

WHITE PAPER 03 · CAMEROON STEEL

ELECTRIC STEELMAKING IS THE RIGHT ROUTE FOR CENTRAL AFRICA

Choosing the route: why an electric arc furnace, fed first with scrap and imported DRI/HBI and later with direct-reduced iron from concentrated Cameroonian ore, balances capital, flexibility, emissions and speed better than a blast furnace.

DOCUMENT CONTROL

Reference	CS-WP-03
Edition	10 October 2026
Status	First edition
Classification	Public
Prepared by	Cameroon Steel
Series	Cameroon Steel public white papers, 03 of 10
Scope	Ironmaking and steelmaking routes, metallic inputs, direct reduction and ore quality, the electric arc furnace melt shop, long-product rolling, product quality, automation, the phased pathway and technology risks
Evidence cut-off	10 October 2026
Sources	Annex C lists every source cited with an [S-id] marker
Data	Annex D lists the values behind every chart; machine-readable files accompany the web edition
Project figures	Planned, target or indicative values from the Cameroon Steel reference configuration RC-1 (planning estimate), edition 10 October 2026; no investment amounts are given
Languages	English (full text), French (full text), Chinese (summary)
Statement of interest	This paper is published by Cameroon Steel, which is developing a steelworks at Kribi. It is written to inform public debate; its analysis is independent of any commercial offer, and every figure is sourced or labelled with its status.

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What this paper is not. It is not a feasibility study, a design basis, an offer or a commitment. Project values are planning figures that will change as engineering, permitting and financing progress.

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EXECUTIVE SUMMARY: START WITH THE FURNACE THAT ACCEPTS ANY IRON

For a new steel producer in Central Africa, an electric arc furnace fed first with scrap and imported direct-reduced iron (DRI) or hot-briquetted iron (HBI), and later with DRI made from concentrated Cameroonian ore, offers the best balance of capital intensity, flexibility, emissions and speed. It emits a fraction of the blast furnace's CO₂, can be built in steps of a few hundred thousand tonnes, starts producing without waiting for a mine, a pellet plant and a gas contract, and keeps the path to Cameroonian iron open. Blast-furnace routes suit very large, coking-coal-backed integrated works that Cameroon does not have. This paper explains the technology choices behind that conclusion and applies them to Cameroon Steel's planned complex at Mboro, in the Kribi industrial-port zone.

37 to 71 %

Less CO₂ per tonne on electric routes than on the blast furnace (worldsteel, 2024 data)

1.2 Mt a year

Iron units a 1 Mtpa melt shop needs, about ten times the scrap Cameroon collects (derived)

62.2 vs 68 % Fe

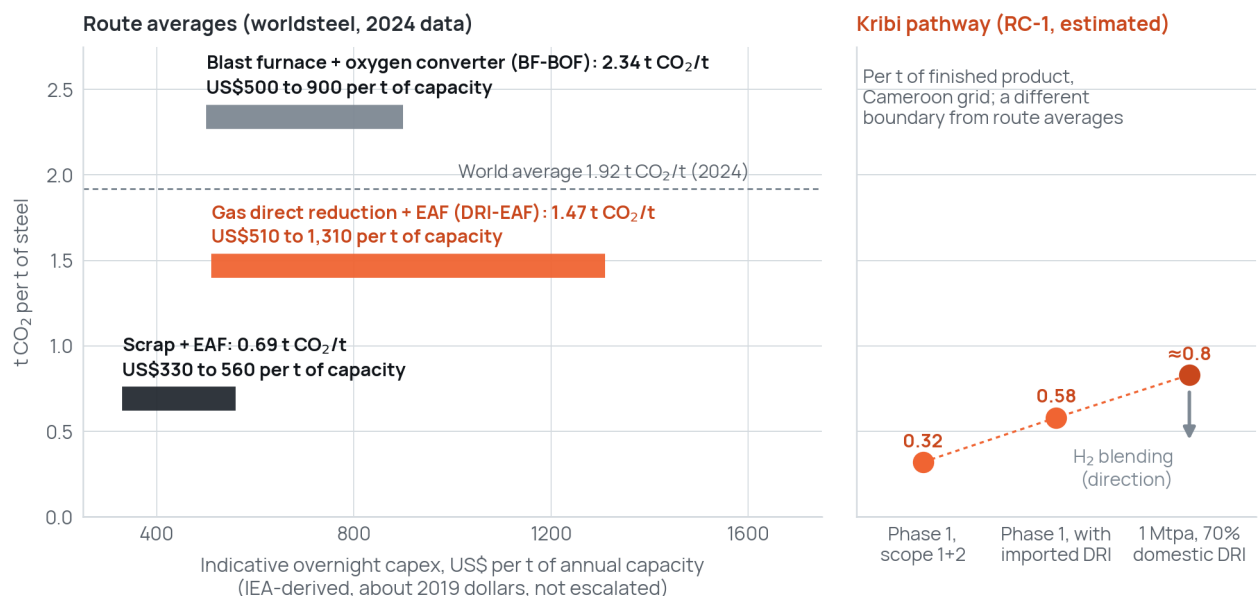
Mbalam direct-shipping ore against its DR-grade testwork concentrate

55 MVA

Phase 1 maximum demand (assumed), within the zone line's initial 100 MW stage

Electric routes cut CO₂ per tonne by 37 to 71% against the blast furnace

Capex ranges are 2019-dollar benchmarks; the blast-furnace range applies only at multi-million-tonne scale with coking coal



DERIVED Figure ES.1. CO₂ intensity and indicative capex per tonne of capacity for the three main routes (2019 dollars), with the estimated intensities of the phased pathway proposed in this paper.

Source: worldsteel Sustainability Indicators 2025, 2024 data [S01]; capex ranges derived from IEA annualised costs, about 2019 US dollars, not escalated [S02]; pathway intensities from the Cameroon Steel reference configuration RC-1 (planning estimate), per tonne of finished product, a different boundary from the route averages [S03]; method in Annex A.

The finding in brief

Steelmaking routes differ above all in where their iron comes from. The blast furnace makes iron from ore with coke at a scale of millions of tonnes a year; the gas-based direct-reduction shaft makes solid iron from high-grade pellets with natural gas or hydrogen, in modules from 0.25 to 2.5 Mt a year [S04]; the electric arc furnace melts whatever iron units it is given, scrap, DRI, HBI or pig iron. An electric melt shop can therefore start on purchased iron units and add domestic ironmaking later, without changing the furnace, the caster or the mills. The blast-furnace route offers no such sequence.

Ten findings

- 01 The route choice is a choice about iron units.** Rolling, casting and refining are common to every route; what differs is how iron is obtained. Cameroon's shortfall is in iron, not in rolling: billets became the country's largest single steel import, at 161,400 t in 2023, three times the 2019 level [S05], while domestic rolling capacity exceeds demand [S06].
- 02 Electric routes cut CO₂ per tonne by 37 to 71%.** worldsteel's 2024 route averages are 2.34 t of CO₂ per tonne of crude steel for the blast furnace and oxygen converter, 1.47 t for DRI-EAF and 0.69 t for scrap-EAF [S01]. On Cameroon's hydro-dominated grid, about 226 g CO₂/kWh in 2024 [S07], the electric routes' advantage is larger still.
- 03 Capital per tonne is not what separates the routes; the size of the indivisible step is.** On IEA-derived benchmarks in 2019 dollars, indicative capex is about US\$500 to 900 per tonne of capacity for a new blast-furnace works, US\$510 to 1,310 for gas DRI-EAF and US\$330 to 560 for scrap-EAF [S02]; budgets announced from 2020 to 2026, which include rolling mills and site works, run higher, from about US\$660 to 1,560 per tonne (Chapter 2). But a blast furnace is economic only at several million tonnes a year, while melt shops and mills of about 0.3 Mt a year are being ordered in Africa today [S08, S09].
- 04 Induction furnaces and smelting reduction do not fit.** Induction furnaces refine poorly; most Indian induction-furnace steel made from DRI exceeded the phosphorus limits of national and ASTM standards [S10]. Smelting reduction still feeds an oxygen converter, depends on coal and is commercial at only a few sites [S11, S12].
- 05 A 1 Mtpa melt shop needs about 1.2 Mt of iron units a year.** RC-1, Cameroon Steel's reference configuration, implies about 363,000 t in Phase 1 and 1.21 Mt at full development (derived) [S03]. Cameroon collects of the order of 0.1 Mt of scrap a year (derived), already used by existing mills; the only national study estimated scrap arising at 53,000 to 61,833 t a year [S13]. RC-1 therefore assumes that the plant can buy only about 30,000 t of domestic scrap a year (range 0 to 60,000 t) [S03].
- 06 Phase 1 should run on scrap and imported DRI or HBI.** RC-1 assumes about 30% DRI or HBI in the Phase 1 charge, within a range of 20 to 50% [S03]. HBI is the practical traded form because it ships with surface ventilation, whereas cold DRI must travel under inert gas [S14, S15]. Two suppliers per iron unit and covered storage are the minimum.
- 07 Cameroonian ore needs a concentrator and a pellet plant before it can feed a shaft furnace.** Direct reduction needs ore of at least 64% iron [S16], and traded DR grade is typically 67 to 68% [S17]. Mbalam's JORC reserve grades 62.2% iron with 7.3% silica and alumina [S18]; testwork on Mbalam itabirite produced a 68% iron DR concentrate [S19]. That product exists only at testwork scale.

- 08 Gas and hydrogen set the pace of domestic ironmaking.** A 1 Mtpa DRI module would need about 9 bcf of gas a year, about 12% of Cameroon's 2025 output (derived) [S20, S21]. Hydrogen-ready shaft furnaces can run on any mix of gas and hydrogen without fundamental changes to the furnace [S22], but full hydrogen operation for 1 Mt of DRI would need about 2.7 TWh of electricity a year (derived), so blending must follow new low-carbon power.
- 09 One furnace of the 40 t class can carry most of Phase 1; the full 0.3 Mtpa needs high availability or a larger transformer.** At the RC-1 planning value of 450 kWh per tonne of liquid steel, a heat of about 40 t takes about 55 minutes tap to tap; at about 490 kWh/t, the upper planning value with 30% DRI or HBI in the charge, about 59 minutes. Nameplate output, about 8,000 heats a year, then needs about 7,300 to 7,900 of the 8,760 hours in a year, so at a realistic 7,000 to 7,700 operating hours Phase 1 delivers about 270,000 to 300,000 t of finished products (derived) [S03]. The furnace offers schedulable load, melting around the grid's peaks, not interruptible load. Arc furnaces cause flicker; other rebar mills have had to retrofit STATCOM compensators under regulatory pressure [S23, S24]. Phase 1's maximum demand, about 55 MVA (assumed), fits the 100 MW initial stage of the zone's 225 kV line [S03, S25].
- 10 Quality and data are part of the product.** Cameroon's rebar standard NC 236 is mandatory and enforced [S26, S27]. An EAF with a ladle furnace and an in-line quench-and-self-temper mill makes ductile, weldable bars to NC 236, BS 4449 and ASTM A615 [S28, S29, S30]. Traceability from heat to bundle, energy management (about 4% savings in the first year in ISO 50001 plants [S31]) and measured CO₂ per product complete the design.

The phased pathway applied to Kribi

Cameroon Steel's reference configuration, RC-1, applies the pathway in four steps [S03]:

- **Phase 1 (planned):** one electric arc furnace of the 40 t class with a ladle furnace, a billet caster, induction billet heating and a bar and wire-rod mill; nameplate capacity 0.3 Mtpa, with an expected sustained output of 270,000 to 300,000 t a year of billets, rebar (8 to 32 mm) and wire rod (5.5 to 12 mm). Works are targeted to start in 2029, after the environmental certificate, with a first heat in the second half of 2030 and ramp-up in 2031.
- **Phase 2 (indicative):** a second melt line and a light and medium sections mill for about 0.2 Mtpa of angles, channels and flats, indicatively 2032 to 2034.
- **Phase 3 (indicative):** melt-shop expansion and a heavy-section mill for H-beams after 2034, bringing the plant to its design capacity of about 1 Mtpa, subject to markets and financing.
- **Reserve (indicative):** a hydrogen-ready direct-reduction (DR) module of about 1 Mt of DRI a year for Cameroonian ore, later, subject to ore quality, gas supply and approvals.

Phase 1's melt shop makes billets, and its output is flexible between rolled products (wire rod and rebar) and merchant billets sold to existing re-rolling mills, for which local scrap covers only about 40% of needs and which imported 161,400 t of billets in 2023 [S05, S32, S33]. Rebar is not where the gap lies: domestic rebar capacity, about 627,000 t a year (read from a source that prints 627 tonnes; White paper 04, Chapter 5), is more than three times rebar demand of about 180,000 t [S06]. Phase 1 tonnage is therefore aimed at displacing imported billets and wire rod and at exports within CEMAC, not at adding rebar to a saturated market. White paper 04 sets out the market evidence and an indicative cost of a Kribi billet against a delivered import.

Phase 1 is all-electric: induction heating removes the need for gas until the Phase 2 section mill [S03]. Its scope 1 and 2 emissions are estimated at about 0.32 t of CO₂ per tonne of finished product (0.33 t at the upper electricity value), and about 0.58 t including the upstream emissions of imported DRI (derived) [S03]. Full development needs the zone line's later stage of 330 to 400 MW [S25, S34]. This paper gives no investment amounts; they will be established by engineering and financing.

START WITH THE FURNACE THAT ACCEPTS ANY IRON; ADD THE PLANT THAT MAKES CAMEROONIAN IRON WHEN THE ORE, THE GAS AND THE POWER ARE READY.

Cameroon Steel, technology pathway

Why the alternatives fall short

Each alternative fails at least one of the four tests of capital, flexibility, emissions and speed. A blast-furnace works would need several million tonnes a year to be efficient, imported coking coal and the highest carbon intensity of any route; it would commit all its capital before producing a tonne. A re-rolling mill without a melt shop would be quick and cheap, but it would add to rolling capacity that already exceeds demand [S06] and leave the plant dependent on imported billets, the very import that most needs replacing [S05]. Induction furnaces cannot reliably meet the phosphorus and ductility requirements of modern rebar standards without additional refining [S10], in a market whose regulators are enforcing quality [S26, S27]. A direct-reduction plant built first would tie the start of production to a concentrator, a pellet plant and a gas contract that do not yet exist. Only the phased electric route starts within a few years, spends capital in steps, meets quality standards with proven equipment and keeps the path to Cameroonian iron open.

Decision criteria

The pathway's main technology risks sit at its interfaces with the grid, the iron-unit markets, the mine and the gas supply. Each can be reduced before the corresponding money is committed. Chapter 10 proposes four gates, each opened by evidence rather than by date:

1. **Phase 1 investment:** a firm 225 kV connection with an accepted flicker study; two sources for each iron unit; a certification path for NC 236 and international grades; performance guarantees for electricity per tonne and furnace availability; an approved impact assessment, disclosed for the period lenders require before board approval.
2. **Phase 2:** twelve months of Phase 1 at design yield, energy and output; confirmed demand for sections; electrical headroom.
3. **Phase 3:** the zone line's later stage contracted; a proven heavy-section market; a metallics plan for 1.2 Mt a year.
4. **Domestic DRI:** DR-grade concentrate of at least 67% iron proven at pilot scale; a pellet supply; audited gas reserves and a long-term contract; a hydrogen-ready design with CO₂ measurement.

What remains uncertain

The paper is explicit about what is not yet known (Chapter 11). The most important open questions are the short-circuit strength of the grid at the plant's connection point; the remaining reserves of Cameroon's producing gas field; whether, when and where a DR-grade concentrator and pellet plant will be built; the measured atmospheric corrosivity at Kribi; and the prices at which imported HBI and scrap can be contracted for the life of Phase 1. None of these uncertainties argues for a different route; each argues for the phased, gated approach.

What the pathway asks of public partners

The phased pathway depends on decisions that are not Cameroon Steel's alone. Six of them shape its timing and its value to the country.

- **A firm grid connection with clear power-quality rules.** The zone's 225 kV line and substation [S25] must be commissioned, and the plant's connection agreement must set the flicker and harmonic limits that its compensator is designed to meet.
- **A framework for industrial gas.** Before any direct-reduction module, the State, the national oil company and producers will need to clarify how gas is allocated, priced and taxed for industrial users over periods of twenty years or more [S21, S35].
- **A bridge between mine and steelworks.** The 15% local-transformation clause in Cameroon Mining Company's convention [S36] becomes valuable for steelmaking only if a DR-grade concentrate is proven and pelletised. A joint pilot programme is the logical first step.
- **Port capacity for bulk iron units.** Phase 1 will import about 351,000 t a year of iron units and consumables through Kribi (derived) [S03]. The mineral terminal, the subject of a memorandum of understanding signed on 4 November 2025 and expected by the port's Director General in March 2026 to be completed within five to six years [S37, S38], matters as much to a steelworks as to a mine; Phase 1 will use the existing terminals.
- **Consistent enforcement of product standards.** The mandatory rebar standard and its enforcement [S26, S27] protect producers that invest in quality, and the public that occupies the buildings.
- **Skills.** Cameroon's engineering schools have no dedicated metallurgy department [S39]; a steel programme with schools and technology suppliers will be needed from Phase 1.

