A Full Life-Cycle Carbon Accounting & Socioeconomic Impact Framework for the Commercial Space Launch Industry

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The launch industry is growing exponentially with no standard to measure its footprint. Applying N50's SILC™ life-cycle method reveals **two emission streams** — a modest, addressable direct-CO_2 stream and a far larger **hidden climate forcing from stratospheric black carbon** that appears in no GHG inventory, ESG report, or offset registry.

1 The Accountability Gap

- In 2025, a record 329 orbital launch attempts occurred worldwide — up ~25% over 2024 and more than triple the 2019 rate [2].
- Cadence has set a new annual record every year since 2021; the sector is on course to rival commercial aviation's climate impact this decade [1].
- Yet no framework measures its environmental or socioeconomic footprint — for investors, regulators, or host communities.

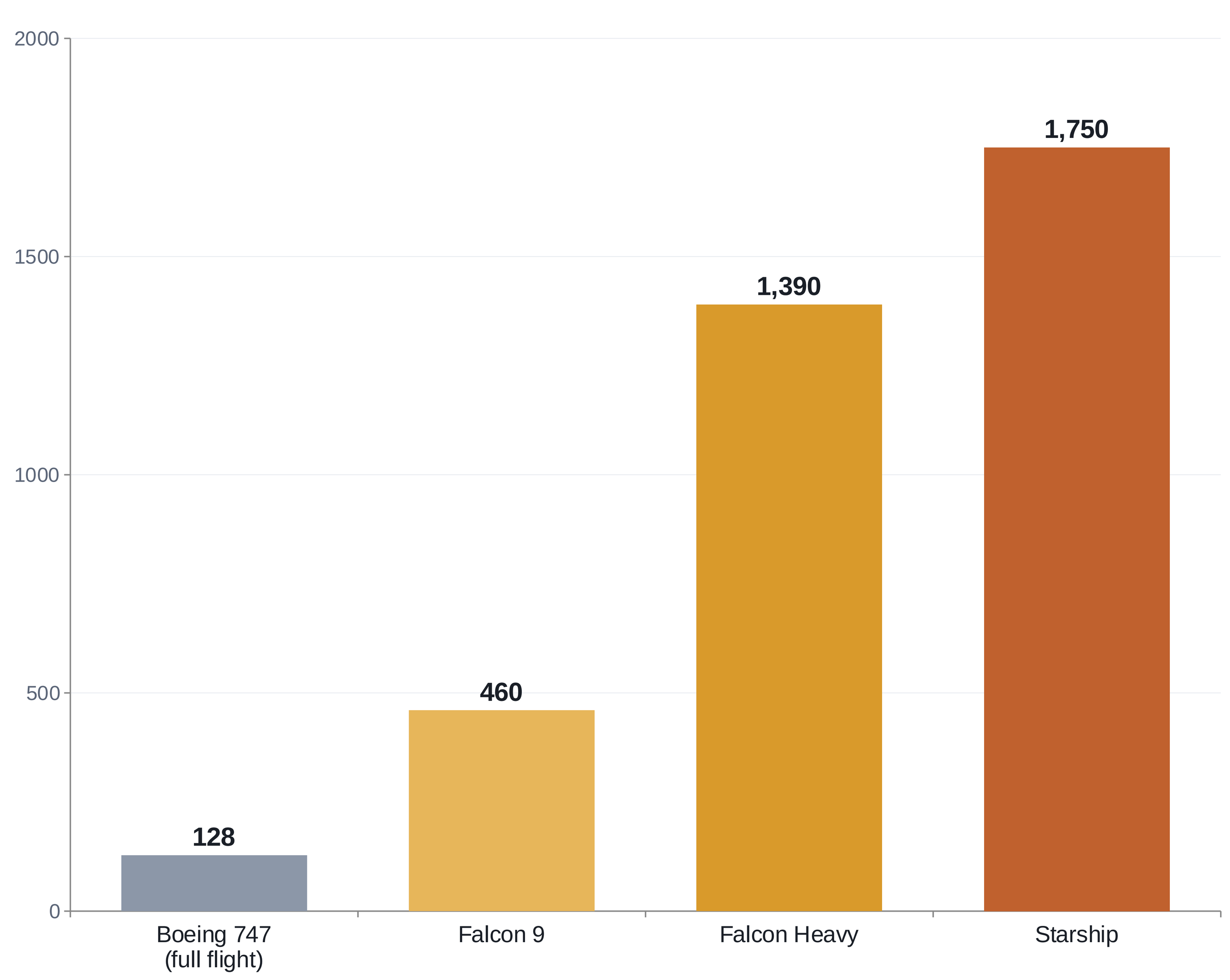
2 Two Emission Streams

Applying the SLCAS method to the 2023 manifest yields two distinct streams:

Direct CO_2 — ≈10,000 t/yr fleet-wide today. Modest, and addressable through existing verified carbon-removal markets.

Stratospheric black carbon — the structurally harder problem (see §3).

FIG. 1 · Direct CO_2 per mission (metric tonnes)



Sources: Wilson 2022 [3]; Brown et al. 2024 [5]. Falcon 9 ≈ 3.6× a full 747 flight.

