Additional sector guidance

Electric utilities and power generators

June 2024
Version 1.0

SICS® industry:
Electric utilities and power generators (IF-EU)

tnfd.global

Taskforce on Nature-related Financial Disclosures

Contents

1. Introduction

1.1. The purpose of this guidance

In September 2023, the TNFD published its recommendations for disclosure of nature-related issues and supporting implementation guidance. This document provides sector-specific additional guidance for the electric utilities and power generators sector, covering:

- The assessment of nature-related issues using the TNFD's LEAP approach (Section 2); and
- The disclosure of sector-specific metrics in line with the TNFD's recommended approach to metrics (Section 3).

The TNFD's Guidance on the identification and assessment of nature-related issues: The LEAP approach is designed as an iterative process – across business locations and business lines – in line with established risk management processes and corporate reporting cycles. Organisations may choose to start with a narrow scope for a LEAP assessment, and gradually expand the scope of the assessment as they gain experience and insight.

The TNFD recognises that there can be significant differences across sectors for corporates applying the LEAP approach. It has published this additional guidance with significant input from a range of knowledge partners and market participants, to help electric utilities and power generators sector participants apply the LEAP approach to their context. The overall structure of the LEAP approach is set out in Figure 1. This guidance follows that structure and Table 1 sets out the elements of LEAP for which this document provides additional guidance.

The Taskforce also recognises that investors and other stakeholders require quantitative information to compare performance and nature-related issues within sectors. To facilitate that sector-level analysis, this guidance also includes:

- Guidance on the application of the core global disclosure indicators and metrics to the electric utilities and power generators sector (Section 3.1); and
- Core and additional sector disclosure indicators and metrics (Sections 3.2 and 3.3).

Figure 2 provides an overview of the TNFD disclosure measurement architecture and where indicators and metrics are listed in the TNFD recommendations and relevant sector guidance.

Figure 1: The TNFD approach for identification and assessment of nature-related issues – LEAP

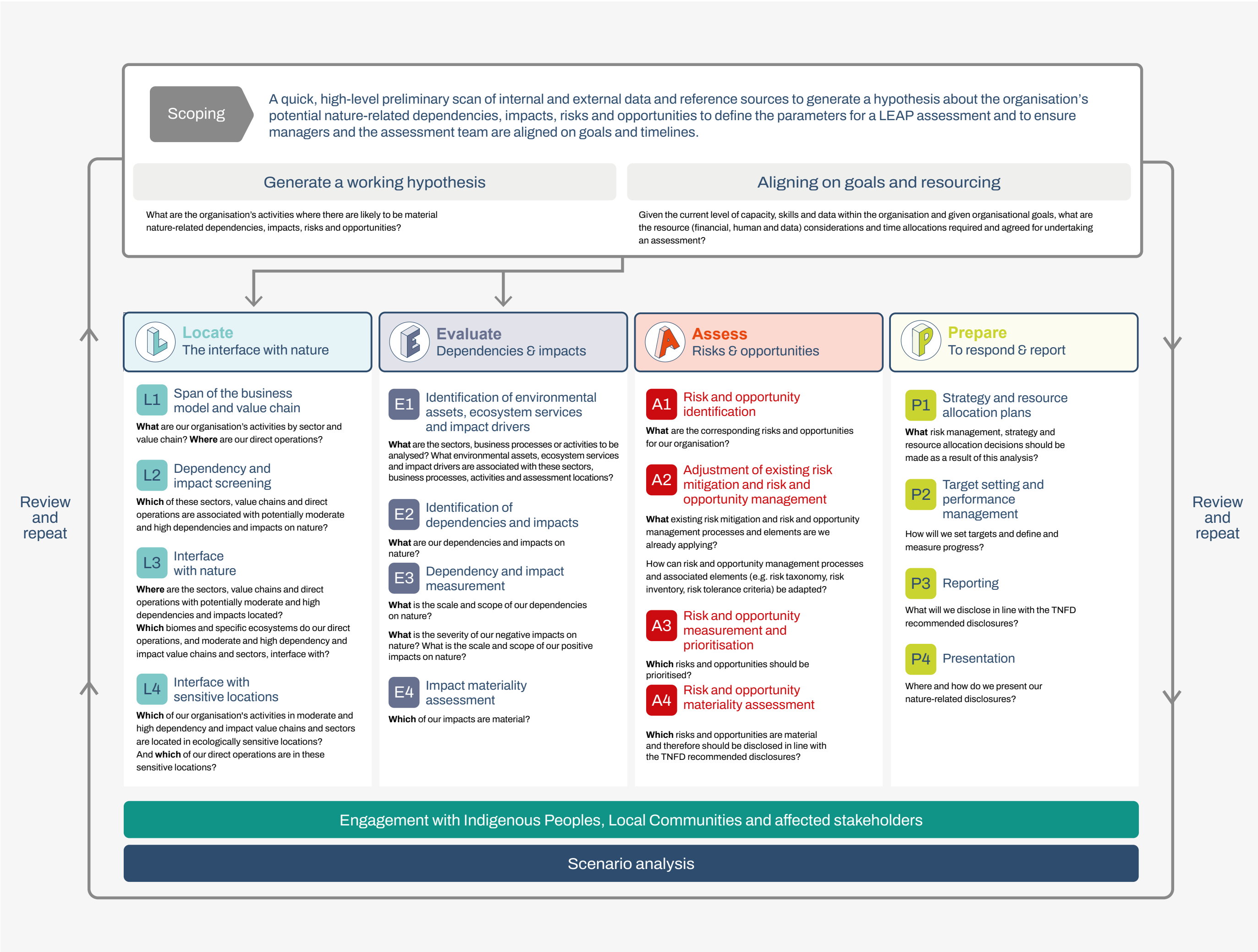
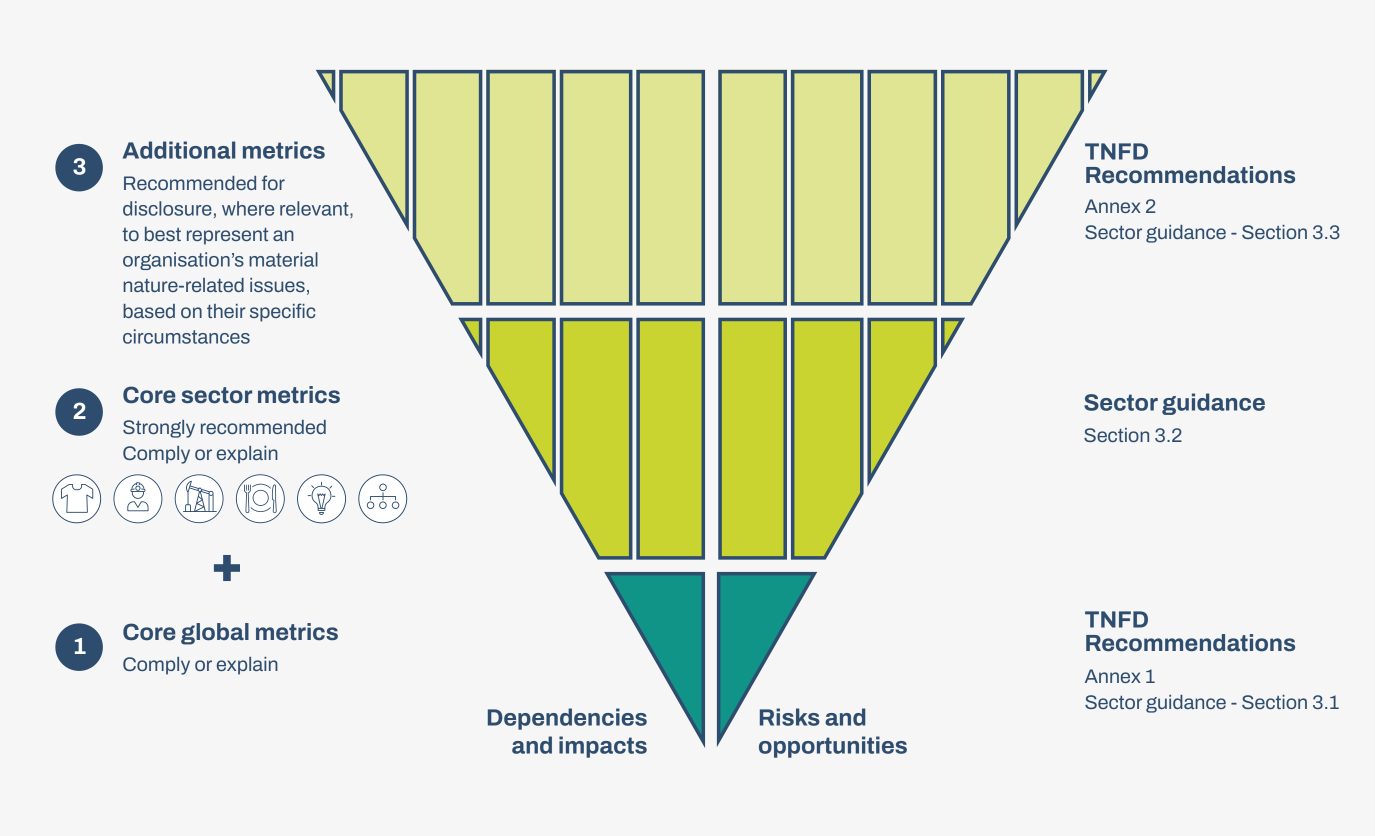


Figure 2: TNFD disclosure metrics architecture signposted to metrics lists



The guidance in Section 3 on the application of the TNFD core global metrics for this sector, as well as the core and additional sector metrics outlined, expand on the disclosure indicators and metrics outlined in Annexes 1 and 2 of the TNFD recommendations. The TNFD has incorporated and sought to build on existing industry standards and disclosure metrics wherever possible to build on current data collection and reporting practices and minimise additional assessment and reporting costs.

1.2. Audience for this guidance

This guidance covers the value chain of organisations in the Sustainable Industry Classification System® (SICS®) developed by the Sustainability Accounting Standards Board (SASB) Electric Utilities and Power Generators industry.[1] This guidance, where relevant, is further broken down by power source: coal, gas and other fossil fuels, solar, wind, hydropower, other renewable energy sources (e.g. geothermal, bioenergy) and nuclear (Box 1). For simplicity, all organisations in this industry are referred to as 'electric utilities and power generators sector organisations' in this guidance.

1 Sustainable Industry Classification System® (SICS®) developed by the Sustainability Accounting Standards Board (SASB) (2018) SASB's Sustainable Industry Classification System (SICS).

Box 1: SICS® industry in the scope of this guidance document

Electric Utilities and Power Generators (IF-EU), which include:

- Coal, natural gas and other fossil fuels;
- Solar power;
- Wind power;
- Hydropower;
- Other renewable energy sources (geothermal, bioenergy, etc.); and
- Nuclear power.

The examples provided in this guidance for the electric utilities and power generators sector are intended to be illustrative. They are not exhaustive, universally applicable or recommended by the TNFD as examples of measures for all entities within the industry. Each company's context, location and nature-related interactions are unique. The TNFD encourages all companies to consult additional relevant sources, including scientific references and relevant industry standards or best practice guides, and conduct thorough assessments to identify and assess nature-related dependencies, impacts, risks and opportunities specific to their operations and value chains. This guidance aims to support, not replace, a tailored assessment, which will be necessary for each entity.

This guidance is a supplement to the TNFD's Guidance on the identification and assessment of nature-related issues: The LEAP approach and should be read in conjunction with that guidance.

Table 1: Areas of LEAP with additional guidance for the electric utilities and power generators sector in this guidance document

Scoping	✓

L1	✓	E1	✓	A1	✓	P1	✓
L2	✓	E2	✓	A2		P2	✓
L3	✓	E3		A3		P3	
L4	✓	E4		A4		P4	

2. Sector-specific LEAP assessment guidance

2.1. Scoping a LEAP assessment

Working hypothesis generation:

What are the organisation's activities where there are likely material nature-related dependencies, impacts, risks and opportunities?

Goals and resourcing alignment:

Given the current level of capacity, skills and data within the organisation and given organisational goals, what are the resource (financial, human and data) considerations and time allocations required and agreed for undertaking an assessment?