None of these is a precondition for every step. Together they decide how quickly the pathway moves from purchased iron to Cameroonian iron.

How this paper is organised

Chapter 1 explains how steel is made, for readers outside the industry. Chapter 2 compares the five routes. Chapter 3 examines iron units and Cameroon's scrap shortfall. Chapter 4 covers direct reduction and ore quality. Chapters 5 and 6 describe the melt shop and the rolling mills. Chapter 7 addresses product quality for tropical construction, and Chapter 8 automation and data. Chapter 9 applies the pathway to RC-1, and Chapter 10 sets out risks and decision criteria. Chapter 11 lists the evidence gaps. The annexes give the method and assumptions, a glossary, the full list of sources and the data behind every chart.

Statement of interest. This paper is published by Cameroon Steel, which is developing a steelworks at Kribi. It is written to inform public debate; its analysis is independent of any commercial offer, and every figure is sourced or labelled with its status.

CHAPTER 1

HOW STEEL IS MADE: TWO WAYS TO MAKE IRON, TWO WAYS TO MAKE STEEL

Every steelworks answers one question before any other: where do its iron units come from? Iron can be won from ore in a blast furnace or in a direct-reduction plant, or it can be recovered from scrap. Steel is then made either by blowing oxygen through liquid iron or by melting solid iron in an electric furnace. Everything downstream, from the ladle to the rolling mill, is broadly common to all routes. This chapter explains each stage in plain language so that readers who do not work in the industry can follow the route comparison in Chapter 2 and the choices made in the rest of this paper.

1.1 Steel is refined iron: the chemistry is simple, the scale is not

Steel is iron that has been refined to a controlled, low carbon content and alloyed in small, precise amounts so that it is strong, tough and weldable. The raw material for new iron is iron ore, a rock in which iron is chemically bound to oxygen. Making steel from ore therefore always involves two operations: removing the oxygen from the ore (ironmaking) and then adjusting the carbon and impurities of the iron and casting it into a shape that can be rolled (steelmaking and casting). Recycled steel scrap skips the first operation, because its iron is already metallic.

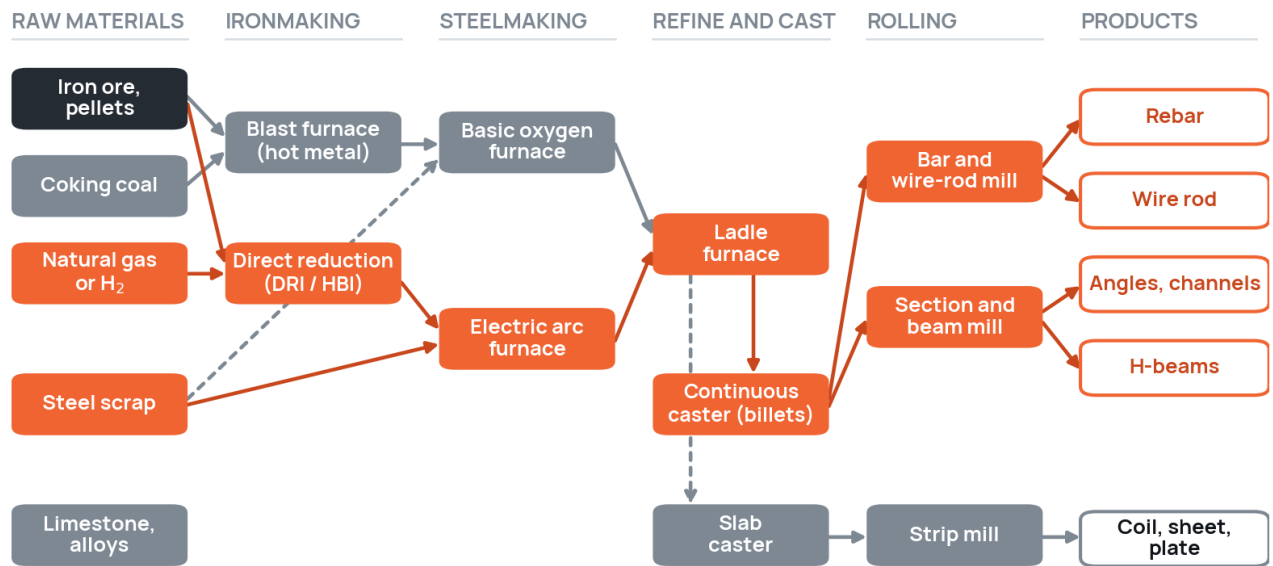
The industry is large, and its routes are well established. The world produced 1,849.4 million tonnes (Mt) of crude steel in 2025, 2.0% less than in 2024 [S40]. About 69.4% of that tonnage was made by the oxygen route and 30.3% in electric furnaces [S41]. Africa produced 29.8 Mt, and 89.0% of it came from electric arc furnaces [S41]. The world also produced 151.0 Mt of direct-reduced iron (DRI) in 2025, two thirds of it with natural gas and one third with coal [S04].

The value chain in Figure 1.1 has six stages. Raw materials (ore or pellets, a reductant such as coke or natural gas, scrap, fluxes and alloys) feed ironmaking. Ironmaking produces either liquid "hot metal" from a blast furnace or solid DRI from a direct-reduction shaft. Steelmaking converts hot metal in a basic oxygen furnace (BOF), or melts DRI and scrap in an electric arc furnace (EAF). Secondary metallurgy, usually a ladle furnace, sets the final chemistry and temperature. A continuous caster solidifies the liquid steel into billets, blooms or slabs. Rolling mills then reheat and deform those semi-finished shapes into finished products: reinforcing bar (rebar), wire rod, angles, channels, beams, plate or coil.

Long products, which are the subject of this paper, are made from billets and blooms on bar, rod and section mills. Flat products (plate, hot-rolled coil, sheet) need a slab caster and a strip mill, which are far larger investments and are outside the scope that Cameroon Steel plans.

From ore to bar: six stages, two ways to make iron, two ways to make steel

The orange path is the electric route Cameroon Steel plans; grey shows the alternatives



Illustrative process map. Flat products (coil, sheet, plate) need a slab caster and strip mill, which are outside the planned scope.

ILLUSTRATIVE Figure 1.1. The steel value chain. Two ironmaking routes (blast furnace, direct reduction) and two steelmaking routes (basic oxygen furnace, electric arc furnace) converge on the same refining, casting and rolling steps. The orange path is the electric route planned by Cameroon Steel.

Source: Cameroon Steel; process stages as described in the IEA Iron and Steel Technology Roadmap [S02] and the EU reference document on iron and steel production [S42].

1.2 Ironmaking means taking oxygen out of ore

The iron in commercial ore is mostly hematite (Fe_2O_3) or magnetite (Fe_3O_4). Pure hematite is 69.9% iron by mass; pure magnetite 72.4% (Figure 1.2). Natural ores are lower because they also contain gangue, mostly silica and alumina, which is chemically inert in the furnace and must eventually leave as slag. Removing oxygen requires a reducing agent that has a stronger affinity for oxygen than iron does at high temperature. Carbon, as carbon monoxide, and hydrogen are the two used at industrial scale. Carbon leaves as carbon dioxide; hydrogen leaves as water vapour.

Making iron means taking oxygen away: hematite holds 70% iron, metallic iron 100%

Each step removes oxygen; carbon carries it away as CO₂, hydrogen as water



With carbon (coke): $\text{Fe}_2\text{O}_3 + 3 \text{CO} \rightarrow 2 \text{Fe} + 3 \text{CO}_2$

With hydrogen: $\text{Fe}_2\text{O}_3 + 3 \text{H}_2 \rightarrow 2 \text{Fe} + 3 \text{H}_2\text{O}$

Iron shares are stoichiometric (atomic masses Fe 55.845, O 15.999). Real ores also carry gangue (silica, alumina), which lowers the grade.

Natural-gas direct reduction uses a mix of CO and H₂, so it emits less CO₂ than coke.

DERIVED **Figure 1.2.** Iron content of the iron oxides and the two reduction reactions. Shares are stoichiometric; real ores carry gangue that lowers the grade.

Source: Cameroon Steel, from atomic masses (Fe 55.845, O 15.999); reaction scheme as in the IEA roadmap [S02].

The blast furnace

A blast furnace is a tall, continuously operated shaft into which sinter or pellets, lump ore and coke are charged from the top while hot air is blown in near the bottom. Coke burns to carbon monoxide, which reduces the ore as it descends; the iron melts, absorbs carbon and collects at the hearth as hot metal. Solidified hot metal is pig iron, which typically contains 3.5 to 4.5% carbon [S43]. The blast furnace is efficient and proven, but it depends on coking coal (and therefore on coke ovens) and on agglomerated ore (sinter plants or pellets), and it is economic only at very large scale. A modern integrated works is built around one or more furnaces producing several million tonnes a year.

Direct reduction

Direct reduction removes oxygen from ore pellets or lump ore while they remain solid. In the gas-based shaft furnaces that dominate the technology, a hot reducing gas rich in hydrogen and carbon monoxide, made from natural gas, rises through a descending bed of pellets. MIDREX and HYL/ENERGIRON plants together produced 64.5% of the world's DRI in 2025, and coal-fired rotary kilns, mostly in India, produced 33.1% [S04]. The product, DRI, is porous metallic iron that keeps the shape of the pellet. Typical DRI is 92 to 96% metallised and carries 1.0 to 4.5% carbon [S14]. Compressed while hot into dense briquettes, it becomes hot-briquetted iron (HBI), with an apparent density above 5.0 t/m³, which is easier and safer to ship [S15].

Because the ore never melts in a shaft furnace, nothing removes its gangue. Every per cent of silica and alumina in the pellet remains in the DRI and has to be melted and slagged off in the electric furnace. That is why direct reduction needs richer, cleaner feed than a blast furnace. Chapter 4 explains why this single fact governs when Cameroonian ore can be used.

THE BLAST FURNACE MELTS ORE AND DISSOLVES CARBON; THE SHAFT FURNACE REMOVES OXYGEN AND LEAVES THE ORE SOLID. THAT DIFFERENCE DECIDES WHICH ORE, WHICH FUEL AND WHICH SCALE EACH ROUTE NEEDS.

Cameroon Steel, technology pathway

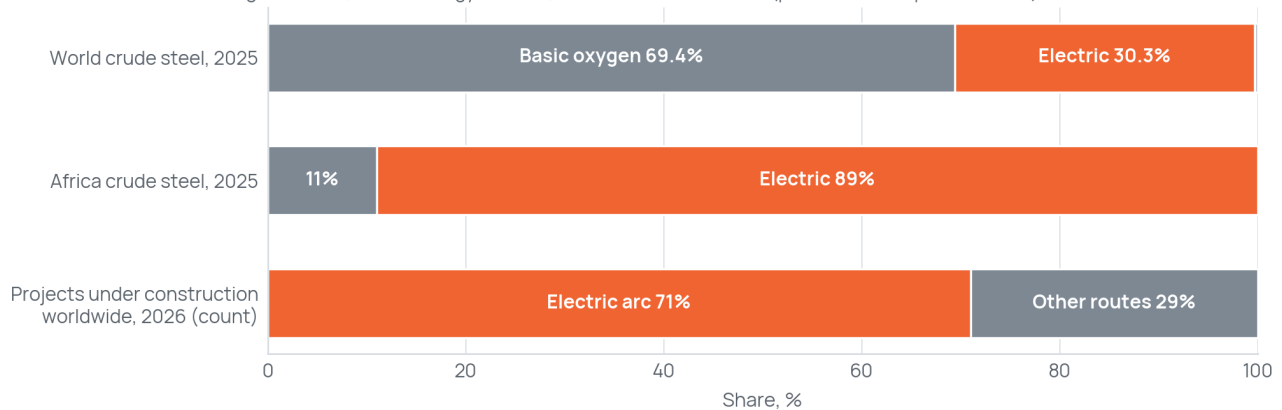
1.3 Steelmaking either burns out carbon or melts solid iron

Hot metal from a blast furnace contains too much carbon, silicon and phosphorus to be useful steel. In a basic oxygen furnace, pure oxygen is blown onto the liquid metal and oxidises those elements in a matter of minutes; the reactions release so much heat that the converter needs no external energy and can melt a share of scrap as coolant. worldsteel's route average for blast furnace and oxygen steelmaking assumes about 10% scrap [S01].

An electric arc furnace works differently. Three graphite electrodes (in the most common AC design) strike arcs onto a charge of scrap, DRI, HBI or pig iron and melt it with electrical energy, helped by oxygen and carbon injected to form a foaming slag that shields the arc and adds chemical energy. The furnace refines the melt through its slag (removing phosphorus, for example) and taps liquid steel into a ladle. EU melt shops use 404 to 748 kWh of electricity per tonne of liquid steel [S42]; IFC benchmarks give 1,250 to 1,800 MJ per tonne, or 347 to 500 kWh [S44]. The EAF needs no ironmaking step of its own and can start and stop within hours, which makes it the natural partner of scrap and of DRI.

Africa already makes 89% of its steel in electric furnaces; new capacity worldwide is going the same way

worldsteel World Steel in Figures 2026; Global Energy Monitor, Pedal to the Metal 2026 (plants of 0.5 Mtpa and above)



SOURCED Figure 1.3. Crude steel by process, world and Africa, 2025, and the share of electric arc furnace projects among steel plants under construction worldwide in 2026.

Source: worldsteel, World Steel in Figures 2026 [S41]; Global Energy Monitor, Pedal to the Metal 2026, plants of 0.5 Mtpa and above [S45].

Induction furnaces are a third, simpler melting technology. They heat metal by electromagnetic induction in a crucible and are widely used in South Asia for small-scale steelmaking from scrap and coal-based sponge iron. Because the slag is cold and difficult to keep fluid in an induction crucible, they refine poorly. Chapter 2 returns to this point.

1.4 Secondary metallurgy sets the final chemistry in the ladle

The steel tapped from a converter or an electric furnace is not yet a finished grade. In a ladle furnace, a smaller arc reheats the steel in the ladle while operators add alloys (manganese, silicon and, for some grades, vanadium or niobium), desulphurise the metal under a basic slag, float out non-metallic inclusions and bring the temperature to the window that the caster needs. A ladle furnace can raise steel temperature by about 4 °C per minute; a twin-station unit commissioned at ArcelorMittal Bremen in 2013 achieved that rate over 30 minutes [S46]. Separating these tasks from the melting furnace lets the EAF do what it does best, which is to melt quickly, and makes the plant more productive.

1.5 Continuous casting turns liquid steel into billets

A continuous caster pours liquid steel from the ladle into a tundish, a refractory-lined distributor, and from there into water-cooled copper moulds. A solid shell forms against the mould wall, and the strand is drawn downward and bent to the horizontal while water sprays complete solidification. Torches or shears cut the strand to length. For long products, the caster makes billets, usually of square section; a 300,000 t/yr bar and wire-rod mill ordered in Tanzania in September 2026 is designed for 150 mm by 150 mm billets at up to 50 t per hour [S08, S47]. Continuous casting replaced ingot casting because it raises yield and consistency and allows billets to travel hot to the rolling mill, which saves energy (Chapter 6).

1.6 Rolling shapes the steel and sets much of its strength

A rolling mill reheats billets to a plastic state and passes them through a series of stands, each pair of rolls reducing the section and lengthening the bar. A bar mill typically has roughing, intermediate and finishing groups. For rebar, the last rolls engrave the ribs that give the bar its bond with concrete, and a water box immediately after the finishing stand quenches the surface: the quench-and-self-temper treatment described in Chapter 7 gives 500 MPa strength from plain carbon-manganese steel [S28]. For wire rod, a high-speed finishing block delivers small sections at high speed to a laying head that forms rings, which cool in a controlled way on a conveyor and are collected as coils. Section and beam mills follow the same logic with shaped rolls and, for wide-flange beams, universal stands.

Rolling is where a long-products plant meets its customers: the size range, tolerance, surface and mechanical properties of the bars and sections are set here, and so is much of the plant's energy use outside the melt shop. A billet that enters the mill hot needs far less heating than a cold one.

