

Equal Harm, Unequal Rules

A Functional-Equivalence Assessment of EU Crude Oil Supply Chains
under RED III

MSc Thesis · Complex Systems Engineering and Management
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by

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Preface

With this thesis, my academic journey comes to an end. After completing my bachelor's at the Vrije Universiteit Amsterdam and now my master's in Complex Systems Engineering and Management at TU Delft, my time as a student is over. It has been a long journey, with its easier stretches and its definitely more difficult ones, and one I am proud to be closing with this work.

Some research questions answer themselves quickly. This was not one of them. The simple question of why biomass and crude oil are held to such different standards led me further than I expected, and the more I learned, the more convinced I became that it was worth asking.

I hope this thesis can, in its own small way, encourage others, and myself, to look more critically at where the true costs of our energy system fall, and to make a difference where one can be made.

At TU Delft, I would like to thank my first supervisor, Dr. Tanzer, for her guidance throughout the process and for helping me find such an interesting topic to make my own. I am also grateful to my second supervisor and chair, Dr. Asveld, for her feedback and for overseeing this work.

Finally, I am grateful for my family and friends; their support made all of it possible. As my final academic words, I would like to thank you, the reader, for taking the time to read this thesis. I sincerely hope you enjoy it.

Flint de Rooij · Delft, July 2026

Abstract

This thesis applies RED III-equivalent non-GHG ecological sustainability criteria to EU crude oil supply chains as a structured thought experiment. The Renewable Energy Directive III (RED III) imposes strict ecological no-go zones and governance requirements on biomass, while crude oil, despite causing comparable or greater ecological harm, faces no equivalent regulation. This research addresses that asymmetry through five sub-questions, moving from criteria mapping through compliance assessment, typological extension, and scenario analysis to policy implications.

Four representative supply chains (Alberta, Canada; Ekofisk, Norway; Niger Delta, Nigeria; and Ghawar, Saudi Arabia) are assessed against fifteen operationalised indicators derived from Articles 29(2)-(7) and 30 of RED III. These results are extended typologically to the fourteen largest EU import source countries using WWF biome classification and the 2017 Natural Resource Governance Index. This extension assigns compliance by biome similarity rather than site-specific assessment, and 22.7% of imports remain unassessed.

Under the strict primary scenario, only 17.6% of current EU crude oil imports qualify as compliant, and the share never exceeds 23.2% under any scenario. Governance failure, not ecological harm, is the primary driver of exclusion, accounting for 25.4% of imports against 8.0% on ecological grounds. Norway and the United Kingdom are the only confirmed compliant sources. Under no IEA demand scenario does compliant supply approach projected demand within the transition period.

The research concludes that the asymmetry between biomass and crude oil lacks an ecological justification: excluding crude oil from an equivalent framework is a political choice rather than an ecological one, and a form of environmental injustice. Because the compliance risk lies in governance rather than spatial overlap, and a hard threshold would exclude most imports at once, any equivalent framework would need to be governance-first, verification-based and phased.

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Introduction

Over the past decade, the European Union has committed to accelerating the transition to renewable energy and phasing out fossil fuels. Producing energy from biomass, a renewable energy source, is itself not without ecological cost. The clearing of forest or draining peatland can destroy the very carbon sinks and habitats the transition is meant to protect (Fleischmann et al., 2024). Sustainability criteria exist to prevent this, and to ensure that energy counted as renewable is not produced at the cost of these ecosystems. As part of efforts to address this in the renewable energy transition, the Renewable Energy Directive III (RED III) introduces strict sustainability criteria for biomass used in transport fuels and energy production. These criteria cover two dimensions: greenhouse gas (GHG) savings requirements and non-GHG ecological criteria. The non-GHG ecological criteria include prohibitive “no-go” criteria for specific protected land types and operational governance requirements. Together they address land-use change, biodiversity protection and governance, and are designed specifically to protect critical carbon sinks and biodiversity hotspots (Fleischmann et al., 2024; Directive (EU) 2023/2413, Recital 83). The same cannot be said for crude oil. Its extraction causes similar categories of ecological harm that RED III’s criteria were designed to prevent, yet no equivalent framework regulates it.

The ecological harms of crude oil extraction are well-documented. In Alberta, Canada, oil sands extraction involves the large-scale conversion of boreal forests and peatlands, leaving behind contaminated and fragmented habitats (Rosa et al., 2017). The Niger Delta adds to this; oil spills, habitat destruction and water contamination have degraded one of the most biodiverse ecosystems over several decades (Ansah et al., 2022; Adeola et al., 2022; Lawson et al., 2022). Both cases describe the land-use conversion and biodiversity harms that RED III targets in biomass supply chains. Yet EU fossil-fuel regulation addresses only the climate dimension: the Fuel Quality Directive and FuelEU Maritime govern lifecycle GHG emissions, not the ecological conditions of extraction (Fuel Quality Directive, 1998; FuelEU Maritime Regulation, 2023). Additionally, fossil-fuel subsidies have been shown to increase rather than constrain the ecological footprint of production (Solarin, 2020; Asmelash, 2022). The scale of this regulatory gap is significant: the EU imports approximately 460 million tonnes of crude oil annually, and roughly 92% of this comes from fourteen major source countries (Eurostat, 2025a). By comparison, the renewables and biofuels that these criteria do govern supplied only about 6.7% of EU road-transport energy in 2023 (Eurostat, 2025c). This is a small share of the fuel mix in contrast to the far larger, ecologically unregulated crude oil supply.

This asymmetry presents a challenge to the internal coherence of EU sustainability governance. Biomass producers must comply with these strict ecological requirements, while crude oil producers operating in ecologically equivalent conditions do not. Coscieme et al. (2021) and Shawoo et al. (2023) document a fragmented policy coherence in which economic and bureaucratic incentives limit measures that would restrict fossil fuels, and Giuli and Oberthür (2023) note that energy-security considerations have historically taken priority over environmental objectives in EU external energy policy. Weber and Cabras (2021) frame this as a form of environmental injustice, arguing that the burden of sustainability compliance falls on renewable-resource producers while fossil-fuel imports remain exempt. Although their case concerns coal, the same logic extends to crude oil. Mai-Moulin et al. (2021) and Stubenrauch & Garske (2023) add that assessment tools already exist and are well developed. This implies that the absence of equivalent criteria for crude oil is a policy decision rather than a methodological limitation.

This research directly addresses this asymmetry. It applies RED III-equivalent non-GHG ecological criteria to EU crude oil supply chains as a strict thought experiment. A systematic compliance assessment of EU crude oil imports against the ecological standards that it already requires for biomass is conducted. This research focuses exclusively on the non-GHG ecological dimension. GHG emissions are excluded from the scope

because crude oil cannot meet GHG sustainability standards, as it inherently emits greenhouse gases when combusted.

Academically, the problem remains underexplored. Literature exists on the sustainability requirements for biomass under RED III (Mai-Moulin et al., 2021; Fleischmann et al., 2024; Stubenrauch & Garske, 2023) and, separately, on the ecological impacts of crude oil extraction (Rosa et al., 2017; Lawson et al., 2022; Adeola et al., 2022; Ansah et al., 2022). However, no study has systematically applied RED III's non-GHG ecological criteria to crude oil supply chains or quantified the implications for EU crude oil supply availability. This research aims to contribute to a more consistent and just energy transition by making the ecological costs of crude oil extraction visible and methodologically assessable. It addresses a coherence gap in EU sustainability governance that current policy has left unresolved.

1.1 Research Question

In order to bridge the identified academic knowledge gap, this research asks:

What are the implications for EU crude oil supply availability if non-GHG sustainability criteria equivalent to those applied to biomass under RED III were imposed on crude oil supply chains?

The sub-questions have been logically sequenced so that the output of each feeds directly as input into the next, forming a coherent analytical chain from criteria mapping through to policy implications. The following sub-questions support the main research question:

1. **SQ1:** Which non-GHG ecological criteria under RED III are applicable to crude oil supply chains, and how can they be operationalised as measurable and consistently scorable indicators?
2. **SQ2:** To what extent do representative EU crude oil supply chains comply with the operationalised RED III ecological criteria?
3. **SQ3:** What share of current EU crude oil imports would fail to meet RED III-equivalent sustainability thresholds under varying levels of criterion stringency?
4. **SQ4:** To what extent does the compliant crude oil supply meet the demand projected in the three energy transition scenarios of the IEA?
5. **SQ5:** What policy implications can be derived to address the regulatory asymmetry between biomass and crude oil sustainability governance in the EU energy system?

1.2 Scope and Delimitations

As established above, this research focuses exclusively on the non-GHG ecological criteria, using the framework as a thought experiment to assess a strict import prohibition. This strict reading has been chosen deliberately to establish the upper bound of non-compliance. It is important to clarify at the outset that RED III does not, in reality, operate as an import prohibition. Non-compliant biomass remains freely tradable within the EU; it simply cannot be counted towards renewable energy targets or qualify for financial support (Directive (EU) 2023/2413, Article 29(1)). This research deliberately adopts the stricter import-prohibition reading as an analytical assumption to produce a clear and assessable upper bound on the compliance gap, rather than to describe the directive's actual enforcement mechanism. The interpretive consequences of this choice are examined in the discussion. Beyond these delimitations, three further decisions bound the scope of the research. The compliance assessment is limited to the extraction region and its attributable zone of influence. Downstream activities such as transportation, trading and refining are outside the scope. The geographic

scope covers the fourteen largest EU crude oil import sources, which account for approximately 92% of the EU import volume (Eurostat, 2025a). The compliance assessment is applied to four representative supply chains: Ekofisk (Norway), Ghawar (Saudi Arabia), the Niger Delta (Nigeria) and Alberta (Canada). These four have been selected for their variation across extraction types, geographies, regulatory contexts, and documentation quality. The full methodological justification for all scope decisions is provided in the methodology.

1.3 Methodological Approach

The methodological foundation of this research is the principle of functional equivalence. This principle holds that if a regulatory criterion is normatively justified by the harm it prevents, and if the same category of harm can be demonstrated in another context through equivalent mechanisms, then the criterion applies with equal force to that context. RED III's prohibitive criteria are justified by the ecological harm that biomass extraction causes. The research therefore tests, for each applicable criterion, whether crude oil extraction causes equivalent harm through equivalent mechanisms; where it does, the same normative justification holds and the criterion is operationalised for crude oil accordingly.

The compliance assessment translates the criteria into scorable indicators using a two-tier framework. Tier 1 covers the prohibitive ecological criteria, the no-go zones of Articles 29(3), 29(4) and 29(5). These criteria are scored against documented spatial overlap and ecological degradation. Tier 2 covers the operational governance criteria, the requirements of Articles 29(2), 29(6) and 29(7). These criteria are scored against the existence, enforcement and application of regulatory frameworks. Rather than relying on subjective interpretation, the EU-recognised ISCC EU 202-3 certification standard serves as a reference for operationalising the legislative text (ISCC System GmbH, 2025).

The four supply chain compliance findings are then extended typologically to the fourteen largest EU import source countries through biome-based ecological classification (Olson et al., 2001) and a country-level governance scoring drawn from the 2017 Resource Governance Index (Natural Resource Governance Institute, 2017). Full methodological justification, including the selection of supply chains, the scoring thresholds, the indicator adaptations, and the limitations of the typological extension, is provided in the methodology.

This research aligns directly with the CoSEM programme's focus on large and complex socio-technical systems. The challenge of extending EU sustainability governance to crude oil supply chains is neither purely technical nor purely political but rather requires the integrated analysis of ecological conditions, governance architectures, regulatory frameworks, energy system dynamics and multi-stakeholder trade-offs across jurisdictions. This research applies systems engineering tools to policy analysis and uses multi-criteria assessment for governance design, thereby directly applying CoSEM's interdisciplinary approach to complex socio-technical problems.

1.4 Research Structure

This research is structured as follows. Chapter 2 describes the research methodology and design. Chapter 3 maps RED III's non-GHG ecological criteria onto crude oil supply chains via functional equivalence, thereby answering SQ1. Chapter 4 applies the resulting compliance matrix to four representative supply chains, answering SQ2. Chapter 5 extends the assessment to the fourteen largest EU crude oil import source countries, answering SQ3. Chapter 6 maps the compliant supply pool against IEA energy transition scenario demand projections, answering SQ4. Chapter 7 derives the policy implications and answers SQ5. Chapter 8 discusses the findings critically. Chapter 9 concludes the thesis.

Research Methodology

The problem and research question established in Chapter 1 dictate the research approach. This chapter provides the full methodological justification for the design decisions introduced in Chapter 1. It explains why a criteria-based compliance assessment was chosen, how the analytical framework was constructed and operationalised, why the specific supply chains were selected, and what the design limitations are. The chapter is structured to follow the analytical chain of the five sub-questions, with each methodological decision linked to the sub-question it discusses.

2.1 Overall Research Design

The research follows a sequential analytical chain in which the output of each sub-question directly feeds into the next. SQ1 produces the criteria and indicator framework that SQ2 applies to four supply chains. SQ2 produces the compliance profiles that SQ3 extends typologically to the full EU import base. SQ3 produces the compliance picture that SQ4 maps against demand projections. The combined findings of SQ1 through SQ4 form the analytical foundation from which SQ5 derives policy implications. This sequential structure has been chosen to ensure that the policy implications in SQ5 are traceable to the empirical compliance findings rather than to normative assumptions. Figure 2.1 visualises this analytical chain, from the inputs and methods of each phase to the output that feeds the next.

The research is exploratory in its nature. It is the first systematic application of RED III-equivalent non-GHG ecological criteria to EU crude oil import supply chains and aims to map compliance profiles and identify their structural drivers, rather than test a specific hypothesis. The exploratory nature is reflected in the multi-level scoring scale, the sensitivity analysis, and the explicitly indicative framing of the typological extension and scenario analysis. None of these claim statistical precision, but rather produce findings about the direction and composition of the compliance gap that do not depend on precise quantities. Consistent with this exploratory framing, the compliance assessment applies RED III's criteria as a strict import prohibition. This is deliberately chosen as a theoretical maximum, not a description of how the directive actually operationalises in reality (see sections 1.2 and 8.1).

The core analytical strategy is a criteria-based compliance assessment. This design was chosen for three reasons. First, it directly mirrors RED III's regulatory logic and keeps results disaggregated by criterion and supply chain, preserving the transparency needed to identify which specific criteria and governance conditions drive the compliance gap. Second, the disaggregated approach allows both the ecological and governance dimensions of compliance to be assessed independently. This is important for the analysis as the relative weight of each dimension is undetermined. Third, the criteria-based approach enables direct comparison between the findings and the biomass framework.

The sub-questions differ in kind, so each method is selected to fit the question it answers. SQ1 and SQ5 require qualitative policy analysis to map criteria and derive implications. SQ2 uses a criteria-based compliance assessment drawing on empirical environmental and governance data; SQ3 employs a mixed approach as it requires qualitative typological classification to assign each import source country the most contextually appropriate profile, combined with the quantitative extension of the resulting compliance results against EU import volume. SQ4 requires quantitative scenario analysis using published demand projections. Each method is chosen because it is most effective at answering its sub-question, rather than restricting it to a single framework. The qualitative and quantitative components are complementary rather than competing.

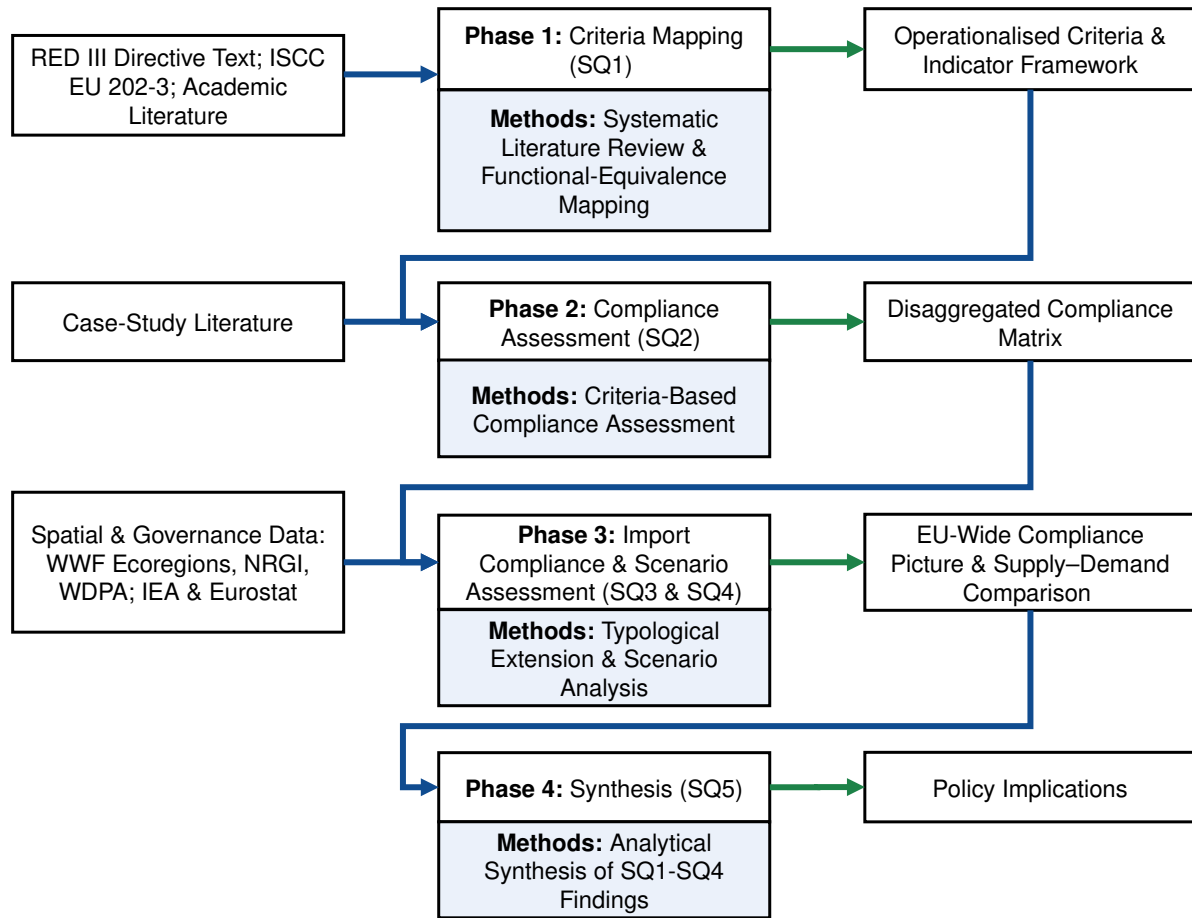


Figure 2.1: Research flow diagram. Each phase corresponds to a sub-question (SQ1 to SQ5), with its inputs and methods on the left producing an output on the right that feeds into the next phase.

2.2 Functional Equivalence as the Methodological Foundation

The principle of functional equivalence is the methodological foundation of this research. This means that if a regulatory criterion is normatively justified by the harms it prevents, and if the same category of harm can be demonstrated in a different context through equivalent mechanisms, then the criterion applies with equal force to that context. A criterion exists to prevent a specific harm, not to regulate a specific resource, so treating that same harm differently only because a different resource causes it would be inconsistent. This mirrors how EU law itself is interpreted. Under a purposive, or teleological, reading, a provision is interpreted according to the objective it pursues, not only its literal wording. This is the interpretive method the European Court of Justice characteristically applies (Lenaerts & Gutiérrez-Fons, 2013). Each criterion is applied on its own terms, with the adaptation limited to translating the biomass extraction context into its crude oil equivalent.

For RED III, the prohibitive and operational criteria are normatively justified by the ecological harm that biomass extraction causes, namely the land-use change, biodiversity loss and destruction of carbon sinks the criteria are designed to prevent (Directive (EU) 2023/2413, Recital 83; Fleischmann et al., 2024). Because it is a directive

specifically designed for biomass, it does not apply to crude oil. This does not mean that no similar harm occurs. Therefore, for each applicable criterion, Chapter 3 identifies the specific harm the criterion prevents in the biomass context. It then examines whether crude oil extraction produces the same category of harm through an equivalent mechanism, such as land conversion, spatial overlap with protected areas, hydrological disruption or contamination. Where it does, the criterion is operationalised for crude oil accordingly.

The principle also has a natural stopping point: functional equivalence requires the presence of the relevant ecosystem type. Where extraction occurs in contexts where the specific ecosystem types named in RED III are absent, the criteria are ecologically inapplicable. This is not a methodological failure but a substantive finding about the framework's scope, discussed in Chapter 8.

2.3 Supply Chain Selection

The compliance assessment in SQ2 is applied to four representative supply chains. The four supply chains were selected for four diverse criteria: extraction type, geographic and ecological context, regulatory environment and documentation quality (Table 2.1).

Table 2.1: Supply chain selection

Supply chain	Extraction type	Ecological context	Regulatory context	Documentation quality
Ekofisk, Norway	Conventional offshore	North Sea marine	High - comprehensive and enforced	High - 50+ years of monitoring data
Alberta, Canada	Oil sands surface mining and in-situ	Boreal forest and peatland	High- comprehensive but enforcement deficient	High - extensive academic literature and publicly accessible monitoring
Niger Delta, Nigeria	Conventional onshore	Tropical wetland and mangrove	Low - legislation exists but systematically unenforced	Moderate - documented but underreported
Ghawar, Saudi Arabia	Conventional onshore	Hyper-arid desert	Opaque - self-regulated under Ministry of Energy	Low - structurally inaccessible

Together, the four supply chains cover the full range of ecologically relevant extraction contexts for EU crude oil imports: offshore conventional, boreal onshore, tropical wetland onshore, and desert onshore. They also span the full spectrum of governance quality, from demonstrated compliance to structural opacity. This variation ensures the compliance framework is tested against different types of compliance outcomes rather than converging on similar findings across cases.

2.4 Compliance Matrix Design

The compliance matrix translates RED III's non-GHG ecological criteria into fifteen scorable indicators across two tiers. This section presents the matrix's structural logic, the scoring scale, and the evidence standards applied throughout.

The criteria assessed here are set out in Article 29 of RED III, which combines a greenhouse-gas saving threshold with the non-GHG ecological criteria that are the focus of this research. These ecological criteria fall into three groups: the prohibitive land-based no-go criteria, the operational governance requirements, and

the verification and traceability procedures of Article 30. Several of the no-go criteria depend on whether an area has been formally designated by a competent authority. In this research, a competent authority is a body empowered by law, or recognised under an international agreement, to make official designations for nature protection, such as a national conservation authority or an international body like the IUCN or the Ramsar Convention Secretariat. This distinction is decisive for several of the prohibitive scores, because documented ecological harm on its own does not satisfy a criterion that requires a formal designation.

2.4.1 Two-Tier Structure

Compliance is structured into two tiers, following the internal logic of the RED III. Tier 1 covers the prohibitive criteria identified in 29(3), 29(4) and 29(5). These no-go zones are assessed against documented spatial overlap or ecological degradation attributable to the extraction site. Tier 2 covers the operational criteria of Articles 29(2), 29(6) and 29(7), which cover the governance and management criteria. Here, compliance is assessed against the existence, enforcement and application of relevant regulatory frameworks. The procedural pillar of Article 30, which addresses verification infrastructure and traceability, does not produce indicators and is therefore excluded from the compliance assessment. Its implications will be addressed in the policy implications.

Keeping the two tiers analytically separate allows the research to identify when non-compliance is ecologically or governance-driven. This distinction is important for deriving policy implications. Tier 1 asks a spatial and ecological question: did extraction occur in, or cause the conversion or degradation of, a land type holding the relevant protected status? Tier 2 asks a governance question: Does a regulatory framework exist, is it enforced, and does extraction operate within it?

2.4.2 The ISCC EU 202-3 as Reference

To ensure the compliance indicators are grounded in established EU-recognised practice rather than interpretation, the ISCC EU 202-3 'Forest Biomass: ISCC Principle 1' certification standard is used as a methodological reference for operationalising the legislative text (ISCC System GmbH, 2025). The standard disaggregates Articles 29(6) and 29(7) into distinct criteria with concrete compliance checks, verification procedures and evidence requirements, and establishes a two-level verification structure that directly corresponds to the Tier 2 governance assessment. Where it specifies compliance mechanisms, a similar mechanism is identified for crude oil through functional equivalence reasoning. The indicators are therefore derived from the standard via the same functional equivalence principle applied to RED III itself.

2.4.3 Indicator Framework

Table 2.2 presents the full indicator framework: the fifteen indicators that operationalise the criteria, split into ten Tier 1 ecological and five Tier 2 governance indicators, each mapped to its RED III article and code. The detailed evidentiary thresholds for each indicator are provided in the scoring forms in Appendix Tables A.1 and A.2.

