Module 2: Environmental Responsibility

Topics Covered:

- **Carbon Footprint Measurement & Reduction Strategies**
- **Renewable Energy & Resource Efficiency**
- **Waste Management & Circular Economy**
- **Environmental Risk Assessment Tools (ISO 14001, GRI)**
- **Case Study: Infosys – Carbon Neutral by 2020 Journey**

Learning Outcome:
Ability to evaluate environmental risks and integrate eco-friendly policies in corporate strategy.

1. Carbon Footprint Measurement & Reduction Strategies

Climate change is primarily driven by **Greenhouse Gas (GHG) emissions** from human activities. Companies, governments and individuals increasingly need to measure and reduce their carbon footprint because:

- Investors demand low-carbon transition plans
- Regulations require disclosure (TCFD, ISSB, BRSR Core, ESRS)
- Customers prefer sustainable brands
- Climate risks affect supply chains, operations and finances

Carbon footprint = total GHG emissions caused directly or indirectly by an activity, product, person or company.

This chapter covers:

- What carbon footprint is
- How to measure it using global standards
- Tools and methodologies
- Reduction strategies (short-term and long-term)
- Examples used by global companies

2. What Is a Carbon Footprint?

Carbon footprint represents the **total greenhouse gases**, expressed in **CO_2 equivalent (CO_2e)**, emitted by an entity.

The 7 key greenhouse gases considered:

1. Carbon dioxide (CO_2)
2. Methane (CH_4)
3. Nitrous oxide (N_2O)
4. Hydrofluorocarbons (HFCs)
5. Perfluorocarbons (PFCs)
6. Sulfur hexafluoride (SF_6)
7. Nitrogen trifluoride (NF_3)

All gases are converted into **CO_2e** based on their **Global Warming Potential (GWP)**.

3. Scope 1, Scope 2, Scope 3 Emissions

The **GHG Protocol** categorises emissions into three scopes:

3.1 Scope 1 – Direct Emissions

Emissions from sources **owned or controlled** by the company.

Examples:

- Company vehicles
- Boilers & furnaces
- Manufacturing processes
- Refrigerant leakage
- On-site diesel generators

3.2 Scope 2 – Indirect Energy Emissions

Emissions from **purchased electricity, heating, or cooling**.

Examples:

- Electricity used in offices, plants
- Purchased steam or chilled water

3.3 Scope 3 – Value Chain Emissions

All **indirect emissions** upstream and downstream.

This is usually **70–90%** of a company's footprint.

Examples include:

- Purchased raw materials
- Supply chain operations
- Business travel
- Employee commuting
- Transportation & logistics
- Use of sold products
- End-of-life waste management

Scope 3 is the most complex but the most important for true decarbonization.

4. Carbon Footprint Measurement Methodology

To measure emissions, companies follow these steps:

Step 1: Define Boundaries

- **Organisational boundary**
  - Equity share
  - Financial control
  - Operational control
- **Operational boundary**
  - Scope 1, 2, 3 categories

This aligns with the GHG Protocol Corporate Standard.

Step 2: Collect Activity Data

Examples of activity data include:

- Litres of diesel consumed
- kWh of electricity used
- Tonnes of raw materials procured
- Distance travelled (km) for logistics
- Number of business flights
- Waste generated (kg/tonnes)

Step 3: Apply Emission Factors

Emission factor =
Amount of CO_2e emitted per unit of activity

Examples:

- 1 litre of diesel = ~2.68 kg CO_2e
- 1 kWh grid electricity (India) = ~0.708 kg CO_2e
- 1 ton cement = ~0.8–1 ton CO_2e

Emission factors come from:

- IPCC
- IEA
- GHG Protocol
- National energy authorities
- Industry sources

Step 4: Calculate Emissions

Formula:
Carbon Emissions = Activity Data × Emission Factor

Example:
Electricity consumption: 100,000 kWh
Emission factor: 0.7 kg CO_2e/kWh
= 70,000 kg = 70 tonnes CO_2e

Step 5: Verification (Optional but Recommended)

Third-party auditors verify:

- Data accuracy

- Methodology
- Emission boundaries

Increasingly required under:

- BRSR Core (India)
- CSRD (EU)
- ESG ratings scrutiny

Step 6: Reporting

Companies report under:

- GHG Protocol
- TCFD
- CDP
- ISSB (IFRS S2)
- BRSR / BRSR Core

5. Tools & Software for Carbon Measurement

Popular global tools:

1. **GHG Protocol Tools**

Global, foundational, most widely accepted carbon calculation methodology
The GHG Protocol provides the scientific foundation for carbon calculation. It is not software — it is a structured guideline + workbook + emission factor library that all other tools rely on.
What You Can Do with GHG Protocol Tools:
Define organisational boundaries
Identify the Scope 1, 2, 3 categories.
Map emission sources
Apply standardised calculation formulas.
Use activity-based + spend-based methods.
Convert GHGs into CO_2e using GWPs
Why It Matters:
Most international reporting (CDP, ISSB, SBTi) requires GHG Protocol alignment
Provides emission factors
Ensures global comparability
Ideal For:
Large corporates
Consultants
Internal sustainability teams
Audit preparation
Limitations:
Not user-friendly for beginners
Requires manual calculations
No automated dashboards

2. **SimaPro**

Features:

- Leading global LCA tool
- Large emission factor database (Ecoinvent)
- Models complex supply chains
- Used by Apple, Philips, Unilever

Strengths:

- Highly accurate for product-level carbon footprint
- Industry-strength analytics

Limitations:

- Requires trained LCA experts
- Expensive

3. **OpenLCA**

Features:

- Free basic software
- Multiple database options (paid/free)
- Supports ISO-compliant LCA

Strengths:

- Cost-effective
- Customizable
- Ideal for academic + corporate use

Limitations:

- Steeper learning curve
- Limited customer support

4. **Carbon Trust Footprint Calculator**

Features:

- Business-friendly online calculator
- Uses UK Defra & IPCC emission factors
- Suitable for SMEs

Strengths:

- Easy to use
- Good for quick estimations

Limitations:

- Not ideal for complex Scope 3 calculations

5. <u>ClimateView</u>

ClimateView is a **climate-transition planning and management platform** designed primarily for **cities, governments, and large regions** to plan, model, implement, and track their journey toward **Net Zero**.

Think of it as:

A digital twin for a city's climate strategy — combining data, modelling, policies, and progress tracking in one platform.

ClimateView was adopted by:

- Sweden (national rollout)
- Cities in Germany, the UK, Canada, Spain, the USA, and more
- Climate agencies and energy transition planners

It is increasingly used by corporate sustainability teams as inspiration for **macro-level transition modelling**.

Why ClimateView Was Created (The Problem It Solves)

Cities produce **70–75% of global GHG emissions**.
Yet most cities struggle with:

- Fragmented climate data
- No unified emissions dashboard
- No way to model climate pathways
- Difficulty coordinating cross-sector actions
- No central strategy to track policies, budgets, and emission impacts
- Challenges in communicating progress to government, investors, and citizens

ClimateView solves these issues by offering a **system-level climate strategy tool**.

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What ClimateView Does (Core Functionalities)

ClimateView is built on a unique methodology called **Transition Elements**, which connects:

- Emissions
- Policies
- Economic impact
- Technology
- Financing
- Stakeholder actions

Here's a detailed breakdown:

Emission Baseline & Inventory Mapping

ClimateView builds a complete emission baseline for a city using:

Sector-wise breakdown:

- Transport
- Buildings
- Electricity
- Industry
- Waste
- Agriculture

Activity-level emission modelling:

Examples:

- Vehicle kilometres travelled
- Heating energy consumption
- Grid electricity mix
- Waste treatment methods

Conversion to CO_2e using standardised emission factors:

- IPCC

- IEA
- National agencies

This creates a **live, accurate carbon inventory**, which cities normally take months to assemble manually.

Transition Element Framework (Heart of ClimateView)

This is the signature component of ClimateView.

Each "Transition Element" is:

- A **policy action**
- Linked to **quantifiable emission impact**
- Connected to **economic, social, and environmental data**

Example Transition Elements:

- Increase electric vehicle adoption
- Retrofit residential buildings
- Expand public transport
- Shift to district heating
- Reduce food waste
- Install solar on public buildings

Each element includes:

- Expected GHG reduction
- Cost of investment
- Time needed
- Stakeholder responsibilities
- Dependencies and interconnections

It becomes a **roadmap of interlinked climate actions**.

Future Scenario Modelling (Forecasting Tool)

This is where ClimateView becomes powerful.

Cities can simulate:

- **Different climate action scenarios**
- **Impact of low, medium, and high ambition strategies**
- **Impact of policy delays**
- **Impact of new technologies**

For example:
"How will emissions change if EV adoption increases from 10% to 50% by 2030?"

ClimateView automatically adjusts:

- Emission pathways
- Required investments
- Economic impacts
- Time to Net Zero

This helps planners create **data-backed policy decisions**.

Integrated Dashboard for Tracking Climate Progress

The platform provides dynamic dashboards showing:

- **Emissions reductions achieved**
- **Remaining gaps**
- **Policy progress**
- **Sector-performance indicators**
- **Financial budgeting & spending**
- **KPI visualisation for reporting**

This is useful for:

- Government leaders
- Public reporting
- Global climate commitments (like C40, Net Zero Cities)
- Funding agencies

Collaboration & Stakeholder Engagement

ClimateView enables:

- Multi-department collaboration (transport, energy, waste, etc.)
- Involving experts, consultants, NGOs
- Public communication portals
- Investor-ready climate strategy visibility

It's a transparent, shared climate roadmap.

Integration With Global Frameworks

ClimateView aligns with:

- **IPCC Guidelines**
- **Paris Agreement pathways**
- **TCFD recommendations** (climate governance + risk modelling)
- **EU climate reporting frameworks (Fit for 55, CSRD)**
- **Science-Based Targets (SBTi) for Cities**

This makes it globally reliable and comparable.

Real Examples of ClimateView Use

- **SE Sweden – National Adoption**
  Used by 100+ municipalities to plan Net Zero pathways.
- **DE Germany – Heidelberg & Dortmund**
  Used for decarbonising transport, energy, and buildings.
- **GB United Kingdom – Nottingham, Newcastle**
  Used to manage citywide climate action plans.
- **CA Canada – Ottawa**
  Used to model long-term climate investments.

Cities report:

- Faster climate planning
- Better coordination
- Stronger investor confidence
- Reduced data complexity

Why ESG Learners Should Study ClimateView

Even though ClimateView is city-focused, ESG professionals benefit because:

- It teaches **holistic climate strategy design**, applicable to companies
- It demonstrates how to link **data → actions → outcomes → reporting**
- It shows how Scope 1, 2, 3 thinking works at the macro level
- It is used by climate agencies to influence corporate regulations
- Businesses can use the same modelling logic for **Net Zero roadmaps**

6. Watershed

Enterprise Carbon Accounting • Climate Strategy • Net-Zero Execution Platform
What is Watershed?

Watershed is a leading **enterprise-grade climate platform** used by global companies to **measure, reduce, and report carbon emissions** across Scope 1, 2, and 3.