1.7 Energy enters at every stage, in different forms

Steelmaking is energy-intensive, and each stage uses energy in a different form, which is why the choice of route is also a choice of energy supply. Ironmaking takes the most: a gas-based direct-reduction plant burns and reforms about 9.2 to 10 GJ of natural gas per tonne of DRI [S20, S48], while a blast furnace draws its energy from coke made from coking coal. Melting in an electric arc furnace takes electricity, 347 to 500 kWh per tonne of liquid steel on IFC benchmarks [S44], supplemented by chemical energy from oxygen and carbon. Reheating billets before rolling takes 0.6 to 1.9 GJ per tonne in EU bar and rod mills, while the rolling itself takes only 0.1 to 0.5 GJ per tonne [S49]. Casting and ladle refining take comparatively little.

Two consequences follow for a country deciding on a route. First, a route that starts with scrap or purchased iron and an electric furnace needs mainly electricity, so its feasibility depends on the grid; a route that includes ironmaking also needs a fuel, natural gas or coal, in large and steady quantities. Second, heat that is not lost does not have to be bought again: billets that go hot from the caster to the mill, and DRI that goes hot from the shaft furnace to the arc furnace, save a large share of the energy that cooling and reheating would waste [S50]. These two points explain why the pathway proposed in this paper starts all-electric, adds gas only when a mill or a direct-reduction plant requires it, and places each plant next to the one it feeds.

1.8 Iron units are the currency of an electric steelworks

An electric steelworks does not make iron: it buys or produces iron units and melts them. The term "iron units" or "metallics" covers every iron-bearing material that can be charged to the furnace. Their properties determine yield, energy use, chemistry and, ultimately, product quality. Table 1.1 summarises the main ones.

Table 1.1 The main iron units for an electric arc furnace, and what each brings to the melt

Iron unit	What it is	Typical iron and carbon	Strengths	Limits and handling
Steel scrap	Recycled steel: home scrap, new (prompt) scrap from manufacturing, old (obsolete) scrap from demolition and end-of-life goods	Metallic iron; carbon low; residual copper, tin and zinc vary by grade	Lowest energy and CO ₂ route; no ironmaking needed	Supply limited by a country's stock of old steel; residuals accumulate in obsolete scrap; needs sorting and preparation
DRI (cold)	Porous pellets of iron reduced in the solid state	92 to 96% metallisation; 1.0 to 4.5% carbon [S14]	Clean iron with low residuals; dilutes scrap impurities; can be fed continuously	Re-oxidises and self-heats if wet; shipped under inert gas; gangue adds slag [S14]
HBI	DRI compacted while hot into briquettes	94% metallisation; 0.5 to 1.6% carbon; apparent density above 5.0 t/m ³ [S15]	Safer and denser to ship and store than DRI; tradeable commodity	Needs surface ventilation in transit; same gangue penalty as DRI [S15]
Pig iron	Solidified blast-furnace hot metal	At least 92% iron; 3.5 to 4.5% carbon [S43]	Carbon adds chemical energy; very low residuals	Made by the blast furnace route, with its emissions; supply concentrated in a few exporters
Billets (semi-finished)	Cast steel bars ready for rolling	Finished steel chemistry	Lets a mill roll without a melt shop	No control over chemistry; exposes the mill to import prices and freight

Source: International Iron Metallics Association fact sheets [S14, S15, S43]; Cameroon Steel. Values are typical ranges, not specifications.

Scrap is the cheapest and lowest-carbon iron unit wherever it is plentiful. DRI and HBI are "virgin" iron with low residual elements, used to make up for scrap shortages and to dilute impurities. Pig iron does the same job but carries the emissions of the blast furnace. Billets are not an iron unit for a melt shop but the input of a re-rolling mill, which buys steel already made elsewhere. Chapter 3 shows that billets are now Cameroon's largest single steel import.

WHAT THE PRIMER MEANS FOR THE ROUTE CHOICE

A new producer in Central Africa does not have to choose one technology for every stage at once. It must choose how it will make steel (oxygen or electricity) and where its iron units will come from in each period. An electric melt shop can start on scrap and imported DRI or HBI, and add domestic ironmaking later, without changing the furnace, the caster or the mills. The blast-furnace route offers no such sequence: the ironmaking plant must come first, at full scale.

1.9 What the primer means for Central Africa

Four practical points follow from the process description and frame the rest of this paper.

First, the decisive variable is the source of iron units, not the steelmaking furnace as such. Scrap is cheap and clean but scarce in an economy whose stock of old steel is small. DRI can be imported now and made locally later from Cameroonian ore, provided the ore is upgraded to direct-reduction grade. Pig iron and billets can be bought, but each carries someone else's emissions and margins.

Second, the casting and rolling steps are common to every route, so they can be built first and kept as the route evolves. A billet caster and a bar and wire-rod mill serve a scrap-fed EAF today and a DRI-fed EAF tomorrow equally well.

Third, scale matters differently on each route. An EAF melt shop is economic at a few hundred thousand tonnes a year; recent bar and rod mills ordered in Tanzania and Côte d'Ivoire are each about 300,000 t a year [S08, S09]. A blast furnace and its coke ovens and sinter plant only make sense at several million tonnes a year. For a market of Cameroon's size, that difference alone narrows the choice, as Chapter 2 shows.

Fourth, each route asks something different of the national energy system. A melt shop running on purchased iron units needs firm, high-quality electricity and little else; a direct-reduction plant adds a long-term demand for natural gas or, later, for very large quantities of low-carbon electricity to make hydrogen; a blast furnace needs a coal supply chain and port facilities for it. A route choice is therefore also a commitment about which energy infrastructure the country will build around the plant, and when.

These four points explain the structure of the chapters that follow. Chapter 2 compares the routes on energy, carbon, capital, scale and raw materials. Chapters 3 and 4 examine the iron units that an electric melt shop would use, from scrap and imported DRI to Cameroonian ore. Chapters 5 to 8 describe how the melt shop, the mills, the products and the control systems would work, and Chapters 9 and 10 apply the result to Cameroon Steel's planned complex and to the decisions that remain.

CHAPTER 2

THE ROUTES COMPARED: ELECTRIC ROUTES WIN ON CARBON, SCALE AND SPEED

Of the five ways to make steel, two fit a new producer in Central Africa: the electric arc furnace fed with scrap and purchased iron, and the electric arc furnace fed with gas-based direct-reduced iron. On worldsteel's 2024 route averages they emit 0.69 and 1.47 t of CO₂ per tonne of crude steel, against 2.34 t for the blast furnace and oxygen converter [S01]. On IEA-derived benchmarks in 2019 dollars their indicative capital cost per tonne is of the same order as the blast furnace's, but they can be built in modules of a few hundred thousand tonnes and started in a fraction of the time. The blast-furnace route belongs to very large works backed by coking coal and sintering plant; induction furnaces and smelting reduction do not meet the quality or maturity bar for structural products.

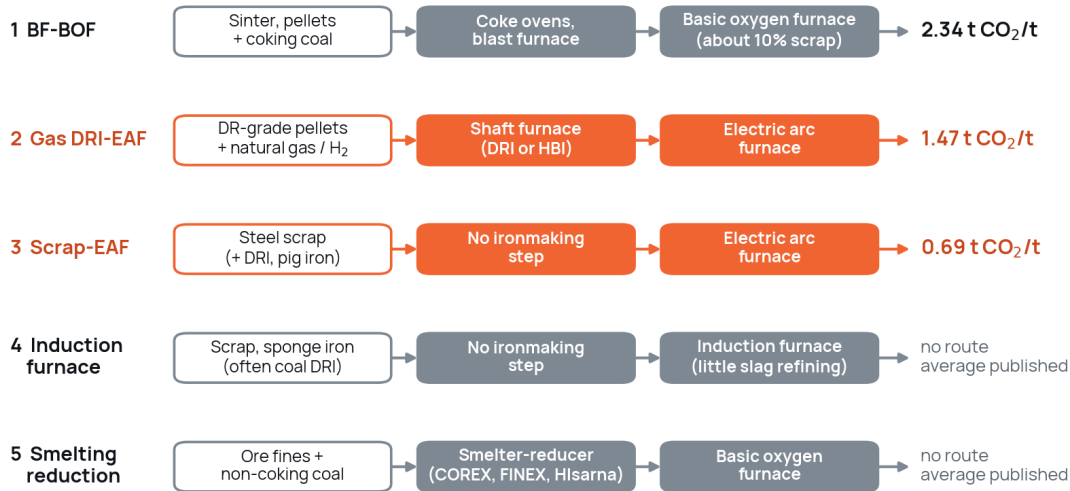
2.1 Five routes, of which three operate at commercial scale worldwide

Figure 2.1 sets out the five routes as a decision-maker meets them: what each consumes, which core plant it requires and how much CO₂ it emits on average. Three of them (blast furnace and basic oxygen furnace, gas-based direct reduction with an electric arc furnace, and scrap-based electric arc furnace) account for almost all of the world's crude steel. Induction furnaces are a niche concentrated in South Asia; smelting reduction is commercial at a handful of sites and is otherwise at pilot stage.

The comparison that follows uses four criteria that matter to a new producer in a mid-sized market: energy and CO₂ per tonne; capital per tonne of capacity; the minimum economic scale; and the raw materials each route needs. A fifth criterion, flexibility (the ability to change inputs and output as markets and supply chains change), runs through all four.

Five ways to make steel, and what each one needs

Inputs (left), core units (centre), CO₂ intensity where a published average exists (right)



CO₂: worldsteel route averages, 2024 data (scope 1, 2 and upstream). Smelting reduction: commercial at a few sites only (FINEX, COREX); Hlsarna at pilot stage.

ILLUSTRATIVE Figure 2.1. The five steelmaking routes: inputs, core units and published CO₂ averages.

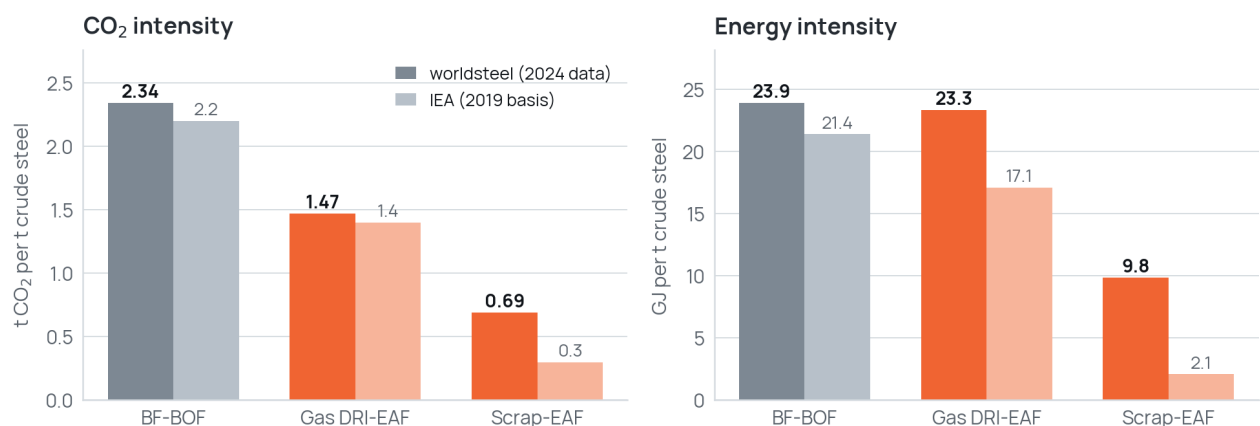
Source: Cameroon Steel; CO₂ values from worldsteel Sustainability Indicators 2025 (2024 data) [S01]; status of smelting reduction from [S11, S12].

2.2 Energy and CO₂: scrap-EAF steel emits about 30% of the blast furnace's CO₂

worldsteel publishes route averages that include direct emissions, emissions from purchased electricity and the upstream emissions of materials. For 2024 data, the blast furnace and oxygen converter route emitted 2.34 t of CO₂ per tonne of crude steel, the DRI-EAF route 1.47 t and the scrap-EAF route 0.69 t; the world average was 1.92 t [S01]. The energy intensities were 23.88, 23.30 and 9.84 GJ per tonne respectively, counting electricity as primary energy [S01]. The IEA, which measures final energy and uses a 2019 world-average grid factor of 538 g CO₂/kWh, gives 21.4, 17.1 and 2.1 GJ per tonne, and direct-plus-indirect CO₂ of 2.2, 1.4 and 0.3 t per tonne [S02]. The two sources differ in boundary, not in ranking (Figure 2.2).

Scrap-EAF steel carries about 30% of the blast furnace's CO₂; gas DRI-EAF about 63%

Darker bars: worldsteel 2024 route averages (scope 1, 2, upstream; power as primary energy). Lighter bars: IEA direct + indirect CO₂ and final energy.



SOURCED Figure 2.2. CO₂ and energy intensity by route on two published bases.

Source: worldsteel Sustainability Indicators 2025, 2024 data [S01]; IEA Iron and Steel Technology Roadmap, 2019 basis [S02].

Three features of these numbers matter for Cameroon.

First, the electric routes' emissions depend heavily on the grid. Cameroon generated about 90% of its electricity from hydropower in 2025 [S51], and Our World in Data, using Ember data, puts the average carbon intensity of the country's electricity at about 226 g CO₂/kWh in 2024 [S07], well under half the world average used by the IEA. An EAF consuming 450 kWh per tonne on that grid adds about 0.10 t of CO₂ per tonne of steel (derived). A gas-based DRI-EAF plant in Cameroon would therefore sit below the worldsteel DRI-EAF average, and closer to the IEA's direct-emission figure of about 1.0 t [S02].

Second, the DRI-EAF route's emissions come mostly from the natural gas burned and reformed in the shaft furnace. Replacing part of that gas with hydrogen reduces them in proportion. ENERGIRON reports reductions of about 53% against the blast-furnace route with natural gas and about 86% with 100% hydrogen [S20]. The DRI-EAF route is therefore the only ore-based route with a credible path to near-zero steel; the IEA's near-zero threshold for steel made entirely from ore is 0.40 t CO₂e per tonne [S52].

Third, carbon is becoming a cost at Europe's border. The EU Carbon Border Adjustment Mechanism (CBAM) entered its definitive phase on 1 January 2026 and covers iron and steel, including DRI, billets, rebar and wire rod, and agglomerated iron ore [S53]. The certificate price for the third quarter of 2026 was €82.32 per tonne of CO₂e [S54]. Applied to worldsteel's route averages, that price would give a gross charge of about €193 per tonne for blast-furnace steel, €121 for DRI-EAF steel and €57 for scrap-EAF steel, before any deductions for EU free allocation (derived). These figures are an upper bound, not an estimate of what an exporter would pay: worldsteel's averages include purchased electricity and upstream inputs, which CBAM does not price for iron and steel, so they overstate the CBAM-relevant emissions, particularly for the electric routes. White paper 06 (Chapter 5, Table 5.2) computes the charge on the CBAM boundary. Free allocation for EU producers falls from 97.5% in 2026 to zero in 2034 [S55], so the charge that exporters face will rise each year.

ON THE SAME GRID, THE ELECTRIC ROUTES CUT CO₂ PER TONNE BY 37 TO 71% AGAINST THE BLAST FURNACE. ON CAMEROON'S HYDRO-DOMINATED GRID THE ADVANTAGE IS LARGER.