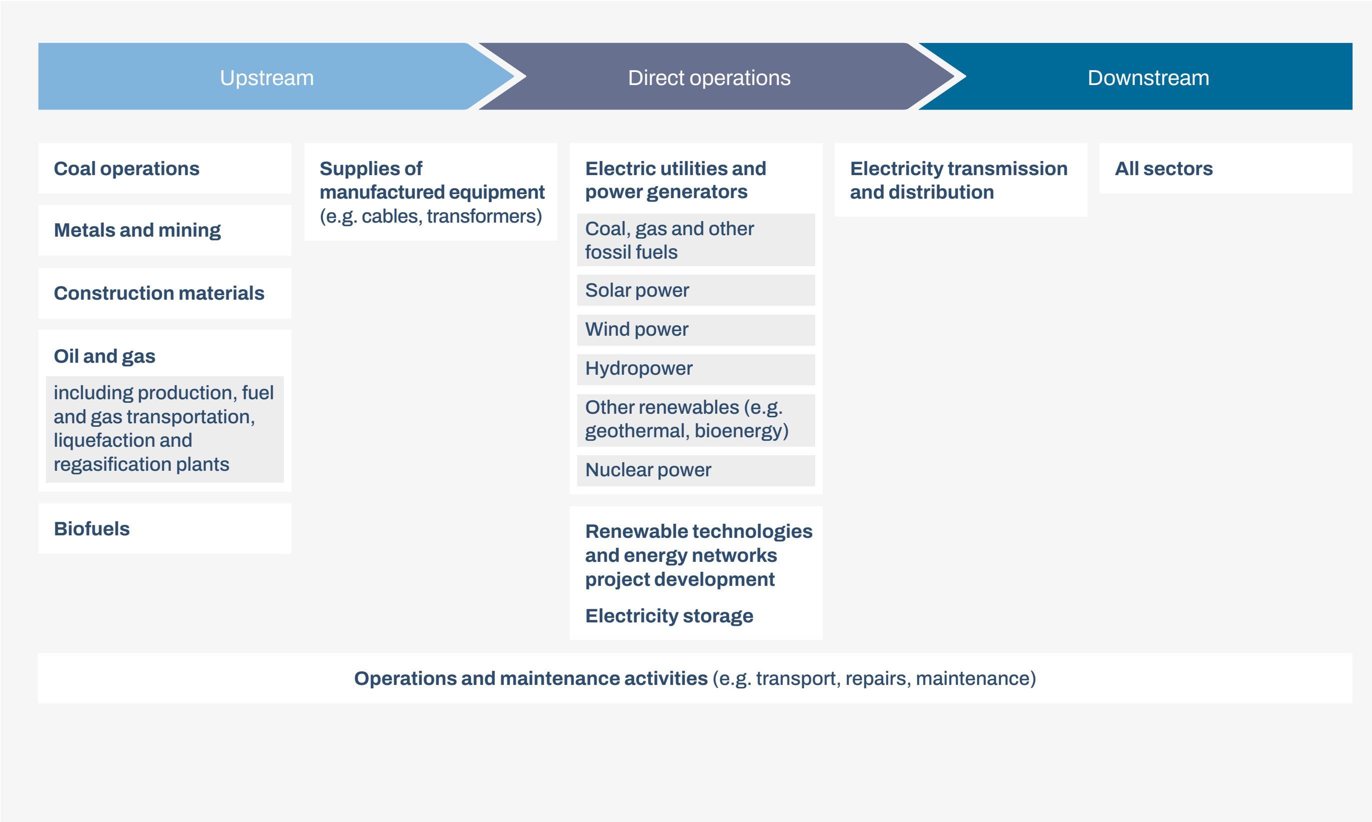
Companies should consider which technologies are within scope for both power sources and assets, for direct operations and across the value chain.

In addition to the cross-sector guidance on the LEAP approach, organisations in the electric utilities and power generators sector scoping their assessment should consider:

- Which power generation sources and technologies (e.g. wind, solar, nuclear, coal, oil and gas) are included in their direct operations and upstream and downstream value chains; and
- Which geographies transmission and distribution lines pass through, where readily available, considering the entire length of the line.

Organisations should also refer to the TNFD sector guidance for the oil and gas, metals and mining, and infrastructure sectors, as well as any other relevant sectors in the value chain.

Figure 3: Overview of the electric utilities and power generators value chain



The value chain shown in Figure 3 provides an overview of typical activities and processes of the electric utilities and power generators value chain. The TNFD recognises that organisations within the sector may have varying focus in their direct operations, as well as different suppliers and customers, based on their specific business model. Consequently, each reporting organisation is encouraged to conduct a tailored assessment of its activities across the full value chain.

Value chain considerations when scoping

Electric utilities and power generators sector organisations may operate across many different sites and have many different suppliers and consumers across their value chains with significant potential nature-related dependencies and impacts. Electric utilities and power generators organisations may therefore choose to start with a narrow scope to create a manageable starting point, such as a small number of high priority sites and areas of the value chain where material nature-related dependencies, impacts, risks and opportunities are most likely to arise. The LEAP approach is designed as an iterative process in line with established risk management processes and corporate reporting cycles, and organisations should look to expand the breadth and depth of the assessment over time as they gain experience and maturity in applying the process. Further guidance is available in the TNFD guidance on value chains.

2.2. Locate the organisation's interface with nature

This section provides additional guidance to help electric utilities and power generators sector organisations with the Locate phase of the LEAP approach.

L1 L1: Span of the business model and value chain

Guiding questions:

What are our organisation's activities by sector, value chain and geography? Where are our direct operations?

Organisations should map out the value chain – direct operations, upstream and downstream – including the technologies used (e.g. wind, solar, nuclear, coal, oil and gas) and commodities required as inputs. This should include:

- Extraction and processing of raw materials like coal, oil, gas and uranium;
- Extraction and processing of metals and minerals required for facility construction and maintenance, and energy generation and storage, including steel, aluminium, copper, lithium, zinc, nickel and rare earth elements, and whether these are obtained from recycled sources;
- Construction of facilities and sites;
- Downstream energy users;
- Fuel and commodity transport; and
- Energy facility maintenance and end of life.

Where individual downstream users cannot be identified, organisations may want to consider the distribution of energy usage across sectors for each market where they operate. This will allow initial identification of potentially high or moderate dependency or impact downstream activities in L2.

L2 L2: Dependency and impact screening

Guiding question:

Which of these sectors, value chains and direct operations are associated with potentially moderate and high dependencies and impacts on nature?

Tables 2a, 2b, 3a and 3b present examples of impact drivers and ecosystem services that are typically relevant to the electric utilities and power generators sector organisations. These tables can be used to help screen an organisation's value chain activities for potentially moderate and high impacts and dependencies on nature.

Table 2a: Materiality ratings of ecosystem services the electric utilities and power generators sector typically depends on (based on ENCORE 2018-2023 data and WBCSD 2023 Roadmaps to nature positive: Foundations for the energy system.)

Ecosystem service category	Ecosystem service	Thermal power stations	Hydropower	Wind	Solar	Biomass	Geothermal	Power transmission and distribution
Provisioning services	Fibres and other materials	-	-	-	-	Very high	-	-
	Groundwater	Medium	Medium	-	Very low	Medium	Very high	-
	Surface water	Very high	Very high	-	Very low	Medium	Medium	-
Regulating and maintenance services	Water flow maintenance	Medium	Very high	-	-	Medium	Medium	-
	Water quality	Low	Low	-	-	Low	Low	-
	Bioremediation	Very low	Very low	-	-	Very low	Very low	-
	Dilution by atmosphere and ecosystems	TBD[1][2]	-	-	-	-	-	-
	Filtration	Low	Very low	-	-	Very low	Very low	-
	Climate regulation	Very low	Very high	Very high	Very high	Very low	Very low	Medium to high[2][3]
	Flood and storm protection	Medium	High	Medium	Medium	Medium	Medium	Very high
	Mass stabilisation and erosion control	Low	High	Medium	Medium	Low	Low	High

Note: The ecosystem service classification used by ENCORE, the source of this table, differs from the classification used by TNFD guidance, based on the UN SEEA. A crosswalk is available from UN SEEA.

Source: ENCORE 2018-2023 data; WBCSD (2023) Roadmaps to nature positive: Foundations for the energy system.

2 Deviation from ENCORE scoring. Nuclear power plants might have a dependency on dilution by the atmosphere and ecosystems because of their discharges.

3 Deviation from ENCORE scoring. Electrical power distribution depends on the processes that regulate weather patterns.

Table 2b: Materiality ratings of ecosystem services the electric utilities and power generators sector typically depends on (based on ENCORE 2024 data)

Ecosystem service category	Ecosystem service	Fossil fuels thermal power stations	Nuclear thermal power stations	Hydropower	Wind	Solar	Biomass	Geothermal	Power transmission and distribution
Provisioning services	Biomass provisioning	N/A	N/A	N/A	N/A	N/A	High	N/A	N/A
	Water supply	High	High	Very High	Very Low	Medium	Low	Medium	Very Low
Regulating and maintenance services	Water flow regulation	High	High	Very High	Medium	Medium	Low	Low	Very Low
	Solid waste remediation	Medium	Low	Low	N/A	N/A	Low	Low	Low
	Soil and sediment retention	Medium	High	Very Low	Medium	Medium	Low	High	Low
	Water purification	Medium	Medium	Low	N/A	N/A	Medium	Medium	N/A
	Dilution by atmosphere and ecosystems	N/A	Very Low	N/A	N/A	N/A	N/A	N/A	N/A
	Air filtration	Very Low	Very Low	N/A	N/A	N/A	Very Low	Very Low	N/A
	Flood control	Medium	Medium	Very High	High	Medium	Very Low	Medium	Medium

Ecosystem service category	Ecosystem service	Fossil fuels thermal power stations	Nuclear thermal power stations	Hydropower	Wind	Solar	Biomass	Geothermal	Power transmission and distribution
Regulating and maintenance services continued	Global climate regulation	Medium	Very Low	Medium	Very High	Very High	Very Low	Very Low	Very Low
	Local (micro and meso) climate regulation	Low	Low	Low	Medium	Medium	Low	Low	Low
	Noise attenuation	Very Low	Very Low	N/A	Medium	Very Low	N/A	Very Low	Very Low
	Storm mitigation	Low	Low	Medium	Medium	Medium	Very Low	Very Low	Medium
	Rainfall pattern regulation	N/A	N/A	N/A	N/A	N/A	Medium	N/A	Very Low

N/A = Non-applicable

Source: ENCORE Partners (Global Canopy, UNEP FI, and UNEP-WCMC) (Unpublished, Expected 2024). ENCORE: Exploring Natural Capital Opportunities, Risks and Exposure. Cambridge, UK: the ENCORE Partners. Available at: https://encorenature.org *DOI:* https://doi.org/10.34892/dz3x-y059

Table 3a: Materiality ratings for impact drivers typically relevant for the electric utilities and power generators sector (based on 2018-2023 version of ENCORE)

Driver of nature change	Impact driver	Power transmission and distribution	Thermal power stations	Hydropower	Wind	Biomass	Geothermal	Solar
Land/freshwater/ ocean-use change	Land-use change	Medium	-	Very High	High	-	-	Very High
	Freshwater-use change	-	High	Very High	Medium	-	-	-
	Ocean-use change	-	-	-	High	-	-	-
Resource exploitation	Water use	-	Very High	Very High	-	High	Very High	Very High
Climate change	GHG emissions	High	High (Low for nuclear)[1][4]	High	-	High	High	-
Pollution/ pollution removal	Non-GHG air pollutants	-	High	-	-	High	-	-
	Water pollutants	Medium	Medium	High	Low	High	High	Low
	Soil pollutants	-	Medium	High	Low	-	High	Low
	Solid waste	-	High	-	Low	High	-	Low
	Disturbances	-	High	-	Medium	-	High	-
Invasives and Other	Biological alterations/ interferences	-	-	High	-	-	-	-

Note: Thermal power plant include fossil fuel and nuclear. Source: ENCORE 2018-2023 data

4 Deviation from ENCORE scoring. Nuclear power plants do not produce direct carbon dioxide emissions.

Table 3b: Materiality ratings for impact drivers typically relevant for the electric utilities and power generators sector (based on 2024 version of ENCORE)

Driver of nature change	Impact driver	Power transmission and distribution	Fossil fuels thermal power stations	Nuclear thermal power stations	Hydropower	Wind	Biomass	Geothermal	Solar
Land/ freshwater/ ocean-use change	Area of land use	Medium	Medium	Medium	Medium	High	High	Low	Low
	Area of freshwater use	Low	Medium	Medium	High	N/A	ND	ND	N/A
	Area of seabed use	Low	ND	N/A	N/A	Medium	N/A	N/A	N/A
Climate change	GHG emissions	Very Low	Very High	Very Low	Low	N/A	High	Medium	ND
Resource exploitation	Volume of water use	Very Low	Medium	Medium	Low	Low	Medium	Medium	Low
	Other biotic resource extraction (e.g. timber)	N/A	N/A	N/A	N/A	N/A	Medium	N/A	N/A
Pollution/ pollution removal	Emissions of non-GHG air pollutants	Very Low	Very High	Low	N/A	N/A	High	High	N/A
	Emissions of nutrient soil and water pollutants	N/A	N/A	N/A	N/A	N/A	Medium	N/A	N/A
	Emissions of toxic soil and water pollutants	Low	Very High	Medium	ND	Very Low	Medium	Medium	Low
	Generation and release of solid waste	Low	High	High	Low	Very Low	High	Very Low	Very Low
	Disturbances (e.g noise, light)	Low	Very High	Medium	High	Medium	High	Medium	Very Low

N/A = Non-applicable. ND = No data

Source: ENCORE Partners (Global Canopy, UNEP FI, and UNEP-WCMC) (Unpublished, Expected 2024). ENCORE: Exploring Natural Capital Opportunities, Risks and Exposure. Cambridge, UK: the ENCORE Partners. Available at: https://encorenature.org. *DOI:* https://doi.org/10.34892/dz3x-y059.

