

Resource Efficiency Indicators

Provides guidance on compiling resource efficiency indicators from ocean accounts: ratios that relate economic outputs to physical resource inputs.

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OUTCOME

This Circular provides guidance on compiling resource efficiency indicators from ocean accounts: ratios that relate economic outputs to physical resource inputs and indicate how effectively ocean industries transform natural capital into economic value. Indicators compiled using this guidance feed directly into budget and planning processes described in [TG-1.1 Budget Processes](#). Prerequisites and cross-references are listed in Section 2.

Upon completing this Circular, readers will understand (1) the conceptual framework for resource efficiency indicators, (2) compilation procedures for deriving material efficiency indicators for fish, water, and energy, (3) methods for computing decoupling indicators that track the relationship between economic growth and resource use, (4) approaches to circular economy indicators for waste, recycling, and resource recovery, and (5) practical applications to sector-specific efficiency metrics for fisheries, aquaculture, maritime transport, and offshore energy.

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ABOUT THIS CIRCULAR

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DRAFT

¶1 ⓘ Framework Position

¶2 TG-2.11 sits at the intersection of the monetary accounts (Section 3) and indicator synthesis (Section 2). It draws on physical flow data from TG-3.2 and economic measures from TG-3.3 to produce efficiency ratios that are consumed by TG-1.1 for budget policy reporting. Compilers who have not yet completed TG-3.3 should do so before applying this Circular.

1. Outcome

¶1 This Circular provides guidance on compiling resource efficiency indicators from ocean accounts: ratios that relate economic outputs to physical resource inputs and indicate how effectively ocean industries transform natural capital into economic value. Indicators compiled using this guidance feed directly into budget and planning processes described in **TG-1.1 Budget Processes**. Prerequisites and cross-references are listed in Section 2.

¶2 Upon completing this Circular, readers will understand (1) the conceptual framework for resource efficiency indicators, (2) compilation procedures for deriving material efficiency indicators for fish, water, and energy, (3) methods for computing decoupling indicators that track the relationship between economic growth and resource use, (4) approaches to circular economy indicators for waste, recycling, and resource recovery, and (5) practical applications to sector-specific efficiency metrics for fisheries, aquaculture, maritime transport, and offshore energy.

2. Requirements

¶1 This Circular requires familiarity with:

- ¶2 **TG-0.1 General Introduction to Ocean Accounts** – for the conceptual framework connecting ecosystems, flows, and economic activity
- ¶3 **TG-0.2 Overview of Relevant Statistical Standards** – for the international statistical standards underpinning ocean accounting, including SNA 2025, SEEA CF, and classification systems
- ¶4 **TG-3.3 Economic Activity** – for the economic measures (output, value added, GDP) that serve as the numerator in efficiency indicators, and for supply and use table structures that provide coherent economic data

¶5 For additional context on physical flow accounting, see **TG-3.2 Flows from Environment to Economy**. For guidance on linking efficiency indicators to environmental asset stocks, see **TG-3.1 Asset Accounts**. For guidance on residual flows that inform circular economy indicators, see **TG-3.4 Flows from Economy to Environment**.

3. Guidance Material

¶1 The SEEA Central Framework identifies resource efficiency and productivity indicators as a key application of environmental-economic accounting, noting that topics covered include “resource efficiency and productivity indicators, decomposition analysis, analysis of net wealth and depletion, sustainable production and consumption, input-output analysis and general equilibrium modelling”¹. The SEEA Applications and Extensions publication provides additional detailed guidance on constructing and interpreting resource efficiency indicators within the environmental-economic accounting framework. Compilers should consult that publication alongside this Circular for extended methodological guidance².

¶2 This circular covers four resource efficiency indicator types (material efficiency, energy intensity³, water intensity⁴, and decoupling). Material, energy and water efficiency are covered in

Section 3.2 and decoupling in Section 3.3; Sections 3.4 and 3.5 add circular economy and sector-specific indicators.

3.1 Resource Efficiency Framework

¶1 Resource efficiency indicators express the relationship between economic outputs and natural resource inputs. The SEEA Central Framework establishes that combined presentations of physical and monetary data “structure information in a manner that supports the derivation of combined indicators, for example, decoupling indicators which track the relationship between the use of resources and growth in production and consumption”⁵.

Decision use cases

¶1 Resource efficiency indicators for the ocean economy serve four primary decision contexts:

¶2 **Circular ocean economy tracking** – governments committed to circular economy transitions require indicators that demonstrate whether ocean industries are reducing material throughput per unit of output, increasing recycling and reuse rates, and closing material loops. The European Commission’s Circular Economy Action Plan and similar national strategies call for monitoring progress through material flow indicators, waste generation rates, and recycling performance metrics⁶.

¶3 **Decoupling analysis** – SDG Target 8.4 explicitly requires countries to “improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation”⁷. Resource efficiency indicators provide the empirical evidence to demonstrate whether ocean economy growth is accompanied by declining resource intensity (relative decoupling) or absolute reductions in resource extraction (absolute decoupling).

¶4 **SDG 12 reporting** – SDG Target 12.2 calls for achieving “sustainable management and efficient use of natural resources” by 2030⁸. The SDG indicator framework includes material footprint per capita and per GDP (indicators 8.4.1 and 12.2.1) as headline measures of progress⁹. Ocean economy resource efficiency indicators contribute directly to national reporting under these frameworks.

¶5 **Green growth measurement** – ministries of finance and planning agencies require evidence that ocean economy growth is compatible with environmental sustainability objectives. Resource efficiency indicators provide quantified metrics for budget presentations, medium-term expenditure frameworks, and national development plans¹⁰.

Basic indicator structure

¶1 Resource efficiency indicators follow a general ratio structure:

$$\text{Resource Efficiency} = \text{Economic Output} / \text{Resource Input}$$

¶2 Where:

- ¶3 **Economic output** may be measured as gross value added (GVA), gross output, or GDP, drawn from the economic accounts described in **TG-2.5 Ocean Economy Structure** and **TG-3.3 Economic Activity**
- ¶4 **Resource input** is measured in physical terms: tonnes of fish extracted, cubic metres of water abstracted, or joules of energy consumed, drawn from physical flow accounts described in **TG-3.2 Flows from Environment to Economy**

¶5 The reciprocal formulation—resource intensity—expresses resource input per unit of economic output:

$$\text{Resource Intensity} = \text{Resource Input} / \text{Economic Output}$$

¶6 Both formulations provide valid analytical perspectives. Resource efficiency emphasises productivity gains (higher values indicate improvement), whilst resource intensity emphasises resource requirements (lower values indicate improvement). The SEEA Energy notes that “indicators of energy efficiency, energy expenditures by different industries and households, and energy intensity” can be derived through combined presentations¹¹.

Selecting the economic measure

¶1 The choice of economic measure in the numerator (or denominator for intensity indicators) affects interpretation and should be made deliberately. Three principal measures are available from the ocean economy thematic and extended accounts described in **TG-3.3 Economic Activity** Section 3.4:

- ¶2 **Gross value added (GVA)** is typically preferred for industry-level analysis because it excludes intermediate consumption, providing a cleaner measure of the value created by an industry from its resource inputs. GVA enables comparison across industries of different sizes and structures. The derivation of GVA from supply and use tables is described in **TG-2.5** Section 3.7.
- ¶3 **Gross output** may be more appropriate for productivity analysis within a single industry, as it captures the total volume of production and thus better reflects physical throughput. However, gross output can be inflated by high intermediate consumption, potentially misrepresenting efficiency.
- ¶4 **GDP** is appropriate only for economy-wide analysis of the total ocean economy’s resource efficiency, as it aggregates across all industries.