Table 2.2: Indicator framework: fifteen compliance indicators

Code	Article	Criterion	Indicator – What It Measures
T1-1	Art. 29(3)(a)	High biodiversity value - Primary / Old-Growth Forest	Does published literature indicate that extraction infrastructure overlaps with or has caused loss of primary old-growth, or intact forest landscape at or traceable to the extraction site
T1-2	Art. 29(3)(b)	High biodiversity value - Highly Biodiverse Forest	Does literature indicate that the extraction site overlaps with or has caused measurable harm to species-rich, non-degraded forest habitat at or near the site?
T1-3	Art. 29(3)(c)(i)	High biodiversity value - Protected Areas	Does literature indicate that extraction infrastructure is located within or causes documented harm to a legally designated protected area?
T1-4	Art. 29(3)(c)(ii)	High biodiversity value - Protected Areas for Threatened Species	Does literature document that extraction overlaps with or harms areas designated for protection of IUCN EN/CR or other internationally recognised rare, threatened or endangered ecosystems or species
T1-5	Art.29(3)(d)(i)	Highly Biodiverse Grassland	Does literature indicate that extraction site overlaps with or has caused degradation of natural species-rich non-degraded grassland, as evidenced by documented decline in native plant species richness or formal national designation?
T1-6	Art.29(3)(d)(ii)	Highly Biodiverse Grassland	Does literature indicate that extraction site overlaps with or has caused degradation of non-natural species-rich non-degraded grassland, as evidenced by documented decline in native plant species richness or formal national designation?
T1-7	Art. 29(3)(e)	Heathland	Does literature indicate that extraction site overlaps with or has caused degradation of heathland
T1-8	Art. 29(4)(a)	High carbon stock - Wetlands	Does literature document that extraction has converted, drained, or degraded wetland systems at or attributable to the extraction site? Applied under both 2008 reference date (post-2008 conversion only) and current conditions (any documented conversion).
T1-9	Art. 29(4)(b/c)	High carbon stock - Forest Carbon Stock	Does literature indicate post-2008 forest/canopy clearance or carbon stock loss attributable to extraction infrastructure at the site, above the 30% canopy threshold (b) or 10–30% threshold without verified carbon maintenance (c)?
T1-10	Art. 29(5)	High carbon stock - Peatland	Does literature indicate that extraction has involved drainage of previously undrained peat at or attributable to the extraction site? Applied under both 2008 reference date (post-2008 conversion only) and current conditions (any documented conversion)
T2-1	Art.29(2)	Soil Quality and Soil Carbon Monitoring	Does literature indicate whether a monitoring plan for soil quality and hydrocarbon levels exists and is implemented?
T2-2	Art.29(6)(i/iv)	Legality of Extraction	Does published documentation indicate legality of extraction?
T2-3	Art.29(6)(ii/v)	Site Remediation / Ecological Recovery	Does literature indicate whether decommissioned or inactive extraction sites have been formally remediated to pre-extraction ecological condition, or are on a documented and independently verified remediation trajectory?
T2-4	Art.29(6)(iv)	Soil Quality/Biodiversity	Does literature indicate whether operational discharge management meets established standards, or whether contamination attributable to operations is documented in receiving environments?
T2-5	Art.29(7)(a/b)	Paris Agreement and NDC	Does literature indicate whether the country of origin is a Party to the Paris Agreement and has submitted a Nationally Determined Contribution covering land-use sectors; and whether national legislation exists operationalising these land-use governance commitments?

2.4.4 Scoring Scale and Evidence Standards

The ISCC certification system relies on a binary compliance logic: it either meets the criteria or it does not. Any violation results in the immediate withdrawal of the certification. This binary structure is suitable for the certification scheme as it is an instrument of market access and not an analytical method. For this research, a multi-level scoring scale is more appropriate. The identification of partial, contested or ambiguous documentation is deemed a finding itself, as it reveals where the RED III framework faces challenges regarding its application to crude oil. One adaptation from the ISCC reference is required: the partial and not assessable categories. There is no regulatory middle ground in RED III; therefore, these are introduced only for this research, to bridge the evidentiary gap between indicative documentation and definitive audit proof. Furthermore, this adaptation reflects the exploratory nature of this research, which aims to identify the friction points rather than a binary certification. The partial category can help more accurately structure the implications for applying the RED III to crude oil. The scale is applied differently across the two tiers as their underlying logic is different. Table 2.3 presents the complete scoring thresholds for both tiers, including the minimum evidence required for each score and the conditions under which each applies.

Table 2.3: Scoring thresholds by tier

Score	Tier	Minimum evidence required	Notes
Compliant	Tier 1	Reliable independent source(s) confirm no spatial overlap and no attributable conversion or degradation.	Also assigned where criterion is ecologically inapplicable to the extraction context (e.g. offshore or desert).
Partial	Tier 1	Reliable independent source(s) indicate presence of relevant land type but do not establish causal degradation. OR harm indicated only by a single uncorroborated source whose independence cannot be established.	Reflects evidentiary gap rather than absence of harm.
Non-Compliant	Tier 1	Reliable independent source(s) explicitly document spatial overlap OR attributable conversion or degradation of the relevant land type.	
Compliant	Tier 2	Regulatory framework exists; enforcement mechanisms are in place; extraction site demonstrably operates within the framework.	
Partial	Tier 2	Regulatory framework exists but documented evidence indicates significant enforcement gaps or only partial coverage.	Framework exists but is not operationalised as required.
Non-Compliant	Tier 2	No relevant regulatory framework exists OR framework is systematically neglected.	
Not Assessable	Tier 2 only	Absence of publicly accessible independent documentation prevents any compliance finding from being made.	Treated as a substantive finding consistent with RED III burden-of-proof logic. Not applicable to Tier 1.

Each score depends on the quality of the evidence behind it. Rather than ranking sources by category, this assessment judges every source on three criteria: whether it is independent of the extraction operator's commercial interests, whether its method and sourcing are transparent, and whether its claims are corroborated. A determinative score, meaning a Tier 1 non-compliant score or a Tier 2 compliance finding, requires at least one independent source with a transparent method, corroborated where the claim is contested. Peer-reviewed academic literature, official governmental or intergovernmental reporting, and regulatory documentation from a competent authority usually meet this standard. They are not treated as automatically neutral, however. Governmental and academic sources have their own motivations, and are weighed with extra caution where the state or funder has a direct stake in the extraction, for example where the state is also the operator.

The sources often grouped together as grey literature are not equivalent, so they are treated differently. Industry self-disclosure carries a structural conflict of interest, because the operator reports on its own conduct. It is used mainly as evidence against interest: it is credible where a company documents harm, but requires corroboration where it asserts compliance. Non-governmental organisation (NGO) reporting and investigative journalism are instead assessed on the independence, transparency and track record of the specific source. Well-sourced reporting of either kind can corroborate a finding, and in some cases establish one on its own, and it often surfaces evidence earlier than peer-reviewed literature. Where the only evidence of harm is a single uncorroborated source whose independence or method cannot be established, the criterion produces a partial score rather than a non-compliant one. This reflects an evidentiary gap rather than the absence of harm. For Tier 2, such a source can point to enforcement gaps but cannot on its own establish whether a regulatory framework exists.

2.4.5 Indicator Adaptations

Four indicator adaptations from the standard RED III criteria are required to apply them meaningfully to crude oil extraction. Each adaptation preserves the normative justification of the criterion while reflecting the structural differences between biomass harvesting and crude oil extraction.

Zone of influence

The RED criteria apply to the spatial land status at or within the extraction site. For crude oil, the ecological harm extends well beyond the direct physical footprint through identifiable mechanisms: infrastructure and fragmentation beyond the lease boundary (Rosa et al., 2017), regional dewatering that lowers water tables by 15 to 25 metres (Volik et al., 2020), and spills that propagate through connected wetland systems (Lawson et al., 2022). The Tier 1 indicators, therefore, assess spatial overlap and ecological degradation within both the extraction site and its attributable zone of influence, rather than the direct footprint alone.

Soil Quality and Biodiversity

Article 29(6)(a)(ii) and (iv) require that harvesting is carried out while taking soil quality and biodiversity into account. In a forestry context, this means maintaining the physical, chemical and biological soil conditions during and after harvesting. No biological material is harvested for crude oil extraction, but the equivalent concern is rather prevention, monitoring and remediation of contamination. Here, contamination is caused through produced water discharge, drilling fluid and oil spills. Therefore, the indicator is altered to contamination and discharge management, and it assesses whether regulatory frameworks exist and are enforced to prevent and manage contamination.

Forest regeneration

Article 29(6)(a)(ii)(v) requires that extraction areas be restored following operations. In the forestry context, this means the regeneration and maintenance of forest capacity. For crude oil, there is no replanting equivalent. Instead, site remediation is considered to be the analogous obligation. This is the requirement to restore extraction sites following the termination of extraction operations and to remediate contaminated sites. The indicator is altered to assess whether regulatory frameworks require and enforce the ecological restoration of extraction sites and remediation of contaminated areas.

Paris Agreement and NDC

Article 29(7) requires that the country of origin is a Party to the Paris Agreement and has submitted a Nationally Determined Contribution covering land-use and carbon stock changes. The LULUCF carbon stock accounting falls under the GHG domain and is therefore not considered within the scope of this research. However, the Paris Agreement and NDC disclosure do indicate whether a country operates within an international regulatory framework that includes national commitments to land-use governance and accountability. The indicator is therefore altered to assess only whether a country is a party to the Paris Agreement and whether it has submitted an NDC that covers land-use regulation.

2.5 Typological Extension

The compliance assessment of four supply chains cannot directly answer SQ3, which requires a comprehensive view of the EU's crude oil import base. A typological extension is used to bridge this gap. Here, the compliance profiles established in SQ2 are extended to the fourteen largest EU crude oil import source countries, based on structural similarity rather than direct assessment.

The extension proceeds in two independent parts. Tier 1 compliance is transferred based on biome context: each import source country is assigned to the supply chain whose ecological context most closely matches its dominant production region, and the assessed supply chain's Tier 1 compliance profile is applied accordingly. Tier 2 compliance is assessed through a country-level governance proxy drawn from the 2017 Resource Governance Index (Natural Resource Governance Institute, 2017). The two tiers are assessed independently and then combined using a decision rule to produce an overall country-level classification.

2.5.1 Biome Classification

The ecological classification is based on the WWF Terrestrial Ecoregions of the World database (Olson et al., 2001). This is the peer-reviewed standard reference of biome classification in conservation and environmental literature. This database classifies 867 land-based ecoregions into 14 biome types. The ecoregion and biome type have been determined by inserting the geographic coordinates of the dominant producing region into the Data Basin platform (Conservation Biology Institute, 2026). The same coordinates can be inserted to replicate the assignment. This produces a reproducible and independently verifiable classification.

Dominant Field Approach

The geographic reference point for each country has been chosen to be the dominant production region. The largest national field is used as the representative site on the assumption that a country's dominant producing region is the most likely source for its EU-bound export. The EU crude oil import statistics are reported at the country level and not site-specific; hence, this assumption. Furthermore, the dominant field is chosen rather than the country-level biome, as the RED III criterion asks whether it was sourced from a specific land holding an ecological status. The country-level ecological status would be considered too vague.

Production heterogeneity

Where a country's production is distributed across more than one biome context, the dominant field approach is applied. This assigns the typological extension based on the biome of the largest field. An exception applies where heterogeneous production contexts would each produce different compliance outcomes, and no single field is sufficiently dominant to be representative. In such cases, the country is left unassessed. The United States falls into this exception due to production distributed across three distinct and compliance-relevant biome contexts. For all other heterogeneous producers, the country-level detail is documented in Chapter 5.

2.5.2 Governance Proxy: The 2017 Resource Governance Index

The Tier 2 operational governance criteria of the RED III assess whether the right governance structures are in place and enforced to assess the legality of extraction and minimisation of ecological degradation. A country-level typological extension is necessary to extend these requirements across the full EU crude oil

import source countries. For the extension, the 2017 Resource Governance Index has been selected. The 2017 Resource Governance Index, established by the Natural Resource Governance Institute (NRGI), covers 81 countries that account for 82% of the world's oil production. The Resource Governance Index is based on researchers' responses to a 149-question questionnaire using almost 10,000 supporting documents across 89 country-sector assessments (Natural Resource Governance Institute, 2017). This coverage is considered sufficient to assess all the major EU crude oil import sources. The 2021 edition, though more recent, has not been selected as it only covers 18 countries and does not include Norway, Kazakhstan, Saudi Arabia, Libya, Iraq, the United Kingdom, Russia or Algeria.

The composite score is built up of an equal-weighted average of three components: Value Realisation, Revenue Management and Enabling Environment. Together, a maximum score of 100 can be obtained. Under the primary (strict) threshold, a score of 75 or above, the NRGI "Good" band, is treated as Compliant, 45 to 74 as Partially Compliant, and below 45 as Non-Compliant. Value Realisation measures the governance of licensing, exploration, production, environmental protection, revenue collection and state-owned enterprises through primary expert research. It has a Local Impact sub-component that includes environmental protection obligations. This most directly responds to the Tier 2 criteria assessed in Chapter 4. Revenue Management covers national budgeting, subnational revenue sharing and sovereign wealth funds. Enabling Environment is based on six Worldwide Governance Indicators of the World Bank: voice and accountability, political stability, government effectiveness, regulatory quality, rule of law and control of corruption. NRGI has also developed and included a seventh Open Data component (Natural Resource Governance Institute, 2017). The Open Data sub-component captures whether governance is sufficiently transparent to allow independent verification and is directly relevant for Tier 2.

As stated above, Revenue Management covers monetary governance and is not directly relevant to environmental compliance obligations. However, the published composite score is used to maintain transparency and comparability.

2.6 Scenario Analysis

The scenario analysis in SQ4 maps the compliant supply pool identified in SQ3 against EU crude oil import demand projections from the IEA World Energy Outlook 2025 (IEA, 2025). Three IEA scenarios are used: the Current Policies Scenario (CPS), which assumes no new policy commitments beyond those currently in force; the Stated Policies Scenario (STEPS), the IEA's central case incorporating all announced policies and pledges; and the Net Zero Emissions by 2050 Scenario (NZE), a normative pathway specifying what the energy system would need to look like to limit warming to 1.5°C.

This analysis is explicitly exploratory. It does not model how governance conditions, supply chains or producing countries would respond to the introduction of a RED III-equivalent framework. This means the compliant supply pool is held constant under the current governance conditions throughout the timeline. This static pool assumption is chosen to deliberately establish the upper bound of the compliance gap. The implications of this assumption are addressed in the limitations section of Chapter 8.

The scenario analysis does not produce a quantitative forecast. Rather, it uses the compliance results to assess whether compliant supply availability strains against projected EU import demand under different energy transition trajectories. Ultimately, determining the conditions under which a RED III-equivalent framework would remain practically viable.

One data limitation affects the NZE scenario specifically: the IEA does not publish disaggregated EU-27 oil demand figures for the NZE. Therefore, a comparable EU-specific demand projection for the NZE cannot be produced. The NZE is included for its directional significance rather than as a quantified projection. The specific demand figures, scenario comparisons and gap calculations are presented in Chapter 6.

2.7 Limitations of the Research Design

Several limitations of the research design are inherent to the methodological choices made and should be distinguished from the findings-level limitations addressed in Chapter 8.

The extraction-only scope is the most significant design limitation. RED III functions through full supply chain traceability under Article 30. This means that the sustainability criteria apply from extraction through to final consumption. This research assesses only the extraction region and its zone of influence. The full supply chain, which includes transportation, trading, refining and delivery to EU markets, is outside scope. This reflects both a practical data constraint and a conceptual one: the traceability records infrastructure required to assess the full crude oil supply chain does not exist, which is itself one of the policy implications the research identifies.

The four supply chains are selected for maximum variation rather than their statistical representativeness. This means that findings from the direct assessment cannot be generalised to all supply chains with full confidence. The typological extension in SQ3 mitigates this by extending the compliance picture to the full EU import base, but it does so through similarity-based inference rather than direct assessment, which introduces its own assumptions.

The functional equivalence methodology requires interpretive judgment at each criterion. The sensitivity analysis tests the robustness of the most consequential boundary cases, yet the methodology cannot entirely eliminate interpretive uncertainty. Different analysts applying the same framework to the same evidence could produce different scores for boundary cases. Ensuring that the scoring documentation is transparent and exactly specifies which evidence is used for each score helps mitigate this limitation.

The NREGI 2017 data cover the 2015-2016 assessment period, creating a gap of over a decade. This limitation is acknowledged, and its implications for the governance gap estimates are discussed in Chapter 8.

Mapping RED III Criteria to Crude Oil through Functional Equivalence

This chapter applies the functional equivalence principle established in Chapter 2 to each applicable RED III criterion in turn. For each criterion, the normative justification of the prohibition or requirement is identified, and the evidence is assessed for whether crude oil extraction causes equivalent harm through equivalent mechanisms. Where equivalence is demonstrated, the criterion is confirmed as applicable to crude oil supply chains and is carried forward into the compliance matrix operationalised in Chapter 4. The criteria are organised into three pillars following the internal structure of RED III: the prohibitive ecological criteria of Articles 29(3), 29(4) and 29(5); the operational governance criteria of Articles 29(2), 29(6) and 29(7); and the procedural verification criteria of Article 30.

3.1 Prohibitive: Ecological “No-Go Zones”

The main focus of this type of RED III framework is to establish strict spatial exclusion for biomass extraction, in which the ecosystems’ statuses as of January 2008 are treated as absolute barriers to sustainable sourcing. The prohibition is operationalised in Articles 29(3), 29(4) and 29(5) of the RED III. In these articles, exact “no-go zones” are identified. The prohibition on biomass sourcing from these “no-go zones” is based on the fact that these ecosystems are critical carbon sinks and biodiversity hotspots (Directive (EU) 2023/2413, Recital 83). Often, when these ecosystems are disturbed, the effects are ecologically irreversible on human timescales (Pan et al., 2011).

Article 29(3) prohibits any extraction of raw material from high biodiversity land if it had one of the following statuses in or after January 2008, irrespective of whether the land still has the same status: Primary and Old-Growth Forests, Highly Biodiverse Forest, Protected Areas, Grasslands, Heathland.

3.1.1 Primary and Old-Growth Forests (Article 29(3)(a))

Article 29(3)(a) of the RED III prohibits sourcing from Primary Forests and Old-Growth forests that were classified as forestland by their respective countries. The rationale for this strict exclusion is the protection of “High biodiversity value” found in ecosystems that have not been significantly disturbed by human activity.

Following the principle of functional equivalence, this criterion is strongly analogous to the clearing and fragmentation of intact boreal and tropical forests for the crude oil infrastructure. Rosa et al. (2017) point out that the oil extraction in the Canadian Oil sands leads to significant “forest loss and fragmentation”. They further highlight that even if the physical footprint of the oil site is small, the associated infrastructure needed to facilitate the oil extraction disrupts the continuity of the Boreal ecosystem, violating the RED III’s requirement for undisturbed ecological processes.

Eugenio et al. (2024) further document the environmental impacts of oil extraction within the Yasuní Reserve (Blocks 16 and 67). Their combined qualitative and Life-Cycle Assessment findings reveal that oil extraction in these primary forest blocks results in irreversible habitat fragmentation and biodiversity loss.

These cases demonstrate that crude oil extraction causes the clearing and fragmentation of primary and old-growth forest ecosystems through mechanisms functionally equivalent to biomass.

3.1.2 Highly Biodiverse Forest (Article 29(3)(b))

Article 29(3)(b) extends the prohibition by including highly biodiverse forest land that is species-rich and not degraded, unless evidence is provided that the production does not interfere with its nature protection purposes. The forest should also be defined as highly biodiverse by a relevant competent authority. The criterion recognises that the protection of ecological value should not be limited to humanly “untouched” ecosystems, but that forests that preserve high species richness and similar structural integrity require equivalent protection.

The ecological degradation of species-rich forests caused by the crude oil infrastructure is functionally equivalent. Lawson et al. (2022) illustrate that tropical peatland swamp forests are one of the last remaining ecosystems for endangered species: the anaconda and black caiman in Peru, the orangutan in Indonesia, and the forest elephant and lowland gorilla in the Congo basin. The oil exploration phase alone has an impact functionally equivalent to “habitat destruction”. They further document that seismic exploration required 78,500 km of trails to be cut in the Sumatra basins, 462,000 km in western Amazonia, and over 3,600 km in the Congo Basin, disrupting the structural integrity of the forest.

Adeola et al. (2022) further indicate that crude oil exploration in the Niger Delta degrades forests through the discharge of drilling fluids and oil spills. The Niger Delta is a region with high biodiversity, and these events severely reduce the area’s ecological function.

Both these cases illustrate that crude oil exploration and extraction represent a structural threat to species-rich environments through mechanisms functionally equivalent to biomass.

3.1.3 Protected Areas (Article 29(3)(c))

Article 29(3)(c) prohibits sourcing from areas designated by law or by a competent authority for nature protection purposes, including areas designated for the protection of rare, threatened or endangered ecosystems or species recognised by international agreements. Unless evidence is provided that the production does not interfere with its nature protection purposes, biomass should not be sourced from the area.

This criterion covers two distinct types of designated protection that are assessed separately in the compliance matrix. The first concerns areas designated for general nature protection purposes. The second concerns areas specifically designated to protect rare, threatened, or endangered species. The distinction is maintained because the evidentiary requirements differ: T1-3 requires evidence of a formal area designation and documented interference with its conservation objectives, while T1-4 additionally requires a formal species-level designation and spatial overlap between extraction and critical habitat. This separation is necessary because a supply chain could comply with one criterion but fail the other.

As previously stated, Eugenio et al. (2024) examine the crude oil extraction in Blocks 16 and 67 of the Yasuní National Park in Ecuador. This park is recognised as one of the most biodiverse areas in the world (UNESCO, n.d.c). Their combined qualitative and Life-Cycle assessment demonstrates that oil extraction activities within this protected area cause irreversible habitat fragmentation and biodiversity loss (Eugenio et al., 2024). This indicates the precise harm that the protected area was established to prevent.

The functional equivalence argument can also be applied beyond land-based protected areas. Article 29(3)(c) designates areas “recognised by international agreements” without restricting to land-based ecosystems. Therefore, marine protected areas established under international agreements receive equivalent consideration, as their ecological values are no less irreplaceable.

The OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic is an equivalent international agreement. OSPAR designates Marine Protected Areas across the North-East Atlantic. This includes ecologically sensitive habitats such as cold-water coral reefs that require decades to recover from

physical disturbance. The OSPAR Quality Status Report explicitly acknowledges that protected areas are more vulnerable to crude oil extraction activities. The installation of the related infrastructure causes lasting physical disturbance to the seabed (OSPAR Commission, 2023). Cordes et al. (2016) confirm these statements and independently document that the cold-water coral ecosystems are directly impacted by drilling operations through smothering, toxic effects from produced water and drill cuttings, and physical disturbance from anchor chains and pipeline installation. Cordes et al. (2016) specifically document that oil and gas development has occurred within the Faroe-Shetland Channel Sponge Belt. This is a designated Nature Conservation Marine Protected Area under UK conservation legislation, establishing that extraction within formally designated marine protected areas already occurs.

The most directly documented case of observable harm to protected marine ecosystems from crude oil extraction is the Deepwater Horizon blowout at the Macondo well. Cordes et al. (2016) highlight the incalculable damage caused by this event. Deep-sea coral ecosystems were contaminated, extending 22 km from the well and at depths exceeding that of the wellhead itself. Over 50% of coral colonies closer to the well showed significant damage. Although described as an accidental spillage rather than a structural discharge, risk modelling suggests that a similar event is expected to occur approximately once every 17 years (Cordes et al., 2016). This indicates that accidental discharges are statistically foreseeable and therefore structural rather than accidental. More importantly, Cordes et al. (2016) estimate that the recovery time of affected deep-sea coral communities is on the order of centuries to millennia, representing a near-permanent interference with nature protection goals.

These cases demonstrate that crude oil extraction causes interference with the conservation objectives of formally designated protected areas through mechanisms functionally equivalent to biomass extraction.

3.1.4 Grasslands (Article 29(3)(d))

Article 29(3)(d) prohibits the sourcing of biomass from highly biodiverse grasslands where extraction would cause the area to lose its biodiversity status, natural species composition, or ecological characteristics. The criterion, therefore, turns on whether crude oil extraction produces that outcome in practice.

The extraction of crude oil causes functionally equivalent degradation in grassland ecosystems. Nasen et al. (2011) document the environmental effects of the petroleum and natural gas developments in the grasslands of Saskatchewan, Canada. Their empirical assessment of 31 oil and gas lease sites provides evidence that crude oil extraction causes the exact harm that Article 29(3)(d) was aimed to prevent.

Nasen et al. (2011) find that active oil and gas lease sites have a significantly lower cover of herbaceous plants, litter and club moss. On the other hand, they show greater cover of bare ground, elevated soil pH and electrical conductivity, and shallower organic soil horizons compared to control reference sites. These soil alterations directly influence the nutrient and water exchange processes, which native grassland plants require. Nasen et al. (2011) further note that lease sites have significantly more undesirable invasive plant species than control sites, with active oil and gas sites showing 3.5 times as many undesirable invasive species. This disturbance can be seen as a direct loss of the natural species composition of Article 29(3)(d).