L3 L3: Interface with nature

Guiding questions:

Where are the sectors, value chains and direct operations with potentially moderate and high dependencies and impacts located?

Which biomes and specific ecosystems do our direct operations, moderate and high dependency and impact value chains and sectors, interface with?

Organisations with power lines or other linear infrastructure in their value chains should consider all the biomes that their infrastructure crosses, rather than point coordinates.

For further guidance, organisations should also refer to the TNFD biome guidance.

L4 L4: Interface with sensitive locations

Guiding questions:

Which of our organisation's activities in moderate and high dependency and impact value chains and sectors are located in ecologically sensitive locations?

And which of our direct operations are in these sensitive locations?

Sensitive locations are those where the assets and/or activities in an organisation's interface with nature in:

- Areas important for biodiversity; and/or
- Areas of high ecosystem integrity; and/or
- Areas of rapid decline in ecosystem integrity; and/or
- Areas of high physical water risks; and/or
- Areas of importance for ecosystem service provision, including benefits to Indigenous Peoples, Local Communities and stakeholders.

As additional guidance for the sector, when considering whether sites are important for biodiversity, organisations should also consider whether the site disrupts a migration route.

High integrity ecosystems and areas of importance for ecosystem services could include free flowing rivers. Only about one third of rivers longer than 1,000km are free-flowing and provide healthy, functional ecosystems, supporting livelihoods.[5]

Refer to the cross-sector LEAP guidance for additional information on sensitive locations.

5 CLEANaction (2023) Nature-safe Energy: Linking energy and nature to tackle the climate and biodiversity crises.

List of datasets and tools

Table 4 provides a list of tools that organisations in the electric utilities and power generators sector may find useful for the Locate phase of LEAP, in addition to those listed in the cross-sector LEAP guidance. These are all particularly useful for components L3 and L4 of LEAP.

Organisations should consider also referring to other tools presented in the LEAP guidance and TNFD tools catalogue, selecting those appropriate for the assessment in scope.

Table 4: Additional tools for organisations in the electrical utilities and power generators sector for the Locate phase of LEAP

Tool name	Description
AVISTEP: the Avian Sensitivity Tool for Energy Planning	Tool for spatial assessment of avian sensitivity in relation to different types of energy infrastructure — wind farms (both on- and offshore), photovoltaic (PV) solar facilities and overhead power lines. Currently covers India, Nepal, Thailand and Vietnam.
BirdLife Soaring Bird Sensitivity Map	Information on the distribution of soaring bird species across the Mediterranean, Middle East and North Africa.
The Nature Conservancy (TNC) Paris to Practice and Energy Sprawl tools	Visualise the trade-offs between energy, carbon emissions and land use based on the world's projected energy needs.
TNC SiteRight	Assess areas for wind and solar development for biodiversity sensitivity in the USA and India.
World Bank Energy Sector Management Assistance Program REZoning tool	Assesses environmental and socio-economic considerations for solar, onshore and offshore wind energy sites.
TMP Systems and International Rivers Riverscope Tool Future Dams programme TNC Hydropower by Design Rapid Basin-wide Hydropower Sustainability Assessment Tool (RSAT)	Tools for identifying interfaces of hydropower projects with nature.
Ocean Data Viewer	A suite of global marine biodiversity and ecosystem service datasets made available by international scientific institutions and other organisations to inform decision making.
Important Marine Mammal Areas e-Atlas and database	Highlight priority areas for marine mammal conservation.

These are only example tools and datasets. The list provided is not exhaustive and there may be other reference sources and datasets that a LEAP assessment team might consider, depending on the specifics of the organisation's business model and value chains.

Relevant information may also be found in national and regional-level data.

Stakeholder engagement and judgement are critical to this assessment, based on the unique business model of the organisation and its interface with nature.

2.3. Evaluate dependencies and impacts on nature

This section provides additional guidance to help organisations in the electric utilities and power generators sector with the Evaluate phase of the LEAP approach.

E1: Identification of environmental assets, ecosystem services and impact drivers

Guiding questions:

What are the sectors, business processes or activities to be analysed?

What environmental assets, ecosystem services and impact drivers are associated with these sectors, business process, activities and assessment locations?

Guidance for components E1 and E2 is provided together under E2.

E2: Identification of dependencies and impacts

Guiding question:

What are our dependencies and impacts on nature?

When considering dependencies and impacts, organisations should consider each technology, value chain segment and commodity separately. Where companies have several sites (e.g. several windfarms or nuclear plants) the cumulative impacts on nature should be considered. While dependencies, impacts, risks and opportunities for individual assets may not appear significant due to the size of some facilities, it is important to consider the potential cumulative pressures on nature, especially when other industries are present in the same area. These cumulative impacts can result in more substantial impacts on nature and society. At the same time, the impacts of other organisations and industries in the same area might amplify the organisation's own dependencies and risks in that location. Therefore, it is important for companies to assess these cumulative impacts, to ensure that all stakeholders are aware of the potential impacts of their actions and can take appropriate measures to avoid and minimise negative impacts.

Dependencies

Table 5 sets out typical ecosystem services and related considerations for common business practices in this sector.

Electric utilities and power generators sector organisations are highly dependent on several ecosystem services of regulation and maintenance, including mitigation of natural hazards, such as floods and storm surges, erosion control, and soil and slope stabilisation. The sector is also heavily dependent on provisioning services, such as surface water for operational use. The most relevant dependencies will vary by company based on their operations, the technologies used directly and across the value chain, and the specific geographies in which they are located.

Organisations should refer to other relevant TNFD sector guidance for upstream and downstream sectors, as well as the biome guidance, for more examples of the ecosystem services that may be present in the locations where the organisation is operating.

Table 5: Examples of dependency pathways for the electric utilities and power generators sector

Business activity	Ecosystem service	Illustrative example	Sources
Fossil fuels thermal generation (Coal, oil and gas)			
Cooling	Water supply	Stable and reliable water supply is essential for cooling processes in thermal power stations, ensuring the efficient operation and consistent power supply.	Global Water Forum
Operation	Rainfall pattern regulation Storm mitigation Flood mitigation	The operational continuity of power plants and their utilities might rely on the ecosystem services of rainfall regulation and mitigation of extreme weather events, such as tropical cyclones or floods.	Gonçalves et al. (2024)
	Soil and sediment retention	The functionality of power generation facilities might depend on the ecosystem service of soil and sediment retention, predominantly provided by vegetation and other environmental assets. Through the soil and sediment retention, the impacts of landslides and erosion are mitigated.	ENCORE (2023)
Hydropower			
Initial flooding, operations	Water supply	A consistent water supply is crucial for both the initial filling of reservoirs formed by dam construction and the ongoing productivity of hydropower plants.	ENCORE (2023)

Business activity	Ecosystem service	Illustrative example	Sources
Nuclear thermal generation (Coal, oil and gas)			
Cooling	Water supply	The availability of water supply is directly linked to the plant's operational safety and efficiency, and essential for removing heat generated during nuclear reactions.	World Nuclear Association
	Climate regulation	The efficiency of cooling mechanisms employed to dissipate the heat generated during nuclear reactions might be dependent upon the ecosystem service of climate regulation, that mitigates the increases of both global and regional temperatures, encompassing water temperatures as well.	ENCORE (2023)
Electricity transmission and distribution			
Construction, Operation	Global climate regulation	The transmission and distribution infrastructure might rely on the ecosystem service of climate regulation for its protection from unstable precipitation and temperature patterns that can have impacts on the maintenance and integrity of the infrastructure.	ENCORE (2023)
	Soil and sediment retention	The operational integrity of transmission and distribution infrastructure might depend on the ecosystem service of soil and sediment retention, predominantly provided by different types of vegetation and other environmental assets. Through the soil and sediment retention, the impacts and damages of landslides and erosion are mitigated.	ENCORE (2023)
	Rainfall pattern regulation Storm mitigation Flood mitigation	The operational integrity of transmission and distribution infrastructure might rely on the ecosystem service of rainfall regulation and mitigation of extreme weather events, such as tropical cyclones or floods, to ensure the stability and uninterrupted functionality of the power transmission and distribution systems.	ENCORE (2023)

Taskforce on Nature-related Financial Disclosures

Impacts

Table 6 sets out typical impact drivers and impacts for common business practices in this sector.

Beyond the scope of this guidance, upstream raw material extraction and the construction of facilities should be carefully considered. Companies can refer to TNFD additional sector guidance for the mining and metals, infrastructure and real estate sectors.

Table 6: Examples of impact pathways for the electric utilities and power generators sector

Business activity	Driver of nature change	Impact driver	Impact considerations	Sources
All				
Land clearance and use, and ocean and freshwater body floor conversion for energy facilities	Land, freshwater and ocean-use change	Land ecosystem use: With poor siting, more than 10 million hectares of natural lands worldwide (an area the size of Iceland) could be cleared for wind and solar development as countries seek to meet their climate commitments under the Paris Agreement.	Organisations should consider not just the area converted or occupied, but also whether the site itself and any supporting infrastructure fragments any habitats. This land use change can have knock-on effects on ecosystem services, particularly cultural services.	CLEANaction (2023)
Fossil fuels thermal generation (Coal, oil and gas)				
Cooling	Resource use/ replenishment	Water use: Thermal power plants have substantial water requirements for their routine operating processes, e.g. production of steam and in cooling processes.	This withdrawal can lead to degradation of aquatic habitats and species and a reduction in the water supply for other users.	ENCORE (2023), CDP 2023 water questionnaire W-EU13 on freshwater use
	Pollution/pollution removal	Water pollutants: Discharge of warm water.	Thermal plants might cause thermal water pollution and impact aquatic wildlife. Thermal pollution of more than 2°C can occur up to 3km from the discharge point.	

