolution mechanisms
				16.3.2	Unsentenced detainees as a proportion of overall prison population
				16.3.3	Proportion of the population who have experienced a dispute in the past two years and who accessed a formal or informal dispute resolution mechanism, by type of mechanism
		16.4	By 2030, significantly reduce illicit financial and arms flows, strengthen the recovery and return of stolen assets and combat all forms of organized crime	16.4.1	Total value of inward and outward illicit financial flows (in current United States dollars)
				16.4.2	Proportion of seized, found or surrendered arms whose illicit origin or context has been traced or established by a competent authority in line with international instruments
		16.5	Substantially reduce corruption and bribery in all their forms	16.5.1	Proportion of persons who had at least one contact with a public official and who paid a bribe to a public official, or were asked for a bribe by those public officials, during the previous 12 months
				16.5.2	Proportion of businesses that had at least one contact with a public official and that paid a bribe to a public official, or were asked for a bribe by those public officials during the previous 12 months
		16.6	Develop effective, accountable and transparent institutions at all levels	16.6.1	Primary government expenditures as a proportion of original approved budget, by sector (or by budget codes or similar)
				16.6.2	Proportion of population satisfied with their last experience of public services
		16.7	Ensure responsive, inclusive, participatory and representative decision-making at all levels	16.7.1	Proportions of positions in national and local institutions, including (a) the legislatures; (b) the public service; and (c) the judiciary, compared to national distributions, by sex, age, persons with disabilities and population groups
				16.7.2	Proportion of population who believe decision-making is inclusive and responsive, by sex, age, disability and population group
		16.8	Broaden and strengthen the participation of developing countries in the institutions of global governance	16.8.1	Proportion of members and voting rights of developing countries in international organizations
		16.9	By 2030, provide legal identity for all, including birth registration	16.9.1	Proportion of children under 5 years of age whose births have been registered with a civil authority, by age
		16.1	Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements	16.10.1	Number of verified cases of killing, kidnapping, enforced disappearance, arbitrary detention and torture of journalists, associated media personnel, trade unionists and human rights advocates in the previous 12 months

				16.10.2	Number of countries that adopt and implement constitutional, statutory and/or policy guarantees for public access to information
		16.a	Strengthen relevant national institutions, including through international cooperation, for building capacity at all levels, in particular in developing countries, to prevent violence and combat terrorism and crime	16.a.1	Existence of independent national human rights institutions in compliance with the Paris Principles
		16.b P	Promote and enforce non-discriminatory laws and policies for sustainable development	16.b.1	Proportion of population reporting having personally felt discriminated against or harassed in the previous 12 months on the basis of a ground of discrimination prohibited under international human rights law

SDG 17	Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development	17.1	Strengthen domestic resource mobilization, including through international support to developing countries, to improve domestic capacity for tax and other revenue collection	17.1.1	Total government revenue as a proportion of GDP, by source
				17.1.2	Proportion of domestic budget funded by domestic taxes
		17.2	Developed countries to implement fully their official development assistance commitments, including the commitment by many developed countries to achieve the target of 0.7 per cent of gross national income for official development assistance (ODA/GNI) to developing countries and 0.15 to 0.20 per cent of ODA/GNI to least developed countries; ODA providers are encouraged to consider setting a target to provide at least 0.20 per cent of ODA/GNI to least developed countries	17.2.1	Net official development assistance, total and to least developed countries, as a proportion of the Organization for Economic Cooperation and Development (OECD) Development Assistance Committee donors' gross national income (GNI)
		17.3	Mobilize additional financial resources for developing countries from multiple sources	17.3.1	Foreign direct investment, official development assistance and South-South cooperation as a proportion of gross national income
				17.3.2	Volume of remittances (in United States dollars) as a proportion of total GDP
		17.4	Assist developing countries in attaining long-term debt sustainability through coordinated policies aimed at fostering debt financing, debt relief and debt restructuring, as appropriate, and address the external debt of highly indebted poor countries to reduce debt distress	17.4.1	Debt service as a proportion of exports of goods and services
		17.5	Adopt and implement investment promotion regimes for least developed countries	17.5.1	Number of countries that adopt and implement investment promotion regimes for developing countries, including the least developed countries
		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	17.6.1	Fixed Internet broadband subscriptions per 100 inhabitants, by speed
		17.7	Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed	17.7.1	Total amount of funding for developing countries to promote the development, transfer, dissemination and diffusion of environmentally sound technologies
		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	17.8.1	Proportion of individuals using the Internet
		17.9	Enhance international support for implementing effective and targeted capacity-building in developing countries to support national plans to implement all the Sustainable Development Goals, including through north–south, South-South and triangular cooperation	17.9.1	Dollar value of financial and technical assistance (including through north–south, South-South and triangular cooperation) committed to developing countries

		17.10	Promote a universal, rules-based, open, non-discriminatory and equitable multilateral trading system under the World Trade Organization, including through the conclusion of negotiations under its Doha Development Agenda	17.10.1	Worldwide weighted tariff-average
		17.11	Significantly increase the exports of developing countries, in particular with a view to doubling the least developed countries' share of global exports by 2020	17.11.1	Developing countries' and least developed countries' share of global exports
		17.12	Realize timely implementation of duty-free and quota-free market access on a lasting basis for all least developed countries, consistent with World Trade Organization decisions, including by ensuring that preferential rules of origin applicable to imports from least developed countries are transparent and simple, and contribute to facilitating market access	17.12.1	Weighted average tariffs faced by developing countries, least developed countries and small island developing States
		17.13	Enhance global macroeconomic stability, including through policy coordination and policy coherence	17.13.1	Macroeconomic Dashboard
		17.14	Enhance policy coherence for sustainable development	17.14.1	Number of countries with mechanisms in place to enhance policy coherence of sustainable development
		17.15	Respect each country's policy space and leadership to establish and implement policies for poverty eradication and sustainable development	17.15.1	Extent of use of country-owned results frameworks and planning tools by providers of development cooperation
		17.16	Enhance the Global Partnership for Sustainable Development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the Sustainable Development Goals in all countries, in particular developing countries	17.16.1	Number of countries reporting progress in multi-stakeholder development effectiveness monitoring frameworks that support the achievement of the sustainable development goals
		17.17	Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships	17.17.1	Amount in United States dollars committed to public-private partnerships for infrastructure
		17.18	By 2020, enhance capacity-building support to developing countries, including for least developed countries and small island developing States, to increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts	17.18.1	Statistical capacity indicator for Sustainable Development Goal monitoring
				17.18.2	Number of countries that have national statistical legislation that complies with the Fundamental Principles of Official Statistics
				17.18.3	Number of countries with a national statistical plan that is fully funded and under implementation, by source of funding
		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	17.19.1	Dollar value of all resources made available to strengthen statistical capacity in developing countries
				17.19.2	Proportion of countries that (a) have conducted at least one population and housing census in the last 10 years; and (b) have achieved 100 per cent birth registration and 80 per cent death registration

BSIM Links to SDG 1

Categories	Themes	Indicators	Issues	SDG 1												
				1.1.1	1.2.1	1.2.2	1.3.1	1.4.1	1.4.2	1.5.1	1.5.2	1.5.3	1.5.4	1.a.1	1.a.2	1.b.1
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden													
			Exposure to Occupational Health & Safety Hazards													
		Food Systems	Food Commodity Supply													
			Food Commodity Imports & Exports													
			Climate Change Resilience													
			Changes in Costs of Agricultural Products													
			Food Prices													
			Food Security													
	Livelihoods	Land Management	Land Ownership						✓							
			Land Access						✓							
		Decent Work	Rights													
			Child Labour													
			Slave Labour													
			International Labour Standards													
		Jobs & Skills	Skilled Jobs													
			Unskilled Jobs													
			Permanent Jobs													
			Temporary Jobs													
			Regional Job Distribution													
			Career Development													
		Change in income	Income from Bioenergy													
			Net Income from Bioenergy													
	Society	Equality	Diversity through Supply Chain Participation													
			Diversity & End Use													
		Peace, Justice & Strong Institutions	Legality													
			Monitoring													
			Bribery & Conflicts of Business													
		Partnerships	Community Partnerships													
			Industry Partnerships													
			Government Partnerships													
			Specialist Bioenergy Partnerships													
		Energy Access	Households using Bioenergy													
			Industry using Bioenergy													
Development	Economy	Economic Performance	Gross Domestic Product													
			Influence on Wider Sectors													
			International Trade													
			Financial Capacity to Adopt Bioenergy													
		Economic Stimulation	Increased Sustainable Energy Generation													
			Economic Support Mechanisms													
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability													
			Existing Infrastructure - Capacity													
			New Infrastructure Capacity													
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)													
			Use of Genetically Modified Materials													
			Feedstock Production Strategy													
			Land Use Productivity													
		Mobilisation	Resource Mobilisation													
			Competition for Resources													
		Distribution	Spatial Distribution of Resources													
			Resource Transportation													
	Technology	Innovation	TRL Development													
			Intellectual Property													
		Efficiencies	Processing Efficiencies													

			Supply Chain Efficiencies														
		Techno-Economics	CAPEX - Direct Fixed Capital Cost														
			CAPEX - Indirect Fixed Capital Cost														
			OPEX - Fixed Operational Costs														
			OPEX - Variable Operational Costs														
			Biomass Feedstock Costs														
			Reliance on Economic Support Measures														
	Energy Sector	**Bioenergy**	Infrastructure Alignment														
			Bio-Product Flexibility (energy)														
			Bio-Product Flexibility (non-energy)														
			Bioenergy Vector Distribution														
			Bioenergy Vector Affordability														
		Energy System Performances	Input Energy Requirements														
			Influences on Energy System Resilience														
			Accessibility to Wider Input Energy														
	Bioeconomy	**Added Value Products**	Bio-Chemicals														
			Bio-Products														
		Bioenergy Complementing Wider Sectors	Agriculture														
			Chemical														
			Waste														
			Construction														
			Transport														
			Services														
			Manufacturing														
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access														
			Location - Influencing Distribution & Connectivity														
			Use of Contaminated Lands														
			Potential for Phytoremediation														
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon														
			Soil Fertility														
			Soil Erosion														
			Accumulation of Mineral Salts														
			Drainage Impacts														
			Soil Compaction														
			Soli Influence on Productivity Yields														
		Ecosystems	Biodiversity														
			Areas of Conservation & High Biodiversity														
			Land Degradation														
			Desertification														
	Air	**PM Pollutants**	PM10s														
			PM2.5s														
		Oxide Pollutants	Sulphur Oxides														
			Nitrogen Oxides														
			Carbon Monoxide														
		Heavy Metal	Cadmium														
			Lead														
			Mercury														
	Water	**Water Use & Efficiency**	Water Withdrawn														
			Water Consumed														
			Non-renewable Water Resources														
			Renewable Water Resources														
		Water Quality	Fertilizer & Pesticide Loadings														
			Pollution from Feedstock Production														
			Pollution from Feedstock Processing														
			Pollution from Feedstock Conversion														
		Water Systems	Flooding														
			Local Water Stresses														
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations														
			Awareness														
		Standards	Fuel Standards														

			Technical Standards														
			Supply Chain of Custody Processes														
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion														
			Feedstock Sources														
			Transport														
			Processing & Pre-treatment														
		Land & Carbon Stocks	Direct Land Use Change														
			Indirect Land Use Change														
			Changes in Carbon Stocks														
		Counterfactual Considerations	Land Use Counterfactuals														
			Resource Use Counterfactuals														
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels														
			Substitution of Traditional Bioenergy														

