

Each sector includes **key activities**, **emission sources**, **required fields**, **formulas**, and **emission factors** (based on IPCC, EPA, and industry standards). Use this as a template for precise calculations.

1. Extraction Sector

Activities: Open-cast (OC) and underground (UG) coal mining.

Emission Sources:

- Fuel combustion (diesel, gasoline).
- Methane (CH₄) fugitive emissions (UG mining).
- Electricity for equipment.

Field	Description	Formula	Emission Factor (EF)
Diesel consumed (liters)	Fuel used in excavators, dumpers, loaders	Diesel (L) × EF_diesel	2.68 kg CO ₂ /L (EPA)
Methane released (m ³)	CH ₄ from UG mining (ventilation/degasification)	CH ₄ (m ³) × GWP_CH ₄	GWP_CH ₄ = 28 (100-year horizon, IPCC AR6)
Electricity (kWh)	Energy for pumps, ventilation, lighting	Electricity (kWh) × EF_grid	EF_grid (e.g., India: 0.82 kg CO ₂ /kWh, CEA 2023)

2. Overburden (OB) Removal Sector

Activities: Stripping soil/rock, blasting, hauling.

Emission Sources:

- Diesel for drilling, blasting, and haul trucks.
- CO₂ from explosives (e.g., ANFO).

Field	Description	Formula	Emission Factor (EF)
Diesel for drilling (L)	Fuel for drill rigs	Diesel (L) × EF_diesel	2.68 kg CO ₂ /L
Explosives used (kg)	ANFO or other explosives	Explosives (kg) × EF_ANFO	0.39 kg CO ₂ /kg (ANFO detonation)

Field	Description	Formula	Emission Factor (EF)
OB hauled (tonnes)	Overburden transported by trucks	Distance (km) × Fuel efficiency (L/km) × EF_diesel	Fuel efficiency = 0.5 L/km (40-tonne truck)

3. Coal Processing & Handling Sector

Activities: Crushing, washing, conveying.

Emission Sources:

- Electricity for crushers, washers, conveyors.
- Fugitive coal dust (CO₂ equivalent).

Field	Description	Formula	Emission Factor (EF)
Electricity (kWh)	Energy for processing plants	Electricity (kWh) × EF_grid	0.82 kg CO ₂ /kWh (India grid)
Coal washed (tonnes)	Fugitive CH ₄ from coal washing	Coal (tonnes) × EF_fugitive_CH ₄	0.02 kg CH ₄ /tonne (IPCC Tier 1)

4. Waste Management Sector

Activities: Storing OB, tailings, and slurry.

Emission Sources:

- Methane from tailings ponds.
- Diesel for waste transport.

Field	Description	Formula	Emission Factor (EF)
Tailings volume (m ³)	CH ₄ from anaerobic decomposition	Tailings (m ³) × EF_tailings_CH ₄	0.05 kg CH ₄ /m ³ (site-specific measurement)
Diesel for transport (L)	Fuel for waste trucks	Diesel (L) × EF_diesel	2.68 kg CO ₂ /L

5. Support Infrastructure Sector

Activities: Workshops, power generation, water pumping.

Emission Sources:

- Diesel generators.
- Grid electricity.

Field	Description	Formula	Emission Factor (EF)
Diesel for generators (L)	Backup power generation	Diesel (L) × EF_diesel	2.68 kg CO ₂ /L
Workshop electricity (kWh)	Energy for repairs	Electricity (kWh) × EF_grid	0.82 kg CO ₂ /kWh

6. Coal Dispatch Sector

Activities: Weighing, stockpiling, transporting.

Emission Sources:

- Diesel for trucks/rail.
- Electricity for conveyors.

Field	Description	Formula	Emission Factor (EF)
Diesel for trucks (L)	Fuel for coal transport	Distance (km) × Fuel efficiency (L/km) × EF_diesel	0.5 L/km (typical coal truck)
Rail transport (tonne-km)	Emissions from rail (diesel/electric)	Tonne-km × EF_rail	0.025 kg CO ₂ /tonne-km (Indian Railways)

7. Rehabilitation Sector

Activities: Reforestation, land restoration.