¶5 Compilers should document which economic measure is used and ensure consistency across time series.

Dimensions of resource efficiency

¶1 Resource efficiency can be analysed across the dimensions summarised in Table 3.1.1 below.¹²

Dimension	Description
Material efficiency	The physical quantity of natural resources (fish, minerals, water) required per unit of economic output.
Energy efficiency	The quantity of energy required per unit of economic output or per unit of physical output.
Water efficiency	The volume of water abstracted or consumed per unit of economic output.
Carbon efficiency	Greenhouse gas emissions per unit of economic output (addressed in TG-2.8 Climate Indicators).

¶2 For ocean accounting, material efficiency is particularly relevant for fisheries and mineral extraction, energy efficiency for maritime transport and offshore energy, and water efficiency for aquaculture and coastal industries.

Resource Efficiency Indicator Specifications

¶1 This circular covers four resource efficiency indicator types (material efficiency, energy intensity, water intensity, and decoupling). Material, energy and water efficiency are covered in Section 3.2 and decoupling in Section 3.3; Sections 3.4 and 3.5 add circular economy and sector-specific indicators.

Analytical levels

¶1 Resource efficiency indicators can be compiled at the analytical levels summarised in Table 3.1.2 below.

Level	Description
Economy-wide	Comparing total ocean economy GVA to total ocean resource use.
Industry-level	Comparing value added or output for specific ocean industries (fishing, shipping, offshore energy) to resource inputs for those industries.
Establishment-level	Comparing output of individual enterprises to their resource consumption (typically available only through survey or administrative data).

¶2 The industry-level analysis is typically most useful for policy, as it reveals differential efficiency across ocean sectors and identifies opportunities for improvement. The SEEA Energy provides example analyses at the industry level, showing “energy intensities for selected industries” that enable comparison across sectors¹³.

¶3 When moving between analytical levels, compilers must observe the following aggregation rules. Efficiency ratios must never be averaged across industries. Averaging ratio values produces misleading results because the importance of each industry (its share of total resource use and total output) is not preserved. Economy-wide indicators must instead be computed by summing the numerator and denominator separately across all relevant industries, then computing the aggregate ratio from those sums. For example, the correct economy-wide fish productivity indicator is total fishing-sector GVA divided by total gross catch – not the average of individual fleet or sub-sector fish productivity ratios. **Cross-resource aggregation** combines fish productivity, energy intensity, and water productivity into a single composite efficiency score. This is not supported by SEEA methodology and should not be attempted without an explicit weighting framework such as environmental cost weights derived from SEEA Ecosystem Accounts. To illustrate the correct approach: if Industry A has GVA of 100 and resource input of 50, and Industry B has GVA of 400 and resource input of 300, the correct aggregate efficiency is $(100 + 400) / (50 + 300) = 1.43$, not the average of the two industry ratios (2.0 and 1.33), which yields 1.67 – an overestimate that misrepresents the aggregate productivity of the sector.

3.2 Material Efficiency Indicators

¶1 Material efficiency indicators measure the relationship between physical resource extraction and economic output. For ocean resources, the primary materials of interest are fish and other aquatic biomass, seawater (for desalination and industrial use), and seabed minerals.

Fish productivity

¶1 Fish productivity indicators relate the value of fishing industry output to the physical quantity of fish extracted. Following SEEA CF guidance on aquatic resources¹⁴, the key physical measure is **gross catch**—the total live weight of fish caught, including discarded catch but excluding pre-catch losses. This measure aligns with the physical flow accounts described in **TG-3.2 Flows from Environment to Economy**.

¶2 Key fish productivity indicators include:

¶3 **Value added per tonne of catch** – the gross value added of the fishing industry divided by total catch weight:

$$\text{Fish Productivity (\$/tonne)} = \text{Fishing Industry GVA} / \text{Gross Catch (tonnes)}$$

¶4 This indicator reveals how much economic value is generated per unit of fish extracted. Higher values may indicate higher-value species composition, more value-added processing, or improved market access. However, compilers should be aware that high economic efficiency is compatible

with overfishing if prices rise as stocks decline—a phenomenon that can occur when scarcity drives up market prices for depleted species. For this reason, fish productivity indicators should always be interpreted alongside sustainability indicators. SDG indicator 14.4.1 measures “proportion of fish stocks within biologically sustainable levels”¹⁵, and the fisheries stock assessment methods described in **TG-6.7 Fisheries Stock Assessment** provide complementary measures of biological sustainability.

¶5 **Fallback hierarchy for discard data unavailability.** In many developing economies and some developed ones, official fisheries statistics record only landed weight. Discard estimates are produced by fisheries science bodies rather than national statistics offices and may not be available for all fisheries. Compilers should apply the following fallback hierarchy:

1. ¶6 **Gross catch (preferred)** – use total live weight including discards where observer programme data or scientific discard estimates are available. This is the measure recommended by SEEA CF paras 5.428–5.429.
2. ¶7 **Landed catch with documentation** – where discard data do not exist, substitute landed catch and document the indicator as “landed fish productivity” rather than “gross catch productivity.” This note must appear in the metadata and the indicator table.
3. ¶8 **Bounded estimate** – where partial discard data exist (for example, observer coverage for trawl fleets only), compute a bounded estimate using the observed discard rate as a lower bound and an assumed upper bound from comparable fisheries, and report the resulting range explicitly.

¶9 Where discard data are systematically unavailable, compilers should consult **TG-6.7 Fisheries Stock Assessment** for stock assessment-based discard estimates that can supplement national statistics office data.

¶10 **Catch per unit of effort (CPUE)** – whilst not strictly an economic efficiency indicator, CPUE relates physical catch to fishing effort and provides insight into the productivity of fishing operations and the abundance of fish stocks. CPUE is addressed in detail in **TG-6.7 Fisheries Stock Assessment**.

¶11 **Sustainable yield ratio** – comparing actual extraction to estimated maximum sustainable yield (MSY) for managed fish stocks, providing a complementary perspective on resource sustainability.

Water productivity

¶1 Water productivity indicators relate economic output to water abstraction and consumption. The SEEA-Water framework provides detailed guidance on water intensity and productivity measurement¹⁶.

¶2 For ocean contexts, relevant water productivity indicators include:

¶3 **Aquaculture water productivity** – the value added of aquaculture production divided by water use. The appropriate water use measure depends on the aquaculture system type. Compilers must not make cross-system comparisons without normalising to a consistent consumption basis:

System type	Denominator definition	Formula
Flow-through (ponds, raceways)	Water abstraction (intake volume)	Aquaculture GVA / Water abstraction (m ³)
Recirculating aquaculture systems (RAS) and closed ponds	Actual water consumption (abstraction minus return flows)	Aquaculture GVA / Water consumption (m ³)

¶4 The distinction between abstraction and consumption follows the SEEA-Water framework. Compilers should consult SEEA-Water Annex 3 Table A3.2 for the precise consumptive-use calculation methodology¹⁷. Using an intake-volume denominator for RAS systems, which recycle 90–99% of water internally, would produce artificially high water productivity figures that are not comparable with flow-through systems. Compilers working with mixed technology portfolios should

present system-specific productivity figures separately and note that aggregate comparisons require normalisation to consumption basis.

¶5 This indicator is relevant for aquaculture operations where water efficiency is a management priority¹⁸, as described in **TG-3.9 Aquaculture Accounts**.

¶6 **Desalination efficiency** – the ratio of freshwater output to energy input in desalination operations, relevant for coastal communities dependent on desalination.