BSIM Links to SDG 2

Categories	Themes	Indicators	Issues	SDG 2														
				2.1.1	2.1.2	2.2.1	2.2.2	2.2.3	2.3.1	2.3.2	2.4.1	2.5.1	2.5.2	2.a.1	2.a.2	2.b.1	2.c.1
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden														
			Exposure to Occupational Health & Safety Hazards														
		Food Systems	Food Commodity Supply	✓													✓
			Food Commodity Imports & Exports														✓
			Climate Change Resilience								✓						
			Changes in Costs of Agricultural Products								✓						
			Food Prices														✓
			Food Security	✓													
	Livelihoods	Land Management	Land Ownership														
			Land Access														
		Decent Work	Rights														
			Child Labour														
			Slave Labour														
			International Labour Standards														
		Jobs & Skills	Skilled Jobs														
			Unskilled Jobs														
			Permanent Jobs														
			Temporary Jobs														
			Regional Job Distribution														
			Career Development														
		Change in income	Income from Bioenergy														
			Net Income from Bioenergy														
	Society	Equality	Diversity through Supply Chain Participation														
			Diversity & End Use														
		Peace, Justice & Strong Institutions	Legality														
			Monitoring														
			Bribery & Conflicts of Business														
		Partnerships	Community Partnerships														
			Industry Partnerships														
			Government Partnerships														
			Specialist Bioenergy Partnerships														
		Energy Access	Households using Bioenergy														
			Industry using Bioenergy														
Development	Economy	Economic Performance	Gross Domestic Product														
			Influence on Wider Sectors														
			International Trade														
			Financial Capacity to Adopt Bioenergy														
		Economic Stimulation	Increased Sustainable Energy Generation														
			Economic Support Mechanisms														
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability														
			Existing Infrastructure - Capacity														
			New Infrastructure Capacity														
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)														
			Use of Genetically Modified Materials														
			Feedstock Production Strategy														
			Land Use Productivity						✓	✓	✓						
		Mobilisation	Resource Mobilisation														
			Competition for Resources														
		Distribution	Spatial Distribution of Resources														
			Resource Transportation														
	Technology	Innovation	TRL Development														
			Intellectual Property														
		Efficiencies	Processing Efficiencies														

			Supply Chain Efficiencies															
		Techno-Economics	CAPEX - Direct Fixed Capital Cost															
			CAPEX - Indirect Fixed Capital Cost															
			OPEX - Fixed Operational Costs															
			OPEX - Variable Operational Costs															
			Biomass Feedstock Costs															
			Reliance on Economic Support Measures															
	Energy Sector	**Bioenergy**	Infrastructure Alignment															
			Bio-Product Flexibility (energy)															
			Bio-Product Flexibility (non-energy)															
			Bioenergy Vector Distribution															
			Bioenergy Vector Affordability															
		Energy System Performances	Input Energy Requirements															
			Influences on Energy System Resilience															
			Accessibility to Wider Input Energy															
	Bioeconomy	**Added Value Products**	Bio-Chemicals															
			Bio-Products															
		Bioenergy Complementing Wider Sectors	Agriculture								✓							
			Chemical															
			Waste															
			Construction															
			Transport															
			Services															
			Manufacturing															
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access															
			Location - Influencing Distribution & Connectivity															
			Use of Contaminated Lands															
			Potential for Phytoremediation															
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon															
			Soil Fertility															
			Soil Erosion															
			Accumulation of Mineral Salts															
			Drainage Impacts															
			Soil Compaction								✓							
			Soli Influence on Productivity Yields								✓							
		Ecosystems	Biodiversity															
			Areas of Conservation & High Biodiversity															
			Land Degradation															
			Desertification															
	Air	**PM Pollutants**	PM10s															
			PM2.5s															
		Oxide Pollutants	Sulphur Oxides															
			Nitrogen Oxides															
			Carbon Monoxide															
		Heavy Metal	Cadmium															
			Lead															
			Mercury															
	Water	**Water Use & Efficiency**	Water Withdrawn															
			Water Consumed															
			Non-renewable Water Resources															
			Renewable Water Resources															
		Water Quality	Fertilizer & Pesticide Loadings															
			Pollution from Feedstock Production															
			Pollution from Feedstock Processing															
			Pollution from Feedstock Conversion															
		Water Systems	Flooding															
			Local Water Stresses															
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations															
			Awareness															
		Standards	Fuel Standards															

			Technical Standards															
			Supply Chain of Custody Processes															
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion															
			Feedstock Sources															
			Transport															
			Processing & Pre-treatment															
		Land & Carbon Stocks	Direct Land Use Change															
			Indirect Land Use Change															
			Changes in Carbon Stocks															
		Counterfactual Considerations	Land Use Counterfactuals															
			Resource Use Counterfactuals															
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels															
			Substitution of Traditional Bioenergy															

BSIM Links to SDG 3

Categories	Themes	Indicators	Issues	SDG 3																														
				3.1.1	3.1.2	3.2.1	3.2.2	3.3.1	3.3.2	3.3.3	3.3.4	3.3.5	3.4.1	3.4.2	3.5.1	3.5.2	3.6.1	3.7.1	3.7.2	3.8.1	3.8.2	3.9.1	3.9.2	3.9.3	3.a.1	3.b.1	3.b.2	3.b.3	3.c.1	3.d.1	3.d.2
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden																			✓	✓	✓							
			Exposure to Occupational Health & Safety Hazards																			✓	✓	✓							
		Food Systems	Food Commodity Supply																												
			Food Commodity Imports & Exports																												
			Climate Change Resilience																												
			Changes in Costs of Agricultural Products																												
			Food Prices																												
			Food Security																												
	Livelihoods	Land Management	Land Ownership																												
			Land Access																												
		Decent Work	Rights																												
			Child Labour																												
			Slave Labour																												
			International Labour Standards																												
		Jobs & Skills	Skilled Jobs																												
			Unskilled Jobs																												
			Permanent Jobs																												
			Temporary Jobs																												
			Regional Job Distribution																												
			Career Development																												
		Change in income	Income from Bioenergy																												
			Net Income from Bioenergy																												
	Society	Equality	Diversity through Supply Chain Participation																												
			Diversity & End Use																												
		Peace, Justice & Strong Institutions	Legality																												
			Monitoring																												
			Bribery & Conflicts of Business																												
		Partnerships	Community Partnerships																												
			Industry Partnerships																												
			Government Partnerships																												
			Specialist Bioenergy Partnerships																												
		Energy Access	Households using Bioenergy																												
			Industry using Bioenergy																												
Development	Economy	Economic Performance	Gross Domestic Product																												
			Influence on Wider Sectors																												
			International Trade																												
			Financial Capacity to Adopt Bioenergy																												
		Economic Stimulation	Increased Sustainable Energy Generation																												
			Economic Support Mechanisms																												
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability																												
			Existing Infrastructure - Capacity																												
			New Infrastructure Capacity																												
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)																												
			Use of Genetically Modified Materials																												
			Feedstock Production Strategy																												
			Land Use Productivity																												
		Mobilisation	Resource Mobilisation																												
			Competition for Resources																												
		Distribution	Spatial Distribution of Resources																												
			Resource Transportation																												
	Technology	Innovation	TRL Development																												
			Intellectual Property																												
		Efficiencies	Processing Efficiencies																												

			Supply Chain Efficiencies																																				
		Techno-Economics	CAPEX - Direct Fixed Capital Cost																																				
			CAPEX - Indirect Fixed Capital Cost																																				
			OPEX - Fixed Operational Costs																																				
			OPEX - Variable Operational Costs																																				
			Biomass Feedstock Costs																																				
			Reliance on Economic Support Measures																																				
	Energy Sector	**Bioenergy**	Infrastructure Alignment																																				
			Bio-Product Flexibility (energy)																																				
			Bio-Product Flexibility (non-energy)																																				
			Bioenergy Vector Distribution																																				
			Bioenergy Vector Affordability																																				
		Energy System Performances	Input Energy Requirements																																				
			Influences on Energy System Resilience																																				
			Accessibility to Wider Input Energy																																				
	Bioeconomy	**Added Value Products**	Bio-Chemicals																																				
			Bio-Products																																				
		Bioenergy Complementing Wider Sectors	Agriculture																																				
			Chemical																																				
			Waste																																				
			Construction																																				
			Transport																																				
			Services																																				
			Manufacturing																																				
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access																																				
			Location - Influencing Distribution & Connectivity																																				
			Use of Contaminated Lands																																				
			Potential for Phytoremediation																																				
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon																																				
			Soil Fertility																																				
			Soil Erosion																																				
			Accumulation of Mineral Salts																																				
			Drainage Impacts																																				
			Soil Compaction																																				
			Soli Influence on Productivity Yields																																				
		Ecosystems	Biodiversity																																				
			Areas of Conservation & High Biodiversity																																				
			Land Degradation																																				
			Desertification																																				
	Air	**PM Pollutants**	PM10s																				✓		✓												
			PM2.5s																				✓		✓												
		Oxide Pollutants	Sulphur Oxides																				✓		✓												
			Nitrogen Oxides																				✓		✓												
			Carbon Monoxide																				✓		✓												
		Heavy Metal	Cadmium																					✓	✓												
			Lead																					✓	✓												
			Mercury																					✓	✓												
	Water	**Water Use & Efficiency**	Water Withdrawn																																				
			Water Consumed																																				
			Non-renewable Water Resources																																				
			Renewable Water Resources																																				
		Water Quality	Fertilizer & Pesticide Loadings																					✓	✓												
			Pollution from Feedstock Production																					✓	✓												
			Pollution from Feedstock Processing																					✓	✓												
			Pollution from Feedstock Conversion																					✓	✓												
		Water Systems	Flooding																																				
			Local Water Stresses																																				
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations																																				
			Awareness																																				
		Standards	Fuel Standards																																				

			Technical Standards																												
			Supply Chain of Custody Processes																												
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion																												
			Feedstock Sources																												
			Transport																												
			Processing & Pre-treatment																												
		Land & Carbon Stocks	Direct Land Use Change																												
			Indirect Land Use Change																												
			Changes in Carbon Stocks																												
		Counterfactual Considerations	Land Use Counterfactuals																												
			Resource Use Counterfactuals																												
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels																												
			Substitution of Traditional Bioenergy																												

BSIM Links to SDG 4

Categories	Themes	Indicators	Issues	SDG 4												
				4.1.1	4.1.2	4.2.1	4.2.2	4.3.1	4.4.1	4.5.1	4.6.1	4.7.1	4.a.1	4.b.1	4.c.1
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden												
			Exposure to Occupational Health & Safety Hazards												
		Food Systems	Food Commodity Supply												
			Food Commodity Imports & Exports												
			Climate Change Resilience												
			Changes in Costs of Agricultural Products												
			Food Prices												
			Food Security												
	Livelihoods	Land Management	Land Ownership												
			Land Access												
		Decent Work	Rights												
			Child Labour												
			Slave Labour												
			International Labour Standards												
		Jobs & Skills	Skilled Jobs												
			Unskilled Jobs												
			Permanent Jobs												
			Temporary Jobs												
			Regional Job Distribution												
			Career Development												
		Change in income	Income from Bioenergy												
			Net Income from Bioenergy												
	Society	Equality	Diversity through Supply Chain Participation												
			Diversity & End Use												
		Peace, Justice & Strong Institutions	Legality												
			Monitoring												
			Bribery & Conflicts of Business												
		Partnerships	Community Partnerships									✓			
			Industry Partnerships									✓			
			Government Partnerships									✓			
			Specialist Bioenergy Partnerships									✓			
		Energy Access	Households using Bioenergy												
			Industry using Bioenergy												
Development	Economy	Economic Performance	Gross Domestic Product												
			Influence on Wider Sectors												
			International Trade												
			Financial Capacity to Adopt Bioenergy												
		Economic Stimulation	Increased Sustainable Energy Generation												
			Economic Support Mechanisms												
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability												
			Existing Infrastructure - Capacity												
			New Infrastructure Capacity												
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)												
			Use of Genetically Modified Materials												
			Feedstock Production Strategy												
			Land Use Productivity												
		Mobilisation	Resource Mobilisation												
			Competition for Resources												
		Distribution	Spatial Distribution of Resources												
			Resource Transportation												
	Technology	Innovation	TRL Development												
			Intellectual Property												
		Efficiencies	Processing Efficiencies												

