## List of All Sustainability Indicators

**Table A.1: Nuclear Energy Indicators used in Previous Sustainability Reports. In the Reference column, capitalised letters denote indicators which are explicitly mentioned. Lower-case letters denote indicators which are inferred either individually or as part of a group.**
**A, a: denotes Reference (1).**
**B, b: denotes Reference (2).**
**C, c: denotes Reference (3).**
**D, d: denotes Section 8 of Reference (4).**
**E, e: denotes Section 2 of Reference (4).**
**F, f: denotes Reference (5).**
**G, g: denotes Reference (6).**
**H, h: denotes Reference (7).**
**I, i: denotes Reference (8).**

| Indicator Label | Indicator | Reference |
|---|---|---|
| E1 | Global Warming Potential [kg($CO_2$)eq/kWh] | A, b, E, F, g, h, I |
| E2 | Freshwater Eco-toxicity Potential [kg(1-,4-DCB)eq/kWh] | A, b, e, g, h, i |
| E3 | Marine Eco-toxicity Potential [kg(1-,4-DCB)eq/kWh] | A, b, e, g, h, i |
| E4 | Ozone Depletion Potential [kg(CFC-11)eq/kWh] | A, b, E, g, h |
| E5 | Acidification Potential [kg($SO_2$)eq/kWh] | A, b, E, g, h, i |
| E6 | Eutrophication Potential [kg($PO_4^{3-}$)eq/kWh] | A, b, E, g, h, i |
| E7 | Photochemical Smog Potential [kg($C_2H_4$)eq/kWh] | A, b, e, g, h, i |
| E8 | Land Occupation [$m^2$yr/kWh] | A, b, e, f, i |
| E9 | Greenfield Land Use [%] | A, b, e, f, i |
| E10 | Terrestrial Eco-toxicity Potential [kg(1,4-DCB)eq/kWh] | A, b, e, g, h, i |
| E11 | Recyclability of Input Materials [%] | A |
| E12 | Freshwater Consumption [l] | B |
| E13 | Freshwater Withdrawals [l] | B |
| E14 | Disposal Space [$m^2$/yr] or [ha/GWh] | B, e, f |
| E15 | Noise Pollution | E, I |
| E16 | Change of Landscape | E, I |
| E17 | Bio-Diversity/Species "Eco-system" | E |
| E18 | Release of Hydrocarbons Following Accident [t$CO_2$eq/kWh] | I |
| E19 | Area of Land Contaminated from Nuclear Accident [$km^2$/kWh] | I |
| E20 | Application of ALARP to Limit Environmental Effects | H |
| E21a | Use of Abiotic Resources (Elements) [kg Sb(eq)/kWh] | A, I |
| E21b | Use of Abiotic Resources (Fossil Fuels) [MJ/kWh] | A, E, I |
| E21c | Use of Aluminium | E, g |
| E21d | Use of Iron | E, g |