¶7 **Industrial water intensity** – for coastal industries using seawater for cooling or processing, the volume of water abstracted per unit of output.

Energy productivity

¶1 Energy productivity indicators relate economic output to energy consumption. The SEEA Energy framework provides extensive guidance on energy intensity indicators¹⁹.

¶2 Key ocean-related energy productivity indicators include:

¶3 **Maritime transport energy intensity** – energy consumption per tonne-kilometre of freight or per passenger-kilometre:

$$\text{Shipping Energy Intensity} = \text{Energy Use (joules)} / \text{Transport Output (tonne-km)}$$

¶4 This indicator is central to monitoring decarbonisation progress in the maritime sector and relates to climate indicators described in **TG-2.8 Climate Indicators**. Energy intensity indicators for maritime transport must be disaggregated by fuel type to support decarbonisation tracking. Aggregating all fuel types into a single joules figure masks fuel substitution trends: a vessel switching from heavy fuel oil to liquefied natural gas (LNG) may show declining energy intensity under a single-fuel metric even if actual greenhouse gas emissions do not decline proportionally. Compilers should therefore report three sub-indicators for maritime transport energy intensity:

- ¶5 **(a) Total energy intensity** – all fuels expressed in tonnes of oil equivalent (toe), used for overall productivity comparisons;
- ¶6 **(b) Fossil energy intensity** – petroleum products and natural gas only, in toe, used for tracking fossil fuel dependency;
- ¶7 **(c) Renewable energy share** – the proportion of total energy consumption sourced from renewables (biofuels, shore power, wind assist, hydrogen), expressed as a percentage.

¶8 The fuel-type classification follows SEEA Energy Chapter 4 on energy supply and use tables²⁰. Total energy intensity alone is insufficient for decarbonisation tracking and must be supplemented by the fuel-type decomposition above and the GHG emission indicators described in **TG-2.8 Climate Indicators**.

¶9 **Offshore energy extraction efficiency** – for offshore oil and gas, the ratio of energy extracted to energy consumed in extraction operations (energy return on energy invested, or EROEI). See **TG-3.10 Offshore Energy Accounts** for detailed guidance.

¶10 **Fishing fleet fuel efficiency** – fuel consumption per tonne of catch, relevant for both cost efficiency and greenhouse gas emission reduction.

¶11 The SEEA Energy notes that energy use combined with economic data enables derivation of “energy use per unit of GDP”²¹, which can be adapted to the ocean economy by relating ocean sector energy use to ocean sector GVA.

3.3 Decoupling Indicators

¶1 Decoupling indicators track the relationship between economic growth and resource use over time. They indicate whether an economy is achieving more output with less environmental

pressure²². SDG Target 8.4 explicitly calls upon countries to “improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation”²³.

Concept of decoupling

¶1 **Decoupling** occurs when the growth rate of an environmental variable (resource use, emissions, waste generation) is lower than the growth rate of the relevant economic variable (GDP, value added, output)²⁴. Two forms are distinguished:

1. ¶2

Relative decoupling – the environmental variable continues to grow, but at a slower rate than economic output. Resource intensity declines, but total resource use increases.

2. ¶3

Absolute decoupling – the environmental variable declines in absolute terms whilst economic output grows. This represents genuine reduction in environmental pressure alongside economic growth.

Computing decoupling indicators

¶1 A decoupling factor can be computed as:

$$\text{Decoupling Factor} = 1 - (\text{Resource Use Growth Rate} / \text{Economic Output Growth Rate})$$

¶2 Where:

- ¶3 A positive decoupling factor indicates relative decoupling
- ¶4 A decoupling factor > 1 indicates absolute decoupling
- ¶5 A negative factor indicates increasing resource intensity (“recoupling”)
- ¶6 A decoupling factor of zero indicates no decoupling – resource use is growing at the same rate as economic output

¶7 These interpretation rules apply when economic output growth is positive. When economic output growth is zero or negative, the decoupling factor must not be computed. Dividing by zero produces an undefined result. Dividing by a negative denominator produces counter-intuitive values that can spuriously indicate absolute decoupling during a recession merely because resource use declined faster than output. In such periods, compilers should instead report:

- ¶8 **Resource intensity ratios** (Section 3.1) for the affected years, showing the physical input per unit of output without reference to growth rates;
- ¶9 **Year-on-year percentage changes** in both the economic and physical series separately;
- ¶10 **Index numbers** (base year = 100 for both series) as the recommended visualisation for multi-year periods that include non-growth episodes. The index-number approach avoids the zero-denominator problem and allows visual comparison of trajectories without computing a ratio of growth rates.

¶11 Figure 2.11.1 summarises the recommended approach, keying the method choice to the sign of economic-output growth: (1) positive growth throughout routes to the decoupling factor, (2) a mixed period is split at the structural break, and (3) zero or negative growth follows the fallback, in which the factor must not be computed and intensity ratios and index-number series are reported instead.