			Supply Chain Efficiencies													
		Techno-Economics	CAPEX - Direct Fixed Capital Cost													
			CAPEX - Indirect Fixed Capital Cost													
			OPEX - Fixed Operational Costs													
			OPEX - Variable Operational Costs													
			Biomass Feedstock Costs													
			Reliance on Economic Support Measures													
	Energy Sector	**Bioenergy**	Infrastructure Alignment													
			Bio-Product Flexibility (energy)													
			Bio-Product Flexibility (non-energy)													
			Bioenergy Vector Distribution													
			Bioenergy Vector Affordability													
		Energy System Performances	Input Energy Requirements													
			Influences on Energy System Resilience													
			Accessibility to Wider Input Energy													
	Bioeconomy	**Added Value Products**	Bio-Chemicals													
			Bio-Products													
		Bioenergy Complementing Wider Sectors	Agriculture													
			Chemical													
			Waste													
			Construction													
			Transport													
			Services													
			Manufacturing													
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access													
			Location - Influencing Distribution & Connectivity													
			Use of Contaminated Lands													
			Potential for Phytoremediation													
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon													
			Soil Fertility													
			Soil Erosion													
			Accumulation of Mineral Salts													
			Drainage Impacts													
			Soil Compaction													
			Soli Influence on Productivity Yields													
		Ecosystems	Biodiversity													
			Areas of Conservation & High Biodiversity													
			Land Degradation													
			Desertification													
	Air	**PM Pollutants**	PM10s													
			PM2.5s													
		Oxide Pollutants	Sulphur Oxides													
			Nitrogen Oxides													
			Carbon Monoxide													
		Heavy Metal	Cadmium													
			Lead													
			Mercury													
	Water	**Water Use & Efficiency**	Water Withdrawn													
			Water Consumed													
			Non-renewable Water Resources													
			Renewable Water Resources													
		Water Quality	Fertilizer & Pesticide Loadings													
			Pollution from Feedstock Production													
			Pollution from Feedstock Processing													
			Pollution from Feedstock Conversion													
		Water Systems	Flooding													
			Local Water Stresses													
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations													
			Awareness										✓			
		Standards	Fuel Standards													

			Technical Standards													
			Supply Chain of Custody Processes													
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion													
			Feedstock Sources													
			Transport													
			Processing & Pre-treatment													
		Land & Carbon Stocks	Direct Land Use Change													
			Indirect Land Use Change													
			Changes in Carbon Stocks													
		Counterfactual Considerations	Land Use Counterfactuals													
			Resource Use Counterfactuals													
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels													
			Substitution of Traditional Bioenergy													

BSIM Links to SDG 5

Categories	Themes	Indicators	Issues	SDG 5														
				5.1.1	5.2.1	5.2.2	5.3.1	5.3.2	5.4.1	5.5.1	5.5.2	5.6.1	5.6.2	5.a.1	5.a.2	5.b.1	5.c.1
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden											✓	✓		
			Exposure to Occupational Health & Safety Hazards														
		Food Systems	Food Commodity Supply														
			Food Commodity Imports & Exports														
			Climate Change Resilience														
			Changes in Costs of Agricultural Products														
			Food Prices														
			Food Security														
	Livelihoods	Land Management	Land Ownership											✓	✓		
			Land Access														
		Decent Work	Rights											✓	✓		
			Child Labour														
			Slave Labour														
			International Labour Standards														
		Jobs & Skills	Skilled Jobs														
			Unskilled Jobs														
			Permanent Jobs														
			Temporary Jobs														
			Regional Job Distribution														
			Career Development														
		Change in income	Income from Bioenergy														
			Net Income from Bioenergy														
	Society	Equality	Diversity through Supply Chain Participation											✓	✓		
			Diversity & End Use														
		Peace, Justice & Strong Institutions	Legality														
			Monitoring														
			Bribery & Conflicts of Business														
		Partnerships	Community Partnerships														
			Industry Partnerships														
			Government Partnerships														
			Specialist Bioenergy Partnerships														
		Energy Access	Households using Bioenergy														
			Industry using Bioenergy														
Development	Economy	Economic Performance	Gross Domestic Product														
			Influence on Wider Sectors														
			International Trade														
			Financial Capacity to Adopt Bioenergy														
		Economic Stimulation	Increased Sustainable Energy Generation														
			Economic Support Mechanisms														
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability														
			Existing Infrastructure - Capacity														
			New Infrastructure Capacity														
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)														
			Use of Genetically Modified Materials														
			Feedstock Production Strategy														
			Land Use Productivity														
		Mobilisation	Resource Mobilisation														
			Competition for Resources														
		Distribution	Spatial Distribution of Resources														
			Resource Transportation														
	Technology	Innovation	TRL Development														
			Intellectual Property														
		Efficiencies	Processing Efficiencies														

			Supply Chain Efficiencies															
		Techno-Economics	CAPEX - Direct Fixed Capital Cost															
			CAPEX - Indirect Fixed Capital Cost															
			OPEX - Fixed Operational Costs															
			OPEX - Variable Operational Costs															
			Biomass Feedstock Costs															
			Reliance on Economic Support Measures															
	Energy Sector	**Bioenergy**	Infrastructure Alignment															
			Bio-Product Flexibility (energy)															
			Bio-Product Flexibility (non-energy)															
			Bioenergy Vector Distribution															
			Bioenergy Vector Affordability															
		Energy System Performances	Input Energy Requirements															
			Influences on Energy System Resilience															
			Accessibility to Wider Input Energy															
	Bioeconomy	**Added Value Products**	Bio-Chemicals															
			Bio-Products															
		Bioenergy Complementing Wider Sectors	Agriculture															
			Chemical															
			Waste															
			Construction															
			Transport															
			Services															
			Manufacturing															
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access															
			Location - Influencing Distribution & Connectivity															
			Use of Contaminated Lands															
			Potential for Phytoremediation															
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon															
			Soil Fertility															
			Soil Erosion															
			Accumulation of Mineral Salts															
			Drainage Impacts															
			Soil Compaction															
			Soli Influence on Productivity Yields															
		Ecosystems	Biodiversity															
			Areas of Conservation & High Biodiversity															
			Land Degradation															
			Desertification															
	Air	**PM Pollutants**	PM10s															
			PM2.5s															
		Oxide Pollutants	Sulphur Oxides															
			Nitrogen Oxides															
			Carbon Monoxide															
		Heavy Metal	Cadmium															
			Lead															
			Mercury															
	Water	**Water Use & Efficiency**	Water Withdrawn															
			Water Consumed															
			Non-renewable Water Resources															
			Renewable Water Resources															
		Water Quality	Fertilizer & Pesticide Loadings															
			Pollution from Feedstock Production															
			Pollution from Feedstock Processing															
			Pollution from Feedstock Conversion															
		Water Systems	Flooding															
			Local Water Stresses															
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations															
			Awareness															
		Standards	Fuel Standards															

			Technical Standards															
			Supply Chain of Custody Processes															
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion															
			Feedstock Sources															
			Transport															
			Processing & Pre-treatment															
		Land & Carbon Stocks	Direct Land Use Change															
			Indirect Land Use Change															
			Changes in Carbon Stocks															
		Counterfactual Considerations	Land Use Counterfactuals															
			Resource Use Counterfactuals															
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels															
			Substitution of Traditional Bioenergy															

BSIM Links to SDG 6

Categories	Themes	Indicators	Issues	SDG 6										
				6.1.1	6.2.1	6.3.1	6.3.2	6.4.1	6.4.2	6.5.1	6.5.2	6.6.1	6.a.1	6.b.1
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden				✓	✓	✓	✓				
			Exposure to Occupational Health & Safety Hazards											
		Food Systems	Food Commodity Supply											
			Food Commodity Imports & Exports											
			Climate Change Resilience											
			Changes in Costs of Agricultural Products											
			Food Prices											
			Food Security											
	Livelihoods	Land Management	Land Ownership											
			Land Access											
		Decent Work	Rights											
			Child Labour											
			Slave Labour											
			International Labour Standards											
		Jobs & Skills	Skilled Jobs											
			Unskilled Jobs											
			Permanent Jobs											
			Temporary Jobs											
			Regional Job Distribution											
			Career Development											
		Change in income	Income from Bioenergy											
			Net Income from Bioenergy											
	Society	Equality	Diversity through Supply Chain Participation											
			Diversity & End Use											
		Peace, Justice & Strong Institutions	Legality											
			Monitoring											
			Bribery & Conflicts of Business											
		Partnerships	Community Partnerships											
			Industry Partnerships											
			Government Partnerships											
			Specialist Bioenergy Partnerships											
		Energy Access	Households using Bioenergy											
			Industry using Bioenergy											
Development	Economy	Economic Performance	Gross Domestic Product											
			Influence on Wider Sectors											
			International Trade											
			Financial Capacity to Adopt Bioenergy											
		Economic Stimulation	Increased Sustainable Energy Generation											
			Economic Support Mechanisms											
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability											
			Existing Infrastructure - Capacity											
			New Infrastructure Capacity											
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)											
			Use of Genetically Modified Materials											
			Feedstock Production Strategy											
			Land Use Productivity											
		Mobilisation	Resource Mobilisation											
			Competition for Resources											
		Distribution	Spatial Distribution of Resources											
			Resource Transportation											
	Technology	Innovation	TRL Development											
			Intellectual Property											
		Efficiencies	Processing Efficiencies											

			Supply Chain Efficiencies												
		Techno-Economics	CAPEX - Direct Fixed Capital Cost												
			CAPEX - Indirect Fixed Capital Cost												
			OPEX - Fixed Operational Costs												
			OPEX - Variable Operational Costs												
			Biomass Feedstock Costs												
			Reliance on Economic Support Measures												
	Energy Sector	**Bioenergy**	Infrastructure Alignment												
			Bio-Product Flexibility (energy)												
			Bio-Product Flexibility (non-energy)												
			Bioenergy Vector Distribution												
			Bioenergy Vector Affordability												
		Energy System Performances	Input Energy Requirements												
			Influences on Energy System Resilience												
			Accessibility to Wider Input Energy												
	Bioeconomy	**Added Value Products**	Bio-Chemicals												
			Bio-Products												
		Bioenergy Complementing Wider Sectors	Agriculture												
			Chemical												
			Waste												
			Construction												
			Transport												
			Services												
			Manufacturing												
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access												
			Location - Influencing Distribution & Connectivity												
			Use of Contaminated Lands												
			Potential for Phytoremediation												
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon												
			Soil Fertility												
			Soil Erosion												
			Accumulation of Mineral Salts												
			Drainage Impacts												
			Soil Compaction												
			Soli Influence on Productivity Yields												
		Ecosystems	Biodiversity												
			Areas of Conservation & High Biodiversity												
			Land Degradation												
			Desertification												
	Air	**PM Pollutants**	PM10s												
			PM2.5s												
		Oxide Pollutants	Sulphur Oxides												
			Nitrogen Oxides												
			Carbon Monoxide												
		Heavy Metal	Cadmium												
			Lead												
			Mercury												
	Water	**Water Use & Efficiency**	Water Withdrawn					✓	✓	✓					
			Water Consumed					✓	✓	✓					
			Non-renewable Water Resources					✓	✓	✓					
			Renewable Water Resources					✓	✓	✓					
		Water Quality	Fertilizer & Pesticide Loadings				✓								
			Pollution from Feedstock Production				✓								
			Pollution from Feedstock Processing				✓								
			Pollution from Feedstock Conversion				✓								
		Water Systems	Flooding							✓					
			Local Water Stresses						✓	✓					
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations												
			Awareness												
		Standards	Fuel Standards												

