Sustainability of bioenergy

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Sustainability of Bioenergy – Mapping the Risks & Benefits to Inform Future Bioenergy Systems

Supplementary Materials

A. UK Organisations Contributing UK Bioenergy Sustainability Maps

The following organisations contributed Case studies to this research, based on their bioenergy projects funded by the UK Supergen Bioenergy Hub.

- Aston University
- Aberystwyth University
- Centre for Ecology & Hydrology
- Imperial College London
- Manchester Metropolitan University
- University of Southampton
- University College London
- University of Aberdeen
- University of Bath
- University of Glasgow
- University of Manchester
- University of Nottingham

B. BSIM Sustainability Assessment Framework

The full list of 126 sustainability issues included within the BSIM, structured within a framework of Sustainability Categories, Themes, Indicators and Issues.

Categories	Themes	Indicators	Issues
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 Agri-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

C. Bioenergy Case studies

Descriptions of the 16 Case studies analysed through this research:

CS1 - Imported Energy Crops: Assessment of the global implications of importing biomass feedstocks to meet UK demand. Focusing on energy crops, CS1 focuses on the production, mobilisation and transport of feedstocks in key international regions such as Africa, South America and South East Asia for the UK end markets.

CS2 - Miscanthus on Marginal Land: Assessment of the potential production of miscanthus on lands that currently have limited agricultural value. CS2 focuses on the production of miscanthus on UK marginal land identified using the MiscanFOR model [18] that highlights hotspots for energy deployment in the UK. The analyses boundary CS2 is limited to the production of the feedstocks and its transportation to centres sites for downstream processing activities.

CS3 – Willow SRC on UK Agricultural Land: Assessment of willow short rotation coppice on farmland in the UK. The sustainability assessment focused on issues related to land use and the production and cultivation of willow. CS3 assumes that willow is planted on previously either arable or rotational grassland on a none organic soil (not drained lowland peat). The crop is managed to current best practices with limited or no use of fertiliser, herbicide and pesticide and is achieving economic viable yields that either match or exceed the previous profit achieved through the use of the land for grazing or arable cropping. CS3 assumes the willow crop will have a life span of 20-25 years with harvesting every 3 yrs.

CS4 – Hydrogen from Wastewater via Catalysis & Gasification: This case study reflects a continuous hydrothermal catalytic process that combines supercritical water gasification (SCWG) technology with in-situ formation of new metal oxide nanocatalyst to convert biomass wastewater into a gas product rich in hydrogen and biomethane, a water product low in COD and TOC, and metal oxide nanocatalyst that can be recovered as the secondary product. Industrial biomass wastewaters such as olive processing water, stillage and spent lees are converted at a short residence time (20 seconds) and at a low gasification temperature (430°C) instead of commonly used temperatures and residence time at ≥600°C and ≥30 seconds, respectively [84]. Continuous formation of nanocatalyst prevents any performance drop or catalyst deactivation during continuous operation.

CS5 – Hydrogen from Wastewater via Photocatalysis: Hydrogen is generated from biomass substrate or wastewater through application of small-scale photocatalytic converters. The biomass feedstocks are chemically converted through irradiation from natural (e.g. solar) and renewable energy powered artificial sources (e.g. LEDs linked to photovoltaic systems). The hydrogen is produced through the photoreforming of the organics in the liquid or gas phase(?).

CS6 – Hydrochar & Liquefied Value Added Products through Hydrothermal Conversion of Wood Residues: Sawdust residue sourced from Northern Ireland is used as a feedstock to produce hydrochar and liquefied value added products. The residue is converted through a semi-continuous flow hydrothermal system: at 100°C (4-180bar) for low-temperature extraction, at 200-300°C (55-240bar) for carbonisation, 300-350°C (140-240bar) for liquefaction and 375°C (240bar) for gasification for 1.5-2.0 hours process time. Resulting in liquid products and hydrochars (solid residue) that were investigated for potential energy and water treatment applications. CS6 focuses on assessing the sustainability of the hydrothermal conversion of the feedstock.

CS7 – Hydrochar & Liquefied Value Added Products through Hydrothermal Conversion of Seaweed: Brown seaweed (Laminaria digitata) is used as a feedstock to produce hydrochar and liquefied value added products. The seaweed is converted through a semi-continuous flow hydrothermal system: at 100°C (4-180bar) for low-temperature extraction, at 200-300°C (55-240bar) for carbonisation, 300-350°C (140-240bar) for liquefaction and 375°C (240bar) for gasification for 1.5-2.0 hours process time. Resulting in liquid products and hydrochars (solid residue) that were investigated for potential energy and water treatment applications. CS6 focuses on assessing the sustainability of the hydrothermal conversion of the feedstock.

CS8 – Biohydrogen replacing Blue Hydrogen: Assessment of the relative sustainability risks and benefits of using biomass-hydrogen to displace blue hydrogen production (natural gas reforming with CCS). Assessing the additional impacts (and avoided impacts) that would result from replacing blue hydrogen including impacts on: the supply chain for natural gas (including fugitive emissions), competition for natural gas resources, influences on price volatility, influences of location and infrastructure, and the potential benefits gained through mitigating the high GHG intensity of blue hydrogen supply chains resulting from process emissions, auxiliary inputs and non-capture of carbon. CS8 assumes that there will be 'marginal replacement' of blue hydrogen with biohydrogen, in that biohydrogen is produced given sustainable limits of biomass availability.

CS9 – Miscanthus as a Feedstock for Local CHP with CCS Plants: A whole bioenergy value chains Case Study where miscanthus is produced as a feedstock for local power stations linked to CCS infrastructure. CS9 assumes that miscanthus is produced using perennial rhizomes with 20-year lifespan providing an annual yield calculated using the MiscanFOR model [20]. Herbicide and fertilizer is used only at the first year or two of the life cycle with limited field management between early spring harvests. Harvested resource from the third year onwards is transported up to 20 miles to a local small to medium combined heat and power (CHP) plant. CS9 assumes up to 90% of plant carbon is captured within post combustion CCS technologies and infrastructure [21].

CS10 – Biofuels & Bioproducts from the Pyrolysis of Microalgae grown on Food Waste: Whole bioenergy value chain Case Study where biofuels and added value products are generated from microalgae. Microalgae are grown within a novel photobioreactor on a supply of nutrients from food processing wastes. The algae are isolated through a film-

scraping step to be feedstocks for pyrolysis thermal conversion. The system generates a range of products including biomethane and biocrude fuels and biochar.

CS11 – Hydrogen from the Pyrolysis of Biogas: Whole bioenergy value chain Case Study where hydrogen is the primary product of the pyrolysis of biogas generated through anaerobic digestion processes. Biogas is converted through fast pyrolysis thermal conversion to produce a hydrogen rich syngas and solid carbon material (carbon black). The sustainability analysis for CS11 focuses on the conversion technologies and the potential onward use of hydrogen as a fuel.

CS12 – Platform Chemicals through Conversion of Miscanthus using Microwave Catalysis: Whole bioenergy value chain Case Study where platform chemical levulinic acid (the precursor to biofuels) is produced through the catalytic conversion of miscanthus feedstock. The high carbohydrates content of miscanthus (up to >60% [68], depending on harvest season) makes it an attractive feedstock for co-producing high value products, energy conversion and for biorefining [69,70]. Within CS12 miscanthus is converted using a novel microwave, mild heating and catalysis (sulphated zirconia with dilute HCl) processing to hydrolyse the cellulose, producing levulinic acid and high density biochar material [22]. The CS12 sustainability assessment focuses on the processing and conversion technologies and the resulting products.

CS13 – Platform Chemicals & Biofuels through Ionic Liquid pretreatment of Lignocellulosic Biomass: Whole bioenergy value chain Case Study where platform chemicals and biofuels are produced through the catalytic conversion of a range of lignocellulosic materials. Materials including energy crops, forestry and agri-residues are processed using the ionoSolv pre-treatment fractionation process, where protic ionic liquids are applied to fractionate the cellulose, lignin and hemicellulose fractions of the biomass to allow separated valorisation. The cellulose fraction being used to produce platform chemicals, biofuels and cellulose based materials, lignin can be used to produce energy and materials, and the hemicellulose fraction can be used for the production of platform chemicals. CS13 focuses on analysing the sustainability of the catalytic conversion processes and the resulting products**.**

CS14 – Gasification of Forestry/Agri-Residues to fuel a Hydrogen Fuel Cell: Whole bioenergy value chain Case Study where forestry and agri-residues are converted through a gasification conversion pathway to produce hydrogen for fuel cell technologies. CS14 focuses sawmill residue that is dried and pelletised to provide a uniform feedstock for an entrained flow gasifier. The thermo-chemical conversion of the biomass in the presence of oxygen to provide a gasification agent and a catalytic bed produces a hydrogen rich syngas. CO2 generated as a side product is captured to be either compressed to a liquid to enter the utilisation market or compressed to a supercritical fluid to be transported and sequestered underground. The process is powered using wind power, while the internal heat demand is met with the combustion of part of the syngas. CS14's sustainability assessment covers each step within the case study life cycle including the onward energy applications for hydrogen.

CS15 – Gasification of Forestry Residues to Produce Sustainable Aviation Fuels: Whole bioenergy value chain Case Study where forestry residues are dried to provide a feedstock for gasification to produce a syngas. Oxygen is used as a gasification agent within high temperature and pressure conditions in the presence of a dolomite catalytic bed to reduce tar formation. The syngas is cleaned (tar removed) and conditioned using a water gas shift (WGS) unit that adjusts the H2/CO ratio for subsequent Fischer Tropsch synthesis. CO2 generated by the WGS is removed through within a carbon capture unit enabled by a Selexol solvent. The clean and conditioned syngas is converted to biocrude through a Fischer Tropsch process where it is then upgraded through hydrotreatment, green hydrogen is used to perform hydrocracking and isomerisation. The upgraded biocrude is separated generating a series of fractions, i.e light gasses, sustainable aviation fuel (SAF), gasoline, diesel and waxes. The light gases and unconverted syngas are reused to power the production processes. The SAF, gasoline and diesel are transported to corresponding storage facilities, the waxes are sold to industry as lubricants and the captured CO2 is compressed and sent to a geological storage site. CS15's sustainability assessment covers each step within the case study life cycle including the onward applications of the products.

CS16 – Hydrogen from Miscanthus via Photocatalysis: Hydrogen is generated from miscanthus through application of small-scale photocatalytic converters deployed locally to allow on-site energy generation for the agricultural sector or nearby community. The miscanthus feedstock is chemically converted through irradiation from natural (e.g. solar) and renewable energy powered artificial sources (e.g. LEDs linked to photovoltaic systems). The hydrogen is produced through the photoreforming of the organics. and is stored to provide dispatchable local energy through fuel cells or hydrogen powered machinery/engines. CS16 assumes an advancement in photocatalytic technology (e.g. TRL 7-9) which would facilitate large scale deployments. The sustainability assessment covers each step within the case study life cycle including the onward applications of the products.

Case Study BSIM Calibration Scores

Sustainability risk and benefit Issues Scores (IS) reflect the outputs of discussions with bioenergy specialists from the project team. IS were calculated as a function of Likelihood Index (LI) x Boost Index (BI) as described further in the BSIM Guidance Manual.

CS1 - Imported Energy Crops

Categories	Themes	Indicators	Issues	Sustainability Issue Scores		
				Applicability	*IS[r]*	*IS[b]*
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden	*No*	*0*	*0*
			Exposure to Occupational Health & Safety Hazards	*No*	*0*	*0*
		Food Systems	Food Commodity Supply	*Yes*	*8*	*0*
			Food Commodity Imports & Exports	*No*	*0*	*0*
			Climate Change Resilience	*Yes*	*8*	*8*
			Changes in Costs of Agricultural Products	*Yes*	*8*	*8*
			Food Prices	*Yes*	*8*	*0*
			Food Security	*Yes*	*8*	*0*
	Livelihoods	Land Management	Land Ownership	*Yes*	*10*	*6*
			Land Access	*Yes*	*10*	*6*
		Decent Work	Rights	*No*	*0*	*0*
			Child Labour	*No*	*0*	*0*
			Slave Labour	*No*	*0*	*0*
			International Labour Standards	*no*	*0*	*0*
		Jobs & Skills	Skilled Jobs	*No*	*0*	*0*
			Unskilled Jobs	*No*	*0*	*0*
			Permanent Jobs	*No*	*0*	*0*
			Temporary Jobs	*No*	*0*	*0*
			Regional Job Distribution	*No*	*0*	*0*
			Career Development	*No*	*0*	*0*
		Change in income	Income from Bioenergy	*No*	*0*	*0*
			Net Income from Bioenergy	*No*	*0*	*0*
	Society	Equality	Diversity through Supply Chain Participation	*No*	*0*	*0*
			Diversity & End Use	*No*	*0*	*0*
		Peace, Justice & Strong Institutions	Legality	*No*	*0*	*0*
			Monitoring	*No*	*0*	*0*
			Bribery & Conflicts of Business	*No*	*0*	*0*
		Partnerships	Community Partnerships	*No*	*0*	*0*
			Industry Partnerships	*No*	*0*	*0*
			Government Partnerships	*No*	*0*	*0*
			Specialist Bioenergy Partnerships	*No*	*0*	*0*
		Energy Access	Households using Bioenergy	*No*	*0*	*0*
			Industry using Bioenergy	*No*	*0*	*0*
Development	Economy	Economic Performance	Gross Domestic Product	*No*	*0*	*0*
			Influence on Wider Sectors	*No*	*0*	*0*
			International Trade	*Yes*	*8*	*8*
			Financial Capacity to Adopt Bioenergy	*No*	*0*	*0*
		Economic Stimulation	Increased Sustainable Energy Generation	*Yes*	*8*	*8*
			Economic Support Mechanisms	*No*	*0*	*0*
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability	*No*	*0*	*0*
			Existing Infrastructure - Capacity	*No*	*0*	*0*
			New Infrastructure Capacity	*Yes*	*10*	*8*
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)	*No*	*0*	*0*
			Use of Genetically Modified Materials	*No*	*0*	*0*
			Feedstock Production Strategy	*No*	*0*	*0*
			Land Use Productivity	*Yes*	*8*	*8*
		Mobilisation	Resource Mobilisation	*No*	*0*	*0*
			Competition for Resources	*Yes*	*10*	*2*
		Distribution	Spatial Distribution of Resources	*Yes*	*10*	*8*
			Resource Transportation	*Yes*	*8*	*8*
	Technology	Innovation	TRL Development	*No*	*0*	*0*
			Intellectual Property	*No*	*0*	*0*
		Efficiencies	Processing Efficiencies	*Yes*	*8*	*6*
			Supply Chain Efficiencies	*Yes*	*8*	*6*
		Techno-Economics	CAPEX - Direct Fixed Capital Cost	*No*	*0*	*0*
			CAPEX - Indirect Fixed Capital Cost	*No*	*0*	*0*
			OPEX - Fixed Operational Costs	*No*	*0*	*0*
			OPEX - Variable Operational Costs	*No*	*0*	*0*
			Biomass Feedstock Costs	*No*	*0*	*0*
			Reliance on Economic Support Measures	*No*	*0*	*0*
	Energy Sector	Bioenergy	Infrastructure Alignment	*No*	*0*	*0*
			Bio-Product Flexibility (energy)	*No*	*0*	*0*
			Bio-Product Flexibility (non-energy)	*No*	*0*	*0*
			Bioenergy Vector Distribution	*No*	*0*	*0*
			Bioenergy Vector Affordability	*No*	*0*	*0*
		Energy System Performances	Input Energy Requirements	*No*	*0*	*0*
			Influences on Energy System Resilience	*Yes*	*8*	*10*
			Accessibility to Wider Input Energy	*No*	*0*	*0*
	Bioeconomy	Added Value Products	Bio-Chemicals	*No*	*0*	*0*
			Bio-Products	*No*	*0*	*0*
		Bioenergy Complementing Wider Sectors	Agriculture	*Yes*	*8*	*10*
			Chemical	*No*	*0*	*0*
			Waste	*No*	*0*	*0*
			Construction	*No*	*0*	*0*
			Transport	*No*	*0*	*0*
			Services	*No*	*0*	*0*
			Manufacturing	*No*	*0*	*0*
	Land Utilisation	Land Characteristics	Topography - Influencing Access	*No*	*0*	*0*
			Location - Influencing Distribution & Connectivity	*No*	*0*	*0*
			Use of Contaminated Lands	*No*	*0*	*0*
			Potential for Phytoremediation	*No*	*0*	*0*
Natural Systems	Land	Soil	Impact on Soil Organic Carbon	*No*	*0*	*0*
			Soil Fertility	*No*	*0*	*0*
			Soil Erosion	*No*	*0*	*0*
			Accumulation of Mineral Salts	*No*	*0*	*0*
			Drainage Impacts	*No*	*0*	*0*
			Soil Compaction	*No*	*0*	*0*
			Soli Influence on Productivity Yields	*No*	*0*	*0*
		Ecosystems	Biodiversity	*Yes*	*10*	*8*

			Areas of Conservation & High Biodiversity	*Yes*	*10*	*0*
			Land Degradation	*Yes*	*8*	*8*
			Desertification	*Yes*	*8*	*8*
	Air	**PM Pollutants**	PM10s	*No*	*0*	*0*
			PM2.5s	*No*	*0*	*0*
		Oxide Pollutants	Sulphur Oxides	*No*	*0*	*0*
			Nitrogen Oxides	*No*	*0*	*0*
			Carbon Monoxide	*No*	*0*	*0*
		Heavy Metal	Cadmium	*No*	*0*	*0*
			Lead	*No*	*0*	*0*
			Mercury	*No*	*0*	*0*
	Water	**Water Use & Efficiency**	Water Withdrawn	*Yes*	*6*	*6*
			Water Consumed	*Yes*	*6*	*6*
			Non-renewable Water Resources	*No*	*0*	*0*
			Renewable Water Resources	*No*	*0*	*0*
		Water Quality	Fertilizer & Pesticide Loadings	*No*	*0*	*0*
			Pollution from Feedstock Production	*No*	*0*	*0*
			Pollution from Feedstock Processing	*No*	*0*	*0*
			Pollution from Feedstock Conversion	*No*	*0*	*0*
		Water Systems	Flooding	*No*	*0*	*0*
			Local Water Stresses	*Yes*	*6*	*6*
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations	*Yes*	*8*	*8*
			Awareness	*No*	*0*	*0*
		Standards	Fuel Standards	*No*	*0*	*0*
			Technical Standards	*No*	*0*	*0*
			Supply Chain of Custody Processes	*No*	*0*	*0*
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion	*No*	*0*	*0*
			Feedstock Sources	*Yes*	*8*	*8*
			Transport	*Yes*	*8*	*0*
			Processing & Pre-treatment	*No*	*0*	*0*
		Land & Carbon Stocks	Direct Land Use Change	*Yes*	*8*	*8*
			Indirect Land Use Change	*Yes*	*10*	*0*
			Changes in Carbon Stocks	*Yes*	*8*	*8*
		Counterfactual Considerations	Land Use Counterfactuals	*Yes*	*10*	*10*
			Resource Use Counterfactuals	*No*	*0*	*0*
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels	*No*	*0*	*0*
			Substitution of Traditional Bioenergy	*No*	*0*	*0*