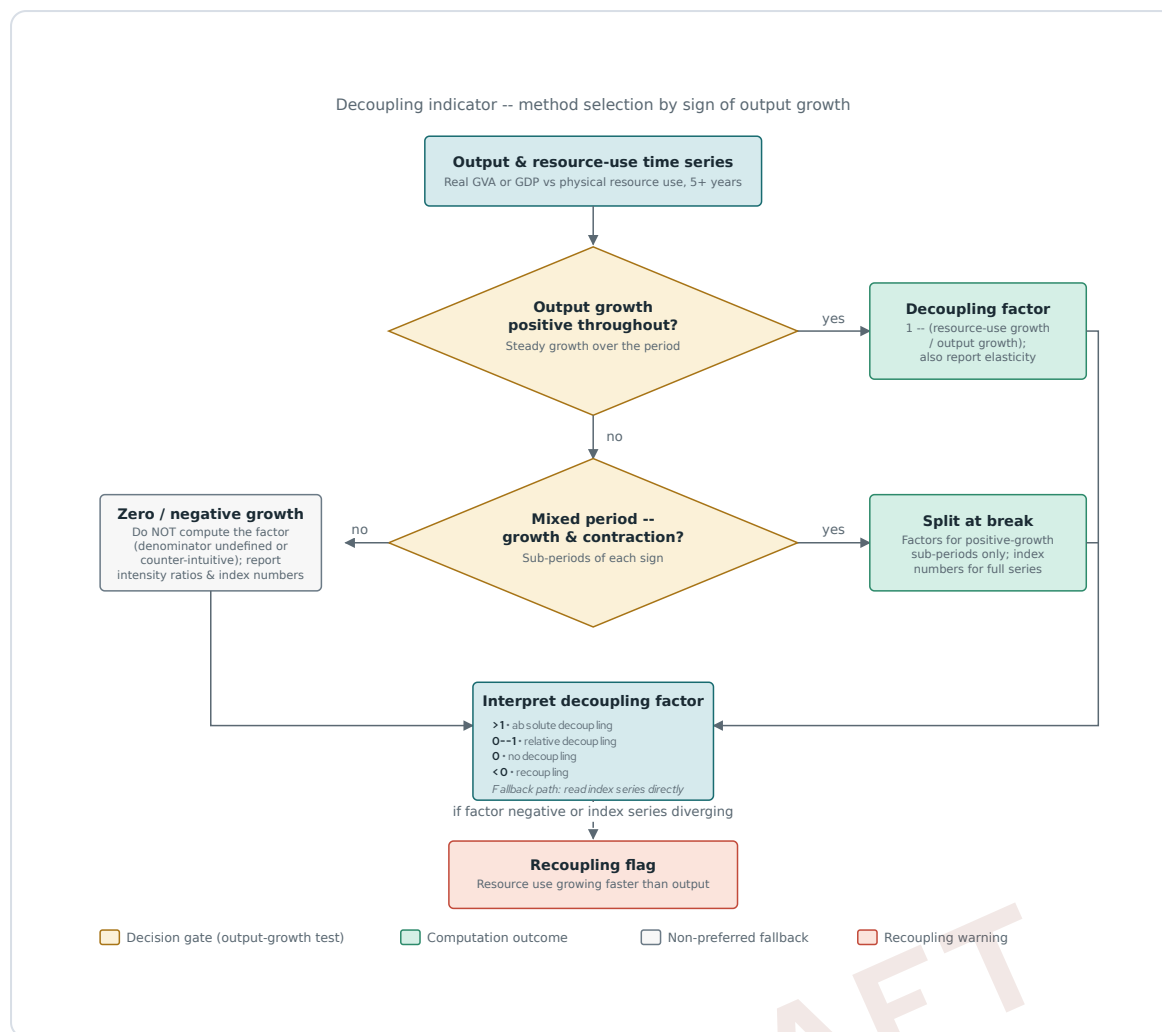


Figure 2.11.1 Decoupling measurement follows a decision tree keyed to the sign of economic-output growth. Positive-growth branch yields a Tapio-style factor; zero/negative growth redirects to intensity ratios and index series.

Source: TG-2.11 Resource Efficiency Indicators, §3.3 (decoupling decision tree and zero/negative-growth fallback).

Adapted from: Tapio (2005) decoupling typology; OECD (2002) *Indicators to Measure Decoupling of Environmental Pressure from Economic Growth*; SEEA Central Framework Ch. 7 (combined physical-monetary indicator derivation); SDG Target 8.4.

¶12 Alternatively, an elasticity formulation expresses the responsiveness of resource use to economic growth:

$$\text{Resource Elasticity} = \% \text{ Change in Resource Use} / \% \text{ Change in Economic Output}$$

¶13 An elasticity less than 1 indicates relative decoupling. A negative elasticity with positive economic growth indicates absolute decoupling. Note that the same zero-denominator constraint applies: the elasticity formulation is undefined when economic output growth is zero.

Base-year selection and sensitivity testing

¶1 Decoupling indicators are sensitive to the choice of base year and comparison period. Compilers must observe the following requirements:

- ¶2 **Base year selection** – the recommended base year for a decoupling assessment is the year prior to the major national ocean economy policy intervention or plan under evaluation (for example, the year before a national ocean policy was enacted). This anchors the decoupling assessment to the period of policy relevance.

- ¶3 **Sensitivity testing** – compilers must test at least two alternative base years and report the resulting range of decoupling factor values as a sensitivity check. If the sign or magnitude of the decoupling factor changes materially across alternative base years, this must be flagged in the methodological notes accompanying the published indicator.
- ¶4 **Standardised comparison intervals** – snapshot comparisons should use evenly spaced periods (for example, five-year intervals aligned to the national development plan cycle) rather than intervals of different length. Uneven intervals produce decoupling factors that cannot be compared across resources or across countries.
- ¶5 **Rolling averages and minimum horizons** – for cyclical industries such as fishing, three-year or five-year rolling averages should be used to smooth annual variability. Decoupling assessments generally require at least five years of data to distinguish genuine structural trends from short-term fluctuations, and ten or more years are preferable.
- ¶6 **Structural breaks** – see the guidance on structural breaks in the time series below.

Structural breaks in the time series

¶1 ⚠ **Structural breaks in the time series**

¶2 Do not use structural break years as decoupling analysis endpoints. Common causes of structural breaks in ocean economy time series include pandemic-related economic contractions (e.g., 2020 COVID-19), major fisheries collapses or stock recovery events, policy changes that alter reporting practices, and natural disasters affecting coastal infrastructure. When a structural break year falls within the analysis period, compilers must: (a) flag the year in indicator metadata with a description of the cause, (b) report pre-break and post-break series separately, with decoupling factors computed within each sub-period, and (c) avoid computing a single decoupling factor that spans the break year as an endpoint. Including a crisis year as an endpoint can produce spurious decoupling results in either direction.

Ocean economy decoupling indicators

¶1 For ocean accounting, key decoupling indicators include:

¶2 **Fish extraction decoupling** – comparing growth in fishing industry GVA to growth in fish catch tonnage:

$$\text{Fish Decoupling Factor} = 1 - (\text{Fish Catch Growth Rate} / \text{Fishing GVA Growth Rate})$$

¶3 Positive values indicate that the fishing sector is generating more value from each tonne of fish extracted—potentially through higher prices, better species mix, or more value-added processing. This indicator should be interpreted alongside stock sustainability indicators from **TG-6.7 Fisheries Stock Assessment**.

¶4 **Maritime emissions decoupling** – comparing growth in shipping sector GVA to growth in greenhouse gas emissions:

$$\text{Shipping Emissions Decoupling} = 1 - (\text{Emissions Growth Rate} / \text{Shipping GVA Growth Rate})$$

¶5 This indicator tracks progress toward the International Maritime Organization's decarbonisation goals and relates to the climate indicators described in **TG-2.8 Climate Indicators**.

¶6 **Material footprint decoupling** – SDG indicators 8.4.1 and 12.2.1 measure material footprint (per capita and per GDP)²⁵, which can be computed for ocean-related materials to track decoupling at the economy-wide level.

3.4 Circular Economy Indicators

¶1 Circular economy indicators measure the extent to which economic systems reduce waste, reuse materials, and recycle resources, moving from linear “take-make-dispose” models toward circular flows. SDG Target 12.5 aims to “substantially reduce waste generation through prevention, reduction, recycling and reuse”²⁶.

Circular economy concepts

¶1 For ocean sectors, circular economy principles apply as summarised in Table 3.4.1 below.²⁷

Sector	Circular Economy Applications
Fishing and aquaculture	Reducing discards and bycatch, utilising fish processing waste for feed or other products.
Maritime transport	Extending vessel lifetimes, recycling ship materials at end of life.
Offshore energy	Decommissioning and recycling offshore platforms, repurposing infrastructure.

¶2 These applications relate to the flows from economy to environment described in **TG-3.4 Flows from Economy to Environment**.

Waste and recycling indicators

¶1 Key circular economy indicators for ocean sectors include:

¶2 **Discard ratio in fisheries** – the proportion of catch that is discarded rather than landed:

$$\text{Discard Ratio} = \text{Discarded Catch} / \text{Gross Catch}$$

¶3 The SEEA CF treats discarded catch as “natural resource residuals”—flows that are extracted but immediately returned to the environment²⁸. SDG indicator 14.4.1 and related fisheries management frameworks track bycatch and discard reduction.

¶4 **Caveat – landing obligation jurisdictions.** In jurisdictions with mandatory landing obligations, such as EU member states operating under the Landing Obligation (EU Regulation 1380/2013, Article 15), reported discard rates may approach zero through legal mandate rather than through genuine circular economy improvement²⁹. A near-zero discard ratio in such a jurisdiction does not indicate that all extracted biomass is being utilised effectively. A large share of the legally mandated landed catch may consist of fish below minimum conservation reference size (MCRS) with low or negative commercial value. Compilers in landing-obligation jurisdictions should therefore report alongside the discard ratio:

- ¶5 **(a) Proportion of landed catch below MCRS** – an indicator of bycatch management performance rather than waste reduction. Data sources and stock reference points are described in **TG-6.7 Fisheries Stock Assessment**.
- ¶6 **(b) Economic utilisation ratio** – the proportion of gross catch that is landed with positive commercial value:

$$\text{Economic Utilisation Ratio} = \text{Commercially Utilised Landed Catch} / \text{Gross Catch}$$

¶7 This complementary indicator captures the economic dimension of catch utilisation that the discard ratio obscures when discard bans are in force.