Business activity	Driver of nature change	Impact driver	Impact considerations	Sources
Power generation, waste disposal	Climate change	Greenhouse gas emissions: Thermal power stations can release significant emissions.	See TCFD and ISSB's IFRS S2 *Climate-related Disclosures*.	
	Pollution/pollution removal	Non-GHG air pollutants: Significant air emissions may include, but are not limited to, mercury, sulphur dioxide, nitrogen oxides, sulphur dioxide, nitrogen oxides, coal pile dust, ash lagoons or ponds, precipitator dust and reservoir draw down dust.	These emissions can lead to degradation of the quality of the surrounding air and ecosystems. Organisations should consider local air currents to determine which ecosystems might be affected.	ENCORE (2023)
	Pollution/pollution removal	Disturbances: Noise and light pollution.	Species can be affected by noise and light pollution during routine operation (e.g. movement of vehicles and facility lighting).	
	Resource use/ replenishment	Water use: Water may be used for processing and consumption, including ash handling and coal cleaning.	This withdrawal can lead to degradation of aquatic habitats and species and a reduction in the water supply for other users.	
Waste	Pollution/pollution removal	Solid waste: Forms of solid waste include resins, sludges and filter media.	The disposal of solid waste can lead to degradation of soil and release of other pollutants into the ecosystem if not well managed.	ENCORE (2023); SASB IF-EU-150a.1 and IF-EU-150a.3

Business activity	Driver of nature change	Impact driver	Impact considerations	Sources
Nuclear thermal generation				
Cooling	Land/freshwater/ ocean use change	Freshwater ecosystem use: Withdrawal of water for cooling.	When water is used for cooling thermal power stations, water withdrawal mechanisms can harm or kill aquatic species.	ENCORE (2023), CDP 2023 W-EU13; Clark, B. (2019)
	Resource use/ replenishment	Water use: Nuclear power plants have substantial water requirements for their routine operating processes, e.g. production of steam and in cooling processes.	This withdrawal can lead to degradation of aquatic habitats and species and a reduction in the water supply for local communities and other users.	
	Pollution/pollution removal	Water pollutants: Discharge of warm water.	Nuclear plants might cause thermal water pollution, affecting aquatic wildlife. Thermal pollution of more than 2°C can occur up to 3 km from the discharge point.	
Other operations	Pollution/pollution removal	Disturbances: Noise and light pollution.	Species can be affected by noise and light pollution during routine operation (e.g. movement of vehicles) and if the facilities are lit.	ENCORE (2023)

Business activity	Driver of nature change	Impact driver	Impact considerations	Sources
Waste	Pollution/pollution removal	Soil, non-GHG air and water pollutants: Nuclear accidents.	Even though very rare, the impacts of a nuclear accident severely impact the surrounding environment. The impact of radiation during normal operation is, however, very limited given compliance with regulatory controls. During decommissioning, the impacts are also very limited when waste is well managed. Nuclear power plants can also emit gases and radioactive substances (e.g. CH14 and H3), which pollute vegetation and lead to decreases in soil productivity.	ENCORE (2023); Hvistendahl, M. (2007)
		Solid waste: Nuclear power stations produce various types of solid waste, most importantly hazardous nuclear waste.	Nuclear waste requires careful treatment and storage to minimise potential impacts.	

Business activity	Driver of nature change	Impact driver	Impact considerations	Sources
Wind energy				
Operation	Pollution/pollution removal	Disturbances	Local communities and tourism might be impacted by wind turbines installed close to their homes.	Knopper, LD. et al. (2014)
		Disturbances: Noise pollution.	Noise pollution from windfarms during the operation phase is medium, affecting marine mammals, fish and turtles. Disturbance to breeding and foraging birds has been recorded up to 800m around individual wind turbines.	ENCORE (2023); Galparsoro, I. et al. (2022); Bennun, L. et al. (2021a); Bennun, L. et al. (2021b)
		Disturbances: Collisions.	Individual casualties (injury or death) through collision with turbine blades is common, especially for birds (including vulnerable species groups such as vultures, raptors, bustards, seabirds and many migratory species) and bats (collision and barotrauma). Turbine construction can disrupt birds' breeding and foraging behaviour and, if inappropriately sited, can lead to habitat destruction.	

Business activity	Driver of nature change	Impact driver	Impact considerations	Sources
Construction	Land/freshwater/ ocean use change	Land and ocean ecosystem use: Construction of wind farms leads to habitat modification, including fragmentation and degradation, both on land and the sea floor.	Organisations should consider the space between the wind turbines as well as the footprint of the turbines themselves. They should also consider the impact in the context of the condition of the surrounding habitat and local communities.	ENCORE (2023); CLEANaction (2023); Galparsoro, I. et al. (2022); Bennun, L. et al. (2021a); Bennun, L. et al. (2021b)
	Pollution/pollution removal	Disturbances: Noise pollution and other.	Noise, particularly during construction of offshore facilities, can particularly affect whales, dolphins, sea turtles and some fish species. It can reach up to 80km away from the site in the marine environment during construction. Mammals and sea turtles also face risks of collision with construction and maintenance vessels.	

Business activity	Driver of nature change	Impact driver	Impact considerations	Sources
Solar energy				
Construction and operation	Land/freshwater/ ocean use change	Land ecosystem use: Solar energy farms use land, which modifies habitats, contributing to degradation and fragmentation.	The footprint of a typical solar farm is estimated at 22.5-25.9 m^2/GWh. In assessing the impact, organisations should consider the space between the panels, as well as the footprint of the panels themselves, and the condition of the surrounding habitat. Placement on buildings will have much lower impacts than on previously unconverted land.	ENCORE (2023); Bennun, L. et al. (2021a); Bennun, L. et al. (2021b); CLEANaction (2023)
		Freshwater and ocean ecosystem use: This should be considered for floating PV plants.	The impacts of floating solar PV plants are still being understood but may include shading effects from panels, and congregation with possible entanglement, though the likelihood appears low.	
Operation	Resource use/ replenishment	Water use: Significant for CSP technology, as the concentrated energy generates heat that needs water to cool down. Water is also necessary for cleaning the reflective surfaces to maintain high operational efficiency. However, it is rather limited for PV systems, where water is used mainly for periodical cleaning.	This withdrawal can lead to degradation of aquatic habitats and species and a reduction in the water supply for other users. This is particularly significant in arid regions.	ENCORE (2023); Bennun, L. et al. (2021a); Bennun, L. et al. (2021b); CLEANaction (2023)

Business activity	Driver of nature change	Impact driver	Impact considerations	Sources
Hydropower				
Initial flooding	Land/freshwater/ ocean use change	Land and freshwater ecosystem use: Hydropower stations lead to a large increase in freshwater habitat (and loss of terrestrial habitat) upstream and a decrease in freshwater habitat downstream.	Dams have a significant impact on land and freshwater ecosystem use, and a permanent impact during operation, with knock-on effects on ecosystem services (e.g. those provided by wetlands, which can be flooded). This can affect terrestrial plants and animals through displacement and/or mortality, particularly for plants. This can lead to a loss of connectivity and also affect downstream ecosystems due to changes in the flow of water and sediment, with impacts all the way to the delta. Supporting infrastructure such as roads can also contribute to fragmentation and increased human activities in the area. Large dams may affect local communities' access to ecosystem services, including the loss of cultural services due to the change in ecosystem and population transfer because of village flooding, and the loss of provisioning services such as freshwater and fisheries.	ENCORE (2023); Convention on Biological Diversity (2017); CLEANaction (2023)
		Land and freshwater ecosystem use: Dams may lead to habitat fragmentation due to the blockage in the river and the widening of the river into a lake upstream, or waterway modification caused by water retention/dropping.	This fragmentation particularly affects aquatic species up and downstream that have their movement blocked, with migratory and range restricted species the priority for assessment.	ENCORE (2023)

Business activity	Driver of nature change	Impact driver	Impact considerations	Sources
Operation	Land/freshwater/ ocean use change	Freshwater and terrestrial ecosystem use: Change in water and sediment flows.	Hydropower can lead to sediment alteration, which can result in an increased likelihood of erosion, increased sedimentation or sediment starvation, as well as eutrophication. Hydropower plants can affect the amount of water available within a watershed by affecting water flow. This can in some cases increase the likelihood of downstream drought or increase the water level.	ENCORE (2023); Convention on Biological Diversity. (2017); CDP (2023) W-EU1.2/W-EU1.3; CLEANaction (2023)
	Resource use/ replenishment	Water use: Some hydropower projects may lead to diversion of water.	This diversion can result in unsustainable water abstraction. Hydropower stations can significantly reduce water flow, which in some cases can increase the likelihood of drought on a local basis.	
	Climate change	Greenhouse gas emissions: Greenhouse gas emissions from water reservoirs contribute to atmospheric pollution.	See TCFD and ISSB's IFRS S2 *Climate-related Disclosures*.	
	Pollution/pollution removal	Water pollutants: Temperature.	Hydropower projects can lead to water pollution by altering temperature balances, water chemistry and by leading to increased sedimentation.	

Business activity	Driver of nature change	Impact driver	Impact considerations	Sources
Transmission and distribution				
Construction and operation	Land/freshwater/ ocean use change	Land, freshwater and ocean ecosystem use: Overhead and underground power lines used to distribute energy contribute to habitat fragmentation (land, marine and/or freshwater) and sub-stations have a local land use footprint. Habitat conversion: Vegetation clearance for transmission lines alters the natural habitat, creating opportunities for the establishment of new (and possibly invasive) plant communities. Fragmentation, barrier, corridor and edge effects: Transmission lines fragment habitats by disrupting natural ecosystems, and may impede wildlife movement by acting as barriers, provide corridors for some species (mainly predators), and alter edge habitats, impacting biodiversity and ecosystem dynamics.	This can contribute to habitat degradation and affect species feeding and reproduction patterns While habitat conversion may benefit some species, it can also facilitate the invasion of exotic plants, disrupting native ecosystems and reducing biodiversity. Fragmentation disrupts natural ecosystems, isolating populations and reducing genetic diversity. The barriers effect can impede wildlife movement, altering species distributions, population dynamics and reducing genetic diversity. Corridor effects may facilitate movement for some species but can also disrupt habitat continuity and increase human access. The edge effects from vegetation clearing further impact adjacent ecosystems, altering microclimates and biodiversity patterns. Collectively, these effects can contribute to habitat degradation, biodiversity loss and ecosystem disruption. Management practices, such as the use of engines for vegetation management under power lines, can lead to soil compaction, and it may alter soil ecosystems, affecting microbial activity and soil biodiversity	ENCORE (2023); Biasotto (2018)

Business activity	Driver of nature change	Impact driver	Impact considerations	Sources
Construction and operation (continued)	Climate change	Greenhouse gas emissions: Sulphur hexafluoride emissions from power lines can be significant.	See TCFD and ISSB's IFRS S2 *Climate-related Disclosures*.	
	Invasive species and other	Introduction of invasive alien species as a result of the construction of the power lines and the vegetation management under it.	The construction of power lines may promote the potential for invasion by displacing native plant species and creating vegetation gaps, which offer new opportunities for rapid colonisation by invasive alien plant species. Vegetation management under power lines can enhance and improve the dispersal of flora invasive alien species.	Biasotto (2018)
	Pollution/pollution removal	Disturbances: Various. Transmission line being used as a resource by animal species, mainly birds. Transmission lines emit electromagnetic fields (EMF) due to the flow of electricity through the cables. Noise may be generated by transmission line infrastructure, such as cable vibration and corona noise, and it can disturb wildlife and nearby human communities.	Aerial transmission line structures, such as pylons and cables, can be used by certain bird species for nesting and perching. While this may benefit some populations, it can also lead to bird mortality through electrocution and collision. Vegetation management under the power lines can lead to animal casualties, including protected and endangered species. Continuous exposure of a species to electromagnetic fields (EMF) from transmission lines may lead to behavioural changes and potential impacts on reproductive success and individual survival.	Guil, F. and PérezGarcía, J. M. (2022); Biasotto (2018)

E3

E3: Dependency and impact measurement

Guiding questions:

What is the scale and scope of our dependencies on nature?

What is the severity of our negative impacts on nature?

What is the scale and scope of our positive impacts on nature?

As for all components, refer to the Guidance on the identification and assessment of nature-related issues: The LEAP approach.

E4

E4: Impact materiality assessment

Guiding question:

Which of our impacts are material?

As for all components, refer to the Guidance on the identification and assessment of nature-related issues: The LEAP approach.

Locate | Evaluate | Assess | Prepare

2.4. Assess risks and opportunities

This section provides additional guidance to help organisations in the electric utilities and power generators sector with the Assess phase of the LEAP approach.

A1 A1: Risk and opportunity identification

Guiding question:

What are the corresponding risks and opportunities for our organisation?

Electric utilities and power generators sector organisations should leverage existing risk assessment and risk mitigation processes and standards. Organisations may find it useful to refer to Table 7 and Table 8 for examples of the nature-related risks and associated risk rating for the electric utilities and power generators sector. Table 9 provides nature-related opportunities for the sector with typical examples. Further examples are also provided by the WBCSD Roadmaps to nature positive: Foundations for the energy system. These tables can be used by an organisation as a first basis to build on their own risk and opportunity identification process.

Table 7: Illustrative nature-related risks for the electric utilities and power generators sector

Type	Category	Nature-related risk	Sector examples
Fossil fuels thermal generation (coal, oil and gas)	Physical risk	Changes to the supply of natural inputs (provisioning services)	Water supply: Progressive reduction of water supply can cause increased operational and sourcing costs due to reduced water available for refrigeration processes at thermal plants.
		Changes to regulating and maintenance services	Global climate regulation: Increased tropical cyclones and other extreme weather events, which can damage facilities, causing operational downtime and increased costs of repairs.
			Soil and sediment retention: Weakening of soil systems due to loss of vegetation on slopes, which could lead to landslides, which can damage facilities, causing operational downtime and increased costs of repairs.
	Transition risk: Reputation	Changes in sentiment towards the organisation/brand due to impacts on nature	Thermal power plants emit significant amounts of greenhouse gases, air pollutants and water pollutants, which can cause loss in revenue due to reputational damage.