CS2 - Miscanthus on Marginal Land

Categories	**Themes**	**Indicators**	**Issues**	**Sustainability Issue Scores**		
				Applicability	*IS[r]*	*IS[b]*
People	**Health**	**Health & Wellbeing**	Mortality Rate & Disease Burden	*No*	*0*	*0*
			Exposure to Occupational Health & Safety Hazards	*No*	*0*	*0*
		Food Systems	Food Commodity Supply	*Yes*	*2*	*8*
			Food Commodity Imports & Exports	*Yes*	*4*	*8*
			Climate Change Resilience	*Yes*	*4*	*6*
			Changes in Costs of Agricultural Products	*Yes*	*6*	*6*
			Food Prices	*Yes*	*6*	*6*
			Food Security	*Yes*	*2*	*8*
	Livelihoods	**Land Management**	Land Ownership	*Yes*	*8*	*6*
			Land Access	*Yes*	*8*	*6*
		Decent Work	Rights	*No*	*0*	*0*
			Child Labour	*No*	*0*	*0*
			Slave Labour	*No*	*0*	*0*
			International Labour Standards	*No*	*0*	*0*
		Jobs & Skills	Skilled Jobs	*Yes*	*6*	*8*
			Unskilled Jobs	*No*	*0*	*0*
			Permanent Jobs	*Yes*	*6*	*8*
			Temporary Jobs	*No*	*0*	*0*
			Regional Job Distribution	*Yes*	*6*	*8*
			Career Development	*No*	*0*	*0*
		Change in income	Income from Bioenergy	*Yes*	*4*	*8*
			Net Income from Bioenergy	*Yes*	*6*	*8*
	Society	**Equality**	Diversity through Supply Chain Participation	*Yes*	*6*	*8*
			Diversity & End Use	*Yes*	*4*	*8*
		Peace, Justice & Strong Institutions	Legality	*No*	*0*	*0*
			Monitoring	*No*	*0*	*0*
			Bribery & Conflicts of Business	*No*	*0*	*0*
		Partnerships	Community Partnerships	*Yes*	*6*	*8*
			Industry Partnerships	*Yes*	*6*	*8*
			Government Partnerships	*Yes*	*6*	*6*
			Specialist Bioenergy Partnerships	*Yes*	*4*	*8*
		Energy Access	Households using Bioenergy	*Yes*	*4*	*8*
			Industry using Bioenergy	*Yes*	*4*	*8*
Development	**Economy**	**Economic Performance**	Gross Domestic Product	*Yes*	*6*	*8*
			Influence on Wider Sectors	*Yes*	*6*	*8*
			International Trade	*Yes*	*8*	*4*
			Financial Capacity to Adopt Bioenergy	*Yes*	*8*	*2*
		Economic Stimulation	Increased Sustainable Energy Generation	*Yes*	*4*	*8*
			Economic Support Mechanisms	*Yes*	*8*	*4*
	Infrastructure	**Infrastructure Requirements**	Existing Infrastructure - Availability	*No*	*0*	*0*
			Existing Infrastructure - Capacity	*No*	*0*	*0*
			New Infrastructure Capacity	*Yes*	*8*	*4*
	Feedstock Production/ Mobilisation/ Distribution	**Production Processes**	Chemical Agro-Chemicals (fertiliser + pesticide)	*No*	*0*	*0*
			Use of Genetically Modified Materials	*No*	*0*	*0*
			Feedstock Production Strategy	*Yes*	*6*	*6*
			Land Use Productivity	*Yes*	*2*	*10*
		Mobilisation	Resource Mobilisation	*Yes*	*6*	*8*
			Competition for Resources	*Yes*	*4*	*8*
		Distribution	Spatial Distribution of Resources	*Yes*	*6*	*8*
			Resource Transportation	*Yes*	*6*	*8*
	Technology	**Innovation**	TRL Development	*No*	*0*	*0*
			Intellectual Property	*No*	*0*	*0*
		Efficiencies	Processing Efficiencies	*No*	*0*	*0*
			Supply Chain Efficiencies	*Yes*	*6*	*8*
		Techno-Economics	CAPEX - Direct Fixed Capital Cost	*No*	*0*	*0*
			CAPEX - Indirect Fixed Capital Cost	*No*	*0*	*0*
			OPEX - Fixed Operational Costs	*No*	*0*	*0*
			OPEX - Variable Operational Costs	*No*	*0*	*0*

			Biomass Feedstock Costs	*Yes*	*8*	*4*
			Reliance on Economic Support Measures	*No*	*0*	*0*
	Energy Sector	**Bioenergy**	Infrastructure Alignment	*Yes*	*6*	*6*
			Bio-Product Flexibility (energy)	*Yes*	*6*	*8*
			Bio-Product Flexibility (non-energy)	*Yes*	*6*	*8*
			Bioenergy Vector Distribution	*Yes*	*6*	*6*
			Bioenergy Vector Affordability	*Yes*	*6*	*6*
		Energy System Performances	Input Energy Requirements	*Yes*	*4*	*8*
			Influences on Energy System Resilience	*Yes*	*4*	*8*
			Accessibility to Wider Input Energy	*Yes*	*6*	*8*
	Bioeconomy	**Added Value Products**	Bio-Chemicals	*No*	*0*	*0*
			Bio-Products	*Yes*	*6*	*8*
		Bioenergy Complementing Wider Sectors	Agriculture	*Yes*	*4*	*10*
			Chemical	*Yes*	*4*	*6*
			Waste	*Yes*	*6*	*8*
			Construction	*No*	*0*	*0*
			Transport	*Yes*	*8*	*4*
			Services	*Yes*	*6*	*6*
			Manufacturing	*No*	*0*	*0*
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access	*Yes*	*4*	*6*
			Location - Influencing Distribution & Connectivity	*Yes*	*8*	*4*
			Use of Contaminated Lands	*Yes*	*4*	*8*
			Potential for Phytoremediation	*Yes*	*4*	*10*
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon	*Yes*	*6*	*8*
			Soil Fertility	*Yes*	*6*	*6*
			Soil Erosion	*Yes*	*4*	*6*
			Accumulation of Mineral Salts	*Yes*	*4*	*6*
			Drainage Impacts	*Yes*	*4*	*4*
			Soil Compaction	*Yes*	*8*	*4*
			Soli Influence on Productivity Yields	*Yes*	*4*	*8*
		Ecosystems	Biodiversity	*Yes*	*8*	*6*
			Areas of Conservation & High Biodiversity	*Yes*	*8*	*6*
			Land Degradation	*Yes*	*2*	*8*
			Desertification	*Yes*	*4*	*8*
	Air	**PM Pollutants**	PM10s	*No*	*0*	*0*
			PM2.5s	*No*	*0*	*0*
		Oxide Pollutants	Sulphur Oxides	*No*	*0*	*0*
			Nitrogen Oxides	*No*	*0*	*0*
			Carbon Monoxide	*No*	*0*	*0*
		Heavy Metal	Cadmium	*No*	*0*	*0*
			Lead	*No*	*0*	*0*
			Mercury	*No*	*0*	*0*
	Water	**Water Use & Efficiency**	Water Withdrawn	*Yes*	*8*	*6*
			Water Consumed	*Yes*	*8*	*4*
			Non-renewable Water Resources	*Yes*	*4*	*6*
			Renewable Water Resources	*Yes*	*4*	*6*
		Water Quality	Fertilizer & Pesticide Loadings	*No*	*0*	*0*
			Pollution from Feedstock Production	*No*	*0*	*0*
			Pollution from Feedstock Processing	*No*	*0*	*0*
			Pollution from Feedstock Conversion	*No*	*0*	*0*
		Water Systems	Flooding	*No*	*0*	*0*
			Local Water Stresses	*No*	*0*	*0*
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations	*Yes*	*4*	*8*
			Awareness	*Yes*	*4*	*8*
		Standards	Fuel Standards	*No*	*0*	*0*
			Technical Standards	*No*	*0*	*0*
			Supply Chain of Custody Processes	*No*	*0*	*0*
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion	*Yes*	*6*	*8*
			Feedstock Sources	*Yes*	*6*	*8*
			Transport	*Yes*	*8*	*4*
			Processing & Pre-treatment	*Yes*	*4*	*8*
		Land & Carbon Stocks	Direct Land Use Change	*Yes*	*4*	*8*
			Indirect Land Use Change	*Yes*	*6*	*8*
			Changes in Carbon Stocks	*Yes*	*4*	*8*
		Counterfactual Considerations	Land Use Counterfactuals	*No*	*0*	*0*
			Resource Use Counterfactuals	*No*	*0*	*0*
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels	*Yes*	*4*	*8*
			Substitution of Traditional Bioenergy	*Yes*	*4*	*8*

CS3 – Willow SRC on UK Agricultural Land

Categories	Themes	Indicators	Issues	Sustainability Issue Scores		
				Applicability	*IS[a]*	*IS[b]*
People	**Health**	**Health & Wellbeing**	Mortality Rate & Disease Burden	*No*	*0*	*0*
			Exposure to Occupational Health & Safety Hazards	*No*	*0*	*0*
		Food Systems	Food Commodity Supply	*No*	*0*	*0*
			Food Commodity Imports & Exports	*No*	*0*	*0*
			Climate Change Resilience	*No*	*0*	*0*
			Changes in Costs of Agricultural Products	*No*	*0*	*0*
			Food Prices	*No*	*0*	*0*
			Food Security	*No*	*0*	*0*
	Livelihoods	**Land Management**	Land Ownership	*No*	*0*	*0*
			Land Access	*No*	*0*	*0*
		Decent Work	Rights	*No*	*0*	*0*
			Child Labour	*No*	*0*	*0*
			Slave Labour	*No*	*0*	*0*
			International Labour Standards	*No*	*0*	*0*
		Jobs & Skills	Skilled Jobs	*No*	*0*	*0*
			Unskilled Jobs	*No*	*0*	*0*
			Permanent Jobs	*No*	*0*	*0*
			Temporary Jobs	*No*	*0*	*0*
			Regional Job Distribution	*No*	*0*	*0*
			Career Development	*No*	*0*	*0*
		Change in income	Income from Bioenergy	*No*	*0*	*0*
			Net Income from Bioenergy	*Yes*	*4*	*6*
	Society	**Equality**	Diversity through Supply Chain Participation	*No*	*0*	*0*
			Diversity & End Use	*No*	*0*	*0*
		Peace, Justice & Strong Institutions	Legality	*No*	*0*	*0*
			Monitoring	*No*	*0*	*0*

			Bribery & Conflicts of Business	*No*	*0*	*0*
		Partnerships	Community Partnerships	*No*	*0*	*0*
			Industry Partnerships	*No*	*0*	*0*
			Government Partnerships	*No*	*0*	*0*
			Specialist Bioenergy Partnerships	*No*	*0*	*0*
		Energy Access	Households using Bioenergy	*No*	*0*	*0*
			Industry using Bioenergy	*No*	*0*	*0*
Development	**Economy**	**Economic Performance**	Gross Domestic Product	*No*	*0*	*0*
			Influence on Wider Sectors	*No*	*0*	*0*
			International Trade	*No*	*0*	*0*
			Financial Capacity to Adopt Bioenergy	*No*	*0*	*0*
		Economic Stimulation	Increased Sustainable Energy Generation	*No*	*0*	*0*
			Economic Support Mechanisms	*No*	*0*	*0*
	Infrastructure	**Infrastructure Requirements**	Existing Infrastructure - Availability	*No*	*0*	*0*
			Existing Infrastructure - Capacity	*No*	*0*	*0*
			New Infrastructure Capacity	*No*	*0*	*0*
	Feedstock Production/ Mobilisation/ Distribution	**Production Processes**	Chemical Agro-Chemicals (fertiliser + pesticide)	*No*	*0*	*0*
			Use of Genetically Modified Materials	*No*	*0*	*0*
			Feedstock Production Strategy	*No*	*0*	*0*
			Land Use Productivity	*Yes*	*4*	*8*
		Mobilisation	Resource Mobilisation	*No*	*0*	*0*
			Competition for Resources	*No*	*0*	*0*
		Distribution	Spatial Distribution of Resources	*No*	*0*	*0*
			Resource Transportation	*No*	*0*	*0*
	Technology	**Innovation**	TRL Development	*No*	*0*	*0*
			Intellectual Property	*No*	*0*	*0*
		Efficiencies	Processing Efficiencies	*No*	*0*	*0*
			Supply Chain Efficiencies	*No*	*0*	*0*
		Techno-Economics	CAPEX - Direct Fixed Capital Cost	*No*	*0*	*0*
			CAPEX - Indirect Fixed Capital Cost	*No*	*0*	*0*
			OPEX - Fixed Operational Costs	*No*	*0*	*0*
			OPEX - Variable Operational Costs	*No*	*0*	*0*
			Biomass Feedstock Costs	*No*	*0*	*0*
			Reliance on Economic Support Measures	*No*	*0*	*0*
	Energy Sector	**Bioenergy**	Infrastructure Alignment	*No*	*0*	*0*
			Bio-Product Flexibility (energy)	*No*	*0*	*0*
			Bio-Product Flexibility (non-energy)	*No*	*0*	*0*
			Bioenergy Vector Distribution	*No*	*0*	*0*
			Bioenergy Vector Affordability	*No*	*0*	*0*
		Energy System Performances	Input Energy Requirements	*No*	*0*	*0*
			Influences on Energy System Resilience	*No*	*0*	*0*
			Accessibility to Wider Input Energy	*No*	*0*	*0*
	Bioeconomy	**Added Value Products**	Bio-Chemicals	*No*	*0*	*0*
			Bio-Products	*No*	*0*	*0*
		Bioenergy Complementing Wider Sectors	Agriculture	*Yes*	*4*	*10*
			Chemical	*No*	*0*	*0*
			Waste	*No*	*0*	*0*
			Construction	*No*	*0*	*0*
			Transport	*No*	*0*	*0*
			Services	*No*	*0*	*0*
			Manufacturing	*No*	*0*	*0*
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access	*No*	*0*	*0*
			Location - Influencing Distribution & Connectivity	*No*	*0*	*0*
			Use of Contaminated Lands	*Yes*	*4*	*8*
			Potential for Phytoremediation	*Yes*	*4*	*10*
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon	*Yes*	*4*	*8*
			Soil Fertility	*Yes*	*4*	*6*
			Soil Erosion	*Yes*	*2*	*8*
			Accumulation of Mineral Salts	*No*	*0*	*0*
			Drainage Impacts	*Yes*	*6*	*8*
			Soil Compaction	*Yes*	*4*	*6*
			Soli Influence on Productivity Yields	*Yes*	*4*	*8*
		Ecosystems	Biodiversity	*Yes*	*6*	*8*
			Areas of Conservation & High Biodiversity	*No*	*0*	*0*
			Land Degradation	*Yes*	*2*	*8*
			Desertification	*No*	*0*	*0*
	Air	**PM Pollutants**	PM10s	*No*	*0*	*0*
			PM2.5s	*No*	*0*	*0*
		Oxide Pollutants	Sulphur Oxides	*No*	*0*	*0*
			Nitrogen Oxides	*Yes*	*2*	*8*
			Carbon Monoxide	*No*	*0*	*0*
		Heavy Metal	Cadmium	*No*	*0*	*0*
			Lead	*No*	*0*	*0*
			Mercury	*No*	*0*	*0*
	Water	**Water Use & Efficiency**	Water Withdrawn	*No*	*0*	*0*
			Water Consumed	*Yes*	*4*	*0*
			Non-renewable Water Resources	*No*	*0*	*0*
			Renewable Water Resources	*Yes*	*4*	*0*
		Water Quality	Fertilizer & Pesticide Loadings	*Yes*	*2*	*10*
			Pollution from Feedstock Production	*Yes*	*2*	*8*
			Pollution from Feedstock Processing	*No*	*0*	*0*
			Pollution from Feedstock Conversion	*No*	*0*	*0*
		Water Systems	Flooding	*Yes*	*4*	*8*
			Local Water Stresses	*No*	*0*	*0*
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations	*No*	*0*	*0*
			Awareness	*No*	*0*	*0*
		Standards	Fuel Standards	*No*	*0*	*0*
			Technical Standards	*No*	*0*	*0*
			Supply Chain of Custody Processes	*No*	*0*	*0*
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion	*No*	*0*	*0*
			Feedstock Sources	*Yes*	*4*	*8*
			Transport	*No*	*0*	*0*
			Processing & Pre-treatment	*No*	*0*	*0*
		Land & Carbon Stocks	Direct Land Use Change	*Yes*	*4*	*8*
			Indirect Land Use Change	*Yes*	*4*	*4*
			Changes in Carbon Stocks	*Yes*	*2*	*8*
		Counterfactual Considerations	Land Use Counterfactuals	*Yes*	*6*	*6*
			Resource Use Counterfactuals	*No*	*0*	*0*
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels	*No*	*0*	*0*
			Substitution of Traditional Bioenergy	*No*	*0*	*0*

CS4 – Hydrogen from Wastewater via Catalysis & Gasification

Categories	Themes	Indicators	Issues	Sustainability Issue Scores		
				Applicability	*IS[a]*	*IS[b]*
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden	*No*	*0*	*0*
			Exposure to Occupational Health & Safety Hazards	*Yes*	*4*	*0*
		Food Systems	Food Commodity Supply	*No*	*0*	*0*
			Food Commodity Imports & Exports	*No*	*0*	*0*
			Climate Change Resilience	*No*	*0*	*0*
			Changes in Costs of Agricultural Products	*No*	*0*	*0*
			Food Prices	*No*	*0*	*0*
			Food Security	*No*	*0*	*0*
	Livelihoods	Land Management	Land Ownership	*No*	*0*	*0*
			Land Access	*No*	*0*	*0*
		Decent Work	Rights	*No*	*0*	*0*
			Child Labour	*No*	*0*	*0*
			Slave Labour	*No*	*0*	*0*
			International Labour Standards	*No*	*0*	*0*
		Jobs & Skills	Skilled Jobs	*No*	*0*	*0*
			Unskilled Jobs	*No*	*0*	*0*
			Permanent Jobs	*No*	*0*	*0*
			Temporary Jobs	*No*	*0*	*0*
			Regional Job Distribution	*No*	*0*	*0*
			Career Development	*No*	*0*	*0*
		Change in income	Income from Bioenergy	*No*	*0*	*0*
			Net Income from Bioenergy	*No*	*0*	*0*
	Society	Equality	Diversity through Supply Chain Participation	*No*	*0*	*0*
			Diversity & End Use	*No*	*0*	*0*
		Peace, Justice & Strong Institutions	Legality	*No*	*0*	*0*
			Monitoring	*No*	*0*	*0*
			Bribery & Conflicts of Business	*No*	*0*	*0*
		Partnerships	Community Partnerships	*No*	*0*	*0*
			Industry Partnerships	*Yes*	*0*	*8*
			Government Partnerships	*No*	*0*	*0*
			Specialist Bioenergy Partnerships	*Yes*	*0*	*8*
		Energy Access	Households using Bioenergy	*No*	*0*	*0*
			Industry using Bioenergy	*Yes*	*4*	*8*
Development	Economy	Economic Performance	Gross Domestic Product	*No*	*0*	*0*
			Influence on Wider Sectors	*Yes*	*2*	*8*
			International Trade	*No*	*0*	*0*
			Financial Capacity to Adopt Bioenergy	*No*	*0*	*0*
		Economic Stimulation	Increased Sustainable Energy Generation	*Yes*	*2*	*8*
			Economic Support Mechanisms	*No*	*0*	*0*
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability	*No*	*0*	*0*
			Existing Infrastructure - Capacity	*No*	*0*	*0*
			New Infrastructure Capacity	*No*	*0*	*0*
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)	*No*	*0*	*0*
			Use of Genetically Modified Materials	*No*	*0*	*0*
			Feedstock Production Strategy	*No*	*0*	*0*
			Land Use Productivity	*No*	*0*	*0*
		Mobilisation	Resource Mobilisation	*No*	*0*	*0*
			Competition for Resources	*No*	*0*	*0*
		Distribution	Spatial Distribution of Resources	*Yes*	*6*	*8*
			Resource Transportation	*Yes*	*6*	*2*
	Technology	Innovation	TRL Development	*Yes*	*8*	*4*
			Intellectual Property	*No*	*0*	*0*
		Efficiencies	Processing Efficiencies	*Yes*	*4*	*8*
			Supply Chain Efficiencies	*No*	*0*	*0*
		Techno-Economics	CAPEX - Direct Fixed Capital Cost	*Yes*	*4*	*8*
			CAPEX - Indirect Fixed Capital Cost	*Yes*	*4*	*8*
			OPEX - Fixed Operational Costs	*Yes*	*4*	*8*
			OPEX - Variable Operational Costs	*Yes*	*4*	*8*
			Biomass Feedstock Costs	*Yes*	*2*	*8*
			Reliance on Economic Support Measures	*No*	*0*	*0*
	Energy Sector	Bioenergy	Infrastructure Alignment	*No*	*0*	*0*
			Bio-Product Flexibility (energy)	*Yes*	*4*	*8*
			Bio-Product Flexibility (non-energy)	*Yes*	*4*	*8*
			Bioenergy Vector Distribution	*No*	*0*	*0*
			Bioenergy Vector Affordability	*No*	*0*	*0*
		Energy System Performances	Input Energy Requirements	*Yes*	*8*	*2*
			Influences on Energy System Resilience	*No*	*0*	*0*
			Accessibility to Wider Input Energy	*No*	*0*	*0*
	Bioeconomy	Added Value Products	Bio-Chemicals	*No*	*0*	*0*
			Bio-Products	*No*	*0*	*0*
		Bioenergy Complementing Wider Sectors	Agriculture	*No*	*0*	*0*
			Chemical	*Yes*	*4*	*8*
			Waste	*Yes*	*4*	*8*
			Construction	*No*	*0*	*0*
			Transport	*No*	*0*	*0*
			Services	*No*	*0*	*0*
			Manufacturing	*No*	*0*	*0*
	Land Utilisation	Land Characteristics	Topography - Influencing Access	*No*	*0*	*0*
			Location - Influencing Distribution & Connectivity	*No*	*0*	*0*
			Use of Contaminated Lands	*No*	*0*	*0*
			Potential for Phytoremediation	*No*	*0*	*0*
Natural Systems	Land	Soil	Impact on Soil Organic Carbon	*No*	*0*	*0*
			Soil Fertility	*No*	*0*	*0*
			Soil Erosion	*No*	*0*	*0*
			Accumulation of Mineral Salts	*No*	*0*	*0*
			Drainage Impacts	*No*	*0*	*0*
			Soil Compaction	*No*	*0*	*0*
			Soli Influence on Productivity Yields	*No*	*0*	*0*
		Ecosystems	Biodiversity	*No*	*0*	*0*
			Areas of Conservation & High Biodiversity	*No*	*0*	*0*
			Land Degradation	*No*	*0*	*0*
			Desertification	*No*	*0*	*0*
	Air	PM Pollutants	PM10s	*No*	*0*	*0*
			PM2.5s	*No*	*0*	*0*
		Oxide Pollutants	Sulphur Oxides	*No*	*0*	*0*
			Nitrogen Oxides	*No*	*0*	*0*
			Carbon Monoxide	*Yes*	*4*	*0*