Emission Sources:

- Diesel for replanting machinery.
- Carbon sequestration (offset).

Field	Description	Formula	Emission Factor (EF)
Diesel for machinery (L)	Fuel for bulldozers, seeders	Diesel (L) × EF_diesel	2.68 kg CO ₂ /L

Field	Description	Formula	Emission Factor (EF)
Trees planted (count)	CO ₂ sequestration (offset)	Trees × Carbon_per_tree	22 kg CO ₂ /tree/year (IPCC)

8. Exploration Sector

Activities: Drilling, surveying.

Emission Sources:

- Diesel for drills/vehicles.

Field	Description	Formula	Emission Factor (EF)
Diesel for drills (L)	Fuel for borehole drilling	Diesel (L) × EF_diesel	2.68 kg CO ₂ /L
Vehicle fuel (L)	Transport of crew/equipment	Distance (km) × Fuel efficiency (L/km) × EF_diesel	0.12 L/km (4x4 vehicle)

Key Notes

- Emission Factors (EF):** Use local/regional data where available (e.g., India’s CEA for grid electricity).
- GWP (Global Warming Potential):** Convert CH₄ to CO₂e using GWP = 28 (IPCC AR6).
- Activity Data:** Collect from fuel invoices, equipment logs, or IoT sensors.

Example Calculation

Scenario: Open-cast mining of Seam X (Choritand Tilaya):

- Diesel consumed:** 10,000 L/month.
- Electricity used:** 50,000 kWh/month.
- OB hauled:** 100,000 tonnes (9.28 Cum/te stripping ratio).

Source	Calculation	Emissions (kg CO ₂ e)
Diesel	10,000 L × 2.68 kg/L	26,800

Source	Calculation	Emissions (kg CO ₂ e)
Electricity	50,000 kWh × 0.82 kg/kWh	41,000
Total		67,800 kg CO₂e/month

1. Organizational Structure Setup

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A[Super Administrator] --> B[Extraction Sector Manager]

A --> C[Overburden Sector Manager]

A --> D[Processing Sector Manager]

B --> E[Field Engineers]

C --> F[Blasting Crew]

D --> G[Processing Plant Operators]

2. Practical Implementation Steps

Step 1: Administrator Setup

1. Digital Platform Setup

- Use existing tools: Microsoft Power Apps + SharePoint
- Custom solution: SAP Sustainability Module
- Open source: OpenProject + Metabase

2. Sector Account Creation

- Create unique credentials for each sector
- Example: Extraction_Sector01@minename.com
- Set permissions: Data entry only for their sector

Step 2: Physical Implementation

1. Sector Manager Onboarding

- Conduct training sessions on:
- Data collection protocols
- Digital platform usage
- Safety procedures

2. Field Equipment Setup

- Install IoT sensors on:
- Diesel generators
- Conveyor belts
- Ventilation systems
- Connect to central monitoring system

3. Workflow Implementation

Administrator's Responsibilities

1. Create sector accounts in the system
2. Assign geographical boundaries using GPS coordinates
3. Set emission thresholds for each sector
4. Monitor real-time dashboards

Sector Manager's Daily Work

1. Data Collection

- Manual entry: Fuel invoices, equipment logs
- Automated: Sensor data from connected devices

2. Emission Calculation

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Daily Extraction Sector Calculation:

- Diesel Used: $1500\text{L} \times 2.68 = 4020 \text{ kg CO}_2$
- Electricity: $5000 \text{ kWh} \times 0.82 = 4100 \text{ kg CO}_2$
- Methane Released: $200 \text{ m}^3 \times 28 = 5600 \text{ kg CO}_2\text{e}$

Total Daily Emissions: 13,720 kg CO₂e

3. Reporting

- Submit weekly reports through the digital platform
- Flag anomalies (e.g., sudden emission spikes)

4. Practical Tools & Methods

A. Access Management

- **Microsoft Entra ID** (Azure Active Directory)
 - Create security groups: Sector_Extraction, Sector_Overburden
 - Assign granular permissions
 - Enable MFA for all accounts