Furthermore, the ecological effects of oil and gas developments extend beyond the direct footprint of the infrastructure itself. Nasen et al. (2011) indicate that the ecological effects extend up to 25 meters beyond the lease site boundary. They further note that the lease sites and associated access roads required accounts for more than 75% of the total mapped disturbance. This indicates that while the individual site impact appears to be localised, the total impact transforms a significant portion of the grassland landscape. Most significantly, Nasen et al. (2011) document that lease sites established as early as 1955 showed no meaningful improvement in ground cover, species diversity, or range health compared to more recently developed sites. Even after complete abandonment, the native grassland communities could not recover through natural processes alone. This suggests that crude oil extraction causes a loss of ecological integrity that native grassland communities cannot reverse through natural processes alone.

3.1.5 Heathland (Article 29(3)(e))

Article 29(3)(e) prohibits the sourcing of biomass from heathland. Unlike the other categories in Article 29(3), this category has no qualifying conditions. It is the strictest prohibition in the entire framework. For the functional equivalence to crude oil, the mere presence of crude oil extraction or any degradation caused immediately fails the criterion. However, the four representative supply chains: Norway, Saudi Arabia, Canada and Nigeria are not geographically located in heathland ecosystems. The criterion is therefore ecologically inapplicable to all four supply chains and produces a compliant score on that basis, consistent with the treatment of other inapplicable criteria. It is kept in the indicator framework as T1-7 for two reasons: transparency, to show that the criterion was considered and not overlooked; and completeness, since the typological extension in Chapter 5 confirms that none of the fourteen major EU crude oil import source countries operates in heathland ecosystems. Heathland is geographically concentrated in northwestern Europe and is absent from all dominant production regions represented in the EU import base. The criterion, therefore, does not affect any compliance outcome in this research, but its explicit inclusion ensures the assessment covers the full scope of RED III's prohibitive framework.

3.1.6 Wetlands (Article 29(4)(a))

Article 29(4) prohibits the sourcing of biomass from land that was a wetland in January 2008 and no longer has that status. A wetland is defined as land covered with or saturated by water permanently or for a significant part of the year. The criterion is triggered by the land's past wetland status, meaning the prohibition applies even where extraction has already converted the wetland. For functional equivalence, the assessment therefore turns on whether crude oil extraction produces a permanent or irreversible conversion of wetland status.

Volik et al. (2020) document that wetlands cover over 50,500 km² of the Athabasca Oil Sands Region (AOSR), accounting for 54% of the total land cover. Despite this abundance, the development of oilsands has caused significant and permanent alterations to the hydrological function of wetlands. Volik et al. (2020) note that as of 2017, 895 km² of wetlands had been impacted by open-pit mining alone. They further noted that mine closure plans showed that the majority would not be returned to the wetlands' original classification. Beyond direct removal, Volik et al. (2020) indicate that the oil sands infrastructure causes hydrological disturbance far beyond its immediate footprint. They demonstrate that mine dewatering and the construction of roads and pipelines trigger severe hydrological damage by lowering regional water tables and compacting the peat profiles necessary for subsurface flow.

Lawson et al. (2022) further document mangrove and freshwater swamp forests covering approximately half of the Delta in Nigeria. Here, the dredging of channels, the construction of access roads and the contamination of wetland soils through oil spills and produced water have led to the conversion and degradation of the wetlands by the oil industry.

These cases demonstrate that crude oil extraction produces a permanent or irreversible conversion of wetlands through mechanisms functionally equivalent to biomass removal.

3.1.7 Continuously Forested Areas (Article 29(4)(b)(c))

Article 29(4)(b) prohibits the sourcing of biomass from land that held continuous forest cover exceeding 30% canopy in January 2008 and has since lost that status. Article 29(4)(c) extends the prohibition to land with canopy cover between 10% and 30% unless evidence is provided that carbon stock levels before and after conversion meet the requirements set out in Annex V of the directive. As Annex V exclusively contains GHG emission accounting methodology, it is excluded from this research.

Rosa et al. (2017) indicate that oil sands extraction causes ongoing significant forest loss and fragmentation across Alberta's boreal landscape. They further note that in Alberta, Canada, the oil sands deposits underlie approximately 75,540 km² of forest cover as of the year 2000, and that a net 10% change in forest cover has occurred since then. More importantly, surface mining operations result in 100% net forest loss within the

operational footprint. This inherently means that the localised carbon stock is depleted and that a change in land status occurs.

As previously stated, Eugenio et al. (2024) provide evidence that the extraction of crude oil leads to habitat fragmentation and biodiversity loss. This fragmentation fundamentally alters the status of “continuously forested area” as the forest cover can no longer be considered continuous.

Both cases demonstrate that the extraction of crude oil results in the loss of a continuous forested area through mechanisms functionally equivalent to biomass removal.

3.1.8 Peatland (Article 29(5))

Article 29(5) prohibits the sourcing of biomass from land that held the status of peatland in January 2008, unless evidence is provided that the extraction of biomass does not involve the drainage of previously undrained soil. Importantly, in contrast to Article 29(4), this article does not require a change in land status. For the functional equivalence assessment, the criterion therefore turns on whether crude oil extraction causes or structurally requires the drainage of previously undrained peat systems.

Volik et al. (2020) document that, in the AOSR, peat-forming wetlands are structurally drained and removed by open-pit mining. They indicate that open-pit mining leads to the permanent removal of 295 km² of peatlands in AOSR alone. Oil sands operations require large-scale dewatering of the extraction area. Volik et al. (2020) indicate that this lowers the regional water table by 15-25 metres near active mining sites. This constitutes a functional drainage of the surrounding peat landscape extending well beyond the direct extraction footprint. Lawson et al. (2022) further indicate that 8.3% of tropical peatland overlaps with oil and gas infrastructure, with the Niger Delta among the three largest areas worldwide. They state that the construction of drainage channels and pipeline infrastructure has directly altered the hydrological conditions of the Delta’s peatlands.

Under the principle of functional equivalence, both cases demonstrate that crude oil extraction leads to the drainage and disturbance of previously undrained peatlands via equivalent mechanisms.

The analysis of Articles 29(3), 29(4), and 29(5) demonstrates that crude oil extraction causes ecological destruction and degradation that are functionally equivalent to the prohibitive criteria for biomass. In each case where biomass sourcing is prohibited, crude oil extraction caused comparable harm. Therefore, there is no basis to limit these criteria to biomass alone, and the prohibitive framework of RED III can be applied to crude oil supply chains accordingly.

3.2 The Operational Pillar: Management and Restoration

The prohibitive criteria focus on where the extraction occurs, and the operational criteria focus on how the activity is managed. These operational requirements are found in Articles 29(2), 29(6) and 29(7) of the RED. These articles establish that sustainable sourcing requires not only spatial exclusion but also that extraction is legally authorised, managed to minimise ecological degradation and embedded within national climate commitments. In this analysis, operationally related articles are clustered thematically to address the underlying governance question.

3.2.1 Legality and Governance

Articles 29(6)(a)(i)(iv) and 29(6)(b) together establish a legality requirement: extraction must be conducted under verified legal authorisation, with auditable evidence of compliance with national laws. For crude oil, this translates directly to the existence and enforcement of national drilling licenses and regulatory frameworks governing ecological compliance. Adeola et al. (2022) indicate that the absence of an effective legal governance framework, or its corruption, has led to ecological degradation. Effectively, illustrating that legal authorisation and governance capacity are necessary to effectively manage the requirements of the RED III, confirming its equivalence to crude oil.

3.2.2 Site Management and Remediation

Article 29(2) establishes a baseline obligation requiring that extraction areas comply with requirements relating to soil quality and carbon monitoring. Articles 29(6)(a)(ii)(v) and 29(6)(a)(iv) together require that extraction areas are restored following operations and that soil quality and biodiversity are actively maintained throughout the extraction process. Article 29(6)(a)(iii)(vi) further reinforces this by requiring that designated sensitive areas are protected throughout extraction. These requirements exist for biomass because extraction without remediation requirements causes permanent ecological damage. Volik et al. (2020) demonstrate that oil extraction without adequate remediation permanently converts peatland and wetland systems, and even when such remediation plans are in place, it still causes conversion. Adeola et al. (2022) further indicate that the absence of enforceable remediation requirements in the Niger Delta causes soil contamination and habitat loss. These cases confirm that site management and remediation requirements are functionally equivalent to prevent the same categories of harm in crude oil extraction.

3.2.3 Paris Agreement and NDC Coverage

Articles 29(7)(a) and 29(7)(b) require that the country of origin is a Party to the Paris Agreement and has submitted a Nationally Determined Contribution covering land-use and carbon stock changes or has equivalent laws in place. This requirement exists because extraction without national accountability for land-use change disregards the ecosystem protection goals. Crude oil extraction changes high-carbon stock ecosystems; the equivalent mechanisms should be applied.

The operational pillar establishes that crude oil extraction requires the same governance framework that RED III demands of biomass. This means that crude oil extraction requires legal authorisation, active site management, enforced remediation and national climate accountability. Where the structures are absent or deficiently enforced, ecological harm still occurs. The operational criteria, therefore, apply to crude oil through functional equivalence.

3.3 The Procedural Pillar: Verification and Traceability

The procedural criteria under Article 30 focus on how compliance with the sustainability criteria can be verified and enforced. It introduces no new criteria but determines how the prohibitive and operational pillars can be enforced in practice. This pillar does not directly produce compliance indicators but rather illustrates the institutional context in which crude oil would operate effectively.

Article 30 establishes a verification infrastructure for biomass. This infrastructure includes mass balance and traceability systems, independent auditing, certification schemes, and bilateral agreements to ensure that the criteria in Articles 29(3) to 29(7) are verifiable throughout the entire supply chain. The practical depth of this infrastructure is further illustrated by the ISCC EU 202-3 certification standard, which translates Articles 29(6) and (7) into concrete compliance tools (ISCC System GmbH, 2025). No equivalent infrastructure exists for crude oil. This absence means that even if countries were to meet ecological standards nominally, there is no mechanism in place to verify, document or enforce the compliance. The operationalisation of the procedural pillar falls outside the scope of the current assessment and will be addressed in the policy implications.

3.4 Conclusion

Sub-question 1 asked which non-GHG ecological criteria under RED III are applicable to crude oil supply chains, and how they can be operationalised as measurable and consistently scorable indicators. The functional equivalence mapping demonstrates that all of RED III's prohibitive criteria (Articles 29(3), 29(4) and 29(5)) and operational criteria (Articles 29(2), 29(6) and 29(7)) are applicable to crude oil. In each case, crude oil extraction causes the same category of ecological harm, through equivalent mechanisms, that the criterion was designed to prevent for biomass. Heathland is the only exception (Article 29(3)(e), T1-7), which is retained to

ensure completeness but is ecologically inapplicable to the production contexts assessed. The procedural pillar of Article 30 confirms that no equivalent verification infrastructure currently exists for crude oil. This finding has direct implications for policy design addressed in Chapter 7. Together, these findings establish that there is no ecological or methodological basis for limiting RED III's framework to biomass alone. The criteria are operationalised as fifteen scorable indicators across two tiers using the EU-recognised ISCC EU 202-3 standard as the operational reference and a four-level scale (Compliant, Partial, Non-Compliant, Not Assessable). A small set of adaptations (the zone of influence, contamination and discharge management, site remediation, and the Paris Agreement/NDC reduction) are required to effectively translate the biomass specifications into their crude oil equivalence, without altering the normative justification. This indicator framework is applied without modification in Chapter 4.

4

Compliance Assessment of Representative Supply Chains

Chapter 4 operationalises the functional equivalence mapping of Chapter 3 into a structured compliance assessment across four representative supply chains. The compliance matrix, scoring thresholds and evidence standards are established in Chapter 2 (Sections 2.4.1 through 2.4.5) and applied here without modification. The compliance indicators are derived from the ISCC EU 202-3 certification standard, which is used as a methodological reference, as described in Section 2.4.2 (ISCC System GmbH, 2025). The four supply chains: Ekofisk (Norway), Ghawar (Saudi Arabia), the Niger Delta (Nigeria), and Alberta (Canada) were selected to maximise variation in extraction type, geography, regulatory context, and documentation quality, as justified in Section 2.3. Table 4.1 presents the combined compliance results across all four supply chains. Each supply chain is then examined in turn, followed by a cross-supply-chain synthesis and sensitivity analysis.

Table 4.1: Cross-supply-chain compliance overview – all four supply chains

Code	Criterion	Article	Alberta	Ekofisk	Niger Delta	Ghawar
Tier 1 – Prohibitive Ecological Criteria (Articles 29(3), 29(4), 29(5))						
T1-1	High biodiversity value - Primary / Old-Growth Forest	Art. 29(3)(a)	Non-Compliant	Compliant	Partial	Compliant
T1-2	High biodiversity value - Highly Biodiverse Forest	Art. 29(3)(b)	Non-Compliant	Compliant	Partial	Compliant
T1-3	High biodiversity value - Protected Areas	Art. 29(3)(c)(i)	Non-Compliant	Compliant	Non-Compliant	Compliant
T1-4	High biodiversity value - Protected Areas for Threatened Species	Art. 29(3)(c)(ii)	Non-Compliant	Compliant	Non-Compliant	Compliant
T1-5	Highly Biodiverse Grassland	Art.29(3)(d)(i)	Compliant	Compliant	Compliant	Compliant
T1-6	Highly Biodiverse Grassland	Art.29(3)(d)(ii)	Compliant	Compliant	Compliant	Compliant
T1-7	Heathland	Art. 29(3)(e)	Compliant	Compliant	Compliant	Compliant
T1-8	High carbon stock - Wetlands	Art. 29(4)(a)	Non-Compliant	Compliant	Non-Compliant	Compliant
T1-9	High carbon stock - Forest Carbon Stock	Art. 29(4)(b/c)	Non-Compliant	Compliant	Non-Compliant	Compliant
T1-10	High carbon stock - Peatland	Art. 29(5)	Non-Compliant	Compliant	Non-Compliant	Compliant
Tier 2 — Operational Governance Criteria (Articles 29(2), 29(6), 29(7))						
T2-1	Soil Quality and Soil Carbon Monitoring	Art.29(2)	Partial	Compliant	Partial	Partial
T2-2	Legality of Extraction	Art.29(6)(i/iv)	Compliant	Compliant	Partial	Partial
T2-3	Site Remediation / Ecological Recovery	Art.29(6)(ii/v)	Partial	Compliant	Partial	NA
T2-4	Soil Quality/Biodiversity	Art.29(6)(iv)	Partial	Compliant	Partial	NA
T2-5	Paris Agreement and NDC	Art.29(7)(a/b)	Compliant	Compliant	Compliant	Compliant
Score key: Compliant Partial Non-Compliant Not Assessable						

4.1 Alberta, Canada - Oil Sands

The Canadian Oil Sands represent surface mining and in situ extraction within the boreal forest and peatland ecosystems of northeastern Alberta. The Athabasca Oil Sands Region underlies approximately 142,200 km² of boreal forest and muskeg (Government of Alberta, 2009). This makes it the most ecologically disruptive extraction context of the four supply chains assessed. This supply chain has high levels of public documentation, extensive peer-reviewed literature and detailed regulatory frameworks. It primarily addresses the no-go zone criteria related to primary forests, continuously forested areas, wetlands and peatland under Articles 29(3)(a), 29(4)(b) and 29(5). The permanent conversion of these areas has been well documented, making it a straightforward assessable case. The full evidentiary compliance matrix is provided in Appendix Tables A.3 and A.4.

4.1.1 Dominant Pattern

Tier 1 results in non-compliance across every ecologically applicable criterion. Primary and old-growth forests, highly biodiverse forests, protected areas, threatened species habitat, wetlands, forest carbon stock, and peatland each produce a non-compliant score. This outcome is driven by the nature of the extraction method. Open-pit extraction, with surface mining, requires the complete physical removal of the boreal landscape above the bitumen deposits. This total landscape conversion triggers multiple prohibitive criteria at the same time. Rosa et al. (2017) document a 100% net forest loss within the operational footprint, and a net 10% change in forest cover across the broader AOSR since 2000. This satisfies the non-compliant thresholds under Articles 29(3)(a), 29(4)(b) and 29(4)(c). Volik et al. (2020) document the permanent conversion of 895 km² of wetlands and the removal of 295 km² of peatland. They further indicate that regional dewatering lowers water tables by 15 to 25 metres. This satisfies the non-compliance thresholds under Articles 29(4)(a) and 29(5). Both grassland criteria are (Article 29(3)(d)(i) and (ii)) ecologically inapplicable: Alberta's Natural Regions map confirms no grassland ecosystems are present within the AOSR (Alberta Environment and Sustainable Resource Development, 2015).

Tier 2 illustrates a structurally different picture. Three of the five criteria produce partial scores, and the remaining produce compliant scores. This finding is consistent with the Alberta regulatory landscape. Governance frameworks are considered comprehensive; however, the enforcement is demonstrably deficient.

4.1.2 Deviations and Boundary Cases

T1-2 - Highly Biodiverse Forest (Article 29(3)(b))

This score requires a methodological explanation. Article 29(3)(b) prohibits sourcing from a forest that is species-rich and not degraded, provided it has been identified as highly biodiverse by a relevant competent authority. Rosa et al. (2017) document significant forest loss and fragmentation across the boreal landscape. Furthermore, Alberta's Species at Risk data identifies multiple boreal species at risk and explicitly lists oil and gas activities as a threat. This combination lays the foundation for the non-compliant score. However, whether this constitutes a formal competent authority highlighting the boreal forest as highly biodiverse is an interpretive question. The SARA listing of at-risk species with critical habitat in the AOSR represents national legislation recognising the boreal forest as a habitat of significant importance for threatened species. This arguably qualifies as species-rich, under the directive's own words. The non-compliant score is based on these arguments; however, it is acknowledged as a boundary case, given the absence of a designation by a competent authority. This will be addressed in the sensitivity testing.

T1-3 - Protected Areas (Article 29(3)(c)(i))

The non-compliant score here is based on a different type of environmental impact than other Tier 1 findings. It represents the most conservative decision in the Alberta Assessment. There is no direct spatial overlap between the oil sands extraction infrastructure and the designated protected area. However, according to Wheatley & Westman (2023), upstream oil activities have caused measurable ecological and hydrological

degradation of the Wood Buffalo National Park. The Wood Buffalo National Park is a UNESCO World Heritage Site (UNESCO, n.d.a). Under the scoring framework, documented harm caused in interference with the conservation objectives of the formally designated area aligns with the non-compliant score. This is regardless of whether extraction physically occurs within the formally designated area. Here, the causal relationship is indirect rather than direct. A strict spatial reading of the criterion would shift the score. Therefore, it will be addressed in the sensitivity testing.

T1-4 - Protected Areas, Threatened Species (Article 29(3)(c)(ii))

The Boreal Caribou has been formally listed as Threatened under the Species at Risk Act since 2003 (Environment Canada, 2012). The Recovery Strategy (Environment Canada, 2012) identifies five critical habitat areas which directly overlap with AOSR oil development (Cold Lake, Richardson, Red Earth, West Side Athabasca River, and East Side Athabasca River). This creates a clear, documented spatial overlap directly satisfying the non-compliant score. Unlike the findings in T1-2, no interpretive ambiguity can be discussed.

T2-2 - Legality of Extraction (Article 29(6)(a)(i))

This compliant score matters for what it implies for the other partial scores of Tier 2. The Oil Sands Conservation Act (RSA 2000, c O-7) regulates the extraction and is administered by the Alberta Energy Regulator. A valid approval is required before any bitumen extraction may occur. The compliant score at T2-2 indicates that governance gaps found in T2-1, T2-3 and T2-4 are not caused by the absence of a legal framework, but rather by the inability to effectively enforce it. Alberta does not lack the governance instruments; it lacks the effective operationalisation.

T2-1, T2-3 and T2-4 - Partial Governance Pattern (Articles 29(6)(a)(ii)(iv)(v))

All three operational governance criteria result in partial scores and reflect the same structural pattern. A documented monitoring plan to track soil quality and pollution levels exists through the Oil Sands Monitoring Program (T2-1). However, its 2024-25 Annual report indicates significant challenges in executing its monitoring workplan (Alberta Environment and Protected Areas, 2025). Furthermore, Boutin and Carpenter (2017) document elevated polycyclic aromatic hydrocarbon (PAH) levels and altered plant life at or near the extraction sites, indicating that toxic soil contamination continues despite the monitoring framework.

The Environmental Protection and Enhancement Act (RSA 2000) explicitly requires the creation of conservation and reclamation plans to ensure site remediation (T2-3). Furthermore, the remediation of soil and groundwater is also explicitly covered (Government of Alberta, 2024). However, Volik et al. (2020) indicate that the majority of wetlands are permanently converted and, because the conversion is irreversible, will not be returned to their original land status. This means that the remediation requirement is not met in practice.

The regulatory framework is set out in the Contaminated Sites Policy Framework (Government of Alberta, 2023) and covers discharge and contamination management (T2-4). However, as previously stated, significant delays and ongoing pollution exceedances are observed (Alberta Environment and Protected Areas, 2025; Boutin & Carpenter, 2017). All illustrate a lack of enforcement rather than an inadequate governance system, a distinction that can be used in the policy implications chapter.

4.2 Ekofisk, Norway - Conventional Offshore

The Ekofisk field is located in the southern part of the Norwegian North Sea. It represents a conventional offshore extraction operation under the OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic and domestic Norwegian environmental legislation. This oil field has provided over 50 years of environmental monitoring data, making it the strongest governance comparator and a benchmark for what a high-transparency regulatory framework should look like. Furthermore, its offshore extraction context renders most Tier 1 criteria inapplicable, except for protected areas under Article 29(3)(c) and Tier 2 operational governance criteria. The full evidentiary compliance matrix is provided in Appendix Tables A.5 and A.6.

4.2.1 Dominant Pattern

The dominant pattern is a compliant score across both tiers. Ekofisk's offshore extraction context renders all Tier 1 criteria ecologically inapplicable except T1-3 and T1-4. Naturally, drilling above a subsea wellhead cannot overlap with primary forests, highly biodiverse forests, grasslands, heathlands, wetlands, or peatlands. All Tier 2 criteria produce compliant scores. The extensive regulatory framework requires environmental impact assessments, operating licences and continuous monitoring before extraction is permitted (Norwegian Ministry of Petroleum and Energy, 1996). The Act is in accordance with the OSPAR Convention's produced water management framework, which imposes individual environmental standards. Beyer et al. (2025) confirm that discharges from the Ekofisk field comply with the zero-adverse-effect goal for produced water. This fully compliant score produced by Ekofisk serves as a clear example of a properly functioning governance structure and can be used for comparison.

4.2.2 Deviations and Boundary Cases

T1-3 and T1-4 - Protected Areas (Articles 29(3)(c)(i) and 29(3)(c)(ii))

These are the only two Tier 1 criteria ecologically applicable. Article 29(3)(c) explicitly covers areas recognised by international agreements for nature protection purposes. As stated previously, these can also be applied to the offshore context. Ergo, designated Marine Protected Areas are within scope. The compliant score produced for T1-3 is based on the absence of spatial overlap between the Ekofisk field and any OSPAR MPA. This has been confirmed by a cartographic verification using the official OSPAR MPA network map (MAIA Network/OFB, 2026).

For T1-4, the Harbour Porpoise is an OSPAR-listed threatened species with its habitat present in the Greater North Sea region. However, no site-specific MPA designation exists that formally protects the Harbour Porpoise's habitat in the Ekofisk area. The compliant score is based on the absence of a formal designation rather than the absence of the species being present.

4.3 Niger Delta, Nigeria - Conventional Onshore

The Niger Delta represents the conventional onshore extraction in a species-rich tropical wetland environment with well-documented ecological harm and significant governmental challenges. Approximately half of the mangrove and swamp forests in the Delta overlap directly with oil extraction infrastructure (Lawson et al. 2022). This makes it the most ecologically sensitive onshore extraction context of this assessment. The conversion and degradation of wetlands, biodiverse forests and peatland ecosystems are documented extensively (Lawson et al. 2022), testing the prohibitive criteria of Tier 1. The Tier 2 operational criteria are tested, as academic literature shows, by decoupling national legislation from operational reality (Adeola et al., 2022). In this supply chain, both the ecological and governance failures are most profound. The full evidentiary compliance matrix is provided in Appendix Tables A.7 and A.8.

4.3.1 Dominant Pattern

Tier 1 is not as uniformly scored as the other supply chains. Non-compliant scores are produced for protected areas, wetlands, forest carbon stock and peatland (T1-3, T1-4, T1-8, T1-9, T1-10). Lawson et al. (2022) document the conversion of mangrove and freshwater swamp wetlands through dredging for pipeline construction and the drainage of peatland systems. Furthermore, Ansah et al. (2022) document a 12% loss of mangrove cover between 2007 and 2017. This satisfies the non-compliant score for T1-8, T1-9, and T1-10. The data limitation regarding the January 2008 reference date of Article 29(4) is addressed in the sensitivity analysis in Section 4.5.2.

Partial scores are produced for primary and old-growth forest and highly biodiverse forest (T1-1, T1-2). And the grassland and heathland criteria are ecologically inapplicable to the tropical wetland biome, producing a

compliant score (T1-5, T1-6, T1-7). The distinction between the partial and non-compliant scores in Tier 1 is due to differences in the competent authority's designation. Documented ecological harm is considered substantial across all criteria. Where the designation does exist, a non-compliant score is produced. Where the designation is absent, the framework's scoring logic considers documented harm alone insufficient. This leads to a partial score. These friction points will be discussed in the sensitivity analysis.