		Heavy Metal	Cadmium	*No*	*0*	*0*
			Lead	*No*	*0*	*0*
			Mercury	*No*	*0*	*0*
	Water	Water Use & Efficiency	Water Withdrawn	*No*	*0*	*0*
			Water Consumed	*Yes*	*6*	*4*
			Non-renewable Water Resources	*No*	*0*	*0*
			Renewable Water Resources	*No*	*0*	*0*
		Water Quality	Fertilizer & Pesticide Loadings	*No*	*0*	*0*
			Pollution from Feedstock Production	*Yes*	*2*	*8*
			Pollution from Feedstock Processing	*Yes*	*2*	*8*
			Pollution from Feedstock Conversion	*No*	*0*	*0*
		Water Systems	Flooding	*No*	*0*	*0*
			Local Water Stresses	*No*	*0*	*0*
Climate Change	Governance	Climate Action	Targets, Legislation & Regulations	*No*	*0*	*0*
			Awareness	*No*	*0*	*0*
		Standards	Fuel Standards	*No*	*0*	*0*
			Technical Standards	*Yes*	*2*	*6*
			Supply Chain of Custody Processes	*No*	*0*	*0*
	Carbon & Emissions	Whole Life Cycle Emissions	Energy Conversion	*No*	*0*	*0*
			Feedstock Sources	*Yes*	*6*	*6*
			Transport	*No*	*0*	*0*
			Processing & Pre-treatment	*Yes*	*4*	*6*
		Land & Carbon Stocks	Direct Land Use Change	*No*	*0*	*0*
			Indirect Land Use Change	*No*	*0*	*0*
			Changes in Carbon Stocks	*No*	*0*	*0*
		Counterfactual Considerations	Land Use Counterfactuals	*No*	*0*	*0*
			Resource Use Counterfactuals	*No*	*0*	*0*
	Energy System	Replaced Fuels	Substitution of Fossil Fuels	*Yes*	*2*	*8*
			Substitution of Traditional Bioenergy	*No*	*0*	*0*

CS5 – Hydrogen from Wastewater via Photocatalysis

Categories	Themes	Indicators	Issues	Sustainability Issue Scores		
				Applicability	*IS[a]*	*IS[b]*
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden	*No*	*0*	*0*
			Exposure to Occupational Health & Safety Hazards	*Yes*	*2*	*0*
		Food Systems	Food Commodity Supply	*No*	*0*	*0*
			Food Commodity Imports & Exports	*No*	*0*	*0*
			Climate Change Resilience	*No*	*0*	*0*
			Changes in Costs of Agricultural Products	*No*	*0*	*0*
			Food Prices	*No*	*0*	*0*
			Food Security	*No*	*0*	*0*
	Livelihoods	Land Management	Land Ownership	*No*	*0*	*0*
			Land Access	*No*	*0*	*0*
		Decent Work	Rights	*No*	*0*	*0*
			Child Labour	*No*	*0*	*0*
			Slave Labour	*No*	*0*	*0*
			International Labour Standards	*No*	*0*	*0*
		Jobs & Skills	Skilled Jobs	*No*	*0*	*0*
			Unskilled Jobs	*No*	*0*	*0*
			Permanent Jobs	*No*	*0*	*0*
			Temporary Jobs	*No*	*0*	*0*
			Regional Job Distribution	*No*	*0*	*0*
			Career Development	*No*	*0*	*0*
		Change in income	Income from Bioenergy	*No*	*0*	*0*
			Net Income from Bioenergy	*No*	*0*	*0*
	Society	Equality	Diversity through Supply Chain Participation	*No*	*0*	*0*
			Diversity & End Use	*No*	*0*	*0*
		Peace, Justice & Strong Institutions	Legality	*No*	*0*	*0*
			Monitoring	*No*	*0*	*0*
			Bribery & Conflicts of Business	*No*	*0*	*0*
		Partnerships	Community Partnerships	*No*	*0*	*0*
			Industry Partnerships	*No*	*0*	*0*
			Government Partnerships	*No*	*0*	*0*
			Specialist Bioenergy Partnerships	*No*	*0*	*0*
		Energy Access	Households using Bioenergy	*No*	*0*	*0*
			Industry using Bioenergy	*No*	*0*	*0*
Development	Economy	Economic Performance	Gross Domestic Product	*No*	*0*	*0*
			Influence on Wider Sectors	*No*	*0*	*0*
			International Trade	*No*	*0*	*0*
			Financial Capacity to Adopt Bioenergy	*No*	*0*	*0*
		Economic Stimulation	Increased Sustainable Energy Generation	*No*	*0*	*0*
			Economic Support Mechanisms	*No*	*0*	*0*
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability	*No*	*0*	*0*
			Existing Infrastructure - Capacity	*No*	*0*	*0*
			New Infrastructure Capacity	*Yes*	*4*	*8*
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)	*No*	*0*	*0*
			Use of Genetically Modified Materials	*No*	*0*	*0*
			Feedstock Production Strategy	*No*	*0*	*0*
			Land Use Productivity	*No*	*0*	*0*
		Mobilisation	Resource Mobilisation	*No*	*0*	*0*
			Competition for Resources	*No*	*0*	*0*
		Distribution	Spatial Distribution of Resources	*Yes*	*4*	*4*
			Resource Transportation	*No*	*0*	*0*
	Technology	Innovation	TRL Development	*Yes*	*6*	*10*
			Intellectual Property	*Yes*	*0*	*10*
		Efficiencies	Processing Efficiencies	*Yes*	*4*	*8*
			Supply Chain Efficiencies	*No*	*0*	*0*
		Techno-Economics	CAPEX - Direct Fixed Capital Cost	*Yes*	*8*	*6*
			CAPEX - Indirect Fixed Capital Cost	*Yes*	*8*	*6*
			OPEX - Fixed Operational Costs	*Yes*	*8*	*6*
			OPEX - Variable Operational Costs	*Yes*	*8*	*6*
			Biomass Feedstock Costs	*No*	*0*	*0*
			Reliance on Economic Support Measures	*No*	*0*	*0*
	Energy Sector	Bioenergy	Infrastructure Alignment	*No*	*0*	*0*
			Bio-Product Flexibility (energy)	*No*	*0*	*0*
			Bio-Product Flexibility (non-energy)	*No*	*0*	*0*
			Bioenergy Vector Distribution	*No*	*0*	*0*
			Bioenergy Vector Affordability	*No*	*0*	*0*
		Energy System Performances	Input Energy Requirements	*Yes*	*4*	*6*

			Influences on Energy System Resilience	*No*	*0*	*0*
			Accessibility to Wider Input Energy	*Yes*	*4*	*6*
	Bioeconomy	**Added Value Products**	Bio-Chemicals	*No*	*0*	*0*
			Bio-Products	*No*	*0*	*0*
		Bioenergy Complementing Wider Sectors	Agriculture	*No*	*0*	*0*
			Chemical	*No*	*0*	*0*
			Waste	*Yes*	*4*	*8*
			Construction	*No*	*0*	*0*
			Transport	*No*	*0*	*0*
			Services	*No*	*0*	*0*
			Manufacturing	*No*	*0*	*0*
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access	*No*	*0*	*0*
			Location - Influencing Distribution & Connectivity	*No*	*0*	*0*
			Use of Contaminated Lands	*No*	*0*	*0*
			Potential for Phytoremediation	*No*	*0*	*0*
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon	*No*	*0*	*0*
			Soil Fertility	*No*	*0*	*0*
			Soil Erosion	*No*	*0*	*0*
			Accumulation of Mineral Salts	*No*	*0*	*0*
			Drainage Impacts	*No*	*0*	*0*
			Soil Compaction	*No*	*0*	*0*
			Soli Influence on Productivity Yields	*No*	*0*	*0*
		Ecosystems	Biodiversity	*No*	*0*	*0*
			Areas of Conservation & High Biodiversity	*No*	*0*	*0*
			Land Degradation	*No*	*0*	*0*
			Desertification	*No*	*0*	*0*
	Air	**PM Pollutants**	PM10s	*No*	*0*	*0*
			PM2.5s	*No*	*0*	*0*
		Oxide Pollutants	Sulphur Oxides	*No*	*0*	*0*
			Nitrogen Oxides	*No*	*0*	*0*
			Carbon Monoxide	*No*	*0*	*0*
		Heavy Metal	Cadmium	*No*	*0*	*0*
			Lead	*No*	*0*	*0*
			Mercury	*No*	*0*	*0*
	Water	**Water Use & Efficiency**	Water Withdrawn	*Yes*	*4*	*8*
			Water Consumed	*Yes*	*4*	*8*
			Non-renewable Water Resources	*Yes*	*4*	*8*
			Renewable Water Resources	*Yes*	*4*	*8*
		Water Quality	Fertilizer & Pesticide Loadings	*No*	*0*	*0*
			Pollution from Feedstock Production	*No*	*0*	*0*
			Pollution from Feedstock Processing	*No*	*0*	*0*
			Pollution from Feedstock Conversion	*Yes*	*4*	*8*
		Water Systems	Flooding	*No*	*0*	*0*
			Local Water Stresses	*No*	*0*	*0*
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations	*No*	*0*	*0*
			Awareness	*No*	*0*	*0*
		Standards	Fuel Standards	*No*	*0*	*0*
			Technical Standards	*Yes*	*0*	*6*
			Supply Chain of Custody Processes	*No*	*0*	*0*
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion	*Yes*	*4*	*6*
			Feedstock Sources	*No*	*0*	*0*
			Transport	*No*	*0*	*0*
			Processing & Pre-treatment	*No*	*0*	*0*
		Land & Carbon Stocks	Direct Land Use Change	*No*	*0*	*0*
			Indirect Land Use Change	*No*	*0*	*0*
			Changes in Carbon Stocks	*No*	*0*	*0*
		Counterfactual Considerations	Land Use Counterfactuals	*No*	*0*	*0*
			Resource Use Counterfactuals	*No*	*0*	*0*
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels	*No*	*0*	*0*
			Substitution of Traditional Bioenergy	*Yes*	*4*	*8*

CS6 – Hydrochar & Liquefied Value Added Products through Catalysis & Hydrolysis of Wood Residues

Categories	Themes	Indicators	Issues	Sustainability Issue Scores		
				Applicability	*IS[r]*	*IS[b]*
People	**Health**	**Health & Wellbeing**	Mortality Rate & Disease Burden	*No*	*0*	*0*
			Exposure to Occupational Health & Safety Hazards	*Yes*	*4*	*6*
		Food Systems	Food Commodity Supply	*No*	*0*	*0*
			Food Commodity Imports & Exports	*No*	*0*	*0*
			Climate Change Resilience	*No*	*0*	*0*
			Changes in Costs of Agricultural Products	*No*	*0*	*0*
			Food Prices	*No*	*0*	*0*
			Food Security	*No*	*0*	*0*
	Livelihoods	**Land Management**	Land Ownership	*No*	*0*	*0*
			Land Access	*No*	*0*	*0*
		Decent Work	Rights	*No*	*0*	*0*
			Child Labour	*No*	*0*	*0*
			Slave Labour	*No*	*0*	*0*
			International Labour Standards	*No*	*0*	*0*
		Jobs & Skills	Skilled Jobs	*No*	*0*	*0*
			Unskilled Jobs	*No*	*0*	*0*
			Permanent Jobs	*No*	*0*	*0*
			Temporary Jobs	*No*	*0*	*0*
			Regional Job Distribution	*No*	*0*	*0*
			Career Development	*No*	*0*	*0*
		Change in income	Income from Bioenergy	*No*	*0*	*0*
			Net Income from Bioenergy	*No*	*0*	*0*
	Society	**Equality**	Diversity through Supply Chain Participation	*No*	*0*	*0*
			Diversity & End Use	*No*	*0*	*0*
		Peace, Justice & Strong Institutions	Legality	*No*	*0*	*0*
			Monitoring	*No*	*0*	*0*
			Bribery & Conflicts of Business	*No*	*0*	*0*
		Partnerships	Community Partnerships	*no*	*0*	*0*
			Industry Partnerships	*No*	*0*	*0*
			Government Partnerships	*no*	*0*	*0*
			Specialist Bioenergy Partnerships	*No*	*0*	*0*
		Energy Access	Households using Bioenergy	*No*	*0*	*0*
			Industry using Bioenergy	*Yes*	*8*	*8*
Development	**Economy**	**Economic Performance**	Gross Domestic Product	*No*	*0*	*0*
			Influence on Wider Sectors	*no*	*0*	*0*

			International Trade	*no*	*0*	*0*
			Financial Capacity to Adopt Bioenergy	*Yes*	*6*	*12*
		Economic Stimulation	Increased Sustainable Energy Generation	*Yes*	*6*	*8*
			Economic Support Mechanisms	*Yes*	*6*	*8*
	Infrastructure	**Infrastructure Requirements**	Existing Infrastructure - Availability	*no*	*0*	*0*
			Existing Infrastructure - Capacity	*no*	*0*	*0*
			New Infrastructure Capacity	*No*	*0*	*0*
	Feedstock Production/ Mobilisation/ Distribution	**Production Processes**	Chemical Agro-Chemicals (fertiliser + pesticide)	*no*	*0*	*0*
			Use of Genetically Modified Materials	*no*	*0*	*0*
			Feedstock Production Strategy	*no*	*0*	*0*
			Land Use Productivity	*no*	*0*	*0*
		Mobilisation	Resource Mobilisation	*no*	*0*	*0*
			Competition for Resources	*no*	*0*	*0*
		Distribution	Spatial Distribution of Resources	*no*	*0*	*0*
			Resource Transportation	*No*	*0*	*0*
	Technology	**Innovation**	TRL Development	*Yes*	*8*	*8*
			Intellectual Property	*Yes*	*2*	*2*
		Efficiencies	Processing Efficiencies	*Yes*	*4*	*12*
			Supply Chain Efficiencies	*Yes*	*4*	*6*
		Techno-Economics	CAPEX - Direct Fixed Capital Cost	*no*	*0*	*0*
			CAPEX - Indirect Fixed Capital Cost	*no*	*0*	*0*
			OPEX - Fixed Operational Costs	*no*	*0*	*0*
			OPEX - Variable Operational Costs	*no*	*0*	*0*
			Biomass Feedstock Costs	*Yes*	*6*	*8*
			Reliance on Economic Support Measures	*no*	*0*	*0*
	Energy Sector	**Bioenergy**	Infrastructure Alignment	*no*	*0*	*0*
			Bio-Product Flexibility (energy)	*No*	*0*	*0*
			Bio-Product Flexibility (non-energy)	*no*	*0*	*0*
			Bioenergy Vector Distribution	*no*	*0*	*0*
			Bioenergy Vector Affordability	*no*	*0*	*0*
		Energy System Performances	Input Energy Requirements	*Yes*	*3*	*8*
			Influences on Energy System Resilience	*no*	*0*	*0*
			Accessibility to Wider Input Energy	*no*	*0*	*0*
	Bioeconomy	**Added Value Products**	Bio-Chemicals	*Yes*	*6*	*8*
			Bio-Products	*Yes*	*2*	*12*
		Bioenergy Complementing Wider Sectors	Agriculture	*no*	*0*	*0*
			Chemical	*Yes*	*12*	*12*
			Waste	*no*	*0*	*0*
			Construction	*no*	*0*	*0*
			Transport	*no*	*0*	*0*
			Services	*no*	*0*	*0*
			Manufacturing	*no*	*0*	*0*
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access	*no*	*0*	*0*
			Location - Influencing Distribution & Connectivity	*no*	*0*	*0*
			Use of Contaminated Lands	*no*	*0*	*0*
			Potential for Phytoremediation	*no*	*0*	*0*
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon	*no*	*0*	*0*
			Soil Fertility	*no*	*0*	*0*
			Soil Erosion	*no*	*0*	*0*
			Accumulation of Mineral Salts	*no*	*0*	*0*
			Drainage Impacts	*no*	*0*	*0*
			Soil Compaction	*no*	*0*	*0*
			Soli Influence on Productivity Yields	*no*	*0*	*0*
		Ecosystems	Biodiversity	*no*	*0*	*0*
			Areas of Conservation & High Biodiversity	*no*	*0*	*0*
			Land Degradation	*no*	*0*	*0*
			Desertification	*no*	*0*	*0*
	Air	**PM Pollutants**	PM10s	*no*	*0*	*0*
			PM2.5s	*no*	*0*	*0*
		Oxide Pollutants	Sulphur Oxides	*no*	*0*	*0*
			Nitrogen Oxides	*no*	*0*	*0*
			Carbon Monoxide	*No*	*0*	*0*
		Heavy Metal	Cadmium	*no*	*0*	*0*
			Lead	*no*	*0*	*0*
			Mercury	*no*	*0*	*0*
	Water	**Water Use & Efficiency**	Water Withdrawn	*Yes*	*8*	*4*
			Water Consumed	*Yes*	*6*	*4*
			Non-renewable Water Resources	*Yes*	*10*	*4*
			Renewable Water Resources	*yes*	*6*	*8*
		Water Quality	Fertilizer & Pesticide Loadings	*no*	*0*	*0*
			Pollution from Feedstock Production	*no*	*0*	*0*
			Pollution from Feedstock Processing	*Yes*	*8*	*6*
			Pollution from Feedstock Conversion	*Yes*	*6*	*6*
		Water Systems	Flooding	*no*	*0*	*0*
			Local Water Stresses	*Yes*	*6*	*6*
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations	*no*	*0*	*0*
			Awareness	*no*	*0*	*0*
		Standards	Fuel Standards	*Yes*	*4*	*6*
			Technical Standards	*Yes*	*4*	*4*
			Supply Chain of Custody Processes	*No*	*0*	*0*
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion	*No*	*0*	*0*
			Feedstock Sources	*No*	*0*	*0*
			Transport	*no*	*0*	*0*
			Processing & Pre-treatment	*Yes*	*6*	*8*
		Land & Carbon Stocks	Direct Land Use Change	*no*	*0*	*0*
			Indirect Land Use Change	*no*	*0*	*0*
			Changes in Carbon Stocks	*no*	*0*	*0*
		Counterfactual Considerations	Land Use Counterfactuals	*No*	*0*	*0*
			Resource Use Counterfactuals	*no*	*0*	*0*
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels	*Yes*	*4*	*10*
			Substitution of Traditional Bioenergy	*no*	*0*	*0*

CS7 – Hydrochar & Liquefied Value Added Products through Catalysis & Hydrolysis of Seaweed