B. Data Collection

- **Field Devices**
 - Fuel flow meters with GSM connectivity
 - Methane detectors with data logging
 - Smart electricity meters
- **Mobile Apps**
 - Develop custom Power Apps interface:

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Extraction Sector Data Entry Form:

[] Diesel Consumption (L)

[] Methane Levels (ppm)

[] Equipment Runtime (hrs)

[SUBMIT]

C. Physical Verification

- **QR Code System**
 - Tag equipment with unique IDs
 - Scan during audits to verify usage data
 - **Fuel Reconciliation**
 - Compare sensor data with procurement records
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5. Security & Compliance

1. Access Control

- Biometric authentication for sensitive areas
- Time-bound access permissions
- Activity logging with Splunk/SolarWinds

2. Data Security

- Encrypt field-to-server communications
- Maintain air-gapped backups
- Implement version control for calculations

3. Compliance

- Automate report generation for:
- CDP (Carbon Disclosure Project)
- GRI (Global Reporting Initiative)
- National Mining Association standards

6. Real-World Example: Coal India Limited

Implementation Flow

1. Administrator creates sector accounts on CIL's portal
 2. Assigns sector managers to specific mines
 3. Sector teams:
 - Collect daily data from Draglines (OB removal)
 - Monitor CH₄ levels in underground mines
 - Track diesel usage in dumpers
 4. System auto-generates reports for:
 - Monthly sustainability reports
 - Government compliance filings
 - Investor ESG disclosures
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7. Maintenance & Support

1. Field Support

- Deploy technical teams for sensor maintenance
- Conduct quarterly calibration checks

2. Software Updates

- Push emission factor updates via MDM solutions
- Maintain version compatibility across sectors

3. Continuous Training

- Monthly workshops on:
 - New regulations (e.g., updated GWP values)
 - Equipment handling best practices
 - Data quality assurance

This implementation ensures:

- Clear accountability chain
- Accurate emission tracking
- Regulatory compliance
- Operational efficiency
- Transparent reporting

Part 1: Implementing Carbon Credits

What Are Carbon Credits?

- 1 carbon credit = 1 tonne of CO₂ offset (removed from the atmosphere).
- Mines **earn** credits by reducing emissions below a baseline or **buy** them to offset emissions.

How You Can Use It Practically

Let's say your system gives a mine the following output:

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Total CO₂ Emissions = 12,000 tonnes/year

Now, based on **baseline targets** or **government limits**, you can:

1. **Set a Target** (E.g., 10,000 tonnes/year for that mine type/size)
2. If actual > target → **Deficit** → Needs to buy credits:

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Carbon Credits to Buy = (12,000 - 10,000) = 2,000

3. If actual < target → **Surplus** → Earn credits:

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Carbon Credits Earned = (10,000 - 8,000) = 2,000

Implementation Steps

1. **Store Baseline Targets** per mine type/region
2. **Calculate Emission Difference** = Actual - Target
3. **Add a Credit Status Indicator:**
 - Red → Need Credits
 - Green → Surplus

4. **Optional:** Integrate a fake or real credit marketplace API (later stage)
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Part 2: Machine Learning for Neutrality Pathways

Idea

Use ML to **suggest how a mine can reduce its emissions**, based on:

- Activity breakdowns (transport, equipment, etc.)
 - Similar mines with lower emissions
 - Historical trends
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ML Techniques You Can Use

1. Clustering (KMeans):

- Group similar mines based on their emissions and activities.
- Help mine admins **compare** themselves to better-performing peers.

2. Decision Trees:

- If you have activity-level inputs (e.g., fuel usage, equipment hours), train a model to **predict high/low emissions**.
- The model can then say:

“Reducing diesel usage in transport by 15% may reduce emissions by 800 tonnes.”

3. Regression:

- Predict CO₂ emissions from activity data.
- Then create a simulation:

“What happens if I reduce transport distance by 10%?”