Type	Category	Nature-related risk	Sector examples
Hydropower	Physical risk	Changes to the supply of natural inputs (provisioning services)	Water supply: A drought can severely affect the amount of water that can be harnessed by hydropower plants, causing a revenue reduction.
		Changes to regulating and maintenance services	Global climate regulation: Increase in capital expenditure on infrastructure repair due to damage by flooding, landslide or other natural disaster in the area of operations.
			Soil and sediment retention: Weakening of soil systems due to loss of vegetation on slopes, which could lead to landslides, may damage facilities, causing an increase in capital expenditure on infrastructure repair.
			Water flow regulation: Potential risk for a hydropower plant if this ecosystem service is damaged includes increased vulnerability to uncontrolled flood events, which can lead to operational disruptions and infrastructure damage, causing an increase in costs on infrastructure repair. Water flow regulation can play a role in hydropower flood mitigation by managing and stabilising the water levels within ecosystems, which can absorb and delay the flow of water during heavy rainfall, reducing flood peaks and the risk of flood-related damage downstream.

Type	Category	Nature-related risk	Sector examples
Nuclear thermal generation	Physical risk	Changes to the supply of natural inputs (provisioning services)	Water supply: Disruption to supply of water required for refrigeration processes for nuclear plants.
		Changes to regulating and maintenance services	Storm mitigation: Increased tropical cyclones and other extreme weather events, which can damage facilities, causing an increase in capital expenditure on infrastructure repair.
			Global climate regulation: Increase in water temperature reduces its cooling properties causing an increase in production costs.
	Transition risk: Reputation	Changes in sentiment towards the organisation/brand due to impacts on nature	Loss in revenue due to reputational damage caused by impacts of nuclear electricity generation on nature.
Offshore wind	Physical risk	Changes to regulating and maintenance services	Global climate regulation: Increased tropical cyclones and other extreme weather events, which can damage facilities, causing an increase in capital expenditure on infrastructure repair.
			Soil and sediment retention: Weakening of soil systems due to loss of vegetation on slopes, which could lead to landslides, may damage the facility, causing an increase in capital expenditure on infrastructure repair.

Type	Category	Nature-related risk	Sector examples
Solar	Physical risk	Changes to regulating and maintenance services	Global climate regulation: Increased tropical cyclones and other extreme weather events, which can damage facilities, causing an increase in capital expenditure on infrastructure repair Different weather and climate patterns can affect energy production output planning, causing revenue reduction.
			Soil and sediment retention: Weakening of soil systems due to loss of vegetation on slopes, leading to landslides, which can damage facilities, causing an increase in capital expenditure on infrastructure repair.
	Transition risk: Policy and legal	Changes to legislation/ regulations aimed at achieving nature-positive outcomes/ reducing nature-negative outcomes	Legislative changes might increase compliance costs to solar developers and operators.

Type	Category	Nature-related risk	Sector examples
Transmission and distribution electric lines	Physical risk	Changes to regulating and maintenance services	Global climate regulation: Increased tropical cyclones and other extreme weather events, which can damage facilities, causing an increase in capital expenditure on infrastructure repair.
			Soil and sediment retention: Weakening of soil systems due to loss of vegetation on slopes, leading to landslides, which can damage facilities, causing an increase in capital expenditure on infrastructure repair.
			Water flow regulation: Vegetation loss increases risks of damage from floods and severe weather events, causing an increase in capital expenditure on infrastructure repair.
	Transition risk: Policy and legal	Changes to legislation/ regulations aimed at achieving nature-positive outcomes/ reducing nature-negative outcomes	Legislative changes might increase compliance costs to transmission and distribution operators.
	Physical risk	Changes to regulating and maintenance services: Pest control	Increases in pests and disease resulting from invasive species introductions can result in increased number of hazard trees (and accompanying outages) that can affect facilities and the company, causing an increase in infrastructure maintenance costs.

Type	Category	Nature-related risk	Sector examples
Onshore wind	Physical risk	Changes to regulating and maintenance services	Global climate regulation: Increased tropical cyclones and other extreme weather events, which can damage facilities, causing an increase in capital expenditure on infrastructure repair.
			Global climate regulation: Changes in wind patterns as a result of climate change could affect power output, causing a revenue reduction.
			Soil and sediment retention: Weakening of soil systems due to loss of vegetation on slopes, which could lead to landslides that damage facilities, causing an increase in capital expenditure on infrastructure repair.
			Water flow regulation: Vegetation loss increases risks of damage from floods and severe weather events, causing an increase in capital expenditure on infrastructure repair.
	Transition risk: Policy and legal	Changes to legislation/ regulations aimed at achieving nature-positive outcomes/ reducing nature-negative outcomes	Legislative changes might increase compliance costs to wind developers and operators.
	Transition risk: Reputation	Changes in sentiment towards the organisation/brand due to impacts on nature	Residents may oppose wind farm development due to impact on landscape, noise and light pollution, causing an increase in operational costs due to reduction in loyalty of suppliers or stakeholders.

Table 8: Illustrative nature-related risks for the electric utilities and power generators sector

Risk type	Risk category	Indicator	Impact/ dependency	Hydropower	Thermal generation (fossil fuels, nuclear)	Solar, wind
Physical risk	Provisioning services	Water scarcity	Dependency	Very high	Very high	Medium
		Forest productivity and distance to markets	Dependency		High	
	Regulating and supporting services – Enabling	Water condition	Dependency	Medium	Low	Low
		Air condition	Dependency	Very low	Low	Low
	Regulating and supporting services – Mitigating	Landslides	Dependency	High	High	High
		Fire hazard	Dependency	Medium	Medium	Medium
		Extreme heat	Dependency	Medium	High	Medium
		Tropical cyclones	Dependency	High	High	High
	Pressures on biodiversity	Land, freshwater and sea use change	Impact	Very high	Very low	Medium
		Tree cover loss	Impact	High	High	Very low
		Invasives	Impact	Low		
		Pollution	Impact	High	Very high	High

Risk type	Risk category	Indicator	Impact/ dependency	Hydropower	Thermal generation (fossil fuels, nuclear)	Solar, wind
Reputational risk	Environmental factors	Protected/conserved areas	Impact	High	Very high	High
		Key biodiversity areas	Impact	Medium	High	Medium
		Other important delineated areas	Impact	High	High	Low
		Ecosystem condition	Impact	High	High	Low
		Range rarity	Impact	Medium	Medium	Medium
	Socioeconomic factors	Indigenous Peoples and Local Communities lands and territories	Impact	Very high	Medium	Medium
		Resource scarcity: food, water, air	Impact	Very low	Very low	
		Labour/human rights	Impact	Low	Low	Low
		Financial inequality	Impact	Low	Low	Low
	Additional reputational factors	Media scrutiny	Dependency	Low	Low	Low
		Political situation	Dependency	Medium	Medium	Low
		Sites of international interest	Dependency	Medium	Medium	Low
		Risk preparation	Dependency	Low	Low	Low

Source: WWF Biodiversity Risk Filter

Table 9: Illustrative nature-related opportunities for the electric utilities and power generators sector

Type	Category	Nature-related opportunity	Sector examples
Offshore wind	Reputational capital	Actions that create positive changes in sentiment towards the organisation/brand due to impacts on environmental assets and ecosystem services that benefit society and improve local economic capabilities.	Offshore wind farms can facilitate the creation of new reefs, which might increase food availability in the vicinity of the installed turbine.
	Ecosystem protection, restoration and regeneration	Indirect restoration, conservation or protection of ecosystems or habitats.	The restriction of trawlers within offshore wind farms in areas where they previously operated can essentially create 'no take zones' over relatively large areas.
Solar	Reputational capital	Actions that create positive changes in sentiment towards the organisation/brand due to impacts on environmental assets and ecosystem services that benefit nature and society and improve local economic capabilities.	Combination of agriculture and solar PV plants (renewable electricity generation) might lead to positive sentiments towards the organisation. Development of nature-positive research and tools through efforts such as the Pollinator Habitat Aligned with Solar Energy (PHASE) project and the Innovative Solar Practices Integrated with Rural Economies and Ecosystems (InSPIRE) project.
	Resource efficiency	Transition to processes with reduced negative impacts on nature/increased positive impacts on nature.	The installation of solar panels can be set up in a way that supports local biodiversity, notably pollinators and some specific plant species.[6]

6 US Department of Energy (n.d.) Innovative solar practices integrated with rural economies and ecosystems.

Type	Category	Nature-related opportunity	Sector examples
Renewable energy sources (e.g. solar, wind, etc.)	Resource efficiency	Transition to processes with reduced negative impacts on nature/increased positive impacts on nature.	Mature renewable energy technologies such as wind and solar photovoltaics (PV) provide clean and affordable energy solutions with the lowest impacts on nature. Organisations should consider instances where local renewable energy options may be feasible. Such renewable energy technologies are also the most affordable energy options and can build resilience, create energy access, alleviate energy poverty and provide greater energy security than fossil fuels.[7]
			If sufficiently large, solar and wind farms could lead to positive climate consequences for vegetation in the Sahara region.[8] A transition to renewable energy focused on wind and solar can result in significantly reduced environmental impacts. These include reduced species impacts and significantly less pollution, ecotoxicity and freshwater impacts overall.[9]
Hydroelectric	Resource efficiency	Transition to more efficient services and processes requiring fewer natural resources, less energy and/or with reduced negative impacts on nature.	Implement measures to maintain environmental flows in rivers where hydroelectric plants operate. Environmental flows are designed to preserve a river's ecological health by ensuring that water levels remain sufficient to support native species and maintain the natural ecosystem processes. This could support compliance with stringent environment regulation and position the power producer as a leader in sustainability.

7 CLEANaction (2023) Nature-safe energy: Linking energy and nature to tackle the climate and biodiversity crises.

8 Li Y, et al. (2018) Climate model shows large-scale wind and solar farms in the Sahara increase rain and vegetation.

9 CLEANaction (2023) Nature-safe energy: Linking energy and nature to tackle the climate and biodiversity crises.

Type	Category	Nature-related opportunity	Sector examples
Electric transmission and distribution	Reputational capital	Actions that create positive changes in sentiment towards the organisation/brand due to impacts on environmental assets and ecosystem services that benefit nature and society and improve local economic capabilities.	National and regional sector collaboration among companies and conservation partners through initiatives such as the Rights-of-Way as Habitat Working Group. This initiative helps supporting pollinators and other wildlife, creating healthier ecosystems, and enhancing safe, reliable transportation and energy systems. At the same time, it may increase positive sentiment towards organisations collaborating with it.
All	Resource efficiency	Transition to processes with reduced negative impacts on nature/increased positive impacts on nature.	Resetting the relationship between energy production and nature by increasing the efficiency of how energy is used and decreasing its demand. This can be achieved through behavioural change and enabling technologies such as 'smart' electricity grids that store and deliver energy more efficiently.[10]
	Resource efficiency	Transition to processes with reduced negative impacts on nature/increased positive impacts on nature.	Investing in climate resilience for a power plant (e.g. flood barriers and elevated structures, vegetation and landscaping changes) might enhance operational reliability, reduce exposure from severe weather events and ensure compliance with tightening regulations. Such investments can also lead to long-term cost savings by minimising repair expenses for operational disruptions and attracting lower insurance premiums.

10 CLEANaction (2023) Nature-safe energy: Linking energy and nature to tackle the climate and biodiversity crises.

Type	Category	Nature-related opportunity	Sector examples
All	Resource efficiency Reputational capital Market	Transition to processes with reduced negative impacts on nature/increased positive impacts on nature. Increased brand value. Increased revenues through access to new and emerging markets.	Capitalise on the increasing demand for sustainable urban energy solutions by specialising through a distinct division/company in high-efficiency and renewable energy products such as solar panels, wind turbines, and smart energy systems tailored for both residential and commercial use.
	Capital flow and financing	Access to nature-related and/or green funds, bonds or loans.	Power producers can tap into the growing market of green and sustainability-focused investments. This can provide a new source of capital at potentially lower costs due to the appealing nature of green and biodiversity bonds.