Categories	Themes	Indicators	Issues	Sustainability Issue Scores		
				Applicability	*IS[a]*	*IS[b]*
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden	*No*	*0*	*0*
			Exposure to Occupational Health & Safety Hazards	*Yes*	*3*	*6*
		Food Systems	Food Commodity Supply	*Yes*	*6*	*6*
			Food Commodity Imports & Exports	*No*	*0*	*0*
			Climate Change Resilience	*Yes*	*6*	*6*
			Changes in Costs of Agricultural Products	*No*	*0*	*0*
			Food Prices	*Yes*	*4*	*6*
			Food Security	*Yes*	*4*	*6*
	Livelihoods	Land Management	Land Ownership	*No*	*0*	*0*
			Land Access	*No*	*0*	*0*
		Decent Work	Rights	*No*	*0*	*0*
			Child Labour	*No*	*0*	*0*
			Slave Labour	*No*	*0*	*0*
			International Labour Standards	*No*	*0*	*0*
		Jobs & Skills	Skilled Jobs	*No*	*0*	*0*
			Unskilled Jobs	*No*	*0*	*0*
			Permanent Jobs	*No*	*0*	*0*
			Temporary Jobs	*No*	*0*	*0*
			Regional Job Distribution	*No*	*0*	*0*
			Career Development	*No*	*0*	*0*
		Change in income	Income from Bioenergy	*No*	*0*	*0*
			Net Income from Bioenergy	*No*	*0*	*0*
	Society	Equality	Diversity through Supply Chain Participation	*No*	*0*	*0*
			Diversity & End Use	*No*	*0*	*0*
		Peace, Justice & Strong Institutions	Legality	*No*	*0*	*0*
			Monitoring	*No*	*0*	*0*
			Bribery & Conflicts of Business	*No*	*0*	*0*
		Partnerships	Community Partnerships	*No*	*0*	*0*
			Industry Partnerships	*No*	*0*	*0*
			Government Partnerships	*No*	*0*	*0*
			Specialist Bioenergy Partnerships	*No*	*0*	*0*
		Energy Access	Households using Bioenergy	*No*	*0*	*0*
			Industry using Bioenergy	*Yes*	*8*	*8*
Development	Economy	Economic Performance	Gross Domestic Product	*No*	*0*	*0*
			Influence on Wider Sectors	*No*	*0*	*0*
			International Trade	*No*	*0*	*0*
			Financial Capacity to Adopt Bioenergy	*No*	*0*	*0*
		Economic Stimulation	Increased Sustainable Energy Generation	*Yes*	*6*	*8*
			Economic Support Mechanisms	*No*	*0*	*0*
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability	*No*	*0*	*0*
			Existing Infrastructure - Capacity	*No*	*0*	*0*
			New Infrastructure Capacity	*No*	*0*	*0*
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)	*No*	*0*	*0*
			Use of Genetically Modified Materials	*No*	*0*	*0*
			Feedstock Production Strategy	*No*	*0*	*0*
			Land Use Productivity	*No*	*0*	*0*
		Mobilisation	Resource Mobilisation	*No*	*0*	*0*
			Competition for Resources	*No*	*0*	*0*
		Distribution	Spatial Distribution of Resources	*No*	*0*	*0*
			Resource Transportation	*No*	*0*	*0*
	Technology	Innovation	TRL Development	*Yes*	*8*	*6*
			Intellectual Property	*Yes*	*2*	*2*
		Efficiencies	Processing Efficiencies	*Yes*	*4*	*8*
			Supply Chain Efficiencies	*No*	*0*	*0*
		Techno-Economics	CAPEX - Direct Fixed Capital Cost	*No*	*0*	*0*
			CAPEX - Indirect Fixed Capital Cost	*No*	*0*	*0*
			OPEX - Fixed Operational Costs	*No*	*0*	*0*
			OPEX - Variable Operational Costs	*No*	*0*	*0*
			Biomass Feedstock Costs	*No*	*0*	*0*
			Reliance on Economic Support Measures	*No*	*0*	*0*
	Energy Sector	Bioenergy	Infrastructure Alignment	*No*	*0*	*0*
			Bio-Product Flexibility (energy)	*No*	*0*	*0*
			Bio-Product Flexibility (non-energy)	*No*	*0*	*0*
			Bioenergy Vector Distribution	*No*	*0*	*0*
			Bioenergy Vector Affordability	*No*	*0*	*0*
		Energy System Performances	Input Energy Requirements	*No*	*0*	*0*
			Influences on Energy System Resilience	*No*	*0*	*0*
			Accessibility to Wider Input Energy	*No*	*0*	*0*
	Bioeconomy	Added Value Products	Bio-Chemicals	*Yes*	*6*	*8*
			Bio-Products	*Yes*	*4*	*6*
		Bioenergy Complementing Wider Sectors	Agriculture	*Yes*	*2*	*2*
			Chemical	*Yes*	*6*	*8*
			Waste	*No*	*0*	*0*
			Construction	*No*	*0*	*0*
			Transport	*No*	*0*	*0*
			Services	*No*	*0*	*0*
			Manufacturing	*No*	*0*	*0*
	Land Utilisation	Land Characteristics	Topography - Influencing Access	*No*	*0*	*0*
			Location - Influencing Distribution & Connectivity	*No*	*0*	*0*
			Use of Contaminated Lands	*No*	*0*	*0*
			Potential for Phytoremediation	*No*	*0*	*0*
Natural Systems	Land	Soil	Impact on Soil Organic Carbon	*No*	*0*	*0*
			Soil Fertility	*No*	*0*	*0*
			Soil Erosion	*No*	*0*	*0*
			Accumulation of Mineral Salts	*No*	*0*	*0*
			Drainage Impacts	*No*	*0*	*0*
			Soil Compaction	*No*	*0*	*0*
			Soli Influence on Productivity Yields	*No*	*0*	*0*
		Ecosystems	Biodiversity	*No*	*0*	*0*
			Areas of Conservation & High Biodiversity	*No*	*0*	*0*
			Land Degradation	*No*	*0*	*0*
			Desertification	*No*	*0*	*0*
	Air	PM Pollutants	PM10s	*No*	*0*	*0*
			PM2.5s	*No*	*0*	*0*
		Oxide Pollutants	Sulphur Oxides	*No*	*0*	*0*
			Nitrogen Oxides	*No*	*0*	*0*
			Carbon Monoxide	*No*	*0*	*0*

		Heavy Metal	Cadmium	*No*	*0*	*0*
			Lead	*No*	*0*	*0*
			Mercury	*No*	*0*	*0*
	Water	Water Use & Efficiency	Water Withdrawn	*Yes*	*8*	*4*
			Water Consumed	*Yes*	*6*	*4*
			Non-renewable Water Resources	*Yes*	*10*	*4*
			Renewable Water Resources	*Yes*	*6*	*6*
		Water Quality	Fertilizer & Pesticide Loadings	*No*	*0*	*0*
			Pollution from Feedstock Production	*No*	*0*	*0*
			Pollution from Feedstock Processing	*Yes*	*8*	*6*
			Pollution from Feedstock Conversion	*Yes*	*6*	*6*
		Water Systems	Flooding	*No*	*0*	*0*
			Local Water Stresses	*Yes*	*6*	*6*
Climate Change	Governance	Climate Action	Targets, Legislation & Regulations	*No*	*0*	*0*
			Awareness	*No*	*0*	*0*
		Standards	Fuel Standards	*Yes*	*4*	*6*
			Technical Standards	*Yes*	*4*	*4*
			Supply Chain of Custody Processes	*No*	*0*	*0*
	Carbon & Emissions	Whole Life Cycle Emissions	Energy Conversion	*No*	*0*	*0*
			Feedstock Sources	*No*	*0*	*0*
			Transport	*No*	*0*	*0*
			Processing & Pre-treatment	*Yes*	*6*	*8*
		Land & Carbon Stocks	Direct Land Use Change	*No*	*0*	*0*
			Indirect Land Use Change	*No*	*0*	*0*
			Changes in Carbon Stocks	*No*	*0*	*0*
		Counterfactual Considerations	Land Use Counterfactuals	*No*	*0*	*0*
			Resource Use Counterfactuals	*No*	*0*	*0*
	Energy System	Replaced Fuels	Substitution of Fossil Fuels	*Yes*	*4*	*8*
			Substitution of Traditional Bioenergy	*No*	*0*	*0*

CS8 – Biohydrogen replacing Blue Hydrogen

Categories	Themes	Indicators	Issues	Sustainability Issue Scores		
				Applicability	*IS[a]*	*IS[b]*
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden	*No*	*0*	*0*
			Exposure to Occupational Health & Safety Hazards	*No*	*0*	*0*
		Food Systems	Food Commodity Supply	*No*	*0*	*0*
			Food Commodity Imports & Exports	*No*	*0*	*0*
			Climate Change Resilience	*No*	*0*	*0*
			Changes in Costs of Agricultural Products	*No*	*0*	*0*
			Food Prices	*No*	*0*	*0*
			Food Security	*No*	*0*	*0*
	Livelihoods	Land Management	Land Ownership	*No*	*0*	*0*
			Land Access	*No*	*0*	*0*
		Decent Work	Rights	*No*	*0*	*0*
			Child Labour	*No*	*0*	*0*
			Slave Labour	*No*	*0*	*0*
			International Labour Standards	*No*	*0*	*0*
		Jobs & Skills	Skilled Jobs	*Yes*	*3*	*3*
			Unskilled Jobs	*Yes*	*3*	*3*
			Permanent Jobs	*Yes*	*3*	*3*
			Temporary Jobs	*Yes*	*3*	*3*
			Regional Job Distribution	*Yes*	*3*	*3*
			Career Development	*Yes*	*3*	*3*
		Change in income	Income from Bioenergy	*No*	*0*	*0*
			Net Income from Bioenergy	*Yes*	*4*	*6*
	Society	Equality	Diversity through Supply Chain Participation	*No*	*0*	*0*
			Diversity & End Use	*No*	*0*	*0*
		Peace, Justice & Strong Institutions	Legality	*No*	*0*	*0*
			Monitoring	*No*	*0*	*0*
			Bribery & Conflicts of Business	*No*	*0*	*0*
		Partnerships	Community Partnerships	*no*	*0*	*0*
			Industry Partnerships	*no*	*0*	*0*
			Government Partnerships	*no*	*0*	*0*
			Specialist Bioenergy Partnerships	*no*	*0*	*0*
		Energy Access	Households using Bioenergy	*Yes*	*2*	*6*
			Industry using Bioenergy	*Yes*	*2*	*6*
Development	Economy	Economic Performance	Gross Domestic Product	*Yes*	*3*	*3*
			Influence on Wider Sectors	*no*	*0*	*0*
			International Trade	*no*	*0*	*0*
			Financial Capacity to Adopt Bioenergy	*no*	*0*	*0*
		Economic Stimulation	Increased Sustainable Energy Generation	*Yes*	*2*	*6*
			Economic Support Mechanisms	*No*	*0*	*0*
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability	*Yes*	*6*	*6*
			Existing Infrastructure - Capacity	*Yes*	*6*	*6*
			New Infrastructure Capacity	*Yes*	*6*	*6*
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)	*no*	*0*	*0*
			Use of Genetically Modified Materials	*no*	*0*	*0*
			Feedstock Production Strategy	*no*	*0*	*0*
			Land Use Productivity	*no*	*0*	*0*
		Mobilisation	Resource Mobilisation	*No*	*0*	*0*
			Competition for Resources	*No*	*0*	*0*
		Distribution	Spatial Distribution of Resources	*no*	*0*	*0*
			Resource Transportation	*no*	*0*	*0*
	Technology	Innovation	TRL Development	*Yes*	*2*	*6*
			Intellectual Property	*Yes*	*2*	*2*
		Efficiencies	Processing Efficiencies	*Yes*	*6*	*6*
			Supply Chain Efficiencies	*Yes*	*6*	*6*
		Techno-Economics	CAPEX - Direct Fixed Capital Cost	*Yes*	*6*	*6*
			CAPEX - Indirect Fixed Capital Cost	*Yes*	*6*	*6*
			OPEX - Fixed Operational Costs	*Yes*	*6*	*6*
			OPEX - Variable Operational Costs	*Yes*	*6*	*6*
			Biomass Feedstock Costs	*Yes*	*3*	*3*
			Reliance on Economic Support Measures	*Yes*	*6*	*6*
	Energy Sector	Bioenergy	Infrastructure Alignment	*Yes*	*4*	*6*
			Bio-Product Flexibility (energy)	*Yes*	*4*	*6*
			Bio-Product Flexibility (non-energy)	*No*	*0*	*0*
			Bioenergy Vector Distribution	*Yes*	*6*	*6*
			Bioenergy Vector Affordability	*Yes*	*6*	*6*
		Energy System Performances	Input Energy Requirements	*Yes*	*4*	*6*

			Influences on Energy System Resilience	*Yes*	*6*	*6*
			Accessibility to Wider Input Energy	*Yes*	*6*	*6*
	Bioeconomy	**Added Value Products**	Bio-Chemicals	*No*	*0*	*0*
			Bio-Products	*No*	*0*	*0*
		Bioenergy Complementing Wider Sectors	Agriculture	*No*	*0*	*0*
			Chemical	*Yes*	*2*	*6*
			Waste	*Yes*	*2*	*6*
			Construction	*No*	*0*	*0*
			Transport	*No*	*0*	*0*
			Services	*No*	*0*	*0*
			Manufacturing	*Yes*	*2*	*6*
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access	*No*	*0*	*0*
			Location - Influencing Distribution & Connectivity	*No*	*0*	*0*
			Use of Contaminated Lands	*No*	*0*	*0*
			Potential for Phytoremediation	*No*	*0*	*0*
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon	*No*	*0*	*0*
			Soil Fertility	*No*	*0*	*0*
			Soil Erosion	*No*	*0*	*0*
			Accumulation of Mineral Salts	*No*	*0*	*0*
			Drainage Impacts	*No*	*0*	*0*
			Soil Compaction	*No*	*0*	*0*
			Soli Influence on Productivity Yields	*No*	*0*	*0*
		Ecosystems	Biodiversity	*no*	*0*	*0*
			Areas of Conservation & High Biodiversity	*no*	*0*	*0*
			Land Degradation	*no*	*0*	*0*
			Desertification	*no*	*0*	*0*
	Air	**PM Pollutants**	PM10s	*Yes*	*1*	*3*
			PM2.5s	*Yes*	*1*	*3*
		Oxide Pollutants	Sulphur Oxides	*Yes*	*1*	*3*
			Nitrogen Oxides	*Yes*	*1*	*3*
			Carbon Monoxide	*Yes*	*1*	*3*
		Heavy Metal	Cadmium	*Yes*	*1*	*3*
			Lead	*Yes*	*1*	*3*
			Mercury	*Yes*	*1*	*3*
	Water	**Water Use & Efficiency**	Water Withdrawn	*Yes*	*2*	*1*
			Water Consumed	*Yes*	*2*	*1*
			Non-renewable Water Resources	*Yes*	*1*	*1*
			Renewable Water Resources	*Yes*	*1*	*1*
		Water Quality	Fertilizer & Pesticide Loadings	*No*	*0*	*0*
			Pollution from Feedstock Production	*No*	*0*	*0*
			Pollution from Feedstock Processing	*No*	*0*	*0*
			Pollution from Feedstock Conversion	*No*	*0*	*0*
		Water Systems	Flooding	*no*	*0*	*0*
			Local Water Stresses	*no*	*0*	*0*
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations	*Yes*	*6*	*6*
			Awareness	*No*	*0*	*0*
		Standards	Fuel Standards	*Yes*	*4*	*4*
			Technical Standards	*Yes*	*4*	*4*
			Supply Chain of Custody Processes	*Yes*	*4*	*4*
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion	*Yes*	*3*	*9*
			Feedstock Sources	*Yes*	*2*	*6*
			Transport	*No*	*0*	*0*
			Processing & Pre-treatment	*No*	*0*	*0*
		Land & Carbon Stocks	Direct Land Use Change	*No*	*0*	*0*
			Indirect Land Use Change	*No*	*0*	*0*
			Changes in Carbon Stocks	*No*	*0*	*0*
		Counterfactual Considerations	Land Use Counterfactuals	*No*	*0*	*0*
			Resource Use Counterfactuals	*No*	*0*	*0*
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels	*Yes*	*8*	*12*
			Substitution of Traditional Bioenergy	*No*	*0*	*0*

CS9 – Miscanthus as a Feedstock for Local CHP with CCS Plants

Categories	Themes	Indicators	Issues	Sustainability Issue Scores		
				Applicability	*IS[r]*	*IS[b]*
People	**Health**	**Health & Wellbeing**	Mortality Rate & Disease Burden	*No*	*0*	*0*
			Exposure to Occupational Health & Safety Hazards	*No*	*0*	*0*
		Food Systems	Food Commodity Supply	*No*	*0*	*0*
			Food Commodity Imports & Exports	*No*	*0*	*0*
			Climate Change Resilience	*No*	*0*	*0*
			Changes in Costs of Agricultural Products	*No*	*0*	*0*
			Food Prices	*No*	*0*	*0*
			Food Security	*No*	*0*	*0*
	Livelihoods	**Land Management**	Land Ownership	*No*	*0*	*0*
			Land Access	*No*	*0*	*0*
		Decent Work	Rights	*No*	*0*	*0*
			Child Labour	*No*	*0*	*0*
			Slave Labour	*No*	*0*	*0*
			International Labour Standards	*No*	*0*	*0*
		Jobs & Skills	Skilled Jobs	*No*	*0*	*0*
			Unskilled Jobs	*No*	*0*	*0*
			Permanent Jobs	*No*	*0*	*0*
			Temporary Jobs	*No*	*0*	*0*
			Regional Job Distribution	*No*	*0*	*0*
			Career Development	*No*	*0*	*0*
		Change in income	Income from Bioenergy	*No*	*0*	*0*
			Net Income from Bioenergy	*Yes*	*6*	*8*
	Society	**Equality**	Diversity through Supply Chain Participation	*No*	*0*	*0*
			Diversity & End Use	*No*	*0*	*0*
		Peace, Justice & Strong Institutions	Legality	*No*	*0*	*0*
			Monitoring	*No*	*0*	*0*
			Bribery & Conflicts of Business	*No*	*0*	*0*
		Partnerships	Community Partnerships	*No*	*0*	*0*
			Industry Partnerships	*No*	*0*	*0*
			Government Partnerships	*No*	*0*	*0*
			Specialist Bioenergy Partnerships	*No*	*0*	*0*
		Energy Access	Households using Bioenergy	*Yes*	*0*	*6*
			Industry using Bioenergy	*Yes*	*0*	*6*
Development	**Economy**	**Economic Performance**	Gross Domestic Product	*No*	*0*	*0*
			Influence on Wider Sectors	*No*	*0*	*0*

			International Trade	*No*	*0*	*0*
			Financial Capacity to Adopt Bioenergy	*No*	*0*	*0*
		Economic Stimulation	Increased Sustainable Energy Generation	*Yes*	*4*	*8*
			Economic Support Mechanisms	*Yes*	*15*	*8*
	Infrastructure	**Infrastructure Requirements**	Existing Infrastructure - Availability	*Yes*	*8*	*8*
			Existing Infrastructure - Capacity	*Yes*	*8*	*8*
			New Infrastructure Capacity	*Yes*	*12*	*8*
	Feedstock Production/ Mobilisation/ Distribution	**Production Processes**	Chemical Agro-Chemicals (fertiliser + pesticide)	*No*	*0*	*0*
			Use of Genetically Modified Materials	*No*	*0*	*0*
			Feedstock Production Strategy	*Yes*	*8*	*15*
			Land Use Productivity	*Yes*	*2*	*10*
		Mobilisation	Resource Mobilisation	*No*	*0*	*0*
			Competition for Resources	*No*	*0*	*0*
		Distribution	Spatial Distribution of Resources	*No*	*0*	*0*
			Resource Transportation	*No*	*0*	*0*
	Technology	**Innovation**	TRL Development	*No*	*0*	*0*
			Intellectual Property	*No*	*0*	*0*
		Efficiencies	Processing Efficiencies	*Yes*	*6*	*6*
			Supply Chain Efficiencies	*Yes*	*6*	*6*
		Techno-Economics	CAPEX - Direct Fixed Capital Cost	*No*	*0*	*0*
			CAPEX - Indirect Fixed Capital Cost	*No*	*0*	*0*
			OPEX - Fixed Operational Costs	*No*	*0*	*0*
			OPEX - Variable Operational Costs	*No*	*0*	*0*
			Biomass Feedstock Costs	*No*	*0*	*0*
			Reliance on Economic Support Measures	*No*	*0*	*0*
	Energy Sector	**Bioenergy**	Infrastructure Alignment	*No*	*0*	*0*
			Bio-Product Flexibility (energy)	*No*	*0*	*0*
			Bio-Product Flexibility (non-energy)	*No*	*0*	*0*
			Bioenergy Vector Distribution	*No*	*0*	*0*
			Bioenergy Vector Affordability	*No*	*0*	*0*
		Energy System Performances	Input Energy Requirements	*No*	*0*	*0*
			Influences on Energy System Resilience	*No*	*0*	*0*
			Accessibility to Wider Input Energy	*No*	*0*	*0*
	Bioeconomy	**Added Value Products**	Bio-Chemicals	*No*	*0*	*0*
			Bio-Products	*Yes*	*4*	*4*
		Bioenergy Complementing Wider Sectors	Agriculture	*Yes*	*8*	*8*
			Chemical	*No*	*0*	*0*
			Waste	*Yes*	*2*	*8*
			Construction	*No*	*0*	*0*
			Transport	*Yes*	*0*	*0*
			Services	*No*	*0*	*0*
			Manufacturing	*No*	*0*	*0*
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access	*Yes*	*8*	*8*
			Location - Influencing Distribution & Connectivity	*Yes*	*15*	*8*
			Use of Contaminated Lands	*No*	*0*	*0*
			Potential for Phytoremediation	*No*	*0*	*0*
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon	*Yes*	*0*	*12*
			Soil Fertility	*Yes*	*0*	*8*
			Soil Erosion	*No*	*0*	*0*
			Accumulation of Mineral Salts	*No*	*0*	*0*
			Drainage Impacts	*Yes*	*0*	*6*
			Soil Compaction	*Yes*	*0*	*6*
			Soli Influence on Productivity Yields	*Yes*	*0*	*6*
		Ecosystems	Biodiversity	*No*	*0*	*0*
			Areas of Conservation & High Biodiversity	*No*	*0*	*0*
			Land Degradation	*No*	*0*	*0*
			Desertification	*No*	*0*	*0*
	Air	**PM Pollutants**	PM10s	*No*	*0*	*0*
			PM2.5s	*No*	*0*	*0*
		Oxide Pollutants	Sulphur Oxides	*No*	*0*	*0*
			Nitrogen Oxides	*No*	*0*	*0*
			Carbon Monoxide	*No*	*0*	*0*
		Heavy Metal	Cadmium	*No*	*0*	*0*
			Lead	*No*	*0*	*0*
			Mercury	*No*	*0*	*0*
	Water	**Water Use & Efficiency**	Water Withdrawn	*Yes*	*6*	*9*
			Water Consumed	*No*	*0*	*0*
			Non-renewable Water Resources	*No*	*0*	*0*
			Renewable Water Resources	*No*	*0*	*0*
		Water Quality	Fertilizer & Pesticide Loadings	*Yes*	*2*	*0*
			Pollution from Feedstock Production	*Yes*	*0*	*0*
			Pollution from Feedstock Processing	*Yes*	*0*	*0*
			Pollution from Feedstock Conversion	*No*	*0*	*0*
		Water Systems	Flooding	*No*	*0*	*0*
			Local Water Stresses	*Yes*	*6*	*6*
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations	*Yes*	*4*	*8*
			Awareness	*No*	*0*	*0*
		Standards	Fuel Standards	*No*	*0*	*0*
			Technical Standards	*No*	*0*	*0*
			Supply Chain of Custody Processes	*No*	*0*	*0*
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion	*Yes*	*6*	*15*
			Feedstock Sources	*Yes*	*6*	*15*
			Transport	*No*	*0*	*0*
			Processing & Pre-treatment	*No*	*0*	*0*
		Land & Carbon Stocks	Direct Land Use Change	*No*	*0*	*0*
			Indirect Land Use Change	*No*	*0*	*0*
			Changes in Carbon Stocks	*Yes*	*2*	*12*
		Counterfactual Considerations	Land Use Counterfactuals	*Yes*	*6*	*8*
			Resource Use Counterfactuals	*No*	*0*	*0*
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels	*Yes*	*4*	*12*
			Substitution of Traditional Bioenergy	*No*	*0*	*0*