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|---|---|---|
| E21e | Use of Copper | E, g |
| E21f | Use of Other Non-Renewable Natural Resources | g, H |
| E21g | Use of Other Renewable Natural Resources | G |
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| T1 | Total Levelised Cost of Electricity [£/kWh] | A, H, I |
| T1a | Total Cost of Electricity [£/kWh] | B |
| T2 | Capital Cost [£] | F, G, H, I |
| T2a | Capital Cost (Reactor) [£] | A, D |
| T2b | Overnight Construction Costs (LCC) [£] | C |
| T2c | Overnight Construction Costs (Risk to Capital) [£] | b, C |
| T3 | Operation and Maintenance Cost [£/kWh] | A, D |
| T3a | Marginal Cost [£/kWh] | G |
| T3b | Waste Operational Costs (Interim Storage to DGD) [£/kWh] | H |
| T3c | Decontamination and Decommissioning Costs (Reactor) [£/kWh] | D, f, H |
| T3d | Total Repository Cost [£] | D, f, H |
| T4 | Levelised Fuel Cycle Cost [£/kWh] | A, B, D, f |
| T5 | Fuel Price Sensitivities [£/kWh] | A, I |
| T6 | Financial Incentives [£/kWh] | A |
| T7 | Disposal Costs [£/kWh] | B |
| T8 | Discount Rate [%] | G |
| T9a | $U_3O_8$ Consumption [kg/kWh] | B, G, H |
| T9b | $ThO_2$ Consumption [kg/kWh] | H |
| T10 | Cost of Raw Materials [£/$U_3O_8$] | c, F, g |
| T11 | Cost of Separation Work [£/SWU] | c, F, g |
| T12 | Cost of Conversion [£/$UO_2$] | c, F, g |
| T13 | Cost of Fabrication [£/Fuel Form] | c, F, g |
| T14 | Cost of Storage [£/Fuel Form] | c, F, g |
| T15 | Cost of Reprocessing [£/$UO_2$_Rep] | c, F, g |
| T16 | Cost of Transport [£.kg/km] | c, F, g |
| T17 | Cost of Encapsulation and Condition [£/kg(SF)] | F |
| T18 | Cost of Disposal [£/kg(SF)] | F |
| T19 | Cost of Governmental Research [£] | d, F |
| T20 | Cost of Non-Governmental Development [£] | d, F |
| T21 | Cost of Basic R&D [£] | d, F |
| T22 | Cost of Laboratory/Process [£] | d, F |
| T23 | Cost of Pre-Industrial [£] | d, F |
| T24 | Cost of Industrial [£] | d, F |
| T25 | Capacity Factor [%] | A, i |
| T26a | Availability Factor [%] | A, I |
| T26b | Forced Outage Rate | C |
| T27 | Technical Dispatchability [Rank] | A, H, i |
| T28 | Economic Dispatchability [#] | A, H |
| T29a | Lifetime of Global Uranium Reserves at Current Extraction Rates [kgU] | A, C, I |
| *T29b* | *Lifetime of Global Thorium Reserves at Current Extraction Rates [kgTh]* | *This Work* |

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|---|---|---|
| T30 | Plant Flexibility [$yr^{-1}$] | A, H |
| T31 | Construction Duration (LCC) [£/yr] | C |
| T32a | Construction Duration (Risk to Capital) [£/yr] | b, C |
| T32b | Time Between Plant Start-Up and Start of Construction [yr] | A, I |
| T32c | Technological Innovation/Improvements [Patents/kWh] | G |
| T33 | Added Value "Income Generation" | E |
| T34 | R/P Ratio | E |
| T35a | Energy Recovered per kgU | F, H |
| T35b | Energy Recovered per kgTh | H |
| T35c | Energy Recovered per kg of Limited Non-Renewable Resource Consumed | H |
| T36a | Ratio of Necessary Energy Input to Obtained Output | F, H |
| T36b | Power Available for Use in the Innovative Nuclear System | H |
| T37 | Range of Ton-Kilometres Energy Intensity Ratio | F |
| T38 | Cost of Incorporating Intrinsic and Extrinsic Measures to Improve PR | H |
| T39 | Availability of Waste Management Technology | H, I |
| T40 | Time Required to Industrialise Waste Management Technology | H |
| T41 | Availability of Resources to Meet Radioactive Waste Demand | H |
| T42 | Financial Figures of Merit | H |
| T43 | Licensing Status | H |
| T44 | Financial Robustness Index of Innovative Nuclear System | H |
| T45 | Status of Legal Frameworks | H |
| T46 | Status of States Capability for the Nuclear Fuel Cycle | H |
| T47 | Availability of Credit Lines | H |
| T48 | Size of Installation | H |
| T49 | Availability of Infrastructure to Support Owner/Operator | H |
| T50 | Availability of Human Resources | H |
| *T51* | *Challenges in Licensing Technology (Qualitative Score)* | *This Work* |
| SO1 | Direct Employment [person-yrs/kWh] | A, E, f, g, I |
| SO2 | Indirect Employment [person-yrs/kWh] | A, f, g |
| SO3 | Proportion of Staff from Locality [%] | A |
| SO4 | Spending on Local Suppliers [%] | A |
| SO5 | Direct Investment in Local Community [%] | A |
| SO6 | Corruption from Supplier Countries [Score] | A |
| SO7 | Imported Fossil Fuel Avoided [toe/kWh] | A |
| SO8 | Fuel Import Dependency | E, I |
| SO9 | Diversity of Fuel Supply Mix [Score] | A, I |
| SO10 | Fuel Storage Capabilities [$GJ/m^3$] | A |
| SO11 | Education [# of Courses] | G |
| SO13 | Mass of Depleted U [kg/kWh] | B |
| SO14 | Public Health [£/kWh] | G |
| SO15 | Change in Work Opportunity | F |
| SO16 | Resettlement Necessities | E |