3 The Hidden Forcing

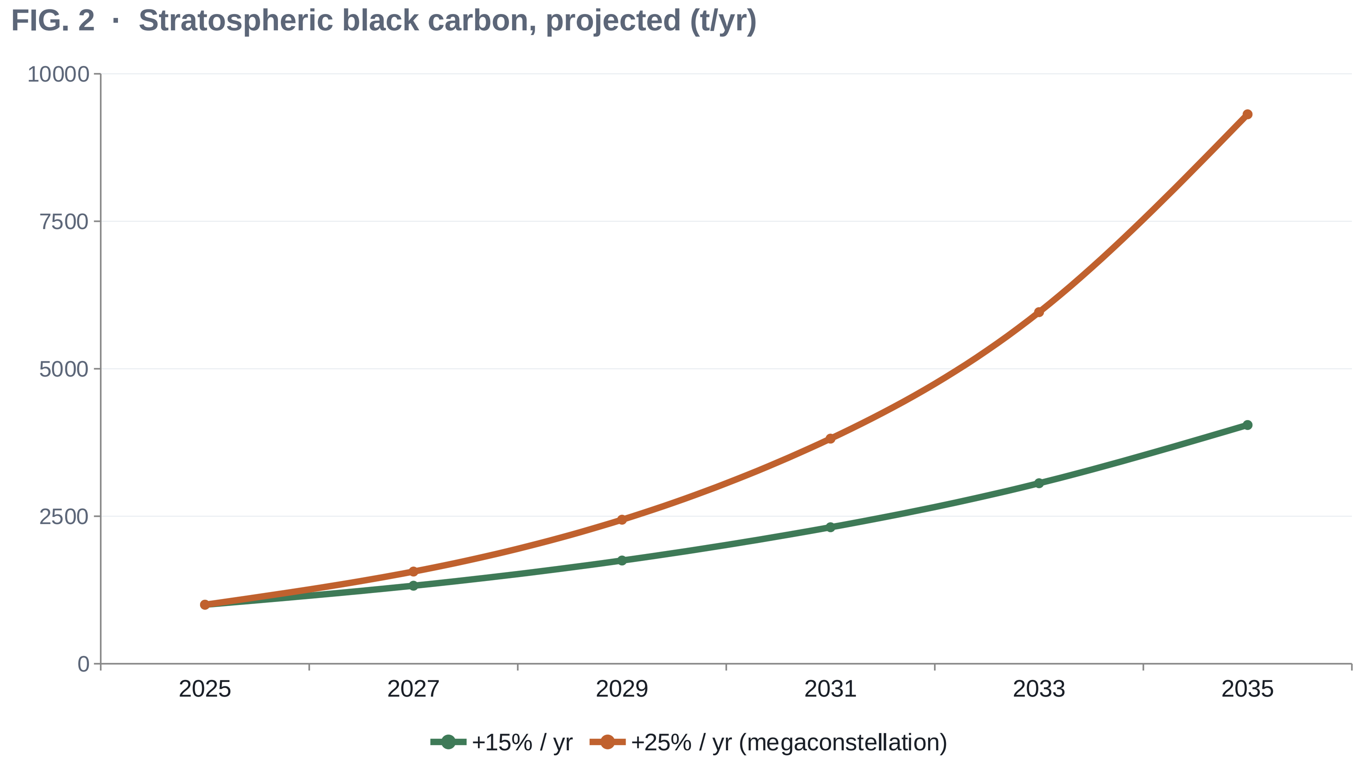
≈500×

mass-specific warming of stratospheric black carbon vs. surface CO_2 [4]

≈1,000 t/yr of black carbon → **≈450,000–550,000 t CO_2e** of effective climate forcing — recorded in no inventory, ESG report, or offset mechanism.

~⅔ of rocket exhaust is injected into the stratosphere/mesosphere, persisting 2–3 years [7]. Under +25%/yr megaconstellation growth, black-carbon deposition could rise ~9× by 2035 [10].

FIG. 2 · Stratospheric black carbon, projected (t/yr)



Baseline ≈1,000 t/yr today. Sources: Maloney et al. 2022 [4]; Barker et al. 2024 [10].

4 The SILC™ Framework

SILC™ (Socioeconomic Impact Lifecycle Carbon) is N50's end-to-end carbon-credit and impact system, verified to ISO 14064-2/3. Adapted for space as a dual standard:

SLCAS — Space Launch Carbon Accounting Standard: full life-cycle GHG method (Scope 1–3) with altitude-stratified warming multipliers for black carbon, H_2O, and chlorine.

SR-SEI — Space Resource Socioeconomic Impact Index: four domains (training & education; health & environmental justice; economic empowerment; gender & social equity). GRI/SASB-compatible.

5 The Socioeconomic Gap

- A review of 12 U.S. commercial launch facilities found none publish community-level impact data on any SR-SEI domain.
- With expanding FAA environmental review and ESG screens on aerospace, this is escalating disclosure risk near Starbase, Vandenberg, and Kennedy Space Center.
- SR-SEI converts stakeholder concerns into comparable, reportable metrics.

6 What Adoption Delivers

1. Access to diversified verified carbon-removal markets for residual emissions.
2. A defensible compliance posture ahead of SEC, EU CSRD, and ISSB disclosure rules.
3. SR-SEI reporting that turns host-community relations into a demonstrable value story.
4. First-mover positioning before regulation inevitably formalizes.

The verification, registry, and data infrastructure already exist in terrestrial carbon markets. Adapting them for space is not a research question — it is an implementation challenge that can begin now.

N50 invites collaboration with launch operators, space resource companies, standards bodies including ISO, NASA, and the FAA.

KEY REFERENCES

[1] Polytechnique Insights 2025 · [2] McDowell, Jonathan's Space Report (2025) · [3] Wilson 2022, Nature Astronomy · [4] Maloney et al. 2022, JGR: Atmospheres
[5] Brown et al. 2024 · [7] Heinecke 2021 · [10] Barker et al. 2024, Scientific Data · [11] Wilson et al. 2023, IEAM