Cameroon Steel, from worldsteel 2024 route averages

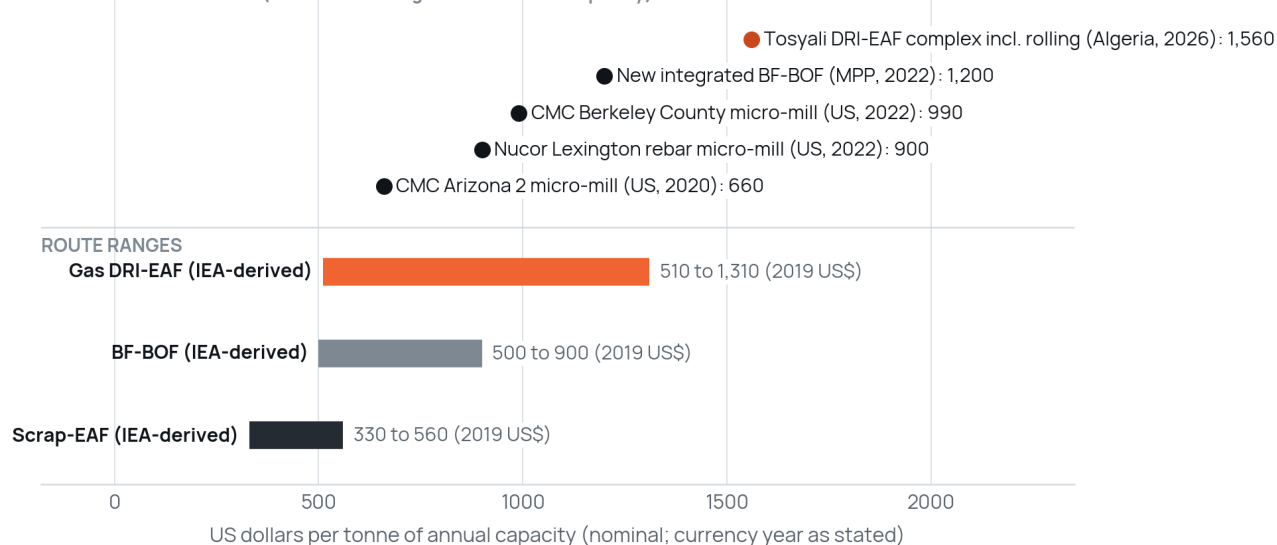
2.3 Capital per tonne is of the same order; what differs is the scale at which it is spent

Published capital costs for steel plants are difficult to compare: they differ in scope (with or without rolling mills, utilities, ports and housing), currency year and location. The most consistent public basis is the IEA's set of annualised capital costs, which converts into indicative overnight costs per tonne of annual capacity of about US\$500 to 900 for a new blast furnace and converter, US\$510 to 1,310 for a gas DRI-EAF plant and US\$330 to 560 for a scrap-EAF melt shop, in about 2019 dollars (derived; method in Annex A) [S02]. These ranges are not escalated to current prices: budgets announced between 2020 and 2026, which also include rolling mills and site works, run from about US\$660 to 1,560 per tonne (Figure 2.3), so the ranges are useful to compare routes, not to price a plant. The Mission Possible Partnership puts a new integrated blast-furnace works at about US\$1.2 billion per million tonnes [S56].

Capex per tonne depends more on scope and site than on route

Ranges and benchmarks are not Cameroon Steel estimates; scope (rolling, utilities, ironmaking) explains most of the spread

PROJECT BENCHMARKS (announced budget ÷ announced capacity)



DERIVED Figure 2.3. Indicative capex per tonne of annual capacity by route, with announced project benchmarks.

Source: IEA-derived ranges [S02]; Mission Possible Partnership [S56]; Nucor [S57]; CMC projects [S58, S59]; Tosyali Algeria [S60]. Project values are announced budgets divided by announced capacity, with US short tons converted to tonnes, and are not comparable in scope.

The project benchmarks in Figure 2.3 show why route is not the main driver. Three US "micro-mills" that melt scrap and roll bar in a single line were announced between 2020 and 2022 at about US\$660, US\$900 and US\$990 per tonne of announced capacity, once their short tons are converted to tonnes (Annex A) [S57, S58, S59]. A new Algerian complex that combines direct reduction, electric steelmaking and rolling was announced in April 2026 at about US\$2.5 billion for 1.6 Mt, or about US\$1,560 per tonne [S60]. Hydrogen-based plants are more expensive still: the first phase of Stegra's hydrogen DRI-EAF plant in Sweden was financed at €6.5 billion for 2.5 Mt a year [S61], and the company was seeking further funding in October 2026 as costs rose [S62].

What separates the routes is the size of the indivisible step. A blast furnace, with its coke ovens, sinter plant and oxygen converter, is economic only at several million tonnes a year; the IEA-derived range assumes that scale. An electric melt shop with its caster is efficient at a few hundred thousand tonnes: US micro-mills are sized at 0.39 to 0.45 Mt a year (430,000 to 500,000 short tons) [S57, S58, S59], and recent African bar and rod mills at about 0.3 Mt [S08, S09]. Direct-reduction modules are available from 0.25 Mt a year, the size of the ENERGIRON ZR micro-module commissioned at Mutún in Bolivia in October 2025, up to 2.5 Mt in a single shaft [S04]. A Central African producer can therefore commit capital in steps that match demand, and add ironmaking when its ore and gas are ready.

2.4 The blast-furnace route suits very large, coal-backed works

The blast furnace remains the world's main ironmaking technology, and 319 Mtpa of new blast-furnace capacity was under development worldwide in 2026, mostly in India and China [S45]. It suits countries that combine a very large steel market, access to coking coal and an ore and logistics chain designed for tens of millions of tonnes of raw materials. Cameroon's apparent steel use is about 450,000 t a year by industry estimates [S32], far below the output of a single modern blast furnace. A blast furnace would depend on imported coking coal, because no Cameroonian coking-coal supply is in operation or in development in the sources reviewed for this paper. It would also carry the highest carbon charge of any route into export markets that apply carbon border measures.

The blast furnace is also the least flexible route. It runs continuously for campaigns of many years; stopping it is costly and restarting it slow. When demand falls, an integrated works cannot easily throttle down, whereas an electric melt shop can reduce shifts. For a producer whose market is still forming, that rigidity is a serious risk.

2.5 Gas-based DRI-EAF is the ore-based route that fits Central Africa

Gas-based direct reduction combined with an electric furnace is how North Africa built its steel industry. Algeria, Egypt and Libya together produced about 14.5 Mt of DRI in 2025 on Midrex plant statistics [S04], and Algeria moved from a net steel deficit to a net surplus on the strength of large DRI-EAF complexes [S63]. The route uses natural gas rather than coking coal, accepts DR-grade pellets or lump ore, and its modules can be sized to the market. A modern MIDREX or ENERGIRON plant consumes about 9.2 to 10 GJ of natural gas per tonne of DRI; Suez Steel reported sustained consumption below 2.2 Gcal (about 9.2 GJ) per tonne in 2026 [S48], and the ENERGIRON reference is about 10 GJ and 73 kWh per tonne of DRI [S20].

Sub-Saharan Africa has almost no gas-based direct reduction in operation: on Midrex plant statistics the region produced 0.09 Mt of DRI in 2025, and its two shaft-furnace DR plants, at Warri in Nigeria (1.02 Mtpa) and Saldanha in South Africa (0.80 Mtpa), were idle [S04]. worldsteel, whose figures include estimates for plants outside that survey, puts East African DRI output at about 2.7 Mt in 2025, in Uganda, Kenya and Tanzania (Chapter 4) [S41]. A DRI module at Kribi would therefore be among the first operating gas-based DR plants in the region. It would also face the two preconditions examined in Chapter 4: DR-grade ore and a long-term gas supply.

2.6 The scrap-fed EAF is the fastest start, but scrap alone cannot feed 1 Mtpa

The scrap-fed electric furnace is the lowest-carbon and lowest-capital route and the quickest to build. Its limit is the supply of scrap, which depends on how much steel an economy has accumulated in buildings, vehicles and machinery. Global scrap use in steelmaking is about 630 Mt a year, according to the Bureau of International Recycling [S64], but it is concentrated in mature economies. Africa was a net importer of ferrous scrap in 2025, importing 3.4 Mt and exporting 1.2 Mt [S41]. Chapter 3 shows that Cameroon's domestic scrap is a fraction of what a 1 Mtpa plant would need. The scrap-EAF is the right way to start, but not a sufficient way to grow.

2.7 Induction furnaces and smelting reduction do not meet the bar for structural steel at scale

Induction furnaces melt scrap and sponge iron cheaply in small units, which explains their popularity in South Asia. Global Energy Monitor counts about 27 Mtpa of tracked induction-furnace capacity, about 1% of operating capacity, mostly in India, Vietnam, Bangladesh and Pakistan; the furnaces it tracks use on average 73% sponge iron (often coal-based) and only 19% scrap [S45]. The IEA describes induction furnaces as typically less energy-efficient than arc furnaces and notes that China closed dozens of illegal induction-furnace plants [S02]. Their metallurgical weakness is refining: without a hot, reactive slag they cannot remove phosphorus and sulphur effectively. India's National Metallurgical Laboratory reported that about 90% of nearly 15 Mt of induction-furnace steel made from DRI contained 0.08 to 0.11% phosphorus, against the 0.03 to 0.06% allowed by Indian and ASTM standards [S10]. For rebar and sections that must meet ductility and weldability requirements, that is a disqualifying risk unless refining is added in the ladle.

Smelting reduction processes reduce and melt ore in one or two vessels using non-coking coal, avoiding coke ovens and, in some designs, sintering. COREX and FINEX are in commercial use; POSCO built its first commercial FINEX plant for 1.5 Mt of hot metal a year at Pohang [S11]. Hisarna has been piloted in the Netherlands and Tata Steel plans an industrial plant of about 1 Mt a year at Jamshedpur by 2030 [S12]. These processes still produce

hot metal for an oxygen converter, still depend on coal and, at commercial scale, still need carbon capture to reach low emissions. They are not an option for a new producer whose ore is not yet upgraded and whose market is measured in hundreds of thousands of tonnes.

2.8 Africa's own experience points the same way

The continent's recent history offers a natural experiment in route choice. Africa made 89.0% of its crude steel in electric furnaces in 2025 [S41]. North Africa built its industry on gas-based direct reduction and electric melt shops behind trade protection: Algeria moved from a net steel deficit of about 1 Mt in 2021 to a net surplus of about 1 Mt in 2025, and the share of imports in its steel use fell from 35% to 16% [S63, S65]. South Africa offers a different lesson: in February 2025 ArcelorMittal South Africa confirmed the wind-down of its long-steel business, citing energy costs, logistics, scrap policy and weak protection against imports [S66].

New capacity follows the electric pattern. Global Energy Monitor lists electric arc furnace projects in development in Namibia, Algeria, Nigeria, Libya, Egypt, South Africa, Zimbabwe, Angola and Mozambique, and direct-reduction projects in Libya, Algeria, Egypt, Angola and Mozambique [S45]. The bar and wire-rod mills ordered in Tanzania and Côte d'Ivoire in September 2026 are each about 300,000 t a year [S08, S09]. A Kribi melt shop would join a regional industry that has already chosen electricity; what would distinguish it is the prospect of feeding that furnace, in time, with iron made from the country's own ore.

2.9 The comparison in one table

Table 2.1 Route comparison for a new long-products producer in Central Africa

Criterion	BF-BOF	Gas DRI-EAF	Scrap-EAF (with purchased DRI/HBI)	Induction furnace	Smelting reduction
CO ₂ , t per t crude steel	2.34 [S01]	1.47 [S01]; about 1.0 direct [S02]	0.69 [S01]	No route average published	Not published at commercial scale; needs carbon capture for low emissions [S12]
Energy, GJ per t	23.88 (worldsteel); 21.4 (IEA) [S01, S02]	23.30; 17.1 [S01, S02]	9.84; 2.1 [S01, S02]	Typically less efficient than EAF [S02]	n.a.
Indicative capex, US\$ per t of capacity	500 to 900 (IEA-derived); about 1,200 (MPP) [S02, S56]	510 to 1,310 (IEA-derived) [S02]	330 to 560 (IEA-derived) [S02]	Low, small units	n.a.
Economic scale	Several Mt a year	DR modules 0.25 to 2.5 Mt [S04]	0.3 to 0.45 Mt per melt line [S08, S57, S58]	Below 0.5 Mt [S45]	About 1 to 1.5 Mt per unit [S11, S12]
Main raw materials	Sinter or pellets, coking coal	DR-grade pellets, natural gas or hydrogen	Scrap, DRI/HBI, pig iron	Scrap, sponge iron	Ore fines, non-coking coal
Flexibility	Low: continuous campaigns	Medium: DR plant continuous, EAF flexible	High: start, stop, change charge	High	Low

Criterion	BF-BOF	Gas DRI-EAF	Scrap-EAF (with purchased DRI/HBI)	Induction furnace	Smelting reduction
Fit for a new Central African producer	Poor: scale, coal, carbon	Best long-term fit once DR-grade ore and gas are secured	Best starting point; needs purchased iron units	Not suitable for structural grades at scale	Not mature for this context

Source: as cited in each cell; Cameroon Steel assessment in the last two rows.

2.10 Why the phased electric route balances the four criteria

The question for Cameroon is not which route is best in the abstract, but which sequence of plants gives the best balance of capital, flexibility, emissions and speed given the market and resources that exist now, and those that may exist in ten years.

On capital, the electric route lets the producer commit in steps of a few hundred thousand tonnes, with each step generating revenue before the next. On flexibility, the electric furnace accepts any mix of scrap, DRI, HBI and pig iron, so the plant can switch suppliers and adjust to prices; and it can be throttled with demand. On emissions, it starts at the scrap-EAF level and rises only as the share of ore-based iron rises, while Cameroon's hydro-dominated grid keeps the electricity component low. On speed, a melt shop and mill can be built and commissioned without waiting for a mine, a concentrator, a pellet plant and a gas contract to be ready at the same time.

Capital and carbon are not the whole case. A melt shop earns its place only if the billets it casts cost less than billets bought abroad and delivered to Kribi. Its largest cost is the metallic charge: at the RC-1 metallic yield of 0.88, each tonne of billet needs about 1.15 t of scrap, HBI or pig iron [S03]. The spread between the delivered price of an imported billet (free on board, plus freight, port charges and duty) and the cost of that charge is what must pay for 450 to 490 kWh of furnace electricity per tonne, electrodes, refractories, alloys, labour and maintenance. The spread moves with world prices for scrap, HBI and billets and with freight, and it is the variable that a Phase 1 investment decision must test. White paper 04 (Chapter 8) sets out an indicative cost of a Kribi billet against a delivered import, as ranges with their sources and uncertainty; this paper does not repeat those figures.

The direct-reduction step is then added when its preconditions are in place. That is the pathway examined in the rest of this paper: an electric arc furnace fed first with scrap and imported DRI or HBI, and later with direct-reduced iron made at Kribi from concentrated Cameroonian ore.

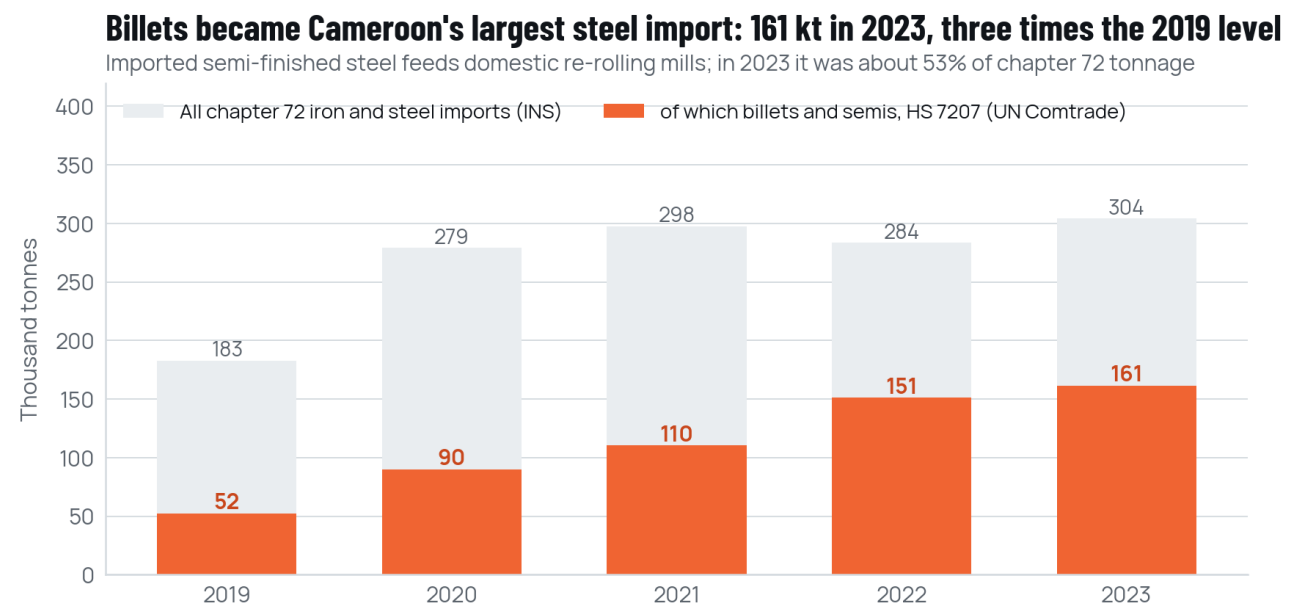
CHAPTER 3

METALLICS: CAMEROON IS SHORT OF IRON UNITS, NOT OF ROLLING CAPACITY

Cameroon's steel industry already rolls more than the country consumes; what it lacks is the iron to feed its mills. Billets became the country's largest single steel import, at 161,400 t in 2023 [S05], and local scrap covers only about 40% of the existing mills' needs [S32, S33]. A 1 Mtpa electric melt shop would need about 1.2 Mt of iron units a year, roughly ten times the scrap collected in Cameroon today. The first phase must therefore be planned on imported scrap and imported DRI or HBI alongside domestic scrap, and the long-term answer is iron made in Cameroon from Cameroonian ore.