A2

A2: Adjustment of existing risk mitigation and risk and opportunity management

Guiding questions:

What existing risk and opportunity management processes and elements are we already applying?

How can risk and opportunity management processes and associated elements (e.g. risk taxonomy, risk inventory, risk tolerance criteria) be adapted?

As for all components, refer to the Guidance on the identification and assessment of nature-related issues: The LEAP approach.

A3

A3: Risk and opportunity measurement and prioritisation

Guiding question:

Which risks and opportunities should be prioritised?

As for all components, refer to the Guidance on the identification and assessment of nature-related issues: The LEAP approach.

A4

A4: Risk and opportunity materiality assessment

Guiding question:

Which risks and opportunities are material and therefore should be disclosed in line with the TNFD recommended disclosures?

As for all components, refer to the Guidance on the identification and assessment of nature-related issues: The LEAP approach.

2.5. Prepare to respond and report

This section provides additional guidance to help electric utilities and power generators sector organisations with the Prepare phase of the LEAP approach.

P1 P1: Strategy and resource allocation plans

Guiding question:

What risk management, strategy and resource allocation decisions should be made as a result of this analysis?

Electric utilities and power generators sector organisations should refer to existing strategy and resource allocation plans when responding to the identified dependencies, impacts, risks and opportunities. Table 10 provides examples of system-wide and site-level actions that organisations could consider across all technologies in the electric utilities and power generators sector.

Organisations may also find it useful to refer to the management and mitigation strategies and actions for various energy types and infrastructure illustrated in Table 11, based on TNFD's interpretation of SBTN's AR3T framework (and pending alignment with future development of SBTN's Step 4 guidance), illustrated in Figure 4.

Figure 4: The SBTN AR3T framework

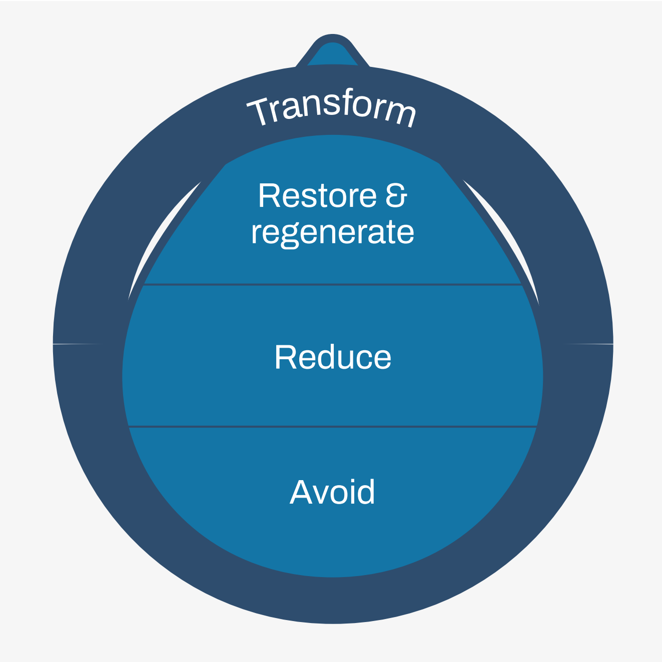


Table 10: Illustrative priority and transformative actions for the electric utilities and power generators sector mapped to the AR3T Framework

Focus/scale of mitigation	Transform	Avoid	Reduce	Restore and regenerate
Systems change	• Plan for and promote decentralised energy generation systems with distributed renewable energy systems that allow for power line sharing and direct required power stations to areas with low environmental sensitivity. • Withhold finance from renewable projects with high biodiversity impacts. • Promote local employment and new job creation through consistent on-site impact monitoring and management. • Promote stakeholder engagement to motivate the integration of biodiversity considerations into early energy planning. • Promote studies, knowledge sharing and best practices for better understanding of the interaction between renewable energies and biodiversity. • Promote accelerated decarbonisation through early switching to proven, nature-safe, low-carbon options and ensure low barriers to widespread deployment.	• Foster innovation and new technologies that avoid and reduce impacts. • Prioritise repowering and hybridisation solutions over the conversion of natural land. • Include cumulative impacts of all activities present in the wider project area in the environmental impact assessment (EIA). • Include a life cycle assessment, which applies a standardised method to account for the full range of potential impacts across a project's life cycle. • Apply a circular approach to ensure the highest possible rates of reuse and recycling and put in place mechanisms to ensure ethical sourcing of materials and minerals.	• Establish cross border energy sharing agreements to drive energy development to areas of maximum yield, while reducing its footprint. • Produce bioenergy from animal and food waste. • Incentivise and subsidise co-use and co-existence solutions such as agrivoltaics.	• Remove relevant dams to restore environmental flows. • Promote investments such as green bonds that can contribute to the protection and restoration of nature. • Use ecosystem-based spatial planning where space for both nature and renewables is designated, and implement holistic marine spatial planning, involving all relevant stakeholders.

Focus/scale of mitigation	Transform	Avoid	Reduce	Restore and regenerate
Site-level mitigation	• Offset residual impacts through investments into projects that restore habitats and avert future losses elsewhere.	• Route linear infrastructure and power lines away from sensitive areas including protected areas, Key Biodiversity Areas, ecological corridors, wetlands, vulnerable coastal habitats and forests. • Bury power lines wherever feasible.	• Control influx of people into the operational area of the project and manage associated impacts on biodiversity. • Minimise mineral extraction and supply chain impacts by optimising site-based infrastructure. • Optimise energy yield in modified habitats – including urban areas and artificial features such as dam reservoirs – such as by installing fixed or floating solar PV, or using land in conjunction with other productive uses (e.g. agrivoltaics). • Implement strict protocols to minimise species impacts, such as the risk of collision with birds and bats, and noise pollution.	• Establish clear closure and end of life plans, including rehabilitation of temporary facilities and post decommissioning. • Use nature-inclusive design for infrastructure to provide opportunities for natural regeneration (e.g. on offshore wind turbine foundations). • Undertake on-site habitat enhancement, such as reintroducing wildflower meadows for pollinators around wind turbines and solar panels.

Sources: CLEANaction (2023) Nature-safe Energy: Linking energy and nature to tackle the climate and biodiversity crises and GRI (2014) GRI G4 Electric utilities sector disclosures.

Table 11: Illustrative priority and transformative actions associated with different energy types and infrastructure mapped against AR3T Framework

Energy type	Impact/risk	Priority actions	SBTN AR3T Framework				
			Avoid	Reduce	Regenerate	Restore	Transform
Solar PV	Impacts resulting from land and water-use change	There are often opportunities to undertake restoration and enhancement around solar arrays, providing the potential to achieve positive biodiversity outcomes, especially in previously degraded lands. Impacts can be mitigated by placing panels away from particularly sensitive areas and instead prioritising placement on man-made water bodies such as hydropower reservoirs. The direct impacts on water bodies should not be discounted and need continued attention, including through standard environmental reviews. The indirect impacts on flow releases (particularly from hybrid hydro-floating PV plants) can be even more important.					
Solar CSP	Impacts from water use	Similarly to solar PV, most of the impacts from CSP can be avoided by placing them in previously degraded lands away from sensitive areas. Technological improvements, such as dry-cleaning technologies, can help minimise this impact.					

Energy type	Impact/risk	Priority actions	SBTN AR3T Framework				
			Avoid	Reduce	Regenerate	Restore	Transform
Wind (onshore)	Bird and bat mortality	Impacts are difficult to avoid entirely, as turbine locations are tightly linked to wind energy potential. Impacts can be reduced by placing turbines away from important bird areas and migratory routes. On-site mitigation strategies include increasing the visibility of turbine blades, acoustic deterrents and procedures to shut down specific turbines when vulnerable birds are in the area. A large concentration of wind farms, in combination with other developments, can create barriers for species movement and potentially cause significant cumulative impacts on species' populations.					
Wind (offshore)	In addition to onshore impacts, offshore impacts on marine fauna resulting from high noise, collision with construction vessels and changes to seafloor.	Construction-related impacts can be minimised by implementing strict construction protocols to reduce noise and temporarily deter sensitive species. The additional risk for ship accidents and subsequent pollution can be mitigated by siting, surveillance and emergency tugs, speed restrictions and optimised shipping routes. Ongoing monitoring and data sharing are key to developing a better understanding of the magnitude of impacts and effectiveness of mitigation measures. Operational impacts and impacts on seafloor habitats can be minimised through careful site selection and as a part of an ecosystem-based marine spatial planning process.					

Taskforce on Nature-related Financial Disclosures

Energy type	Impact/risk	Priority actions	SBTN AR3T Framework				
			Avoid	Reduce	Regenerate	Restore	Transform
Hydropower	Land and water-use change, loss of connectivity and changes to water and sediment flow. Increased human access.	Maintaining environmental flows and construction of fish passages can mitigate some of the impacts. Ongoing monitoring is needed to better understand environmental and downstream flow regimes (e.g. concerning hydro peaking). Internationally recognised hydropower sustainability tools designed to provide guidance on how to achieve biodiversity conservation good practice during hydropower development include: • Hydropower Sustainability Guidelines on Good International Industry Practice (HGIIP); • Hydropower Sustainability Assessment Protocol (HSAP); and • Hydropower Sustainability ESG Gap Analysis Tool (HESG). At the watershed or hydrological basin level, organisations should consider collaborative approaches to managing watersheds and reservoirs for multiple uses, such as irrigation, drinking water and ecosystem conservation. Organisations should also consider long-term plans for securing water resources, meeting the needs of both the utility and other stakeholders (e.g. local communities). This includes applying criteria for managing maximum/minimum flow of surface water and volume of ground water and how these are determined and maintained.					

Energy type	Impact/risk	Priority actions	SBTN AR3T Framework				
			Avoid	Reduce	Regenerate	Restore	Transform
Nuclear	Discharge of warm water and impacts of nuclear waste	Deploy management strategy and storage methods for different types of radioactive nuclear waste, including: • Temporary and permanent storage; • Environmental, health and safety impacts of radioactive nuclear waste; and • Security measures according to the applicable management standards/legislative frameworks. Management of nuclear waste using International Atomic Energy Agency (IAEA) definitions and protocols.					
Coal/fuel/gas	Acid rain, climate change, radioactive and other contamination, air pollution	Electric utilities should consider strategies such as the installation of pollution control systems and the development and utilisation of power generation methods based on renewable energy and other non-fossil sources such as nuclear, wind, biomass, hydroelectric and solar power, and to help meet demand with demand-side management solutions. These operational strategies include energy use reduction strategies and the shifting of electricity demand to off-peak hours of operation. Deployment of strategies for managing and phasing out high level and low level in-service Polychlorinated biphenyls (PCBs).					

Energy type	Impact/risk	Priority actions	SBTN AR3T Framework				
			Avoid	Reduce	Regenerate	Restore	Transform
Energy infrastructure (transmission and distribution lines)	Electrocution of birds; materials use	Construction of safe distribution lines that include insulation and appropriate spacing of conductors can address risks to birds when integrated into early design. Collisions with transmission lines can be reduced through the installation of bird flight diverters, bird-safe designs and by burying power lines or routing them to avoid sensitive areas such as wetlands. Attention is required to the habitat conversion caused by a new powerline or access road, since the natural processes are usually permanently altered. The end of life of energy infrastructure and transmission and distribution lines should be considered, with emphasis on recyclability to minimise new resource exploitation and to restore polluted soils.					

Sources: CLEANaction (2023) Nature-safe Energy: Linking energy and nature to tackle the climate and biodiversity crises *and GRI (2014)* GRI G4 Electric utilities sector disclosures.

P2: Target setting and performance management

Guiding question:

How will we set targets and define and measure progress?

As for all components, refer to the Guidance on the identification and assessment of nature-related issues: The LEAP approach, which includes additional guidance on target setting in this component P2.

Organisations may wish to refer to the target-setting methods developed by the Science Based Targets Network and the summary guidance on SBTN's methods for setting science-based targets for nature, which the TNFD has co-developed with the Science Based Targets Network (SBTN).

P3: Reporting

Guiding question:

What will we disclose in line with the TNFD recommended disclosures?

As for all components, refer to the Guidance on the identification and assessment of nature-related issues: The LEAP approach.

P4: Presentation

Guiding question:

Where and how do we present our nature-related disclosures?

As for all components, refer to the Guidance on the identification and assessment of nature-related issues: The LEAP approach.

