

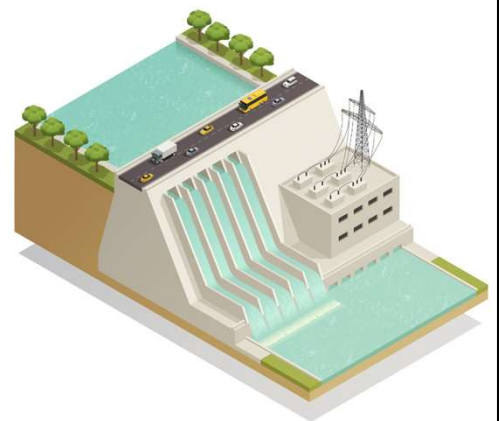
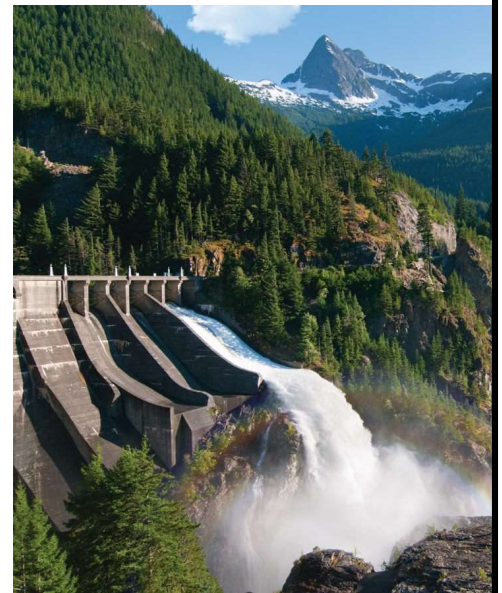


## Hydropower Carbon

Hydropower carbon offsets refer to activities that compensate for the emission of greenhouse gases (GHGs) by generating clean, renewable energy from hydropower projects. These projects help reduce reliance on fossil fuels, thereby decreasing overall GHG emissions. Hydropower activities that contribute to carbon offsets include the development of new hydropower plants, improving the efficiency of existing plants, and implementing small-scale hydropower solutions.

## Carbon Offsets

These activities can be eligible for carbon credits, which represent the amount of carbon dioxide equivalent ( $\text{CO}_2\text{e}$ ) that the hydropower project offsets. Carbon dioxide is the most significant GHG, so all other GHGs are compared to  $\text{CO}_2$ . Typically, one carbon credit is issued for each metric ton of  $\text{CO}_2\text{e}$  offset or removed. These carbon credits can then be bought and sold through a carbon market, allowing organizations and individuals to offset their emissions by supporting hydropower initiatives.





# Carbon Markets

Carbon markets can be categorized as either voluntary or regulatory (compliance) markets. Compliance markets are regulated by governments, while voluntary carbon markets consist of individuals, companies, and governments dedicated to reducing their carbon footprint. These organizations work to lower their GHG emissions and purchase carbon credits in carbon markets to offset any residual emissions. Carbon credits are issued and traded through a carbon registry. Often, private companies and individuals collaborate with landowners to develop, enroll, and validate carbon offset projects.

## Carbon Registries

Carbon registries operate as a marketplace for carbon credits. Before a carbon credit can be registered for sale, an independent third party must verify that an approved protocol was followed to measure the amount of CO<sub>2</sub>e. Upon successful verification, carbon credits are issued and tracked with a unique serial number to prevent double counting. Registries must address the following requirements:

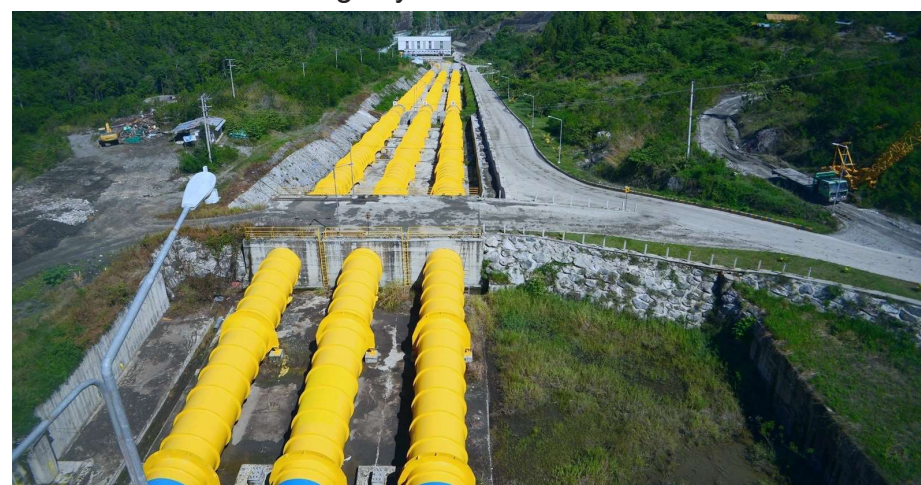
**Additionality** – carbon credits must only be issued for projects that otherwise would not have occurred in the absence of the issued credit.