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| SO17 | "Public Acceptance" NIMBY/BANANA | E, f, H |
| SO18 | "Risk Aversion" Kind of Risk Constraints | E, f |
| SO19 | "Risk Aversion" Nature of Risk Source | E, f |
| SO20 | "Risk Aversion" Dimensions of Risk Consequence | E, f |
| SO21 | Human Toxicity Potential [kg (1,4-DCB)eq/kWh] | A |
| SO22 | Volume of Liquid $CO_2$ to be Stored [$m^3$/kWh] | A |
| SO23 | Autonomy of Resources | F |
| SO24 | Induced Industrial Production | F |
| SO25 | Long Term Commitment to Nuclear Option | H |
| SO26 | Demand For and Price of Energy Products | H |
| SO27 | Information Provided to the Public | H |
| SO28 | Participation of the Public in Decision Making | H, I |
| SO29 | Government Policy | H |
| SO30 | Attitude to Safety and Security | H |
| SO31 | Perceived Risk Characteristic from Normal Operation | I |
| SO32 | Perceived Risk Characteristic from Accidents | I |
| SO33 | Potential of Energy System Induced Conflicts | I |
| SA1a | Operational Accidents [#/yr] | B, F |
| SA1b | Calculated Frequency of Occurrence of Design Basis Accidents | H |
| SA1c | Calculated Frequency of Major Release of Radioactive Materials into the Environment | H |
| SA1d | Expected Frequency of Abnormal Operation and Accidents | H |
| SA1e | Expected Frequency of Failures of Disturbances | H |
| SA2 | Core Damage Frequency [#/yr] | B |
| SA3 | Potential Damage of Severe Accidents (Range) [m] | E |
| SA3a | Consequence of Abnormal Operation | H |
| SA3b | Consequence of Accidents | H |
| SA4 | Accident Exposures | C, H |
| SA4a | Health Impact of Accidents on Workers | E, h |
| SA4b | Health Impact of Accidents on Public | E, h |
| SA5a | Estimated Peak Dose Rate [mrem/yr] | B |
| SA5b | Maximum Individual Dose to Public | B, D |
| SA5c | Maximum Individual Dose to Workers | B, D |
| SA6 | Fatalities Due to Large Accidents [# Fatalities/GWh] | A, I |
| SA6a | Worker Fatalities [# Fatalities/GWh] | A, D |
| SA6b | Maximum Credible Number of Fatalities per Accident [Fatalities/Accident] | I |
| SA6c | Expected Number of Fatalities from Successful Terrorist Attacks [Ordinal] | I |
| *SA6d* | *Fatalities in Normal Operation (without Large Accident)* | *This Work* |
| SA7 | Number of Latent Cancer Fatalities [#] | B |
| SA8 | Total Human Health Impacts from Radiation [DALY/GWh] | A, D, I |
| SA8a | Public Human Health Impacts from Radiation [DALY/GWh] | E |
| SA8b | Worker Human Health Impacts from Radiation [DALY/GWh] | A, E |
| SA8c | Reduced Life Expectancy Due to Normal Operation | I |