It is widely used by:

- Walmart
- Shopify
- Airbnb
- Spotify

- Stripe
- DoorDash
- BlackRock (for portfolio analysis)
- Hundreds of Fortunes 500 companies

Watershed positions itself as:

"A full-stack climate platform for corporate decarbonization."

It focuses on:

- Accurate carbon measurement
- Automated data ingestion
- Supplier engagement
- Climate action modelling
- Reduction planning
- Reporting (CDP, TCFD, SBTi, ISSB)

Why Watershed Was Created (The Problem It Solves)

Modern companies face major challenges:

- 70–95% of emissions are in **Scope 3**
- Carbon data scattered across teams
- Manual Excel-based calculations are not scalable
- Global reporting standards becoming mandatory
- Investors expect **audit-quality ESG data**

Watershed solves these challenges by providing:

- A single platform
- Granular carbon measurement
- Automated data capture
- Advanced modelling tools
- Verified reduction pathways

What Watershed Does (Core Functionalities)

Watershed provides an end-to-end decarbonization system with 6 pillars:

Carbon Measurement & Accounting

Watershed ingests thousands of data points from:

- ERP systems
- Finance systems (SAP, Oracle)
- Utility bills

- Procurement databases
- Supplier questionnaires
- Logistics data
- Travel & commuting data

Key Features:

- Automated emission factor mapping
- Machine-learning–driven data estimation for missing values
- Sector-specific carbon models
- Audit-ready Scope 1, 2, and 3

Strength:

It calculates emissions at the **unit level**, not just annually.
(E.g., per shipment, per supplier, per product).

Supplier Engagement Tools

Since Scope 3 is the biggest challenge, Watershed:

- Sends supplier questionnaires
- Helps suppliers calculate their own emissions
- Benchmarks suppliers
- Tracks emissions reductions over time
- Provides "Supplier Scorecards"

This helps companies shift from:
❌ Estimating supply chain emissions
to
✓ Actively decarbonising them through supplier collaboration.

Climate Action Planning (Decarbonization Pathways)

Watershed includes a **scenario modeller** that allows companies to simulate:

- RE100 transition (100% renewable energy)
- Electrification of processes
- Efficiency programs
- Low-carbon procurement
- EV fleet adoption
- Circular economy initiatives

It answers:

- "Where should we invest to reduce emissions fastest?"
- "Which strategy gives maximum ROI?"

- "How will emissions look by 2030 under different pathways?"

Net-Zero Target Setting (SBTi-Aligned)

Watershed supports:

- SBTi near-term targets
- SBTi Net Zero targets
- Science-based decarbonization forecasting
- Finance impact modelling

It automatically evaluates:

- Required emission reduction percentages
- Target timelines
- Sector-specific pathways

Climate Reporting & Regulatory Compliance

Watershed generates reports aligned with:

- CDP
- ISSB IFRS S1/S2
- TCFD
- SEC Climate Rule (US)
- ESRS (EU)
- BRSR Core (India – partial compatibility)

Reports include:

- Emission summaries
- Reduction plans
- Climate risk disclosures
- Governance summaries

Watershed simplifies what normally takes companies **months** to prepare.

Climate Financing & Carbon Credits (High-Quality Offsets)

Via **Watershed Marketplace**, companies' access:

- Nature-based offsets
- Tech-based carbon removal
- Direct air capture projects
- Reforestation programs
- Soil carbon projects

All verified by:

- Gold Standard
- Verra
- Puro
- CarbonPlan

This helps manage **residual emissions** after reduction.

Why Watershed Is Popular (Key Advantages)

- **Enterprise-ready**
  Used by global companies dealing with large data volumes.
- **Deep Scope 3 analytics**
  Most tools struggle with Scope 3; Watershed is one of the strongest.
- **Automated data ingestion**
  Integrates with ERP, transport, finance, energy, and HR systems**.**
- **Scenario modelling**
  Helps companies simulate climate outcomes.
- **Audit-ready**
  Built for investor scrutiny and assurance.
- **Integrates reduction initiatives**
  A "strategy + execution" tool, not just a calculator.

Limitations (Balanced View for LMS)

- **Costly for SMEs**
  Designed for mid-size and large enterprises.
- **Requires organised data**
  Companies with poor data systems may face onboarding delays.
- **Many companies still need consultants**
  Watershed supplements but does not replace sustainability expertise.

Example Use Cases of Watershed

- **Shopify**
  Tracks emissions across thousands of shipments
  Invests in carbon removal through Watershed Marketplace
- **Walmart Supplier Program**
  Suppliers onboarded to measure and reduce Scope 3
  Integrated supplier climate scorecards
- **Airbnb**
  Models' emissions from server usage, travel, and properties
  Built a renewable energy strategy using Watershed modelling
- **Stripe**
  Invests in advanced carbon removal technologies
  Uses Watershed to verify climate impact

Who Should Use Watershed?

Suitable for:

- Large enterprises
- Multinationals
- Tech companies
- Retail & e-commerce
- Logistics-heavy companies
- Manufacturers with a large Scope 3

Not ideal for:

- Tiny businesses
- Companies needing free/basic tools

7. Normative

AI-Powered Carbon Accounting • Scope 3 Accuracy • Enterprise Emission Management

What is Normative?

Normative is an **AI-driven carbon accounting platform** founded in Sweden and backed by **Google.org**, designed to help companies measure and reduce their **full carbon footprint**, especially **Scope 3 emissions.**

Normative is known for:

- **Highly accurate Scope 3 calculations** (the biggest pain point for companies)

- AI-based estimation models
- Automated emission factor selection
- Supplier engagement tools
- Compliance-ready reporting

Normative calls itself:

"The world's first emissions accounting engine."

Why Normative Exists (The Problem It Solves)

Most companies face the same carbon challenges:

Scope 3 emissions are hard to measure

Because they involve:

- Purchased goods
- Logistics
- Supplier activities
- Use phase
- End-of-life
- Business travel
- Capital goods

Excel-based carbon calculations are inaccurate

Typical errors:

- Wrong emission factors
- Missing supplier data
- Overestimation or underestimation
- Incomplete boundary definition

Reporting rules are getting stricter

CDP, ISSB, SEC, CSRD, BRSR Core — all require GOOD data.

Investors demand audit-ready emissions data

Not rough estimates.

Normative solves these issues by combining:

- **AI**
- **Big data**
- **Global emission factor libraries**

- **Automated Scope 3 models**

What Normative Does (Core Functionalities)

Narrative's capabilities revolve around a **full-stack carbon accounting engine**, designed for accuracy, automation, and compliance.

End-to-End Carbon Measurement (Scope 1, 2, and 3)

Normative tracks:

- Fuel use
- Electricity consumption
- Process emissions
- Logistics/transport
- Raw materials
- Purchased goods & services
- Business travel
- Waste & water
- Upstream/downstream activities

How it works:

- It integrates with accounting systems, procurement databases, and ERP data.
- AI scans financial transactions and categorises emissions using **spend-based AND activity-based** methods.
- It cross-checks with global emission factor databases.

Strength:

It creates one of the **most accurate and comprehensive Scope 3 footprints** available.

Automated Emission Factor Mapping (Huge Advantage)

Normative uses the **largest library of emission factors**, including:

- IPCC
- IEA
- DEFRA (UK)
- EPA (US)
- EXIOBASE
- Ecoinvent
- National environmental agencies

AI automatically:

- Matches company activities to the correct emission factors

- Removes duplicates
- Alerts when data is missing
- Updates as global databases evolve

This avoids the #1 cause of carbon accounting errors: **wrong emission factor usage.**

Supplier Engagement & Scope 3 Data Collection

Normative has powerful supply-chain collaboration tools:

- **Supplier survey portal**
- **Pre-built questionnaires**
- **Supplier training modules**
- **Carbon calculations for suppliers**
- **Supplier benchmarking dashboards**

Normative helps suppliers move from:
"We don't know our emissions"
to
"We can measure and report accurately."

This is critical because Scope 3 can be **70–90%** of a company's footprint.

Reduction Insights & Decarbonization Roadmaps

Normative analyses emissions hotspots and generates strategies:

- Low-carbon procurement
- Renewable energy
- Supplier switching
- Logistics optimisation
- Better materials
- Low-emission travel policies

It provides:

- Projected emission reductions
- Cost estimation
- Timeline modelling
- Risk analysis

This enables companies to build a **science-aligned decarbonization strategy.**

Compliance-Ready Climate Reporting

Normative's reporting engine supports:

- **CDP submissions**
- **TCFD alignment**
- **ISSB IFRS S2** climate reporting
- **EU CSRD/ESRS climate disclosures**
- **SBTi target setting**
- **Net-zero strategy submissions**
- **BRSR/BRSR Core (partial alignment)**

Reports are:

- Audit-ready
- Traceable
- Fully documented
- Linked back to data sources

Engagement With Science-Based Targets (SBTi)

Normative helps companies:

- Calculate baseline
- Model pathways
- Set SBTi-aligned targets
- Track yearly emissions
- Validate climate actions

Its output is directly compatible with SBTi requirements.

Advantages of Normative (Why Companies Use It)

- **Best-in-class Scope 3 accuracy** Most t
  Tools over- or underestimate Scope 3 — Normative excels here.
- **AI eliminates manual errors**
  No more manual Excel sheets.
- **Very strong for procurement-heavy industries**
  Retail, e-commerce, and manufacturing.
- **Integrates with ERP systems**
  SAP, Oracle, QuickBooks, Xero, NetSuite.
- **Backed by Google.org**
  Adds credibility and technology support.
- **Continuously updated emission factor database**
  Ensures compliance with global standards.

Limitations (Balanced & Realistic)

- **Not ideal for very small companies**
  Designed for medium-large businesses.
- **Requires decent-quality financial data**
  Poor bookkeeping = poor results.
- **Not an LCA tool**
  It doesn't give full product lifecycle footprints like SimaPro/GaBi.
- **Complex for beginners**
  Needs onboarding support.

Real Use Cases of Normative

A retail chain

- Integrates procurement data
- Identifies high-emission suppliers
- Switches to low-carbon materials
- Reports Scope 3 reductions annually

A logistics companies

- Tracks fuel consumption
- Analyses fleet emissions
- Models EV transition scenarios

An FMCG company

- Measures emissions of packaging, raw materials
- Works with suppliers to reduce embedded emissions

A technology firms

- Tracks cloud server emissions
- Optimises travel and remote work emissions

Best Fit Industries

- Retail & Consumer Goods
- Manufacturing
- Logistics
- Hospitality
- E-commerce
- IT & Technology
- Food & Agriculture

Industries with complex supply chains benefit the most.

Indian tools:

- **CII Carbon Footprint Tool**
- **TERI calculators**
- **BEE energy calculators**

6. Carbon Reduction Strategies

Carbon reduction strategies fall into **three categories**:

1. **Avoid**
2. **Reduce**
3. **Replace**
4. **Offset** (only after real reduction)

Let's break them down.