Tier 2 produces partial scores across four criteria (T2-1, T2-2, T2-3, T2-4). The Petroleum Industry Act (PIA, 2021) and the associated Nigerian Upstream Petroleum Environmental Regulations provide the formal legislative basis for governance requirements across T2-1, T2-2 and T2-4. However, the PIA was established in 2021, meaning the regulatory framework was introduced after much of the documented harm had already occurred. Adeola et al. (2022) document a systematic decoupling of national legislation from operational reality across the Delta. This supply chain represents the most significant governance failure in the assessment. Though the regulatory framework exists, the structural inability to enforce it is the main finding.

4.3.2 Deviations and Boundary Cases

T1-1 and T1-2 - Primary Forest and Highly Biodiverse Forest (Articles 29(3)(a) and 29(3)(b))

The partial scores produced by these criteria are the most important finding in the Niger Delta Tier 1 Assessment. Again, the evidence of ecological harm is not in question. Lawson et al. (2022) document that mangrove and swamp forests cover approximately half of the Delta and are structurally degraded, and Ogbeibu & Oribhabor (2023) document oil-caused fragmentation and deforestation across the Delta's mangrove and swamp forest systems. However, no independent source explicitly classifies the affected areas as primary or old-growth forestland under Nigerian law.

For T1-2, the partial score is caused by the absence of a designation by a competent authority marking it as highly biodiverse. This designation is specifically required for Article 29(3)(b). Ogbeibu & Oribhabor (2023) describe the area as a biodiversity hotspot but explicitly state it has not been formally recognised by IUCN. They further advocate for the protection of the area. The presence of academic literature indicating it as highly biodiverse, however, is not a substitute for the required authority designation.

In both cases, the scores reveal a limitation of applying the RED III framework to a jurisdiction where formal ecological classification systems are less developed. Documented ecological harm that would produce a non-compliant score in a robust framework instead produces a partial score. This in itself is a substantive finding and will be discussed in the sensitivity analysis.

T1-3 and T1-4 - Protected Areas (Articles 29(3)(c)(i) and 29(3)(c)(ii))

In contrast to T1-1 and T1-2, these criteria produce non-compliant scores because the formal designation exists. The Apoi Creek Forest Reserve has been formally designated by the Ramsar Convention as a wetland of international importance (Ramsar Convention Secretariat, 2023). This constitutes a formal competent authority designation required by Article 29(3)(c). Ansah et al. (2022) document that oil extraction activities interfere with the nature protection purposes of this designated area by causing habitat fragmentation and species displacement. For T1-4, multiple IUCN Red List species have their critical habitat inside the Delta, and are threatened by oil extraction activities (Ansah et al., 2022). The existence of the formal designation allows these criteria to produce a non-compliant score in contrast to the primary and highly biodiverse forest criteria (T1-1, T1-2).

T2-2 - Legality of Extraction (Article 29(6)(a)(i))

The Partial score here requires explanation. The PIA (2021) and the Nigerian Upstream Petroleum Regulatory Commission (NUPRC) established a comprehensive legal framework for oil and gas extraction. However, this framework was established in 2021, and most of the ecological harm had occurred long before then. The legal framework currently exists; however, Daukere (2025) documents that illegal crude oil extraction persists. Furthermore, he identifies weaknesses in the systemic enforcement of the rule of law. This indicates that effective operational governance is lacking, even though the legal frameworks exist. This leads to a partial score.

T2-3 - Site Remediation (Article 29(6)(a)(ii)(v))

A mandatory remediation and decommissioning framework exists through the PIA (2021), NOSDRA (2006) and UPER (2022). This framework requires operators to restore the impacted environments to their original state, maintain a decommissioning fund, and assume liability for remediation. However, NOSDRA's own data estimate that 92% of contaminated sites remained unremediated as of 2021 (Adeniran et al., 2023). The UNEP Environmental Assessment of Ogoniland (2011) documents the scale of contamination that the governance framework failed to address. The existence of a legal framework prevents a non-compliant score, but the extensively documented ecological harm and the sheer lack of enforcement result in a partial score.

T2-1 and T2-4 - Soil quality, Soil carbon, Contamination Monitoring and Discharge Management (Articles 29(2) and 29(6)(a)(iv))

Both criteria produce a partial score, where, in essence, the same structural pattern can be observed as in T2-2 and T2-3. The regulatory frameworks exist in the Petroleum Industry Act (PIA, 2021) and its implementing environmental regulations (NUPRC, 2022). However, Adeola et al. (2022) document soil contamination across extraction sites in the Niger Delta. Lawson et al. (2022) and Alao et al. (2025) further confirm that hydrocarbon and heavy metal levels exceed regulatory thresholds.

4.4 Ghawar, Saudi Arabia - Conventional Onshore

Ghawar is the world's largest conventional onshore oil field located in the Eastern Province of Saudi Arabia. The extraction region is situated in an arid desert environment, providing an essential contrast to the boreal (Alberta), tropical-wetland (Niger Delta) and offshore (Ekofisk) cases. The arid landscape renders most of the Tier 1 criteria inapplicable, shifting the assessment almost entirely to the Tier 2 governance criteria. Saudi Arabia has a state regulatory model with limited availability of independent environmental monitoring documentation. This makes it a primary case for the Not Assessable category. Here, the absence of governance frameworks and enforcement is treated as a substantive finding. This is conducted to reflect the structural transparency requirements of the RED III. The full evidentiary compliance matrix is provided in Appendix Tables A.9 and A.10.

4.4.1 Dominant Pattern

The dominant Tier 1 result is compliant across all criteria. Primary and old-growth forests, highly biodiverse forests, grasslands, heathlands, wetlands, and prohibitions on forest carbon stocks and peatlands are all ecologically inapplicable. Therefore, only T1-3 and T1-4 require explanation. Tier 2 criteria produce a partial, three not assessable and a compliant score. This reflects the existence of governance frameworks whose enforcement cannot be verified. The independent documentation confirming whether Aramco's upstream operation meets the required criteria is not publicly accessible. This supply chain features an inherently different governance finding and therefore, is analytically distinct from the others. The structural blockage of documentation prevents the assessment of enforcement.

4.4.2 Deviations and Boundary Cases

T1-3 and T1-4 - Protected Areas (Articles 29(3)(c)(i) and 29(3)(c)(ii))

These are the only two criteria ecologically applicable. The Ghawar oil field overlaps with the Al Ahsa Oasis UNESCO World Heritage Site; this site is designated as a cultural landscape rather than a natural protected area (UNESCO, n.d.b). Article 29(3)(c)(i)(ii) requires areas designated by law or competent authority for nature protection purposes. A UNESCO cultural heritage designation does not satisfy this requirement. No other formally designated area could be observed in literature in or near the extraction site.

T2-2 - Legality of Extraction (Article 29(6)(a)(i)(iv))

The legality of extraction has been formally established. The Basic Law of Saudi Arabia (Royal Decree No. A/90, 1992) vests all oil and gas wealth in the government, with Saudi Aramco established by Royal Decree in 1988 as the only operator authorised for upstream extraction. Saudi Aramco operates under a 60-year

contract granted in 2017, which expires on December 31, 2077. This contract explicitly covers the Ghawar field (Weijermars & Al-Shehri, 2022). However, the specific terms of the agreement are not publicly accessible. The existence of a legal framework and the absence of transparency produce a Partial score.

T2-1, T2-3 and T2-4 - Soil Monitoring, Site Remediation and Discharge Management (Articles 29(2) and 29(6)(a)(ii)(iv)(v))

All three criteria produce not assessable scores. In each case, a national regulatory framework exists. The Executive Regulation for the Prevention and Remediation of Soil Pollution (MEWA, 2021, Art. 2) requires soil quality monitoring, including explicit hydrocarbon contamination thresholds. The Executive Regulations for the Environmental Rehabilitation of Degraded Sites (MEWA, 2021, Art. 2, 4) formally apply to all sites in Saudi Arabia. The Environmental Law (Royal Decree M/165, 2021, Art. 6, 11) and Soil Pollution Regulation (MEWA, 2021, Art. 7) prohibit discharge and contamination activities nationally.

However, across all three criteria, no independent peer-reviewed or governmental documents could independently verify whether these standards have in fact been applied or enforced at the Ghawar extraction site. Saudi Aramco's upstream extraction activities are self-regulated under the Ministry of Energy rather than the national MEWA and NCEC frameworks (World Bank Flaring Regulations Database, 2024). Therefore, a not assessable score is produced due to the inability to verify. This score is not considered a methodological limitation but rather a substantive finding in itself. The structural lack of transparency is the defining characteristic of the Ghawar extraction site, distinguishing it analytically from the other supply chains.

The four supply chain assessments demonstrate that the compliance assessment produces distinguishable results for different extraction contexts, ecosystems, and governance structures. No two supply chains produce the same compliance assessment. One finding worth noting is that all supply chains produced a compliant score for the Paris Agreement and NDC criterion. As noted in Section 2.4.5, the alteration of the T2-5 criterion makes it less effective at distinguishing between individual supply chains. The limited discriminating power at the national level is a finding in itself, indicating that meaningful differentiation occurs at the operational governance and sub-national levels.

4.5 Sensitivity Analysis

The compliance scores produced in the supply chain assessments above are based on a combination of interpretive decisions and evidentiary choices. Different interpretations are plausible, and data limitations affect the scoring principle. In this instance, the score becomes a boundary case rather than a definitive finding. The sensitivity analysis tests these boundary cases and checks whether a shift in interpretation or evidence changes the individual scores and, more importantly, the overall supply chain-level compliance finding. The boundary cases can be divided into two categories: interpretive and data limitations.

4.5.1 Interpretive Boundary Cases

Alberta T1-2 - Highly Biodiverse Forest (Non-Compliant → Compliant)

The non-compliant score for T1-2 is based on Alberta's Species at Risk Guide (Alberta Environment and Sustainable Resource Development, 2015), identifying multiple at-risk boreal species. This, in combination with the threatened Boreal Caribou with its critical habitat in the AOSR, identifies the species richness criteria of Article 29(3)(b). However, no formal designation by a competent authority explicitly marks the boreal forest as highly biodiverse. A strict interpretation of the directive would shift the Non-Compliant score to Compliant, even though ecological harm is documented.

Alberta T1-3 - Protected Areas, General (Non-Compliant → Partial)

The non-compliant score for T1-3 is based on the ecological and hydrological degradation in Wood Buffalo National Park, as documented by Wheatley & Westman (2023). This argument causes an interpretative conflict. The extraction of crude oil causes measurable harm, interfering with the protected area's conservation

objectives. However, the extraction did not physically occur within the Protected area. This ambiguity could leave room for argumentation, at most shifting the non-compliant score from Non-Compliant to Partial.

The implication of these interpretive boundary cases for the overall finding is that Alberta's T1 score remains unaffected, as 2 criteria might shift to partial and compliant, leaving 5 definitive non-compliant scores.

Niger Delta T1-1 and T1-2 - Primary Forest and Highly Biodiverse Forest (Partial → Non-Compliant)

The partial scores for T1-1 and T1-2 are based on the absence of independent sources classifying the areas as primary or old-growth forest under Nigerian law. The second is based on the absence of a formal designation by a competent authority, marking the forest as highly biodiverse. Both scores would shift from partial to non-compliant if the designation requirement is interpreted more broadly. Accepting IUCN Red List documentation or Ramsar designation as equivalent would, for example, cause this shift.

The implication for the overall findings is that the Niger Delta's case would worsen, with additional criteria resulting in a non-compliant score. However, the overall finding of non-compliance with T1 criteria would remain. This means that the magnitude is altered rather than the direction. This boundary case is more important for SQ3, as it would likely lead to the exclusion of more tropical forest extraction contexts.

Ekofisk T1-3 and T1-4 — Protected Areas (Compliant → potentially Non-Compliant)

The compliant scores for T1-3 and T1-4 are based on a cartographic verification using the OSPAR MPA network map. This confirms that there is no spatial overlap between the Ekofisk oil field and any formally designated MPA. This verification was conducted through a map review rather than a formal spatial analysis. But given the clear geographic separation between the Ekofisk field and the nearest MPA, the risk of the criterion shifting from compliant to non-compliant is considerably low. For T1-4, the Harbour Porpoise's habitat is in the Greater North Sea, but no specific MPA has currently been designated. If such an MPA were to exist and overlap with Ekofisk, this would result in a shift.

This is the most consequential sensitivity finding in the overall assessment, as an alteration in the single score would cause the overall compliance score to lose its fully compliant status. This would have significant implications for SQ3 as it would remove the benchmark for other supply chains and possibly render Norwegian crude oil as non-compliant.

Not Assessable

The not assessable scores assigned to Ghawar T2-1, T2-3, and T2-4 are based on the absence of public literature rather than evidentiary governance failure. Within the assessment, not assessable is considered a distinctive finding in itself. Given the fact that the regulatory frameworks are in theory in place, but it cannot be checked whether they apply to the Ghawar field, a shift to Partial can also be considered suitable. This interpretive choice does not affect the Tier 1 profile of Ghawar and does not change any other supply chain's findings.

4.5.2 Data Limitation Cases

Alberta T1-8 and T1-9 - Post-2008 Reference Date

Rosa et al. (2017) document forest cover change between the 2000-2014 period. In this period, the January 2008 reference date of Article 29(4) is included. Post-2008 conversion is not isolated in the data; however, oil sands surface mining has expanded continuously since 2008. This means that ongoing conversion within the post-2008 period is structurally inherent to this type of extraction. The non-compliant scores are therefore considered robust.

Niger Delta T1-8, T1-9 and T1-10 - Post-2008 Reference Date

Lawson et al. (2022) use NOSDRA oil spill data from 2006 to 2021, and Ansah et al. (2022) document mangrove cover loss from 2007 to 2017. Both these cases started before the 2008 reference date. The post-2008 data is not isolated in either dataset. For the peatland criterion, it is less problematic, as evidence indicating conversion or drainage post-2008 is considered sufficient. For T1-8 and T1-9, the majority of the Ansah et al. study period falls after January 2008 (2008–2017). Continuous extraction and infrastructure

expansion in the Niger Delta post-2008 further reinforce that post-2008 conversion is structurally inherent. Therefore, the non-compliant scores are treated as robust, with the data limitation noted.

4.5.3 Summary of Sensitivity Implications

The boundary cases produce three analytically distinct findings. Firstly, for Alberta and the Niger Delta, the non-compliant scores are considered robust. A single score shift does not lead to an overall change in compliance score, as several independent criteria establish it. Second, the Ekofisk compliant score is the most sensitive to change. This makes spatial verification especially important. However, it is also considered low risk. Third, the Ghawar not assessable findings are considered substantive but could also be considered partial. These implications will be used in the following chapters.

4.6 Cross-Supply-Chain Synthesis and Conclusion

Cross-supply-chain analysis helps reveal insights that are not possible to obtain from individual assessments.

The first is a distinction of three types of governance structures. For Ekofisk, the framework exists, enforcement is verified, and operational monitoring is confirmed, representing demonstrated compliance. Alberta and the Niger Delta are both cases with comprehensive frameworks, but, in practice, are not operationalised. This represents a formally adequate but deficiently enforced system. The Ghawar case is an example of structural opacity, in which it cannot be independently verified from publicly accessible documents whether the standards are met. The difference between documented failure and structural opacity matters because it produces different policy implications and responses.

The second pattern is regarding the designation requirement in Articles 29(3)(a) and 29(3)(b). In both the Alberta and the Niger Delta cases, the absence of formal competent authority designations effectively limits the framework's ability to produce non-compliant scores, even though significant ecological harm is documented. This designation gap affects both supply chains; however, the Niger Delta in particular yields consequential results, as the less-developed classification infrastructure produces partial scores despite often worse-documented harm compared to Alberta. This is a systemic pattern rather than a case-specific limitation.

The third pattern is that differentiation between supply chains can be observed at the operational governance level (T2-1-T2-4), rather than at the level of international commitments. T2-5 confirms that all four supply chains comply with the national governance criteria. This means the criterion cannot discriminate at this level of abstraction.

A fourth observation concerns the not assessable finding for Ghawar's Tier 2 governance criteria. This finding is analytically distinct from the partial scores produced for Alberta and the Niger Delta and requires separate treatment. Partial Tier 2 scores for Alberta and the Niger Delta indicate that regulatory frameworks exist but are demonstrably deficient in their enforcement. This means that the governance failure is documented and attributable to a specific gap between legislative requirements and operational reality. The not assessable score for Ghawar indicates something structurally different: that the institutional architecture required to make any finding possible is absent. This distinction matters because it implies a different regulatory problem and a different response. The broader implications of this distinction for framework design are addressed in Chapter 8.

Together, the four supply chain assessments answer SQ2: representative EU crude oil supply chains do not uniformly comply with the operationalised RED III ecological criteria. Ekofisk is the only supply chain that produces an unambiguously compliant profile across both tiers. Alberta and the Niger Delta are non-compliant on Tier 1 ecological grounds, with governance frameworks in place but demonstrably unenforced. Ghawar is not assessable on Tier 2 governance grounds due to structural opacity rather than documented failure.

5

The EU Crude Oil Import Compliance Picture

After conducting an extensive site-specific compliance assessment of four representative supply chains, this chapter extends that framework to the broader EU crude oil imports. Using typological extension, the compliance assessment is applied to the fourteen largest EU crude oil-importing countries. These countries account for approximately 92% of the EU's import volume (Eurostat, 2025a).

The extension is conducted simultaneously in two analytically different parts. The first covers Tier 1 compliance, in which each of the countries' dominant producing regions is assigned to one of the four supply chains based on its biome context. The Tier 1 criteria associated with the assessed supply chains are transferred accordingly. The second assesses Tier 2 compliance using a country-level governance scoring drawn from the 2017 Resource Governance Index (Natural Resource Governance Institute, 2017). Both Tiers can be assessed independently without influencing each other. The results are then combined to produce an overall country-level classification.

This chapter is explicitly exploratory. Among the import source countries, only Norway, Nigeria and Saudi Arabia were assessed site-specifically in Chapter 4; the fourth directly assessed supply chain, Alberta (Canada), is not itself an EU import source but provides the boreal proxy later applied to Russia. All remaining import source countries are assessed through the typological extension, which is used as an indicative instrument to estimate the magnitude of compliance risk rather than to produce a precise and significant number. This limitation is acknowledged and will be addressed.

5.1 EU Crude Oil Import Composition

The EU's import composition is based on the most recent Eurostat trade statistics dataset (2025). The fourteen largest import source countries are used to apply the typological extension. Together, they account for approximately 92% of EU crude oil imports by volume. Table 5.1 presents a breakdown of EU crude oil imports by source: the fourteen largest source countries and a residual 'Others' category, as a percentage share of total import volume, together with each country's dominant producing field, its coordinates and biome classification.

The composition of import source countries is structurally diverse. It represents offshore conventional, onshore desert, tropical wetland and boreal-context production across the globe. This geographic and ecological diversity is important to the analytical value of the biome-based classification in Section 5.2.

Table 5.1: EU crude oil import composition, biome classification and dominant-field coordinates

Country	Share	Largest Field	Lon, Lat	WWF Ecoregion	T1 Proxy
United States of America	14.6%	Permian Basin	-102.08, 32.00	Western short grasslands	Mixed
Kazakhstan	12.8%	Tengiz	53.39, 46.15	Caspian lowland desert	Ghawar
Norway	12.8%	Ekofisk	3.21, 56.55	Offshore	Ekofisk
Libya	9.1%	El Sharara	12.22, 26.58	Sahara desert	Ghawar
Saudi Arabia	6.8%	Ghawar	49.62, 25.43	Persian Gulf desert and semi-desert	Ghawar
Nigeria	5.8%	Forcados/Qua Iboe	6.47, 5.32	Niger Delta swamp forests and Central African mangroves	Niger Delta
Iraq	5.8%	Rumaila	47.41, 30.23	Arabian Desert and East Saharo-Arabian xeric shrublands	Ghawar
United Kingdom	4.8%	Clair	-2.24, 60.75	Offshore	Ekofisk
Azerbaijan	4.1%	Azeri-Chirag-Gunashli	51.16, 40.10	Offshore	Ekofisk
Guyana	3.8%	Liza	-57.04, 8.05	Offshore	Ekofisk
Algeria	3.7%	Hassi Messaoud	6.07, 31.70	North Saharan steppe and woodlands	Ghawar
Brazil	3.4%	Lula	-42.19, -24.19	Offshore	Ekofisk
Russia	2.2%	Samotlor	76.45, 61.70	West Siberian taiga	Non-Compliant
Mexico	2.2%	Ku-Maloob-Zaap	-92.20, 19.10	Offshore	Ekofisk
Others	8.1%	N/A	N/A	N/A	N/A

5.2 Tier 1 Ecological Assessment: Biome-Based Typological Classification

The biome classification and dominant field approach follow the methodology established in Section 2.5.1. The geographic coordinates of the dominant producing field for each import-source country were entered into the Data Basin platform (Conservation Biology Institute, 2026) to retrieve the WWF ecoregion classification (Olson et al., 2001). Where production is distributed across more than one biome context, the dominant field approach is applied as described in Chapter 2, with the United States left unassessed due to heterogeneity in production across three compliance-relevant biome contexts. Figure 5.1 maps the dominant producing field of each import source country, together with the four assessed supply chains, onto the WWF terrestrial ecoregions. The specific field selections and heterogeneity decisions for Kazakhstan, Mexico and Iraq are documented below.

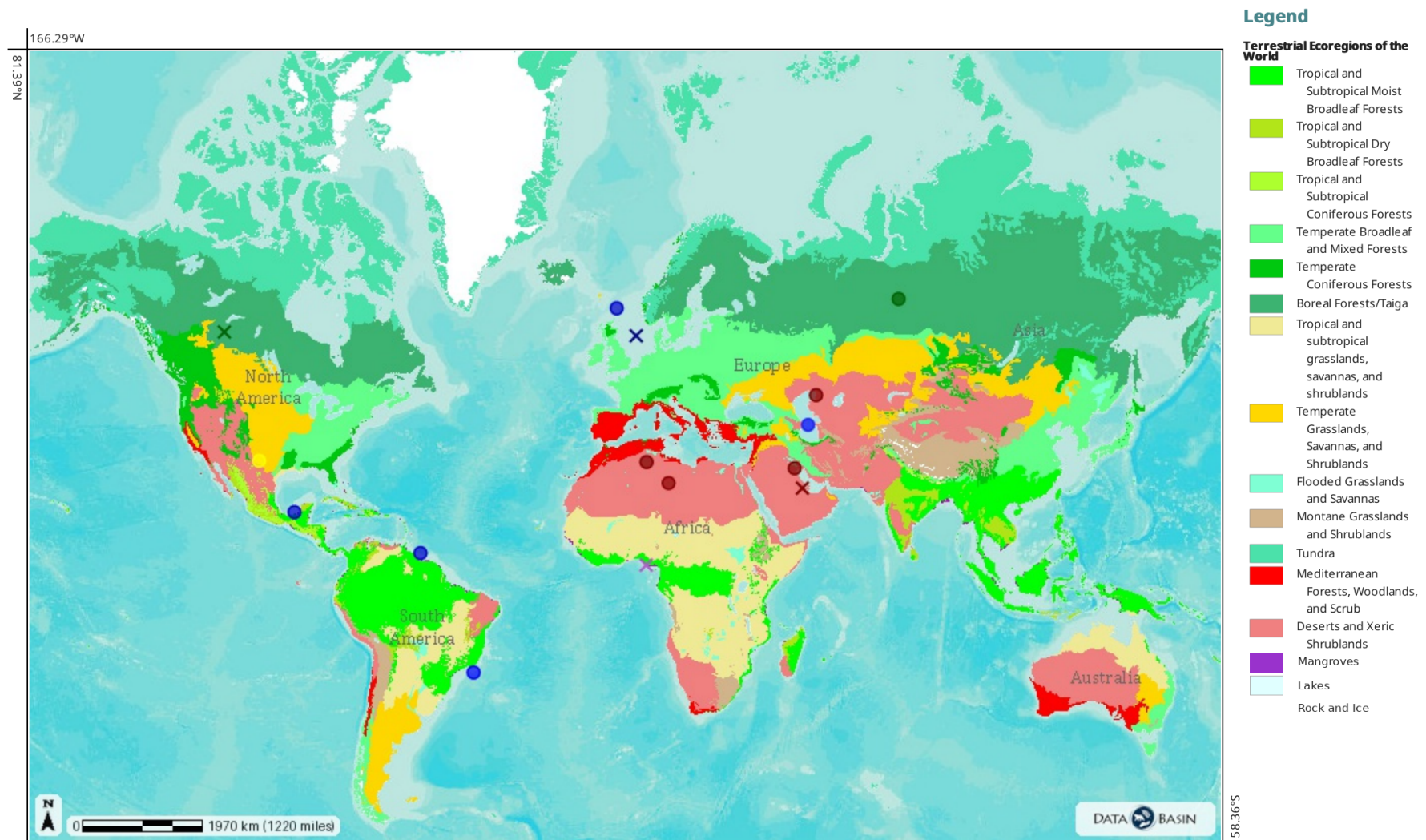


Figure 5.1: The largest EU crude oil import source countries and the four directly assessed supply chains, mapped onto the WWF Terrestrial Ecoregions of the World (Olson et al., 2001). Each country's dominant producing field is marked by a coloured circle and the four directly assessed supply chains by a cross (×); marker colour indicates the typological context (blue, offshore; red, desert; yellow, grassland; green, boreal/taiga; purple, tropical/mangrove). Biome colours follow the legend. Classification retrieved from the Data Basin platform (Conservation Biology Institute, 2026).