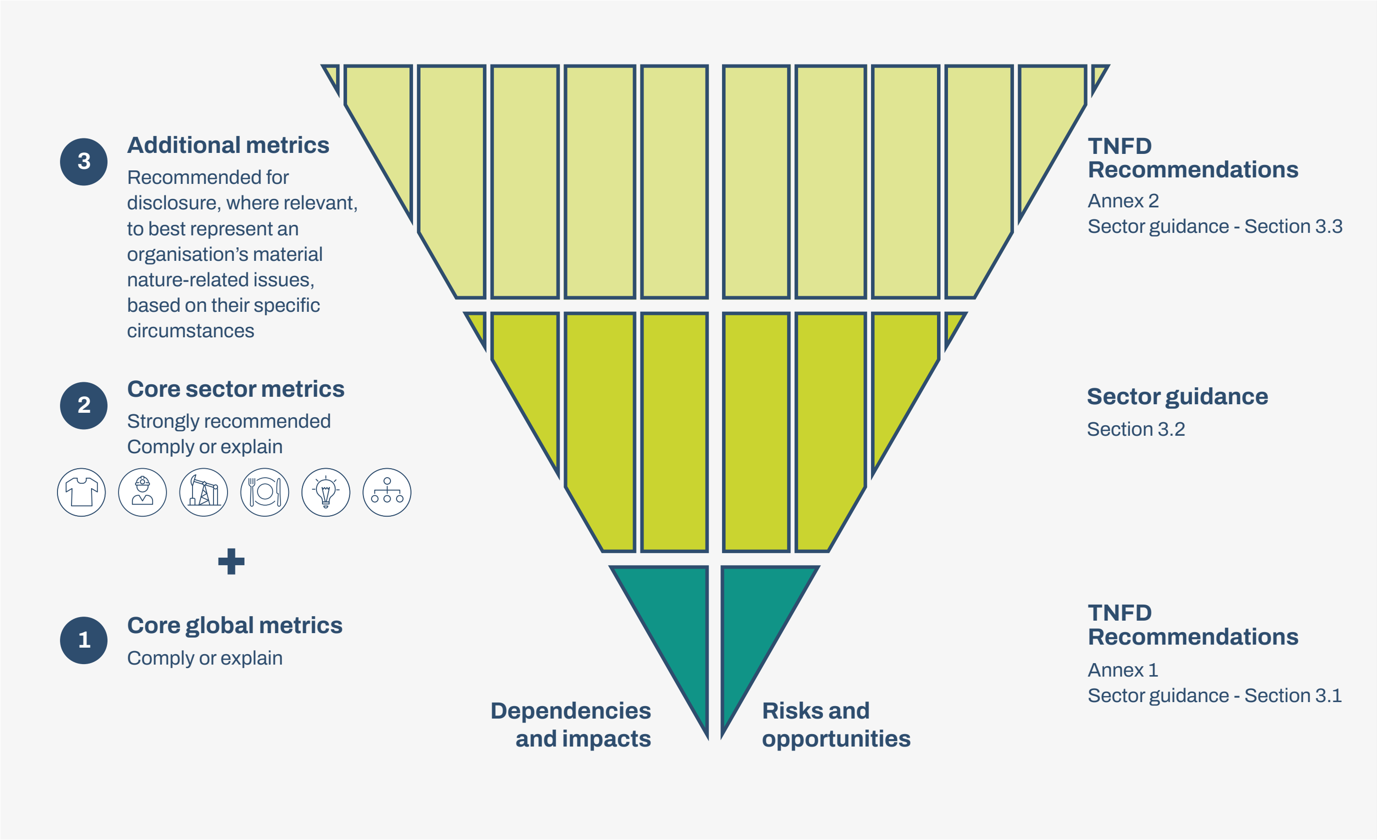
3. Sector-specific disclosure metrics and related guidance – Electric utilities and power generators

Sector-specific metrics form an important part of the TNFD's measurement architecture (see Figure 5). This reflects the diversity of business models across value chains and their interface with nature across and within sectors. Sector-specific metrics help financial institutions to compare organisations within the same sector, which often face similar nature-related issues.

This section provides the TNFD sector-specific metrics for the electric utilities and power generators sector. It includes:

- Guidance on the application of the core global disclosure indicators and metrics to the electric utilities and power generators sector (Section 3.1); and
- Core and additional disclosure indicators and metrics for the electric utilities and power generators sector (Sections 3.2 and 3.3).

Figure 5: TNFD disclosure measurement architecture



Where available, the TNFD's recommended metrics for disclosure draw from a range of existing standards and frameworks including the IFRS Sustainability Disclosure Standards, SASB Standards, GRI Standards, the CDP disclosure platform, the Kunming-Montreal Global Biodiversity Framework and other relevant UN frameworks, ESRS and others. A number of organisations, including standard-setting organisations, continue to work on identifying relevant sector-level assessment and reporting metrics. The Taskforce recommends that report preparers stay engaged with year-on-year progress on these developments and implement the latest definitions within their risk management processes and disclosures. The TNFD is working closely with standard-setting organisations and others and will periodically update this guidance on recommended sector metrics for disclosure in line with these ongoing initiatives.

Organisations in the electric utilities and power generators sector should refer to Annex 1 of the TNFD Recommendations for further information on the core global disclosure metrics. As outlined in the TNFD Recommendations, core global disclosure metrics should be reported on a comply or explain basis, with the exception of the placeholder metrics.

Where organisations are unable to report against any of the core global metrics, they should provide a short explanatory statement as to why they have not reported those metrics. An organisation should report on the core global disclosure metrics unless:

- It has not been identified as relevant and material to the organisation, e.g. not relevant to business activities or the location the organisation is operating in, or not found to be a material issue for the organisation; or
- It has been identified as relevant and material, but the organisation is unable to measure it due to limitations with methodologies, access to data or because the information is commercially sensitive. In this case, organisations should explain how they plan to address this in future reporting periods.

Companies should report on the same basis for the core sector disclosure metrics outlined in Section 3.2.

Organisations are also encouraged to draw on the TNFD additional sector disclosure indicators and metrics outlined in Section 3.3 and any other relevant metrics to represent most accurately the organisation's nature-related dependencies, impacts, risks and opportunities.

3.1. Guidance on the application of the core global disclosure metrics

This section provides guidance, where relevant, on how to apply the TNFD core global disclosure metrics in the electric utilities and power generators sector. If no further sector specific guidance is provided, organisations should refer to the core global disclosure metrics.

As outlined above, core global disclosure metrics should be reported on a comply or explain basis following the guidance for the electric utilities and power generators sector where provided.

For the placeholder indicators on invasive alien species and the state of nature, the TNFD encourages organisations to consider and report against these indicators where possible, but are not expected on a comply or explain basis. There are not yet widely accepted metrics for these indicators, but the Taskforce recognises their importance, and will continue to work with knowledge partners to develop further guidance on these metrics.

Table 12: Guidance on the application of the core global disclosure metrics

Driver of nature change/Other metric category	Metric no.	Core global indicator	Core global metric	Guidance for sector	Source
Land/freshwater/ ocean-use change	C1.0	Total spatial footprint	Total spatial footprint (km^2) (sum of): • Total surface area controlled/ managed by the organisation, where the organisation has control (km^2); • Total disturbed area (km^2); and • Total rehabilitated/restored area (km^2).	No further sector specific guidance; refer to the core global disclosure metric.	TNFD

Driver of nature change/Other metric category	Metric no.	Core global indicator	Core global metric	Guidance for sector	Source
Land/freshwater/ ocean-use change	C1.1	Extent of land/ freshwater/ ocean-use change	Extent of land/freshwater/ ocean ecosystem use change (km²) by: • Type of ecosystem;[11] and • Type of business activity.	An organisation may provide information additional to the IUCN Global Ecosystem Typology (GET) to define the type of ecosystem they refer to, such as regional or local classifications.	TNFD
Land/freshwater/ ocean-use change	C1.1	Extent of land/ freshwater/ ocean-use change	Extent of land/freshwater/ ocean ecosystem conserved or restored (km²), split into: • Voluntary; and • Required by statutes or regulations.	An organisation should report area conserved and restored separately, if data is available.	TNFD
Land/freshwater/ ocean-use change	C1.1	Extent of land/ freshwater/ ocean-use change	Extent of land/freshwater/ ocean ecosystem that is sustainably managed (km²) by: • Type of ecosystem;[12] and • Type of business activity.	No further sector specific guidance; refer to the core global disclosure metric.	TNFD
Pollution/pollution removal	C2.0	Pollutants released to soil split by type	Pollutants released to soil (tonnes) by type, referring to sector-specific guidance on types of pollutants.	No further sector specific guidance; refer to the core global disclosure metric.	TNFD

11 When disclosing on ecosystem types, refer to the International Union for Conservation of Nature Global Ecosystem Typology.

12 When disclosing on ecosystem types, refer to the International Union for Conservation of Nature Global Ecosystem Typology.

Driver of nature change/Other metric category	Metric no.	Core global indicator	Core global metric	Guidance for sector	Source
Pollution/pollution removal	C2.1	Wastewater discharged	Volume of water discharged (m^3), split into: • Total; • Freshwater; and • Other.[13] Including: • Concentrations of key pollutants in the wastewater discharged, by type of pollutant, referring to sector-specific guidance for types of pollutants; and • Temperature of water discharged, where relevant.	**Nuclear; Thermal** In reporting this core global disclosure metric, an organisation should include thermal discharges.	TNFD

13 Freshwater: (≤1,000 mg/L Total Dissolved Solids). Other: (>1,000 mg/L Total Dissolved Solids).Reference: GRI (2018) GRI 303-4 Water discharge.

Driver of nature change/Other metric category	Metric no.	Core global indicator	Core global metric	Guidance for sector	Source
Pollution/pollution removal	C2.2	Waste generation and disposal	Weight of hazardous and non-hazardous waste generated by type (tonnes), referring to sector-specific guidance for types of waste. Weight of hazardous and non-hazardous waste (tonnes) disposed of, split into: • Waste incinerated (with and without energy recovery); • Waste sent to landfill; and • Other disposal methods. Weight of hazardous and non-hazardous waste (tonnes) diverted from landfill, split into waste: • Reused; • Recycled; and • Other recovery operations.	No further sector specific guidance; refer to the core global disclosure metric.	TNFD

Driver of nature change/Other metric category	Metric no.	Core global indicator	Core global metric	Guidance for sector	Source
Pollution/pollution removal	C2.3	Plastic pollution	Plastic footprint as measured by total weight (tonnes) of plastics (polymers, durable goods and packaging) used or sold broken down into the raw material content.[14] For plastic packaging, percentage of plastics that is: • Re-usable; • Compostable; • Technically recyclable; and • Recyclable in practice and at scale.	No further sector specific guidance; refer to the core global disclosure metric.	TNFD

14 Raw material content: % of virgin fossil-fuel feedstock; % of post-consumer recycled feedstock; % of post-industrial recycled feedstock; % of virgin renewable feedstock.

Driver of nature change/Other metric category	Metric no.	Core global indicator	Core global metric	Guidance for sector	Source
Pollution/pollution removal	C2.4	Non-GHG air pollutants	Non-GHG air pollutants (tonnes) by type: • Particulate matter (PM2.5 and/or PM10); • Nitrogen oxides (NO_2, NO and NO_3); • Volatile organic compounds (VOC or NMVOC); • Sulphur oxides (SO_2, SO, SO_3, SO_x); and • Ammonia (NH_3).	**Thermal** From the list of pollutants under this core global disclosure metric, an organisation should include: • Fine particulate matter ($PM_{2.5}$); • Sulphur dioxide (SO_x); • Nitrogen oxides (NO_x); • Nonmethane volatile organic compounds (NMVOC); and • Ammonia (NH_3). Additional pollutants to report under the core global disclosure metric include: • Heavy metals (HM) as referred to in Annex I of EU Directive 2016/2284; • Coal pile dust; • Emissions from ash lagoons or ponds; Precipitator dust; and • Reservoir drawdown dust. An organisation should also report: • Emissions of these pollutants per MWh net generation.	TNFD

Driver of nature change/Other metric category	Metric no.	Core global indicator	Core global metric	Guidance for sector	Source
Resource use/ replenishment	C3.0	Water withdrawal and consumption from areas of water scarcity	Water withdrawal and consumption[15] (m^3) from areas of water scarcity, including identification of water source.[16]	**Nuclear; thermal** In reporting this core global disclosure metric, an organisation should include: • Water usage for processing, cooling and consumption in powerplants, including use of water in ash handling.	GRI G4 (2014) Electric Utilities Disclosure EN8, TNFD
Resource use/ replenishment	C3.1	Quantity of high-risk natural commodities sourced from land/ ocean/ freshwater	Quantity of high-risk natural commodities[17] (tonnes) sourced from land/ocean/ freshwater, split into types, including proportion of total natural commodities.	No further sector specific guidance; refer to the core global disclosure metric.	TNFD

15 Water consumption is equal to water withdrawal less water discharge. Reference: GRI (2018) GRI 303-5.

16 Surface water; groundwater; seawater; produced water; third-party water. Reference: GRI (2018) GRI 303-3.

17 Users should refer to the Science Based Targets Network (SBTN) High Impact Commodity List (HICL), species listed as vulnerable, endangered or critically endangered on the IUCN red list, and species listed in appendix I, II and III of CITES.