3.1 Billets show where the shortfall lies

Cameroon's imports of iron and steel (customs chapter 72) rose from 182,890 t in 2019 to 412,049 t in 2025, according to the national statistics institute; in 2025 alone they rose by 33% [S67, S68]. The composition of those imports is more revealing than the total. In 2023, the last year reported to the UN Comtrade database, semi-finished steel (HS 7207, mostly billets) amounted to 161,400 t worth US\$151.7 million, three times the 2019 level [S05]. Indonesia supplied 125,500 t of it, or 78% [S05]. Imports of rebar, by contrast, were marginal because rebar imports have been prohibited since 2016, a ban that Customs confirmed in April 2023 [S69].



SOURCED Figure 3.1. Cameroon's chapter 72 imports and the billet share, 2019 to 2023.

Source: INS Cameroun foreign-trade notes for chapter 72 tonnage [S67, S70, S71]; UN Comtrade for HS 7207 [S05]. The 2023 billet share of chapter 72 tonnage (about 53%) is derived.

The pattern is that of an industry that owns rolling mills but not enough steelmaking. Cameroon Tribune, citing the industry association, reported in May 2026 that domestic rebar capacity far exceeds the rebar market [S06]. Industry sources describe about 1.2 Mt a year of installed steel transformation capacity running at about half of its potential, and note that local scrap now covers only about 40% of mill needs [S32, S33]. In September 2026 a leading domestic producer secured a €40 million revolving facility from Afreximbank, reported by the financial press as intended to import billets [S33, S72].

Cameroon is not new to electric steelmaking: in 2023 Cameroon Tribune described a Douala producer's electric arc furnace, of about 200,000 t of rebar a year, as the first of its kind in Central Africa [S73]. But domestic melting remains far smaller than domestic rolling.

The implication for technology is direct. A new producer adds the least value, and takes the most market risk, if it builds another re-rolling mill that buys imported billets. It adds the most value by making steel, the step the country lacks. A melt shop with a billet caster also has an option that a re-roller does not: it can supply billets to other mills.

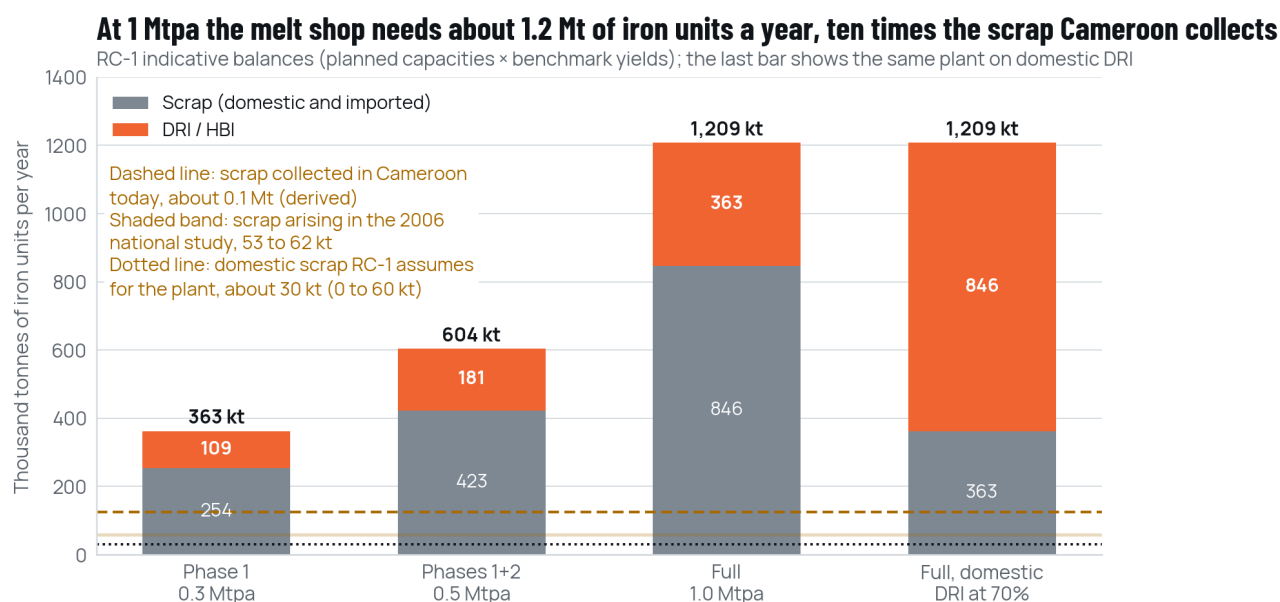
THE CONSTRAINT IS IRON, NOT ROLLING

Rolling capacity in Cameroon exceeds demand; iron units do not. The value of a new steelworks lies in its melt shop, and the value of its melt shop depends on secure iron units. Every later choice in this paper follows from that.

3.2 Domestic scrap is a fraction of what a steelworks needs

Scrap supply grows with a country's accumulated stock of steel in use: buildings, bridges, vehicles, machinery and packaging that reach the end of their lives. Cameroon's stock is small, and so is its scrap. The only quantified national study, published in 2007 by researchers from the National Advanced School of Engineering in Yaoundé, estimated annual ferrous scrap arising at 53,000 to 61,833 t, of which 53% was collected by recyclers, 29% by informal dismantlers and 15% by exporters [S13]. Recorded scrap exports have since fallen to near zero: 3,675 t in 2019 and 15 t in 2023 [S05]. Scrap purchase prices rose by about 30% in the year to September 2026, according to the press [S32].

No more recent survey exists. A rough cross-check is possible: domestic mills produced about 260,000 t in 2022 [S74]; if they consume about 1.2 t of metallic charge per tonne of product (the RC-1 yields) and local scrap covers about 40% of it, domestic scrap collected is of the order of 0.1 Mt a year (derived; Annex A). That scrap is already consumed by existing mills. A new melt shop that competed for it would mainly raise its price.



DERIVED Figure 3.2. Iron units required by the RC-1 phases, compared with domestic scrap; the last bar shows the full plant with 70% domestic DRI in the charge.

Source: Cameroon Steel reference configuration RC-1 (planning estimate), indicative balances [S03]; scrap study [S13]; production and scrap-share inputs [S32, S74]; derivations in Annex A.

Figure 3.2 shows the scale of the gap. Cameroon Steel's reference configuration (RC-1) plans 0.3 Mtpa of finished products in Phase 1, rising to 0.5 Mtpa and then to 1 Mtpa [S03]. With a metallic yield of 0.88 t of liquid steel per tonne charged and a casting and rolling yield of 0.94, those capacities need about 363,000 t, 604,000 t and 1.21 Mt of iron units a year (derived from RC-1 assumptions) [S03]. Even Phase 1 would need between three and four times the scrap that Cameroon collects today, and about six times the scrap arising estimated by the 2006 national study.

3.3 Imported scrap, DRI, HBI and pig iron fill the gap

An electric melt shop at a deep-water port can buy iron units on the international market. Each has a different profile.

Imported scrap is the cheapest iron unit per tonne of iron where it is available, but Africa as a whole was a net importer of ferrous scrap in 2025, importing 3.4 Mt and exporting 1.2 Mt [S41]. The large exporting regions are the European Union and the United States, which shipped 16.7 Mt and 11.8 Mt respectively in 2025, while Türkiye imported 18.8 Mt [S64]. Scrap prices follow those flows, and the quality of imported scrap (its residual copper and tin, its density and its contamination) varies widely.

Direct-reduced iron and hot-briquetted iron are the traded virgin iron units. International DRI trade was about 10.8 Mt in 2025 on trade data, or about 13.2 Mt including sanctioned origins; Russia exported more than 2.0 Mt of HBI and India 1.6 Mt, while the United States, Türkiye, India, Nepal and Italy were the largest importers [S04]. HBI accounted for 11.6 Mt, or 7.7% of world DRI output [S04]. For a buyer without its own reduction plant, HBI is the practical form: it can be shipped with surface ventilation, whereas cold DRI must travel under an inert atmosphere because it re-oxidises and self-heats when wet [S14, S15].

Merchant pig iron offers clean iron with high carbon, which adds chemical energy in the EAF [S43]. Its supply is concentrated in a few exporting countries and it carries the emissions of the blast furnace that made it.

Table 3.1 Iron-unit options for the Kribi melt shop, by role and risk

Option	Role in the charge	Quality profile	Supply and logistics	Main risk	Use in the pathway
Domestic scrap	Base charge where available	Variable; needs sorting, shredding and inspection	About 0.1 Mt collected a year (derived), already used by existing mills; RC-1 assumes about 30,000 t a year for the plant (0 to 60,000) [S03]	Competition and price; quality	Buy where economic; support formal collection
Imported scrap	Base charge	Grade-dependent; residuals vary	Bulk or container shipments through Kribi	Price volatility; residuals	Main scrap source in Phase 1
Imported HBI	Clean iron to dilute residuals and stabilise chemistry	94% metallisation; dense briquettes [S15]	Traded internationally; ventilated holds [S15]	Price; supplier concentration	20 to 50% of the charge in Phase 1 (RC-1 assumption) [S03]
Imported cold DRI	As HBI	92 to 96% metallisation [S14]	Inert-gas shipping; dry covered storage [S14]	Re-oxidation, fire risk	Only if HBI is unavailable
Pig iron	Carbon and clean iron	3.5 to 4.5% C [S43]	Few exporters	Price; blast-furnace emissions	Trim addition
Domestic DRI (Kribi)	Main virgin iron unit	Depends on pellet gangue (Chapter 4)	Hot charge possible	Ore, gas, pellet plant readiness	Later phase, subject to the gate in Chapter 10

Source: Cameroon Steel; [S03, S04, S14, S15, S41, S43, S64].

3.4 How iron units change the melt shop's performance

The choice of iron units is not only a supply question; it changes how the furnace operates.

Scrap is already metallic and melts with the least energy, but its residual elements (copper, tin, nickel, chromium) cannot be removed in the furnace and accumulate in each recycling cycle. For rebar these residuals are tolerable within limits; for wire rod destined for fine drawing, they matter more. DRI and HBI dilute residuals because they contain almost none.

DRI and HBI carry gangue (silica and alumina from the ore) and some unreduced iron oxide. The furnace must melt the gangue and flux it with lime, which increases slag volume, electrical energy and refractory wear, and reduces metallic yield. The ENERGIRON reference indicates that each additional 10% of DRI in the charge adds about 14.5 kWh per tonne of liquid steel (Chapter 5) [S20]. That penalty is the price of independence from scrap.

Pig iron and the carbon in DRI add chemical energy when oxidised with injected oxygen, which partly offsets the electrical penalty and helps form the foaming slag that protects the furnace walls.

The planning assumption in RC-1 is that imported DRI or HBI forms about 30% of the Phase 1 charge, within a range of 20 to 50%, with the balance in scrap [S03]. On that basis, Phase 1 would use about 109,000 t of DRI or HBI and 254,000 t of scrap a year (derived) [S03]. Because domestic scrap is scarce and already in use, RC-1 assumes that the plant can buy only about 30,000 t of it a year, within a range of 0 to 60,000 t bounded by the 2006 national estimate of scrap arising [S03, S13]; about 224,000 t of the scrap, and all of the DRI or HBI, would be imported. Any configuration that relied on more than about 60,000 t a year of domestic scrap would not be feasible on current evidence. RC-1 estimates inbound port tonnage of about 351,000 t a year in Phase 1 for imported metallics and consumables (derived) [S03].

A MELT SHOP ON THE COAST CAN BUY IRON FROM THE WORLD; A MELT SHOP THAT MAKES ITS OWN IRON FROM CAMEROONIAN ORE KEEPS THE VALUE, AND THE FOREIGN EXCHANGE, AT HOME.

Cameroon Steel, technology pathway

3.5 Scrap quality and preparation decide yield

Scrap is not a single commodity. It arrives as heavy melting steel from demolition, light sheet and packaging, turnings and borings from machining, and shredded scrap from end-of-life vehicles and appliances. Each grade has a different density, cleanliness and residual content, and the melt shop's yield, energy use and charging time depend on the mix. Dense scrap fills the furnace in fewer charges: a large modern furnace published in 2026 is designed to run on two bucket charges with scrap densities down to 550 kg/m³ [S75]. Light, dirty or wet scrap needs more charges, more energy and more fume treatment.

Preparation therefore belongs to the melt shop's design. A scrap yard needs space to separate grades, shears or balers to cut and compact oversized and light material, magnets and cranes to build buckets to a recipe, and inspection at the gate for sealed containers, explosives and radioactive sources, which are standard hazards in scrap trading. Imported scrap should be bought to recognised grade specifications and checked on arrival; domestic scrap, much of it collected informally [S13], will need sorting and cleaning before it can be charged safely.

3.6 Receiving iron units through Kribi

Because most Phase 1 iron units will be imported, the plant's metalics chain starts at the port. The Port Autonome de Kribi inaugurated its second container terminal, with a 715 m quay and 16 m of water depth, in May 2025 [S76]. A mineral terminal of 125 Mt a year was the subject of a memorandum of understanding signed on 4 November 2025 [S37], and in March 2026 the port's Director General expected the mineral and hydrocarbon terminals to be completed within five to six years [S38]. Phase 1 therefore plans on the existing general-cargo and container terminals; White paper 02 examines the port's bulk capacity. HBI and scrap move in bulk carriers or containers; both need covered or well-drained storage at the port and at the plant. RC-1 estimates that Phase 1 would bring in about 351,000 t a year of imported metalics and consumables, and about 74 truck loads a day if all movements go by road before a rail siding exists (derived) [S03]. The site layout keeps a reserve for a rail siding and logistics corridor [S03]. When a direct-reduction module is built, the same logistics chain will handle about 1.45 t of pellets for every tonne of DRI (Chapter 4).

3.7 A metalics strategy, not a single supplier

Iron-unit security will be one of the main operating risks of the Kribi melt shop, and it can be managed with a small number of disciplined practices.

Two sources for every iron unit. Phase 1 should be supplied under term contracts with at least two suppliers each for scrap and for HBI, from different regions, with spot purchases on top. That reduces exposure to a single supplier, freight lane or sanctions regime.

Storage sized for disruption. HBI and DRI must be stored dry and covered; scrap yards need space for grading and preparation. RC-1 reserves a scrap and metalics stockyard with a covered DRI/HBI store in Phase 1 [S03].

Quality at the gate. Every delivery should be sampled for metallisation, carbon and gangue (for DRI/HBI) or inspected and graded (for scrap), and the results linked to the heats in which the material is used (Chapter 8).

Formal domestic collection. Supporting a formal scrap collection and preparation chain, with weighbridges, shears and safe handling, improves quality and traceability and keeps domestic scrap in Cameroon.

A clear path to domestic iron. The decisive step is to make DRI at Kribi from Cameroonian ore. The mining convention of Cameroon Mining Company, Cameroon Steel's sister company and holder of the Mbalam permit [S77], is reported to provide for 15% of production to be transformed locally; the same press report presents Cameroon Steel as the national steel hub of the programme [S36]. Chapter 4 examines what has to happen to the ore before that clause can feed a shaft furnace.

3.8 What the metallics balance means for the pathway

The metallics balance explains the shape of the pathway. Phase 1 can be built and run on purchased iron units because a 0.3 Mtpa melt shop needs about 0.36 Mt of them a year, a quantity the international market can supply. At 1 Mtpa the requirement rises to about 1.2 Mt a year. Buying that quantity indefinitely would expose the plant to import prices, freight and foreign-exchange risk for most of its costs; making a large part of it in Cameroon would retain the value added and reduce imports. Figure 3.2 shows that with domestic DRI at 70% of the charge, the full plant would need about 846,000 t of DRI and about 363,000 t of scrap a year (derived) [S03]. That is why RC-1 keeps a reserve for a direct-reduction module of about 1 Mt of DRI a year at full development, subject to ore quality and gas supply [S03].