¶8 **Fish waste utilisation rate** – the proportion of fish processing residues (heads, bones, offal) that are converted to useful products (fishmeal, fish oil, fertiliser):

$$\text{Waste Utilisation Rate} = \text{Residues Utilised} / \text{Total Processing Residues}$$

¶9 **National recycling rate** – SDG indicator 12.5.1 measures the national recycling rate³⁰, which can be disaggregated for materials relevant to ocean sectors (plastics, metals from shipbuilding).

¶10 **Marine litter generation** – flows of waste to the marine environment, representing a failure of circular economy systems. Addressed in **TG-2.7 Pollution Flows** and **TG-6.12 Marine Litter**.

Resource recovery indicators

¶1 For extractive ocean industries, resource recovery indicators measure the proportion of in-situ resources that are successfully captured:

¶2 **Extraction efficiency for minerals** – the proportion of identified reserves that are extracted over the lifetime of an operation, relevant for seabed mining and offshore hydrocarbons.

¶3 **Energy recovery in offshore operations** – the proportion of potential energy content captured in oil and gas extraction, accounting for losses from flaring, venting, and fugitive emissions. See **TG-3.10 Offshore Energy Accounts** for detailed guidance.

3.5 Sector-Specific Efficiency Indicators

¶1 Different ocean sectors require tailored efficiency indicators that reflect their specific resource use patterns and economic characteristics.

Fisheries efficiency indicators

¶1 For the fishing industry, key efficiency indicators include:

Indicator	Formula	Policy Relevance	Cross-Reference
Economic yield per unit effort	GVA / Fishing effort (days at sea)	Fishing capacity management	TG-6.7
Value added per tonne caught	GVA / Catch (tonnes)	Resource productivity	TG-3.2
Fuel efficiency	Catch (tonnes) / Fuel consumption	Operating costs, emissions	TG-2.8
Employment per tonne	Employment / Catch (tonnes)	Social efficiency	TG-3.3

¶2 *Table 2: Key fisheries efficiency indicators. For the fallback data hierarchy (preferred gross catch vs. landings vs. bounded estimate), see Section 3.2.*

¶3 The relationship between these indicators and sustainable yield is addressed in **TG-6.7 Fisheries Stock Assessment**.

Aquaculture efficiency indicators

¶1 For aquaculture, efficiency indicators focus on feed conversion, water use, and energy intensity:

Indicator	Formula	Policy Relevance	Cross-Reference
Feed conversion ratio	Feed input (kg) / Fish output (kg)	Resource efficiency (fed species only)	TG-3.9
Water productivity	Output (tonnes) / Water use (m ³)	Water resource management	TG-3.9
Energy intensity	Energy use / Output (tonnes)	Operating costs, emissions	TG-2.8

Indicator	Formula	Policy Relevance	Cross-Reference
Land use efficiency	Output (tonnes) / Area (hectares)	Spatial planning	TG-1.2
Biofiltration ratio (filter-feeders)	Volume filtered (m ³) / Production (kg)	Water quality co-benefit	TG-3.9
Chlorophyll removal rate (filter-feeders)	Chlorophyll removed (µg/L·m ³) / Production (kg)	Eutrophication management	TG-3.9
Area productivity (filter-feeders)	Production (kg) / Cultivation area (ha·yr)	Spatial planning	TG-1.2

¶12 *Table 3: Key aquaculture efficiency indicators. The feed conversion ratio applies to fed species (fin-fish, shrimp); it is inapplicable to filter-feeding bivalves (oysters, mussels, clams) that require no manufactured feed input. For bivalve aquaculture, use the three filter-feeder indicators listed above. For integrated multi-trophic aquaculture (IMTA) systems, efficiency should be assessed at the whole-system level: sum GVA across all trophic levels and divide by external inputs only, excluding internal nutrient cycling within the system. Detailed guidance on aquaculture system-boundary definition is provided in **TG-3.9 Aquaculture Accounts**.*

Maritime transport efficiency indicators

¶1 For shipping and maritime transport, efficiency indicators serve two distinct purposes that require different data sources and compilation agencies. Compilers should not attempt to combine or aggregate indicators from the two sub-tables below into a single score.

¶12 Sub-table 4a: IMO-aligned physical efficiency indicators

¶3 These indicators are defined by the International Maritime Organization and compiled primarily by port authorities, ship registries, and flag state administrations rather than national statistics offices. NSOs should coordinate with the relevant maritime administration to obtain these data.

Indicator	Formula	Policy Relevance	Cross-Reference
Energy Efficiency Operational Indicator (EEOI)	CO ₂ emissions / Transport work (tonne-nm)	IMO MEPC.1/Circ.684 31	TG-2.8
Carbon Intensity Indicator (CII)	CO ₂ emissions / Transport work (tonne-nm)	IMO MEPC.377(80) 32	TG-2.8

¶4 *Table 4a: IMO-aligned physical efficiency indicators. Units are IMO standard (tonne-nautical-miles). These are regulatory compliance metrics; they do not involve monetary values and cannot be combined with the economic efficiency indicators in Table 4b.*

¶15 Sub-table 4b: NSO-compiled economic efficiency indicators

¶6 These indicators are compiled by national statistics offices using monetary and physical data from the national accounts and transport statistics.

Indicator	Formula	Policy Relevance	Cross-Reference
Total energy intensity	All energy (toe) / Transport output (tonne-km)	Overall energy productivity	TG-3.3
Fossil energy intensity	Fossil energy (toe) / Transport output (tonne-km)	Decarbonisation tracking	TG-2.8
Renewable energy share	Renewable energy / Total energy (%)	Fuel mix transition	TG-2.8

Indicator	Formula	Policy Relevance	Cross-Reference
Value added per tonne-km	GVA / Transport output (tonne-km)	Economic productivity	TG-3.3
Fleet age and efficiency	Average vessel age, average efficiency rating	Fleet modernisation	TG-4.3

¶7 *Table 4b: NSO-compiled economic efficiency indicators. The three energy sub-indicators (total intensity, fossil intensity, renewable share) are required for decarbonisation monitoring; total energy intensity alone is insufficient. See Section 3.2 for the rationale.*

¶8 The International Maritime Organization's greenhouse gas strategy establishes targets for reducing carbon intensity of international shipping³².

Offshore energy efficiency indicators

¶1 For offshore energy extraction, efficiency indicators address both conventional and renewable energy:

Indicator	Formula	Policy Relevance	Cross-Reference
Energy return on investment	Energy extracted / Energy invested	Net energy contribution	TG-3.10
Capacity factor	Actual generation / Potential generation	Renewable energy performance	TG-3.10
Value added per energy unit	GVA / Energy output (joules)	Economic productivity	TG-3.3
Decommissioning intensity	Decommissioning waste / Energy produced	Circular economy	TG-3.4

¶2 *Table 5: Key offshore energy efficiency indicators*

3.6 Compilation Procedure

¶1 The procedure described below follows the SEEA Central Framework guidance on combined presentations and indicator derivation³³.