Data Needed

To train ML models:

- Mine type, coal production
- Activity-specific data (excavation, transport fuel, equipment runtime, etc.)

- Emissions (your current output)

Even if you don't have real-world training data, you can:

- **Generate synthetic data** to simulate a prototype
 - **Fine-tune** later with real mine data when available
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Implementation Flow:

1. Collect activity-level data → already part of your sector form
 2. Use that as **features** (X) and carbon emissions as **target** (y)
 3. Train ML model (start with Decision Tree / Regression)
 4. On mine dashboard, add a “Suggestions for Neutrality” section:
 - “Reduce equipment idle hours by 20% → ~300 tonnes CO₂ saved”
 - “Switch to electric transport → ~1,000 tonnes CO₂ saved”
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Dashboard Example Additions

- **Carbon Credit Meter** – Shows buy/sell status
- **ML-Based Recommendations Panel**
 - "3 steps to reduce emissions"
 - "Similar mine X achieved 15% reduction by doing Y"

Carbon emission Offset:

Mining companies are implementing a range of carbon offset strategies to reduce their greenhouse gas emissions. Here's a comprehensive overview:

1. Carbon Mineralization via Mine Tailings

Overview: Utilizing magnesium-rich mine tailings to absorb atmospheric CO₂, forming stable carbonates.

Example: BHP's Nickel West mine in Western Australia captures approximately 40,000 tonnes of CO₂ annually through natural mineralization, offsetting about 11% of the mine's emissions. [Carbon Credits](#)

2. Methane Capture in Underground Mining

Overview: Capturing methane emissions from underground mines to prevent their release into the atmosphere.

Example: Implementing methane capture systems can significantly reduce greenhouse gas emissions, as methane has a global warming potential 28 times greater than CO₂.

3. Reforestation and Afforestation Projects

Overview: Planting trees to sequester CO₂ from the atmosphere.

Example: Reforestation projects can remove significant amounts of CO₂ annually, depending on the scale and tree species planted.

4. Renewable Energy Adoption

Overview: Transitioning mining operations to renewable energy sources like solar and wind.

Example: Rio Tinto's solar farm at the Weipa bauxite mine in Australia has reduced carbon emissions by 30%. [baresyndicate](#)

5. Electrification of Mining Equipment

Overview: Replacing diesel-powered machinery with electric or hydrogen-powered alternatives.

Example: Anglo American introduced a hydrogen-powered haul truck, reducing diesel use on-site by up to 80%. [baresyndicate](#)

6. Carbon Capture and Storage (CCS)

Overview: Capturing CO₂ emissions from industrial processes and storing them underground. [baresyndicate+1engisphere.com+1](#)

Example: Glencore's CCS projects at Mount Isa Mines in Australia capture CO₂ from copper smelting, significantly reducing emissions. [baresyndicate](#)

7. Blockchain for Carbon Credit Transparency

Overview: Using blockchain technology to track and verify carbon credits, ensuring transparency and preventing double-counting. [WIRED](#)

Example: Toucan's platform standardizes carbon credits into tokens on a unified blockchain registry, facilitating transparent trading. [WIRED](#)

8. Circular Economy Initiatives

Overview: Reusing mining waste and incorporating recycled materials into operations to reduce emissions. [engisphere.com](#)

Example: Companies are exploring ways to repurpose tailings and other waste materials, contributing to emission reductions. [engisphere.com](#)

9. Automation and AI Integration

Overview: Implementing automation and AI to optimize energy usage and reduce emissions. [engisphere.com](#)

Example: AI and machine learning technologies help monitor and minimize emissions in real-time, enhancing operational efficiency. [engisphere.com](#)

10. Carbon Credit Generation and Trading

Overview: Generating carbon credits through various offset projects and trading them in carbon markets. [wsj.com](https://www.wsj.com)

Example: BHP's carbon mineralization efforts could potentially earn up to \$1.4 million annually through Australian Carbon Credit Units (ACCUs). [MINING.COM+2CarbonCredits+2globalcarbonfund.com+2](https://mining.com+2CarbonCredits+2globalcarbonfund.com+2)