			Technical Standards											
			Supply Chain of Custody Processes											
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion											
			Feedstock Sources											
			Transport											
			Processing & Pre-treatment											
		Land & Carbon Stocks	Direct Land Use Change											
			Indirect Land Use Change											
			Changes in Carbon Stocks											
		Counterfactual Considerations	Land Use Counterfactuals											
			Resource Use Counterfactuals											
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels											
			Substitution of Traditional Bioenergy											

BSIM Links to SDG 7

Categories	Themes	Indicators	Issues	SDG 7					
				7.1.1	7.1.2	7.2.1	7.3.1	7.a.1	7.b.1
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden						
			Exposure to Occupational Health & Safety Hazards						
		Food Systems	Food Commodity Supply						
			Food Commodity Imports & Exports						
			Climate Change Resilience						
			Changes in Costs of Agricultural Products						
			Food Prices						
			Food Security						
	Livelihoods	Land Management	Land Ownership						
			Land Access						
		Decent Work	Rights						
			Child Labour						
			Slave Labour						
			International Labour Standards						
		Jobs & Skills	Skilled Jobs						
			Unskilled Jobs						
			Permanent Jobs						
			Temporary Jobs						
			Regional Job Distribution						
			Career Development						
		Change in income	Income from Bioenergy						
			Net Income from Bioenergy						
	Society	Equality	Diversity through Supply Chain Participation						
			Diversity & End Use						
		Peace, Justice & Strong Institutions	Legality						
			Monitoring						
			Bribery & Conflicts of Business						
		Partnerships	Community Partnerships						
			Industry Partnerships						
			Government Partnerships						
			Specialist Bioenergy Partnerships						
		Energy Access	Households using Bioenergy	✓	✓	✓	✓		✓
			Industry using Bioenergy	✓	✓	✓	✓		✓
Development	Economy	Economic Performance	Gross Domestic Product				✓	✓	
			Influence on Wider Sectors				✓	✓	
			International Trade					✓	
			Financial Capacity to Adopt Bioenergy					✓	✓
		Economic Stimulation	Increased Sustainable Energy Generation	✓	✓	✓	✓		✓
			Economic Support Mechanisms					✓	✓
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability						
			Existing Infrastructure - Capacity						
			New Infrastructure Capacity						
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)						
			Use of Genetically Modified Materials						
			Feedstock Production Strategy						
			Land Use Productivity						
		Mobilisation	Resource Mobilisation						
			Competition for Resources						
		Distribution	Spatial Distribution of Resources						
			Resource Transportation						
	Technology	Innovation	TRL Development						
			Intellectual Property						
		Efficiencies	Processing Efficiencies						

			Supply Chain Efficiencies						
		Techno-Economics	CAPEX - Direct Fixed Capital Cost	✓	✓				
			CAPEX - Indirect Fixed Capital Cost	✓	✓				
			OPEX - Fixed Operational Costs	✓	✓				
			OPEX - Variable Operational Costs	✓	✓				
			Biomass Feedstock Costs	✓	✓				
			Reliance on Economic Support Measures	✓	✓				✓
	Energy Sector	**Bioenergy**	Infrastructure Alignment						
			Bio-Product Flexibility (energy)	✓	✓	✓			
			Bio-Product Flexibility (non-energy)			✓			
			Bioenergy Vector Distribution	✓	✓	✓		✓	
			Bioenergy Vector Affordability	✓	✓	✓		✓	
		Energy System Performances	Input Energy Requirements						
			Influences on Energy System Resilience			✓			
			Accessibility to Wider Input Energy						✓
	Bioeconomy	**Added Value Products**	Bio-Chemicals						
			Bio-Products						
		Bioenergy Complementing Wider Sectors	Agriculture						
			Chemical						
			Waste						
			Construction						
			Transport						
			Services						
			Manufacturing						
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access						
			Location - Influencing Distribution & Connectivity						
			Use of Contaminated Lands						
			Potential for Phytoremediation						
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon						
			Soil Fertility						
			Soil Erosion						
			Accumulation of Mineral Salts						
			Drainage Impacts						
			Soil Compaction						
			Soli Influence on Productivity Yields						
		Ecosystems	Biodiversity						
			Areas of Conservation & High Biodiversity						
			Land Degradation						
			Desertification						
	Air	**PM Pollutants**	PM10s						
			PM2.5s						
		Oxide Pollutants	Sulphur Oxides						
			Nitrogen Oxides						
			Carbon Monoxide						
		Heavy Metal	Cadmium						
			Lead						
			Mercury						
	Water	**Water Use & Efficiency**	Water Withdrawn						
			Water Consumed						
			Non-renewable Water Resources						
			Renewable Water Resources						
		Water Quality	Fertilizer & Pesticide Loadings						
			Pollution from Feedstock Production						
			Pollution from Feedstock Processing						
			Pollution from Feedstock Conversion						
		Water Systems	Flooding						
			Local Water Stresses						
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations						
			Awareness						
		Standards	Fuel Standards						

			Technical Standards						
			Supply Chain of Custody Processes						
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion						
			Feedstock Sources						
			Transport						
			Processing & Pre-treatment						
		Land & Carbon Stocks	Direct Land Use Change						
			Indirect Land Use Change						
			Changes in Carbon Stocks						
		Counterfactual Considerations	Land Use Counterfactuals						
			Resource Use Counterfactuals						
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels	✓	✓	✓			
			Substitution of Traditional Bioenergy	✓	✓	✓			

BSIM Links to SDG 8

Categories	Themes	Indicators	Issues	SDG 8														
				8.1.1	8.2.1	8.3.1	8.4.1	8.4.2	8.5.1	8.5.2	8.6.1	8.7.1	8.8.1	8.8.2	8.9.1	8.10.1	8.10.2
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden										✓	✓			
			Exposure to Occupational Health & Safety Hazards										✓				
		Food Systems	Food Commodity Supply														
			Food Commodity Imports & Exports														
			Climate Change Resilience														
			Changes in Costs of Agricultural Products														
			Food Prices														
			Food Security														
	Livelihoods	Land Management	Land Ownership														
			Land Access														
		Decent Work	Rights								✓	✓	✓	✓			
			Child Labour								✓	✓	✓	✓			
			Slave Labour								✓	✓	✓	✓			
			International Labour Standards						✓	✓	✓	✓	✓	✓			
		Jobs & Skills	Skilled Jobs		✓				✓	✓	✓						
			Unskilled Jobs		✓				✓	✓	✓						
			Permanent Jobs		✓				✓	✓	✓						
			Temporary Jobs		✓	✓			✓	✓	✓						
			Regional Job Distribution			✓			✓	✓	✓						
			Career Development			✓			✓	✓	✓						
		Change in income	Income from Bioenergy	✓	✓												
			Net Income from Bioenergy	✓	✓												
	Society	Equality	Diversity through Supply Chain Participation														
			Diversity & End Use														
		Peace, Justice & Strong Institutions	Legality										✓	✓			
			Monitoring										✓	✓			
			Bribery & Conflicts of Business														
		Partnerships	Community Partnerships											✓			
			Industry Partnerships											✓			
			Government Partnerships											✓			
			Specialist Bioenergy Partnerships											✓			
		Energy Access	Households using Bioenergy														
			Industry using Bioenergy														
Development	Economy	Economic Performance	Gross Domestic Product	✓	✓				✓	✓							
			Influence on Wider Sectors	✓	✓				✓	✓							
			International Trade	✓					✓								
			Financial Capacity to Adopt Bioenergy														
		Economic Stimulation	Increased Sustainable Energy Generation														
			Economic Support Mechanisms														
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability														
			Existing Infrastructure - Capacity														
			New Infrastructure Capacity														
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)														
			Use of Genetically Modified Materials														
			Feedstock Production Strategy														
			Land Use Productivity	✓	✓		✓	✓									
		Mobilisation	Resource Mobilisation														
			Competition for Resources														
		Distribution	Spatial Distribution of Resources														
			Resource Transportation														
	Technology	Innovation	TRL Development														
			Intellectual Property														
		Efficiencies	Processing Efficiencies				✓	✓									

			Supply Chain Efficiencies				✓	✓										
		Techno-Economics	CAPEX - Direct Fixed Capital Cost															
			CAPEX - Indirect Fixed Capital Cost															
			OPEX - Fixed Operational Costs															
			OPEX - Variable Operational Costs															
			Biomass Feedstock Costs															
			Reliance on Economic Support Measures															
	Energy Sector	**Bioenergy**	Infrastructure Alignment															
			Bio-Product Flexibility (energy)															
			Bio-Product Flexibility (non-energy)															
			Bioenergy Vector Distribution															
			Bioenergy Vector Affordability															
		Energy System Performances	Input Energy Requirements															
			Influences on Energy System Resilience															
			Accessibility to Wider Input Energy															
	Bioeconomy	**Added Value Products**	Bio-Chemicals	✓	✓													
			Bio-Products	✓	✓													
		Bioenergy Complementing Wider Sectors	Agriculture	✓	✓	✓			✓	✓								
			Chemical	✓	✓	✓			✓	✓								
			Waste	✓	✓	✓			✓	✓								
			Construction	✓	✓	✓			✓	✓								
			Transport	✓	✓	✓			✓	✓								
			Services	✓	✓	✓			✓	✓								
			Manufacturing	✓	✓	✓			✓	✓								
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access															
			Location - Influencing Distribution & Connectivity															
			Use of Contaminated Lands															
			Potential for Phytoremediation															
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon															
			Soil Fertility															
			Soil Erosion															
			Accumulation of Mineral Salts															
			Drainage Impacts															
			Soil Compaction															
			Soli Influence on Productivity Yields															
		Ecosystems	Biodiversity															
			Areas of Conservation & High Biodiversity															
			Land Degradation															
			Desertification															
	Air	**PM Pollutants**	PM10s															
			PM2.5s															
		Oxide Pollutants	Sulphur Oxides															
			Nitrogen Oxides															
			Carbon Monoxide															
		Heavy Metal	Cadmium															
			Lead															
			Mercury															
	Water	**Water Use & Efficiency**	Water Withdrawn															
			Water Consumed															
			Non-renewable Water Resources															
			Renewable Water Resources															
		Water Quality	Fertilizer & Pesticide Loadings															
			Pollution from Feedstock Production															
			Pollution from Feedstock Processing															
			Pollution from Feedstock Conversion															
		Water Systems	Flooding															
			Local Water Stresses															
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations															
			Awareness															
		Standards	Fuel Standards															

			Technical Standards															
			Supply Chain of Custody Processes															
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion															
			Feedstock Sources															
			Transport															
			Processing & Pre-treatment															
		Land & Carbon Stocks	Direct Land Use Change															
			Indirect Land Use Change															
			Changes in Carbon Stocks															
		Counterfactual Considerations	Land Use Counterfactuals															
			Resource Use Counterfactuals															
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels															
			Substitution of Traditional Bioenergy															