5.2.1 Treatment of Production Heterogeneity

The United States cannot be assigned a single typological extension, as the production can be divided into three different biome contexts, reaching different compliance outcomes. The Permian Basin accounts for approximately 48% of US crude oil production (EIA, 2025c), and the Gulf of Mexico offshore accounts for approximately 14%, with the remainder distributed across further onshore regions (EIA, 2024). The Permian Basin (Western short grasslands ecoregion), the Offshore Gulf of Mexico (offshore marine context) and the many different ecoregion types in the oil-producing states make a single typological assignment a misrepresentation. The United States is therefore left *unassessed* in this research, its producing regions can be assessed individually. The Gulf of Mexico offshore, for instance, sits in a context structurally similar to Ekofisk, but doing so would require a separate, region-by-region assessment beyond the scope of this typological extension. This differs from the Not Assessable classification applied to Ghawar, which reflects a genuine absence of independent data.

Several other import sources have production distributed across more than one biome context; however, these are distinguishable on two different grounds. Kazakhstan's dominant extraction site is the Tengiz field (610,000 b/d) and lies within the Caspian Lowland Desert ecoregion (EIA, 2025b). The other large field is Kashagan (255,000 b/d), an offshore oil field in the Caspian Sea (EIA, 2025b). As both the offshore and desert contexts render a compliant score for the Tier 1 criteria, taking Tengiz as a reference point is considered acceptable.

Mexico and Iraq represent a comparable situation in which a minor heterogeneous component exists. For Mexico, the dominant oil field is the Ku-Maloob-Zaap complex, an offshore oil field that accounts for 29% of Mexico's production (EIA, 2023). Furthermore, 70% of the oil reserves are located in an offshore context (EIA, 2023). The remaining production is onshore and could potentially trigger other Tier 1 criteria. However, given that the vast majority occurs offshore, the Ku-Maloob-Zaap reference point is considered acceptable.

For Iraq, the major field is the Rumaila field, which produces around 30% of Iraq's crude oil output and is located in the southern Basra region within the Arabian Desert and East Saharo-Arabian xeric shrublands ecoregion (BP, n.d.; EIA, 2025a). The Majnoon field is adjacent to the Mesopotamian marshes and could potentially trigger Tier 1 criteria, as it lies within a designated Ramsar wetland system (Ramsar Convention Secretariat, 2023). However, given the relatively small contribution (~5.5%) (EIA, 2025a), it is considered negligible. Since most oil fields are in desert environments, the Rumaila field, as a reference, is considered representative.

5.2.2 Ecological Inapplicability: Offshore and Desert

The Ekofisk or Ghawar typological extension covers eleven of the fourteen largest import source countries. Two of these, Norway and Saudi Arabia, are directly assessed reference supply chains; the remaining nine receive a Tier 1 compliant score through the ecological inapplicability of their offshore or desert contexts. That transfer requires justification.

The offshore context renders the land-based criteria obsolete, as primary and old-growth forests, highly biodiverse forests, protected areas, grasslands, heathlands, wetlands, and peatlands are all ecosystems found solely on land and absent from the open marine environment. Therefore, the ecological inapplicability can be directly transferred to other offshore contexts, except for the protected areas of T1-3 and T1-4. These protected areas can also apply in an offshore context as MPAs. This exception applies to all offshore contexts assigned the Ekofisk typological extension; no MPA overlap was identified for any offshore fields through cartographic verification of the MPA database (Marine Conservation Institute, 2026).

The WWF biome classification confirms that all production regions assigned to the Ghawar typological extension fall within the Deserts and Xeric Shrublands biome (Olson et al., 2001). None of the ecosystems described in the Tier 1 criteria are present as a dominant land use in hyper-arid and semi-arid desert ecoregions. The assessment of Ghawar confirmed the ecological inapplicability to the Arabian desert. Following the same ecological logic, this extends to the Caspian Lowland Desert (Kazakhstan), the Sahara Desert (Libya), the

Arabian Desert and East Saharo-Arabian xeric shrublands (Iraq), and North Saharan steppe and woodlands (Algeria). Again, the protected areas could produce a non-compliant score; however, every location has been checked using cartographic verification of the World Database of Protected Areas, and no spatial overlap was observed (UNEP-WCMC & IUCN, 2026). Similarly, a cartographic verification using the Global Peatlands Initiative map confirmed that there was no overlap between any of the production regions and mapped peatland systems (Global Peatlands Initiative, 2022).

For Algeria, the ecoregion returned by the WWF database is the North Saharan steppe and woodlands. Despite its name, Olson et al. (2001) define it as the Deserts and Xeric Shrublands biome rather than the Temperate Grasslands, Savannas, and Shrublands biome. Therefore, the typological extension of Ghawar can still be applied.

The Permian Basin falls within the Western short grasslands ecoregion, which Olson et al. (2001) classified within the Temperate Grasslands, Savannas and Shrublands biome. This biome context could potentially trigger the Tier 1 grassland criteria (T1-5 and T1-6). This, in combination with the heterogeneous production of the US, further emphasises the choice to leave the US unassessed.

5.2.3 Tier 1 Compliance Transfer

The typological extension transfers the exact Tier 1 compliance profile of the directly assessed supply chain to each country. It is transferred per criterion as follows:

Countries assigned the Ekofisk typological extension, Norway, the United Kingdom, Guyana, Brazil, Azerbaijan and Mexico, all receive ecological inapplicability for all criteria except T1-3 and T1-4 (Protected Areas). For each country, cartographic verification is used to check whether an MPA overlaps with offshore fields. No MPA overlap could be observed for any of these offshore fields (Marine Conservation Institute, 2026).

Countries assigned the Ghawar typological extension, Kazakhstan, Libya, Saudi Arabia, Iraq and Algeria, all receive ecological inapplicability for all criteria except T1-3 and T1-4 (Protected Areas). For each country, cartographic verification is used to check whether a WDPA overlaps with onshore fields. No WDPA overlap could be observed for any of these fields (UNEP-WCMC & IUCN, 2026).

Nigeria is assessed directly, and its Tier 1 profile is applied. Russia is assigned the Alberta typological extension as the West Siberian Taiga shares the boreal forest and peatland context of the Athabasca Oil Sands Region. The Alberta Tier 1 profile is transferred: T1-1, T1-2, T1-8, T1-9 and T1-10 are all non-compliant, T1-5, T1-6, and T1-7 are inapplicable, and T1-3 and T1-4 (Protected Areas) are considered inapplicable (compliant) as no overlap with any WDPA could be cartographically verified (UNEP-WCMC & IUCN, 2026).

5.3 Tier 2 Governance Assessment

The Tier 2 governance assessment uses the 2017 Resource Governance Index as described in Section 2.5.2 (Natural Resource Governance Institute, 2017). Two country-specific data decisions require noting before the score calibration is applied.

5.3.1 Specific Countries Notes

The United States is assessed in the 2017 NRGI for the Gulf of Mexico region rather than the Permian Basin (Natural Resource Governance Institute, 2017). This creates inconsistency and provides a further methodological basis, beyond T1 production heterogeneity, for excluding the US from the assessment.

Guyana is not assessed in the 2017 NRGI edition because oil production had not yet begun in the 2015-2016 period. However, it has been included in the 2021 edition with a score of 56 (Weak) and was published after the Liza field had been operationalised. The 2021 score for Guyana is therefore used as an exception to the 2017 edition. Using this 2021 data in a 2017-based analysis is treated as a data limitation rather than an invalidation.

This is also considered the relatively small import share of Guyana (3.8%) (Natural Resource Governance Institute, 2021).

5.3.2 Score Calibration

There is no established protocol for translating NRGi scores into the Tier 2 compliance categories of Compliant, Partially Compliant, and Non-Compliant. The NRGi band descriptions help to translate more accurately. The Good band (75-100) describes governance characterised by laws and practices likely to result in resource wealth benefiting citizens (Natural Resource Governance Institute, 2017). This aligns with the compliant score of the compliance categories; the framework exists, is enforced, and the site is compliant. The Poor (30-44) and Failing (0-29) band descriptions describe almost no governance framework, aligning with Non-Compliant. The Satisfactory (60-74) and Weak (45-59) bands describe partial and mixed governance, aligning with Partially Compliant.

The Not Assessable category in Tier 2 would be applied to countries not covered by the NRGi index. This is different from the Not Assessable finding in chapter 5. This was based on the structural absence of publicly accessible documentation. In the typological extension, country-level NRGi coverage is sufficient for classification, regardless of whether site-level documentation exists. Furthermore, the absence of documentation may be treated as non-compliant, as operators are required to demonstrate compliance within the RED III. Countries without an NRGi score would therefore be considered Non-Compliant. In practice, all fourteen import sources are scored by the NRGi. To calibrate the scores accordingly, the four assessed supply chains are mapped.

Two constraints are identified. The good band does not guarantee a compliant outcome. Alberta scores 75 and is partially compliant due to enforcement gaps in the frameworks. This shows an overestimation of compliance. Nigeria, on the other hand, scores 42 and overestimates non-compliance. Given these limitations, no single threshold mapping can be considered definitive. The three scenarios address this uncertainty by testing the sensitivity of the results to the placement of the compliance thresholds.

5.3.3 Governance Threshold Scenarios

Three scenarios are tested with a varying threshold between Partially Compliant and Non-Compliant. Scenario 1 is designated the primary finding. The RED III requires operators to demonstrate their compliance; in the absence of such a demonstration, they are considered non-compliant. Furthermore, there is no partial scoring in the RED III, meaning that even if a single criterion is contested or non-compliant, certification is denied immediately. This logic is most consistent with the strict threshold applied in scenario 1. The overestimation bias, where even 'good' band countries may not achieve full compliance, further emphasises the strict threshold. Scenarios 2 and 3 function as a sensitivity analysis, testing how the compliance picture shifts when the threshold between Non-Compliant and Partially Compliant is set at different points on the NRGi scale. The choice of threshold is the single most consequential calibration decision in the Tier 2 assessment, and the three scenarios together demonstrate whether the primary finding is sensitive to it.

Scenario 1 - Strict

Countries scoring 75 or above are classified as Compliant. Countries scoring between 45 and 74 are classified as Partially Compliant. Countries scoring below 45 are classified as Non-Compliant.

Scenario 2 - Moderate

Countries scoring 75 or above are classified as Compliant. Countries scoring between 30 and 74 are classified as Partially Compliant. Countries scoring below 30 are classified as Non-Compliant. This adjustment is based on Nigeria's score (42, Poor). Nigeria produces a partially compliant score in the assessment of Chapter 4. The Non-Compliant threshold is therefore placed at the Poor/Failing boundary.

Scenario 3 - Lenient

Countries scoring 60 or above are classified as Compliant. Countries scoring between 30 and 59 are classified as Partially Compliant. Countries scoring below 30 are classified as Non-Compliant. This adjustment is based on the most tolerant reading of the satisfactory threshold.

5.4 Combined Compliance Results

Table 5.2 presents the combined Tier 1 and Tier 2 classification for each country under all three scenarios. Table 5.3 then aggregates these into shares of EU crude oil imports by compliance category. The combined results reveal five patterns.

Table 5.2: Combined Tier 1 and Tier 2 classification per country and scenario

Country	Share	NRGI	T2 S1	T2 S2	T2 S3	T1 Result	Combined S1
United States of America	14.6%	*74	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed
Guyana	3.8%	**56	Partial	Partial	Partial	Compliant	Conditional
Norway	12.8%	86	Compliant	Compliant	Compliant	Compliant	Included
United Kingdom	4.8%	77	Compliant	Compliant	Compliant	Compliant	Included
Brazil	3.4%	71	Partial	Partial	Compliant	Compliant	Conditional
Mexico	2.2%	61	Partial	Partial	Compliant	Compliant	Conditional
Kazakhstan	12.8%	56	Partial	Partial	Partial	Compliant	Conditional
Azerbaijan	4.1%	47	Partial	Partial	Partial	Compliant	Conditional
Russia	2.2%	45	Partial	Partial	Partial	Non-Compliant	Excluded
Nigeria	5.8%	42	Non-Compliant	Partial	Partial	Non-Compliant	Excluded
Iraq	5.8%	38	Non-Compliant	Partial	Partial	Compliant	Excluded
Saudi Arabia	6.8%	36	Non-Compliant	Partial	Partial	Compliant	Excluded
Algeria	3.7%	33	Non-Compliant	Partial	Partial	Compliant	Excluded
Libya	9.1%	18	Non-Compliant	Non-Compliant	Non-Compliant	Compliant	Excluded
Others	8.1%	N/A	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed

Note: S1 = Strict (T2 ≥ 75/45/45-); S2 = Moderate (75/30/30-); S3 = Lenient (60/30/30-).

Score key: Compliant/Included Partial/Conditional Non-Compliant/Excluded Not Assessable Unassessed

Table 5.3: Share of EU crude oil imports by compliance category (%)

Category	Scenario 1	Scenario 2	Scenario 3
Included (Compliant)	17.6%	17.6%	23.2%
Conditional (Partial)	26.3%	42.6%	37.0%
Excluded – Ecological (T1)	8.0%	8.0%	8.0%
Excluded – Governance (T2)	25.4%	9.1%	9.1%
Total Excluded	33.4%	17.1%	17.1%
Unassessed	22.7%	22.7%	22.7%
Total	100.0%	100.0%	100.0%

Source: Author's calculations based on Eurostat (2025a) and NRGI (2017).

Pattern 1 - compliant supply is low and stable

The compliant supply of EU crude oil imports under no scenario exceeds 23.2%. Only Norway and the United Kingdom produce an included score under Scenarios 1 and 2, accounting for 17.6% of the supply. This is because they both score in the Good band of the NRGI (86 and 77, respectively), and their offshore context renders most Tier 1 criteria ecologically inapplicable. Under the most lenient governance threshold (scenario 3), both Mexico and Brazil also produce an included score. This raises the included share to 23.2%. The included supply is notably insensitive to the choice of threshold, with only a 5.6 percentage-point change

between the strictest and most lenient scenarios. Regardless of the governance threshold's calibration, most EU crude oil imports are not able to comply with a RED III equivalent framework.

Pattern 2 - Governance exclusion exceeds ecological exclusions

The total excluded supply amounts to 33.4% of EU imports under scenario 1. 8.0% of this import is excluded based on ecological grounds: Nigeria (5.8%) based on the Niger Delta typological extension and Russia (2.2%) based on the Alberta typological extension. 25.4 percentage points on governance grounds alone, comprising Libya (9.1%), Saudi Arabia (6.8%), Iraq (5.8%) and Algeria (3.7%). Governance exclusion exceeds ecological exclusion by a factor of more than three under the primary finding. If conditional is also treated as excluded, this number would rise even further to 51.7%, with all excluded on a governance basis. This would mean that, under a strict reading, 87% of Non-Compliant supply would fail on governance standards rather than on ecological standards. This structural dominance holds across all three scenarios: under Scenarios 2 and 3, total governance-based non-compliance remains 51.7% and 46.1%, respectively, while ecological exclusions remain fixed at 8.0%.

This pattern arises because the majority of Tier 1 ecological prohibitions are inapplicable to desert and offshore production contexts, which together account for the majority of EU crude oil imports.

Pattern 3 - Libya is the only country excluded on governance grounds under all scenarios

Libya produces a score of 18 on the NRGI and produces a Non-Compliant Tier 2 classification under all three scenarios. Its score falls below the Non-Compliant threshold in every case. When combined with a Tier 1 inapplicable classification, Libya is excluded on governance grounds regardless of the threshold choice. At 9.1% of EU imports, this represents the only governance-based exclusion that is not sensitive to changes in the threshold.

Saudi Arabia (36), Iraq (38) and Algeria (33) are excluded under Scenario 1 but shift to Conditional under Scenarios 2 and 3 as the Non-Compliant threshold moves from 45 to 30. These three countries together account for 16.3% of EU imports. Whether they are excluded or conditional is the most consequential single threshold decision in the Tier 2 assessment. This sensitivity further advocates for selecting Scenario 1 as the primary finding.

Pattern 4 - Nigeria and Russia exclusion

Nigeria and Russia are excluded on Tier 1 ecological grounds across all three scenarios. Nigeria's Niger Delta production context is Non-Compliant across multiple Tier 1 criteria in the direct supply chain assessment, and Russia's West Siberian Taiga context transfers the Alberta boreal proxy profile, producing Non-Compliant outcomes for primary forest, wetland, forest carbon stock and peatland criteria. These exclusions are not subject to the governance threshold choice and are robust across all scenarios. Notably, Nigeria also scores 42 on the NRGI (Poor), which would produce a Non-Compliant Tier 2 classification under Scenario 1. Russia scores 45 (Weak), producing Partially Compliant. This means it fails on governance grounds under the strict reading. While Tier 1 exclusion takes precedence in the combined outcome, the fact that both countries fail independently on governance grounds reinforces the overall non-compliance finding. Neither country could demonstrate compliance under either tier independently.

Pattern 5 - The unassessed share reflects a scope decision, not a data limitation

The United States and the Others category together account for 22.7% of EU imports and remain unassessed across all three scenarios. For the United States this reflects a scope decision rather than an inability to assess: its production is spread across three compliance-relevant biome contexts that would each reach different outcomes, and assessing them properly would require a separate, region-by-region analysis beyond the scope of this research. This is distinct from the Not Assessable classification applied to Ghawar, which reflects a genuine absence of independent data. The Others category is closer to the latter, containing unspecified origins for which no dominant field or governance score can be assigned.

5.5 Sensitivity to Scenario Choice

Moving from Scenario 1 to Scenario 2 reduces total excluded supply from 33.4% to 17.1%. The entire reduction is attributable to Saudi Arabia, Iraq and Algeria shifting from Excluded to Conditional as the Non-Compliant threshold moves from 45 to 30. Correspondingly, the Conditional share increases from 26.3% to 42.6%. The total non-compliant share, which is the sum of conditional and excluded shares, remains at 59.7% in both Scenario 1 and Scenario 2. The threshold choice, therefore, does not change the overall magnitude of non-compliance but does change its composition: under Scenario 1, more supply is directly excluded, while under Scenario 2, the same supply is classified as Conditional rather than Excluded. Under Scenario 3, the total non-compliant share decreases to 54.1% as Brazil and Mexico move from Conditional to Included.

This finding reinforces the case for Scenario 1 as the primary result. The RED III's burden-of-proof logic places the obligation to demonstrate compliance on the operator; Conditional supply has not met this standard. Under a strict reading, Scenario 1 and Scenario 2 produce the same total non-compliance share (59.7%), and the distinction between Excluded and Conditional is an analytical refinement, rather than a regulatory one.

5.6 Conclusion

Sub-question 3 asked what share of current EU crude oil imports would fail to meet RED III-equivalent sustainability thresholds under varying levels of criterion stringency. Under the primary finding of Scenario 1, 17.6% of EU crude oil imports are included, 33.4% are excluded, and a further 26.3% are Conditional. This technically means non-compliant under the directive's binary logic. A total of 59.7% of EU crude oil imports fail under the strict threshold. A further 22.7% cannot be assessed. Under no scenario does the included share exceed 23.2%.

Governance failure is the primary driver. Under Scenario 1, governance-based exclusions (25.4%) exceed ecological exclusions (8.0%) by more than three to one. This demonstrates that the governance pillar of an equivalent RED III framework is as consequential as, or more consequential than, the ecological pillar for crude oil supply chain compliance. The finding is robust at its core: regardless of scenario, Nigeria and Russia are ecologically excluded, Libya is governance-excluded, and Norway and the United Kingdom are the only import sources that unambiguously comply. Everything else is contingent on the choice of threshold.

Compliant Supply versus Projected EU Demand

The preceding chapters have established a criteria framework, conducted a compliance assessment across four representative crude oil supply chains, and estimated the aggregate share of EU crude oil imports that would fail to meet the RED III-equivalent sustainability threshold under varying levels of criterion stringency. In this chapter, the analysis is extended by projecting it into the future dimension. It uses the three energy transition scenarios in the International Energy Agency's World Energy Outlook (IEA, 2025) to explore the extent to which the EU's import supply would meet projected demand over time.

This analysis is explicitly exploratory. Due to a limited number of supply chains assessed and inherent uncertainty in the scenario projections, this chapter does not produce a quantitative forecast. Rather, it uses the compliance results to assess whether supply availability strains under EU import demand. Ultimately, it is necessary to determine under which conditions the regulatory framework is considered practically viable.

6.1 Three IEA Scenarios

The World Energy Outlook (WEO) presents three core scenarios to represent the divergent pathways for the global energy system. Each scenario is based on a different set of assumptions, all of which produce a significantly different demand for oil.

The Current Policies Scenario (CPS) assumes that current energy policies remain in force and that no new policy commitments are implemented. In this scenario, global demand rises from 100 million barrels per day (mb/d) in 2024 to 105 mb/d in 2035. This demand is projected to reach 113 mb/d by 2050 (IEA, 2025). The CPS represents the upper boundary of the projected demand and reflects the scenario implied by regulatory inertia.

The Stated Policies Scenario (STEPS) extends the CPS by incorporating the government's announced policies, pledges and climate targets. In the STEPS, global oil demand peaks around 2030 at approximately 102 mb/d before it declines gradually and returns to near 100 mb/d by 2035. After that, it declines by approximately 0.2 mb/d per year (IEA, 2025). The STEPS represents the IEA's central case as it implies the current policy landscape at its most ambitious.

The Net Zero Emissions by 2050 Scenario (NZE) presents the pathway required to limit the global average temperature rise to 1.5 degrees Celsius. This scenario is normative rather than predictive, as it specifies what the energy system would need to look like to achieve the defined climate outcome, rather than relying on current trends. The WEO states that the NZE Scenario sees 'much faster electrification of the vehicle fleet, with much stronger implications for oil use' than the STEPS, and that global fossil fuel consumption drops by 8 EJ annually, 'led by oil' (IEA, 2025, pp. 22, 71). The WEO-2025 further acknowledges that exceeding 1.5 degrees Celsius is now inevitable under current trajectories and that the NZE Scenario requires a pace of policy implementation not yet observed at scale (IEA, 2025).

For this chapter, the distinction between the scenarios is analytically useful for assessing both the underlying logics of policy ambitions and whether supply suffices to meet demand levels.

6.2 EU Import Demand Projection Across Scenarios

As this research focuses on the EU, the projected EU-specific import demand is taken into account. For the baseline, the Eurostat data show that EU crude oil imports amounted to 460.8 million tonnes (Mt) in 2024 (Eurostat, 2025a). At the standard crude oil conversion of 7.33 barrels per tonne, this is equivalent to approximately 9.25 million barrels per day. Because the EU relies on imports for about 97% of its crude oil (Eurostat, 2025b), import volumes closely mirror total demand. This allows the import baseline to be set against WEO demand projections. It is consistent with the WEO figure of 9.0 mb/d for EU oil demand in 2024 (IEA, 2025). This slight difference is likely caused by methodological differences and, given the exploratory nature of this analysis, is therefore ignored. Also, the supply gap between CPS and STEPS is in the range of 4-5 mb/d, which is an order of magnitude larger.

The WEO provides the oil demand figures for CPS and STEPS for 2035 and 2050, summarised in Table 6.1. In the CPS, EU oil demand falls from 9.0 mb/d in 2024 to 6.6 in 2035 and to 3.3 mb/d by 2050 (IEA, 2025). The WEO confirms that the oil demand falls by more than 20% to 2035 in the CPS, with the main drivers being road transport electrification and heating policies already in place (IEA, 2025).

In the STEPS, EU oil demand falls more steeply, declining to 6.4 mb/d by 2035. This is also in line with the WEO statement that demand in the EU is among the fastest-falling in advanced economies, at approximately 30% by 2035 and 2.9 mb/d by 2050 (IEA, 2025).

For the NZE scenario, the WEO does not publish any oil demand projections because no disaggregated data are available for this scenario; therefore, no reliable EU-specific figure can be produced. This is noted as a data limitation.

Table 6.1: EU oil demand projections by IEA scenario (mb/d)

Scenario	2024 (baseline)	2035	2050
CPS (Current Policies)	9.0 mb/d	6.6 mb/d	3.3 mb/d
STEPS (Stated Policies)	9.0 mb/d	6.4 mb/d	2.9 mb/d

Source: IEA World Energy Outlook 2025 (Table A.9).
mb/d = million barrels per day.

6.2.1 Compliant Supply Pool

As established in Chapter 5, the typological extension of the compliance assessment across the fourteen largest EU crude oil import source countries produced a clear finding. Under the primary finding of scenario 1, 17.6% of EU crude oil imports are classified as included, 33.4% as excluded, and a further 26.3% as conditional. Given the binary logic of the RED, both excluded and conditional are considered non-compliant. This results in a non-compliant share of 59.7% of total imports. The included share does not exceed 23.2% under any scenario.