CS10 – Biofuels & Bioproducts from the Pyrolysis of Microalgae grown on Food Waste

Categories	Themes	Indicators	Issues	Sustainability Issue Scores		
				Applicability	*IS[a]*	*IS[b]*
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden	*No*	*0*	*0*
			Exposure to Occupational Health & Safety Hazards	*Yes*	*2*	*6*
		Food Systems	Food Commodity Supply	*Yes*	*6*	*6*
			Food Commodity Imports & Exports	*No*	*0*	*0*
			Climate Change Resilience	*Yes*	*6*	*6*
			Changes in Costs of Agricultural Products	*No*	*0*	*0*
			Food Prices	*Yes*	*2*	*2*
			Food Security	*Yes*	*0*	*8*
	Livelihoods	Land Management	Land Ownership	*Yes*	*2*	*2*
			Land Access	*Yes*	*4*	*2*
		Decent Work	Rights	*No*	*0*	*0*
			Child Labour	*No*	*0*	*0*
			Slave Labour	*No*	*0*	*0*
			International Labour Standards	*No*	*0*	*0*
		Jobs & Skills	Skilled Jobs	*Yes*	*6*	*10*
			Unskilled Jobs	*Yes*	*2*	*2*
			Permanent Jobs	*Yes*	*6*	*6*
			Temporary Jobs	*Yes*	*6*	*6*
			Regional Job Distribution	*Yes*	*6*	*6*
			Career Development	*Yes*	*6*	*6*
		Change in income	Income from Bioenergy	*No*	*0*	*0*
			Net Income from Bioenergy	*No*	*0*	*0*
	Society	Equality	Diversity through Supply Chain Participation	*No*	*0*	*0*
			Diversity & End Use	*No*	*0*	*0*
		Peace, Justice & Strong Institutions	Legality	*No*	*0*	*0*
			Monitoring	*No*	*0*	*0*
			Bribery & Conflicts of Business	*No*	*0*	*0*
		Partnerships	Community Partnerships	*No*	*0*	*0*
			Industry Partnerships	*No*	*0*	*0*
			Government Partnerships	*No*	*0*	*0*
			Specialist Bioenergy Partnerships	*No*	*0*	*0*
		Energy Access	Households using Bioenergy	*No*	*0*	*0*
			Industry using Bioenergy	*Yes*	*2*	*10*
Development	Economy	Economic Performance	Gross Domestic Product	*No*	*0*	*0*
			Influence on Wider Sectors	*Yes*	*6*	*8*
			International Trade	*Yes*	*6*	*6*
			Financial Capacity to Adopt Bioenergy	*No*	*0*	*0*
		Economic Stimulation	Increased Sustainable Energy Generation	*Yes*	*6*	*10*
			Economic Support Mechanisms	*No*	*0*	*0*
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability	*No*	*0*	*0*
			Existing Infrastructure - Capacity	*No*	*0*	*0*
			New Infrastructure Capacity	*No*	*0*	*0*
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)	*No*	*0*	*0*
			Use of Genetically Modified Materials	*No*	*0*	*0*
			Feedstock Production Strategy	*Yes*	*10*	*10*
			Land Use Productivity	*Yes*	*8*	*8*
		Mobilisation	Resource Mobilisation	*Yes*	*4*	*10*
			Competition for Resources	*Yes*	*8*	*8*
		Distribution	Spatial Distribution of Resources	*Yes*	*8*	*8*
			Resource Transportation	*Yes*	*8*	*4*
	Technology	Innovation	TRL Development	*Yes*	*10*	*10*
			Intellectual Property	*Yes*	*6*	*10*
		Efficiencies	Processing Efficiencies	*Yes*	*8*	*6*
			Supply Chain Efficiencies	*No*	*0*	*0*
		Techno-Economics	CAPEX - Direct Fixed Capital Cost	*No*	*0*	*0*
			CAPEX - Indirect Fixed Capital Cost	*No*	*0*	*0*
			OPEX - Fixed Operational Costs	*No*	*0*	*0*
			OPEX - Variable Operational Costs	*No*	*0*	*0*
			Biomass Feedstock Costs	*Yes*	*8*	*8*
			Reliance on Economic Support Measures	*No*	*0*	*0*
	Energy Sector	Bioenergy	Infrastructure Alignment	*Yes*	*6*	*6*
			Bio-Product Flexibility (energy)	*Yes*	*4*	*10*
			Bio-Product Flexibility (non-energy)	*Yes*	*4*	*10*
			Bioenergy Vector Distribution	*Yes*	*8*	*8*
			Bioenergy Vector Affordability	*Yes*	*10*	*10*
		Energy System Performances	Input Energy Requirements	*Yes*	*2*	*10*
			Influences on Energy System Resilience	*Yes*	*6*	*6*
			Accessibility to Wider Input Energy	*Yes*	*6*	*6*
	Bioeconomy	Added Value Products	Bio-Chemicals	*Yes*	*2*	*10*
			Bio-Products	*Yes*	*2*	*10*
		Bioenergy Complementing Wider Sectors	Agriculture	*No*	*0*	*0*
			Chemical	*Yes*	*6*	*6*
			Waste	*Yes*	*6*	*6*
			Construction	*No*	*0*	*0*
			Transport	*Yes*	*6*	*6*
			Services	*No*	*0*	*0*
			Manufacturing	*No*	*0*	*0*
	Land Utilisation	Land Characteristics	Topography - Influencing Access	*No*	*0*	*0*
			Location - Influencing Distribution & Connectivity	*Yes*	*8*	*6*
			Use of Contaminated Lands	*Yes*	*6*	*6*
			Potential for Phytoremediation	*No*	*0*	*0*
Natural Systems	Land	Soil	Impact on Soil Organic Carbon	*Yes*	*6*	*6*
			Soil Fertility	*Yes*	*6*	*6*
			Soil Erosion	*No*	*0*	*0*
			Accumulation of Mineral Salts	*No*	*0*	*0*
			Drainage Impacts	*No*	*0*	*0*
			Soil Compaction	*No*	*0*	*0*
			Soli Influence on Productivity Yields	*No*	*0*	*0*
		Ecosystems	Biodiversity	*No*	*0*	*0*
			Areas of Conservation & High Biodiversity	*No*	*0*	*0*
			Land Degradation	*No*	*0*	*0*
			Desertification	*No*	*0*	*0*
	Air	PM Pollutants	PM10s	*No*	*0*	*0*
			PM2.5s	*No*	*0*	*0*
		Oxide Pollutants	Sulphur Oxides	*No*	*0*	*0*
			Nitrogen Oxides	*No*	*0*	*0*
			Carbon Monoxide	*No*	*0*	*0*

		Heavy Metal	Cadmium	*No*	*0*	*0*
			Lead	*No*	*0*	*0*
			Mercury	*No*	*0*	*0*
	Water	Water Use & Efficiency	Water Withdrawn	*Yes*	*6*	*6*
			Water Consumed	*Yes*	*2*	*10*
			Non-renewable Water Resources	*No*	*0*	*0*
			Renewable Water Resources	*Yes*	*2*	*8*
		Water Quality	Fertilizer & Pesticide Loadings	*No*	*0*	*0*
			Pollution from Feedstock Production	*No*	*0*	*0*
			Pollution from Feedstock Processing	*No*	*0*	*0*
			Pollution from Feedstock Conversion	*No*	*0*	*0*
		Water Systems	Flooding	*No*	*0*	*0*
			Local Water Stresses	*No*	*0*	*0*
Climate Change	Governance	Climate Action	Targets, Legislation & Regulations	*Yes*	*6*	*10*
			Awareness	*Yes*	*6*	*8*
		Standards	Fuel Standards	*Yes*	*8*	*10*
			Technical Standards	*Yes*	*6*	*6*
			Supply Chain of Custody Processes	*No*	*0*	*0*
	Carbon & Emissions	Whole Life Cycle Emissions	Energy Conversion	*Yes*	*6*	*8*
			Feedstock Sources	*Yes*	*6*	*6*
			Transport	*Yes*	*6*	*6*
			Processing & Pre-treatment	*Yes*	*6*	*6*
		Land & Carbon Stocks	Direct Land Use Change	*Yes*	*2*	*2*
			Indirect Land Use Change	*Yes*	*6*	*6*
			Changes in Carbon Stocks	*Yes*	*6*	*6*
		Counterfactual Considerations	Land Use Counterfactuals	*No*	*0*	*0*
			Resource Use Counterfactuals	*No*	*0*	*0*
	Energy System	Replaced Fuels	Substitution of Fossil Fuels	*Yes*	*4*	*8*
			Substitution of Traditional Bioenergy	*Yes*	*6*	*8*

CS11 – Hydrogen from the Pyrolysis of Biogas

Categories	Themes	Indicators	Issues	Sustainability Issue Scores		
				Applicability	*IS[a]*	*IS[b]*
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden	*No*	*0*	*0*
			Exposure to Occupational Health & Safety Hazards	*No*	*0*	*0*
		Food Systems	Food Commodity Supply	*No*	*0*	*0*
			Food Commodity Imports & Exports	*No*	*0*	*0*
			Climate Change Resilience	*No*	*0*	*0*
			Changes in Costs of Agricultural Products	*No*	*0*	*0*
			Food Prices	*No*	*0*	*0*
			Food Security	*No*	*0*	*0*
	Livelihoods	Land Management	Land Ownership	*No*	*0*	*0*
			Land Access	*No*	*0*	*0*
		Decent Work	Rights	*No*	*0*	*0*
			Child Labour	*No*	*0*	*0*
			Slave Labour	*No*	*0*	*0*
			International Labour Standards	*No*	*0*	*0*
		Jobs & Skills	Skilled Jobs	*Yes*	*0*	*8*
			Unskilled Jobs	*Yes*	*0*	*6*
			Permanent Jobs	*Yes*	*0*	*6*
			Temporary Jobs	*Yes*	*0*	*4*
			Regional Job Distribution	*Yes*	*0*	*6*
			Career Development	*Yes*	*0*	*6*
		Change in income	Income from Bioenergy	*Yes*	*0*	*4*
			Net Income from Bioenergy	*Yes*	*0*	*4*
	Society	Equality	Diversity through Supply Chain Participation	*No*	*0*	*0*
			Diversity & End Use	*No*	*0*	*0*
		Peace, Justice & Strong Institutions	Legality	*No*	*0*	*0*
			Monitoring	*No*	*0*	*0*
			Bribery & Conflicts of Business	*No*	*0*	*0*
		Partnerships	Community Partnerships	*Yes*	*0*	*4*
			Industry Partnerships	*Yes*	*0*	*6*
			Government Partnerships	*Yes*	*0*	*6*
			Specialist Bioenergy Partnerships	*Yes*	*0*	*6*
		Energy Access	Households using Bioenergy	*No*	*0*	*0*
			Industry using Bioenergy	*No*	*0*	*0*
Development	Economy	Economic Performance	Gross Domestic Product	*No*	*0*	*0*
			Influence on Wider Sectors	*Yes*	*0*	*4*
			International Trade	*No*	*0*	*0*
			Financial Capacity to Adopt Bioenergy	*No*	*0*	*0*
		Economic Stimulation	Increased Sustainable Energy Generation	*Yes*	*0*	*6*
			Economic Support Mechanisms	*Yes*	*8*	*8*
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability	*Yes*	*0*	*8*
			Existing Infrastructure - Capacity	*Yes*	*0*	*6*
			New Infrastructure Capacity	*Yes*	*6*	*8*
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)	*No*	*0*	*0*
			Use of Genetically Modified Materials	*No*	*0*	*0*
			Feedstock Production Strategy	*No*	*0*	*0*
			Land Use Productivity	*No*	*0*	*0*
		Mobilisation	Resource Mobilisation	*No*	*0*	*0*
			Competition for Resources	*No*	*0*	*0*
		Distribution	Spatial Distribution of Resources	*No*	*0*	*0*
			Resource Transportation	*Yes*	*4*	*0*
	Technology	Innovation	TRL Development	*Yes*	*8*	*8*
			Intellectual Property	*No*	*0*	*0*
		Efficiencies	Processing Efficiencies	*Yes*	*8*	*8*
			Supply Chain Efficiencies	*No*	*0*	*0*
		Techno-Economics	CAPEX - Direct Fixed Capital Cost	*Yes*	*8*	*6*
			CAPEX - Indirect Fixed Capital Cost	*Yes*	*8*	*6*
			OPEX - Fixed Operational Costs	*Yes*	*8*	*6*
			OPEX - Variable Operational Costs	*Yes*	*8*	*6*
			Biomass Feedstock Costs	*No*	*0*	*0*
			Reliance on Economic Support Measures	*No*	*0*	*0*
	Energy Sector	Bioenergy	Infrastructure Alignment	*Yes*	*4*	*4*
			Bio-Product Flexibility (energy)	*Yes*	*0*	*8*
			Bio-Product Flexibility (non-energy)	*Yes*	*0*	*2*
			Bioenergy Vector Distribution	*Yes*	*0*	*4*
			Bioenergy Vector Affordability	*Yes*	*8*	*0*
		Energy System Performances	Input Energy Requirements	*Yes*	*0*	*2*

			Influences on Energy System Resilience	*Yes*	*0*	*2*
			Accessibility to Wider Input Energy	*Yes*	*8*	*0*
	Bioeconomy	**Added Value Products**	Bio-Chemicals	*No*	*0*	*0*
			Bio-Products	*Yes*	*4*	*6*
		Bioenergy Complementing Wider Sectors	Agriculture	*Yes*	*0*	*4*
			Chemical	*No*	*0*	*0*
			Waste	*No*	*0*	*0*
			Construction	*No*	*0*	*0*
			Transport	*Yes*	*6*	*4*
			Services	*No*	*0*	*0*
			Manufacturing	*Yes*	*2*	*6*
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access	*No*	*0*	*0*
			Location - Influencing Distribution & Connectivity	*No*	*0*	*0*
			Use of Contaminated Lands	*No*	*0*	*0*
			Potential for Phytoremediation	*No*	*0*	*0*
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon	*No*	*0*	*0*
			Soil Fertility	*No*	*0*	*0*
			Soil Erosion	*No*	*0*	*0*
			Accumulation of Mineral Salts	*No*	*0*	*0*
			Drainage Impacts	*No*	*0*	*0*
			Soil Compaction	*No*	*0*	*0*
			Soli Influence on Productivity Yields	*No*	*0*	*0*
		Ecosystems	Biodiversity	*No*	*0*	*0*
			Areas of Conservation & High Biodiversity	*No*	*0*	*0*
			Land Degradation	*No*	*0*	*0*
			Desertification	*No*	*0*	*0*
	Air	**PM Pollutants**	PM10s	*Yes*	*6*	*0*
			PM2.5s	*Yes*	*6*	*0*
		Oxide Pollutants	Sulphur Oxides	*No*	*0*	*0*
			Nitrogen Oxides	*Yes*	*6*	*0*
			Carbon Monoxide	*Yes*	*6*	*0*
		Heavy Metal	Cadmium	*No*	*0*	*0*
			Lead	*No*	*0*	*0*
			Mercury	*No*	*0*	*0*
	Water	**Water Use & Efficiency**	Water Withdrawn	*No*	*0*	*0*
			Water Consumed	*Yes*	*6*	*0*
			Non-renewable Water Resources	*No*	*0*	*0*
			Renewable Water Resources	*Yes*	*6*	*0*
		Water Quality	Fertilizer & Pesticide Loadings	*No*	*0*	*0*
			Pollution from Feedstock Production	*No*	*0*	*0*
			Pollution from Feedstock Processing	*No*	*0*	*0*
			Pollution from Feedstock Conversion	*No*	*0*	*0*
		Water Systems	Flooding	*No*	*0*	*0*
			Local Water Stresses	*No*	*0*	*0*
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations	*Yes*	*4*	*10*
			Awareness	*Yes*	*4*	*4*
		Standards	Fuel Standards	*Yes*	*6*	*0*
			Technical Standards	*Yes*	*6*	*0*
			Supply Chain of Custody Processes	*No*	*0*	*0*
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion	*Yes*	*10*	*6*
			Feedstock Sources	*No*	*0*	*0*
			Transport	*Yes*	*4*	*0*
			Processing & Pre-treatment	*Yes*	*6*	*6*
		Land & Carbon Stocks	Direct Land Use Change	*No*	*0*	*0*
			Indirect Land Use Change	*No*	*0*	*0*
			Changes in Carbon Stocks	*No*	*0*	*0*
		Counterfactual Considerations	Land Use Counterfactuals	*No*	*0*	*0*
			Resource Use Counterfactuals	*Yes*	*4*	*8*
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels	*Yes*	*4*	*8*
			Substitution of Traditional Bioenergy	*No*	*0*	*0*

CS12 – Platform Chemicals through Conversion of Miscanthus using Microwave Catalysis

Categories	Themes	Indicators	Issues	Sustainability Issue Scores		
				Applicability	*IS[r]*	*IS[b]*
People	**Health**	**Health & Wellbeing**	Mortality Rate & Disease Burden	*No*	*0*	*0*
			Exposure to Occupational Health & Safety Hazards	*Yes*	*2*	*8*
		Food Systems	Food Commodity Supply	*No*	*0*	*0*
			Food Commodity Imports & Exports	*No*	*0*	*0*
			Climate Change Resilience	*No*	*0*	*0*
			Changes in Costs of Agricultural Products	*No*	*0*	*0*
			Food Prices	*No*	*0*	*0*
			Food Security	*No*	*0*	*0*
	Livelihoods	**Land Management**	Land Ownership	*Yes*	*6*	*8*
			Land Access	*Yes*	*2*	*10*
		Decent Work	Rights	*No*	*0*	*0*
			Child Labour	*No*	*0*	*0*
			Slave Labour	*No*	*0*	*0*
			International Labour Standards	*No*	*0*	*0*
		Jobs & Skills	Skilled Jobs	*Yes*	*6*	*8*
			Unskilled Jobs	*Yes*	*8*	*6*
			Permanent Jobs	*Yes*	*8*	*8*
			Temporary Jobs	*No*	*0*	*0*
			Regional Job Distribution	*Yes*	*6*	*10*
			Career Development	*Yes*	*4*	*6*
		Change in income	Income from Bioenergy	*Yes*	*6*	*8*
			Net Income from Bioenergy	*Yes*	*6*	*8*
	Society	**Equality**	Diversity through Supply Chain Participation	*Yes*	*8*	*4*
			Diversity & End Use	*No*	*0*	*0*
		Peace, Justice & Strong Institutions	Legality	*No*	*0*	*0*
			Monitoring	*No*	*0*	*0*
			Bribery & Conflicts of Business	*No*	*0*	*0*
		Partnerships	Community Partnerships	*No*	*0*	*0*
			Industry Partnerships	*No*	*0*	*0*
			Government Partnerships	*No*	*0*	*0*
			Specialist Bioenergy Partnerships	*No*	*0*	*0*
		Energy Access	Households using Bioenergy	*No*	*0*	*0*
			Industry using Bioenergy	*Yes*	*4*	*8*
Development	**Economy**	**Economic Performance**	Gross Domestic Product	*Yes*	*4*	*6*
			Influence on Wider Sectors	*Yes*	*6*	*8*