6.1 Operational Emission Reductions (Scope 1)

Energy efficiency upgrades

- LED lighting
- Efficient motors
- Variable frequency drives (VFDs)
- Waste heat recovery

Cleaner fuels

- Shift from diesel to natural gas
- Use of biofuels

Electrification of processes

- Electric boilers
- Electric forklifts
- Electrified industrial equipment

Reduce fugitive emissions

- Refrigerant management (HFC reduction)
- Leak detection & repair (LDAR)

6.2 Purchased Energy Emissions (Scope 2)

Switch to renewable electricity

- Rooftop solar
- Solar/wind PPAs
- Green power procurement

Energy optimization

- Smart meters
- Energy audits
- Peak demand management

6.3 Value-Chain Emission Reduction (Scope 3)

This is the **hardest** but **most impactful**.

Upstream Measures

- Supplier ESG audits
- Low-carbon raw materials
- Green procurement policy
- Collaboration with logistics partners

Transportation

- EV fleets
- Efficient routing
- Improved load capacity

Product design

- Lightweight materials
- Recyclable packaging
- Circular product design

Downstream Measures

- Product energy efficiency
- Recyclability programs
- Take-back schemes

7. Net Zero Roadmap (Long-Term Strategies)

Companies aiming for Net Zero follow these steps:

1. Measure baseline (Scope 1–3)
2. Set science-based targets (SBTi)
3. Reduce operational emissions (20–40%)
4. Decarbonise electricity (100% RE)
5. Engage suppliers (value-chain decarbonization)
6. Innovate low-carbon products
7. Offset residual emissions (5–10%)

8. Carbon Offset Strategies (Last Step Only)

Offsets must be used **only after** actual reduction.

Common offset types:

- Forest restoration
- Renewable energy projects
- Methane capture projects
- Soil carbon sequestration
- Blue carbon (mangrove, seagrass restoration)

Offsets should follow standards:

- Verra (VCS)
- Gold Standard
- CDM (UN)

9. Examples of Global Companies Leading Carbon Reduction

- **Tata Steel**
  Hydrogen-based steelmaking
  Carbon capture pilots
- **Tata Power**
  70% of new capex in renewables
- **Microsoft**
  Carbon negative by 2030
- **Unilever**
  Net zero across the supply chain by 2039
- **Apple**
  Carbon-neutral products using recycled materials
- **Mahindra**
  Carbon-neutral commitment by 2040

2. Renewable Energy & Resource Efficiency

You'll learn:

- Why renewable energy (RE) and resource efficiency (REff) matter to climate, costs and resilience
- Technical options (solar, wind, bioenergy, storage) and efficiency levers (energy, water, materials)
- How to evaluate projects (energy savings, CO_2 impact, payback) with worked examples
- Implementation steps, procurement best practices, financing models, and M&V (measurement & verification)
- KPIs, dashboards and common barriers + mitigation

Renewable Energy (RE) — energy from sources that naturally replenish (solar, wind, hydro, biomass, geothermal).
Resource Efficiency (REff) — using less energy, water, material or waste to deliver the same (or better) output; includes circular-economy measures (reuse/recycle).

Why both matter

- RE reduces emissions from energy supply (affects Scope 2 and, partly, Scope 3).
- REff reduces demand (lowers Scope 1, 2, 3), improves margins, and often lowers operational risk.

High-level strategy for companies

1. **Measure baseline** (energy, water, material intensity per product or m^2).
2. **Prioritise low-cost/quick wins** (lighting, controls, compressed-air leaks).
3. **Plan deep decarbonisation**: on-site RE + PPAs + electrification + process redesign.
4. **Engage suppliers** on low-carbon inputs (Scope 3).
5. **Finance smartly** (ESCo / PPA / green loans).
6. **Monitor & verify** impact and report using standard KPIs.

1. Introduction: The Foundation of Low-Carbon Business

Climate change, energy security, rising fuel costs, and global ESG pressures make **Renewable Energy (RE)** and **Resource Efficiency (REff)** two of the most powerful levers for sustainable business transformation.

They contribute directly to:

- **Lower greenhouse gas emissions**
- **Reduced operating costs**
- **Energy independence**
- **Operational resilience**
- **Regulatory compliance (BRSR, ISSB, SBTi)**
- **Improved ESG performance**

Together, RE + REff form the backbone of corporate decarbonization.

2. Renewable Energy (RE): Concept & Importance

Renewable energy comes from natural sources that replenish continuously, unlike fossil fuels.
The main RE sources are:

- **Solar**
- **Wind**
- **Hydro**
- **Biomass/Biogas**
- **Geothermal**
- **Green Hydrogen** (emerging)

Why RE Is Critical for Companies

1. It reduces **Scope 2 emissions** drastically.
2. Stabilises long-term costs (renewables have no fuel volatility).
3. Meets investor expectations (RE100 goals).
4. Improves energy security.
5. Qualifies for green finance & tax incentives.

Companies worldwide are shifting towards:

- **On-site solar/wind**
- **Corporate PPAs**
- **Renewable Energy Certificates (RECs)**

3. Major Types of Renewable Energy (Detailed)

3.1 Solar Energy (PV & Thermal)

- Works for rooftops, ground-mounted, parking structures, and industrial sheds.
- Modular, scalable, rapidly deployable.
- Now among the **cheapest forms of electricity** globally.

Factors affecting solar output:

- Location (sunlight availability)
- Tilt angle
- Panel efficiency
- Temperature
- Shading

3.2 Wind Energy (Onshore & Offshore)

- Higher output at good wind sites.
- Suitable for large industrial clusters or utility-scale procurement via PPAs.

Challenges:

- Land requirement
- Power evacuation infrastructure
- Seasonal variations

3.3 Biomass/Biogas

- Suitable for companies generating organic waste.
- Provides **steady (dispatchable)** thermal or electrical energy.

Used in:

- Food processing
- Agriculture
- Paper mills
- Distilleries

3.4 Hydropower

- Reliable, firm power.
- Used mainly in grid-scale procurement.

3.5 Green Hydrogen (Future Energy)

Made by using renewable electricity to split water (electrolysis).
Useful for:

- Steelmaking
- Fertilizer production
- Heavy transport
- High-temperature heat

4. How Companies Adopt Renewable Energy

4.1 On-Site Generation

- Rooftop solar
- Ground-mounted solar
- Wind turbines (where feasible)

Pros:
Low cost, reduces grid dependency, and long-term savings

Cons:
Space requirements, CAPEX

4.2 Off-Site / Utility Procurement

- **Corporate Power Purchase Agreements (PPAs)**
- **Green Tariff Programs (utilities supply RE)**
- **Group captive RE projects**
- **Open Access RE**

Pros:
Large capacity, long-term stable tariffs

4.3 Renewable Energy Certificates (RECs)

Used when direct RE procurement is not possible.
Provides a way to claim renewable energy usage legally.

5. Resource Efficiency (REff): The Second Pillar of Decarbonization

Resource efficiency is about **producing more with fewer resources**:

- Less electricity
- Less fuel
- Less water
- Fewer raw materials
- Lower waste generation

It directly improves margins and sustainability performance.

6. Types of Resource Efficiency

6.1 Energy Efficiency in Operations

a. Equipment Upgrades

- LED lighting
- High-efficiency motors
- VFDs (Variable Frequency Drives)
- Efficient HVAC systems

b. Process Optimisation

- Compressed air leak management

- Boiler efficiency improvement
- Heat recovery systems
- Automation to reduce idle time

c. Building Efficiency

- Insulation
- Energy-efficient glazing
- Smart metering
- Building Management Systems (BMS)

6.2 Water Efficiency

- Water recycling & reuse
- Rainwater harvesting
- Low-flow fixtures
- Cooling tower optimization
- Leak detection systems

6.3 Material Efficiency & Circularity

- Lightweighting products
- Designing for reuse
- Recycled raw materials
- Take-back programs
- Industrial symbiosis (waste of one company → input for another)

6.4 Waste Reduction

- Zero waste-to-landfill initiatives
- Composting organic waste
- Segregation at source
- Recyclable packaging

7. Combined Impact: RE + REff Together

A company must apply both:

- **Resource Efficiency reduces energy demand.**
- **Renewable Energy supplies the remaining energy with lower emissions.**

This makes deep decarbonization technically and financially feasible.

8. How to Implement RE & Resource Efficiency (Step-by-Step)

Step 1: Baseline Assessment

- Energy audit (electricity + thermal)
- Water audit
- Material flow analysis
- Carbon footprint (Scope 1–3)

Step 2: Identify Savings & RE Opportunities

Use tools like:

- RETScreen
- HOMER
- BEE calculators
- Carbon accounting tools (Watershed, Normative)

Step 3: Prioritise Based on Impact

Parameters:

- Emission reduction potential
- Investment required (CAPEX)
- Payback period
- Ease of implementation
- Co-benefits (productivity, safety, comfort)

Step 4: Financing Options

- Direct CAPEX
- PPA (Power Purchase Agreement)
- ESCO (Energy Service Company) models
- Green Loans
- Sustainability-Linked Loans

Step 5: Implementation

- Install RE systems
- Retrofit equipment
- Redesign processes
- Train staff

Step 6: Monitoring & Verification

Use:

- IoT sensors
- BMS/SCADA systems

- Sub-metering
- Energy dashboards

Ensure compliance with:

- ISO 50001 (Energy Management)
- ISO 14001 (Environmental Management)

Step 7: Reporting (ESG/BRSR/ISSB/SBTi)

- Report renewable energy share
- Report energy/water/material intensity
- Report emissions savings (CO_2e)

9. Real-World Examples (Industry Specific)

Learning goal: show concrete RE + REff measures for 5 industry archetypes, with implementation steps, likely KPIs, common pitfalls, and a short worked calculation for each where useful.

A. Manufacturing (Automotive / Heavy Manufacturing)

Typical problems: high thermal loads, heavy motors, large compressed-air systems, and significant process wastewater.

Typical measures

1. **Compressed-air leak detection & repair** (LDAR program)
2. **Motor upgrades + VFDs** on pumps/blowers
3. **Waste-heat recovery** from furnaces/ovens to preheat feedstock or to produce steam
4. **Rooftop solar** to cover daytime electricity demand
5. **Electrification of process heat** where feasible (heat pumps, electric boilers)

Implementation steps

1. Baseline energy audit (disaggregate by process line).
2. Install sub-meters on major feeders (motors, compressors, ovens).
3. Run LDAR campaign and prioritize compressor fixes.
4. Replace motors <—> size VFDs and implement control logic.
5. Pilot rooftop solar on one plant roof; expand after M&V.

KPIs to monitor

- Specific energy consumption (SEC) = kWh / tonne product
- Compressor leakage rate (m^3/hr lost)
- Heat recovery efficiency (%)
- % of electricity from on-site RE

Worked example — compressed air leak savings (digit-by-digit)

Scenario: Plant has 10 identified leaks totalling 250 L/min (litres per minute) of air loss at 7 bars. Operating 8,400 hours/year (24×350). Compressor power penalty ≈ 0.010 kW per L/min at 7 bars (typical rule of thumb).

1. Total leakage (L/min) = 250 L/min.
2. Convert to kW: power loss = 250 L/min × 0.010 kW/(L/min) = 2.5 kW.
   - 250 × 0.010 = 2.5.
3. Annual hours = 24 × 350 = 8,400 hours.
   - 24 × 350 = 8,400.
4. Annual energy wasted = 2.5 kW × 8,400 h = 21,000 kWh.
   - 2.5 × 8,400 = 21,000.
5. If electricity cost = ₹8/kWh, annual cost saving when fixed = 21,000 × 8 = ₹168,000.
   - 21,000 × 8 = 168,000.
6. If emission factor = 0.708 kgCO_2e/kWh, annual CO_2e avoided = 21,000 × 0.708 = ?
   - 21,000 × 0.7 = 14,700.
   - 21,000 × 0.008 = 168.
   - Total = 14,700 + 168 = 14,868 kgCO_2e = 14.868 tCO_2e.