The compliant supply is geographically concentrated. Norway (12.8%) and the United Kingdom (4.8%) are the only import sources that satisfy both tiers across all scenarios, producing a combined included share of 17.6%. Both are offshore conventional producers operating under governance frameworks that score in the Good band of the Resource Governance Index (86 and 77, respectively). In the most lenient scenario, both Brazil (3.4%) and Mexico (2.2%) are included. This shift causes the compliant share to rise to 23.2%. For this chapter, the compliant supply pool is fixed at the Scenario 1 primary finding: approximately 17.6% of the 9.25 mb/d import baseline, or approximately 1.6 mb/d, with a ceiling of 23.2%, equivalent to approximately 2.1 mb/d under the most lenient threshold.

The United States and the Others category together account for 22.7% (approximately 2.1 mb/d) of EU crude oil imports and are left unassessed under the framework applied in this research: they are assessable in

principle, but only through direct, region-level analysis beyond this research's scope. This share is larger than the entire compliant pool and is not equivalent to the non-compliant supply. US Gulf of Mexico offshore production, in particular, operates in a context structurally similar to Ekofisk. The supply gap identified in the scenario comparison below should therefore be understood as a conservative upper bound: the true gap is likely somewhat smaller. How much smaller cannot be determined without a direct assessment of the US and Others specifically. This falls outside the scope of this research but represents a relevant qualification of the findings.

Under the STEPS, the Norwegian oil production is projected to fall by approximately 40% between 2024 and 2035 (IEA, 2025, p. 211). The Norwegian production is both the largest and most clearly compliant source in the EU import mix. A 40% decline in Norwegian production from its 2024 level of approximately 1.2 mb/d supplied to the EU reduces the Norwegian contribution to approximately 0.7 mb/d by 2035. This is before any governance improvements elsewhere are taken into account in the supplier base. The effective compliant supply mix in 2035 is therefore likely to be smaller than the 1.6 mb/d estimated from current import shares. However, this is in the absence of governance improvements in other supplying countries.

6.3 Scenario Comparison

The three scenarios serve as the expected demand to which the compliant supply is mapped. Here, the question is not how large the gap is in absolute terms, but rather whether the falling demand can shrink the deficit quickly enough.

Under the CPS, EU oil demand falls from 9.0 mb/d in 2024 to 6.6 mb/d by 2035 and to 3.3 mb/d by 2050 (IEA, 2025, WEO Table A.9). This is the slowest projected reduction scenario. Against the compliant supply of approximately 1.6 mb/d, the structural deficit is in the range of 4.5-5 mb/d in 2035. In 2050, when demand has fallen to 3.3 mb/d, the gap remains substantial, especially as Norwegian production is expected to decrease as well. The CPS is therefore the scenario in which the tension between a RED III-equivalent import standard and supply availability is most severe and most persistent. The policy context implies regulatory inertia. This also means that the introduction of new sustainability criteria for crude oil is most likely to face resistance.

Under the STEPS, EU oil demand falls to 6.4 mb/d by 2035 and to 2.9 mb/d by 2050 (IEA, 2025, WEO Table A.9). The decline in demand is more notable, but the gap between supply and demand remains broadly similar in 2035 (4 to 5 mb/d). This is because the demand reduction is only 0.2 mb/d between the two scenarios. The problem remains structurally unchanged. By 2050, at 2.9 mb/d, EU demand in the STEPS approaches the upper bound of the compliant supply range, but the demand is still approximately twice as high as the compliant supply. Near-balance at the 2050 horizon is theoretically achievable under the STEPS, but only if governance conditions across the broader supplier base improve and Norwegian production decline does not outpace those improvements. Neither condition is guaranteed by demand reduction alone.

As previously stated, for the NZE scenario, no EU-specific demand figure is available. The WEO states that the oil demand would decline substantially faster than under the STEPS, driven by much faster vehicle fleet electrification and broader fossil fuel displacement across all sectors. The NZE is therefore the only scenario in which the rapid demand reduction could plausibly converge with the compliant import supply. However, this scenario is highly dependent on the pace of the energy transition, and the WEO itself states that it is currently not on track (IEA, 2025). The NZE is included in this analysis for its directional significance rather than as a quantified projection.

Two structural patterns can be observed from the scenario comparisons. The first is the persistence of the 2035 gap across all quantified scenarios. The IEA's central case, STEPS, also results in a structural gap of around 4.8 mb/d. The difference between the CPS and STEPS at 2035 is only 0.2 mb/d. This means that the distinction between regulatory inertia and full implementation of all pledged EU policies makes almost no difference in this timeframe. This reflects the structural narrowness of the compliant supply pool identified in Chapter 5: only Norway and the United Kingdom produce an included score, together accounting for 17.6% of

current EU imports. This pool is too small relative to the total import dependency. Even under the most lenient governance threshold of Scenario 3 (23.2%), the compliant pool remains a fraction of projected EU demand under both the CPS and STEPS. The gap is therefore primarily considered to be caused by the insufficient amount of supply relative to the EU demand.

It should further be noted that the net gap closure across scenarios is slower than demand figures alone suggest. This is due to the contraction of Norwegian production, which simultaneously reduces the compliant pool over the same period.

6.4 Conclusion

SQ4 asked to what extent compliant crude oil supply meets the demand projected in the three IEA energy transition scenarios. The answer is clear at the 2035 timeframe across all scenarios for which EU-specific data exists: it does not. Under current governance conditions, the compliant supply pool of approximately 1.6 mb/d falls approximately 5 to 5.3 mb/d short of EU crude oil demand under both the CPS and approximately 4.8 to 5.1 mb/d STEPS. This demonstrates that even in the full implementation of all pledged EU energy policies, the compliance picture is not altered significantly. Furthermore, with the projected decline in Norwegian production, the net gap is expected to close more slowly than the demand figures suggest.

The only scenario in which the convergence of compliant supply and EU demand is plausible within the timeframe is the NZE. In this scenario, demand declines substantially faster than under the STEPS. However, no EU-specific figure is available for the NZE, and the WEO acknowledges that the pace of transition it requires is not currently on track (IEA, 2025).

These findings raise the central question for Chapter 7: whether a RED III-equivalent instrument could be designed to remain practically viable given the structural gap between compliant supply and EU import demand identified here, and if so, under what conditions.

Policy Implications

The preceding chapters have established that applying RED III-equivalent sustainability criteria to EU crude oil imports produces a structural compliance gap under current governance conditions. This chapter does not provide a legislative solution to that finding; instead, it extracts policy implications that follow directly from the preceding chapters.

7.1 Governance Failure

The first implication follows directly from the findings of SQ3. Under scenario 1, governance-based exclusions exceed ecological exclusion three to one. When conditional supply is also treated as non-compliant under the strict reading, governance accounts for 51.7% of the 59.7% of total supply that fails. This means that roughly 87% of all non-compliant supplies fail on governance grounds rather than ecological ones. Libya, Saudi Arabia, Iraq, Algeria, Guyana, Kazakhstan, and Azerbaijan together account for 46.1% of all EU imports and are non-compliant or conditional primarily because of insufficient governance transparency and enforcement, not because their extraction sites overlap with prohibited areas.

This finding has a direct implication for how any framework that extends the EU's ecological protection logic to crude oil should be designed. The prohibitive criteria of the RED III are largely ecologically inapplicable to the desert and offshore production contexts that dominate EU crude oil imports. A framework that is directly analogous to the RED III's spatial prohibitions, therefore, would not be directly suitable for crude oil.

The framework that extends the EU's protection logic to crude oil should be governance first, rather than ecological, when strictly looking at the RED III. The main point of attention should be in the verification and governance pillar, the equivalent of Article 30 of the RED III. The policy challenge for crude oil is primarily one of transparency and enforcement architecture.

7.2 The Ecological Protection Gap

The second implication follows from Chapter 6. The share of EU crude oil imports that could meet the RED III-equivalent sustainability criteria under current governance conditions, 17.6%, is not expected to improve meaningfully when looking at 2035. The difference in EU demand between CPS and STEPS is only 0.2 mb/d. This means that the full implementation of all pledged EU energy policies does not change the compliance picture.

This demonstrates that the ecological harm identified does not resolve itself through the energy transition alone. Even with the expected decline in demand, it does not necessarily mean that the governance conditions of the remaining supply will automatically improve. This means that the ecological harm and transparency deficits continue to take place regardless of the pace of EU demand reduction. The energy transition reduces crude oil volumes but does not address the ecological or governance conditions under which it is extracted.

This ecological protection gap exists persistently throughout the transition period and is not an argument against the energy transition, but rather an observation that the transition alone is an insufficient response to the ecological and governance issues associated with crude oil extraction.

7.3 Verification Infrastructure

The third implication is based on the procedural pillar analysis in Chapter 3. Article 30 of the RED III establishes the verification infrastructure that enables the criteria to be enforced in practice through mass balance systems, independent auditing, certification schemes, and traceability requirements, such as the ISCC EU (ISCC System GmbH, 2025). This verification infrastructure is necessary to verify, enforce or act upon the criteria. No equivalent infrastructure exists for crude oil.

The absence of a verification infrastructure means that even if the criteria were defined and a framework were designed, there would be no way to effectively demonstrate compliance. It is therefore considered a precondition for any criteria to be meaningful in practice.

7.4 Structural Gap Implies Sequencing

The fourth implication is that a RED III-equivalent regulatory framework for crude oil cannot function as a strict, non-negotiable barrier on all imports simultaneously. This would result in approximately 59.7% of total EU crude oil imports failing, with no verified alternative supply available to meet that demand.

This does not mean that the framework is infeasible; however, it requires sequencing. The RED III itself did not apply its sustainability criteria to biomass overnight. The Directive 2009/28/EC was first introduced in 2009. Requirements were phased in progressively and revised where needed through the 2018 recast (Directive (EU) 2018/2001) and the 2023 RED III amendment (Directive (EU) 2023/2413). This gradual implementation is needed for the supply base to adapt to the new regulatory requirements. The same logic should apply to crude oil. The supply gap is substantial, no equivalent verification infrastructure currently exists, and the governance reform required in major producing countries represents a structural challenge. A phase-in period is therefore not merely preferable but necessary.

7.5 Summary of Implications

Sub-question 5 asked what policy implications can be derived to address the regulatory asymmetry between the sustainability governance of biomass and crude oil in the EU energy system. Four policy implications follow from the analytical findings of this thesis. The first is that the compliance risk in EU crude oil supply chains is primarily driven by governance failure rather than ecological harm. Any framework that extends the EU's ecological protection logic to crude oil would therefore need to be governance-first in its design.

The second is that the ecological protection gap does not resolve itself through the energy transition. Demand reduction alone is insufficient to address the ecological harm and transparency deficits, as they continue to take place regardless of the pace. The third is that the absence of verification infrastructure is a practical constraint. It is a precondition for any framework to be meaningful in practice and is currently absent for crude oil supply chains. The fourth is that the scale of the compliance gap means that any framework would require a sequential trajectory rather than immediate full application.

These implications do not specify what the legislative framework should look like, but rather characterise the structural conditions required to extend a RED III-equivalent framework to crude oil. The discussion covers not just whether the asymmetry exists, but also why it exists and what it reveals about the EU's regulatory architecture.

This chapter steps back from the analytical findings of the preceding chapter to reflect critically on what they mean, where they are limited, and what broader questions they raise.

8.1 The Thought Experiment and Its Interpretive Scope

The compliance assessment applies the RED III-equivalent sustainability as a strict thought experiment to crude oil. The binary logic of the RED III is applied: the supply chain either complies or it does not. This indicates that 59.7% of the total EU crude oil imports would fail to meet RED III-equivalent thresholds under the primary scenario. In this thought experiment, it is assumed that crude oil is not allowed to enter the EU unless it meets the sustainability requirements. This represents the strictest possible reading of the framework and is deliberately chosen to reveal the maximum implications of applying RED III-equivalent criteria to crude oil supply chains. This is done to show the impact that implementing such a framework would have on the overall EU import level. The import prohibition also shows whether the implementation of a RED III equivalent framework would help in the energy transition. The compliance gap identified in Chapter 6 could create structural pressure to accelerate demand reduction. In this sense, a strict RED III-equivalent framework could function as a complementary instrument to the energy transition. One could argue that in order to achieve the NZE scenario, a framework similar to the RED III could contribute to accelerating the demand reduction. However, the same pressure could equally incentivise making a shift in import suppliers. This means that the acceleration of the transition might be plausible, but it is not guaranteed.

However, it must be clearly stated that, in reality, applying RED III to biomass does not constitute an import prohibition. Non-compliant biomass remains freely tradable but cannot be counted towards the renewable energy target or receive financial support (Directive (EU) 2023/2413, Art 29(1)). The thought experiment deliberately applies a stricter reading in order to establish the maximum scope of the compliance gap.

8.2 What Ecological Inapplicability Actually Means

A central finding of this research is that eleven of the fourteen largest EU crude oil import source countries receive a Tier 1-compliant score. This is not because their extraction is considered harmless, but rather because their extraction region is ecologically inapplicable to the specific ecosystem types named in Articles 29(3), 29(4) and 29(5) of the RED III. Libya, Saudi Arabia, Iraq, Algeria, and Kazakhstan all extract from desert and xeric shrubland biomes, where forests, wetlands, and peatlands are absent. Norway, the United Kingdom, Guyana, Brazil, Azerbaijan, and Mexico are all offshore-extraction contexts in which land-based ecosystems are, by definition, absent. All these contexts produce a compliant score through ecological inapplicability rather than through ecological compliance.

This requires careful interpretation. Ecological inapplicability means that the criteria are inapplicable to the extraction contexts, not that the extraction is harmless. Offshore crude oil extraction causes documented harm through mechanisms that the Tier 1 criteria were not designed to capture. Cordes et al. (2016) document that deep-sea coral ecosystems in the Gulf of Mexico were contaminated by the Deepwater Horizon blowout within a 22-kilometre radius. Recovery times were estimated to span centuries to millennia, indicating long-lasting harm. They further document that oil and gas development has occurred in the Faroe-Shetland Channel Sponge Belt. This is a designated marine protected area. OSPAR Commission (2023) confirm that seabed infrastructure installation causes lasting physical disturbance to cold-water coral habitats designated under the OSPAR Convention.

In the desert context, Nothers et al. (2017) document that an oil spill in a hyper-arid desert reduced *Acacia* regeneration by 74%, with adverse ecological effects still measurable 40 years later. Deserts are noted as the most frequent locations of crude oil contamination, with ecological effects poorly studied. The ecological harm in this case can therefore be considered real, but falls outside of the specific ecosystem categories of the RED III.

The inapplicability finding reveals more than a methodological limitation; it reveals the structural characteristic of applying a biomass-designed framework to crude oil. The prohibitive criteria were designed to protect specific ecosystems from the threat of biomass extraction. This threat does not directly map onto the dominant production contexts of the EU imports. The spirit of the directive is that EU energy consumption should not drive ecological destruction, regardless of the type of energy carrier. This would essentially also cover the harms documented above. However, the direct formulation of the directive does not, as it specifies land types and ecosystems. This gap between the spirit and the directive's formulation is not incidental; it reflects the intended design for biomass. The extension to crude oil, therefore, requires the normative intention rather than the specific criteria.

This observation reveals a deeper issue: the normative justification of the RED III is itself selective. Recital 83 of Directive (EU) 2023/2413 justifies the prohibitive criteria to protect critical carbon sinks and biodiversity hotspots. This is a conception of ecological value that is focused on forest and wetland biomes. Desert and marine ecosystems fall outside this conception despite their unique ecological values, and are often demonstrably vulnerable to harm from crude oil extraction as well. This selectivity raises the question of whether the categories of ecological value that the RED III protects are sufficient even for biomass, let alone crude oil. The absence of these ecosystems from the protective framework is not a deliberate exclusion based on ecological reasoning, but rather a reflection of the biomass extraction context. Under this ecological protection logic, not only is extending the existing criteria to crude oil required, but also a reconsideration of whether the categories of harm those criteria address are comprehensive enough to reflect the full range of ecosystems at risk.

8.3 Documentation Infrastructure, Designation Gaps and Structural Opacity

A related but distinct finding is the designation requirement of Articles 29(3)(a) and 29(3)(b). Both articles require a formal designation by a competent authority, primary and old-growth forest status under national law for Article 29(3)(a), and designation as highly biodiverse by a relevant competent authority for Article 29(3)(b). In the compliance assessment, the formal designation requirement produces a systematic pattern: the Niger Delta received partial rather than non-compliant scores for T1-1 and T1-2, not because the ecological harm was less severe than in Alberta, but because Nigeria lacks the formal ecological classification infrastructure that Canada possesses. Ogbeibu & Oribhabor (2023) describe the Niger Delta explicitly as an exceptional biodiversity hotspot. They further note that it has not been formally recognised as such by any international competent authority. The ecological harm is comparable to or worse than that in the Alberta case. However, Alberta produces non-compliant scores on the same criteria because it has SARA designations and government species-at-risk documentations that provide the classification infrastructure.

This is a systemic design flaw rather than a case-specific limitation. The RED III's designation requirement presupposes that the formal classification and competent authority systems are in place, as in the EU. Applied globally, this presupposition does not hold, as it is more tolerant of countries with the weakest institutional capacity. These countries often document the most severe ecological harm and are the least regulated. The framework currently rewards the absence of a designation infrastructure, and penalises the existence of a robust ecological classification system. This results in countries with stronger institutional capacity being held to stricter standards than those with weaker institutional capacity, even when documented harm is often comparable or worse. Any framework that extends the RED III's ecological protection logic to crude oil should address the gap explicitly, either through the application of prohibition regardless of formal designation or through a broader evidentiary standard that accepts scientific literature as equivalent to formal competent

authority designation.

The Alberta T1-3 case reveals an interpretive boundary worth acknowledging. Article 29(3)(c) prohibits raw material obtained from areas designated for nature protection purposes. The non-compliant score is based on the ecological harm documented upstream in Wood Buffalo National Park and is caused by contamination carried by the river rather than by direct extraction within the National Park. This documented ecological harm is interpreted as functionally equivalent. However, this interpretation is analytically distinct from the functional equivalence argument that is the basis for the rest of the Tier 1 assessment. Here, it rests on the interpretive reading of Article 29(3)(c); the documented interference with the conservation objectives of a designated area is considered sufficient, regardless of whether the extraction occurred within the area. Under a strict spatial reading, the score would shift from non-compliant to compliant as no extraction occurs within the area. This case represents the limit of the functional equivalence methodology used in the research. This boundary should not be understood as a flaw but rather as a friction point of the directive's wording and protective intention, and should be addressed explicitly when a similar framework is extended to crude oil.

A related finding is the not-assessable scores assigned to Ghawar's Tier 2 governance criteria. Saudi Aramco's upstream operations are self-regulated by the Ministry of Energy rather than by the national environmental frameworks administered by MEWA and NCEC (World Bank Flaring Regulations Database, 2024), and no independent documentation could be found to verify whether national environmental standards apply to the Ghawar extraction site. In this research, the structural opacity is treated as equivalent to non-compliant due to the absence of demonstrated compliance. This is consistent with how the ISCC EU certification scheme operates for biomass (ISCC System GmbH, 2025). This raises a question for the design of any real regulatory instrument: should structural opacity automatically lead to exclusion, or to enhanced due diligence? Automatic exclusion follows the RED III burden-of-proof logic, where unverifiable compliance is treated as non-compliant. Enhanced due diligence assumes the opposite, that opacity reflects weak documentation rather than hidden violations. This assumption is questionable, as the two are not independent. The same conditions that prevent independent verification, such as self-regulation, limited transparency and a weak rule of law, also tend to allow weak enforcement. Opacity is therefore more of a risk signal than a neutral information gap. This supports the stricter reading, though enhanced due diligence may still fit where the opacity is genuinely capacity-driven. This friction point falls outside the scope of the research but is relevant for the design of any equivalent framework for crude oil.

8.4 The Exclusion of Crude Oil is a Political Choice, Not an Ecological One

The functional equivalence mapping conducted in Chapter 3 demonstrated that crude oil extraction causes the same categories of ecological harm that the RED III was designed to prevent for biomass. The normative justification for the prohibitive criteria, protecting ecosystems from which recovery is ecologically irreversible on human timescales (Directive (EU) 2023/2413, Recital 83; Pan et al., 2011), applies equally to the harms documented in the compliance assessment. The exclusion of crude oil from an equivalent framework is therefore not ecologically justified. The exclusion is rather a political choice that reflects the EU's crude oil import dependence, the complexity of imposing sustainability criteria, and the framing of fossil fuel harm primarily in terms of GHG emissions.

The majority of EU regulations for fossil fuels concern GHG emissions and are addressed through carbon pricing, emissions trading, and phase-out trajectories rather than non-GHG ecological conditions. This research does not argue against that framing but rather suggests an additional regulatory concern: the ecological conditions under which the EU's crude oil is extracted.

Weber and Cabras (2021), in their study of EU coal imports from Colombia, frame this pattern as a form of environmental injustice: the EU benefits from cheap fossil-fuel imports while the associated ecological and social costs fall on producing communities, with no EU sustainability obligation attaching to those imports. Although their case concerns coal, the same logic extends directly to crude oil. As this research has shown, the weight of sustainability compliance falls disproportionately on renewable-resource producers, while crude

oil supply chains remain largely unregulated by EU sustainability standards (Asmelash, 2022).

Mai-Moulin et al. (2021) establish that the absence of equivalent sustainability criteria is a policy decision rather than a methodological limitation. They note that comparative sustainability assessment tools already exist and are extensive. Taken together, these observations indicate that the exclusion of crude oil from a sustainability framework similar to the RED III is a political choice, not an ecological one.

Why the asymmetry persists is a separate question from whether it is justified. Three structural barriers to reform help explain why it has proven resistant to change. The first is import dependence. The EU relies on imports for about 97% of its crude oil. A strict standard would therefore act on its own energy security, in a way a biomass standard does not. Regulating a resource the EU barely produces, and cannot easily replace, is a different political proposition from regulating one it can produce domestically. The second is the distribution of responsibility. The harm falls on the producing regions, while consuming regions experience the economic benefit without the associated footprint. Neither side has a strong incentive to act. Producers compete on cost, and importers treat the ecological conditions of extraction as external to their own regulation. The third is a status-quo effect. Fossil fuel imports are long established and infrastructurally locked in. Framing their harm as a purely climate problem has kept the non-GHG ecological dimension off the regulatory agenda. Giuli & Oberthür (2023) document this pattern in EU external energy policy. Energy-security priorities have repeatedly overridden ecological objectives, particularly during supply crises. The asymmetry is therefore not a simple oversight. These conditions actively hold it in place.

8.5 What an Equivalent Framework Would Require in Practice

A direct analogue of the RED III is poorly suited to crude oil, but not because ecological criteria as such cannot apply. As Section 8.2 sets out, the prohibitive criteria are scoped to the carbon-rich land ecosystems that biomass threatens, so they return inapplicable in the desert and offshore contexts that dominate EU imports; this reflects the criteria's coverage, not an absence of harm. What matters for the design question is where the compliance risk actually concentrates. The findings show it concentrates in governance rather than in spatial overlap, and a hard import threshold would in any case act on 59.7% of current imports at once against a compliant pool of only 17.6%, with no verified alternative supply within the assessed import base at that scale. Exclusion as the primary mechanism is therefore both misaligned with where the risk lies and infeasible in the near term.

It does not follow that a single alternative is correct. Which instrument fits depends on what the framework is meant to achieve, and that objective is not self-evident. If the aim is to stop the EU from profiting from ecological harm, a market barrier addresses it. If the aim is to reduce the harm itself, a barrier does comparatively little. The excluded oil is sold to buyers without such criteria, and extraction continues. The design question is therefore prior to the choice of mechanism.

Two mechanisms can be compared. The first is exclusion, the strict reading applied in this research's thought experiment. Access to the EU market is conditioned on meeting a fixed threshold, and supply that fails is kept out. As noted in Section 8.1, this is stricter than the RED III, which does not ban non-compliant biomass but only prevents it from counting towards the renewable energy target or receiving support (Directive (EU) 2023/2413, Art 29(1)). The second is due diligence, which the EU already applies to supply chains through two different models. The Deforestation Regulation ties market access to a due-diligence check that products are deforestation-free and legal (Regulation (EU) 2023/1115). Non-compliant products cannot enter the EU market, so access is the lever, but operators can meet the requirement and improve on it, rather than a whole source being shut out. The Corporate Sustainability Due Diligence Directive works differently. It places an ongoing duty on companies to find and address environmental harm in their supply chains, enforced through supervisory oversight rather than a market ban (Directive (EU) 2024/1760). A crude oil equivalent could draw on either. Both put the burden of proof on operators, as the RED III does for biomass, and both keep a path open through demonstration and improvement, rather than a single pass-or-fail verdict.

The choice of mechanism also matters for what the framework would achieve, because the two act on different things. Exclusion acts on what the EU buys, not on how the oil is produced. Oil excluded on ecological grounds does not stop being extracted, so a pure exclusion framework would end the EU's complicity in the harm without reducing it. Due diligence, by contrast, keeps the EU in the relationship and attaches obligations to it, so it can require improvement and remediation at the source.