**Leakage** – carbon offset projects must not shift CO<sub>2</sub> emissions elsewhere as a consequence of the project.

**Permanence** – carbon offsetting projects must not be reversed before the allotted time after the issuance of the carbon credit.

**Exclusive** – carbon credits must be issued for at least one metric ton of CO<sub>2</sub>e and to only one entity for each credit.

**Verified** – carbon credits must be quantified based on scientific evidence, verified through a third-party, and enrolled in a credible carbon registry.



## Forevergreen Project 1

**Location:** Central Sulawesi Province, Indonesia

**Project Type:** Hydroelectric Power Plant

**Annual Reduction:** 1,024,074tCO<sub>2</sub>e

**Project Standard:** Clean Development Mechanism (CDM)

## Carbon Calculations

The CO<sub>2</sub>e of any GHG is calculated by multiplying the amount of the GHG by its global warming potential (GWP). The U.S. Environmental Protection Agency defines the GWP as “how much energy the emissions of one ton of a gas will absorb over a given period of time, relative to the emissions of one ton of carbon dioxide.”

Gas Compound	20 Year GWP	100 Year GWP
Carbon Dioxide (CO <sub>2</sub> )	1	1
Methane (CH <sub>4</sub> )	84	25
Nitrous Oxide (N <sub>2</sub> O)	264	298
HFC-134a	3710	1430
CFC-11	6900	7390
Carbon tetrafluoride (CF <sub>4</sub> )	4880	17200

$CO_2e = GHG \times GWP = 4 \text{ tons } CH_4 \times 25 = 100 \text{ tons of } CO_2e$

*\*Methane (CH<sub>4</sub>) has a GWP of 25, meaning 4 tons of CH<sub>4</sub> released into the atmosphere will trap as much heat as 100 tons of CO<sub>2</sub>.*

# Hydropower Credits

## Overview of Hydropower Carbon Credits

Hydropower carbon credits are generated through hydropower projects that produce electricity from the potential energy of water, typically through dams or run-of-river systems. These projects are recognized for their ability to displace electricity generated from fossil fuels, thereby reducing greenhouse gas (GHG) emissions and contributing to global efforts to combat climate change. The credits are typically sold on carbon markets, where companies or individuals can purchase them to offset their carbon emissions.

## Types of Hydropower Projects

### Large-Scale Hydropower Projects:

- **Dams and Reservoirs:** These are the most common type of hydropower projects. They involve the construction of large dams to create reservoirs that store water. The water is released through turbines to generate electricity. The Three Gorges Dam in China is a prime example.
- **Carbon Credit Generation:** Large-scale hydropower projects can generate substantial amounts of carbon credits thanks to their high electricity output. These projects have the potential to make a significant contribution to reducing greenhouse gas emissions, and when managed responsibly, they can provide substantial benefits to both local communities and ecosystems. As a result, they can be a valuable component of broader carbon reduction strategies, particularly in regions where large-scale energy solutions are necessary.

### Small-Scale Hydropower Projects :

- **Run-of-River Projects:** These projects do not require large reservoirs and are often seen as more environmentally friendly. They divert a portion of a river's flow through turbines and return the water downstream.
- **Carbon Credit Generation:** While the carbon credits generated are smaller in volume compared to large-scale projects, these credits are often more attractive in voluntary carbon markets due to the perceived lower environmental impact.

## Hydropower Carbon Credit Calculation and Methodology

The calculation of carbon credits from hydropower projects involves several key steps:

- **Baseline Scenario:** Establishing a baseline scenario is the first step. This involves estimating the amount of electricity that would have been generated from fossil fuels if the hydropower project had not been implemented.
- **Monitoring and Verification:** Continuous monitoring of the project's electricity generation and the associated GHG emissions reduction is required. Independent third-party verifiers must validate the emissions reductions.
- **Emission Factors:** Emission factors for the displaced electricity grid must be applied to determine the volume of carbon credits generated. For example, in regions where coal is the dominant electricity source, the emission factor would be higher, resulting in more carbon credits.