Outcome: Fixing leaks saves 21,000 kWh, ₹168k/yr, ~14.9 tCO_2e/yr — often with <12 months payback.

<u>B. Textiles (Dyeing / Finishing)</u>

Typical problems: high water use, thermal energy in dyeing, wastewater heat content, and chemical usage.

Typical measures

1. **Process heat recovery** from wastewater (plate heat exchangers).
2. **Low liquor ratio dyeing** and optimised batch sizes.
3. **Water recirculation & ultrafiltration** for reuse.
4. **Biogas from effluent** to fuel boilers.
5. **Solar thermal** for low-temperature process heating.

Implementation steps

- Map water & heat flows; identify heat in effluent > implement heat exchangers.
- Pilot water reuse on one dye line.
- Install online monitoring for COD/BOD to ensure the quality of recycled water.

KPIs

- Water intensity = L / kg fabric
- Steam consumption = kg steam/kg fabric
- Wastewater reuse %

- Chemical consumption per kg fabric

Quick calc — heat recovery from effluent

Scenario: 10 m^3/hr effluent at 60°C cooled to 35°C, capturing heat for preheating incoming water. Specific heat ≈ 4.186 kJ/kg·K; assume density ≈ 1 kg/L ⇒ 10,000 L/hr = 10,000 kg/hr.

1. Temperature drop ΔT = 60 − 35 = 25°C.
   - 60 − 35 = 25.
2. Energy recovered per hour = mass × Cp × ΔT = 10,000 kg × 4.186 kJ/kg·K × 25 K = ? kJ.
   - 4.186 × 25 = 104.65.
   - 10,000 × 104.65 = 1,046,500 kJ/hr.
3. Convert to kWh: 1 kWh = 3,600 kJ. So kWh/hr = 1,046,500 ÷ 3,600 = ?
   - 3,600 × 290 = 1,044,000.
   - Remainder: 1,046,500 − 1,044,000 = 2,500.
   - 2,500 ÷ 3,600 ≈ 0.694.
   - So ≈ 290.694 kWh recovered per hour.
4. Annual (8,000 hr/year operation): 290.694 × 8,000 ≈ 2,325,552 kWh/year.
   - 290.694 × 8,000 = 2,325,552.
5. That is large — in practice efficiencies, heat exchanger effectiveness and usable fraction reduce capture; even capturing 20% yields ≈ 465,110 kWh/yr.

Outcome: Heat recovery is a major savings lever in textiles; it pays back through reduced steam/fuel demand.

<u>C. IT / Data Centres & Tech Firms</u>

Typical problems: high electricity for servers and cooling; PUE optimisation; large Scope 3 from cloud providers.

Typical measures

1. **PPA for renewables** or on-site rooftop + green tariffs.
2. **Server consolidation & virtualisation** to reduce server count.
3. **Free-cooling** and hot-aisle containment to reduce chiller loads.
4. **Workload scheduling** to shift compute to lower-emission hours (if matched with RE availability).

KPIs

- PUE (Power Usage Effectiveness) = Total facility energy ÷ IT equipment energy
- % renewable electricity
- CPU utilisation efficiency

Worked idea — PUE improvement ROI

If a data center reduces PUE from 1.8 → 1.4 and IT load = 1,000 kW:

1. IT load = 1,000 kW.
2. Total energy before = 1,000 × 1.8 = 1,800 kW.
   - 1,000 × 1.8 = 1,800.
3. Total energy after = 1,000 × 1.4 = 1,400 kW.
   - 1,000 × 1.4 = 1,400.
4. Power reduction = 1,800 − 1,400 = 400 kW.
   - 1,800 − 1,400 = 400.
5. Annual hours 8,760 → energy saved/year = 400 × 8,760 = 3,504,000 kWh.
   - 400 × 8,760 = 3,504,000.
6. At ₹8/kWh → cost saving = 3,504,000 × 8 = ₹28,032,000.
   - 3,504,000 × 8 = 28,032,000.

Outcome: Optimising PUE is extremely high-value for data centres.

D. Retail Chain (Stores & Cold-Chain)

Typical issues: many small sites with lighting, HVAC, refrigeration — good rooftop potential, and centralised purchasing power.

Measures

1. **Rooftop solar across stores** (distributed model or PPA).
2. **LED lighting + daylight sensors** in stores.
3. **Efficient refrigeration systems** and leakless refrigerant management.
4. **Smart thermostats** and demand response with time-of-use tariffs.

KPIs

- Energy per store (kWh/store/month)
- Refrigeration COP (Coefficient of Performance)
- % stores with solar

Implementation notes

Rollout in pilot clusters — monitor yield, O&M issues, then scale.

E. FMCG / Consumer Goods (Packaging & Supply Chain)

Typical issues: product-embedded emissions (packaging, agricultural inputs), distribution footprint.

Measures

1. **Lightweight packaging** and recycled content.
2. **Supplier engagement** for agricultural best practices.

3. **Electrified logistics** for last-mile delivery.
4. **Renewable procurement** for factories.

KPIs

- Embodied carbon per product (kg CO_2e/unit)
- % recycled content in packaging
- Distribution tCO_2e per unit

10. Key Benefits of RE & Resource Efficiency

Learning goal: explain how each benefit category translates into measurable business value, the typical KPIs used, how to quantify benefits, and examples of how to present this to leadership/investors.

Overview (four benefit pillars)

1. **Environmental** — emission reduction, pollution control, biodiversity co-benefits
2. **Economic** — OPEX savings, stabilised energy cost, improved margins, new revenue streams
3. **Social** — employee health & productivity, community goodwill, customer preference
4. **Governance** — regulatory compliance, reduced legal risk, improved disclosures and investor confidence

We'll unpack each.

1) Environmental benefits — what and how to measure

What: Reduced GHG emissions (Scope 1/2/3), lower air/water pollution, less resource depletion.

How to measure (metrics):

- tCO_2e avoided per year (directly measured via energy savings or RE generation)
- Emissions intensity = tCO_2e / unit revenue or per product
- Water saved (m^3/year)
- Waste diverted (t/year)

How to quantify (example — rooftop solar avoided emissions)
Scenario: 100 kW solar system, capacity factor 0.18, annual hours = 8,760.

1. Annual generation = 100 kW × 8,760 h × 0.18 =? kWh.
   - 100 × 8,760 = 876,000.
   - 876,000 × 0.18 = 157,680 kWh.
2. Emissions avoided = 157,680 × 0.708 $kgCO_2e$/kWh =? kg.
   - 157,680 × 0.7 = 110,376.

- $157{,}680 \times 0.008 = 1{,}261.44$.
- Total = $110{,}376 + 1{,}261.44 = 111{,}637.44$ kg = 111.64 tCO_2e/year.

Narrative: That single 100 kW installation avoids ~112 tCO_2e/year — scalable across sites.

2) Economic benefits — concrete levers & KPIs

Direct savings:

- Energy bill reduction (kWh × tariff)
- Fuel savings (for process heat)
- Lower maintenance with newer equipment

Indirect financial benefits:

- Lower cost of capital (access to green loans, lower interest rates)
- Tax incentives, depreciation benefits
- Higher asset resale value (energy-efficient factory)
- Reduced exposure to volatile fossil fuel markets

KPIs:

- Annual ₹ saved
- Payback (years)
- NPV and IRR of projects
- Cost avoided per tCO_2e (₹/tCO_2e)

How to present to CFO

- Show cashflow table over project life (CAPEX, O&M, savings)
- Include conservative scenarios for tariff escalation and degradation

Worked example — payback (rooftop solar) (short repeat from module)

- CAPEX = ₹2,500,000; annual saving = ₹700,800 → payback ≈ 3.57 years (see earlier step-by-step).

3) Social benefits — concrete outcomes

What: improved worker health, community resilience, job creation, customer trust.

Examples & KPIs:

- Reduced workplace heat stress → lower absenteeism (% change)
- Jobs created in installation & O&M (FTEs)
- Local community programs funded from energy savings
- Customer NPS uplift after sustainability branding (qualitative but trackable)

How to quantify:

- Translate reduced sick days into productivity gain: e.g., 10 fewer sick days × average daily output value.

4) Governance & strategic benefits — investor & regulatory impacts

What: better ESG ratings, compliance readiness, lower regulatory risk, stronger stakeholder trust.

Measurable effects:

- Improved ESG scores (MSCI, Sustainalytics) — correlates with valuation premiums in some studies.
- Easier access to sustainability-linked loans with KPI targets (lower interest when targets are met).
- Reduced probability of regulatory fines for pollution / non-compliance.

How to show board:

- Map RE/REff initiatives to specific disclosure requirements (BRSR, ISSB S2, TCFD) to demonstrate compliance and reduced audit risk.
- Provide scenario analysis: cost of non-action (carbon price exposure, penalty risk) vs cost of action.

Co-benefits & strategic synergies

- **Energy resilience:** on-site RE + storage reduces outage risk (business continuity).
- **Brand & market advantage:** a product labelled "lower-carbon" can command a premium or secure procurement contracts.
- **Innovation:** process optimisation often uncovers product improvements and new revenue streams (recycled content product lines).
- **Supply-chain leadership:** companies with strong RE/REff can require suppliers to upgrade, multiplying impact across the value chain.

Quantifying benefits across categories — sample dashboard (what to report)

- Annual energy saved (kWh) → converts to ₹ saved and tCO_2e avoided
- % energy from renewables (monthly)
- Water saved (m^3) and cost equivalent
- Waste diverted (t) and disposal cost avoided
- ROI, payback, NPV, IRR for projects
- Jobs created (FTE) and community spend

- Changes in ESG rating or cost of capital (if measurable)

Typical timelines & time horizons

- **Quick wins:** 0–12 months (LEDs, compressed air fixes)
- **Medium investments:** 1–3 years (motor replacements, rooftop solar pilots)
- **Deep transitions:** 3–10+ years (PPAs, process electrification, green hydrogen adoption)
- **Strategic benefits** (brand, lower cost of capital) often accrue over 2–5 years.

Common ROI framing for executives

- Present both **financial ROI** (NPV/IRR) and **cost of carbon avoided**.
- Scenario: If internal carbon price = ₹2,000/tCO_2e, show added value from avoided emissions (e.g., 111.64 tCO_2e × ₹2,000 = ₹223,280/yr implicit value).

Short teaching activities (for module wrap)

1. **Financial case build:** students build NPV for a 250-kW solar farm with given tariff escalations.
2. **Benefits mapping exercise:** for a proposed efficiency project, map environmental, economic, social, governance impacts and KPIs.
3. **Stakeholder memo:** draft a 1-page memo to the CFO summarising expected savings, payback, and strategic benefits.