Neither instrument escapes the same limit. Oil can be sold to other buyers. A producer that finds either requirement too costly can redirect its supply elsewhere, so the leverage of both depends on the EU market being valuable enough to keep. Where they differ is in how they present the choice. Exclusion is binary: a producer either meets the full threshold or loses the EU market entirely, which leaves non-compliant producers little reason to stay. Due diligence is incremental: a producer keeps access while demonstrating improvement, which gives more producers a reason to remain engaged rather than exit. For the supply it retains, it acts on the harm directly. So if the objective is less ecological damage and less of the environmental injustice identified above, rather than only a cleaner import profile, a due-diligence approach may do more than exclusion, though it is not immune to the same source-shifting. This does not make exclusion pointless: withdrawing the EU market from the worst-governed supply is a real signal and a real revenue loss. But exclusion is better understood as one instrument among several than as the framework in itself.

Any such framework would carry trade-offs this research can identify but not resolve. A stricter standard could accelerate demand reduction, but it could equally shift imports toward compliant producers without changing global extraction, as noted in Section 8.1. Reducing crude oil volumes does not remove ecological harm in general either, since the materials required for the energy transition carry their own extractive footprint. And a framework assessed against formal governance indicators remains open to changes that satisfy the criteria on paper without changing the operational reality, as discussed in Section 8.7. These tensions are why the design question, what to regulate, through which instrument, and at what pace, cannot be settled by a compliance assessment alone. What this research establishes is the starting point: the asymmetry lacks an ecological justification, exclusion does not appear well suited as the primary instrument, and a governance-first, due-diligence-based and phased approach seems the direction most consistent with the findings. Two points should be noted alongside this. First, this research shows where the compliance risk concentrates and how large the exclusion shock would be. It does not show that a due-diligence mechanism would perform better in practice, so the comparison is an inference from the findings rather than a tested result. Second, due diligence depends on independent verification, and this is precisely what is missing in the weak-governance contexts that drive most of the non-compliance identified here. The Ghawar case, where structural opacity made the governance criteria not assessable, illustrates this. Due diligence may therefore be least effective where the compliance risk is greatest, which is a limit any equivalent framework would need to address.

8.6 Fossil Fuels, the GHG Exclusion, and the Limits of the Sustainability Frame

The deliberate exclusion of GHG criteria from this research is based on the categorical distinction between biomass and crude oil. Biomass can, in principle, be sourced sustainably. The RED III criteria ensure that biomass energy meets both ecological and GHG standards. Crude oil, on the other hand, is inherently not sustainable and therefore cannot be designated as sustainable within the EU's energy policy architecture. It irreducibly produces GHG when combusted, and no governance framework changes that fundamental characteristic. So, fossil fuels are incompatible with the EU's climate neutrality objectives. The non-GHG sustainability criteria are, therefore, the only dimension on which crude oil supply chains can improve without ceasing to be what they are.

This does not invalidate the research. The non-GHG sustainability dimension of crude oil is a real and documented problem that exists independently of the GHG emissions. Ecological degradation and governance failure documented in the compliance assessment affect communities and ecosystems in ways that GHG accounting does not capture. Therefore, the compliance findings are best understood not as an argument that crude oil supply chains are sustainable, but rather as evidence that current crude oil governance is inadequate

to address the non-GHG sustainability requirements the EU considers necessary for biomass.

8.7 Limitations

Throughout the typological extension in Chapter 5 and the scenario analysis in Chapter 6, governance quality is treated as fixed. The compliance gap and the compliant supply pool are both calculated on the assumption that governance conditions do not change over the scenario timeline. This assumption is likely to overstate the long-term compliance in one direction. The introduction of a RED III-equivalent framework to crude oil would likely strongly incentivise countries economically to change their governance frameworks accordingly. Nigeria's Petroleum Industry Act (2021) and Saudi Arabia's revised Environmental Law (2021) both demonstrate that governance is not fixed and can change in response to different external pressures.

However, the static assumption could also cause a different type of risk in the opposite direction. While the introduction of a regulatory framework creates incentives to introduce genuine improvements, it also creates incentives for the appearance of governance improvements. Here, producing countries facing exclusion could introduce regulatory changes that satisfy the compliance criteria without necessarily changing the operational reality. Despite the introduction of the Petroleum Industry Act (2021) in Nigeria, Adeola et al. (2022) document that systematic decoupling of legislation from operational reality continues. A compliance framework assessed against formal governance indicators is therefore vulnerable to regulatory adaptations that conform to the exact wording of the regulations without addressing the underlying purpose.

A further limitation concerns the usage of the NRGi database. The NRGi 2017 covers the 2015-2016 assessment period. This creates a gap of approximately a decade between the database and the current assessment. The absence of a suitable alternative is the reason this database has been chosen. No other publicly available governance index combines comparable country coverage, sectoral specificity for oil and gas, and transparency. Even though it can be considered relatively outdated, the NRGi index remains the most suitable for assessing the governance score. This absence reveals that the data infrastructure required to conduct a current and comprehensive governance assessment of global supply chains does not exist. This is part of the same systemic problem identified in this research and is considered a necessary criterion for any equivalent regulatory framework.

A third limitation concerns the typological extension used in Chapter 5. Assigning Tier 1 compliance profiles to import source countries based on biome similarity to one of the four directly assessed supply chains is a necessary simplification given data availability and research scope, but it substitutes ecological similarity for site-specific assessment. Countries sharing a biome context with an assessed supply chain may differ in extraction methods, infrastructure footprints, regulatory environments, and specific ecological conditions in ways that affect compliance outcomes. A more suitable approach would assess each of the fourteen import source countries individually against the full compliance matrix. Due to time constraints in this research, the individual assessment is considered too time-consuming and is therefore skipped.

8.8 Recommendations for Future Research

Four directions for further research follow directly from the findings and limitations of this research.

The most immediate gap is the unassessed status of the United States. The US accounts for approximately 14.6% of the EU's crude oil imports. It is left unassessed across all scenarios in this research due to the heterogeneity of its production contexts and due to the inapplicability of the NRGi score to the Permian Basin. Given the significant share of crude oil that the US provides to the EU, a dedicated compliance assessment of the US extraction contexts is necessary. This would help to revise the supply gap estimates produced in Chapter 6 and complete the EU import picture. The unassessed share is currently larger than the total compliant pool, so assessing it would give a more complete picture.

The second direction would be to address what a verification framework specifically for crude oil supply chains would look like. The absence of a verification framework is identified as a necessary criterion for any equivalent regulatory framework. Research into what a crude oil equivalent of the ISCC EU certification system would look like would directly address the most fundamental barrier identified in this research. This verification framework is a precondition and, therefore, one of the most important research gaps for policy translation.

The third direction follows directly from the limitation on typological extension. Conducting an individual assessment of each crude oil supply chain against the full compliance picture would provide a directly evidenced picture of compliance. Individual assessments would help test the robustness of the compliance picture and determine whether the typological extension provides an accurate score.

A fourth direction concerns the instrument itself. This research establishes that a governance-first, due-diligence-based approach is the direction most consistent with the findings, but it neither designs nor tests such an instrument. Research into how a due-diligence or market-access framework for crude oil would be designed, and how it would compare with outright exclusion in reducing harm at the source, is recommended, as this would translate the direction identified here into a concrete policy proposal.

8.9 Conclusion of the Discussion

This chapter has reflected on eight observations that contextualise and extend the analytical findings of the previous chapters. First, the thought experiment applies a stricter reading than RED III does to biomass. A strict equivalent framework could create pressure that accelerates the demand reduction; however, the same pressure could also cause source shifts, which means that the transition-accelerating effects are plausible but not guaranteed. Second, ecological inapplicability does not mean that no ecological harm occurs. Both offshore and desert contexts produce a compliant score because the RED III's criteria do not accommodate these contexts, not because the extraction itself is harmless. Third, the normative conception of the RED III's ecological value is selective and excludes desert and marine ecosystems from its scope, despite their documented vulnerability. Fourth, the designation requirement is a systemic design flaw when applied to global supply chains, because it rewards the absence of a classification infrastructure and penalises its existence. This often leads to a greater tolerance for outcomes in which ecological harm is the worst. Fifth, structural opacity differs from governance failure: not assessable means the institutional architecture is absent, rather than documented non-compliance. This needs a different regulatory response. Sixth, the exclusion of crude oil is a political choice, not an ecological one, and it persists for structural reasons rather than through oversight. Seventh, the asymmetry is a form of environmental injustice, but a RED III-style exclusion would limit the EU's profiting from that injustice without reducing it, since the excluded oil is sold to other buyers and the harm continues; reducing the injustice therefore requires mechanisms that act on the harm directly. Eighth, crude oil is not considered sustainable within the EU's energy policy architecture, and a framework that extends the EU's protection logic to it would need to be governance-first, verification-based and phased rather than a direct analogue of the spatial prohibitions.

Taken together, these observations point toward a broader conceptual conclusion that extends past the compliance findings. The EU has established a sustainability governance architecture for biomass based on the principle that EU energy consumption should not drive specific categories of ecological harm. That principle is not applied to crude oil, despite comparable ecological harm. The energy transition will reduce consumption volumes, but it does not address the governance conditions under which the remaining volume is extracted. This research contributes to the empirical foundation of the debate and demonstrates that the regulatory asymmetry between biomass and crude oil sustainability governance lacks an ecological rationale.

Conclusion

This research examined the implications for EU crude oil availability of imposing RED III-equivalent non-GHG sustainability criteria on crude oil supply chains. In the strict thought experiment, approximately 59.7% of total EU crude oil imports would fail to meet the RED III-equivalent thresholds in the primary scenario. Only Norway and the United Kingdom produce an unambiguously compliant profile. Together they account for 17.6% of EU crude oil imports. No combination of demand reduction and compliant supply growth closes this gap within near-term policy timelines. Under every IEA scenario for which EU-specific data exist, the compliant pool of roughly 1.6 mb/d remains several million barrels per day short of projected demand. The difference between regulatory inertia and the full implementation of pledged EU policies is small at the 2035 horizon.

The research proceeded through five sub-questions. It moved from criteria mapping through compliance assessment, typological extension, scenario analysis, and policy implications. The research was originally designed around ecological criteria and their applicability to crude oil. It was, however, governance failure rather than ecological harm that presented the greatest compliance risk. This contradicts the design of the RED III, which presumes that the spatial ecological prohibition is the main regulatory challenge. The compliance assessment also showed that ecological inapplicability does not mean that those extraction contexts are harmless. It means that the framework was not designed to capture the specific harms they cause.

These findings also carry an implication for how such a framework should be built. Because the compliance risk lies in governance rather than spatial overlap, and a hard threshold would exclude most imports at once with no verified alternative, exclusion is poorly suited as the primary instrument. If the aim is to reduce the harm rather than only clean the EU's import profile, instruments that act at the source fit better, and the EU already applies these through the Deforestation Regulation and the Corporate Sustainability Due Diligence Directive. This points to a governance-first, due-diligence-based and phased direction. That direction follows from the findings but has not been tested here, and one caveat applies: due diligence depends on the independent verification that is missing precisely where governance is weakest, so it may be least effective where the risk is greatest.

This research makes two original contributions to the field. First, it provides the first systematic application of RED III-equivalent non-GHG sustainability criteria to EU crude oil supply chains. Through the functional equivalence principle, it shows that the criteria applicable in practice produce a meaningful compliance differentiation across supply chains. It thereby addresses the academic knowledge gap identified at the start of this research, as no study had yet examined the application of the RED III's non-GHG sustainability criteria to crude oil supply chains.

Second, it reframes the biomass-crude oil asymmetry as a normative rather than a technical problem. Crude oil extraction causes harm comparable to that the RED III already regulates for biomass, so its exclusion from an equivalent framework constitutes a form of environmental injustice. An import exclusion would limit the EU's profiting from that injustice, but it would not reduce it. Reducing it requires instruments that act on the harm directly.

Four directions for further research follow from the findings and limitations. The most immediate gap is a dedicated compliance assessment of US crude oil production contexts. These account for 14.6% of EU imports and remain unassessed in this research. The unassessed share is currently larger than the entire compliant pool. The second is research into what a verification framework designed specifically for crude oil supply chains would look like. This is the binding precondition for any regulatory framework to function in practice. The third is individual site-specific compliance assessments for each of the fourteen import source countries. This would replace the typological extension with a directly evidenced picture of compliance. The fourth is research into how a due-diligence or market-access instrument for crude oil would be designed, and how it would compare with outright exclusion in reducing harm at the source, translating the direction identified in this

research into a concrete policy proposal.

This research exposes an asymmetry at the heart of EU energy policy. Biomass governance is bound to the principle of preventing ecological harm, while crude oil remains excused, despite evidence of comparable harm. The asymmetry has no ecological justification. It persists because of import dependence, the distribution of responsibility between consuming and producing regions, and the framing of fossil-fuel harm as a purely climate problem. Whether the EU addresses it, and how, is ultimately a political choice rather than an ecological one.

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AI Statement

During the development of this thesis, the generative-AI tools ChatGPT (OpenAI), Gemini (Google), and Claude (Anthropic) were used as writing and editing assistants. These tools helped to formulate concepts, enhance the structure, improve sentence clarity and academic tone, rephrase text, and format the document and its tables in LaTeX. Grammarly (Grammarly, Inc.) was used as a spelling and grammar checker. All research design, data collection, analysis, legal interpretations, governance assessments, and conclusions are the author's own work. All AI-assisted output has been critically reviewed, edited, and verified by the author, who takes full responsibility for the content, interpretation, and conclusions of this thesis.



Full Compliance Matrices

This appendix presents the complete evidentiary compliance matrices for all four assessed supply chains. Full argumentation is provided for each indicator score.

Score key: **Compliant** **Partial** **Non-Compliant** *Not Assessable*

Table A.1: Compliance assessment scoring form - Tier 1 prohibitive ecological criteria (Art. 29(3)-(5)): minimum literature evidence required for each score.

Indicator	✓ Compliant	~ Partial	✗ Non-Compliant
T1-1 Art. 29(3)(a) High biodiversity value - Primary / Old-Growth Forest	Reliable independent source(s) confirm no primary/old-growth forest overlap with the extraction site. AND no harm caused attributable to extraction site OR criterion is ecologically inapplicable to this site context (no forest habitat).	Reliable independent source(s) indicates presence of primary/old-growth forest near the extraction site but does not establish causal degradation. OR single grey literature source indicates overlap without independent verification	Reliable independent source(s) explicitly indicates destruction, conversion, or fragmentation of primary/old-growth forest directly caused by or attributed to extraction infrastructure at the case study site or its operational footprint.
T1-2 Art. 29(3)(b) High biodiversity value - Highly Biodiverse Forest	Reliable independent source(s) confirm no spatial overlap with highly biodiversity forest with the extraction area. OR evidence is provided that extraction does not interfere with nature protection purposes. OR criterion ecologically inapplicable (no forest habitat).	Reliable independent source(s) indicates presence of highly biodiverse forest near the extraction site but does not establish causal degradation. OR single grey literature source indicates overlap without independent verification	Reliable independent source(s) indicates that extraction infrastructure spatially overlaps with highly biodiverse forest, AND indicates measurable harm attributable to extraction.
T1-3 Art. 29(3)(c)(i) High biodiversity value - Protected Areas (General)	Reliable independent source(s) confirm no spatial overlap with any designated protected area and no documented interference with conservation objectives. OR not applicable (no legally designated protected area)	Reliable independent source(s) indicates proximity to or interaction with a designated area but does not confirm spatial overlap. OR single grey literature source indicates overlap without independent verification.	Reliable independent source(s) indicates that extraction infrastructure spatially overlaps with a formally designated protected area, OR documents measurable harm to the conservation objectives of a designated area attributable to extraction.
T1-4 Art. 29(3)(c)(ii) High biodiversity value - Protected Areas for Threatened Species	Reliable independent source(s) confirm that no area formally designated for EN/CR or rare, threatened or endangered species or ecosystems protection overlaps with the extraction site. OR not applicable (no legally designated protected area)	Reliable independent source(s) indicates documents presence of rare, threatened or endangered ecosystems or EN/CR species near the site without official designation, OR formal designation documented but causal harm to species not established in literature.	Reliable independent source(s) indicates direct overlap with formally designated area for rare, threatened or endangered ecosystems or EN/CR species. AND either evidence of ecological harm OR no independent evidence of non-interference with conservation objectives of the designation.
T1-5 Art.29(3)(d)(i) Highly Biodiverse Grassland	Reliable independent source(s) confirms no biodiverse grassland is present within the extraction site and zone of influence, or that extraction has not caused measurable decline. OR criterion inapplicable (no grassland area)	Reliable independent source(s) indicates grassland presence and extraction activity in proximity without establishing causal species richness decline. OR formal designation exists but causal harm to designation objectives not established in literature.	Independent reliable source(s) indicates measurable decline in native plant species richness, or infringement on formally designated highly biodiverse grassland, directly attributable to extraction infrastructure at the site.
T1-6 Art.29(3)(d)(ii) Highly Biodiverse Grassland	Reliable independent source(s) confirms no biodiverse grassland is present within the extraction site and zone of influence, or that extraction has not caused measurable decline or is necessary to maintain ecosystem status. OR criterion inapplicable (no grassland area)	Reliable independent source(s) indicates grassland presence and extraction activity in proximity without establishing causal species richness decline. OR formal designation exists but causal harm to designation objectives not established in literature.	Independent reliable source(s) indicates measurable decline in native plant species richness, or infringement on formally designated highly biodiverse grassland, directly attributable to extraction infrastructure at the site.
T1-7 Art.29(3)(d)(ii) Heathland	Reliable independent source(s) confirms no heathland is present within the extraction site and zone of influence. OR criterion inapplicable (no heathland area)	Grey literature indicates extraction on or degradation of heathland within the extraction site and zone of influence.	Any reliable independent source confirms extraction occurs on heathland or has caused any degradation of it. The threshold is lower than for any other criterion: even minor, localised degradation counts because the directive draws no distinction between degrees of harm
T1-8 Art. 29(4)(a) High carbon stock - Wetlands (land-use change trigger)	Reliable independent source(s) confirm no wetland conversion, drainage or degradation attributable to the site. OR criterion ecologically inapplicable (no wetland area)	Independent reliable source(s) indicates wetland loss attributable to oil but not specifically to the case study site. OR wetland degradation documented but direct cause to oil extraction contested in literature.	Reliable independent source(s) indicates extraction site directly overlaps with wetland and indicates wetland loss, conversion or degradation attributable to oil extraction
T1-9 Art. 29(4)(b/c) High carbon stock - Forest Carbon Stock (canopy cover thresholds)	Reliable independent source(s) confirm no significant post-2008 canopy loss attributable to the site. OR criterion ecologically inapplicable (no forest carbon stock area)	Reliable independent source(s) indicates forest/carbon loss at sectoral level without site-specific attribution. OR grey literature indicates clearance without independent verification.	Reliable independent source indicates measurable post-2008 canopy cover loss or carbon stock reduction directly attributable to extraction infrastructure at the case study site, above the relevant threshold
T1-10 Art. 29(5) High carbon stock - Peatland (drainage prohibition)	Reliable independent source(s) confirm no peatland is present within the extraction footprint, or that peat present was already drained prior to extraction operations. OR criterion inapplicable (no peatland area)	Reliable independent source(s) indicates peatland presence within or adjacent to the extraction site and confirms extraction operations, but does not specifically document drainage of previously undrained peat. OR evidence of peatland drainage at regional level without site-specific attribution.	Reliable source(s) indicates that extraction has involved drainage, excavation, or disturbance of peat layers at the extraction site, with evidence that the peat was previously undrained.

Table A.2: Compliance assessment scoring form – Tier 2 operational governance criteria (Art. 29(2),(6),(7)): minimum literature evidence required for each score.

Indicator	✓ Compliant	~ Partial	× Non-Compliant	○ Not Assessable
T2-1 Art.29(2)				
Soil Quality and Soil Carbon Monitoring	A documented monitoring and management plan for soil quality and soil carbon monitoring exists for the extraction site. AND Monitoring system is independently verified, results are submitted to a competent authority, and no significant lack of enforcement is observable.	A documented monitoring and management plan for soil quality and soil carbon monitoring exists for the extraction site but documentation shows significant lack of or only partial enforcement. OR framework exists but incomplete OR Data reliability is explicitly contested in literature.	No management plan for soil quality and soil carbon monitoring for the extraction site exists. Impacts on soil and carbon remain unmonitored	Whether a soil monitoring plan exists and is applied to this site cannot be determined from publicly accessible sources.
T2-2 Art.29(6)(i/iv)				
Legality of Extraction	A valid extraction license exists in the regulatory framework. AND the extraction site complies with all legally required obligations. AND no significant lack of enforcement observable.	A valid extraction licence exists in the regulatory framework and the site complies with legally required obligations, but documentation shows significant lack of or only partial enforcement. OR framework exists but incomplete	No valid extraction licence or mandatory regulatory framework exists. Extraction proceeds without legally required authorisation.	Whether a licensing framework exists and is applied to this site cannot be determined from publicly accessible literature.
T2-3 Art.29(6)(ii/v)				
Site Remediation / Ecological Recovery	A mandatory site remediation obligation exists in the regulatory framework. The extraction site complies with all legally required restoration targets. No significant lack of enforcement is observable.	A mandatory site remediation obligation exists in the regulatory framework, but documentation shows significant lack of or only partial enforcement. OR framework exists but incomplete OR Data reliability is explicitly contested in literature.	No mandatory site remediation obligation exists in the regulatory framework. Remediation of extraction sites is not conducted.	Whether a mandatory remediation framework exists and is applied to this site cannot be determined from publicly accessible sources.
T2-4 Art.29(6)(iv)				
Soil Quality/Biodiversity	A mandatory operational framework governing both physical disturbance management and discharge and contamination standards exists in the regulatory framework. The extraction site complies with all legally required operational obligations under both components. No significant lack of enforcement is observable.	A mandatory operational framework exists under one or both components, but documentation shows significant lack of or only partial enforcement. OR A mandatory operational framework exist for only one component. OR framework exists but incomplete OR Data reliability is explicitly contested in literature.	No mandatory operational framework exists for either component. Extraction operations proceed without legally required standards for physical disturbance or contamination control.	Whether a mandatory operational framework exists and is applied to this site cannot be determined from publicly accessible literature.
T2-5 Art.29(7)(a/b)				
Paris Agreement and NDC	Country is a Party to the Paris Agreement, has submitted an NDC covering land-use sectors, and national legislation operationalising these commitments exists.	Country is a Party and has submitted an NDC, but national legislation is absent, incomplete, or demonstrably unenforced at national level.	Country is not a Party to the Paris Agreement, or no national legislation addressing land-use governance exists.	It is always scoreable, so not applicable.