			International Trade	*Yes*	*6*	*8*
			Financial Capacity to Adopt Bioenergy	*Yes*	*8*	*10*
		Economic Stimulation	Increased Sustainable Energy Generation	*Yes*	*6*	*8*
			Economic Support Mechanisms	*No*	*0*	*0*
	Infrastructure	**Infrastructure Requirements**	Existing Infrastructure - Availability	*Yes*	*4*	*8*
			Existing Infrastructure - Capacity	*Yes*	*8*	*10*
			New Infrastructure Capacity	*No*	*0*	*0*
	Feedstock Production/ Mobilisation/ Distribution	**Production Processes**	Chemical Agro-Chemicals (fertiliser + pesticide)	*Yes*	*8*	*6*
			Use of Genetically Modified Materials	*No*	*0*	*0*
			Feedstock Production Strategy	*No*	*0*	*0*
			Land Use Productivity	*Yes*	*6*	*8*
		Mobilisation	Resource Mobilisation	*Yes*	*6*	*8*
			Competition for Resources	*Yes*	*10*	*6*
		Distribution	Spatial Distribution of Resources	*Yes*	*8*	*6*
			Resource Transportation	*Yes*	*8*	*8*
	Technology	**Innovation**	TRL Development	*Yes*	*4*	*8*
			Intellectual Property	*No*	*0*	*0*
		Efficiencies	Processing Efficiencies	*Yes*	*6*	*8*
			Supply Chain Efficiencies	*No*	*0*	*0*
		Techno-Economics	CAPEX - Direct Fixed Capital Cost	*No*	*0*	*0*
			CAPEX - Indirect Fixed Capital Cost	*No*	*0*	*0*
			OPEX - Fixed Operational Costs	*No*	*0*	*0*
			OPEX - Variable Operational Costs	*No*	*0*	*0*
			Biomass Feedstock Costs	*Yes*	*6*	*8*
			Reliance on Economic Support Measures	*Yes*	*8*	*6*
	Energy Sector	**Bioenergy**	Infrastructure Alignment	*Yes*	*4*	*6*
			Bio-Product Flexibility (energy)	*Yes*	*6*	*8*
			Bio-Product Flexibility (non-energy)	*Yes*	*4*	*6*
			Bioenergy Vector Distribution	*Yes*	*6*	*8*
			Bioenergy Vector Affordability	*Yes*	*6*	*10*
		Energy System Performances	Input Energy Requirements	*Yes*	*4*	*6*
			Influences on Energy System Resilience	*No*	*0*	*0*
			Accessibility to Wider Input Energy	*No*	*0*	*0*
	Bioeconomy	**Added Value Products**	Bio-Chemicals	*Yes*	*4*	*6*
			Bio-Products	*Yes*	*4*	*6*
		Bioenergy Complementing Wider Sectors	Agriculture	*Yes*	*4*	*8*
			Chemical	*Yes*	*4*	*8*
			Waste	*No*	*0*	*0*
			Construction	*No*	*0*	*0*
			Transport	*Yes*	*2*	*8*
			Services	*No*	*0*	*0*
			Manufacturing	*No*	*0*	*0*
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access	*No*	*0*	*0*
			Location - Influencing Distribution & Connectivity	*Yes*	*8*	*8*
			Use of Contaminated Lands	*Yes*	*2*	*10*
			Potential for Phytoremediation	*Yes*	*4*	*10*
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon	*Yes*	*4*	*8*
			Soil Fertility	*Yes*	*2*	*8*
			Soil Erosion	*Yes*	*4*	*8*
			Accumulation of Mineral Salts	*No*	*0*	*0*
			Drainage Impacts	*No*	*0*	*0*
			Soil Compaction	*No*	*0*	*0*
			Soli Influence on Productivity Yields	*No*	*0*	*0*
		Ecosystems	Biodiversity	*No*	*0*	*0*
			Areas of Conservation & High Biodiversity	*No*	*0*	*0*
			Land Degradation	*Yes*	*4*	*8*
			Desertification	*No*	*0*	*0*
	Air	**PM Pollutants**	PM10s	*Yes*	*6*	*8*
			PM2.5s	*Yes*	*6*	*8*
		Oxide Pollutants	Sulphur Oxides	*No*	*0*	*0*
			Nitrogen Oxides	*No*	*0*	*0*
			Carbon Monoxide	*No*	*0*	*0*
		Heavy Metal	Cadmium	*No*	*0*	*0*
			Lead	*No*	*0*	*0*
			Mercury	*No*	*0*	*0*
	Water	**Water Use & Efficiency**	Water Withdrawn	*No*	*0*	*0*
			Water Consumed	*No*	*0*	*0*
			Non-renewable Water Resources	*Yes*	*6*	*10*
			Renewable Water Resources	*No*	*0*	*0*
		Water Quality	Fertilizer & Pesticide Loadings	*No*	*0*	*0*
			Pollution from Feedstock Production	*No*	*0*	*0*
			Pollution from Feedstock Processing	*No*	*0*	*0*
			Pollution from Feedstock Conversion	*No*	*0*	*0*
		Water Systems	Flooding	*No*	*0*	*0*
			Local Water Stresses	*No*	*0*	*0*
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations	*Yes*	*2*	*8*
			Awareness	*Yes*	*8*	*8*
		Standards	Fuel Standards	*No*	*0*	*0*
			Technical Standards	*Yes*	*6*	*8*
			Supply Chain of Custody Processes	*No*	*0*	*0*
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion	*Yes*	*4*	*6*
			Feedstock Sources	*No*	*0*	*0*
			Transport	*No*	*0*	*0*
			Processing & Pre-treatment	*Yes*	*6*	*8*
		Land & Carbon Stocks	Direct Land Use Change	*Yes*	*6*	*4*
			Indirect Land Use Change	*No*	*0*	*0*
			Changes in Carbon Stocks	*No*	*0*	*0*
		Counterfactual Considerations	Land Use Counterfactuals	*No*	*0*	*0*
			Resource Use Counterfactuals	*No*	*0*	*0*
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels	*Yes*	*0*	*8*
			Substitution of Traditional Bioenergy	*No*	*0*	*0*

CS13 – Platform Chemicals & Biofuels through Ionic Liquid Catalysis of Lignocellulosic Biomass

Categories	Themes	Indicators	Issues	Sustainability Issue Scores		
				Applicability	*IS[a]*	*IS[b]*
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden	*No*	*0*	*0*
			Exposure to Occupational Health & Safety Hazards	*No*	*0*	*0*
		Food Systems	Food Commodity Supply	*No*	*0*	*0*
			Food Commodity Imports & Exports	*No*	*0*	*0*
			Climate Change Resilience	*No*	*0*	*0*
			Changes in Costs of Agricultural Products	*No*	*0*	*0*
			Food Prices	*No*	*0*	*0*
			Food Security	*No*	*0*	*0*
	Livelihoods	Land Management	Land Ownership	*No*	*0*	*0*
			Land Access	*No*	*0*	*0*
		Decent Work	Rights	*No*	*0*	*0*
			Child Labour	*No*	*0*	*0*
			Slave Labour	*No*	*0*	*0*
			International Labour Standards	*No*	*0*	*0*
		Jobs & Skills	Skilled Jobs	*Yes*	*2*	*8*
			Unskilled Jobs	*Yes*	*2*	*4*
			Permanent Jobs	*Yes*	*2*	*6*
			Temporary Jobs	*Yes*	*2*	*4*
			Regional Job Distribution	*Yes*	*0*	*4*
			Career Development	*Yes*	*2*	*8*
		Change in income	Income from Bioenergy	*Yes*	*2*	*8*
			Net Income from Bioenergy	*Yes*	*4*	*8*
	Society	Equality	Diversity through Supply Chain Participation	*No*	*0*	*0*
			Diversity & End Use	*No*	*0*	*0*
		Peace, Justice & Strong Institutions	Legality	*No*	*0*	*0*
			Monitoring	*No*	*0*	*0*
			Bribery & Conflicts of Business	*No*	*0*	*0*
		Partnerships	Community Partnerships	*No*	*0*	*0*
			Industry Partnerships	*Yes*	*8*	*10*
			Government Partnerships	*Yes*	*10*	*8*
			Specialist Bioenergy Partnerships	*Yes*	*8*	*10*
		Energy Access	Households using Bioenergy	*Yes*	*4*	*6*
			Industry using Bioenergy	*Yes*	*6*	*6*
Development	Economy	Economic Performance	Gross Domestic Product	*Yes*	*0*	*4*
			Influence on Wider Sectors	*Yes*	*4*	*8*
			International Trade	*Yes*	*4*	*6*
			Financial Capacity to Adopt Bioenergy	*Yes*	*8*	*8*
		Economic Stimulation	Increased Sustainable Energy Generation	*Yes*	*2*	*8*
			Economic Support Mechanisms	*Yes*	*8*	*8*
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability	*No*	*0*	*0*
			Existing Infrastructure - Capacity	*No*	*0*	*0*
			New Infrastructure Capacity	*Yes*	*10*	*10*
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)	*No*	*0*	*0*
			Use of Genetically Modified Materials	*Yes*	*2*	*2*
			Feedstock Production Strategy	*Yes*	*2*	*4*
			Land Use Productivity	*Yes*	*6*	*6*
		Mobilisation	Resource Mobilisation	*Yes*	*2*	*2*
			Competition for Resources	*Yes*	*2*	*8*
		Distribution	Spatial Distribution of Resources	*Yes*	*2*	*6*
			Resource Transportation	*Yes*	*6*	*6*
	Technology	Innovation	TRL Development	*Yes*	*8*	*8*
			Intellectual Property	*Yes*	*6*	*6*
		Efficiencies	Processing Efficiencies	*Yes*	*8*	*10*
			Supply Chain Efficiencies	*Yes*	*8*	*2*
		Techno-Economics	CAPEX - Direct Fixed Capital Cost	*Yes*	*8*	*8*
			CAPEX - Indirect Fixed Capital Cost	*Yes*	*8*	*6*
			OPEX - Fixed Operational Costs	*Yes*	*8*	*8*
			OPEX - Variable Operational Costs	*Yes*	*8*	*10*
			Biomass Feedstock Costs	*Yes*	*4*	*8*
			Reliance on Economic Support Measures	*Yes*	*10*	*2*
	Energy Sector	Bioenergy	Infrastructure Alignment	*Yes*	*4*	*4*
			Bio-Product Flexibility (energy)	*Yes*	*2*	*8*
			Bio-Product Flexibility (non-energy)	*Yes*	*2*	*10*
			Bioenergy Vector Distribution	*Yes*	*4*	*6*
			Bioenergy Vector Affordability	*Yes*	*4*	*10*
		Energy System Performances	Input Energy Requirements	*Yes*	*8*	*6*
			Influences on Energy System Resilience	*No*	*0*	*0*
			Accessibility to Wider Input Energy	*Yes*	*6*	*8*
	Bioeconomy	Added Value Products	Bio-Chemicals	*Yes*	*2*	*10*
			Bio-Products	*Yes*	*2*	*10*
		Bioenergy Complementing Wider Sectors	Agriculture	*Yes*	*2*	*10*
			Chemical	*Yes*	*2*	*10*
			Waste	*Yes*	*2*	*10*
			Construction	*Yes*	*2*	*6*
			Transport	*Yes*	*4*	*6*
			Services	*No*	*0*	*0*
			Manufacturing	*Yes*	*6*	*8*
	Land Utilisation	Land Characteristics	Topography - Influencing Access	*No*	*0*	*0*
			Location - Influencing Distribution & Connectivity	*No*	*0*	*0*
			Use of Contaminated Lands	*Yes*	*2*	*10*
			Potential for Phytoremediation	*Yes*	*2*	*10*
Natural Systems	Land	Soil	Impact on Soil Organic Carbon	*No*	*0*	*0*
			Soil Fertility	*No*	*0*	*0*
			Soil Erosion	*No*	*0*	*0*
			Accumulation of Mineral Salts	*No*	*0*	*0*
			Drainage Impacts	*No*	*0*	*0*
			Soil Compaction	*No*	*0*	*0*
			Soli Influence on Productivity Yields	*No*	*0*	*0*
		Ecosystems	Biodiversity	*No*	*0*	*0*
			Areas of Conservation & High Biodiversity	*No*	*0*	*0*
			Land Degradation	*No*	*0*	*0*
			Desertification	*No*	*0*	*0*
	Air	PM Pollutants	PM10s	*No*	*0*	*0*
			PM2.5s	*No*	*0*	*0*
		Oxide Pollutants	Sulphur Oxides	*Yes*	*4*	*10*
			Nitrogen Oxides	*Yes*	*4*	*10*
			Carbon Monoxide	*No*	*0*	*0*

		Heavy Metal	Cadmium	*No*	*0*	*0*
			Lead	*No*	*0*	*0*
			Mercury	*No*	*0*	*0*
	Water	Water Use & Efficiency	Water Withdrawn	*Yes*	*6*	*6*
			Water Consumed	*Yes*	*6*	*6*
			Non-renewable Water Resources	*No*	*0*	*0*
			Renewable Water Resources	*No*	*0*	*0*
		Water Quality	Fertilizer & Pesticide Loadings	*No*	*0*	*0*
			Pollution from Feedstock Production	*No*	*0*	*0*
			Pollution from Feedstock Processing	*Yes*	*6*	*10*
			Pollution from Feedstock Conversion	*Yes*	*6*	*10*
		Water Systems	Flooding	*No*	*0*	*0*
			Local Water Stresses	*No*	*0*	*0*
Climate Change	Governance	Climate Action	Targets, Legislation & Regulations	*No*	*0*	*0*
			Awareness	*Yes*	*4*	*8*
		Standards	Fuel Standards	*No*	*0*	*0*
			Technical Standards	*Yes*	*6*	*8*
			Supply Chain of Custody Processes	*No*	*0*	*0*
	Carbon & Emissions	Whole Life Cycle Emissions	Energy Conversion	*No*	*0*	*0*
			Feedstock Sources	*No*	*0*	*0*
			Transport	*No*	*0*	*0*
			Processing & Pre-treatment	*Yes*	*6*	*10*
		Land & Carbon Stocks	Direct Land Use Change	*No*	*0*	*0*
			Indirect Land Use Change	*No*	*0*	*0*
			Changes in Carbon Stocks	*No*	*0*	*0*
		Counterfactual Considerations	Land Use Counterfactuals	*No*	*0*	*0*
			Resource Use Counterfactuals	*No*	*0*	*0*
	Energy System	Replaced Fuels	Substitution of Fossil Fuels	*Yes*	*6*	*10*
			Substitution of Traditional Bioenergy	*Yes*	*4*	*10*

CS14 – Gasification of Forestry/Agri-Residues to fuel a Hydrogen Fuel Cell

Categories	Themes	Indicators	Issues	Sustainability Issue Scores		
				Applicability	*IS[a]*	*IS[b]*
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden	*No*	*0*	*0*
			Exposure to Occupational Health & Safety Hazards	*No*	*0*	*0*
		Food Systems	Food Commodity Supply	*no*	*0*	*0*
			Food Commodity Imports & Exports	*no*	*0*	*0*
			Climate Change Resilience	*no*	*0*	*0*
			Changes in Costs of Agricultural Products	*no*	*0*	*0*
			Food Prices	*no*	*0*	*0*
			Food Security	*no*	*0*	*0*
	Livelihoods	Land Management	Land Ownership	*no*	*0*	*0*
			Land Access	*no*	*0*	*0*
		Decent Work	Rights	*no*	*0*	*0*
			Child Labour	*no*	*0*	*0*
			Slave Labour	*no*	*0*	*0*
			International Labour Standards	*no*	*0*	*0*
		Jobs & Skills	Skilled Jobs	*no*	*0*	*0*
			Unskilled Jobs	*no*	*0*	*0*
			Permanent Jobs	*no*	*0*	*0*
			Temporary Jobs	*no*	*0*	*0*
			Regional Job Distribution	*no*	*0*	*0*
			Career Development	*no*	*0*	*0*
		Change in income	Income from Bioenergy	*no*	*0*	*0*
			Net Income from Bioenergy	*no*	*0*	*0*
	Society	Equality	Diversity through Supply Chain Participation	*no*	*0*	*0*
			Diversity & End Use	*no*	*0*	*0*
		Peace, Justice & Strong Institutions	Legality	*no*	*0*	*0*
			Monitoring	*no*	*0*	*0*
			Bribery & Conflicts of Business	*no*	*0*	*0*
		Partnerships	Community Partnerships	*no*	*0*	*0*
			Industry Partnerships	*no*	*0*	*0*
			Government Partnerships	*no*	*0*	*0*
			Specialist Bioenergy Partnerships	*no*	*0*	*0*
		Energy Access	Households using Bioenergy	*no*	*0*	*0*
			Industry using Bioenergy	*no*	*0*	*0*
Development	Economy	Economic Performance	Gross Domestic Product	*No*	*0*	*0*
			Influence on Wider Sectors	*No*	*0*	*0*
			International Trade	*No*	*0*	*0*
			Financial Capacity to Adopt Bioenergy	*No*	*0*	*0*
		Economic Stimulation	Increased Sustainable Energy Generation	*Yes*	*4*	*8*
			Economic Support Mechanisms	*Yes*	*8*	*8*
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability	*Yes*	*10*	*4*
			Existing Infrastructure - Capacity	*Yes*	*10*	*4*
			New Infrastructure Capacity	*Yes*	*10*	*10*
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)	*No*	*0*	*0*
			Use of Genetically Modified Materials	*No*	*0*	*0*
			Feedstock Production Strategy	*No*	*0*	*0*
			Land Use Productivity	*No*	*0*	*0*
		Mobilisation	Resource Mobilisation	*Yes*	*4*	*4*
			Competition for Resources	*Yes*	*10*	*2*
		Distribution	Spatial Distribution of Resources	*No*	*0*	*0*
			Resource Transportation	*No*	*0*	*0*
	Technology	Innovation	TRL Development	*Yes*	*6*	*8*
			Intellectual Property	*No*	*0*	*0*
		Efficiencies	Processing Efficiencies	*Yes*	*8*	*10*
			Supply Chain Efficiencies	*Yes*	*4*	*6*
		Techno-Economics	CAPEX - Direct Fixed Capital Cost	*No*	*0*	*0*
			CAPEX - Indirect Fixed Capital Cost	*No*	*0*	*0*
			OPEX - Fixed Operational Costs	*No*	*0*	*0*
			OPEX - Variable Operational Costs	*No*	*0*	*0*
			Biomass Feedstock Costs	*No*	*0*	*0*
			Reliance on Economic Support Measures	*No*	*0*	*0*
	Energy Sector	Bioenergy	Infrastructure Alignment	*Yes*	*4*	*4*
			Bio-Product Flexibility (energy)	*Yes*	*2*	*8*
			Bio-Product Flexibility (non-energy)	*No*	*0*	*0*
			Bioenergy Vector Distribution	*Yes*	*8*	*8*
			Bioenergy Vector Affordability	*Yes*	*10*	*8*
		Energy System Performances	Input Energy Requirements	*No*	*0*	*0*

