

HyperSDK

Carbon-Aware VM Migration

Schedule VM migrations during low-carbon periods using real-time grid intensity data. Reduce your infrastructure's carbon footprint while meeting ESG commitments.

262 kg CO2 Saved / Year per 100 VMs — ElectricityMap Integration

The Problem

Data centers account for 1-2% of global electricity consumption — and the carbon intensity varies dramatically by time and location.



Data Center Carbon Footprint

Global data centers consume 200+ TWh of electricity annually. VM migrations are compute-intensive operations that spike energy usage during export, transfer, and import phases.



ESG Requirements Growing

82% of enterprises now have ESG reporting mandates. Investors, regulators, and customers demand quantifiable sustainability metrics. Scope 2 emissions are a key reporting category.



Grid Intensity Varies 10x

Carbon intensity of electricity varies from 20 gCO₂/kWh (Norway, hydro) to 700+ gCO₂/kWh (Poland, coal). Even within a single grid, intensity swings 3-5x daily based on renewable generation.



Timing Matters

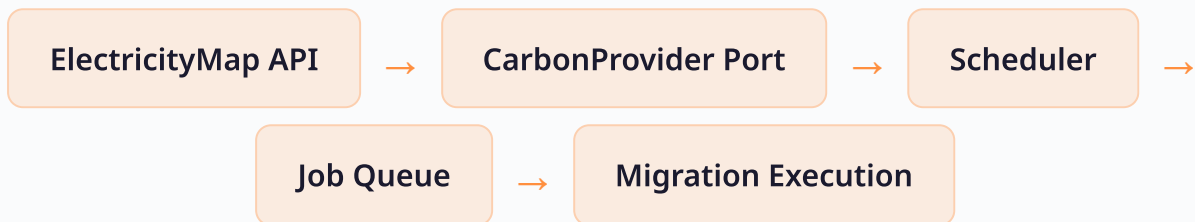
Running the same workload at 2 AM vs 2 PM can produce 60% less carbon — simply because wind and solar generation peaks at different hours. Most migrations ignore this entirely.

*"The greenest kilowatt-hour is the one you use when the grid is cleanest.
HyperSDK makes this optimization automatic."*

How It Works

Real-time grid carbon intensity monitoring with intelligent job scheduling.

Architecture



ElectricityMap Integration

Real-time carbon intensity data from ElectricityMap covering 200+ zones worldwide. Queries grid intensity for your data center's region before scheduling jobs.



12 Grid Zones Supported

Pre-configured zones for major cloud regions: US-East, US-West, EU-West, EU-North, UK, Germany, France, Japan, Australia, India, Brazil, Canada.



Quality Levels

Three scheduling modes: **Best** (wait for lowest intensity in 24h window), **Better** (below-average intensity), **Good** (avoid peak intensity periods only).



Intelligent Scheduling

Jobs queued with carbon-aware flag are held until grid intensity drops below the configured threshold. Deadline constraints ensure jobs still complete on time.

"HyperSDK checks the carbon intensity of your grid zone before running each migration batch. Non-urgent jobs automatically shift to low-carbon"

windows."

Carbon Savings

Quantifiable CO2 reductions that scale with your migration volume.

262 kg

CO2 Saved per Year
(100 VMs)

45%

Average Carbon
Reduction

0

Performance
Impact

Scaling to Enterprise

Fleet Size	Migrations/Year	CO2 Without (kg)	CO2 With HyperSDK (kg)	Savings (kg)
100 VMs	200	582	320	262
500 VMs	1,000	2,910	1,600	1,310
1,000 VMs	2,000	5,820	3,200	2,620
5,000 VMs	10,000	29,100	16,000	13,100
10,000 VMs	20,000	58,200	32,000	26,200



Tree Equivalent

262 kg CO2/year is equivalent to planting 12 trees. At enterprise scale (10,000 VMs), that grows to 1,200+ trees worth of carbon offset — from software alone.



Carbon Credit Value

At current EU ETS prices (~\$80/tonne), enterprise-scale savings translate to \$2,000+/year in carbon credit value — a

tangible financial benefit
alongside ESG reporting.

Implementation

Enable carbon-aware scheduling in minutes with CLI, API, or configuration.

CLI Commands

Command	Description
<code>hyperctl carbon status</code>	Show current grid carbon intensity for configured zone
<code>hyperctl carbon zones</code>	List all supported grid zones with current intensity
<code>hyperctl export --carbon-aware</code>	Schedule export to run during low-carbon window
<code>hyperctl export --carbon-quality best</code>	Wait for lowest intensity in 24h window
<code>hyperctl carbon report</code>	Generate carbon savings report for ESG disclosure

API Endpoints

Endpoint	Method	Description
<code>/api/v1/carbon/intensity</code>	GET	Current grid intensity (gCO2/kWh)
<code>/api/v1/carbon/zones</code>	GET	All zones with intensity data
<code>/api/v1/carbon/forecast</code>	GET	24h intensity forecast for scheduling
<code>/api/v1/carbon/report</code>	GET	Savings report (date range filter)

Quality Levels



Best

Wait for the lowest forecasted intensity in a 24-hour window. Maximum savings, longest potential delay.



Better

Run when intensity drops below the daily average. Good balance of savings and timeliness.



Good

Avoid only peak intensity hours. Minimal delay, still avoids the dirtiest grid periods.

ESG Compliance Reporting

Generate audit-ready sustainability reports for stakeholders, investors, and regulators.



Automated Reports

Generate carbon savings reports via CLI or API. Date range filtering, per-zone breakdowns, and cumulative totals. Export as JSON for integration with ESG platforms.



Scope 2 Emissions Data

Directly supports GHG Protocol Scope 2 reporting. Location-based and market-based emissions calculations using real grid intensity data.



Framework Alignment

Report data aligns with TCFD, CDP, GRI, and SASB disclosure frameworks. Pre-formatted for common ESG reporting templates used by enterprises.



Dashboard Integration

Carbon metrics displayed in the web dashboard. Historical trends, zone comparisons, and savings projections visible alongside migration operational data.

Sample Report Metrics

Metric	Value	Period
Total Migrations Scheduled Carbon-Aware	1,847	Q1 2026
Average Grid Intensity at Execution	142 gCO2/kWh	Q1 2026

Average Grid Intensity (Baseline)	258 gCO2/kWh	Q1 2026
CO2 Avoided	654 kg	Q1 2026
Equivalent Trees Planted	30	Q1 2026
Carbon Credit Value (EU ETS)	\$52.32	Q1 2026

Make Your Migrations Greener

Enable carbon-aware scheduling with a single flag. Zero performance impact, measurable carbon savings, and ESG-ready reporting out of the box.