BSIM Links to SDG 9

Categories	Themes	Indicators	Issues	SDG 9											
				9.1.1	9.1.2	9.2.1	9.2.2	9.3.1	9.3.2	9.4.1	9.5.1	9.5.2	9.a.1	9.b.1	9.c.1
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden												
			Exposure to Occupational Health & Safety Hazards												
		Food Systems	Food Commodity Supply												
			Food Commodity Imports & Exports												
			Climate Change Resilience												
			Changes in Costs of Agricultural Products												
			Food Prices												
			Food Security												
	Livelihoods	Land Management	Land Ownership												
			Land Access	✓											
		Decent Work	Rights												
			Child Labour												
			Slave Labour												
			International Labour Standards												
		Jobs & Skills	Skilled Jobs					✓							
			Unskilled Jobs					✓							
			Permanent Jobs					✓							
			Temporary Jobs					✓							
			Regional Job Distribution					✓							
			Career Development					✓			✓	✓			
		Change in income	Income from Bioenergy					✓	✓		✓	✓	✓	✓	
			Net Income from Bioenergy					✓	✓				✓	✓	
	Society	Equality	Diversity through Supply Chain Participation					✓							
			Diversity & End Use												
		Peace, Justice & Strong Institutions	Legality												
			Monitoring												
			Bribery & Conflicts of Business												
		Partnerships	Community Partnerships					✓						✓	
			Industry Partnerships					✓			✓	✓	✓	✓	
			Government Partnerships					✓			✓	✓	✓	✓	
			Specialist Bioenergy Partnerships					✓			✓	✓	✓	✓	
		Energy Access	Households using Bioenergy											✓	
			Industry using Bioenergy										✓	✓	
Development	Economy	Economic Performance	Gross Domestic Product			✓	✓	✓	✓		✓	✓	✓	✓	
			Influence on Wider Sectors			✓	✓	✓	✓		✓	✓	✓	✓	
			International Trade			✓	✓	✓					✓	✓	
			Financial Capacity to Adopt Bioenergy					✓	✓						
		Economic Stimulation	Increased Sustainable Energy Generation					✓						✓	
			Economic Support Mechanisms					✓	✓				✓		
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability	✓											
			Existing Infrastructure - Capacity	✓											
			New Infrastructure Capacity	✓											
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)			✓	✓			✓					
			Use of Genetically Modified Materials												
			Feedstock Production Strategy	✓		✓	✓			✓					
			Land Use Productivity	✓						✓					
		Mobilisation	Resource Mobilisation												
			Competition for Resources												
		Distribution	Spatial Distribution of Resources	✓											
			Resource Transportation	✓											
	Technology	Innovation	TRL Development								✓	✓			
			Intellectual Property								✓	✓			
		Efficiencies	Processing Efficiencies							✓				✓	

			Supply Chain Efficiencies						✓				✓		
		Techno-Economics	CAPEX - Direct Fixed Capital Cost					✓				✓			
			CAPEX - Indirect Fixed Capital Cost					✓				✓			
			OPEX - Fixed Operational Costs					✓				✓			
			OPEX - Variable Operational Costs					✓				✓			
			Biomass Feedstock Costs					✓				✓	✓		
			Reliance on Economic Support Measures					✓				✓			
	Energy Sector	**Bioenergy**	Infrastructure Alignment	✓		✓	✓								
			Bio-Product Flexibility (energy)			✓	✓								
			Bio-Product Flexibility (non-energy)												
			Bioenergy Vector Distribution	✓											
			Bioenergy Vector Affordability												
		Energy System Performances	Input Energy Requirements												
			Influences on Energy System Resilience												
			Accessibility to Wider Input Energy												
	Bioeconomy	**Added Value Products**	Bio-Chemicals			✓	✓	✓		✓				✓	
			Bio-Products			✓	✓	✓		✓				✓	
		Bioenergy Complementing Wider Sectors	Agriculture			✓	✓	✓		✓				✓	
			Chemical			✓	✓	✓		✓				✓	
			Waste			✓	✓	✓		✓				✓	
			Construction			✓	✓	✓		✓				✓	
			Transport			✓	✓	✓		✓				✓	
			Services			✓	✓	✓		✓				✓	
			Manufacturing			✓	✓	✓		✓				✓	
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access												
			Location - Influencing Distribution & Connectivity												
			Use of Contaminated Lands												
			Potential for Phytoremediation											✓	
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon												
			Soil Fertility												
			Soil Erosion												
			Accumulation of Mineral Salts												
			Drainage Impacts												
			Soil Compaction												
			Soli Influence on Productivity Yields												
		Ecosystems	Biodiversity												
			Areas of Conservation & High Biodiversity												
			Land Degradation												
			Desertification												
	Air	**PM Pollutants**	PM10s												
			PM2.5s												
		Oxide Pollutants	Sulphur Oxides												
			Nitrogen Oxides												
			Carbon Monoxide												
		Heavy Metal	Cadmium												
			Lead												
			Mercury												
	Water	**Water Use & Efficiency**	Water Withdrawn												
			Water Consumed												
			Non-renewable Water Resources												
			Renewable Water Resources												
		Water Quality	Fertilizer & Pesticide Loadings												
			Pollution from Feedstock Production												
			Pollution from Feedstock Processing												
			Pollution from Feedstock Conversion												
		Water Systems	Flooding												
			Local Water Stresses												
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations												
			Awareness												
		Standards	Fuel Standards												

			Technical Standards													
			Supply Chain of Custody Processes													
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion						✓							
			Feedstock Sources						✓							
			Transport						✓							
			Processing & Pre-treatment						✓							
		Land & Carbon Stocks	Direct Land Use Change						✓							
			Indirect Land Use Change						✓							
			Changes in Carbon Stocks						✓							
		Counterfactual Considerations	Land Use Counterfactuals						✓					✓		
			Resource Use Counterfactuals						✓					✓		
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels						✓					✓		
			Substitution of Traditional Bioenergy						✓					✓		

BSIM Links to SDG 10

Categories	Themes	Indicators	Issues	SDG 10												
				10.1.1	10.2.1	10.3.1	10.4.1	10.4.2	10.6.1	10.7.1	10.7.2	10.7.3	10.7.4	10.a.1	10.b.1	10.c.1
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden													
			Exposure to Occupational Health & Safety Hazards													
		Food Systems	Food Commodity Supply													
			Food Commodity Imports & Exports													
			Climate Change Resilience													
			Changes in Costs of Agricultural Products													
			Food Prices	✓												
			Food Security													
	Livelihoods	Land Management	Land Ownership													
			Land Access													
		Decent Work	Rights													
			Child Labour													
			Slave Labour													
			International Labour Standards													
		Jobs & Skills	Skilled Jobs													
			Unskilled Jobs													
			Permanent Jobs													
			Temporary Jobs													
			Regional Job Distribution					✓								
			Career Development													
		Change in income	Income from Bioenergy													
			Net Income from Bioenergy													
	Society	Equality	Diversity through Supply Chain Participation													
			Diversity & End Use													
		Peace, Justice & Strong Institutions	Legality													
			Monitoring													
			Bribery & Conflicts of Business													
		Partnerships	Community Partnerships													
			Industry Partnerships													
			Government Partnerships													
			Specialist Bioenergy Partnerships													
		Energy Access	Households using Bioenergy													
			Industry using Bioenergy													
Development	Economy	Economic Performance	Gross Domestic Product													
			Influence on Wider Sectors													
			International Trade											✓	✓	
			Financial Capacity to Adopt Bioenergy													
		Economic Stimulation	Increased Sustainable Energy Generation													
			Economic Support Mechanisms													
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability													
			Existing Infrastructure - Capacity													
			New Infrastructure Capacity													
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)													
			Use of Genetically Modified Materials													
			Feedstock Production Strategy													
			Land Use Productivity													
		Mobilisation	Resource Mobilisation													
			Competition for Resources													
		Distribution	Spatial Distribution of Resources													
			Resource Transportation													
	Technology	Innovation	TRL Development													
			Intellectual Property													
		Efficiencies	Processing Efficiencies													

			Supply Chain Efficiencies														
		Techno-Economics	CAPEX - Direct Fixed Capital Cost														
			CAPEX - Indirect Fixed Capital Cost														
			OPEX - Fixed Operational Costs														
			OPEX - Variable Operational Costs														
			Biomass Feedstock Costs														
			Reliance on Economic Support Measures														
	Energy Sector	**Bioenergy**	Infrastructure Alignment														
			Bio-Product Flexibility (energy)														
			Bio-Product Flexibility (non-energy)														
			Bioenergy Vector Distribution														
			Bioenergy Vector Affordability														
		Energy System Performances	Input Energy Requirements														
			Influences on Energy System Resilience														
			Accessibility to Wider Input Energy														
	Bioeconomy	**Added Value Products**	Bio-Chemicals														
			Bio-Products														
		Bioenergy Complementing Wider Sectors	Agriculture														
			Chemical														
			Waste														
			Construction														
			Transport														
			Services														
			Manufacturing														
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access														
			Location - Influencing Distribution & Connectivity														
			Use of Contaminated Lands														
			Potential for Phytoremediation														
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon														
			Soil Fertility														
			Soil Erosion														
			Accumulation of Mineral Salts														
			Drainage Impacts														
			Soil Compaction														
			Soli Influence on Productivity Yields														
		Ecosystems	Biodiversity														
			Areas of Conservation & High Biodiversity														
			Land Degradation														
			Desertification														
	Air	**PM Pollutants**	PM10s														
			PM2.5s														
		Oxide Pollutants	Sulphur Oxides														
			Nitrogen Oxides														
			Carbon Monoxide														
		Heavy Metal	Cadmium														
			Lead														
			Mercury														
	Water	**Water Use & Efficiency**	Water Withdrawn														
			Water Consumed														
			Non-renewable Water Resources														
			Renewable Water Resources														
		Water Quality	Fertilizer & Pesticide Loadings														
			Pollution from Feedstock Production														
			Pollution from Feedstock Processing														
			Pollution from Feedstock Conversion														
		Water Systems	Flooding														
			Local Water Stresses														
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations														
			Awareness														
		Standards	Fuel Standards														

			Technical Standards														
			Supply Chain of Custody Processes														
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion														
			Feedstock Sources														
			Transport														
			Processing & Pre-treatment														
		Land & Carbon Stocks	Direct Land Use Change														
			Indirect Land Use Change														
			Changes in Carbon Stocks														
		Counterfactual Considerations	Land Use Counterfactuals														
			Resource Use Counterfactuals														
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels														
			Substitution of Traditional Bioenergy														

BSIM Links to SDG 11

Categories	Themes	Indicators	Issues	SDG 11															
				11.1.1	11.2.1	11.3.1	11.3.2	11.4.1	11.5.1	11.5.2	11.6.1	11.6.2	11.7.1	11.7.2	11.a.1	11.b.1	11.b.2	11.c.1
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden															
			Exposure to Occupational Health & Safety Hazards									✓						
		Food Systems	Food Commodity Supply															
			Food Commodity Imports & Exports															
			Climate Change Resilience															
			Changes in Costs of Agricultural Products															
			Food Prices															
			Food Security															
	Livelihoods	Land Management	Land Ownership			✓												
			Land Access			✓												
		Decent Work	Rights															
			Child Labour															
			Slave Labour															
			International Labour Standards															
		Jobs & Skills	Skilled Jobs															
			Unskilled Jobs															
			Permanent Jobs															
			Temporary Jobs															
			Regional Job Distribution															
			Career Development															
		Change in income	Income from Bioenergy															
			Net Income from Bioenergy															
	Society	Equality	Diversity through Supply Chain Participation		✓													
			Diversity & End Use		✓													
		Peace, Justice & Strong Institutions	Legality															
			Monitoring															
			Bribery & Conflicts of Business															
		Partnerships	Community Partnerships			✓					✓							
			Industry Partnerships			✓					✓							
			Government Partnerships			✓					✓							
			Specialist Bioenergy Partnerships			✓					✓							
		Energy Access	Households using Bioenergy															
			Industry using Bioenergy															
Development	Economy	Economic Performance	Gross Domestic Product															
			Influence on Wider Sectors															
			International Trade															
			Financial Capacity to Adopt Bioenergy															
		Economic Stimulation	Increased Sustainable Energy Generation															
			Economic Support Mechanisms															
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability		✓						✓							
			Existing Infrastructure - Capacity		✓						✓							
			New Infrastructure Capacity		✓						✓							
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)															
			Use of Genetically Modified Materials															
			Feedstock Production Strategy			✓												
			Land Use Productivity			✓												
		Mobilisation	Resource Mobilisation								✓							
			Competition for Resources								✓							
		Distribution	Spatial Distribution of Resources								✓							
			Resource Transportation								✓							
	Technology	Innovation	TRL Development															
			Intellectual Property															
		Efficiencies	Processing Efficiencies								✓							