			Influences on Energy System Resilience	*No*	*0*	*0*
			Accessibility to Wider Input Energy	*No*	*0*	*0*
	Bioeconomy	**Added Value Products**	Bio-Chemicals	*No*	*0*	*0*
			Bio-Products	*No*	*0*	*0*
		Bioenergy Complementing Wider Sectors	Agriculture	*Yes*	*0*	*8*
			Chemical	*No*	*0*	*0*
			Waste	*No*	*0*	*0*
			Construction	*No*	*0*	*0*
			Transport	*Yes*	*2*	*8*
			Services	*No*	*0*	*0*
			Manufacturing	*No*	*0*	*0*
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access	*No*	*0*	*0*
			Location - Influencing Distribution & Connectivity	*No*	*0*	*0*
			Use of Contaminated Lands	*No*	*0*	*0*
			Potential for Phytoremediation	*No*	*0*	*0*
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon	*No*	*0*	*0*
			Soil Fertility	*No*	*0*	*0*
			Soil Erosion	*No*	*0*	*0*
			Accumulation of Mineral Salts	*No*	*0*	*0*
			Drainage Impacts	*No*	*0*	*0*
			Soil Compaction	*No*	*0*	*0*
			Soli Influence on Productivity Yields	*No*	*0*	*0*
		Ecosystems	Biodiversity	*No*	*0*	*0*
			Areas of Conservation & High Biodiversity	*No*	*0*	*0*
			Land Degradation	*No*	*0*	*0*
			Desertification	*No*	*0*	*0*
	Air	**PM Pollutants**	PM10s	*No*	*0*	*0*
			PM2.5s	*No*	*0*	*0*
		Oxide Pollutants	Sulphur Oxides	*No*	*0*	*0*
			Nitrogen Oxides	*No*	*0*	*0*
			Carbon Monoxide	*No*	*0*	*0*
		Heavy Metal	Cadmium	*No*	*0*	*0*
			Lead	*No*	*0*	*0*
			Mercury	*No*	*0*	*0*
	Water	**Water Use & Efficiency**	Water Withdrawn	*No*	*0*	*0*
			Water Consumed	*No*	*0*	*0*
			Non-renewable Water Resources	*No*	*0*	*0*
			Renewable Water Resources	*No*	*0*	*0*
		Water Quality	Fertilizer & Pesticide Loadings	*No*	*0*	*0*
			Pollution from Feedstock Production	*No*	*0*	*0*
			Pollution from Feedstock Processing	*No*	*0*	*0*
			Pollution from Feedstock Conversion	*No*	*0*	*0*
		Water Systems	Flooding	*No*	*0*	*0*
			Local Water Stresses	*No*	*0*	*0*
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations	*Yes*	*6*	*10*
			Awareness	*Yes*	*6*	*6*
		Standards	Fuel Standards	*Yes*	*2*	*8*
			Technical Standards	*No*	*0*	*0*
			Supply Chain of Custody Processes	*No*	*0*	*0*
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion	*Yes*	*2*	*10*
			Feedstock Sources	*Yes*	*2*	*8*
			Transport	*Yes*	*2*	*8*
			Processing & Pre-treatment	*Yes*	*4*	*8*
		Land & Carbon Stocks	Direct Land Use Change	*No*	*0*	*0*
			Indirect Land Use Change	*No*	*0*	*0*
			Changes in Carbon Stocks	*No*	*0*	*0*
		Counterfactual Considerations	Land Use Counterfactuals	*No*	*0*	*0*
			Resource Use Counterfactuals	*Yes*	*8*	*8*
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels	*Yes*	*2*	*10*
			Substitution of Traditional Bioenergy	*No*	*0*	*0*

CS15 – Gasification of Forestry Residues to Produce Sustainable Aviation Fuels

Categories	Themes	Indicators	Issues	Sustainability Issue Scores		
				Applicability	*IS[r]*	*IS[b]*
People	**Health**	**Health & Wellbeing**	Mortality Rate & Disease Burden	*No*	*0*	*0*
			Exposure to Occupational Health & Safety Hazards	*No*	*0*	*0*
		Food Systems	Food Commodity Supply	*No*	*0*	*0*
			Food Commodity Imports & Exports	*No*	*0*	*0*
			Climate Change Resilience	*Yes*	*2*	*8*
			Changes in Costs of Agricultural Products	*No*	*0*	*0*
			Food Prices	*No*	*0*	*0*
			Food Security	*No*	*0*	*0*
	Livelihoods	**Land Management**	Land Ownership	*Yes*	*6*	*6*
			Land Access	*Yes*	*6*	*6*
		Decent Work	Rights	*No*	*0*	*0*
			Child Labour	*No*	*0*	*0*
			Slave Labour	*No*	*0*	*0*
			International Labour Standards	*No*	*0*	*0*
		Jobs & Skills	Skilled Jobs	*Yes*	*2*	*8*
			Unskilled Jobs	*Yes*	*2*	*8*
			Permanent Jobs	*Yes*	*2*	*8*
			Temporary Jobs	*Yes*	*2*	*8*
			Regional Job Distribution	*Yes*	*2*	*10*
			Career Development	*Yes*	*2*	*6*
		Change in income	Income from Bioenergy	*Yes*	*2*	*6*
			Net Income from Bioenergy	*Yes*	*8*	*8*
	Society	**Equality**	Diversity through Supply Chain Participation	*No*	*0*	*0*
			Diversity & End Use	*No*	*0*	*0*
		Peace, Justice & Strong Institutions	Legality	*No*	*0*	*0*
			Monitoring	*No*	*0*	*0*
			Bribery & Conflicts of Business	*No*	*0*	*0*
		Partnerships	Community Partnerships	*No*	*0*	*0*
			Industry Partnerships	*Yes*	*4*	*8*
			Government Partnerships	*No*	*0*	*0*
			Specialist Bioenergy Partnerships	*Yes*	*4*	*8*
		Energy Access	Households using Bioenergy	*No*	*0*	*0*
			Industry using Bioenergy	*No*	*0*	*0*
Development	**Economy**	**Economic Performance**	Gross Domestic Product	*Yes*	*6*	*6*
			Influence on Wider Sectors	*Yes*	*6*	*6*

			International Trade	*No*	*0*	*0*
			Financial Capacity to Adopt Bioenergy	*Yes*	*6*	*6*
		Economic Stimulation	Increased Sustainable Energy Generation	*Yes*	*2*	*6*
			Economic Support Mechanisms	*Yes*	*8*	*8*
	Infrastructure	**Infrastructure Requirements**	Existing Infrastructure - Availability	*Yes*	*8*	*6*
			Existing Infrastructure - Capacity	*Yes*	*8*	*6*
			New Infrastructure Capacity	*Yes*	*8*	*6*
	Feedstock Production/ Mobilisation/ Distribution	**Production Processes**	Chemical Agro-Chemicals (fertiliser + pesticide)	*No*	*0*	*0*
			Use of Genetically Modified Materials	*No*	*0*	*0*
			Feedstock Production Strategy	*Yes*	*10*	*8*
			Land Use Productivity	*No*	*0*	*0*
		Mobilisation	Resource Mobilisation	*Yes*	*8*	*6*
			Competition for Resources	*Yes*	*10*	*4*
		Distribution	Spatial Distribution of Resources	*No*	*0*	*0*
			Resource Transportation	*No*	*0*	*0*
	Technology	**Innovation**	TRL Development	*Yes*	*8*	*10*
			Intellectual Property	*Yes*	*8*	*10*
		Efficiencies	Processing Efficiencies	*Yes*	*10*	*6*
			Supply Chain Efficiencies	*Yes*	*8*	*8*
		Techno-Economics	CAPEX - Direct Fixed Capital Cost	*Yes*	*8*	*8*
			CAPEX - Indirect Fixed Capital Cost	*Yes*	*8*	*8*
			OPEX - Fixed Operational Costs	*Yes*	*8*	*8*
			OPEX - Variable Operational Costs	*Yes*	*8*	*8*
			Biomass Feedstock Costs	*Yes*	*6*	*6*
			Reliance on Economic Support Measures	*Yes*	*10*	*4*
	Energy Sector	**Bioenergy**	Infrastructure Alignment	*Yes*	*4*	*8*
			Bio-Product Flexibility (energy)	*No*	*0*	*0*
			Bio-Product Flexibility (non-energy)	*No*	*0*	*0*
			Bioenergy Vector Distribution	*Yes*	*4*	*8*
			Bioenergy Vector Affordability	*Yes*	*8*	*2*
		Energy System Performances	Input Energy Requirements	*Yes*	*6*	*6*
			Influences on Energy System Resilience	*Yes*	*4*	*4*
			Accessibility to Wider Input Energy	*No*	*0*	*0*
	Bioeconomy	**Added Value Products**	Bio-Chemicals	*No*	*0*	*0*
			Bio-Products	*Yes*	*2*	*2*
		Bioenergy Complementing Wider Sectors	Agriculture	*Yes*	*4*	*8*
			Chemical	*No*	*0*	*0*
			Waste	*No*	*0*	*0*
			Construction	*No*	*0*	*0*
			Transport	*Yes*	*4*	*8*
			Services	*No*	*0*	*0*
			Manufacturing	*No*	*0*	*0*
	Land Utilisation	**Land Characteristics**	Topography - Influencing Access	*Yes*	*4*	*4*
			Location - Influencing Distribution & Connectivity	*No*	*0*	*0*
			Use of Contaminated Lands	*No*	*0*	*0*
			Potential for Phytoremediation	*No*	*0*	*0*
Natural Systems	**Land**	**Soil**	Impact on Soil Organic Carbon	*Yes*	*4*	*8*
			Soil Fertility	*No*	*0*	*0*
			Soil Erosion	*Yes*	*4*	*8*
			Accumulation of Mineral Salts	*No*	*0*	*0*
			Drainage Impacts	*Yes*	*6*	*8*
			Soil Compaction	*No*	*0*	*0*
			Soli Influence on Productivity Yields	*No*	*0*	*0*
		Ecosystems	Biodiversity	*Yes*	*4*	*8*
			Areas of Conservation & High Biodiversity	*Yes*	*4*	*6*
			Land Degradation	*Yes*	*2*	*8*
			Desertification	*No*	*0*	*0*
	Air	**PM Pollutants**	PM10s	*No*	*0*	*0*
			PM2.5s	*No*	*0*	*0*
		Oxide Pollutants	Sulphur Oxides	*Yes*	*4*	*6*
			Nitrogen Oxides	*No*	*0*	*0*
			Carbon Monoxide	*No*	*0*	*0*
		Heavy Metal	Cadmium	*No*	*0*	*0*
			Lead	*No*	*0*	*0*
			Mercury	*No*	*0*	*0*
	Water	**Water Use & Efficiency**	Water Withdrawn	*No*	*0*	*0*
			Water Consumed	*No*	*0*	*0*
			Non-renewable Water Resources	*No*	*0*	*0*
			Renewable Water Resources	*No*	*0*	*0*
		Water Quality	Fertilizer & Pesticide Loadings	*No*	*0*	*0*
			Pollution from Feedstock Production	*No*	*0*	*0*
			Pollution from Feedstock Processing	*No*	*0*	*0*
			Pollution from Feedstock Conversion	*No*	*0*	*0*
		Water Systems	Flooding	*Yes*	*0*	*8*
			Local Water Stresses	*Yes*	*6*	*6*
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations	*Yes*	*6*	*8*
			Awareness	*Yes*	*4*	*8*
		Standards	Fuel Standards	*Yes*	*6*	*8*
			Technical Standards	*Yes*	*6*	*6*
			Supply Chain of Custody Processes	*Yes*	*6*	*8*
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion	*Yes*	*4*	*8*
			Feedstock Sources	*Yes*	*2*	*8*
			Transport	*Yes*	*2*	*10*
			Processing & Pre-treatment	*Yes*	*4*	*8*
		Land & Carbon Stocks	Direct Land Use Change	*Yes*	*6*	*8*
			Indirect Land Use Change	*No*	*0*	*0*
			Changes in Carbon Stocks	*Yes*	*2*	*8*
		Counterfactual Considerations	Land Use Counterfactuals	*Yes*	*4*	*8*
			Resource Use Counterfactuals	*Yes*	*8*	*8*
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels	*Yes*	*2*	*10*
			Substitution of Traditional Bioenergy	*No*	*0*	*0*

CS16 – Hydrogen from Miscanthus via Photocatalysis

Categories	Themes	Indicators	Issues	Sustainability Issue Scores		
				Applicability	*IS[a]*	*IS[b]*
People	Health	Health & Wellbeing	Mortality Rate & Disease Burden	*No*	*0*	*0*
			Exposure to Occupational Health & Safety Hazards	*Yes*	*6*	*0*
		Food Systems	Food Commodity Supply	*No*	*0*	*0*
			Food Commodity Imports & Exports	*No*	*0*	*0*
			Climate Change Resilience	*No*	*0*	*0*
			Changes in Costs of Agricultural Products	*Yes*	*8*	*6*
			Food Prices	*No*	*0*	*0*
			Food Security	*No*	*0*	*0*
	Livelihoods	Land Management	Land Ownership	*No*	*0*	*0*
			Land Access	*Yes*	*6*	*6*
		Decent Work	Rights	*No*	*0*	*0*
			Child Labour	*No*	*0*	*0*
			Slave Labour	*No*	*0*	*0*
			International Labour Standards	*No*	*0*	*0*
		Jobs & Skills	Skilled Jobs	*Yes*	*4*	*8*
			Unskilled Jobs	*Yes*	*4*	*8*
			Permanent Jobs	*Yes*	*4*	*4*
			Temporary Jobs	*Yes*	*4*	*4*
			Regional Job Distribution	*Yes*	*4*	*8*
			Career Development	*Yes*	*4*	*8*
		Change in income	Income from Bioenergy	*No*	*0*	*0*
			Net Income from Bioenergy	*No*	*0*	*0*
	Society	Equality	Diversity through Supply Chain Participation	*No*	*0*	*0*
			Diversity & End Use	*No*	*0*	*0*
		Peace, Justice & Strong Institutions	Legality	*No*	*0*	*0*
			Monitoring	*No*	*0*	*0*
			Bribery & Conflicts of Business	*No*	*0*	*0*
		Partnerships	Community Partnerships	*No*	*0*	*0*
			Industry Partnerships	*No*	*0*	*0*
			Government Partnerships	*No*	*0*	*0*
			Specialist Bioenergy Partnerships	*No*	*0*	*0*
		Energy Access	Households using Bioenergy	*Yes*	*6*	*8*
			Industry using Bioenergy	*Yes*	*4*	*10*
Development	Economy	Economic Performance	Gross Domestic Product	*No*	*0*	*0*
			Influence on Wider Sectors	*No*	*0*	*0*
			International Trade	*No*	*0*	*0*
			Financial Capacity to Adopt Bioenergy	*No*	*0*	*0*
		Economic Stimulation	Increased Sustainable Energy Generation	*Yes*	*4*	*8*
			Economic Support Mechanisms	*No*	*0*	*0*
	Infrastructure	Infrastructure Requirements	Existing Infrastructure - Availability	*Yes*	*8*	*8*
			Existing Infrastructure - Capacity	*Yes*	*8*	*8*
			New Infrastructure Capacity	*Yes*	*4*	*8*
	Feedstock Production/ Mobilisation/ Distribution	Production Processes	Chemical Agro-Chemicals (fertiliser + pesticide)	*No*	*0*	*0*
			Use of Genetically Modified Materials	*No*	*0*	*0*
			Feedstock Production Strategy	*No*	*0*	*0*
			Land Use Productivity	*Yes*	*6*	*4*
		Mobilisation	Resource Mobilisation	*Yes*	*4*	*8*
			Competition for Resources	*No*	*0*	*0*
		Distribution	Spatial Distribution of Resources	*Yes*	*6*	*6*
			Resource Transportation	*No*	*0*	*0*
	Technology	Innovation	TRL Development	*Yes*	*4*	*8*
			Intellectual Property	*Yes*	*4*	*8*
		Efficiencies	Processing Efficiencies	*No*	*0*	*0*
			Supply Chain Efficiencies	*Yes*	*4*	*8*
		Techno-Economics	CAPEX - Direct Fixed Capital Cost	*Yes*	*8*	*6*
			CAPEX - Indirect Fixed Capital Cost	*Yes*	*8*	*6*
			OPEX - Fixed Operational Costs	*Yes*	*8*	*6*
			OPEX - Variable Operational Costs	*Yes*	*8*	*6*
			Biomass Feedstock Costs	*Yes*	*8*	*6*
			Reliance on Economic Support Measures	*No*	*0*	*0*
	Energy Sector	Bioenergy	Infrastructure Alignment	*Yes*	*4*	*8*
			Bio-Product Flexibility (energy)	*No*	*0*	*0*
			Bio-Product Flexibility (non-energy)	*No*	*0*	*0*
			Bioenergy Vector Distribution	*Yes*	*4*	*6*
			Bioenergy Vector Affordability	*Yes*	*6*	*6*
		Energy System Performances	Input Energy Requirements	*Yes*	*6*	*8*
			Influences on Energy System Resilience	*No*	*0*	*0*
			Accessibility to Wider Input Energy	*No*	*0*	*0*
	Bioeconomy	Added Value Products	Bio-Chemicals	*No*	*0*	*0*
			Bio-Products	*No*	*0*	*0*
		Bioenergy Complementing Wider Sectors	Agriculture	*No*	*0*	*0*
			Chemical	*No*	*0*	*0*
			Waste	*No*	*0*	*0*
			Construction	*No*	*0*	*0*
			Transport	*No*	*0*	*0*
			Services	*No*	*0*	*0*
			Manufacturing	*No*	*0*	*0*
	Land Utilisation	Land Characteristics	Topography - Influencing Access	*No*	*0*	*0*
			Location - Influencing Distribution & Connectivity	*Yes*	*6*	*8*
			Use of Contaminated Lands	*No*	*0*	*0*
			Potential for Phytoremediation	*No*	*0*	*0*
Natural Systems	Land	Soil	Impact on Soil Organic Carbon	*Yes*	*6*	*6*
			Soil Fertility	*Yes*	*6*	*6*
			Soil Erosion	*Yes*	*6*	*6*
			Accumulation of Mineral Salts	*Yes*	*6*	*6*
			Drainage Impacts	*Yes*	*6*	*6*
			Soil Compaction	*Yes*	*6*	*6*
			Soli Influence on Productivity Yields	*Yes*	*6*	*6*
		Ecosystems	Biodiversity	*No*	*0*	*0*
			Areas of Conservation & High Biodiversity	*No*	*0*	*0*
			Land Degradation	*No*	*0*	*0*
			Desertification	*No*	*0*	*0*
	Air	PM Pollutants	PM10s	*No*	*0*	*0*
			PM2.5s	*No*	*0*	*0*
		Oxide Pollutants	Sulphur Oxides	*No*	*0*	*0*
			Nitrogen Oxides	*No*	*0*	*0*
			Carbon Monoxide	*No*	*0*	*0*

		Heavy Metal	Cadmium	*No*	*0*	*0*
			Lead	*No*	*0*	*0*
			Mercury	*No*	*0*	*0*
	Water	**Water Use & Efficiency**	Water Withdrawn	*No*	*0*	*0*
			Water Consumed	*Yes*	*4*	*0*
			Non-renewable Water Resources	*No*	*0*	*0*
			Renewable Water Resources	*No*	*0*	*0*
		Water Quality	Fertilizer & Pesticide Loadings	*No*	*0*	*0*
			Pollution from Feedstock Production	*Yes*	*4*	*0*
			Pollution from Feedstock Processing	*No*	*0*	*0*
			Pollution from Feedstock Conversion	*No*	*0*	*0*
		Water Systems	Flooding	*No*	*0*	*0*
			Local Water Stresses	*No*	*0*	*0*
Climate Change	**Governance**	**Climate Action**	Targets, Legislation & Regulations	*No*	*0*	*0*
			Awareness	*No*	*0*	*0*
		Standards	Fuel Standards	*No*	*0*	*0*
			Technical Standards	*No*	*0*	*0*
			Supply Chain of Custody Processes	*No*	*0*	*0*
	Carbon & Emissions	**Whole Life Cycle Emissions**	Energy Conversion	*Yes*	*6*	*8*
			Feedstock Sources	*No*	*0*	*0*
			Transport	*Yes*	*4*	*0*
			Processing & Pre-treatment	*Yes*	*4*	*0*
		Land & Carbon Stocks	Direct Land Use Change	*Yes*	*4*	*6*
			Indirect Land Use Change	*Yes*	*4*	*6*
			Changes in Carbon Stocks	*No*	*0*	*0*
		Counterfactual Considerations	Land Use Counterfactuals	*No*	*0*	*0*
			Resource Use Counterfactuals	*No*	*0*	*0*
	Energy System	**Replaced Fuels**	Substitution of Fossil Fuels	*Yes*	*0*	*10*
			Substitution of Traditional Bioenergy	*No*	*0*	*0*

D. BSIM Weightings

The following tables list the default BSIM 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. Default weighting were developed through consultation with bioenergy and bioeconomy stakeholders as described in the BSIM Guidance Manual [17].