CHAPTER 4

DIRECT REDUCTION AND ORE QUALITY: CAMEROONIAN IRON NEEDS A CONCENTRATOR AND A PELLET PLANT FIRST

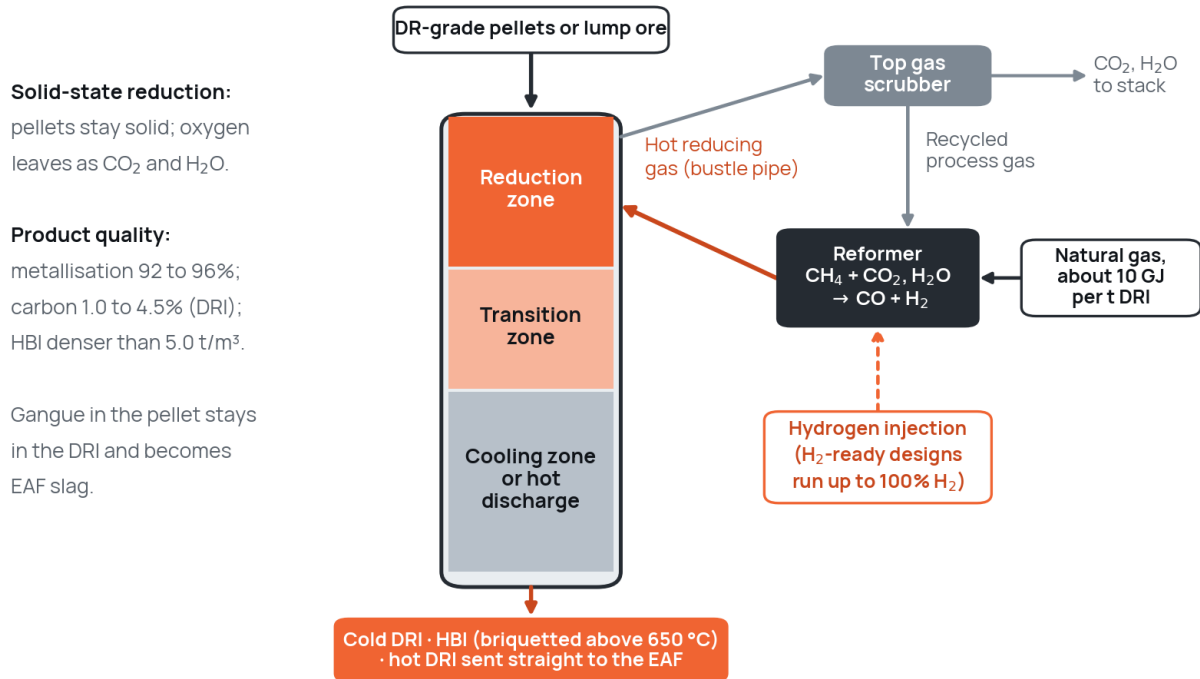
Direct reduction can turn Cameroonian ore into clean iron at Kribi, but only once the ore has been upgraded to direct-reduction grade. worldsteel states that direct-reduction processes need ore of at least 64% iron [S16], and traded DR-grade pellets typically carry 67 to 68% iron with little gangue [S17]. The published Mbalam reserve grades 62.2% iron with 7.3% silica and alumina [S18], which is blast-furnace grade; metallurgical testwork on Mbalam itabirite produced a 68% iron concentrate with 2.0% silica and alumina [S19], which is DR grade. Between the two stands a concentrator and a pellet plant. A 1 Mtpa DRI module would also need about 9 billion cubic feet (bcf) of natural gas a year, about 12% of Cameroon's 2025 gas output (derived). Hydrogen-ready shaft furnaces allow that gas to be replaced progressively. Domestic DRI is therefore a later phase with clear preconditions, not a starting point.

4.1 A shaft furnace removes oxygen from solid pellets

A gas-based direct-reduction plant is built around a vertical shaft furnace (Figure 4.1). Oxide pellets or lump ore are charged at the top through a gas seal and descend by gravity. A hot reducing gas, made by reforming natural gas into a mixture of hydrogen and carbon monoxide, enters through a bustle pipe at the base of the reduction zone and rises against the burden. As it passes, it strips the oxygen from the iron oxide, leaving as water vapour and carbon dioxide. The spent "top gas" is cleaned, recycled to the reformer and partly burned as fuel. Below the reduction zone, the iron either cools in a cooling zone and leaves as cold DRI, or is discharged hot and briquetted into HBI or carried directly to an adjacent electric furnace as hot DRI.

A gas-based shaft furnace removes oxygen from solid pellets without melting them

Simplified MIDREX-type flowsheet; ENERGIRON-type plants differ in gas loop and pressure but follow the same principle

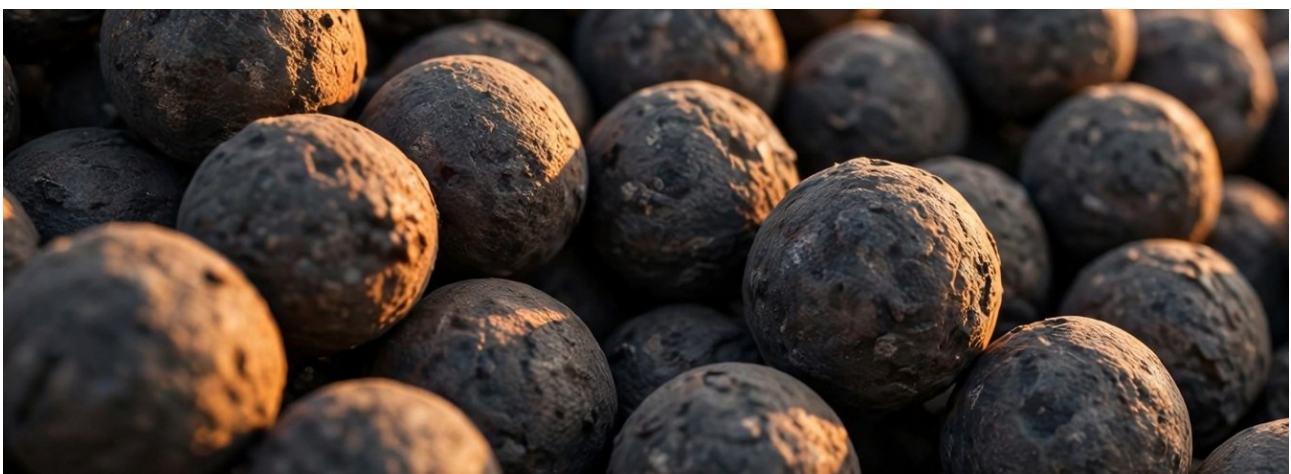


ILLUSTRATIVE Figure 4.1. Simplified gas-based shaft furnace (MIDREX-type). ENERGIRON-type plants use a different gas loop and pressure but the same reduction principle.

Source: Cameroon Steel, after Midrex [S22] and ENERGIRON [S20] process descriptions; product properties from IIMA [S14, S15].

Two features make the process attractive for Cameroon. It uses natural gas rather than coking coal; and the reducing gas of a natural-gas plant is already rich in hydrogen. In Midrex laboratory tests representing natural-gas operation, the reducing gas contained about 55% hydrogen, 36% carbon monoxide, 5% carbon dioxide and 4% methane [S22]. Moving towards hydrogen is therefore a change of degree, not of kind.

The product's quality is fixed by the feed. A modern shaft furnace delivers DRI that is 92 to 96% metallised [S14], but it cannot remove gangue. DRI made from ore of 65.5 to 68% iron contains 3.9 to 8.4% gangue [S14]. That gangue becomes slag in the electric furnace, where it costs electricity, lime, refractory and yield.



ILLUSTRATIVE Illustrative view. Generated image of iron-oxide pellets, the usual feed of a direct-reduction shaft furnace; not a photograph of any project, place or person.

4.2 DR-grade feed is scarce and becoming scarcer

worldsteel's climate policy paper notes that current direct-reduction processes require high-grade ore, of 64% iron or more [S16]. In practice the seaborne DR-grade market trades at higher grades: the main DR-grade materials described by IEEFA carry about 67 to 68% iron, with low silica and alumina [S17]. Only about 31% of the world's DR-grade pellet supply was sourced from the seaborne market in 2024; the rest was produced and consumed regionally [S17].

Demand for that material is rising faster than supply. IEEFA reports that BloombergNEF expects a seaborne DR-grade pellet deficit of 15 Mt a year by 2030, widening to 133 Mt a year by 2040, and that Midrex has flagged a possible shortfall of up to 16.4 Mt a year by 2034 [S17]. Agora Industry reached a similar conclusion in 2023, warning that DR-grade ore supply would lag demand by 2030 [S78]. For Cameroon Steel this cuts two ways. It means that imported DR pellets may become expensive and contested, so a plan that relies on them for decades is fragile. It also means that a Cameroonian source of DR-grade concentrate would be valuable in its own right, both to the Kribi plant and as an export.

A SHAFT FURNACE CANNOT REMOVE GANGUE. EVERY POINT OF SILICA IN THE PELLET IS PAID FOR AGAIN IN THE ELECTRIC FURNACE.

Cameroon Steel, technology pathway

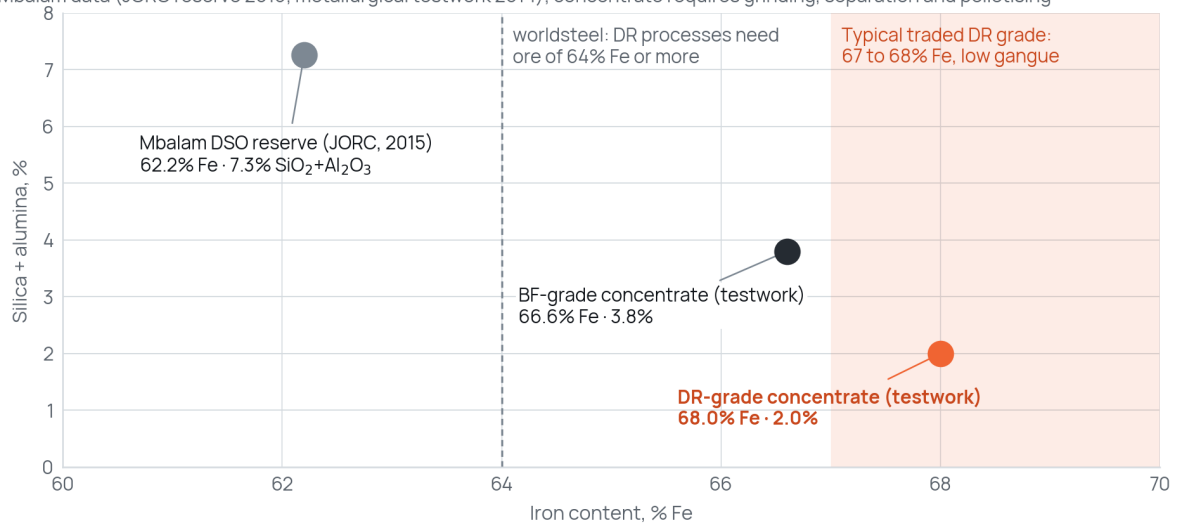
4.3 What the published data say about Cameroonian ore

Cameroon has several iron-ore deposits at different stages. The most studied is Mbalam, whose exploitation permit is held by Cameroon Mining Company, Cameroon Steel's sister company [S77]. The only code-compliant dataset for Mbalam was published under the JORC Code by the permit's previous holder in 2015. It gives a probable ore reserve of 517 Mt grading 62.2% iron, 4.46% silica, 2.80% alumina and 0.09% phosphorus, of direct-shipping hematite; a further high-grade hematite resource of 805.7 Mt at 57.3% iron; and an itabirite resource of 5,638 Mt at 33.4% iron [S18]. Itabirite is a banded iron formation in which fine hematite or magnetite is interlayered with silica; it must be ground and concentrated before use.

Metallurgical testwork on Mbalam itabirite, published in 2014, produced two concentrates: a blast-furnace-grade product of 66.6% iron and 3.5% silica, and a DR-grade product of 68% iron, 1.8% silica, 0.2% alumina and 0.03% phosphorus, after grinding to a P80 of 53 µm, with a mass yield of 45% and an iron recovery of 81% [S19]. Figure 4.2 places these products against the DR-grade thresholds.

Mbalam's direct-shipping ore is blast-furnace grade; its itabirite concentrate reached DR grade in testwork

Published Mbalam data (JORC reserve 2015; metallurgical testwork 2014); concentrate requires grinding, separation and pelletising



SOURCED Figure 4.2. Mbalam products against DR-grade thresholds: iron content against silica plus alumina.

Source: JORC reserve statement, 2015 [S18]; metallurgical testwork, 2014 [S19]; worldsteel threshold [S16]; typical traded DR grade [S17].

The figure makes the central point plainly. Mbalam's direct-shipping ore, the material that the current mining plan will export first, is a good blast-furnace and sinter feed, but it is not DR grade: its iron content is below even worldsteel's minimum and its gangue is three to four times that of DR pellets. The DR-grade product exists only at testwork scale, from a different ore type that requires a concentrator.

The current state of Cameroon's other projects points the same way. Cameroon Mining Company reported in December 2025 that its processing plant would have a capacity of 3.6 Mt a year, rising to 10 Mt by 2027, with first exports then expected in early 2026 [S36, S79]; in May 2026 Cameroon Tribune reported that uncertainties could push the start to 2027 [S80]. The Kribi-Lobé magnetite project plans a concentrate above 60% iron, and its exports have been postponed to July 2027 [S81]. Neither plan, as published, includes DR-grade concentrate or a pellet plant.

Table 4.1 Cameroonian iron-ore products against direct-reduction requirements

Product	Iron, %	Silica + alumina, %	Status	DR grade?
Typical traded DR pellet	67 to 68	Low	Commercial	Benchmark [S17]
worldsteel minimum for DR processes	64	Not stated	Policy statement	Threshold [S16]
Mbalam direct-shipping ore (JORC probable reserve, 2015)	62.2	7.26	Mining start expected 2026 to 2027	No: blast-furnace and sinter grade [S18, S80]
Mbalam itabirite, blast-furnace concentrate (testwork, 2014)	66.6	3.8	Testwork only	Marginal: gangue too high [S19]
Mbalam itabirite, DR concentrate (testwork, 2014)	68.0	2.0	Testwork only; no concentrator or pellet plant planned	Yes, on specification [S19]
Kribi-Lobé magnetite concentrate (planned)	Above 60	Not published	Exports postponed to July 2027	Not as planned [S81]

Source: as cited; Cameroon Steel assessment in the last column.

THE ORE EXISTS; THE DR-GRADE PRODUCT DOES NOT YET

Cameroon has large iron resources, and testwork shows that Mbalam itabirite can be upgraded to a 68% iron DR concentrate. No concentrator or pellet plant to make that product is yet planned. Until one is built and proven, the Kribi melt shop should be designed to run on scrap and imported DRI or HBI, with a reserved site for a direct-reduction module.

4.4 From ore to pellet: three plants before the steelworks

Turning itabirite into DRI takes three industrial steps before the shaft furnace (Figure 4.3).

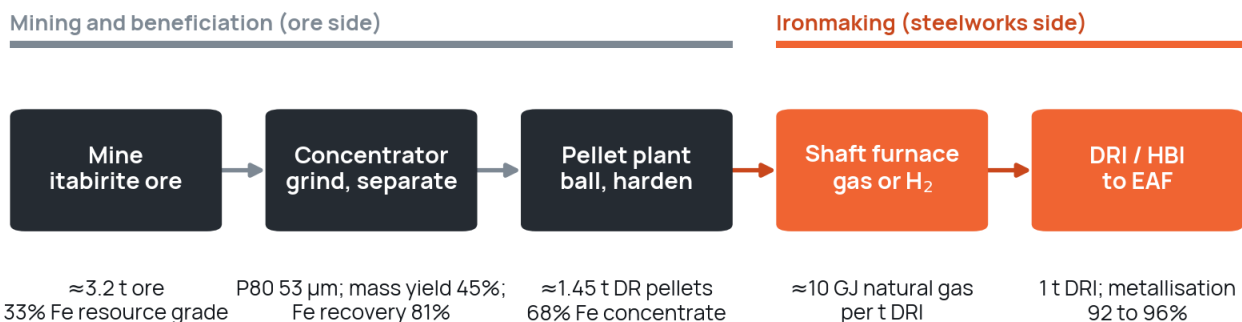
Mining and crushing. Itabirite at about 33% iron is mined, crushed and milled. Because so much of the rock is silica, large tonnages must be moved: at the testwork's 45% mass yield, about 2.2 t of ore are needed for each tonne of concentrate (derived) [S19].

Concentration. The milled ore, ground to a P80 of 53 μm in the Mbalam testwork, is separated into an iron-rich concentrate and a silica-rich tailing [S19]. Fine grinding consumes a great deal of electricity and the tailings require engineered storage. These costs are borne by the mining side of the chain and must be agreed between the mine and the steelworks.