Step-by-step compilation

¶1 **Steps 1–3 are compilation, not indicator derivation.** The efficiency ratios below divide an economic measure by a physical one, and both come from accounts compiled elsewhere:

- ¶2 **The economic measure** – GVA by ocean industry, with ocean ratios applied – from **TG-3.3 Economic Activity Relevant to the Ocean** Sections 3.4 and 3.5. Where an enterprise straddles the ocean boundary under one ISIC code, TG-3.3 Section 3.4 sets the default allocation key (revenue share) and the requirement to hold it constant across the time series; the ISIC concordance with the allocation key and preferred data source per class is TG-3.3 Table 2.
- ¶3 **The physical measure** – fish catch, water abstraction, energy consumption by industry – from **TG-3.2 Flows from Environment to Economy** Section 3.3 for natural resource inputs, and **TG-3.4 Flows from Economy to Environment** for residuals.

¶4 **The one condition that governs whether a ratio is meaningful:** the physical and monetary accounts must use the same industry classification and the same reference period. Where they do not, reconcile through the TG-3.3 Table 2 concordance before computing anything – an efficiency ratio built across mismatched classifications is not an efficiency ratio, and the mismatch is invisible in the result. Common cases are disaggregating offshore energy from total energy extraction, and isolating the coastal tourism share of accommodation water use.

¶5 **Step 4: Compute resource efficiency ratios.** For each industry and resource type, compute the efficiency ratio:

$$\text{Resource Efficiency} = \text{GVA (constant-price currency units)} / \text{Physical Input (physical units)}$$

¶6 Or the intensity ratio:

$$\text{Resource Intensity} = \text{Physical Input (physical units)} / \text{GVA (constant-price currency units)}$$

¶7 For time-series resource efficiency indicators, GVA must be expressed in constant prices (volume terms) using the industry-specific output deflator, or the GDP deflator as a fallback. Expressing GVA in current prices will conflate price inflation with genuine efficiency improvement. If fish prices double whilst catch and processing methods are unchanged, current-price fish productivity doubles even though no real efficiency gain has occurred. Where only current-price GVA is available, compilers must present both the nominal (current-price) and real (constant-price) efficiency series side by side and prominently note the price basis of each. Deflation methodology follows **TG-3.3 Economic Activity** on price and volume measures. See also SEEA CF paras 6.107–6.110³⁴ and SNA 2025 Chapter 15 on constant-price GDP denominators.

¶8 Document the units clearly (e.g., “constant-2020-USD per tonne of fish caught” or “joules per constant-2020-USD of shipping GVA”) and the price base year.

¶9 **Step 5: Compile time series and compute growth rates.** For decoupling analysis, compile resource efficiency indicators for multiple years (minimum five years recommended). Compute annual growth rates for both economic output and physical input variables. Apply the decoupling formulas and decision tree from Section 3.3 to derive decoupling factors or elasticities, noting any years where zero or negative output growth requires the fallback procedure.

¶10 **Step 6: Present results with context.** Resource efficiency indicators should be presented alongside:

- ¶11 The absolute levels of both numerator and denominator (to avoid misleading interpretations)
- ¶12 Benchmark comparisons (national average, international comparisons, historical trends)
- ¶13 Contextual information on policy drivers, structural changes, or data quality limitations

Data quality and uncertainty

¶1 Resource efficiency indicators are ratio estimates derived from two independently compiled datasets – monetary accounts and physical flow accounts – each with its own measurement error. Compilers should assess and communicate data quality using the following framework.

¶2 **Uncertainty propagation.** The relative standard error (RSE) of a ratio indicator is approximately the root-sum-of-squares of the relative standard errors of the numerator and denominator:

$$RSE(\text{ratio}) \approx \sqrt{RSE_{\text{numerator}}^2 + RSE_{\text{denominator}}^2}$$

¶3 For example, if the GVA estimate has a relative standard error of 5% and the physical catch estimate has a relative standard error of 8%, the fish productivity ratio has an approximate relative standard error of $\sqrt{(25 + 64)} = \sqrt{89} \approx 9.4\%$.

¶4 **Three-tier quality classification.** Compilers should assign each published resource efficiency indicator to one of three quality tiers:

Tier	Label	Criteria	Presentation requirement
1	Indicative	Single source; no independent uncertainty estimate available	Flag as “indicative” in table notes; do not cite in official statistical releases without review
2	Intermediate	Two independent sources; approximate error range can be constructed	Publish with an approximate range (e.g., ±X%) derived from the RSE formula above
3	Published	Two independent sources; formal standard error computed; revision policy documented	Publish with formal confidence interval; include in official national statistical releases

¶15 **Methodological note requirement.** Any official publication of resource efficiency indicators must include a methodological note describing: (1) the data sources used for numerator and denominator, (2) the price basis and deflator applied, (3) the industry classification concordance method, (4) the revision policy, and (5) known limitations (e.g., substitution of landings for gross catch, or use of current-price GVA for recent years pending deflator availability). This requirement aligns with the UN Fundamental Principles of Official Statistics³⁵ and the PARIS21 data quality assessment framework³⁶.

3.7 Worked Examples

¶1 This section presents worked examples illustrating the compilation and interpretation of resource efficiency indicators for a hypothetical medium-income coastal state (“Country B”). All monetary values are expressed in constant 2020 USD unless otherwise noted. Physical quantities use standard SI units.

Example 1: Marine fishing material productivity

¶1 **Context:** Country B’s marine fishing industry reported the following data for 2023 and 2024 (GVA in constant 2020 USD):

Year	Gross catch (tonnes)	Fishing industry GVA (million USD, constant 2020)	Discarded catch (tonnes)	Data availability
2023	120,000	180	24,000	Gross catch: observer programme; GVA: supply and use tables
2024	115,000	190	20,000	Gross catch: observer programme; GVA: supply and use tables

¶2 **Computation:**

¶3 Fish productivity (2023):

$$USD\ 180,000,000 / 120,000\ tonnes = USD\ 1,500/tonne$$

¶4 Fish productivity (2024):

$$USD\ 190,000,000 / 115,000\ tonnes = USD\ 1,652/tonne$$

¶5 Productivity change:

$$(1,652 - 1,500) / 1,500 \times 100 = 10.1\% \text{ increase}$$

¶6 Discard ratio (2023):

$$24,000 / 120,000 = 20\%$$

¶7 Discard ratio (2024):

$$20,000 / 115,000 = 17.4\%$$

¶8 **Interpretation:** Fish productivity increased by 10.1 per cent between 2023 and 2024, whilst total catch declined by 4.2 per cent. This suggests improved economic efficiency: the industry generated more value per tonne of fish extracted. The declining discard ratio (from 20 per cent to 17.4 per cent) indicates progress toward circular economy principles, with a larger proportion of catch being landed rather than discarded. However, compilers should verify whether the productivity increase reflects sustainable management (higher-value species, better processing) or scarcity effects (rising prices for depleted stocks). Cross-referencing with stock assessment data from **TG-6.7** would provide this context. A practical diagnostic: if fish productivity (USD per tonne) is rising whilst catch per unit effort (CPUE) is declining and stock biomass is below B_{MSY} , the productivity increase likely reflects scarcity-driven price inflation rather than genuine efficiency improvement.

Example 2: Aquaculture water productivity

¶1 **Context:** Country B's marine aquaculture industry operates primarily extensive flow-through pond systems for shrimp and finfish production. GVA is expressed in constant 2020 USD.

Year	Production (tonnes)	GVA (million USD, constant 2020)	Water abstraction (million m ³)	System type
2023	45,000	135	9	Flow-through ponds
2024	48,000	145	9.2	Flow-through ponds

¶2 Note: water abstraction for flow-through pond systems (9 million m³ = 9,000,000 m³ in 2023) is used as the denominator in accordance with the system-type formula table in Section 3.2. Water use per tonne of production (2023) = 9,000,000 m³ / 45,000 tonnes = 200 m³/tonne, consistent with FAO benchmark ranges of 100–500 m³/tonne for semi-intensive tropical shrimp pond systems³⁷.