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

			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
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			

E. Sustainable Performance Scores of the Bioenergy Case studies Analysed using the Bioeconomy Sustainability Indicator Model

Sustainable Performance Scores of the Bioenergy Case studies CS1, CS2, CS3 and CS4

Indicators		CS1		CS2		CS3		CS4	
		Benefit	*Risk*	*Benefit*	*Risk*	*Benefit*	*Risk*	*Benefit*	*Risk*
1	Health & Wellbeing	-	-	-	-	-	-	-	*-3.65*
2	Food Systems	*4.60*	*-12.25*	*12.07*	*-7.35*	-	-	-	-
3	Land Management	*10.97*	*-20.88*	*10.97*	*-16.70*	-	-	-	-
4	Decent Work	-	-	-	-	-	-	-	-
5	Jobs & Skills	-	-	*8.02*	*-4.79*	-	-	-	-
6	Change in income	-	-	*12.97*	*-7.63*	*4.86*	*-3.05*	-	-
7	Equality	-	-	*13.52*	*-8.00*	-	-	-	-
8	Peace, Justice & Strong Institutions	-	-	-	-	-	-	-	-
9	Partnerships	-	-	*15.78*	*-8.80*	-	-	*8.41*	-
10	Energy Access	-	-	*16.15*	*-7.33*	-	-	*8.07*	*-3.67*
11	Economic Performance	*3.72*	*-3.77*	*10.23*	*-13.21*	-	-	*3.72*	*-0.94*
12	Economic Stimulation	*8.41*	*-7.00*	*12.62*	*-10.50*	-	-	*8.41*	*-1.75*
13	Infrastructure Requirements	*5.24*	*-6.11*	*2.62*	*-4.89*	-	-	-	-
14	Production Processes	*3.52*	*-4.10*	*7.03*	*-4.10*	*3.52*	*-2.05*	-	-
15	Mobilisation	*1.90*	*-10.39*	*15.23*	*-10.39*	-	-	-	-
16	Distribution	*14.62*	*-18.45*	*14.62*	*-12.30*	-	-	*9.14*	*-12.30*
17	Innovation	-	-	-	-	-	-	*3.91*	*-7.37*
18	Efficiencies	*8.48*	*-16.40*	*5.66*	*-6.15*	-	-	*5.66*	*-4.10*
19	Techno-Economics	-	-	*1.10*	*-2.68*	-	-	*11.01*	*-6.03*
20	Bioenergy	-	-	*13.31*	*-11.90*	-	-	*6.26*	*-3.17*
21	Energy System Performances	*5.26*	*-4.69*	*12.61*	*-8.21*	-	-	*1.05*	*-4.69*
22	Added Value Products	-	-	*8.01*	*-5.20*	-	-	-	-
23	Bioenergy Complementing Wider Sectors	*2.71*	*-2.26*	*9.22*	*-7.93*	*2.71*	*-1.13*	*4.34*	*-2.26*
24	Land Characteristics	-	-	*13.61*	*-9.55*	*8.75*	*-3.82*	-	-
25	Soil	-	-	*10.95*	*-8.29*	*11.47*	*-5.53*	-	-
26	Ecosystems	*9.75*	*-14.86*	*11.38*	*-9.08*	*6.50*	*-3.30*	-	-
27	PM Pollutants	-	-	-	-	-	-	-	-
28	Oxide Pollutants	-	-	-	-	*4.32*	*-0.92*	-	*-1.83*
29	Heavy Metals	-	-	-	-	-	-	-	-
30	Water Use & Efficiency	*4.97*	*-5.48*	*9.10*	*-10.95*	-	*-3.65*	*1.66*	*-2.74*
31	Water Quality	-	-	-	-	*7.91*	*-1.64*	*7.03*	*-1.64*
32	Water Systems	*5.48*	*-4.13*	-	-	*7.31*	*-2.75*	-	-
33	Climate Action	*7.63*	*-8.55*	*15.26*	*-8.55*	-	-	-	-
34	Standards	-	-	-	-	-	-	*3.98*	*-0.99*
35	Whole Life Cycle Emissions	*3.51*	*-7.45*	*12.27*	*-11.18*	*3.51*	*-1.86*	*5.26*	*-4.66*
36	Land & Carbon Stocks	*10.85*	*-20.58*	*16.28*	*-11.08*	*13.56*	*-7.92*	-	-
37	Counterfactual Considerations	*10.52*	*-11.75*	-	-	*6.31*	*-7.05*	-	-
38	Replaced Fuels	-	-	*18.21*	*-5.80*	-	-	*9.10*	*-1.45*

Sustainable Performance Scores of the Bioenergy Case studies CS5, CS6, CS7 and CS8

Indicators		CS5		CS6		CS7		CS8	
		Benefit	*Risk*	*Benefit*	*Risk*	*Benefit*	*Risk*	*Benefit*	*Risk*
1	Health & Wellbeing	-	*-1.83*	*4.86*	*-3.65*	*4.86*	*-2.74*	-	-
2	Food Systems	-	-	-	-	*6.90*	*-6.13*	-	-
3	Land Management	-	-	-	-	-	-	-	-
4	Decent Work	-	-	-	-	-	-	-	-
5	Jobs & Skills	-	-	-	-	-	-	*6.01*	*-4.79*
6	Change in income	-	-	-	-	-	-	*4.86*	*-3.05*
7	Equality	-	-	-	-	-	-	-	-
8	Peace, Justice & Strong Institutions	-	-	-	-	-	-	-	-
9	Partnerships	-	-	-	-	-	-	-	-
10	Energy Access	-	-	*8.07*	*-7.33*	*8.07*	*-7.33*	*12.11*	*-3.67*
11	Economic Performance	-	-	*5.58*	*-2.83*	-	-	*1.39*	*-1.42*
12	Economic Stimulation	-	-	*16.83*	*-10.50*	*8.41*	*-5.25*	*6.31*	*-1.75*
13	Infrastructure Requirements	*5.24*	*-2.44*	-	-	-	-	*11.79*	*-11.00*
14	Production Processes	-	-	-	-	-	-	-	-
15	Mobilisation	-	-	-	-	-	-	-	-
16	Distribution	*3.66*	*-4.10*	-	-	-	-	-	-
17	Innovation	*19.55*	*-5.53*	*9.77*	*-9.21*	*7.82*	*-9.21*	*7.82*	*-3.68*
18	Efficiencies	*5.66*	*-4.10*	*12.72*	*-8.20*	*5.66*	*-4.10*	*8.48*	*-12.30*
19	Techno-Economics	*6.61*	*-10.72*	*2.20*	*-2.01*	-	-	*9.08*	*-11.05*
20	Bioenergy	-	-	-	-	-	-	*9.39*	*-7.94*
21	Energy System Performances	*6.31*	*-4.69*	*4.20*	*-1.76*	-	-	*9.46*	*-9.38*
22	Added Value Products	-	-	*20.03*	*-6.93*	*14.02*	*-8.67*	-	-
23	Bioenergy Complementing Wider Sectors	*2.17*	*-1.13*	*3.25*	*-3.40*	*2.71*	*-2.26*	*4.88*	*-1.70*
24	Land Characteristics	-	-	-	-	-	-	-	-
25	Soil	-	-	-	-	-	-	-	-
26	Ecosystems	-	-	-	-	-	-	-	-
27	PM Pollutants	-	-	-	-	-	-	*4.66*	*-1.90*
28	Oxide Pollutants	-	-	-	-	-	-	*4.86*	*-1.38*
29	Heavy Metals	-	-	-	-	-	-	*4.45*	*-1.75*
30	Water Use & Efficiency	*13.24*	*-7.30*	*8.28*	*-13.69*	*7.45*	*-13.69*	*1.66*	*-2.74*
31	Water Quality	*3.52*	*-1.64*	*5.28*	*-5.75*	*5.28*	*-5.75*	-	-
32	Water Systems	-	-	*5.48*	*-4.13*	*5.48*	*-4.13*	-	-
33	Climate Action	-	-	-	-	-	-	*5.72*	*-6.41*
34	Standards	*3.98*	-	*6.63*	*-3.96*	*6.63*	*-3.96*	*7.95*	*-5.93*
35	Whole Life Cycle Emissions	*2.63*	*-1.86*	*3.51*	*-2.79*	*3.51*	*-2.79*	*6.57*	*-2.33*
36	Land & Carbon Stocks	-	-	-	-	-	-	-	-
37	Counterfactual Considerations	-	-	-	-	-	-	-	-
38	Replaced Fuels	*9.10*	*-2.90*	*11.38*	*-2.90*	*9.10*	*-2.90*	*13.66*	*-5.80*

Sustainable Performance Scores of the Bioenergy Case studies CS9, CS10, CS11 and CS12

Indicators		CS9		CS10		CS11		CS12	
		Benefit	*Risk*	*Benefit*	*Risk*	*Benefit*	*Risk*	*Benefit*	*Risk*
1	Health & Wellbeing	-	-	*4.86*	*-1.83*	-	-	*6.48*	*-1.83*
2	Food Systems	-	-	*6.32*	*-4.29*	-	-	-	-
3	Land Management	-	-	*3.66*	*-6.26*	-	-	*16.45*	*-8.35*
4	Decent Work	-	-	-	-	-	-	-	-
5	Jobs & Skills	-	-	*12.02*	*-8.51*	*12.02*	-	*12.69*	*-8.51*
6	Change in income	*6.48*	*-4.58*	-	-	*6.48*	-	*12.97*	*-9.15*
7	Equality	-	-	-	-	-	-	*3.38*	*-6.40*
8	Peace, Justice & Strong Institutions	-	-	-	-	-	-	-	-
9	Partnerships	-	-	-	-	*11.57*	-	-	-
10	Energy Access	*12.11*	-	*10.09*	*-1.83*	-	-	*8.07*	*-3.67*
11	Economic Performance	-	-	*6.51*	*-5.66*	*1.86*	-	*14.87*	*-11.32*
12	Economic Stimulation	*16.83*	*-12.25*	*10.52*	*-5.25*	*14.72*	*-7.00*	*8.41*	*-5.25*
13	Infrastructure Requirements	*15.72*	*-14.66*	-	-	*14.41*	*-3.67*	*11.79*	*-7.33*
14	Production Processes	*8.79*	*-5.13*	*7.91*	*-9.23*	-	-	*6.16*	*-7.18*
15	Mobilisation	-	-	*17.14*	*-12.46*	-	-	*13.33*	*-16.62*
16	Distribution	-	-	*10.97*	*-16.40*	-	*-4.10*	*12.79*	*-16.40*
17	Innovation	-	-	*19.55*	*-14.74*	*7.82*	*-7.37*	*7.82*	*-3.68*
18	Efficiencies	*8.48*	*-12.30*	*4.24*	*-8.20*	*5.66*	*-8.20*	*5.66*	*-6.15*
19	Techno-Economics	-	-	*2.20*	*-2.68*	*6.61*	*-10.72*	*3.85*	*-4.69*
20	Bioenergy	-	-	*17.22*	*-12.70*	*7.05*	*-4.76*	*14.87*	*-10.32*
21	Energy System Performances	-	-	*11.56*	*-8.21*	*2.10*	*-4.69*	*3.15*	*-2.35*
22	Added Value Products	*4.01*	*-3.47*	*20.03*	*-3.47*	*6.01*	*-3.47*	*12.02*	*-6.93*
23	Bioenergy Complementing Wider Sectors	*4.34*	*-2.83*	*4.88*	*-5.10*	*3.80*	*-2.26*	*6.51*	*-2.83*
24	Land Characteristics	*7.78*	*-8.60*	*5.83*	*-6.69*	-	-	*13.61*	*-6.69*
25	Soil	*8.86*	-	*3.13*	*-2.76*	-	-	*6.26*	*-2.30*
26	Ecosystems	-	-	-	-	-	-	*3.25*	*-1.65*
27	PM Pollutants	-	-	-	-	-	*-11.40*	*12.41*	*-11.40*
28	Oxide Pollutants	-	-	-	-	-	*-5.50*	-	-
29	Heavy Metals	-	-	-	-	-	-	-	-
30	Water Use & Efficiency	*2.48*	*-2.74*	*9.93*	*-4.56*	-	*-5.48*	*4.14*	*-2.74*
31	Water Quality	-	*-0.82*	-	-	-	-	-	-
32	Water Systems	*5.48*	*-4.13*	-	-	-	-	-	-
33	Climate Action	*7.63*	*-4.28*	*17.17*	*-12.83*	*13.36*	*-8.55*	*15.26*	*-10.69*
34	Standards	-	-	*10.61*	*-6.92*	-	*-5.93*	*5.30*	*-2.97*
35	Whole Life Cycle Emissions	*8.76*	*-5.59*	*11.39*	*-11.18*	*5.26*	*-9.31*	*6.14*	*-4.66*
36	Land & Carbon Stocks	*5.43*	*-1.58*	*9.49*	*-11.08*	-	-	*2.71*	*-4.75*
37	Counterfactual Considerations	*8.41*	*-7.05*	-	-	*8.41*	*-4.70*	-	-
38	Replaced Fuels	*9.10*	*-2.90*	*18.21*	*-7.25*	*9.10*	*-2.90*	*9.10*	-

Sustainable Performance Scores of the Bioenergy Case studies CS13, CS14, CS15 and CS16

Indicators		CS13		CS14		CS15		CS16	
		Benefit	*Risk*	*Benefit*	*Risk*	*Benefit*	*Risk*	*Benefit*	*Risk*
1	Health & Wellbeing	-	-	-	-	-	-	-	*-2.74*
2	Food Systems	-	-	-	-	*2.30*	*-0.61*	*1.72*	*-0.36*
3	Land Management	-	-	-	-	*10.97*	*-12.53*	*5.48*	*-0.39*
4	Decent Work	-	-	-	-	-	-	-	-
5	Jobs & Skills	*11.36*	*-2.66*	-	-	*16.03*	*-3.19*	*13.36*	*3.49*
6	Change in income	*12.97*	*-4.58*	-	-	*11.34*	*-7.63*	-	-
7	Equality	-	-	-	-	-	-	-	-
8	Peace, Justice & Strong Institutions	-	-	-	-	-	-	-	-
9	Partnerships	*14.72*	*-10.40*	-	-	*8.41*	*-3.20*	-	-
10	Energy Access	*12.11*	*-9.17*	-	-	-	-	*18.17*	*4.50*
11	Economic Performance	*12.09*	*-7.55*	-	-	*8.37*	*-8.49*	-	-
12	Economic Stimulation	*16.83*	*-8.75*	*16.83*	*-10.50*	*14.72*	*-8.75*	*8.41*	*2.46*
13	Infrastructure Requirements	*6.55*	*-6.11*	*11.79*	*-18.33*	*11.79*	*-14.66*	*15.72*	*1.75*
14	Production Processes	*5.28*	*-5.13*	-	-	*3.52*	*-5.13*	*1.76*	*-0.66*
15	Mobilisation	*9.52*	*-4.15*	*5.71*	*-14.54*	*9.52*	*-18.70*	*7.62*	*1.73*
16	Distribution	*10.97*	*-8.20*	-	-	-	-	*5.48*	*-0.33*
17	Innovation	*13.68*	*-12.90*	*7.82*	*-5.53*	*19.55*	*-14.74*	*15.64*	*4.14*
18	Efficiencies	*8.48*	*-16.40*	*11.31*	*-12.30*	*9.90*	*-18.45*	*5.66*	*0.78*
19	Techno-Economics	*11.56*	*-15.41*	-	-	*11.56*	*-16.08*	*8.26*	*-2.57*
20	Bioenergy	*14.87*	*-6.35*	*10.96*	*-9.52*	*7.05*	*-6.35*	*7.83*	*1.14*
21	Energy System Performances	*7.36*	*-8.21*	-	-	*5.26*	*-5.86*	*4.20*	*0.34*
22	Added Value Products	*20.03*	*-3.47*	-	-	*2.00*	*-1.73*	-	-
23	Bioenergy Complementing Wider Sectors	*13.56*	*-5.10*	*4.34*	*-0.57*	*4.34*	*-2.26*	-	-
24	Land Characteristics	*9.72*	*-1.91*	-	-	*1.94*	*-1.91*	*3.89*	*0.51*
25	Soil	-	-	-	-	*6.26*	*-3.22*	*10.95*	*0.64*
26	Ecosystems	-	-	-	-	*8.94*	*-4.13*	-	-
27	PM Pollutants	-	-	-	-	-	-	-	-
28	Oxide Pollutants	*10.80*	*-3.67*	-	-	*3.24*	*-1.83*	-	-
29	Heavy Metals	-	-	-	-	-	-	-	-
30	Water Use & Efficiency	*4.97*	*-5.48*	-	-	-	-	-	*-0.91*
31	Water Quality	*8.79*	*-4.93*	-	-	-	-	-	*-0.82*
32	Water Systems	-	-	-	-	*12.79*	*-4.13*	-	-
33	Climate Action	*7.63*	*-4.28*	*15.26*	*-12.83*	*15.26*	*-10.69*	-	-
34	Standards	*5.30*	*-2.97*	*5.30*	*-0.99*	*14.58*	*-8.90*	-	-
35	Whole Life Cycle Emissions	*4.38*	*-2.79*	*14.90*	*-4.66*	*14.90*	*-5.59*	*3.51*	*-1.51*
36	Land & Carbon Stocks	-	-	-	-	*10.85*	*-6.33*	*8.14*	*0.90*
37	Counterfactual Considerations	-	-	*8.41*	*-9.40*	*16.83*	*-14.10*	-	-
38	Replaced Fuels	*22.76*	*-7.25*	*11.38*	*-1.45*	*11.38*	*-1.45*	*11.38*	*5.69*

F. Mapped Influence of the Bioenergy Case Studies on the United Nation's 17 SDGs

Sustainability Index Values Mapping the Potential Influence of Case Studies 1-8 on the SDGs

	CS1		CS2		CS3		CS4		CS5		CS6		CS7		CS8	
	B	*R*	*B*	*R*	*B*	*R*	*B*	*R*	*B*	*R*	*B*	*R*	*B*	*R*	*B*	*R*
SDG 1	-	-1	1	-	-	-	-	-	-	-	-	-	1	-	-	-
SDG 2	1	-3	6	-3	-	-	-	-	1	-	3	-	1	-2	-	-1
SDG 3	-	-	16	-2	6	-	4	-3	2	-3	3	-2	5	-	6	-
SDG 4	-	-1	2	-1	1	-	-	-	-	-	-	-	-	-	-	-
SDG 5	-	-4	4	-2	-	-	-	-	-	-	-	-	2	-	2	-
SDG 6	-	-	11	-5	12	-	-	-	-	-	-	-	-	-	-	-
SDG 7	4	-3	20	-2	2	-	7	-4	1	-1	1	-	1	-	7	-
SDG 8	-	-14	18	-19	-	-	29	-1	4	-21	14	-	3	-	14	-34
SDG 9	5	-17	54	-16	3	-	39	-2	7	-20	19	-	6	-	37	-40
SDG 10	1	-	4	-	-	-	2	-	-	-	-	-	-	-	1	-
SDG 11	2	-3	18	-4	-	-	9	-1	2	-3	6	-1	6	-	13	-2
SDG 12	15	-15	62	-21	17	-	35	-2	6	-16	12	-2	8	-	32	-22
SDG 13	6	-15	29	-13	10	-	10	-3	6	-5	6	-1	2	-2	16	-12
SDG 14	-	-	11	-1	8	-	-	-	-	-	2	-	2	-	1	-
SDG 15	14	-5	57	-11	16	-	6	-3	5	-	18	-	11	-5	31	-9
SDG 16	-	-	11	-	5	-	-	-	-	-	-	-	-	-	5	-
SDG 17	-	-	7	-	-	-	3	-	-	-	-	-	-	-	4	-

Sustainability Index Values Mapping the Potential Influence of Case Studies 9-16 on the SDGs

	CS9		CS10		CS11		CS12		CS13		CS14		CS15		CS16	
	B	*R*	*B*	*R*	*B*	*R*	*B*	*R*	*B*	*R*	*B*	*R*	*B*	*R*	*B*	*R*
SDG 1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
SDG 2	-	-	1	-3	-	-1	-	-3	1	-3	-	-	1	-3	-	-1
SDG 3	8	-	13	-	2	-2	13	-	10	-	2	-	8	-	6	-5
SDG 4	-	-	-	-	-	-	-	-1	-	-	-	-	1	-	-	-
SDG 5	-	-	4	-2	2	-	4	-	2	-	-	-	2	-2	2	-
SDG 6	5	-3	5	-3	-	-	12	-	6	-	-	-	3	-	9	-1
SDG 7	4	-	4	-9	10	-4	3	-3	12	-11	-	-3	7	-5	4	-3
SDG 8	-	-6	18	-10	22	-22	26	-10	28	-28	4	-2	21	-43	16	-30
SDG 9	10	-13	28	-13	40	-30	33	-	54	-39	8	-14	32	-50	30	-27
SDG 10	-	-	1	-	3	-	1	-	3	-	-	-	3	-	1	-1
SDG 11	6	-2	14	-1	9	-2	12	-	17	-3	6	-1	6	-5	10	-3
SDG 12	14	-4	29	-1	24	-22	40	-	49	-22	12	-1	39	-27	16	-20
SDG 13	5	-3	8	-8	16	-12	17	-	20	-12	4	-6	22	-16	11	-7
SDG 14	5	-1	7	-1	1	-	11	-	5	-	-	-	5	-	7	-2
SDG 15	15	-1	29	-7	34	-9	45	-8	51	-6	10	-4	33	-11	11	-1
SDG 16	5	-	-	-	10	-	10	-	10	-	-	-	10	-	-	-
SDG 17	-	-	4	-	9	-	2	-	7	-	-	-	7	-	4	-

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