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| | [YOLL/GWh] | |
| SA9a | Collective Dose to Public [mrem/yr] | B, c, D, f, G, H |
| SA9b | Collective Dose to Workers [mrem/yr] | B, c, D, f, H |
| SA10 | Discharged Waste Heat | B, C, E |
| SA11 | Transports of Radioactive Waste[#] | B |
| SA12 | Reliable Reactivity Control | C, h |
| SA13 | Reliable Decay Heat Removal | C, h |
| SA14 | Dominant Phenomena Uncertainty | C |
| SA15 | Long Fuel Thermal Response Time | C, H |
| SA16 | Integral Experiments Scalability | C, H |
| SA17 | Source Term | C |
| SA18 | Mechanisms for Energy Release | C |
| SA19 | Long System Time Constraints | C, H |
| SA20 | Long and Effective Holdup | C |
| SA21a | Passive Safety Features | C, H |
| SA21b | Active Safety Features | H |
| SA22 | Robustness of Design | H |
| SA22a | Sub-Criticality Margins | H |
| SA23a | High Quality of Operation | H |
| SA23b | Capability to Inspect | H |
| SA24 | Reliability of Engineered Safety Features | H |
| SA25 | Number of Confinement Barriers Maintained | H |
| SA26 | Capability of Engineered Safety Features to Restore Innovative Nuclear System to a Controlled State | H |
| SA27 | Calculated Frequency of Major Release of Radioactive Materials into Containment/Confinement | H |
| SA28 | Ability to Control Relative System Parameters and Activity Levels in Containment | H |
| SA29 | In-Plant Severe Accident Management | H |
| SA30 | Independence of Different Levels of DID | H |
| SA31 | Evidence that Human Factors are Addressed Systematically in the Plant Life Cycle | H |
| SA32 | Application of Formal Human Response Models from Other Industries or Development of Nuclear | H |
| SA33a | Stored Energy | H |
| SA33b | Flammability | H |
| SA33c | Criticality | H |
| SA33d | Inventory of Radioactive Materials | H |
| SA33e | Available Excess Reactivity | H |
| SA33f | Reactivity Feedback | H |
| SA34 | Confidence in Innovative Components and Approaches | H |
| SA35 | Safety Concept Defined | H |
| SA36 | Clear Process for Addressing Safety Issues | H |
| SA37 | RD&D Defined and Performed and Database Developed | H |

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| SA38 | Computer Codes or Analytical Methods Developed and Validated | H |
| SA39 | Scaling Understood and/or Full Scale Tests Performed | H |
| SA40 | Degree of Novelty of the Process | H |
| SA41 | Use of Risk Informed Approach | H |
| SA42 | Uncertainties and Sensitivities Identified and Appropriately Dealt With | H |
| SA43 | Long Term Safety from Radioactive Waste | H |
| SA44 | Radioactive Emission Control Measures from Waste Management Facility | H |
| SA45 | Waste Forms | H |
| WA0 | Total Activity [Bq/GWh] | H |
| WA1 | HLW Disposal Mass [kg/GWh] | B, c, g, h |
| WA2 | HLW Disposal Volume [$m^3$/GWh] | a, B, c, D, e, f, g, h, i |
| WA2a | Volume of Alpha-emitters from HLW | F |
| WA2b | Volume of Gamma-emitters from HLW | f, h |
| WA3 | HLW Radiological Hazard Potential | B |
| WA4 | Thermal Output of HLW after 50 years | D |
| WA5 | Volume of ILW | a, c, D, e, f, g, h, i |
| WA6a | Mass of ILW | c, g, h |
| WA6b | Mass of LLW | c, g, h |
| WA7 | LLW Solid Waste (Volume) [$m^3$/GWh] | a, B, c, D, e, f, g, h |
| WA7a | Volume of Alpha-Emitters from LLW | F |
| WA7b | Volume of Gamma-Emitters from LLW | f, h |
| WA8 | LLW Gaseous Releases [kg/GWh] | B, c, g, h |
| WA9 | Radiotoxicity of Gaseous Releases | c, D, e |
| WA10 | LLW Liquid Releases [$m^3$/GWh] | B, c, g, h |
| WA11 | Radiotoxicity of Liquid Releases | c, D, e |
| WA12 | Non-Radioactive Toxic Waste | c, E, g, h, I |
| WA13 | Non-Radioactive Non-Toxic waste | C, E, g, h |
| WA14 | Operational Waste | C, D, g, h |
| WA15 | Decommissioning Waste | C, D, g, h |
| WA16 | Length of Repository Gallery Required for Waste | D |
| WA17a | Time of Confined Alpha-Emitters | E, F |
| WA17b | Time of Confined Gamma-Emitters | E, F |
| WA18a | Radiotoxicity at 500 years | C, D |
| WA18b | Radiotoxicity at 10,000 years | C, D |
| WA18c | Radiotoxicity at 1,000,000 years | C, D |
| WA19a | Radiotoxicity Flux Released into the Biosphere (0-10,000 y) | C, D |
| WA19b | Radiotoxicity Flux Released into the Biosphere (10,000-100,000 y) | C, D |
| WA19c | Radiotoxicity Flux Released into the Biosphere (100,000- | C, D |