Pelletising. Fine concentrate cannot be charged to a shaft furnace as powder. It is mixed with a binder, rolled into green balls about the size of a marble and hardened by firing (induration) into pellets strong enough to survive the shaft. A DR plant consumes roughly 1.45 t of pellets per tonne of DRI, as implied by the BloombergNEF pellet and DRI figures cited by IEEFA (derived) [S17].

Turning Cameroonian itabirite into DRI takes three plants before the steelworks

Indicative mass flow per tonne of DRI; based on published Mbalam testwork and industry ratios



Derived: ore per t DRI = pellets per t DRI $\div$ mass yield; binder, moisture and pellet-plant losses ignored. Pellets per t DRI ≈ 1.45 implied by BNEF figures cited by IEEFA (2026). Testwork values: Mbalam itabirite, 2014. Gas: ENERGIRON reference, about 10 GJ per t DRI.

DERIVED Figure 4.3. From itabirite to DRI: indicative mass flow per tonne of DRI.

Source: Cameroon Steel, from Mbalam testwork [S19], pellet ratio implied by [S17], gas consumption [S20] and DRI metallisation [S14]. Binder, moisture and pellet-plant losses ignored; Annex A.

At the scale of the RC-1 reserve, about 1 Mt of DRI a year [S03], the chain would need roughly 1.45 Mt of DR pellets and, from itabirite, of the order of 3.2 Mt of ore a year (derived). Those quantities are small next to the export volumes planned for Mbalam, which is why the 15% local-transformation clause in Cameroon Mining

Company's convention [S36] could in principle cover them several times over. The difficulty is not volume; it is the investment and the technical proof needed for a concentrator and a pellet plant producing DR-grade product.

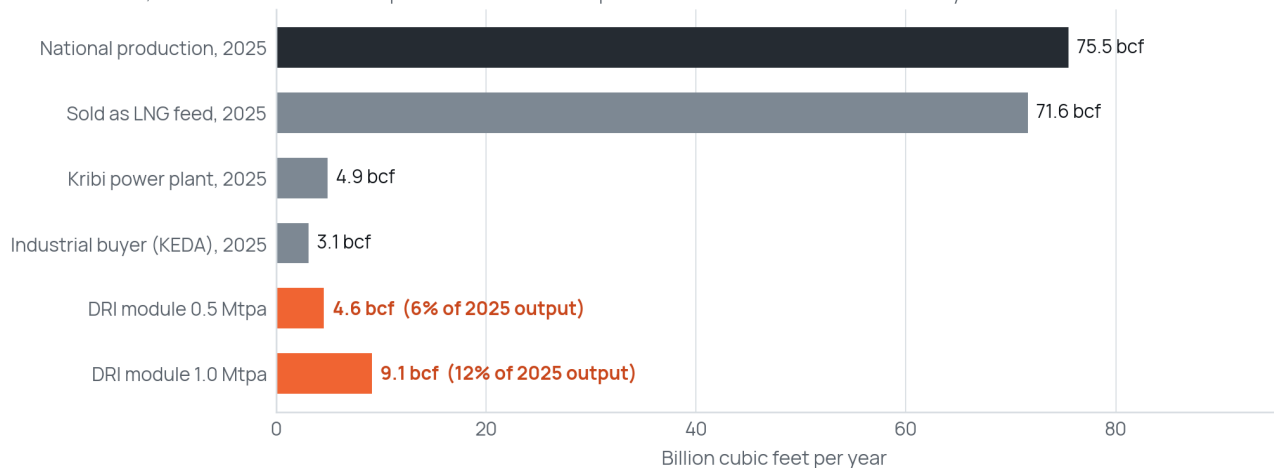
4.5 Gas is the second precondition

A gas-based DR plant consumes about 10 GJ of natural gas per tonne of DRI on the ENERGIRON reference [S20]; the best sustained performance reported, at Suez Steel in Egypt, is about 9.2 GJ [S48]. At 10 GJ per tonne, a 1 Mtpa module would use about 10 PJ of gas a year, or about 9.1 bcf; a 0.5 Mt module about 4.6 bcf (derived; conversion in Annex A).

Cameroon produced 75.5 bcf of natural gas in 2025, almost all of it from the Sanaga Sud field off Kribi; about 95% was sold as feed to a floating liquefaction vessel, 4.9 bcf went to the Kribi power plant at about 1,810 to 1,858 FCFA per thousand cubic feet and 3.1 bcf to an industrial buyer at 3,135 FCFA [S21]. The liquefaction vessel left Cameroon in July 2026 at the end of its charter [S82]; White paper 05 (Chapters 6 and 7) analyses what its departure means for gas supply to industry. At first sight this leaves gas available near Kribi. But remaining certified reserves of the producing field are not public, and the main undeveloped resource, the cross-border Yoyo-Yolanda discovery of about 2.5 trillion cubic feet, would need about US\$4 billion of development and had no final investment decision in July 2026 [S35].

A 1 Mtpa DRI module would need about 9 bcf of gas a year, 12% of Cameroon's 2025 output

SNH 2025 sales; DRI demand at about 10 GJ per t DRI. Most 2025 output fed an LNG vessel that left Kribi in July 2026



DERIVED Figure 4.4. Gas demand of a DRI module compared with Cameroon's 2025 gas production and its main uses.

Source: SNH, Données pétrolières 2025 [S21]; DRI gas demand at about 10 GJ per tonne [S20]; departure of the FLNG vessel [S82]. Annex A gives the conversion.

At the 2025 prices paid by SNH's industrial buyer and by the power plant, gas would cost about US\$27 to 51 per tonne of DRI (derived in White paper 05, Chapter 7, for 9.2 to 10 GJ per tonne at SNH's quarterly exchange rates; at 10 GJ and a planning rate of 600 FCFA per US dollar, roughly 17,000 to 29,000 FCFA, or US\$28 to 48, Annex A) [S03, S21]. That is competitive internationally, but only if it can be contracted for the life of the plant. A DR module therefore requires an audited reserve, a long-term gas sales agreement and clarity on gas taxation before a final investment decision.

4.6 Hydrogen-ready shaft furnaces keep the decarbonisation option open

The direct-reduction route is the only ore-based route whose emissions can be cut progressively without rebuilding the plant. Midrex designs its MIDREX Flex plants to run on any mix from 100% natural gas to 100% hydrogen; hydrogen is added downstream of the reformer for most of the range, and the shaft furnace itself needs no fundamental changes, with existing refractory suitable for hydrogen operation [S22]. In June 2025 a Malaysian developer selected the technology for a 2.0 Mtpa HBI plant due to start in 2029, planning to begin on a gas and hydrogen blend [S83]. ENERGIRON reports CO₂ reductions of about 86% against the blast-furnace route when running on 100% hydrogen [S20]. In Germany, the Power4Steel project at Saarstahl and Dillinger expects emissions to fall from 1.921 t CO₂e per tonne on the blast-furnace route to 1.098 t with gas-based DRI-EAF and 0.339 t with green hydrogen and green power [S84].

The limit is hydrogen supply. Reducing one tonne of DRI with hydrogen alone needs about 54 kg of hydrogen [S85]. At an electrolyser consumption of about 50 MWh per tonne of hydrogen (an assumption within published ranges; Annex A), a 1 Mtpa module running on 100% hydrogen would need about 2.7 TWh of electricity a year, about a third of Cameroon's total generation of 8.12 TWh in 2025 [S51] (derived). That is not a near-term option. Cameroon's hydropower potential is large, about 115 TWh a year with about 4% developed according to the US International Trade Administration [S86], and Africa's first renewables-powered green-iron plant opened in Namibia in April 2025 [S87]. A sensible path is to specify a hydrogen-ready shaft furnace, start on natural gas, and blend hydrogen as low-carbon electricity becomes available.

4.7 What Africa's existing DR plants teach

Africa is not new to direct reduction. On worldsteel figures, the continent produced 16.3 Mt of DRI in 2025, led by Egypt (6.6 Mt) and Algeria (about 5.0 Mt), followed by Libya (1.7 Mt) and, on worldsteel estimates, Uganda (1.5 Mt), Kenya (1.0 Mt) and Tanzania (0.2 Mt) [S41]. Midrex plant statistics, which cover the plants in its survey, rank Algeria first (6.70 Mt) ahead of Egypt (6.06 Mt) and give the Middle East and North Africa together 67.7 Mt [S04]. The two series differ in coverage and in how they estimate unreported plants, so this paper states the basis each time it quotes a national figure. The North African plants are gas-based shaft furnaces that run on imported or domestic DR pellets and feed adjacent electric melt shops, which is exactly the configuration envisaged for Kribi in its later phase.

The record also contains warnings. At the end of 2025, three large African DR plants were idle: Delta Steel at Warri in Nigeria (1.02 Mt a year, built in 1982), ArcelorMittal South Africa's Saldanha plant (0.80 Mt) and ESISCO in Egypt (1.76 Mt) [S04]. A shaft furnace is a continuous process that needs a steady supply of pellets and gas, a melt shop or export market that takes its output every day, and the skills to keep it running. Where any of these fail, the plant stops, and restarting an idle module is costly. The lesson for Cameroon is not to avoid direct reduction but to build it only when its supply chain, its gas contract and its downstream melt shop are already secure, which is the logic of the gate described in Chapter 10.

4.8 Sizing the direct-reduction module

Direct-reduction modules have grown steadily: the first MIDREX MEGAMOD module, of 1.0 Mt a year, was built for JSW at Dolvi in India, and the largest single module, of 2.5 Mt a year, started at Tosyali Algérie in 2018 [S88]. Modules are now offered from 0.25 Mt a year (the ENERGIRON ZR micro-module at Mutún, Bolivia, commissioned in October 2025) to 2.5 Mt a year in a single shaft, with African modules between 0.65 and 2.5 Mt [S04]. RC-1 keeps a reserve for a module of about 1 Mt of DRI a year, within a range of 0.8 to 1.1 Mt, sized to the melt shop's iron-unit needs at 1 Mtpa and subject to ore quality and gas supply [S03]. A smaller first module, of about 0.5 Mt,

would halve the gas requirement and could be justified if the pellet supply or the gas contract is initially limited. Either way, the module would be placed next to the melt shop so that hot DRI can be charged directly to the furnace, which saves electricity and avoids the re-oxidation risk of storing cold DRI.

4.9 What must be true before Kribi makes its own iron

Four conditions, tested at the gate described in Chapter 10, determine when the direct-reduction module can proceed:

1. **DR-grade concentrate proven at pilot scale.** A Cameroonian concentrate of at least 67% iron with low silica and alumina, produced continuously in a pilot plant from a defined ore body, with pellets tested for strength and reducibility.
2. **A pellet supply.** A pellet plant at the mine, at Kribi or with a third party, contracted for the life of the DR module; or a bridging contract for imported DR pellets.
3. **Gas for the life of the plant.** An independently audited reserve and a long-term gas sales agreement for about 4.6 to 9.1 bcf a year, depending on module size, with agreed pricing and taxation.
4. **A hydrogen-ready design and a carbon plan.** A shaft furnace specified for progressive hydrogen use, and a measurement, reporting and verification system for CO₂ from the first day of operation.

None of these conditions is unusual; each is standard for any DR project worldwide. Taken together, they explain why domestic DRI is the right long-term direction for Cameroon Steel and why it should not be a condition for starting.



**THE FURNACE MELTS IN MINUTES WHAT THE GRID
MUST CARRY FOR YEARS: DESIGN THE ARC, THE
COMPENSATOR AND THE LINE TOGETHER.**

Illustrative view. Generated image of a molten steel surface; not a photograph of any project, place or person.

CHAPTER 5

THE EAF MELT SHOP: ONE FURNACE OF THE 40 T CLASS CAN CARRY MOST OF PHASE 1 IF THE POWER SYSTEM IS DESIGNED WITH IT

A single electric arc furnace of the 40 t class, with a ladle furnace and a billet caster, can carry most of Phase 1, but the full nameplate of 0.3 Mtpa needs high availability or a larger transformer. At the RC-1 planning value of 450 kWh per tonne of liquid steel, a heat of about 40 t takes about 55 minutes tap to tap; at about 490 kWh per tonne, the upper planning value with 30% DRI or HBI in the charge, about 59 minutes. Nameplate output, about 8,000 heats a year, then occupies about 7,300 to 7,900 of the 8,760 hours in a year, and at a realistic 7,000 to 7,700 operating hours the shop delivers about 270,000 to 300,000 t of finished products (all derived from the RC-1 planning basis) [S03]. The melt shop's hardest design problem is not metallurgical but electrical. An arc furnace draws a large, rapidly fluctuating load that causes voltage flicker and harmonics, and Cameroon's grid already leaves 150 MW of industrial demand unmet [S89]. The furnace, its compensator (an SVC or, preferably, a STATCOM) and the 225 kV connection must be specified as one system from the start.

5.1 A melt shop is a power system and a material line

Figure 5.1 shows the melt shop as two coupled chains. The material line runs from the scrap yard and the DRI or HBI silos through charging, the electric arc furnace, the ladle, the ladle furnace and the billet caster to the rolling mill. The power chain runs from the 225 kV supply through the plant substation and the compensator to the furnace and ladle-furnace transformers, the mills and the utilities. By-product streams leave the furnace as slag, fume and dust.

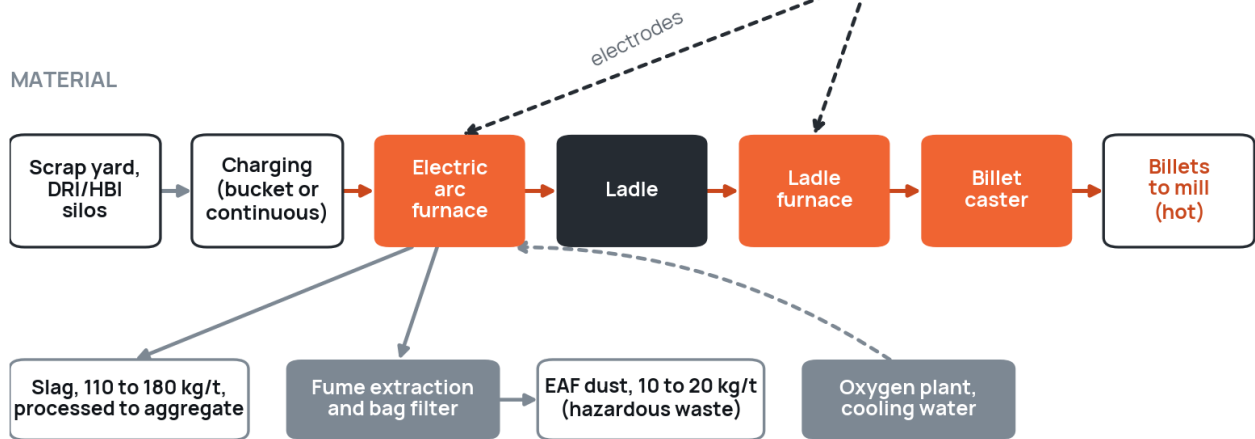
The melt shop: a power system and a material line that must be designed together

Indicative arrangement for a single-furnace Phase 1 melt shop; not a layout drawing

POWER



MATERIAL



Benchmarks: IFC EHS Guidelines for steel mills. The compensator sits on the medium-voltage bus that feeds the furnace transformer so that it can cancel the furnace's fast reactive-power swings before they reach the grid.

ILLUSTRATIVE Figure 5.1. The melt shop as a power system and a material line, with its by-product streams.

Source: Cameroon Steel. The slag range is the IFC benchmark for the solid residue of an electric arc furnace, which is mostly slag [S44]; the dust range is a planning range (the European reference document reports 10 to 30 kg) [S42].

RC-1, Cameroon Steel's reference configuration, defines Phase 1 as one electric arc furnace of the 40 t class, a ladle furnace, a billet caster, an induction billet heater, a rebar mill and a high-speed wire-rod mill, with a nameplate capacity of about 300,000 t a year of finished products, or about 320,000 t of liquid steel, and an expected sustained output of 270,000 to 300,000 t of finished products [S03]. These are planning values; the supplier's front-end engineering will set the equipment ratings.