¶3 **Computation:**

¶4 Water productivity (2023):

$$USD\ 135,000,000 / 9,000,000\ m^3 = USD\ 15.00/m^3$$

¶5 Water productivity (2024):

$$USD\ 145,000,000 / 9,200,000\ m^3 = USD\ 15.76/m^3$$

¶6 Productivity change:

$$(15.76 - 15.00) / 15.00 \times 100 = 5.1\% \text{ increase}$$

¶7 Output per water unit (2023):

$$45,000 \text{ tonnes} / 9,000,000 \text{ m}^3 = 5.0 \text{ kg/m}^3$$

¶8 Output per water unit (2024):

$$48,000 \text{ tonnes} / 9,200,000 \text{ m}^3 = 5.2 \text{ kg/m}^3$$

¶9 **Plausibility check:** FAO benchmark water use intensities for semi-intensive tropical pond aquaculture range from approximately 100 to 500 m³/tonne depending on exchange rate and climate³⁷. Country B's 200 m³/tonne falls within this range. If a compiler's calculated value falls outside 100–2,000 m³/tonne for any pond system, the input data should be reviewed before publication.

¶10 **Interpretation:** Aquaculture water productivity improved by 5.1 per cent, indicating that the industry generated more economic value per cubic metre of water abstracted. Physical output per water unit also increased slightly (from 5.0 to 5.2 kg/m³), suggesting genuine improvements in water use efficiency rather than price effects alone. This progress aligns with SDG Target 12.2 on efficient use of natural resources. The modest increase in total water abstraction (2.2 per cent) coupled with a 6.7 per cent increase in production demonstrates relative decoupling of aquaculture growth from water abstraction.

Example 3: Maritime transport energy intensity and decoupling

¶1 **Context:** Country B's maritime transport sector (sea and coastal freight and passenger transport) reported (GVA in constant 2020 USD):

Year	GVA (million USD, constant 2020)	Fuel consumption (thousand toe)	Transport output (billion tonne-km)
2019	420	850	145
2020	385	790	130
2021	410	800	138
2022	440	820	148
2023	465	830	155
2024	490	840	162

¶2 Note: 2020 is flagged as a structural break year due to the COVID-19 pandemic (see Section 3.3). The 2020 structural break triggers the sub-period pathway in the Section 3.3 decision tree. Apply that pathway as specified.

¶3 Computation – full period (2019–2024):

¶4 The indicators computed below are NSO-compiled economic efficiency indicators (Sub-table 4b). The IMO-defined physical indicators in Sub-table 4a require separate data and compilation procedures not illustrated here.

¶5 Energy intensity (2024):

$$840,000 \text{ toe} / \text{USD } 490,000,000 = 1,714 \text{ toe per million USD GVA}$$

¶6 Or per physical output:

$$840,000 \text{ toe} / 162,000,000,000 \text{ tonne-km} = 5.19 \text{ toe per million tonne-km}$$

¶7 Energy intensity (2019):

$$850,000 \text{ toe} / 145,000,000,000 \text{ tonne-km} = 5.86 \text{ toe per million tonne-km}$$

¶8 Five-year GVA growth (2019–2024):

$$(490 - 420) / 420 \times 100 = 16.7\%$$

¶9 Five-year energy consumption growth:

$$(840 - 850) / 850 \times 100 = -1.2\%$$

¶10 No single decoupling factor is computed for 2019–2024, because the period spans the 2020 break (Section 3.3). The factor is computed within the post-break sub-period; the pre-break side holds only 2019.

¶11 **Post-break sub-period (2021–2024):**

¶12 GVA growth (2021–2024):

$$(490 - 410) / 410 \times 100 = 19.5\%$$

¶13 Energy consumption growth (2021–2024):

$$(840 - 800) / 800 \times 100 = 5.0\%$$

¶14 Decoupling factor:

$$1 - (5.0\% / 19.5\%) = 0.74$$

¶15 **Structural break sub-period (2019–2020):** Index numbers (base 2019 = 100): GVA = 91.7, energy = 92.9.

¶16 **Interpretation:** Country B's maritime transport sector achieved relative decoupling in the post-break period 2021–2024: GVA grew by 19.5 per cent whilst energy consumption grew by 5.0 per cent, a decoupling factor of 0.74 (between 0 and 1). Over 2019–2024 GVA grew by 16.7 per cent and energy consumption fell by 1.2 per cent, but no single factor is reported across the 2020 break. The energy intensity per tonne-km declined from 5.86 toe/million tonne-km in 2019 to 5.19 in 2024 (11.4 per cent improvement), demonstrating genuine efficiency gains. The temporary dip in

2020 (COVID-19 pandemic) has been flagged as a structural break. The sub-period analysis confirms that the 2019–2020 contraction does not by itself indicate efficiency improvement. This performance contributes to national progress under SDG Target 8.4 and aligns with the IMO's greenhouse gas reduction strategy.

¶17 **Corrected 24 September 2026**

¶18 This example previously reported a single 2019–2024 decoupling factor of 1.07 (absolute decoupling), which spans the 2020 structural break that Section 3.3 says must split the series. Computed within the post-break sub-period, the factor is 0.74: relative, not absolute, decoupling.

Example 4: Ocean economy-wide decoupling analysis

¶1 **Context:** Country B's total ocean economy reported the following aggregates over a ten-year period (GVA in constant 2020 USD). Per the base-year selection guidance in Section 3.3, the base year (2014) was selected as the year prior to Country B's adoption of its first national ocean economy development plan. The comparison points use evenly spaced five-year intervals.

Year	Ocean GVA (million USD, constant 2020)	Fish catch (tonnes)	Energy use (thousand toe)	Water abstraction (million m³)
2014	1,380	138,000	2,050	1,750
2019	1,720	128,000	2,250	1,950
2024	1,950	125,000	2,300	2,050

¶2 Note: 2019 and 2024 are the two five-year endpoints. The year 2020 has been excluded as a structural break year (COVID-19). It must not be used as a base year or comparison endpoint. Base-year sensitivity testing follows the procedure in Section 3.3. Alternative base years (2013 and 2015) yielded decoupling factors for fish extraction ranging from 1.18 to 1.24.

¶3 **Computation – period 1 (2014–2019):**

¶4 GVA growth: $(1,720 - 1,380) / 1,380 \times 100 = 24.6\%$

- ¶5 Fish catch: $(128,000 - 138,000) / 138,000 \times 100 = -7.2\% \rightarrow$ Decoupling factor: $1 - (-7.2\% / 24.6\%) = 1.29$ (absolute decoupling)
- ¶6 Energy use: $(2,250 - 2,050) / 2,050 \times 100 = 9.8\% \rightarrow$ Decoupling factor: $1 - (9.8\% / 24.6\%) = 0.60$ (relative decoupling)
- ¶7 Water abstraction: $(1,950 - 1,750) / 1,750 \times 100 = 11.4\% \rightarrow$ Decoupling factor: $1 - (11.4\% / 24.6\%) = 0.54$ (relative decoupling)

¶8 **Computation – period 2 (2019–2024):**

¶9 GVA growth: $(1,950 - 1,720) / 1,720 \times 100 = 13.4\%$

- ¶10 Fish catch: $(125,000 - 128,000) / 128,000 \times 100 = -2.3\% \rightarrow$ Decoupling factor: $1 - (-2.3\% / 13.4\%) = 1.17$ (absolute decoupling)
- ¶11 Energy use: $(2,300 - 2,250) / 2,250 \times 100 = 2.2\% \rightarrow$ Decoupling factor: $1 - (2.2\% / 13.4\%) = 0.84$ (relative decoupling)
- ¶12 Water abstraction: $(2,050 - 1,950) / 1,950 \times 100 = 5.1\% \rightarrow$ Decoupling factor: $1 - (5.1\% / 13.4\%) = 0.62$ (relative decoupling)

¶13 **Interpretation:** Across both sub-periods, Country B's ocean economy decoupled absolutely from fish extraction and relatively from energy and water use. Absolute decoupling of fish extraction was stronger in the first period (factor 1.29) than the second (1.17), which may indicate that the easiest efficiency gains have been captured and further progress requires additional policy effort. Relative decoupling improved for energy use between the two periods (factor rising from 0.60 to 0.84), suggesting that energy productivity gains are slowing and the sector is approaching the limits of operational efficiency improvements without technology transition. Water abstraction

exhibits consistent relative decoupling across both periods (0.54 and 0.62), with room for further improvement. These results can be reported under SDG indicators 8.4.1 and 12.2.1.