11. Metrics & KPIs (For ESG Reporting)

KPI	Description
Energy intensity	kWh per unit of output
Renewable energy share	% of energy from RE sources
Water intensity	Litres per unit of output
Waste diversion rate	% waste recycled/composted
GHG reduction	Tonnes CO_2e avoided
PUE (for data centres)	Power Usage Effectiveness

12. Challenges & How to Overcome Them

Challenge	Solution
High upfront cost	Use PPA, ESCO, green loans
Lack of data	Install sub-meters, use digital tools
Space constraints	Opt for off-site PPAs

Challenge	Solution
Technical complexity	Hire experienced EPC contractors
Resistance to change	Conduct training & awareness

13. The Future of RE & Resource Efficiency

- Growing adoption of **AI-driven energy management**
- Widespread **solar + storage** use
- Rapid decrease in renewable costs
- Circular economy integration into core business strategy
- Carbon-neutral and net-zero companies becoming mainstream

3. Waste Management & Circular Economy

A complete explanation of concepts, frameworks, tools, business practices, technologies, case studies, KPIs & implementation strategy.

Introduction: Why Waste Management & Circularity Matter

Waste is not just an environmental problem.
It is a **material inefficiency, financial leakage, operational risk, compliance burden, and brand opportunity**.
Circularity transforms waste from a liability into a **resource and revenue stream**.

Below is a detailed breakdown of why this topic is fundamentally important for modern businesses, societies, and the planet.

1. Environmental Importance: Waste = Emissions + Pollution + Resource Loss

1.1 Waste directly drives climate change

- 45% of global GHG emissions come from **producing, using, and discarding** materials.
- Landfills release **methane**, 28–34× more potent than CO_2.
- Plastic waste breaks into microplastics → contaminates soil, oceans, food chains.

Key insight:
🌱 Every tonne of waste avoided = emissions avoided from extraction, manufacturing, transport, and disposal.

1.2 Natural resource depletion

Every product requires:

- mining
- processing
- transportation
- energy
- water
- packaging

When wasted, these resources are lost forever.

Examples:

- Only **9%** of all plastic ever produced has been recycled.
- 50% of all aluminium cans are still landfilled — despite aluminium being infinitely recyclable.
- Textile waste in fast fashion leads to massive water and energy losses

1.3 Land, water & air pollution

Poor waste management causes:

- toxic leachate into groundwater
- air pollution from burning
- soil contamination
- marine life destruction

Circular models reduce extraction → fewer mines, fewer landfills, less pollution.

2. Economic Importance: Waste Is Expensive (A Hidden Cost Centre)

2.1 Waste = Lost Materials = Lost Money

Every kg of waste represents:

- lost raw materials
- lost labour
- lost energy
- lost packaging
- lost transport
- lost storage space

Companies often don't realise these hidden costs.

💡 A study by McKinsey shows circularity can unlock USD 4.5 trillion in economic value by 2030.

2.2 Recycling saves money & generates new revenue

- Metal scraps → sold at high value
- Paper/cardboard → recyclable revenue
- Plastics → recycled granules
- Food waste → biogas and compost
- E-waste → gold, silver, copper recovery

Circular economy creates **new material flows** instead of paying for disposal.

2.3 Reduces operational costs

Efficient waste systems:

- reduce transportation costs
- reduce storage area required
- reduce penalties/fines
- reduce downtime (cleaner, safer floors & processes)

Large FMCG & automotive companies save **millions annually** just by segregating better.

3. Regulatory & Compliance Importance

Governments worldwide are tightening waste rules:

- **EPR (Extended Producer Responsibility)**
- **Plastic Waste Management Rules**
- **E-Waste Management Rules**
- **Hazardous Waste Rules**
- **BRSR (India)**
- **EU CSRD (Europe)**

Regulations now require companies to:

- Track their waste
- File EPR reports
- Reduce use of virgin plastic
- Meet recycling targets
- Demonstrate circular material use
- Show landfill diversion numbers

Companies that ignore these face:

- fines
- import bans
- loss of licenses
- supply chain disruption

Circularity is now a compliance requirement — not a choice.

4. Social Importance: Health, Safety & Community Well-being

4.1 Cleaner environments reduce diseases

Poor waste causes:

- dengue, malaria (mosquito breeding)
- respiratory illness (burning plastic)
- groundwater contamination from chemicals
- food contamination from microplastics

Circular systems create:

- cleaner air
- safer water
- healthier ecosystems

4.2 Green jobs & social equity

Circular economy creates **millions of jobs** in:

- recycling industries
- repair & refurbishing
- composting facilities
- remanufacturing
- sorting & logistics
- plastic upcycling

It also integrates informal waste pickers into formal systems → better wages & safety.

5. Operational Importance: Efficiency, Resilience & Risk Reduction

5.1 Waste signals inefficiency

If a process generates waste, it means:

- material losses
- inefficiency
- poor design
- excess energy consumption
- defects or quality issues

Circularity helps companies find **root causes** and remove inefficiencies.

5.2 Supply chain resilience

Virgin material prices fluctuate.
Recycled materials:

- are cheaper
- more stable in price
- reduce dependency on external suppliers

Circular supply chains are **less vulnerable to global disruptions**.

6. Brand & Consumer Preference Importance

6.1 Consumers demand sustainable products

Millennials & Gen Z prioritise brands that:

- use recycled materials
- reduce plastic
- offer sustainable packaging
- run take-back programs

Companies with strong circularity messaging:

- win brand loyalty
- attract premium customers
- increase repeat sales

6.2 Investor expectations

Investors want companies that:

- minimise ESG risk
- have circular business models
- reduce environmental liabilities

Circularity improves ESG ratings → attracts capital, green loans, and sustainability-linked investments.

7. Strategic Importance: Future-Proofing Business Models

7.1 Circularity drives innovation

Examples:

- Furniture rental instead of sales (IKEA)
- Refurbished electronics (Apple)
- Deposit-return systems (Coca-Cola, PepsiCo)
- Zero-waste stores & refill stations

Circularity unlocks new revenue streams and business models.

7.2 Supports Net Zero Goals

A Net Zero target **cannot be achieved** without circularity.

Why?

Because Scope 3 emissions (typically 70–90% of total emissions) come from:

- raw materials
- manufacturing
- packaging
- downstream disposal

Circularity directly reduces Scope 3.

7.3 Reduces long-term business risk

Circularity helps companies avoid:

- resource scarcity
- raw material price shocks
- legal penalties
- stranded assets
- negative publicity

8. Planetary & Global Importance: Ensuring Long-Term Survival

8.1 Finite resources — infinite economic growth is impossible without circularity

Circularity breaks the link between:

- resource extraction
  and
- economic growth

It enables economies to grow sustainably using fewer materials.

8.2 Supports UN Sustainable Development Goals (SDGs)

Especially:

- SDG 12 (Responsible Consumption & Production)
- SDG 13 (Climate Action)
- SDG 14 (Life Below Water)

- SDG 15 (Life on Land)
- SDG 9 (Industry, Innovation, Infrastructure)

2. Waste Management vs Circular Economy: Difference & Relationship

Linear Model	Waste Management	Circular Economy
Take → Make → Dispose	cuses on handling waste after it is created	cuses on eliminating waste *before it is created*
Extractive	Reactive	Preventive + regenerative
Cost center	Compliance	Business growth and value creation

A **strong waste management system** is the foundation.
A **circular economy model** transforms waste into resources and redesigns entire processes.

3. Waste Management: Concepts & Hierarchy

The globally accepted framework is the **Waste Management Hierarchy**, listed from best to worst:

3.1 Prevent (Best)

- Redesign products
- Optimise processes
- Reduce raw material use
- Shift from single-use to reusable

3.2 Reduce

- Energy-efficient machinery (less waste heat)
- Precision manufacturing (less scrap)
- Smart printing, batching, cutting

3.3 Reuse

- Reusable packaging
- Returnable containers
- Reusing components in refurbishing units

3.4 Recycle

- Mechanical recycling
- Chemical recycling
- Metal, plastic, textile recycling

3.5 Recover

- Energy recovery (waste-to-energy plants)
- Anaerobic digestion
- Co-processing in cement kilns

3.6 Dispose (Landfill) (Worst)

- Only for residues that cannot be reused/recycled
- Leads to methane emissions & long-term contamination

4. Types of Waste (Industry Focused)

4.1 Municipal Solid Waste (MSW)
Household waste, packaging, food scraps.

4.2 Industrial Waste
Scrap metal, chemicals, rejected products, plastics, paper, and sludge.

4.3 Hazardous Waste
Chemicals, batteries, e-waste, solvents, and biomedical waste.

4.4 Construction & Demolition Waste
Concrete, bricks, metals, ceramics.

4.5 E-Waste
PCBs, wires, chips, computers, phones — fastest growing waste stream.

4.6 Agricultural Waste
Crop residues, manure, husk.

5. Waste Management Systems & Technologies

5.1 Segregation at Source

The single most important stage.

- 2-bin, 3-bin, or 4-bin systems
- Color coding (green → organic, blue → dry recyclables, red → hazardous)
- Reduces contamination
- Increases recycling value

5.2 Collection & Transportation

- GPS-tracked vehicles
- Compactors for volume reduction
- RFID tags for waste tracking
- Weighbridge integration to measure waste loads

5.3 Material Recovery Facility (MRF)

Where mixed waste is sorted using:

- Conveyor belts
- Trommel separators
- Magnetic separators for metals
- Air blowers for plastics/lightweights
- Optical sorters (advanced)

MRFs convert waste streams into **high-purity recyclables**.

5.4 Recycling Technologies

- **Mechanical Recycling**
  Plastic → flakes → granules → new plastic products.
- **Chemical Recycling**
  Plastic → monomers → new plastic
  Useful for multilayer packaging.
- **Metal Recycling**
  Steel, aluminium → high-value recovery.
- **Paper Recycling**
  Deinking, pulping, reprocessing.
- **Glass Recycling**
  Crushing → cullet → remelting.

5.5 Organic Waste Treatment

Composting (Aerobic)

- Converts organics → compost
- 45–60 days
- Requires aeration, moisture control

Anaerobic Digestion (Biogas)

- Produces methane-rich biogas
- Digestate → fertilizer

- Used by food industries & municipalities

Vermicomposting

Using worms to speed up decomposition.

5.6 Waste-to-Energy (WTE)

- Incineration with energy generation
- RDF (Refuse-derived Fuel) for cement kilns
- Pyrolysis for plastics → fuel oil

5.7 Landfill Management

- Scientific landfills with liners
- Leachate treatment
- Methane capture for electricity
- Post-closure monitoring

6. Circular Economy: Deep Dive into Framework & Strategies

Circular Economy (CE) aims to redesign systems so that materials continuously flow in closed loops.

The CE model is built on **three core principles** (Ellen MacArthur Foundation):

6.1 Principle 1 — Eliminate Waste & Pollution

- Design out waste
- Minimise virgin resource extraction
- Ban single-use products
- Use renewable energy for production

6.2 Principle 2 — Keep Products & Materials in Use

Through loops:

- Reuse
- Repair
- Refurbish
- Remanufacture
- Recycle
- Industrial symbiosis

Circularity prioritises **highest-value loops first** (reuse > recycling).