Table A.3: Alberta Oil Sands – Tier 1 Compliance Matrix

Code	Article	Score	Indicator	Argumentation
Tier 1 – Prohibitive Ecological Criteria (Art. 29(3)-(5))				
T1-1	Art. 29(3)(a)	Non-Compliant	Does published literature indicate that extraction infrastructure overlaps with or has caused loss of primary old-growth, or intact forest landscape at or traceable to the extraction site	Rosa et al. (2017) indicate surface mining leads to 100% net forest loss within the operational footprint, causing permanent fragmentation of primary boreal forest.
T1-2	Art. 29(3)(b)	Non-Compliant	Does literature indicate that the extraction site overlaps with or has caused measurable harm to species-rich, non-degraded forest habitat at or near the site?	Rosa et al. (2017) document significant forest loss and fragmentation across the boreal landscape. Alberta's Species at Risk Guide (ESRD, 2015) identifies multiple at risk boreal species. Oil and gas activities are explicitly listed a threat to their species-rich forest habitat.
T1-3	Art. 29(3)(c)(i)	Non-Compliant	Does literature indicate that extraction infrastructure is located within or causes documented harm to a legally designated protected area?	Though no direct spatial overlap is observable, Wheatley & Westman (2023) indicate that the upstream activities of oil extraction has negatively affected the ecological and hydrological conditions of the UNESCO listed Wood Buffalo National Park.
T1-4	Art. 29(3)(c)(ii)	Non-Compliant	Does literature document that extraction overlaps with or harms areas designated for protection of IUCN EN/CR or other internationally recognised rare, threatened or endangered ecosystems or species	The Boreal Caribou had been listed as Threatened under the SARA since 2003. The Recovery Strategy (Environment Canada, 2012) identifies five critical habitat areas which directly overlap with AOSR oil development (Cold lake, Richardson, Red Earth, West Side Athabasca River, and East Side Athabasca River).
T1-5	Art.29(3)(d)(i)	Compliant	Does literature indicate that extraction site overlaps with or has caused degradation of natural species-rich non-degraded grassland, as evidenced by documented decline in native plant species richness or formal national designation?	Ecologically Inapplicable: the AOSR is situated in the Boreal Forest region of Alberta. Alberta's Natural Regions map (ESRD, 2015) confirms no presence of Grassland.
T1-6	Art.29(3)(d)(ii)	Compliant	Does literature indicate that extraction site overlaps with or has caused degradation of non-natural species-rich non-degraded grassland, as evidenced by documented decline in native plant species richness or formal national designation?	Ecologically Inapplicable: same rationale as T1-5.
T1-7	Art. 29(3)(e)	Compliant	Does literature document any extraction on heathland?	Ecologically Inapplicable: Heathland ecosystems are not present in AOSR.
T1-8	Art. 29(4)(a)	Non-Compliant	Does literature document that extraction has converted, drained, or degraded wetland systems at or attributable to the extraction site? Applied under both 2008 reference date (post-2008 conversion only) and current conditions (any documented conversion).	Volik et al. (2020) document that 895 km ² of wetlands were impacted by 2017, with a projected permanent net loss of 295 km ²
T1-9	Art. 29(4)(b/c)	Non-Compliant	Does literature indicate post-2008 forest/canopy clearance or carbon stock loss attributable to extraction infrastructure at the site, above the 30% canopy threshold (b) or 10–30% threshold without verified carbon maintenance (c)?	Rosa et al. (2017) document a net 10% forest cover change in the region since 2000. Mining operations cause total removal of canopy within extraction footprints,
T1-10	Art. 29(5)	Non-Compliant	Does literature indicate that extraction has involved drainage of previously undrained peat at or attributable to the extraction site? Applied under both 2008 reference date (post-2008 conversion only) and current conditions (any documented conversion)	Volik et al. (2020) document the removal of 295 km ² of peatlands and regional dewatering that lowers water tables by 15-25m. This constitutes as functional draining of previously undrained peat systems.
Tier summary (10 indicators):				Compliant: 3 Partial: 0 Non-Compliant: 7 Not Assessable: 0

Table A.4: Alberta Oil Sands – Tier 2 Compliance Matrix

Code	Article	Score	Indicator	Argumentation
Tier 2 – Operational Governance Criteria (Art. 29(2), 29(6)-(7))				
T2-1	Art.29(2)	Partial	Does literature indicate whether a monitoring plan for soil quality and hydrocarbon levels exists and is implemented?	A documented monitoring plan exists via the Oil Sands Monitoring (OSM) Program. However, the 2024-25 Annual Report documents challenges in delivering workplans and hiring (Alberta Environment and Protected Areas, 2025). Furthermore, scientific evidence (Boutin & Carpenter, 2017) indicates that sites near mining still exhibit altered vegetation and elevated pollutants compared to control sites, indicating it is not enforced.
T2-2	Art.29(6)(i/iv)	Compliant	Does published documentation indicate legality of extraction?	A comprehensive licensing framework exists under the Oil Sands Conservation Act (RSA 2000, c O-7), administered by the Alberta Energy Regulator (AER). The Government of Alberta's Introduction to Oil Sands Regulatory Processes confirms no extraction of bitumen can begin without a valid AER approval. No evidence of extraction proceeding without legal authorisation exists in literature.
T2-3	Art.29(6)(ii/v)	Partial	Does literature indicate whether decommissioned or inactive extraction sites have been formally remediated to pre-extraction ecological condition, or are on a documented and independently verified remediation trajectory?	A mandatory reclamation framework exists under the Environmental Protection and Enhancement Act (EPEA), which requires companies to submit conservation, reclamation, and closure plans throughout the life of in situ oil sands operations. Volik et al. 2020 indicate that majority of converted wetlands will not be returned to original status. Furthermore, enforcement is deficient as only 0,1% of land is reclaimed (Lothian, 2017).
T2-4	Art.29(6)(iv)	Partial	Does literature indicate whether operational discharge management meets established standards, or whether contamination attributable to operations is documented in receiving environments?	A regulatory framework for discharge management exists under the EPEA and is operationalised through Alberta's Contaminated Sites Policy Framework (Government of Alberta, 2023). However, Boutin & Carpenter, 2017 found elevated levels of PAH and metals in the soil and water near extraction site. The Oil Sands Monitoring Program (2025) documents delays and failure to execute monitoring activities. This indicates lack of enforcement.
T2-5	Art.29(7)(a/b)	Compliant	Does literature indicate whether the country of origin is a Party to the Paris Agreement and has submitted a Nationally Determined Contribution covering land-use sectors; and whether national legislation exists operationalising these land-use governance commitments?	Canada is a Party to the Paris Agreement. Canada's NDC, submitted to the UNFCCC, covers agriculture, forestry and land-use sectors, including AFOLU emissions and removals. The Canadian Net-Zero Emissions Accountability Act (2021) establishes the national legislative framework operationalising these governance commitments.
<i>Tier summary (5 indicators):</i>				Compliant: 2 Partial: 3 Non-Compliant: 0 Not Assessable: 0
Overall (15 indicators):				Compliant: 5 Partial: 3 Non-Compliant: 7 Not Assessable: 0

Table A.5: Ekofisk, Norway – Tier 1 Compliance Matrix

Code	Article	Score	Indicator	Argumentation
Tier 1 – Prohibitive Ecological Criteria (Art. 29(3)-(5))				
T1-1	Art. 29(3)(a)	Compliant	Does published literature indicate that extraction infrastructure overlaps with or has caused loss of primary old-growth, or intact forest landscape at or traceable to the extraction site	Ekofisk is an offshore field in the North Sea, criterion inapplicable.
T1-2	Art. 29(3)(b)	Compliant	Does literature indicate that the extraction site overlaps with or has caused measurable harm to species-rich, non-degraded forest habitat at or near the site?	Same reasoning, offshore, ecologically inapplicable.
T1-3	Art. 29(3)(c)(i)	Compliant	Does literature indicate that extraction infrastructure is located within or causes documented harm to a legally designated protected area?	No literature was found confirming or disproving whether Ekofisk falls within a designated marine protected area. A visual scan of the official OSPAR MPA map (MAIA Network/OFB, accessed May 2026) shows no overlap.
T1-4	Art. 29(3)(c)(ii)	Compliant	Does literature document that extraction overlaps with or harms areas designated for protection of IUCN EN/CR or other internationally recognised rare, threatened or endangered ecosystems or species	No literature documents that Ekofisk extraction overlaps with a designated area specifically established for the protection of IUCN EN/CR or equivalent threatened species. However, the harbour porpoise is an OSPAR-listed threatened and declining species for the Greater North Sea region in general. However, no site-specific designation for threatened species protection exists at or near the Ekofisk location (OSPAR, 2023; MAIA Network/OFB, accessed May 2026)
T1-5	Art.29(3)(d)(i)	Compliant	Does literature indicate that extraction site overlaps with or has caused degradation of natural species-rich non-degraded grassland, as evidenced by documented decline in native plant species richness or formal national designation?	Offshore, ecologically inapplicable.
T1-6	Art.29(3)(d)(ii)	Compliant	Does literature indicate that extraction site overlaps with or has caused degradation of non-natural species-rich non-degraded grassland, as evidenced by documented decline in native plant species richness or formal national designation?	Offshore, ecologically inapplicable.
T1-7	Art. 29(3)(e)	Compliant	Does literature document any extraction on heathland?	Offshore, ecologically inapplicable.
T1-8	Art. 29(4)(a)	Compliant	Does literature document that extraction has converted, drained, or degraded wetland systems at or attributable to the extraction site? Applied under both 2008 reference date (post-2008 conversion only) and current conditions (any documented conversion).	Offshore extraction does not involve land conversion, ecologically inapplicable.
T1-9	Art. 29(4)(b/c)	Compliant	Does literature indicate post-2008 forest/canopy clearance or carbon stock loss attributable to extraction infrastructure at the site, above the 30% canopy threshold (b) or 10–30% threshold without verified carbon maintenance (c)?	Offshore, ecologically inapplicable.
T1-10	Art. 29(5)	Compliant	Does literature indicate that extraction has involved drainage of previously undrained peat at or attributable to the extraction site? Applied under both 2008 reference date (post-2008 conversion only) and current conditions (any documented conversion)	Offshore, ecologically inapplicable.
Tier summary (10 indicators):				Compliant: 10 Partial: 0 Non-Compliant: 0 Not Assessable: 0

Table A.6: Ekofisk, Norway – Tier 2 Compliance Matrix

Code	Article	Score	Indicator	Argumentation
Tier 2 – Operational Governance Criteria (Art. 29(2), 29(6)-(7))				
T2-1	Art.29(2)	Compliant	Does literature indicate whether a monitoring plan for soil quality and hydrocarbon levels exists and is implemented?	Though soil not directly applicable in offshore context, the Norwegian Environment Agency Guidelines (2020) require mandated monitoring of hydrocarbon levels, sediment quality and marine fauna. Ekofisk is explicitly listed in region I and subject to surveys every 3 years. Beyer et al. (2025) confirms that Ekofisk extraction is functionally in line with environmental standards.
T2-2	Art.29(6)(i/iv)	Compliant	Does published documentation indicate legality of extraction?	Ekofisk extraction is conducted under Production Licence 018, governed by the Norwegian Petroleum Act (Act of 29 November 1996 No. 72). This act requires companies to obtain licences and approval for all phases of petroleum activities (Norwegian Petroleum/Ministry of Energy & Norwegian Offshore Directorate, 2025). The licence was extended to 2048 by the Norwegian Ministry of Energy. This confirms active legal status (ConocoPhillips Norway, 2022).
T2-3	Art.29(6)(ii/v)	Compliant	Does literature indicate whether decommissioned or inactive extraction sites have been formally remediated to pre-extraction ecological condition, or are on a documented and independently verified remediation trajectory?	Ekofisk decommissioning is governed by the Norwegian Petroleum Act and the OSPAR Convention, which require a formal decommissioning plan and the removal of facilities at the end (Norwegian Petroleum/Ministry of Energy & Norwegian Offshore Directorate, 2025). 14 Ekofisk installations were removed and recycled between 2005 and 2021 (Sandberg, Norwegian Petroleum Museum, 2022). Beyer et al. 2025 confirms that substantial regional sediment and macrofauna recovery can be observed when cutting discharges.
T2-4	Art.29(6)(iv)	Compliant	Does literature indicate whether operational discharge management meets established standards, or whether contamination attributable to operations is documented in receiving environments?	Operational discharge management at Ekofisk is governed by the Norwegian Environment Agency's Guidelines M-408 (2020). It mandates the monitoring of hydrocarbons, metals and biological impacts. Beyer et al. (2025) confirm that produced water discharges comply with the zero-adverse-effect goal set by Norwegian authorities.
T2-5	Art.29(7)(a/b)	Compliant	Does literature indicate whether the country of origin is a Party to the Paris Agreement and has submitted a Nationally Determined Contribution covering land-use sectors; and whether national legislation exists operationalising these land-use governance commitments?	Norway is a Party to the Paris Agreement and has submitted NDCs covering national emissions commitments (UNFCCC, 2025). The Climate Change Act (2017) establishes comprehensive national legislation operationalising these governance commitments.
<i>Tier summary (5 indicators):</i>				Compliant: 5 Partial: 0 Non-Compliant: 0 Not Assessable: 0
Overall (15 indicators):				Compliant: 15 Partial: 0 Non-Compliant: 0 Not Assessable: 0

Table A.7: Niger Delta, Nigeria – Tier 1 Compliance Matrix

Code	Article	Score	Indicator	Argumentation
Tier 1 – Prohibitive Ecological Criteria (Art. 29(3)-(5))				
T1-1	Art. 29(3)(a)	Partial	Does published literature indicate that extraction infrastructure overlaps with or has caused loss of primary old-growth, or intact forest landscape at or traceable to the extraction site	Ogbeibu and Oribhabor (2023) document oil-caused fragmentation and deforestation across the Delta's mangrove and swamp forest systems. However, no independent source explicitly classifies the affected areas as primary or old-growth under Nigerian law.
T1-2	Art. 29(3)(b)	Partial	Does literature indicate that the extraction site overlaps with or has caused measurable harm to species-rich, non-degraded forest habitat at or near the site?	Ogbeibu & Oribhabor (2023) describe the Niger Delta as a biodiversity hotspot with exceptional species richness across flora and fauna. This has been confirmed by multiple peer-reviewed sources. However, the same source explicitly states the region has not been formally recognised as highly biodiverse by any international competent authority. This absence of a formal competent authority designation required by Article 29(3)(b) prevents a non-compliant score despite documented oil-caused harm (Lawson et al., 2022)(Ansah et al., 2022).
T1-3	Art. 29(3)(c)(i)	Non-Compliant	Does literature indicate that extraction infrastructure is located within or causes documented harm to a legally designated protected area?	Ansah et al. (2022) document 322 oil spills inside 18 Niger Delta protected area (2016-2020). The Apoi Creek Ramsar Site suffered the highest impact with over 45 spills. They further indicate that wellheads, pipelines and flow stations directly operate inside the Ramsar boundaries. This proves direct infrastructure overlap and attributable ecological harm.
T1-4	Art. 29(3)(c)(ii)	Non-Compliant	Does literature document that extraction overlaps with or harms areas designated for protection of IUCN EN/CR or other internationally recognised rare, threatened or endangered ecosystems or species	The Apoi Creek Ramsar Site was designated specifically to protect the endemic, critically endangered Niger Delta Red Colobus Monkey. Same argument as above applies (Ansah et al., 2022).
T1-5	Art.29(3)(d)(i)	Compliant	Does literature indicate that extraction site overlaps with or has caused degradation of natural species-rich non-degraded grassland, as evidenced by documented decline in native plant species richness or formal national designation?	The Niger Delta is a tropical wetland system, criterion inapplicable.
T1-6	Art.29(3)(d)(ii)	Compliant	Does literature indicate that extraction site overlaps with or has caused degradation of non-natural species-rich non-degraded grassland, as evidenced by documented decline in native plant species richness or formal national designation?	Same reasoning, ecologically inapplicable.
T1-7	Art. 29(3)(e)	Compliant	Does literature document any extraction on heathland?	Same reasoning, ecologically inapplicable.
T1-8	Art. 29(4)(a)	Non-Compliant	Does literature document that extraction has converted, drained, or degraded wetland systems at or attributable to the extraction site? Applied under both 2008 reference date (post-2008 conversion only) and current conditions (any documented conversion).	Lawson et al. (2022) indicate that half of the Delta is covered by mangrove and freshwater swamp forests, with the construction of pipelines and dredging of channels leading to wetland conversion. They further indicate that the Niger delta has one of the three largest oil infrastructure overlap with peatland in the world. Alao et al. (2025) further document the contamination and degradation of the wetland system.
T1-9	Art. 29(4)(b/c)	Non-Compliant	Does literature indicate post-2008 forest/canopy clearance or carbon stock loss attributable to extraction infrastructure at the site, above the 30% canopy threshold (b) or 10–30% threshold without verified carbon maintenance (c)?	Ansah et al. (2022) document that forest cover was the land-cover type most heavily affected by oil spills between 2016-2020. 848 recorded spill incidents occurred in tree cover areas. They also note that approximately 12% of mangrove cover was lost between 2007 and 2017. Ogbeibu & Oribhabor (2023) further document that disturbed areas are permanently replaced by invasive Nipa palm, resulting in no natural forest carbon stock recovery.
T1-10	Art. 29(5)	Non-Compliant	Does literature indicate that extraction has involved drainage of previously undrained peat at or attributable to the extraction site? Applied under both 2008 reference date (post-2008 conversion only) and current conditions (any documented conversion)	Lawson et al. (2022) indicate that 8,3% of tropical peatlands directly overlaps with oil infrastructure and that dredging and pipeline have directly altered the hydrology of the peatland.
Tier summary (10 indicators):				Compliant: 3 Partial: 2 Non-Compliant: 5 Not Assessable: 0

Table A.8: Niger Delta, Nigeria – Tier 2 Compliance Matrix

Code	Article	Score	Indicator	Argumentation
Tier 2 – Operational Governance Criteria (Art. 29(2), 29(6)-(7))				
T2-1	Art.29(2)	Partial	Does literature indicate whether a monitoring plan for soil quality and hydrocarbon levels exists and is implemented?	A mandatory soil and environment monitoring framework exist under te Nigerian upstream regulation. This regualtion requires periodic environmental evaluation studies, documentation of baselines and the registration of pulsted sites. However, the Nigerian Petroleum Policy (2017) explicitly acknowledges the lack of enforcement capcity. Furhtermore, Adeola et al. (2022) document unmonitored soil contamination across extraction sites in the Delta.
T2-2	Art.29(6)(i/iv)	Partial	Does published documentation indicate legality of extraction?	A comprehensive licensing framework exist under the Petroleum Industry Act (2021), administered by the Nigerian Upstream Petroleum Regulatory Comission. All extraction requires licencing. However, the effectiveness of the legal framework is considered weak as illegal crude oil extraction occurs heavily Daukere (2025). He further indicates that both the poor rule of law and corruption are considered factors that undermine the governance effectiveness and enforcement.
T2-3	Art.29(6)(ii/v)	Partial	Does literature indicate whether decommissioned or inactive extraction sites have been formally remediated to pre-extraction ecological condition, or are on a documented and independently verified remediation trajectory?	A mandatory remediation and decommissioning framework exists. This requires operators to restore impacted environments to their original state, maintain a decommissioning fund and continue to have liability for remediation (PIA, 2021; NOSDRA, 2006; NUPRC, 2022). NOSDRA's own data estimate that over 92% of crude oil-contaminated sites in the Niger Delta remained unremediated as of 2021, with minimal scheduled cleanup (Adeniran et al., 2023). The UNEP Environemnetal Asessement of Ogoniland (2011) established the remediation mandate and address the sclae of contamination.
T2-4	Art.29(6)(iv)	Partial	Does literature indicate whether operational discharge management meets established standards, or whether contamination attributable to operations is documented in receiving environments?	A mandatory operational framework governing discharge and contamination standards exists in Nigerian upstream petroleum regulation (UPER, 2022; PIA, 2021). However, Lawson et al. (2022) indicate that levels of hydrocarbons and heavy metals exceeded regulatory levels due to produced water spills. Alao et al. (2025) also indicate water and soil contamination reaching far beyond international safety limits.
T2-5	Art.29(7)(a/b)	Compliant	Does literature indicate whether the country of origin is a Party to the Paris Agreement and has submitted a Nationally Determined Contribution covering land-use sectors; and whether national legislation exists operationalising these land-use governance commitments?	Nigeria is a Party to the Paris Agreement. Nigeria's Third Nationally Determined Contribution (NDC 3.0, 2025) covers land-use sectors including explicit LULUCF commitments. The Climate Change Act (2021) establishes the national legislative framework.
Tier summary (5 indicators):				Compliant: 1 Partial: 4 Non-Compliant: 0 Not Assessable: 0
Overall (15 indicators):				Compliant: 4 Partial: 6 Non-Compliant: 5 Not Assessable: 0

Table A.9: Ghawar, Saudi Arabia – Tier 1 Compliance Matrix

Code	Article	Score	Indicator	Argumentation
Tier 1 – Prohibitive Ecological Criteria (Art. 29(3)-(5))				
T1-1	Art. 29(3)(a)	Compliant	Does published literature indicate that extraction infrastructure overlaps with or has caused loss of primary old-growth, or intact forest landscape at or traceable to the extraction site	The Ghawar oil field is located in an arid desert system, so criterion ecologically inapplicable
T1-2	Art. 29(3)(b)	Compliant	Does literature indicate that the extraction site overlaps with or has caused measurable harm to species-rich, non-degraded forest habitat at or near the site?	Same reasoning, ecologically inapplicable
T1-3	Art. 29(3)(c)(i)	Compliant	Does literature indicate that extraction infrastructure is located within or causes documented harm to a legally designated protected area?	No formally designated protected areas are located within or immediately adjacent to the Ghawar oil field. The Al-Ahsa Oasis UNESCO World Heritage Site overlaps with the field boundary but is designated as a cultural landscape, not a natural protected area. All other protected areas are located so far away that they cannot be influenced by the oil extraction site.
T1-4	Art. 29(3)(c)(ii)	Compliant	Does literature document that extraction overlaps with or harms areas designated for protection of IUCN EN/CR or other internationally recognised rare, threatened or endangered ecosystems or species	No formally designated protected areas or protected species are located within or immediately adjacent to the Ghawar oil field. The Al-Ahsa Oasis UNESCO World Heritage Site overlaps with the field boundary but is designated as a cultural landscape, not a natural protected area. All other protected areas are located so far away that they cannot be influenced by the oil extraction site.
T1-5	Art.29(3)(d)(i)	Compliant	Does literature indicate that extraction site overlaps with or has caused degradation of natural species-rich non-degraded grassland, as evidenced by documented decline in native plant species richness or formal national designation?	Arid desert system, ecologically inapplicable
T1-6	Art.29(3)(d)(ii)	Compliant	Does literature indicate that extraction site overlaps with or has caused degradation of non-natural species-rich non-degraded grassland, as evidenced by documented decline in native plant species richness or formal national designation?	Arid desert system, ecologically inapplicable
T1-7	Art. 29(3)(e)	Compliant	Does literature document any extraction on heathland?	Arid desert system, ecologically inapplicable
T1-8	Art. 29(4)(a)	Compliant	Does literature document that extraction has converted, drained, or degraded wetland systems at or attributable to the extraction site? Applied under both 2008 reference date (post-2008 conversion only) and current conditions (any documented conversion).	Arid desert system, ecologically inapplicable
T1-9	Art. 29(4)(b/c)	Compliant	Does literature indicate post-2008 forest/canopy clearance or carbon stock loss attributable to extraction infrastructure at the site, above the 30% canopy threshold (b) or 10–30% threshold without verified carbon maintenance (c)?	Arid desert system, ecologically inapplicable
T1-10	Art. 29(5)	Compliant	Does literature indicate that extraction has involved drainage of previously undrained peat at or attributable to the extraction site? Applied under both 2008 reference date (post-2008 conversion only) and current conditions (any documented conversion)	Arid desert system, ecologically inapplicable
Tier summary (10 indicators):				Compliant: 10 Partial: 0 Non-Compliant: 0 Not Assessable: 0

Table A.10: Ghawar, Saudi Arabia – Tier 2 Compliance Matrix

Code	Article	Score	Indicator	Argumentation
Tier 2 – Operational Governance Criteria (Art. 29(2), 29(6)-(7))				
T2-1	Art.29(2)	<i>Not Assessable</i>	Does literature indicate whether a monitoring plan for soil quality and hydrocarbon levels exists and is implemented?	The Executive Regulation for the Prevention and Remediation of Soil Pollution (MEWA, 2021, Art. 2) applies to all persons in Saudi Arabia and includes explicit hydrocarbon contamination threshold. However, Saudi Aramco's upstream operations self-regulate via internal engineering standards under Ministry of Energy oversight rather than national MEWA/NCEC frameworks (World Bank Flaring Regulations Database, 2024). There could be no independent literature found whether Soil Quality and soil carbon monitoring plans have been applied or enforced at the Ghawar site.
T2-2	Art.29(6)(i/iv)	Partial	Does published documentation indicate legality of extraction?	Saudi Aramco operates under a 60-year contract granted in 2017, and expiring December 31, 2077. It explicitly covers the Ghawar field (Weijermars & Al-Shehri, 2022). The Basic Law of Saudi Arabia (Royal Decree No. A/90, 1992) vests all oil and gas wealth in the government, with Saudi Aramco established by Royal Decree in 1988 as the only entity authorised for upstream extraction. The legality of extraction is therefore clearly established. However, the specific terms and compliance obligations of the concession agreement are not publicly accessible.
T2-3	Art.29(6)(ii/v)	<i>Not Assessable</i>	Does literature indicate whether decommissioned or inactive extraction sites have been formally remediated to pre-extraction ecological condition, or are on a documented and independently verified remediation trajectory?	The Executive Regulations for the Environmental Rehabilitation of Degraded Sites (MEWA, 2021, Art. 2, 4) formally apply to all sites in Saudi Arabia. However, Saudi Aramco's upstream operations self-regulate under Ministry of Energy oversight rather than the NCEC-administered national framework (World Bank Flaring Regulations Database, 2024). There could be no independent literature found whether remediation obligations have been applied or enforced at the Ghawar site.
T2-4	Art.29(6)(iv)	<i>Not Assessable</i>	Does literature indicate whether operational discharge management meets established standards, or whether contamination attributable to operations is documented in receiving environments?	The Environmental Law (Royal Decree M/165, 2021, Art. 6, 11) and the Soil Pollution Regulation (MEWA, 2021, Art. 7) prohibit discharge and contamination activities nationally. Again, Aramco upstream operations fall under Ministry of Energy rather than NCEC oversight (World Bank Flaring Regulations Database, 2024), and therefore no independent literature indicates whether operational discharge standards are applied or enforced at the Ghawar extraction site.
T2-5	Art.29(7)(a/b)	Compliant	Does literature indicate whether the country of origin is a Party to the Paris Agreement and has submitted a Nationally Determined Contribution covering land-use sectors; and whether national legislation exists operationalising these land-use governance commitments?	Saudi Arabia is a Party to the Paris Agreement. The Second NDC (KSA NDC, 2025) formally covers LULUCF, but commitments are focused on desertification and afforestation rather than broad land-use governance. National legislation exists under the Environmental Law (Royal Decree M/165, 2021).
Tier summary (5 indicators):				Compliant: 1 Partial: 1 Non-Compliant: 0 Not Assessable: 3
Overall (15 indicators):				Compliant: 11 Partial: 1 Non-Compliant: 0 Not Assessable: 3