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| | 1,000,000 y) | |
| WA20a | Dose to Human Intrusion at 300 years | C, D |
| WA20b | Dose to Human Intrusion at 10,000 years | C, D |
| WA21 | Required Isolation Time (To Reach 10 mSv Intervention Level) | D, H |
| WA22 | Appropriate Waste Classification Scheme | H |
| WA23 | Time to Produce the Waste Form Specified for End State | H |
| WA24a | Waste Minimization Study | H |
| WA24b | Volume and Activity Reduction Measures | H |
| WA25 | Process Descriptions that Encompass the Entire Waste Cycle | H |
| *WA26* | *Neutron Emission Rate per Spent Fuel Assembly after 50 years* | *This Work* |
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| PR0 | Proliferation Resistance | A, D, F, I |
| PR1 | Mass of SNM [kg/GWh] | B, c, e, h |
| PR2 | Required Enrichment Capacity [kgSWU/GWh] | B, e |
| PR3 | Attractiveness of SNM | B, c, e, h |
| PR4 | Mass of Separated Plutonium [kg/GWh] | B, c, e, h |
| PR5 | Mass of Other Separated SNM/ANM [kg/GWh] | c, e, h |
| PR6 | Extrinsic Proliferation Resistance | E |
| PR6a | Accountability of Nuclear Materials | H |
| PR6b | Amenability of Nuclear Materials | H |
| PR6c | Detectability of Nuclear Materials | H |
| PR7 | Attractiveness of Nuclear Technology | H |
| PR8a | Difficulty to Modify Process | h |
| PR8b | Difficulty to Modify Facility Design | h |
| PR8c | Difficulty to Misuse Technology or Facilities | h |
| PR9 | Redundancy of Intrinsic and Extrinsic PR Measures | H |
| PR10 | Robustness of Barriers Covering Each Acquisition Path | H |
| PR11 | PR Taken into Account Early as Possible in Design of INS | H |
| PR12 | States Commitment, Policies and Obligations to Non-Proliferation | H |
| PR13 | Verification of Extrinsic Measures by State and IAEA | H |
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| PP1 | "Public Security" Measures Against Terrorist Attacks | E, I |
| PP2a | Competent PP Authorities Designated, Empowered (with Responsibilities) | H |
| PP2b | Legislative and Regulatory PP Framework Development | H |
| PP2c | Responsibilities of PP Between Authorities and Facility Operator Defined | H |
| PP3a | Addressing of Synergies Between PR, PP, Safety and Operations | H |
| PP3b | Accounting of PP in All INPRO Areas | H |
| PP3c | Evidence of PP when Innovative Nuclear System is Shut-Down/Decommissioned | H |
| PP4 | Is There a Trustworthiness Program (with Established Criteria) | H |
| PP5a | Has There Been Development of a Confidentiality Program | H |
| PP5b | Has the Confidentiality Program Been Implemented Over All Levels | H |
| PP6a | Is There Evidence of a DBT or Other Appropriate Threat | H |

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| | Statement Which Has Been Developed | |
| PP6b | Are There Provisions for Periodic Review of Threat by the State | H |
| PP6c | Is There Evidence that the Concept of DBT (or Other) Been Used to Establish the PP System | H |
| PP6d | Has the Designer Introduced Flexibility in PPS Design to Cope with the Dynamic Nature of Threat | H |
| PP7a | Judicial Consequences Defined For Malicious Acts Against Nuclear Materials and Facilities | H |
| PP7b | Application of "Graded" Approach to PP Requirements | H |
| PP8 | Definition and Implementation of Quality Assurance Policies to PP | H |
| PP9 | Security Culture Developed and Implemented for All Organisations and Persons In Innovative Nuclear Systems | H |
| PP10a | Assessment of Potential Benefits of Terrain, Topography and Geography to Adversaries | H |
| PP10b | Assessment of Transportation and Off-Site Response Routes | H |
| PP10c | Consideration of Future Development and Encroachment by Public | H |
| PP11a | Consideration of PP to Design of Innovative Nuclear System Components | H |
| PP11b | Consideration of PP to Layout of Innovative Nuclear System Components | H |
| PP12a | Integration of DDAD, and Response to Achieve Timely Interruption | H |
| PP12b | PPS Designed to Account for Insider Adversaries | H |
| PP12c | Redundancy of PPS | H |
| PP13a | Assignment of Responsibilities for Executing Emergency Plans | H |
| PP13b | Established Capabilities of PP to Prevent/Mitigate Radiological Consequences of Sabotage | H |
| PP13c | Established Capabilities of PP to Recover Stolen Nuclear Materials or Recapture Nuclear Facility | H |

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