4. Acknowledgements

¶1 **Authors:** [To be confirmed]

¶2 **Reviewers:** [To be confirmed]

5. References

1. ¶1 SEEA Central Framework, para 1.20. "Topics covered include resource efficiency and productivity indicators, decomposition analysis, analysis of net wealth and depletion, sustainable production and consumption."
2. ¶2 SEEA Central Framework, para 1.20 identifies the *SEEA Applications and Extensions* publication as providing extended guidance on resource efficiency and productivity indicators, decomposition analysis, and related topics.
3. ¶3 SEEA Energy, Chapter 7 on indicators and Chapter 4 on combined presentations; SEEA Energy para 4.53 on deriving energy-related indicators.
4. ¶4 SEEA-Water, Chapter 9 on indicators and policy applications; SEEA-Water Annex 3, Tables A3.1–A3.2 on water intensity and productivity indicators.
5. ¶5 SEEA Central Framework, para 1.54. Combined presentations "structure information in a manner that supports the derivation of combined indicators, for example, decoupling indicators."
6. ¶6 European Commission (2020). *A new Circular Economy Action Plan: For a cleaner and more competitive Europe*. Brussels. COM(2020) 98 final.
7. ¶7 United Nations General Assembly (2015). *Transforming our world: the 2030 Agenda for Sustainable Development*. A/RES/70/1. SDG Target 8.4.
8. ¶8 United Nations General Assembly (2015). *Transforming our world: the 2030 Agenda for Sustainable Development*. A/RES/70/1. SDG Target 12.2.
9. ¶9 United Nations (2024). *Global indicator framework for the Sustainable Development Goals*. SDG indicators 8.4.1, 8.4.2, 12.2.1, and 12.2.2 on material footprint and domestic material consumption.
10. ¶10 OECD (2011). *Towards Green Growth*. Paris: OECD Publishing. Identifies resource productivity as a key indicator of progress toward green growth.
11. ¶11 SEEA Energy, para 4.53. "Combined presentations are also useful for the derivation of many energy-related indicators."
12. ¶12 Adapted from SEEA Applications and Extensions framework for resource efficiency indicators.
13. ¶13 SEEA Energy, Section 7.5.1 on energy intensities for selected industries; SEEA Energy Table 4.6 on calculating energy intensity of industries.
14. ¶14 SEEA Central Framework, paras 5.428–5.429. The SEEA CF recommends using gross catch rather than landings as the measure of extraction.
15. ¶15 United Nations (2024). *Global indicator framework*. SDG indicator 14.4.1: "Proportion of fish stocks within biologically sustainable levels."
16. ¶16 SEEA-Water, Annex 3, Tables A3.1–A3.2 on water intensity and productivity indicators.
17. ¶17 SEEA-Water, Annex 3, Table A3.2. Provides the methodology for calculating water consumption (abstraction minus return flows) for different water use categories, including aquaculture systems.
18. ¶18 SEEA-Water, paras 1.24–1.25. Water efficiency "can be improved from the demand as well as the supply side."
19. ¶19 SEEA Energy, Chapter 7 on energy indicators linked to social, economic, and environmental dimensions.
20. ¶20 SEEA Energy, Chapter 4 on energy supply and use tables, including fuel-type classification. Distinguishes petroleum products, natural gas, electricity, biofuels, and other renewable energy sources.
21. ¶21 SEEA Energy, Table 7.2. Energy use per unit of GDP is identified as an overall productivity indicator.
22. ¶22 SEEA Central Framework, para 1.54.
23. ¶23 SDG Target 8.4. "Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation."
24. ¶24 OECD (2002). *Indicators to Measure Decoupling of Environmental Pressure from Economic Growth*. Paris: OECD Publishing.
25. ¶25 United Nations (2024). *Global indicator framework*. SDG indicators 8.4.1 and 12.2.1 on material footprint per GDP.
26. ¶26 SDG Target 12.5. "By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse."
27. ¶27 Ellen MacArthur Foundation (2015). *Towards a Circular Economy: Business Rationale for an Accelerated Transition*. The circular economy framework emphasises keeping materials in use and regenerating natural systems.
28. ¶28 SEEA Central Framework, para 3.50 on unused extraction including discarded catch; FAO (1995) *Code of Conduct for Responsible Fisheries* on bycatch and discard reduction.

9. ¶29 EU Regulation 1380/2013 (Common Fisheries Policy), Article 15 (Landing Obligation). Phased in progressively from January 2015 and fully applicable from January 2019. Requires EU fishers to land almost all caught species, with specific exemptions for prohibited species, high-survival species, and de minimis quantities.
10. ¶30 United Nations (2024). *Global indicator framework*. SDG indicator 12.5.1: "National recycling rate, tons of material recycled."
1. ¶31 International Maritime Organization (2009). *Guidelines for Voluntary Use of the Ship Energy Efficiency Operational Indicator (EEOI)*. MEPC.1/Circ.684. Issued August 2009. Defines the EEOI as mass of CO₂ emitted divided by transport work in tonne-nautical-miles.
2. ¶32 International Maritime Organization (2023). *2023 IMO Strategy on Reduction of GHG Emissions from Ships* (MEPC.377(80)). Targets include reducing total annual GHG emissions from international shipping by at least 20% by 2030 (striving for 30%) and by at least 70% by 2040 (striving for 80%) compared to 2008, with a commitment to reaching net-zero GHG emissions by or around 2050.
3. ¶33 SEEA Central Framework, paras 6.107–6.110 on productivity, intensity, and decoupling indicators; SEEA Energy Table 4.6 and para 4.53 on combined presentations for indicator derivation.
4. ¶34 SEEA Central Framework, Chapter 6, Section 6.4 on combined presentations; SEEA CF paras 6.107–6.110 on productivity, intensity, and decoupling indicators.
5. ¶35 United Nations Statistical Commission (1994, reaffirmed 2013). *Fundamental Principles of Official Statistics*. Principle 3 on accountability and transparency; Principle 6 on data quality and confidentiality.
6. ¶36 PARIS21 (2021). *Data Quality Assessment Framework*. Describes minimum quality standards for national statistical indicators, including uncertainty reporting and methodological documentation.
7. ¶37 FAO (2014). *Small-scale aquaculture technical guidance: water use benchmarks*. Typical water use intensities for semi-intensive tropical pond aquaculture range from approximately 100 to 500 m³ per tonne of production depending on exchange rate, climate, and management practice. See also Verdegem, M.C.J. and Bosma, R.H. (2009). Water withdrawal for brackish and inland aquaculture, and options to produce more fish in ponds with present water use. *Water Policy* 11(S1): 52–68.

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