			Supply Chain Efficiencies								✓								
		Techno-Economics	CAPEX - Direct Fixed Capital Cost																
			CAPEX - Indirect Fixed Capital Cost																
			OPEX - Fixed Operational Costs																
			OPEX - Variable Operational Costs																
			Biomass Feedstock Costs																
			Reliance on Economic Support Measures																
	Energy Sector	**Bioenergy**	Infrastructure Alignment								✓								
			Bio-Product Flexibility (energy)																
			Bio-Product Flexibility (non-energy)																
			Bioenergy Vector Distribution																
			Bioenergy Vector Affordability																
		Energy System Performances	Input Energy Requirements																
			Influences on Energy System Resilience																
			Accessibility to Wider Input Energy																
	Bioeconomy	**Added Value Products**	Bio-Chemicals																
			Bio-Products																
		Bioenergy Complementing Wider Sectors	Agriculture																
			Chemical																
			Waste								✓								
			Construction								✓								
			Transport																
			Services																
			Manufacturing																
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access			✓													
			Location - Influencing Distribution & Connectivity			✓					✓								
			Use of Contaminated Lands			✓													
			Potential for Phytoremediation			✓													
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon																
			Soil Fertility																
			Soil Erosion																
			Accumulation of Mineral Salts																
			Drainage Impacts																
			Soil Compaction																
			Soli Influence on Productivity Yields																
		Ecosystems	Biodiversity																
			Areas of Conservation & High Biodiversity																
			Land Degradation																
			Desertification																
	Air	**PM Pollutants**	PM10s									✓							
			PM2.5s									✓							
		Oxide Pollutants	Sulphur Oxides																
			Nitrogen Oxides																
			Carbon Monoxide																
		Heavy Metal	Cadmium																
			Lead																
			Mercury																
	Water	**Water Use & Efficiency**	Water Withdrawn																
			Water Consumed																
			Non-renewable Water Resources																
			Renewable Water Resources																
		Water Quality	Fertilizer & Pesticide Loadings																
			Pollution from Feedstock Production																
			Pollution from Feedstock Processing																
			Pollution from Feedstock Conversion																
		Water Systems	Flooding																
			Local Water Stresses																
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations																
			Awareness																
		Standards	Fuel Standards																

			Technical Standards																
			Supply Chain of Custody Processes																
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion																
			Feedstock Sources																
			Transport																
			Processing & Pre-treatment																
		Land & Carbon Stocks	Direct Land Use Change																
			Indirect Land Use Change																
			Changes in Carbon Stocks																
		Counterfactual Considerations	Land Use Counterfactuals																
			Resource Use Counterfactuals																
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels																
			Substitution of Traditional Bioenergy																

BSIM Links to SDG 12

Categories	Themes	Indicators	Issues	SDG 12												
				12.1.1	12.2.1	12.2.2	12.3.1	12.4.1	12.4.2	12.5.1	12.6.1	12.7.1	12.8.1	12.a.1	12.b.1	12.c.1
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden													
			Exposure to Occupational Health & Safety Hazards													
		Food Systems	Food Commodity Supply													
			Food Commodity Imports & Exports													
			Climate Change Resilience				✓									
			Changes in Costs of Agricultural Products													
			Food Prices													
			Food Security													
	Livelihoods	Land Management	Land Ownership													
			Land Access													
		Decent Work	Rights													
			Child Labour													
			Slave Labour													
			International Labour Standards													
		Jobs & Skills	Skilled Jobs													
			Unskilled Jobs													
			Permanent Jobs													
			Temporary Jobs													
			Regional Job Distribution													
			Career Development													
		Change in income	Income from Bioenergy													
			Net Income from Bioenergy													
	Society	Equality	Diversity through Supply Chain Participation													
			Diversity & End Use													
		Peace, Justice & Strong Institutions	Legality				✓			✓	✓	✓				
			Monitoring				✓			✓	✓	✓				
			Bribery & Conflicts of Business													
		Partnerships	Community Partnerships				✓			✓	✓	✓		✓		
			Industry Partnerships				✓			✓	✓	✓		✓		
			Government Partnerships				✓			✓	✓	✓		✓		
			Specialist Bioenergy Partnerships				✓			✓	✓	✓		✓		
		Energy Access	Households using Bioenergy				✓			✓				✓		
			Industry using Bioenergy				✓			✓				✓		
Development	Economy	Economic Performance	Gross Domestic Product									✓				
			Influence on Wider Sectors									✓				
			International Trade									✓				
			Financial Capacity to Adopt Bioenergy									✓				
		Economic Stimulation	Increased Sustainable Energy Generation											✓		
			Economic Support Mechanisms									✓				
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability							✓						
			Existing Infrastructure - Capacity							✓						
			New Infrastructure Capacity							✓						
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)					✓	✓							
			Use of Genetically Modified Materials					✓	✓							
			Feedstock Production Strategy		✓	✓	✓	✓	✓							
			Land Use Productivity		✓	✓	✓									
		Mobilisation	Resource Mobilisation		✓	✓	✓			✓						
			Competition for Resources		✓	✓	✓			✓						
		Distribution	Spatial Distribution of Resources							✓						
			Resource Transportation		✓	✓				✓						
	Technology	Innovation	TRL Development													
			Intellectual Property													
		Efficiencies	Processing Efficiencies		✓	✓	✓									

			Supply Chain Efficiencies		✓	✓	✓										
		Techno-Economics	CAPEX - Direct Fixed Capital Cost														
			CAPEX - Indirect Fixed Capital Cost														
			OPEX - Fixed Operational Costs														
			OPEX - Variable Operational Costs														
			Biomass Feedstock Costs														
			Reliance on Economic Support Measures														
	Energy Sector	**Bioenergy**	Infrastructure Alignment							✓							
			Bio-Product Flexibility (energy)														
			Bio-Product Flexibility (non-energy)														
			Bioenergy Vector Distribution														
			Bioenergy Vector Affordability														
		Energy System Performances	Input Energy Requirements														
			Influences on Energy System Resilience												✓		
			Accessibility to Wider Input Energy												✓		
	Bioeconomy	**Added Value Products**	Bio-Chemicals														
			Bio-Products														
		Bioenergy Complementing Wider Sectors	Agriculture		✓	✓	✓	✓	✓								
			Chemical		✓	✓		✓	✓								
			Waste		✓	✓	✓	✓	✓	✓							
			Construction		✓	✓		✓	✓								
			Transport					✓	✓								
			Services					✓	✓								
			Manufacturing		✓	✓		✓	✓								
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access														
			Location - Influencing Distribution & Connectivity														
			Use of Contaminated Lands					✓	✓								
			Potential for Phytoremediation					✓	✓								
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon														
			Soil Fertility														
			Soil Erosion														
			Accumulation of Mineral Salts														
			Drainage Impacts														
			Soil Compaction														
			Soli Influence on Productivity Yields														
		Ecosystems	Biodiversity														
			Areas of Conservation & High Biodiversity														
			Land Degradation														
			Desertification														
	Air	**PM Pollutants**	PM10s					✓	✓								
			PM2.5s					✓	✓								
		Oxide Pollutants	Sulphur Oxides					✓	✓								
			Nitrogen Oxides					✓	✓								
			Carbon Monoxide					✓	✓								
		Heavy Metal	Cadmium					✓	✓								
			Lead					✓	✓								
			Mercury					✓	✓								
	Water	**Water Use & Efficiency**	Water Withdrawn														
			Water Consumed														
			Non-renewable Water Resources														
			Renewable Water Resources														
		Water Quality	Fertilizer & Pesticide Loadings					✓	✓								
			Pollution from Feedstock Production					✓	✓								
			Pollution from Feedstock Processing					✓	✓								
			Pollution from Feedstock Conversion					✓	✓								
		Water Systems	Flooding														
			Local Water Stresses														
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations		✓	✓	✓	✓	✓	✓	✓	✓		✓			
			Awareness				✓				✓	✓					
		Standards	Fuel Standards								✓	✓					

			Technical Standards		✓	✓	✓			✓	✓	✓					
			Supply Chain of Custody Processes		✓	✓	✓			✓	✓	✓					
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion														
			Feedstock Sources														
			Transport														
			Processing & Pre-treatment														
		Land & Carbon Stocks	Direct Land Use Change		✓	✓											
			Indirect Land Use Change		✓	✓											
			Changes in Carbon Stocks		✓	✓											
		Counterfactual Considerations	Land Use Counterfactuals		✓	✓											
			Resource Use Counterfactuals		✓	✓	✓			✓							
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels											✓			
			Substitution of Traditional Bioenergy											✓			

BSIM Links to SDG 13

Categories	Themes	Indicators	Issues	SDG 13							
				13.1.1	13.1.2	13.1.3	13.2.1	13.2.2	13.3.1	13.a.1	13.b.1
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden								
			Exposure to Occupational Health & Safety Hazards								
		Food Systems	Food Commodity Supply								
			Food Commodity Imports & Exports								
			Climate Change Resilience								
			Changes in Costs of Agricultural Products								
			Food Prices								
			Food Security								
	Livelihoods	Land Management	Land Ownership								
			Land Access								
		Decent Work	Rights								
			Child Labour								
			Slave Labour								
			International Labour Standards								
		Jobs & Skills	Skilled Jobs								
			Unskilled Jobs								
			Permanent Jobs								
			Temporary Jobs								
			Regional Job Distribution								
			Career Development								
		Change in income	Income from Bioenergy							✓	
			Net Income from Bioenergy							✓	
	Society	Equality	Diversity through Supply Chain Participation								
			Diversity & End Use								
		Peace, Justice & Strong Institutions	Legality				✓				
			Monitoring				✓				
			Bribery & Conflicts of Business								
		Partnerships	Community Partnerships				✓			✓	✓
			Industry Partnerships				✓			✓	✓
			Government Partnerships				✓			✓	✓
			Specialist Bioenergy Partnerships				✓			✓	✓
		Energy Access	Households using Bioenergy					✓			
			Industry using Bioenergy					✓			
Development	Economy	Economic Performance	Gross Domestic Product							✓	✓
			Influence on Wider Sectors							✓	✓
			International Trade							✓	✓
			Financial Capacity to Adopt Bioenergy							✓	
		Economic Stimulation	Increased Sustainable Energy Generation					✓			
			Economic Support Mechanisms							✓	
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability								
			Existing Infrastructure - Capacity								
			New Infrastructure Capacity								
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)								
			Use of Genetically Modified Materials								
			Feedstock Production Strategy					✓			
			Land Use Productivity					✓			
		Mobilisation	Resource Mobilisation								
			Competition for Resources								
		Distribution	Spatial Distribution of Resources								
			Resource Transportation								
	Technology	Innovation	TRL Development							✓	
			Intellectual Property							✓	
		Efficiencies	Processing Efficiencies					✓			