6.3 Principle 3 — Regenerate Natural Systems

- Composting
- Soil regeneration
- Restoring biodiversity
- Returning nutrients to ecosystems

7. Circular Economy Strategies

7.1 Product Design for Circularity

- Modular design (replace parts, not products)
- Design for disassembly
- Using recycled materials
- Avoiding toxic substances
- Standardised components (easy repair)

7.2 Circular Supply Chains

- Recycled raw materials
- Bio-based materials (compostable, biodegradable)
- Supplier sustainability scorecards
- Closed-loop manufacturing systems

7.3 Reverse Logistics

Systems to collect used products:

- Take-back programs
- Deposit/refund systems
- Collection centres
- E-commerce returns streams

Helps recover valuable materials.

7.4 Circular Business Models

- **Product-as-a-service (PaaS)**
  Companies lease products instead of selling (e.g., washing machines, office printers).
- **Sharing economy**
  Car-sharing, tool libraries.
- **Refurbish & resale**
  Electronics, furniture, fashion.
- **Remanufacturing**
  Replace worn-out parts → restore products to as-new condition.

7.5 Industrial Symbiosis

Waste from one company = resource for another.
Examples:

- Cement industry uses industrial waste as an alternative fuel.
- Food processing waste → biogas for energy.
- Textile waste → insulation materials.

8. Metrics & KPIs for Waste & Circularity

Waste Management KPIs

- Waste intensity = kg waste/unit production
- % waste diverted from landfill
- % waste recycled
- Cost of waste disposal
- Hazardous waste compliance score

Circularity KPIs

- Circular material use rate (CMUR)
- % recycled content in products
- Product lifespan
- Reuse rate (%)
- Material recovery rate
- Take-back collection rate

Carbon Metrics

- CO_2e avoided through recycling vs virgin material
- Methane emissions avoided through composting

9. Regulatory & Reporting Requirements (India + Global)

India

- **Plastic Waste Management Rules (EPR obligations)**
- **E-Waste Management Rules**
- **Hazardous Waste Rules**
- **Solid Waste Management Rules**
- **BRSR (Business Responsibility & Sustainability Reporting)** requires waste KPIs.

Global

- **EU CSRD**
- **EPR frameworks**

- **GRI 306 (Waste)**
- **ISO 14040/44 (LCA) standards** for assessing material flows

10. Tools & Technologies Used for Circularity & Waste Analytics

Modern circular economy and waste management require **data, traceability, performance analytics, and lifecycle intelligence**.
These tools help companies:

- Measure waste
- Track materials
- Optimise recycling
- Model circular flows
- Calculate environmental impact
- Ensure regulatory compliance
- Report transparently (BRSR, GRI 306, CSRD, ISSB)

A. Lifecycle Assessment Tools (LCA Tools)

These tools evaluate the **environmental impact of a product from cradle-to-grave**:

- Raw material extraction
- Manufacturing
- Transport
- Use
- End-of-life

They are essential for circular product design, recycled-content analysis, and EPR compliance.

1. SimaPro

What it is:

One of the world's most trusted professional LCA tools used by industry, academia, and consultants.

Why it matters for circularity:

- Identifies material hotspots
- Compares virgin vs recycled material impact
- Models end-of-life scenarios (recycling rates, landfill burden, incineration)
- Helps decide whether **reuse / refurbish/recycle** is most impactful

Key Use Cases:

- Packaging redesign (FMCG)

- Automotive part lifecycle analysis
- Fashion/textiles sustainability claims
- Corporate EPR submissions

Strengths:

- Most comprehensive database
- Highly accurate scientific modelling

Limitations:

- Requires expert skill
- High licensing cost

2. GaBi Software

What it is:

The advanced LCA platform is strong in the **industrial & manufacturing sectors**.

Why it matters:

- Excellent for plastics, metals, chemicals
- Helps companies design **low-waste manufacturing processes**

Use Cases:

- Comparing multi-layer vs mono-layer packaging
- Choosing between metal/plastic/composite designs
- Industrial waste minimisation projects

3. OpenLCA

What it is:

Open-source LCA software.

Why it matters:

Enables SMEs to start LCA-based waste reduction cost-effectively.

Use Cases:

- Conducting LCAs for university research or smaller companies
- Evaluating circular material substitutions

B. Material Flow Analysis Tools (MFA Tools)

Tracks **material movement** in a facility, city, or supply chain.
Helps identify where waste is generated and how materials can be looped back.

4. STAN (Substance Flow Analysis Tool)

What it is:

A tool to create **material flow diagrams**.

Why it matters:

- Visualises circular loops
- Shows material losses at each stage
- Helps identify waste hotspots

Use Cases:

- Industrial symbiosis planning
- Mapping flows in textile manufacturing
- Identifying highest-value waste streams

5. Ecoinvent Database + MFA Tools

Provides global emission and resource datasets.

Why it matters:

It supports decision-making by showing:

- Environmental footprint of materials
- Impacts of recycling vs disposal

C. Waste Tracking & Monitoring Tools (Digital Platforms)

Used to track waste generation, movement, treatment, and recycling.

6. RFID-Enabled Waste Tracking Systems

How it works:

- Bins, trucks, and bags are tagged
- Scanners track movement
- Real-time visibility on waste streams

Why it matters:

Prevents waste leakages, fraud, and misreporting.

Used by:

Smart cities, airport waste systems, malls, and large corporations.

7. Weighbridge & IoT Sensor Systems

What they measure:

- Weight of waste loads
- Moisture content
- Fill levels in bins
- Temperature (for hazardous waste)

Why they matter:

Provides **accurate waste data** for KPIs:

- Waste per unit output
- Recycling rate
- Hazardous waste compliance

8. Smart Bins (IoT-enabled)

Function:

Auto-detects:

- Waste level
- Type of waste
- Odour (organic waste monitoring)

Use Case:

- Helps organisations optimise collection routes
- Reduces overflow & contamination
- Supports segregation at source

D. Blockchain for Waste Traceability

Blockchain ensures **tamper-proof tracking of waste**.

9. Blockchain-based EPR & Recycling Platforms

Why used:

To certify:

- Recycled plastic content
- Responsible e-waste handling
- Supply chain material recovery
- Proof of recycling for EPR compliance

Examples:

- Plastic credits platforms
- E-waste traceability pilots
- Textile recycling blockchain pilots

Why it matters:
It builds **trust** between producers, recyclers, regulators, and customers.

E. Carbon & Waste Impact Calculators

10. GHG Protocol Waste Tool

What it calculates:

- GHG emissions from landfilling
- Composting emissions
- Recycling emissions savings
- Waste-to-energy emissions

Why it matters:

Helps companies calculate:

- Carbon savings from recycling
- Emissions avoided from composting
- Scope 3 Category 5 (Waste) emissions

11. EPA WARM Model

(Used globally, even outside the US)

Why it matters:

Shows **carbon savings** when materials are:

- Recycled
- Composted
- Landfilled
- Incinerated

Useful for carbon accounting & ESG reporting.

F. Waste Sorting & Recycling Technologies

12. Optical Sorting Machines (AI + Vision Systems)

Function:

- Use cameras, sensors, and AI to classify plastics, paper, and metals
- High accuracy sorting → higher recycling quality

Why it matters:

Enables **high-purity recycling**, which increases revenue value.

13. Magnetic & Eddy Current Separators

Function:

- Magnetic: extracts ferrous metals
- Eddy Current: extracts non-ferrous metals (aluminium)

Essential for automated MRFs (Material Recovery Facilities).

14. Robotics-Based Sorting

Robotic arms + AI vision sort waste with high speed and precision.

Why it matters

Solves labour shortages and contamination issues in recycling facilities.

G. Circular Design Tools

15. Circularity Indicators Tool (by Ellen MacArthur Foundation + Granta)

What it does:

Calculates:

- Circularity score of products
- Material recovery potential
- Durability
- Recyclability
- Reuse potential

Why it matters:

Supports product designers in identifying:

- Where to reduce material
- How to increase lifespan
- Where to include recycled content

16. Autodesk Sustainability Tools (CAD-integrated)

Function:

- Models environmental impact during product design
- Helps choose sustainable materials
- Optimises product life extension

Use Case:

Engineering teams designing circular products.

H. Reverse Logistics & Recycling Platforms

17. EPR Compliance Platforms

Examples: Recycle, NEPRA, Saahas Zero Waste.

Function:

- Track waste through the recycling network
- Generate EPR certificates
- Verify recycling claims
- Provide producer dashboards

Why it matters:

Ensures companies meet mandated recycling targets.

18. Reverse Logistics Management Software

Tracks:

- Product returns
- Repair/refurbish flows
- Resale
- Parts recovery

Popular in:

- Electronics industry

- FMCG
- Fashion industry

I. Data Analytics & Dashboard Tools

19. Power BI / Tableau Waste Dashboards

Why used:

To visualise:

- Waste generation trends
- Recycling rate by category
- Waste cost analytics
- EPR performance
- Circular material flows

20. ERP Integrated Waste Modules (SAP EHS / Oracle SCM)

Function:

Track waste:

- type
- quantity
- treatment
- vendor
- cost
- compliance

Enables end-to-end digital compliance reporting.

J. Digital Twins for Circular Manufacturing

21. Digital Twins (Siemens, Dassault, AVEVA)

Function:

Simulates:

- Production flows
- Material loops
- Scrap reduction
- Resource optimisation
- Predictive maintenance

Why it matters:

Helps companies achieve:

- Near-zero waste factories
- Higher recycling rates
- Better yield

K. Certification & Labelling Tools (Support Circularity Claims)

22. Recycled Content Verification Tools

Certifications:

- GRS (Global Recycled Standard)
- RCS (Recycled Claim Standard)
- Fair Rubber
- FSC (paper/wood)

Why they matter:

Brands can prove:

- "Made with 50% recycled content"
- "Fully recyclable packaging"
- "Zero waste to landfill" status

11. Real-World Case Examples

1. IKEA — Circular Product Design

- Target: 100% renewable or recycled materials by 2030
- Modular furniture → easier to repair & reuse
- Large take-back program globally

2. Tata Motors — Multi-layer Waste Reduction

- Paint sludge → recycled into construction bricks
- Waste oil → re-refined
- Metal scrap → returned to suppliers
- Achieved >95% waste diversion from landfill at several plants

3. Unilever — Zero Waste to Landfill

- 600+ sites achieved 100% waste diversion
- Organic waste → biogas for energy
- Reusable packaging innovations

4. DLF / IT Parks (India)

- Segregation at source
- Composting units
- E-waste collection drives
- Wastewater recycling → landscaping irrigation

12. Step-by-Step Implementation Framework for Companies

Step 1: Baseline Assessment

- Material flow analysis (MFA)
- Waste audit (quantities, types, sources)
- Cost analysis (disposal, handling, transport)

Step 2: Segregation & Infrastructure Setup

- Bin systems
- On-site collection points
- Employee training
- Partnerships with recyclers

Step 3: Implement Reduction & Reuse Measures

- Redesign packaging
- Reuse internal materials
- Optimise processes to reduce scra

Step 4: Recycling Partnerships

- Authorised recyclers
- Buy-back agreements
- E-waste partners
- Reverse logistics networks

Step 5: Circularity Planning

- Product redesign
- Supplier circularity requirements
- Repair/refurbish centres
- Customer take-back programs

Step 6: Monitoring & Verification

- Sub-metering
- Weighbridge data
- LCA models for material savings
- Digital dashboards (Power BI, IoT)

Step 7: Reporting & Compliance

- ISSB, GRI 306, BRSR
- EPR reports
- Carbon disclosures
- Annual sustainability report

13. Benefits of Waste Management & Circular Economy

Environmental

- Reduces GHG emissions
- Minimises landfill usage
- Saves water & energy
- Protects ecosystems

Economic

- Reduces raw material cost
- Creates new revenue from recycling
- Increases product value (eco-design)
- Qualifies for green finance

Social

- Clean communities
- New jobs in recycling & remanufacturing
- Health benefits

Governance

- Stronger ESG performance
- Regulatory compliance
- Enhanced stakeholder trust

4. Environmental Risk Assessment Tools (ISO 14001, GRI)

Environmental Risk Assessment (ERA) tools help organizations identify, evaluate, control, monitor, and report environmental risks. These risks include pollution, waste, biodiversity loss, water scarcity, emissions, hazardous materials, and climate impacts.