Driver of nature change/Other metric category	Metric no.	Core global indicator	Core global metric	Guidance for sector	Source
Resource use/ replenishment	C3.1	Quantity of high-risk natural commodities sourced from land/ ocean/ freshwater	Quantity of high-risk natural commodities[18] (tonnes) sourced under a sustainable management plan or certification programme, including proportion of total high-risk natural commodities.	No further sector specific guidance; refer to the core global disclosure metric.	TNFD
Invasive alien species and other	C4.0	Placeholder indicator: Measures against unintentional introduction of invasive alien species (IAS)[19]	Proportion of high-risk activities operated under appropriate measures to prevent unintentional introduction of IAS, or low-risk designed activities.	No further sector specific guidance; refer to the core global disclosure metric.	TNFD

18 Users should refer to the Science Based Targets Network (SBTN) High Impact Commodity List (HICL), species listed as vulnerable, endangered or critically endangered on the IUCN red list, and species listed in appendix I, II and III of CITES.

19 Due to the measurement of levels of invasive species for organisations being a developing area, the chosen indicator focuses on whether an appropriate management response is in place for the organisation. The additional sets of metrics contain measurement of the level of invasive species within an area. The TNFD intends to do further work with experts to define 'high-risk activities' and 'low-risk designed activities'.

Driver of nature change/Other metric category	Metric no.	Core global indicator	Core global metric	Guidance for sector	Source
State of nature	C5.0	Placeholder indicator: Ecosystem condition	For those organisations that choose to report on state of nature metrics, the TNFD encourages them to report the following indicators, and to refer to the TNFD additional guidance on measurement of the state of nature in Annex 2 of the LEAP approach: • Level of ecosystem condition by type of ecosystem and business activity; • Species extinction risk. There are a number of different measurement options for these indicators. The TNFD does not currently specify one metric as there is no single metric that will capture all relevant dimensions of changes to the state of nature and a consensus is still developing. The TNFD will continue to work with knowledge partners to increase alignment.	No further sector specific guidance; refer to the core global disclosure metric.	TNFD

Driver of nature change/Other metric category	Metric no.	Core global indicator	Core global metric	Guidance for sector	Source
State of nature	C5.0	Placeholder indicator: Species extinction risk	For those organisations that choose to report on state of nature metrics, the TNFD encourages them to report the following indicators, and to refer to the TNFD additional guidance on measurement of the state of nature in Annex 2 of the LEAP approach: • Level of ecosystem condition by type of ecosystem and business activity; • Species extinction risk. There are a number of different measurement options for these indicators. The TNFD does not currently specify one metric as there is no single metric that will capture all relevant dimensions of changes to the state of nature and a consensus is still developing. The TNFD will continue to work with knowledge partners to increase alignment.	No further sector specific guidance; refer to the core global disclosure metric.	TNFD
Climate change		GHG emissions	Refer to IFRS S2 Climate-related Disclosures	No further sector specific guidance; refer to the core global disclosure metric.	TNFD

3.2. Core sector disclosure indicators and metrics

The TNFD core sector disclosure metrics for the electric utilities and power generators sector are outlined below. These metrics are recommended by the TNFD to be disclosed by all report preparers in the sector on a comply or explain basis.

Table 13: Core sector disclosure indicators and metrics

Metric category	Metric subcategory	Metric no.	Indicator	Core sector metrics	Source
Impact driver	Land/freshwater/ ocean-use change	EP.C1.0	Threatened species casualties	**Wind** Number of bird and bat casualties.	TNFD
Impact driver	Land/freshwater/ ocean-use change	EP.C1.1	Environmental flow versus total flow	**Hydropower** Proportion (%) of environmental/ecological flow versus total flow, taking into account climatic variability (e.g. El Niño–Southern Oscillation).	TNFD
Impact driver	Land/freshwater/ ocean-use change	EP.C1.2	Sediment retired	**Hydropower** Quantity (tonnes) of sediment retired.	TNFD
Impact driver	Pollution/pollution removal	EP.C2.0	Coal combustion residuals	**Thermal** Volume (tonnes) of coal combustion products (CCPs) generated and proportion (%) that are recycled.	SASB IF-EU-150a.1
Impact driver	Pollution/pollution removal	EP.C2.1	Coal combustion residuals	**Thermal** Total number of coal combustion residual (CCR) impoundments, broken down by hazard potential classification and structural integrity assessment.	SASB IF-EU-150a.2

Metric category	Metric subcategory	Metric no.	Indicator	Core sector metrics	Source
Impact driver	Pollution/pollution removal	EP.C2.2	Nuclear waste storage	**Nuclear** Volume (tonnes) of nuclear waste permanently and safely stored (e.g. deep underground storage).	TNFD
Impact driver	Resource use/ replenishment	EP.C3.0	Plant heat rate	**Thermal** Heat rate by plant (Btu/kWh).	TNFD

3.3. Additional sector disclosure indicators and metrics

There are no suggested TNFD additional sector disclosure indicators and metrics for the electric utilities and power generators sector.

4. References

Bennun, L., van Bochove, J., Fletcher, C., Wilson, D., Phair, N. and Carbone, G. (2021a) Industry guidance for early screening of biodiversity risk – offshore wind. Gland, Switzerland: IUCN and Cambridge, UK: The Biodiversity Consultancy.

Bennun, L., van Bochove, J., Ng, C., Fletcher, C., Wilson, D., Phair, N. and Carbone, G. (2021b) Mitigating biodiversity impacts associated with solar and wind energy development. Guidelines for project developers. Gland, Switzerland: IUCN and Cambridge, UK: The Biodiversity Consultancy.

Biasotto, L. D., & Kindel, A. (2018). Power lines and impacts on biodiversity: A systematic review. Environmental Impact Assessment Review, 71, 110-119.

BirdLife (n.d.) AVISTEP The Avian Sensitivity Tool for Energy Planning.

BirdLife (n.d.) Soaring Bird Sensitivity Mapping Tool. A planning tool for wind energy and other sectors.

CBD (2017) Mainstreaming biodiversity into the energy and mining sectors. Convention on Biological Diversity.

CDP (2023) CDP Water security 2023 reporting guidance. Carbon Disclsure Project.

CLEANaction (2023) Nature-safe Energy: Linking energy and nature to tackle the climate and biodiversity crises.

DRISCOLL, D.A., BANKS S. C., BARTION P. S., LINDENMAYER D. B., SMITH A. L. (2013) Conceptual domain of the matrix in fragmented landscapes,Trends in Ecology & Evolution. https://doi.org/10.1016/j.tree.2013.06.010

ENCORE Partners (Global Canopy, UNEP FI, and UNEP-WCMC) (Unpublished, Expected 2024 and 2018-2023). ENCORE: Exploring Natural Capital Opportunities, Risks and Exposure. Cambridge, UK: the ENCORE Partners. Available at: https://encorenature.org DOI: https://doi.org/10.34892/dz3x-y059

ERC, UIC (2018) Rights-of-Way as Habitat Working Group, habitat conservation + working landscapes. Energy Resources Center. University of Illinois Chicago.

Galparsoro Iza, I., Menchaca, I., Garmendia, J., Borge, A., Maldonado, A., Iglesias, G. and Bald, J. (2022) Reviewing the ecological impacts of offshore wind farms. Ocean Sustainability 1.

Gibon, T., Hertwich, E. G., Arvesen, A., Singh, B. and Verones, F. (2017) Health benefits, ecological threats of lowcarbon electricity. Environmental Research Letters 12, 034023.

GRI (2018) GRI 303: Water and Effluents 2018.

GRI (2014) GRI G4 Electric utilities sector disclosures.

Gonçalves, A. C., Costoya, X., Nieto, R., & Liberato, M. L. (2024). Extreme weather events on energy systems: a comprehensive review on impacts, mitigation, and adaptation measures. *Sustainable Energy Research*, 11(1), 4.

Guil, F. and Pérez-García, J. M. (2022) Bird electrocution on power lines: Spatial gaps and identification of driving factors at global scales.

Hertwich, E. G., Gibon, T., Bouman, E. A., Arvesen, A., Suh, S., Heath, G. A., Bergesen, J. D., Ramirez, A., Vega, M. I. and Shi, L. (2015) Integrated life-cycle assessment of electricity-supply scenarios confirms global environmental benefit of low-carbon technologies. Proceedings of the National Academy of Sciences 112, 6277–6282.

Hvistendahl, M. (2007) Coal ash is more radioactive than nuclear waste. Scientific American.

IAEA (2014) What is radioactive waste? International Atomic Energy Agency.

IIED (2020) FutureDAMS programme. International Institute for Environmental and Development.

IUCN (2020) Guidelines for Conserving Connectivity through Ecological Networks and Corridors. Best Practice Protected Area Guidelines Series No. 30. The International Union for Conservation of Nature.

IUCN MARINE MAMMAL PROTECTED AREAS TASK FORCE (2013) Important Marine Mammal Areas e-Atlas and database. The International Union for Conservation of Nature

IUCN (2024) IUCN Red List categories.The International Union for Conservation of Nature
IUCN, WCPA (2013) Best Practice Guidance on Recognising Protected Areas and Assigning Management Categories and Governance Types, Best Practice Protected Area Guidelines Series. The International Union for Conservation of Nature.

Knopper LD, Ollson CA, McCallum LC, Whitfield Aslund ML, Berger RG, Souweine K, McDaniel M. (2014) Wind turbines and human health. Front Public Health

Li Y , et al. (2018) Climate model shows large-scale wind and solar farms in the Sahara increase rain and vegetation. Science.

Luderer, G., Pehl, M., Arvesen, A., Gibon, T., Bodirsky, B. L., de Boer, H. S., Fricko, O., Hejazi, M., Humpenöder, F. and Iyer, G. (2019) Environmental co-benefits and adverse side effects of alternative power sector decarbonisation strategies. Nature Communications 10: 5229.

Organisation for Economic Co-operation and Development (2018) Due Diligence Guidance for Responsible Business Conduct.

SASB Standards (2023) Electric Utilities & Power Generators.

SBTN (2023) ART3 Framework. Science Based Targets Network.

SBTN (2023) High impact commodity list (HICL). Science Based Targets Network.

TMPSYSTEMS, International Rivers (2023) Riverscope Tool.

TNC (n.d.) Hydropower by Design: A guide (beta). The Nature Conservancy.

TNC (2022) Site Renewables Right. The Nature Conservancy.

TNC (2019) A Better Blueprint for the Clean Energy Landscape. The Nature Conservancy.

UNEP (2016) Green Energy Choices: The benefits, risks, and trade-offs of low-carbon technologies for electricity production. United Nations Environment Programme.

UNESCO (2010) GWF, Global Water Forum. United Nations Educational Scientific and Cultural Organization.

UNEP-WCMC (2014) Ocean Data Viewer. UN Environment Programme World Conservation Monitoring Centre.

US Department of Energy (n.d.) InSPIRE. Innovative solar practices integrated with rural economies and ecosystems. United States Department of Energy

US Department of Energy Technology Office (n.d.) PHASE. Pollinator Habitat Aligned with Solar Energy. United States Department of Energy Technology Office.

WBCSD (2023) Roadmaps to nature positive: Foundations for the energy system. World Business Council for Sustainable Development.

World Bank (2023) REZoning 1.2: The Renewable Energy Zoning tool.

World Nuclear Association (2020). Cooling Power Plants.

WWF (2013) Rapid Sustainability Assessment Tool (RSAT). The World Wide Fund for Nature.

Taskforce on Nature-related Financial Disclosures

tnfd.global