			Supply Chain Efficiencies					✓				
		Techno-Economics	CAPEX - Direct Fixed Capital Cost							✓		
			CAPEX - Indirect Fixed Capital Cost							✓		
			OPEX - Fixed Operational Costs							✓		
			OPEX - Variable Operational Costs							✓		
			Biomass Feedstock Costs							✓		
			Reliance on Economic Support Measures							✓		
	Energy Sector	**Bioenergy**	Infrastructure Alignment									
			Bio-Product Flexibility (energy)					✓				
			Bio-Product Flexibility (non-energy)					✓				
			Bioenergy Vector Distribution									
			Bioenergy Vector Affordability							✓		
		Energy System Performances	Input Energy Requirements					✓				
			Influences on Energy System Resilience					✓				
			Accessibility to Wider Input Energy					✓				
	Bioeconomy	**Added Value Products**	Bio-Chemicals					✓				
			Bio-Products					✓				
		Bioenergy Complementing Wider Sectors	Agriculture					✓				
			Chemical					✓				
			Waste					✓				
			Construction					✓				
			Transport					✓				
			Services					✓				
			Manufacturing					✓				
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access									
			Location - Influencing Distribution & Connectivity									
			Use of Contaminated Lands									
			Potential for Phytoremediation									
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon					✓				
			Soil Fertility					✓				
			Soil Erosion					✓				
			Accumulation of Mineral Salts					✓				
			Drainage Impacts					✓				
			Soil Compaction					✓				
			Soli Influence on Productivity Yields					✓				
		Ecosystems	Biodiversity									
			Areas of Conservation & High Biodiversity									
			Land Degradation					✓				
			Desertification					✓				
	Air	**PM Pollutants**	PM10s									
			PM2.5s									
		Oxide Pollutants	Sulphur Oxides									
			Nitrogen Oxides									
			Carbon Monoxide									
		Heavy Metal	Cadmium									
			Lead									
			Mercury									
	Water	**Water Use & Efficiency**	Water Withdrawn									
			Water Consumed									
			Non-renewable Water Resources									
			Renewable Water Resources									
		Water Quality	Fertilizer & Pesticide Loadings									
			Pollution from Feedstock Production									
			Pollution from Feedstock Processing									
			Pollution from Feedstock Conversion									
		Water Systems	Flooding									
			Local Water Stresses									
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations				✓	✓		✓	✓	
			Awareness				✓	✓		✓	✓	
		Standards	Fuel Standards				✓	✓			✓	

			Technical Standards				✓	✓			✓
			Supply Chain of Custody Processes				✓	✓			✓
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion					✓			
			Feedstock Sources					✓			
			Transport					✓			
			Processing & Pre-treatment					✓			
		Land & Carbon Stocks	Direct Land Use Change					✓			
			Indirect Land Use Change					✓			
			Changes in Carbon Stocks					✓			
		Counterfactual Considerations	Land Use Counterfactuals					✓			
			Resource Use Counterfactuals					✓			
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels					✓			
			Substitution of Traditional Bioenergy					✓			

BSIM Links to SDG 14

Categories	Themes	Indicators	Issues	SDG 14									
				14.1.1	14.2.1	14.3.1	14.4.1	14.5.1	14.6.1	14.7.1	14.a.1	14.b.1	14.c.1
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden										
			Exposure to Occupational Health & Safety Hazards										
		Food Systems	Food Commodity Supply										
			Food Commodity Imports & Exports										
			Climate Change Resilience										
			Changes in Costs of Agricultural Products										
			Food Prices										
			Food Security										
	Livelihoods	Land Management	Land Ownership										
			Land Access										
		Decent Work	Rights										
			Child Labour										
			Slave Labour										
			International Labour Standards										
		Jobs & Skills	Skilled Jobs										
			Unskilled Jobs										
			Permanent Jobs										
			Temporary Jobs										
			Regional Job Distribution										
			Career Development										
		Change in income	Income from Bioenergy										
			Net Income from Bioenergy										
	Society	Equality	Diversity through Supply Chain Participation										
			Diversity & End Use										
		Peace, Justice & Strong Institutions	Legality										
			Monitoring										
			Bribery & Conflicts of Business										
		Partnerships	Community Partnerships										
			Industry Partnerships										
			Government Partnerships										
			Specialist Bioenergy Partnerships										
		Energy Access	Households using Bioenergy										
			Industry using Bioenergy										
Development	Economy	Economic Performance	Gross Domestic Product										
			Influence on Wider Sectors										
			International Trade										
			Financial Capacity to Adopt Bioenergy										
		Economic Stimulation	Increased Sustainable Energy Generation										
			Economic Support Mechanisms										
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability										
			Existing Infrastructure - Capacity										
			New Infrastructure Capacity										
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)										
			Use of Genetically Modified Materials										
			Feedstock Production Strategy										
			Land Use Productivity										
		Mobilisation	Resource Mobilisation										
			Competition for Resources										
		Distribution	Spatial Distribution of Resources										
			Resource Transportation										
	Technology	Innovation	TRL Development										
			Intellectual Property										
		Efficiencies	Processing Efficiencies										

			Supply Chain Efficiencies										
		Techno-Economics	CAPEX - Direct Fixed Capital Cost										
			CAPEX - Indirect Fixed Capital Cost										
			OPEX - Fixed Operational Costs										
			OPEX - Variable Operational Costs										
			Biomass Feedstock Costs										
			Reliance on Economic Support Measures										
	Energy Sector	**Bioenergy**	Infrastructure Alignment										
			Bio-Product Flexibility (energy)										
			Bio-Product Flexibility (non-energy)										
			Bioenergy Vector Distribution										
			Bioenergy Vector Affordability										
		Energy System Performances	Input Energy Requirements										
			Influences on Energy System Resilience										
			Accessibility to Wider Input Energy										
	Bioeconomy	**Added Value Products**	Bio-Chemicals										
			Bio-Products										
		Bioenergy Complementing Wider Sectors	Agriculture										
			Chemical										
			Waste										
			Construction										
			Transport										
			Services										
			Manufacturing										
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access										
			Location - Influencing Distribution & Connectivity										
			Use of Contaminated Lands										
			Potential for Phytoremediation										
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon										
			Soil Fertility										
			Soil Erosion										
			Accumulation of Mineral Salts										
			Drainage Impacts										
			Soil Compaction										
			Soli Influence on Productivity Yields										
		Ecosystems	Biodiversity	✓		✓							
			Areas of Conservation & High Biodiversity										
			Land Degradation										
			Desertification										
	Air	**PM Pollutants**	PM10s										
			PM2.5s										
		Oxide Pollutants	Sulphur Oxides										
			Nitrogen Oxides										
			Carbon Monoxide										
		Heavy Metal	Cadmium			✓							
			Lead			✓							
			Mercury			✓							
	Water	**Water Use & Efficiency**	Water Withdrawn			✓							
			Water Consumed			✓							
			Non-renewable Water Resources			✓							
			Renewable Water Resources			✓							
		Water Quality	Fertilizer & Pesticide Loadings	✓		✓							
			Pollution from Feedstock Production	✓		✓							
			Pollution from Feedstock Processing	✓		✓							
			Pollution from Feedstock Conversion	✓		✓							
		Water Systems	Flooding										
			Local Water Stresses										
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations										
			Awareness										
		Standards	Fuel Standards										

			Technical Standards										
			Supply Chain of Custody Processes										
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion										
			Feedstock Sources										
			Transport										
			Processing & Pre-treatment										
		Land & Carbon Stocks	Direct Land Use Change										
			Indirect Land Use Change										
			Changes in Carbon Stocks										
		Counterfactual Considerations	Land Use Counterfactuals										
			Resource Use Counterfactuals										
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels										
			Substitution of Traditional Bioenergy										

BSIM Links to SDG 15

Categories	Themes	Indicators	Issues	SDG 15														
				15.1.1	15.1.2	15.2.1	15.3.1	15.4.1	15.4.2	15.5.1	15.6.1	15.7.1	15.8.1	15.9.1	15.a.1	15.b.1	15.c.1
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden														
			Exposure to Occupational Health & Safety Hazards														
		Food Systems	Food Commodity Supply														
			Food Commodity Imports & Exports														
			Climate Change Resilience														
			Changes in Costs of Agricultural Products														
			Food Prices														
			Food Security														
	Livelihoods	Land Management	Land Ownership														
			Land Access														
		Decent Work	Rights														
			Child Labour														
			Slave Labour														
			International Labour Standards														
		Jobs & Skills	Skilled Jobs														
			Unskilled Jobs														
			Permanent Jobs														
			Temporary Jobs														
			Regional Job Distribution														
			Career Development														
		Change in income	Income from Bioenergy														
			Net Income from Bioenergy														
	Society	Equality	Diversity through Supply Chain Participation														
			Diversity & End Use														
		Peace, Justice & Strong Institutions	Legality		✓	✓	✓	✓		✓							
			Monitoring		✓	✓	✓	✓		✓							
			Bribery & Conflicts of Business														
		Partnerships	Community Partnerships	✓		✓	✓	✓		✓							
			Industry Partnerships	✓		✓	✓	✓		✓							
			Government Partnerships	✓		✓	✓	✓		✓							
			Specialist Bioenergy Partnerships	✓		✓	✓	✓		✓							
		Energy Access	Households using Bioenergy														
			Industry using Bioenergy														
Development	Economy	Economic Performance	Gross Domestic Product														
			Influence on Wider Sectors	✓		✓											
			International Trade														
			Financial Capacity to Adopt Bioenergy														
		Economic Stimulation	Increased Sustainable Energy Generation														
			Economic Support Mechanisms														
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability														
			Existing Infrastructure - Capacity														
			New Infrastructure Capacity														
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)		✓												
			Use of Genetically Modified Materials		✓												
			Feedstock Production Strategy	✓	✓	✓	✓										
			Land Use Productivity	✓		✓	✓										
		Mobilisation	Resource Mobilisation	✓			✓										
			Competition for Resources	✓													
		Distribution	Spatial Distribution of Resources	✓													
			Resource Transportation														
	Technology	Innovation	TRL Development														
			Intellectual Property														