Two of the most widely used frameworks for environmental assessment and reporting are:

- **ISO 14001: Environmental Management Systems (EMS)**
- **GRI: Global Reporting Initiative (GRI Standards)**

Both help organisations **manage risks**, **ensure compliance**, and **disclose performance**.

PART 1 — ISO 14001: Environmental Risk Assessment

🌱 What is ISO 14001?

ISO 14001 is a global standard for creating an **Environmental Management System (EMS)**.
It requires companies to:

- Identify environmental aspects & impacts
- Assess risks & opportunities
- Implement controls
- Monitor environmental performance
- Drive continuous improvement

ISO 14001 = Risk Management + Compliance + Operational Control + Monitoring

1. Key ISO 14001 Concepts for Environmental Risk Assessment

A. Environmental Aspects

An **aspect** is anything in your operations that interacts with the environment.

Examples:

- Fuel consumption
- Emissions to air
- Wastewater discharge
- Hazardous waste generation
- Noise
- Raw material use

B. Environmental Impacts

An **impact** is the positive/negative change caused by an aspect.

Examples:

- Air pollution
- Water scarcity
- Soil contamination
- GHG emissions
- Resource depletion

2. ISO 14001 Risk Assessment Methodology (Step-by-Step)

Step 1: Identify Environmental Aspects

This includes:

- Inputs (materials, energy)
- Processes
- Outputs (products, waste, emissions)

Tools used:

- Facility walkthroughs
- Material flow analysis
- Process mapping
- Historical incident review

Step 2: Determine Impacts

For each aspect, ask:

- What could go wrong?
- What environmental harm could occur?

Example:
Aspect → Diesel generator use
Impact → Air emissions, noise, fuel spills

Step 3: Evaluate Risk (Severity × Likelihood × Frequency)

ISO 14001 commonly uses a risk matrix.

Risk factors include:

- Environmental damage potential
- Regulatory implications
- Community impact
- Financial loss
- Probability of occurrence
- Emergency response capability

Example matrix:

Likelihood	Severity	Rating
High	High	Critical
Medium	High	Major
Low	Low	Minor

Step 4: Determine "Significant Environmental Aspects" (SEAs)

These require **mandatory controls**.

Examples:

- Hazardous waste
- Effluent discharge
- Air emissions
- Use of chemicals
- High energy consumption

Step 5: Implement Operational Controls

Controls may include:

- SOPs
- Preventive maintenance
- Emergency preparedness
- Waste segregation
- Legal compliance monitoring
- Training programs

Step 6: Monitor & Measure

Tools include:

- Energy meters
- Effluent testing
- Air emission analysers
- Waste tracking
- Internal audits

Step 7: Continual Improvement

ISO 14001 requires:

- Review of performance
- Corrective action
- Updated risk assessment annually

ISO 14001 Risk Assessment Tools (Commonly Used)

1. **Risk Matrix (5×5 or 3×3)**
2. **Environmental Aspect-Impact Register**
3. **Legal Compliance Register**
4. **Material Flow Analysis**
5. **Operational Control Plans**
6. **Environmental Incident Database**
7. **Emergency Preparedness Analysis**

These tools help organisations evaluate environmental risk holistically.

PART 2 — GRI Standards (Environmental Risk Disclosure Framework)

What is GRI?

The **Global Reporting Initiative (GRI)** provides a globally accepted framework for **environmental, social, and governance (ESG) reporting**.

While ISO 14001 helps manage risks, **GRI helps measure + report** environmental performance transparently.

GRI Standards are most important for environmental risk:

- **GRI 302: Energy**
- **GRI 303: Water & Effluents**
- **GRI 304: Biodiversity**
- **GRI 305: Emissions**
- **GRI 306: Waste**
- **GRI 301: Materials**
- **GRI 307: Environmental Compliance**

1. How GRI Supports Environmental Risk Assessment

GRI requires companies to:

A. Identify environmental topics material to their operations

Examples:

- High waste generation
- High emissions from manufacturing
- Biodiversity impacts from mining
- High water dependency

B. Set boundaries of impact

Where does impact occur?

- Inside the plant
- Supplier operations
- Transportation
- Product use
- End-of-life disposal

This process directly feeds into risk assessment.

2. Key GRI Standards for Environmental Risk

GRI 302: Energy

Assesses risks related to:

- High energy consumption
- Source of energy (renewable vs fossil)
- Cost volatility
- Carbon emissions

Data required:

- kWh consumed
- Renewable energy %
- Energy intensity

Risk: high cost + high emission intensity → regulatory penalties, operational exposure.

GRI 303: Water & Effluents

Assesses risks from:

- Water scarcity
- Wastewater discharge
- Contamination

Companies must track:

- Withdrawal
- Consumption
- Discharge quality
- Water-stressed region dependency

Risk: water shortages may halt production.

GRI 304: Biodiversity

Assesses:

- Land use
- Impact on protected areas
- Deforestation
- Habitat disruption

Risk: supply chain disruptions, legal restrictions.

GRI 305: Emissions

Tracks:

- Scope 1
- Scope 2
- Scope 3
- GHG intensity
- Reduction initiatives

Risk: future carbon taxes, compliance costs.

GRI 306: Waste

Monitors:

- Hazardous waste
- Recycled waste
- Landfill rate
- Circularity strategies

Risk: EPR non-compliance, pollution.

GRI 301: Materials

Measures:

- Recycled content
- Virgin material use
- Circularity rate

Risk: dependence on expensive virgin materials.

GRI 307: Environmental Compliance

Tracks:

- Number of fines
- Sanctions
- Compliance failures

Risk: legal repercussions.

3. Environmental Risk Assessment Using GRI — Process Flow

Step 1 — Identify environmental topics (Materiality Assessment)

Use:

- Stakeholder input
- Industry risks
- Environmental footprint

Step 2 — Collect quantitative data

Energy, emissions, water, waste, and biodiversity units.

Step 3 — Compare performance with benchmarks

- Industry peers
- Regulatory limits
- Regional environmental risks

Step 4 — Assess risks (likelihood × impact)

Step 5 — Report AND act

GRI requires you to disclose:

- Performance
- Risk
- Policies
- Targets
- Progress

PART 3 — ISO 14001 vs GRI: What's the Difference?

eature	ISO 14001	GRI Standards
urpose	nage environmental risks internally	ort environmental performance externally
Focus	Processes, controls, compliance	Transparency, metrics, impact
se Case	Operations, EHS, risk teams	Sustainability reports, investors
pproach	Risk prevention	Measurement + disclosure
uirement	Certification optional	Reporting voluntary or mandated

Together, ISO 14001 + GRI = full environmental risk governance.

PART 4 — Why These Tools Are Essential for ESG

- **Ensure regulatory compliance**
- **Reduce environmental liability**

- **Lower operational risk**
- **Improve ESG scores**
- **Attract investors**
- **Build climate resilience**
- **Enable continuous improvement**
- **Provide audit-ready data**

These tools help companies transition from reactive to proactive risk management.

5. Case Study: Infosys – Carbon Neutral by 2020 Journey

Infosys is one of the world's first large IT companies to achieve **carbon neutrality across Scope 1, 2, and 3** by **2020**.
Its sustainability journey is considered a global benchmark in corporate climate leadership.

This case study covers:

1. Background & Vision
2. Timeline of the Journey
3. Strategies for Carbon Reduction
4. Renewable Energy and Energy Efficiency
5. Scope 3 Supply Chain Strategy
6. Offsetting Approach
7. Governance, Tools & Reporting
8. Impact Achieved
9. Lessons for Businesses
10. Key Takeaways

1. Background: Why Infosys Started the Journey

Infosys began its climate action early—around **2008–2009**, driven by:

- Rising **energy costs**
- Growing **global client expectations (Fortune 500 clients)**
- Brand value and global competitiveness
- Internal commitment from founders (Narayana Murthy, Kris Gopalakrishnan)
- Increasing regulatory trends

Goal Set: Become **carbon neutral by 2020** (10 years ahead of many global peers).

2. Timeline of Infosys' Carbon Neutral Roadmap (2008–2020)

2008–2011: Foundation Phase

- Set carbon neutrality ambition
- Established sustainability team
- Began detailed energy audits

- Baseline carbon footprint creation
- Started green building program

2011–2015: Acceleration Phase

- Massive solar investments
- Deep energy retrofits across campuses
- Smart metering rollout
- First big leadership sustainability pledge
- Launched internal carbon price

2015–2018: Scope 3 Integration Phase

- Supply chain carbon mapping
- Employee commute & business travel reduction initiatives
- Vendor training & sustainability procurement

2018–2020: Final Neutrality Phase

- 100% of electricity consumption in India is sourced via **renewable energy**
- Last-mile offsetting through **community-based carbon projects**
- External verification completed
- Declared carbon-neutral status (2020)

3. Strategy Breakdown: Infosys' Carbon-Neutral Framework

Infosys used a **3-pillar approach**:

Pillar 1 – Reduce Energy Demand (Energy Efficiency)

Pillar 2 – Replace Fossil Electricity with Renewable Energy (RE)

Pillar 3 – Offset residual emissions responsibly

4. Pillar 1: Energy Efficiency (Deep Dive)

Infosys chose a rare strategy:
➡️ **Use efficiency first, before investing in RE**.

Their target: "Reduce 50% energy consumption per employee."

4.1 Green Buildings Program

Infosys designed **all new buildings as green buildings,** complying with:

- LEED Platinum
- Indian Green Building Council (IGBC) ratings

Tech used:

- Optimal orientation
- Daylight harvesting
- Double-glazed windows
- High-efficiency HVAC
- Natural ventilation concepts in some buildings
- Occupancy sensors

4.2 Smart Building Management Systems (BMS)

Infosys implemented:

- Sensor-based controls
- Real-time monitoring dashboards
- Energy modelling tools
- Demand-side management algorithms

4.3 Energy Efficiency Measures

- LED adoption across campuses
- Chiller optimisation (COP > 6)
- AHU/VAV optimisation
- Server virtualisation
- Efficient UPS systems
- Smart meters at the feeder-level and equipment-level

4.4 Outcome of Efficiency Measures

Infosys achieved:
🌱 **46% reduction in per-capita energy consumption**
🌱 Became one of the lowest energy-intensity IT companies globally
🌱 Reduced millions in energy costs

5. Pillar 2: Renewable Energy (Deep Dive)

Infosys shifted to green electricity aggressively across India.