		Efficiencies	Processing Efficiencies																
			Supply Chain Efficiencies																
		Techno-Economics	CAPEX - Direct Fixed Capital Cost																
			CAPEX - Indirect Fixed Capital Cost																
			OPEX - Fixed Operational Costs																
			OPEX - Variable Operational Costs																
			Biomass Feedstock Costs																
			Reliance on Economic Support Measures																
	Energy Sector	**Bioenergy**	Infrastructure Alignment																
			Bio-Product Flexibility (energy)																
			Bio-Product Flexibility (non-energy)																
			Bioenergy Vector Distribution																
			Bioenergy Vector Affordability																
		Energy System Performances	Input Energy Requirements																
			Influences on Energy System Resilience																
			Accessibility to Wider Input Energy																
	Bioeconomy	**Added Value Products**	Bio-Chemicals																
			Bio-Products																
		Bioenergy Complementing Wider Sectors	Agriculture	✓	✓														
			Chemical																
			Waste																
			Construction																
			Transport																
			Services																
			Manufacturing																
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access																
			Location - Influencing Distribution & Connectivity	✓															
			Use of Contaminated Lands		✓		✓												
			Potential for Phytoremediation		✓		✓												
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon		✓	✓													
			Soil Fertility		✓	✓													
			Soil Erosion	✓	✓	✓													
			Accumulation of Mineral Salts		✓	✓	✓												
			Drainage Impacts	✓	✓	✓													
			Soil Compaction		✓	✓													
			Soli Influence on Productivity Yields		✓	✓													
		Ecosystems	Biodiversity	✓	✓	✓		✓		✓									
			Areas of Conservation & High Biodiversity	✓	✓	✓		✓		✓									
			Land Degradation	✓	✓	✓		✓		✓									
			Desertification	✓	✓	✓		✓		✓									
	Air	**PM Pollutants**	PM10s																
			PM2.5s																
		Oxide Pollutants	Sulphur Oxides																
			Nitrogen Oxides																
			Carbon Monoxide																
		Heavy Metal	Cadmium				✓												
			Lead				✓												
			Mercury				✓												
	Water	**Water Use & Efficiency**	Water Withdrawn																
			Water Consumed																
			Non-renewable Water Resources		✓														
			Renewable Water Resources		✓														
		Water Quality	Fertilizer & Pesticide Loadings		✓		✓												
			Pollution from Feedstock Production		✓														
			Pollution from Feedstock Processing		✓														
			Pollution from Feedstock Conversion		✓														
		Water Systems	Flooding																
			Local Water Stresses																
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations		✓	✓	✓	✓											
			Awareness																

		Standards	Fuel Standards				✓											
			Technical Standards				✓											
			Supply Chain of Custody Processes		✓	✓	✓	✓										
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion															
			Feedstock Sources															
			Transport															
			Processing & Pre-treatment															
		Land & Carbon Stocks	Direct Land Use Change		✓	✓	✓	✓		✓								
			Indirect Land Use Change		✓	✓	✓	✓		✓								
			Changes in Carbon Stocks															
		Counterfactual Considerations	Land Use Counterfactuals	✓	✓	✓	✓	✓		✓								
			Resource Use Counterfactuals	✓	✓	✓	✓	✓		✓								
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels				✓											
			Substitution of Traditional Bioenergy	✓	✓	✓		✓		✓								

BSIM Links to SDG 16

Categories	Themes	Indicators	Issues	SDG 16																								
				16.1.1	16.1.2	16.1.3	16.1.4	16.2.1	16.2.2	16.2.3	16.3.1	16.3.2	16.3.3	16.4.1	16.4.2	16.5.1	16.5.2	16.6.1	16.6.2	16.7.1	16.7.2	16.8.1	16.9.1	16.10.	16.10.	16.a.1	16.b.1
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden																									
			Exposure to Occupational Health & Safety Hazards																									
		Food Systems	Food Commodity Supply																									
			Food Commodity Imports & Exports																									
			Climate Change Resilience																									
			Changes in Costs of Agricultural Products																									
			Food Prices																									
			Food Security																									
	Livelihoods	Land Management	Land Ownership																									
			Land Access																									
		Decent Work	Rights																									
			Child Labour																									
			Slave Labour																									
			International Labour Standards																									
		Jobs & Skills	Skilled Jobs																									
			Unskilled Jobs																									
			Permanent Jobs																									
			Temporary Jobs																									
			Regional Job Distribution																									
			Career Development																									
		Change in income	Income from Bioenergy																									
			Net Income from Bioenergy																									
	Society	Equality	Diversity through Supply Chain Participation																									
			Diversity & End Use																									
		Peace, Justice & Strong Institutions	Legality										✓			✓	✓	✓	✓									
			Monitoring										✓			✓	✓	✓	✓									
			Bribery & Conflicts of Business										✓			✓	✓	✓	✓									
		Partnerships	Community Partnerships																									
			Industry Partnerships																									
			Government Partnerships																			✓						
			Specialist Bioenergy Partnerships																									
		Energy Access	Households using Bioenergy																									
			Industry using Bioenergy																									
Development	Economy	Economic Performance	Gross Domestic Product																									
			Influence on Wider Sectors																									
			International Trade																									
			Financial Capacity to Adopt Bioenergy																									
		Economic Stimulation	Increased Sustainable Energy Generation																									
			Economic Support Mechanisms																									
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability																									
			Existing Infrastructure - Capacity																									
			New Infrastructure Capacity																									
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)																									
			Use of Genetically Modified Materials																									
			Feedstock Production Strategy																									
			Land Use Productivity																									
		Mobilisation	Resource Mobilisation																									
			Competition for Resources																									
		Distribution	Spatial Distribution of Resources																									
			Resource Transportation																									
	Technology	Innovation	TRL Development																									
			Intellectual Property																									
		Efficiencies	Processing Efficiencies																									

			Supply Chain Efficiencies																										
		Techno-Economics	CAPEX - Direct Fixed Capital Cost																										
			CAPEX - Indirect Fixed Capital Cost																										
			OPEX - Fixed Operational Costs																										
			OPEX - Variable Operational Costs																										
			Biomass Feedstock Costs																										
			Reliance on Economic Support Measures																										
	Energy Sector	**Bioenergy**	Infrastructure Alignment																										
			Bio-Product Flexibility (energy)																										
			Bio-Product Flexibility (non-energy)																										
			Bioenergy Vector Distribution																										
			Bioenergy Vector Affordability																										
		Energy System Performances	Input Energy Requirements																										
			Influences on Energy System Resilience																										
			Accessibility to Wider Input Energy																										
	Bioeconomy	**Added Value Products**	Bio-Chemicals																										
			Bio-Products																										
		Bioenergy Complementing Wider Sectors	Agriculture																										
			Chemical																										
			Waste																										
			Construction																										
			Transport																										
			Services																										
			Manufacturing																										
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access																										
			Location - Influencing Distribution & Connectivity																										
			Use of Contaminated Lands																										
			Potential for Phytoremediation																										
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon																										
			Soil Fertility																										
			Soil Erosion																										
			Accumulation of Mineral Salts																										
			Drainage Impacts																										
			Soil Compaction																										
			Soli Influence on Productivity Yields																										
		Ecosystems	Biodiversity																										
			Areas of Conservation & High Biodiversity																										
			Land Degradation																										
			Desertification																										
	Air	**PM Pollutants**	PM10s																										
			PM2.5s																										
		Oxide Pollutants	Sulphur Oxides																										
			Nitrogen Oxides																										
			Carbon Monoxide																										
		Heavy Metal	Cadmium																										
			Lead																										
			Mercury																										
	Water	**Water Use & Efficiency**	Water Withdrawn																										
			Water Consumed																										
			Non-renewable Water Resources																										
			Renewable Water Resources																										
		Water Quality	Fertilizer & Pesticide Loadings																										
			Pollution from Feedstock Production																										
			Pollution from Feedstock Processing																										
			Pollution from Feedstock Conversion																										
		Water Systems	Flooding																										
			Local Water Stresses																										
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations																										
			Awareness																										
		Standards	Fuel Standards																										

			Technical Standards																											
			Supply Chain of Custody Processes																											
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion																											
			Feedstock Sources																											
			Transport																											
			Processing & Pre-treatment																											
		Land & Carbon Stocks	Direct Land Use Change																											
			Indirect Land Use Change																											
			Changes in Carbon Stocks																											
		Counterfactual Considerations	Land Use Counterfactuals																											
			Resource Use Counterfactuals																											
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels																											
			Substitution of Traditional Bioenergy																											

BSIM Links to SDG 17

Categories	Themes	Indicators	Issues	SDG 17																										
				17.1.1	17.1.2	17.2.1	17.3.1	17.3.2	17.4.1	17.5.1	17.6.1	17.7.1	17.8.1	17.9.1	17.10.1	17.11.1	17.12.1	17.13.1	17.14.1	17.15.1	17.16.1	17.17.1	17.18.1	17.18.2	17.18.3	17.19.1	17.19.2
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden																											
			Exposure to Occupational Health & Safety Hazards																											
		Food Systems	Food Commodity Supply																											
			Food Commodity Imports & Exports																											
			Climate Change Resilience																											
			Changes in Costs of Agricultural Products																											
			Food Prices																											
			Food Security																											
	Livelihoods	Land Management	Land Ownership																											
			Land Access																											
		Decent Work	Rights																											
			Child Labour																											
			Slave Labour																											
			International Labour Standards																											
		Jobs & Skills	Skilled Jobs																											
			Unskilled Jobs																											
			Permanent Jobs																											
			Temporary Jobs																											
			Regional Job Distribution																											
			Career Development																											
		Change in income	Income from Bioenergy	✓								✓																		
			Net Income from Bioenergy	✓								✓																		
	Society	Equality	Diversity through Supply Chain Participation																											
			Diversity & End Use																											
		Peace, Justice & Strong Institutions	Legality																											
			Monitoring																											
			Bribery & Conflicts of Business																											
		Partnerships	Community Partnerships																											
			Industry Partnerships																											
			Government Partnerships																											
			Specialist Bioenergy Partnerships																											
		Energy Access	Households using Bioenergy																											
			Industry using Bioenergy																											
Development	Economy	Economic Performance	Gross Domestic Product	✓								✓																		
			Influence on Wider Sectors	✓								✓																		
			International Trade	✓								✓				✓														
			Financial Capacity to Adopt Bioenergy																											
		Economic Stimulation	Increased Sustainable Energy Generation																											
			Economic Support Mechanisms									✓																		
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability																											
			Existing Infrastructure - Capacity																											
			New Infrastructure Capacity																											
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)																											
			Use of Genetically Modified Materials																											
			Feedstock Production Strategy																											
			Land Use Productivity																											
		Mobilisation	Resource Mobilisation																											
			Competition for Resources																											
		Distribution	Spatial Distribution of Resources																											
			Resource Transportation																											
	Technology	Innovation	TRL Development																											
			Intellectual Property																											

		Efficiencies	Processing Efficiencies																									
			Supply Chain Efficiencies																									
		Techno-Economics	CAPEX - Direct Fixed Capital Cost																									
			CAPEX - Indirect Fixed Capital Cost																									
			OPEX - Fixed Operational Costs																									
			OPEX - Variable Operational Costs																									
			Biomass Feedstock Costs																									
			Reliance on Economic Support Measures																									
	Energy Sector	**Bioenergy**	Infrastructure Alignment																									
			Bio-Product Flexibility (energy)																									
			Bio-Product Flexibility (non-energy)																									
			Bioenergy Vector Distribution																									
			Bioenergy Vector Affordability																									
		Energy System Performances	Input Energy Requirements																									
			Influences on Energy System Resilience																									
			Accessibility to Wider Input Energy																									
	Bioeconomy	**Added Value Products**	Bio-Chemicals																									
			Bio-Products																									
		Bioenergy Complementing Wider Sectors	Agriculture																									
			Chemical																									
			Waste																									
			Construction																									
			Transport																									
			Services																									
			Manufacturing																									
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access																									
			Location - Influencing Distribution & Connectivity																									
			Use of Contaminated Lands																									
			Potential for Phytoremediation																									
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon																									
			Soil Fertility																									
			Soil Erosion																									
			Accumulation of Mineral Salts																									
			Drainage Impacts																									
			Soil Compaction																									
			Soli Influence on Productivity Yields																									
		Ecosystems	Biodiversity																									
			Areas of Conservation & High Biodiversity																									
			Land Degradation																									
			Desertification																									
	Air	**PM Pollutants**	PM10s																									
			PM2.5s																									
		Oxide Pollutants	Sulphur Oxides																									
			Nitrogen Oxides																									
			Carbon Monoxide																									
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		Water Systems	Flooding																									
			Local Water Stresses																									
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations																✓									
			Awareness																									

		Standards	Fuel Standards																											
			Technical Standards																											
			Supply Chain of Custody Processes																											
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