5.1 Solar Power Projects

Installed:

- **~60 MW** of on-site solar
- Rooftop + ground-mounted plants across campuses (Mysore, Mangalore, Hyderabad, Pune, Bangalore)

5.2 Off-site Renewable Power

Used:

- **Group captive models**
- **Solar PPAs**
- Wind power PPAs in Karnataka & Tamil Nadu

5.3 Renewable Energy Certificates (RECs)

Infosys purchased RECs to match any remaining conventional grid electricity.

Outcomes:

🌞 **All Indian campuses run on renewable electricity (near 100% RE share)**
⚡ About **55% reduction** in electricity-related emissions
💰 Significant long-term savings due to low solar tariffs

6. Pillar 3: Scope 3 Emissions (Deep Dive)

Infosys created a **holistic Scope 3 strategy** across:

6.1 Business Travel

- Virtual collaboration tools
- Strict travel approval process
- Behavioural programs

Result: 20–30% travel reduction even before COVID.

6.2 Employee Commute

- Company buses (electric/hybrid pilots)
- Carpooling platform
- Incentives for public transport

6.3 Supply Chain & Vendor Emissions

- Sustainability criteria added to vendor selection
- Vendor training workshops
- Carbon data disclosure from suppliers
- Started responsible procurement standards

6.4 Product/Service Lifecycle

Infosys assessed emissions from:

- Cloud services
- IT infrastructure
- End-user compute lifecycle
- Server end-of-life disposal

- Recycling partnerships

7. Residual Emissions & Offsetting Strategy (Final Neutrality Step)

After reducing emissions across all scopes, some emissions remained.

Infosys used **high-quality offsets**, including:

7.1 Community-Based Carbon Projects

- Rural biogas projects
- Efficient cookstove programs
- Rural afforestation packs
- Water purification systems using solar
- Tree plantation in Karnataka & Rajasthan

Infosys ensured:

- Verified Carbon Standard (VCS) projects
- Gold Standard accreditation
- Community impact (women’s health, rural jobs)

8. Governance, Tools & Reporting

Infosys followed world-class governance.

8.1 Internal Carbon Price

Infosys applied a **shadow carbon price** (internal pricing mechanism).

8.2 Monitoring Tools

- Real-time dashboards
- Smart meters
- Energy analytics platforms

8.3 Standards Adopted

- **ISO 14001 (Environmental Management)**
- **ISO 50001 (Energy Management)**
- **GRI Standards**
- **CDP Climate Reporting**
- **Integrated Reporting Framework (<IR>)**
- **Science-Based Targets (SBT-aligned methods)**

8.4 External Audits

Independent auditors validated carbon neutrality using:

- GHG Protocol
- ISO 14064-1 (Carbon Inventory)
- Assurance audits

9. Impact Achieved (Verified)

🌱 **Achieved Carbon Neutrality by 2020**
Across Scope 1, Scope 2, and Scope 3**.**

🌞 **Renewable Energy Share:**
~100% for India operations.

📉 **Per Capita Electricity Consumption:**
Reduced by **46%** in 10 years.

💧 **Water Efficiency:**
~50% water savings (parallel sustainability initiatives).

🌍 **Community Impact:**
Over 100,000+ families benefited from clean cookstove projects.

💰 **Financial Impact:**
Millions saved annually through energy efficiency + RE procurement.

10. What Other Companies Can Learn from Infosys

1 Start with energy efficiency before RE

You can reduce **30–50%** energy demand, → makes RE goals easier.

2 Use data & smart technologies

Smart meters + building automation = big savings.

3 Integrate Scope 3 early

Travel + commute, + supply chain has huge emissions.

4 Balance RE portfolio

On-site + off-site + PPAs + RECs = flexible RE strategy.

5 Invest in local communities

Offsets that support local communities build brand trust.

6 Show leadership at the board level

Infosys founders personally drove sustainability decisions.

7 Commit early & report transparently

Use:

- GRI
- CDP
- Integrated Reporting
- ISO 14001
- ISO 50001

Transparency increases investor confidence.

Quiz Questions & Answers

1. Which protocol is globally used for measuring Scope 1, 2, and 3 emissions?

A. IPCC Protocol
B. GHG Protocol
C. UN SDG Framework
D. ISO 26000
Answer: B

2. What does Scope 3 primarily represent?

A. Direct fuel combustion
B. Purchased electricity
C. Supply chain & indirect value-chain emissions
D. Refrigerant leakage
Answer: C

3. Which of the following is an example of an activity-based emission factor?

A. ₹ spent on raw materials
B. kWh of electricity used
C. Number of employees
D. Company revenue
Answer: B

4. Which tool is best for a full product lifecycle carbon assessment?

A. Power BI
B. SimaPro
C. SAP
D. MS Excel
Answer: B

5. Carbon intensity is measured as:

A. Total carbon emissions
B. Carbon per unit of output/revenue
C. Reduction percentage
D. Indirect emissions only
Answer: B

6. Which strategy directly reduces Scope 2 emissions?

A. Vendor sustainability programs
B. Renewable energy procurement
C. Fleet electrification
D. Waste reduction
Answer: B

7. An internal carbon price is used to:

A. Replace taxes
B. Evaluate project feasibility
C. Penalise employees
D. Fund CSR projects
Answer: B

8. Energy efficiency is prioritised because:

A. It is expensive
B. It reduces demand before the RE supply
C. It reduces employee count
D. It increases emissions
Answer: B

9. Carbon offsets should be used:

A. Before any reduction efforts
B. Only for unavoidable residual emissions
C. For all Scope 1 emissions
D. To replace renewable energy
Answer: B

10. Science-Based Targets (SBTi) require:

A. Political approval
B. Short-term reduction goals
C. Offsetting 70% emissions
D. Only Scope 1 reporting
Answer: B

11. The largest global source of renewable electricity is:

A. Solar
B. Wind
C. Biomass
D. Hydropower
Answer: D

12. A rooftop solar plant mainly reduces:

A. Scope 1
B. Scope 2
C. Scope 3
D. Waste emissions
Answer: B

13. Energy intensity refers to:

A. Total electricity use
B. kWh consumed per unit of output
C. Employee energy behaviour
D. Generator runtime
Answer: B

14. Which is NOT a resource efficiency measure?

A. LED lighting
B. Heat recovery systems
C. Solar PV
D. Low-flow water fixtures
Answer: C

15. A PPA (Power Purchase Agreement) is useful because:

A. It eliminates equipment warranties
B. It requires no upfront CAPEX
C. It increases fossil fuel dependency
D. It increases transmission losses
Answer: B

16. In energy efficiency, the biggest savings typically come from:

A. New buildings
B. HVAC optimisation
C. Office furniture
D. Parking design
Answer: B

17. A circular business model prioritises:

A. Maximising waste
B. One-time product sales
C. Reuse, repair, refurbish
D. Charge customers more
Answer: C

18. Heat recovery systems target which resource?

A. Electricity
B. Waste heat
C. Chemicals
D. Water only
Answer: B

19. Water intensity is measured as:

A. Litres used per unit of output
B. Total litres consumed
C. Water bill per month
D. Rainwater harvesting potential
Answer: A

20. The best first step in reducing energy usage is:

A. Change supplier
B. Conduct an energy audit
C. Replace all machinery
D. Increase production rate
Answer: B

21. Which is the top-most priority in the waste hierarchy?

A. Recycling
B. Prevention
C. Landfilling
D. Incineration
Answer: B

22. The circular economy is based on:

A. Take–Make–Dispose
B. Linear resource use
C. Keeping materials in use
D. Increasing landfill lifespan
Answer: C

23. Which tool tracks material flows in a circular system?

A. STAN
B. Photoshop
C. Excel graphs
D. Tally ERP
Answer: A

24. Recycling reduces emissions primarily by:

A. Increasing waste
B. Avoiding virgin material extraction
C. Increasing energy demand
D. Lowering product quality
Answer: B

25. EPR stands for:

A. Extended Producer Responsibility
B. Environmental Pollution Rate
C. Emission Prevention Regulation
D. Environmental Producer Review
Answer: A

26. Waste-to-energy plants primarily use:

A. Solar PV
B. Pyrolysis or incineration
C. Wind turbines
D. Rainwater
Answer: B

27. The biggest challenge in recycling systems is:

A. Skilled labour
B. Government taxes
C. Contamination of waste streams
D. High-quality bins
Answer: C

28. Which technology ensures tamper-proof recycling traceability?

A. Blockchain
B. Photoshop
C. Email systems
D. CCTV
Answer: A

29. GRI 306 specifically deals with:

A. Emissions
B. Water
C. Waste
D. Biodiversity
Answer: C

30. Circular product design includes:

A. Mixed material packaging
B. Modular repair-friendly design
C. Excessive packaging
D. Short lifespan design
Answer: B

31. ISO 14001 primarily focuses on:

A. Environmental reporting
B. Environmental management system
C. Social auditing
D. HR policies
Answer: B

32. Environmental aspects under ISO 14001 include:

A. Employee satisfaction
B. Waste generation, emissions, water use
C. Revenue growth
D. Social campaign cost
Answer: B

33. GRI standards are used for:

A. Investment accounting
B. Environmental performance reporting
C. Payroll audits
D. Customer experience
Answer: B

34. GRI 305 covers:

A. Water
B. Emissions
C. Biodiversity
D. Waste
Answer: B

35. ISO 14001 risk evaluation uses:

A. Risk matrix
B. Brand survey
C. Fundraising
D. HR documentation
Answer: A

36. A "significant aspect" in ISO 14001 is one that:

A. Affects employee morale
B. Has high environmental impact or risk
C. Generates media headlines
D. It is easy to fix
Answer: B

37. GRI requires companies to identify:

A. Profit drivers
B. Material topics
C. Competitor pricing
D. HR turnover
Answer: B

38. ISO 14001 requires which process?

A. Continual improvement
B. Once-in-5-years audit
C. Annual tax reporting
D. Branding campaigns
Answer: A

39. GRI 303 deals with:

A. Waste
B. Water & effluents
C. Emissions
D. Energy
Answer: B

40. ISO 14001 compliance helps reduce:

A. Hiring needs
B. Environmental risk and liabilities
C. Sales targets
D. Marketing campaigns
Answer: B

41. Infosys began its carbon neutrality journey around:

A. 1995
B. 2000
C. 2008
D. 2021
Answer: C

42. The biggest contributor to Infosys' emission reduction was:

A. Offsets
B. Employee welfare programs
C. Energy efficiency + renewable energy
D. Hiring more staff
Answer: C

43. Infosys reached almost 100% renewable electricity using:

A. Diesel generators
B. Fossil-fuel PPAs
C. Solar & wind PPAs + onsite solar
D. Imported coal plants
Answer: C

44. Which offsets did Infosys prioritise?

A. Cryptocurrency mining
B. Community-based biogas & cookstove projects
C. Plastic credits only
D. Airline offsets
Answer: B

45. A major governance tool used by Infosys was:

A. Internal carbon pricing
B. Celebrity endorsement
C. Double taxation
D. Off-budget financing
Answer: A