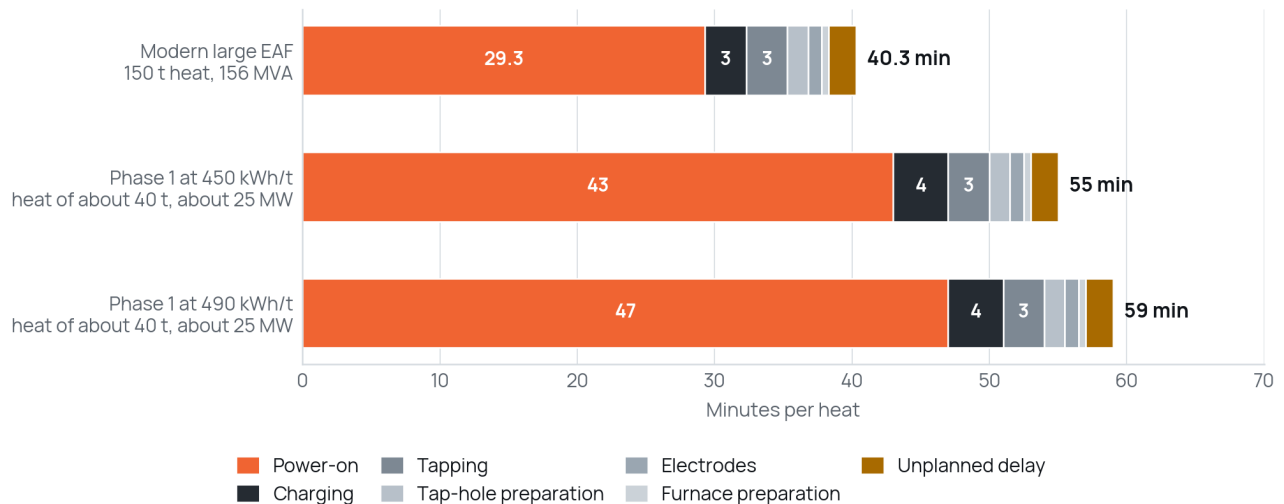
5.2 Sizing the furnace from the tonnage

Furnace sizing starts from the tonnage the caster and mills need and works backwards. At nameplate, Phase 1 needs about 320,000 t of liquid steel a year [S03]. With heats of about 40 t, that is about 8,000 heats a year. The time per heat depends on how much energy each heat needs and how fast the transformer can deliver it. RC-1 plans on 450 kWh per tonne, a planning value within the IFC range of 347 to 500 kWh [S03, S44]. Read as an all-scrap figure, that value rises by about 14.5 kWh per tonne for each 10% of DRI in the charge [S20], which gives about 490 kWh per tonne with the planned 30% DRI or HBI. This paper therefore uses 450 kWh per tonne as the planning value and about 490 kWh as the upper planning value (Table 5.1).

A heat of about 40 t needs about 18 MWh at 450 kWh per tonne and about 19.6 MWh at 490 kWh. A furnace transformer in the 30 to 33 MVA class, operated at an average power factor of about 0.8, delivers about 25 MW of active power, so the power-on time is about 43 minutes in the first case and about 47 minutes in the second. Adding charging, tapping, tap-hole preparation, electrode handling, furnace preparation and an allowance for delays, about 12 minutes in all, gives a tap-to-tap time of about 55 and 59 minutes. About 8,000 such heats then occupy about 7,300 or 7,900 furnace hours, out of the 8,760 hours in a year (all derived; Annex A).

A furnace of the 40 t class needs 55 to 59 minutes per heat, so nameplate takes 7,300 to 7,900 hours a year

About 8,000 heats at nameplate; 7,000 to 7,700 operating hours give about 270 to 300 kt of products;
top bar: a published 150 t design



DERIVED Figure 5.2. Tap-to-tap time balance: the indicative Phase 1 furnace at 450 and 490 kWh per tonne against a published large modern EAF design.

Source: indicative Phase 1 derived from the Cameroon Steel reference configuration RC-1 (planning estimate) [S03] and IFC energy benchmarks [S44]; benchmark design published by Badische Stahl-Engineering in La Metallurgia Italiana, June 2026 [S75].

Such utilisation is demanding for a first single-furnace shop on a grid that already leaves industrial demand unmet [S89]; a realistic planning range is 7,000 to 7,700 operating hours a year. In that range the furnace casts about 305,000 to 336,000 t of liquid steel at 450 kWh per tonne and about 285,000 to 313,000 t at 490 kWh. After casting and rolling losses, and within the mill's nameplate, that gives about 270,000 to 300,000 t of finished products (derived; Annex A), which is the expected sustained output in RC-1 [S03]. One furnace can therefore carry most of Phase 1; reaching the full nameplate needs high availability, more chemical energy or a larger transformer. Delivering 320,000 t of liquid steel in 7,000 hours at 490 kWh per tonne would need a transformer of about 36 to 40 MVA (derived). The choice belongs in front-end engineering and in the supplier's capacity guarantee, which Gate 1 requires (Chapter 10).

Either way, the utilisation explains two design priorities. First, power-on time dominates the cycle, so anything that shortens it (chemical energy from oxygen and carbon injection, burners, a well-foamed slag, scrap preheating or continuous charging) raises capacity directly. Second, the furnace has little spare time for unplanned stops, so maintenance planning, refractory practice and spare parts for transformers, electrodes and water-cooled panels are as important as nominal ratings.

The comparison in Figure 5.2 is instructive. A large modern furnace published in June 2026 combines a 150 t heat with a 156 MVA transformer, about 1.04 MVA per tonne, and achieves a net tap-to-tap time of 40.3 minutes with 29.3 minutes of power-on and a productivity of 224 t of liquid steel per hour [S75]. The Phase 1 furnace has a lower specific power, which lengthens the heat but also limits the disturbance it imposes on the grid. A US rebar mill in Charlotte, North Carolina, operates a 30 to 33 MVA furnace of the same transformer class, alongside an 18 MVA ladle furnace, on a 100 kV supply [S23].

Continuous charging is one proven way to raise output and lower energy use within the same transformer. The European Commission's innovation centre reports that the Consteel process, which preheats scrap on a conveyor using furnace off-gas and feeds it continuously into a flat bath, reached 321 kWh per tonne at Pomina in Vietnam, cut electricity use by 10 to 15% and electrode use to below 1 kg per tonne [S90]. DRI and HBI are suited to continuous feeding through the roof, which stabilises the arc.

Table 5.1 Indicative Phase 1 melt-shop parameters (planning values, to be confirmed in front-end engineering)

Parameter	Indicative value	Status	Basis
Finished products	Nameplate about 300,000 t/yr; expected sustained 270,000 to 300,000 t/yr	Planned; derived	RC-1 [S03]; Annex A
Liquid steel	About 320,000 t/yr at nameplate	Planned	RC-1 [S03]
Electric arc furnace	One furnace of the 40 t class	Indicative	RC-1 [S03]
Furnace transformer	30 to 33 MVA class (about 25 MW active power)	Assumed	Annex A; class as in [S23]
Ladle furnace	One, matched to the furnace's heats	Indicative	RC-1 [S03]
Heats per year; tap-to-tap	About 8,000 at nameplate; about 55 minutes (450 kWh/t) to 59 minutes (490 kWh/t)	Derived	Annex A
Furnace hours for about 8,000 heats	About 7,300 to 7,900, out of 8,760 in a year	Derived	Annex A
Operating hours for planning	7,000 to 7,700 a year, giving 270,000 to 300,000 t/yr of finished products	Assumed; derived	Annex A
EAF electricity	450 kWh/t liquid, planning value (IFC range 347 to 500); about 490 kWh/t, upper planning value with 30% DRI/HBI	Sourced; derived	[S03, S20, S44]
Electrodes	2 to 6 kg/t (EU melt-shop range)	Benchmark	[S42]
Oxygen	35 Nm ³ /t liquid (25 to 45)	Assumed	RC-1 [S03]
Metallic yield	0.88 t liquid per t charged (0.85 to 0.91)	Assumed	RC-1 [S03]
Solid residue, mostly slag	110 to 180 kg/t of product	Benchmark	IFC [S44]
EAF dust (managed as hazardous waste)	10 to 20 kg/t liquid, a planning range (the European reference document reports 10 to 30)	Assumed	RC-1 [S03]; [S42]
Phase 1 maximum electrical demand	About 55 MVA (45 to 65)	Assumed	RC-1 [S03]

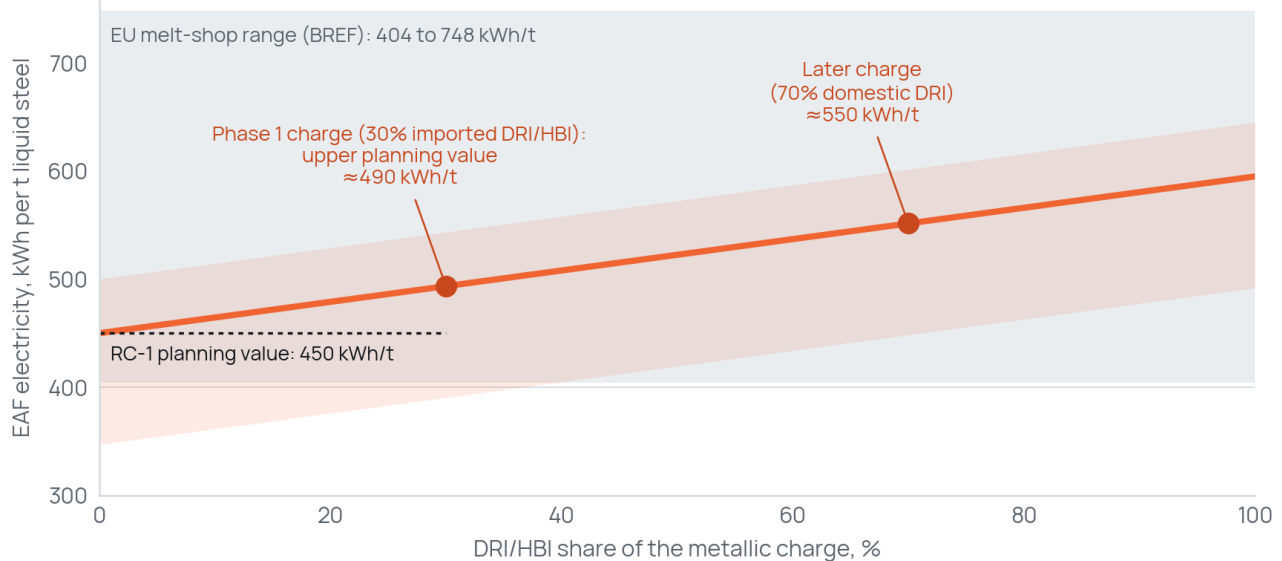
Source: Cameroon Steel reference configuration RC-1 (planning estimate) [S03] and benchmarks as cited.

5.3 Energy and consumables depend on the charge

Electricity is the largest single input of the melt shop after iron units. EU melt shops use 404 to 748 kWh per tonne of liquid steel [S42]; the IFC benchmark is 347 to 500 kWh [S44]. The spread reflects furnace design, charge and practice. The share of DRI or HBI in the charge is one of the main drivers: the ENERGIRON reference indicates that each additional 10% of DRI raises EAF electricity by about 14.5 kWh per tonne, because the furnace must melt the gangue and finish reducing the residual iron oxide [S20]. Read against an all-scrap base of 450 kWh, a 30% DRI charge, the Phase 1 planning assumption, needs about 490 kWh per tonne, the upper planning value used in this paper, and a 70% domestic-DRI charge about 550 kWh (derived) (Figure 5.3).

Each 10 points of DRI in the charge adds about 15 kWh per tonne of steel

Line: 450 kWh/t read as all-scrap (band 347 to 500, IFC) plus 14.5 kWh/t per 10% DRI (ENERGIRON reference)



DERIVED Figure 5.3. EAF electricity as a function of the DRI/HBI share of the charge.

Source: Cameroon Steel, from the IFC range [S44], the ENERGIRON DRI penalty [S20] and the EU BREF range [S42]; Annex A.

Hot DRI changes the arithmetic. When a direct-reduction module sits next to the melt shop, DRI can be charged hot instead of cold, which recovers part of the energy spent in the shaft furnace and avoids the re-oxidation risk of storage. That is one reason for reserving the DR module's site next to the melt shop rather than at the mine.

Graphite electrodes, refractories, lime and alloys complete the list of consumables. EU melt shops use 2 to 6 kg of electrodes per tonne [S42]; continuous-charging practice can bring that below 1 kg [S90]. Most of these consumables will be imported in Phase 1, and the supply chain for them belongs in the same procurement strategy as iron units (Chapter 3).

5.4 The ladle furnace and the caster set the rhythm of the shop

The ladle furnace decouples refining from melting. While the next heat melts in the EAF, the previous one is heated, alloyed, desulphurised and cleaned in the ladle. A ladle furnace typically raises temperature by about 4 °C per minute [S46], so a ladle furnace matched to heats of about 40 t has ample margin to hold steel at casting temperature and absorb small delays between the furnace and the caster. For rebar grades the ladle furnace adjusts manganese and silicon and, where needed, microalloying additions; for wire rod destined for drawing, it controls sulphur, oxygen and inclusions, which determine how well the rod draws into fine wire.

The billet caster must match the furnace's output and run in long sequences, casting heat after heat without stopping, because each restart costs yield and time. Billet section is chosen with the mill: 150 mm square billets suit a 300,000 t/yr bar and rod mill, as in the mill ordered in Tanzania in September 2026 [S47]. Caster speed and strand count are then set so that the caster can absorb a heat in less than the furnace's tap-to-tap time. Cast steel leaves a continuous caster at about 1,200 to 1,250 °C [S50], so billets sent straight to the mill keep much of that heat, which is the energy logic of Chapter 6.

5.5 Power quality: flicker, harmonics and reactive power

An arc furnace is one of the most disturbing loads a power system can carry. During melting, the arcs move, extinguish and restrike as scrap collapses, so the furnace's reactive power swings within fractions of a second. Those swings cause voltage fluctuations that people perceive as flicker in lighting, and the arcs inject harmonic

currents. Utilities set limits on both at the point where the plant connects. In the Serbian case described below, the limits at the grid owner's substation were a short-term flicker severity (Pst, 95th percentile) below 1.0 and a long-term severity (Plt) below 0.75, with voltage unbalance below 1% and total harmonic distortion below 3% [S24].

The size of the disturbance depends on the ratio between the furnace's power and the strength (short-circuit power) of the grid at the connection point. A strong grid absorbs the swings; a weak one transmits them to neighbouring consumers. Two published cases show what happens when the grid is not strong enough.

At Metalfer, a 400,000 t/yr scrap-based EAF mini-mill in Serbia that is the country's only rebar producer, the furnace generated flicker that the existing conventional static var compensator (SVC) could not reduce enough; the transmission operator ordered the plant to solve the problem or have its power cut. A modular multilevel STATCOM rated from minus 49 to plus 121 Mvar at 20 kV, commissioned in March 2023, achieved a flicker reduction factor above 5 despite a relatively low short-circuit level [S24]. At Gerdau's mill in Charlotte, USA, with a 30 to 33 MVA furnace, stricter flicker requirements followed the development of homes and businesses around the plant; the existing SVC was no longer sufficient, and an SVC Light (a STATCOM) of 0 to 64 Mvar was specified for a flicker reduction factor above 5; the supplier also expects productivity gains [S23].

Table 5.2 Power-quality limits and results at a 400 kt/yr EAF rebar mill after STATCOM compensation

Indicator	Limit applied	Measured with STATCOM	Measured at
Power factor of the EAF load	0.98 or higher	0.999	Customer substation
Short-term flicker, Pst (95%)	Below 1.0	0.653	Grid owner's substation
Long-term flicker, Plt (95%)	Below 0.75	0.569	Grid owner's substation
Voltage unbalance (95%)	Below 1%	0.25%	Customer substation
Voltage total harmonic distortion (95%)	Below 3%	Below 0.7%	Customer substation

Source: GE Vernova Power Conversion, case study of the Metalfer steel mill, Serbia, revised February 2024 [S24].

Both cases point to the same design rule for Kribi: assume that a fast compensator will be needed, specify it with the furnace, and verify it with a flicker study based on the actual short-circuit level at the plant's connection point.

That connection point is still being built. Cameroon had 2,033 MW of installed capacity against a peak demand of 1,278 MW in 2025, but about 90% of its electricity came from hydropower [S51], and in October 2026 delays to the Nachtigal evacuation line left 150 MW of industrial demand unmet, with the 400 kV line then due in November 2026 [S89]. The Port Autonome de Kribi is building a 225 kV double-circuit line from the Kribi gas power plant to the port with a 225/30 kV substation, designed to deliver 100 MW at first and 330 to 400 MW at a later stage [S25, S34]. RC-1 estimates Phase 1 maximum demand at about 55 MVA [S03], which fits within the initial stage. Electricity is already a major cost for Cameroon's steel industry: the largest consumer among Douala's steel mills paid 8.37 billion FCFA for electricity in 2024 [S91]. A domestic precedent for a high-voltage solution exists: a Douala steel producer moved to a high-voltage connection with a dedicated 50 MVA transformer [S51]. White paper 05 (Chapters 2 and 3) analyses the power system and large-user supply in detail.

SPECIFY THE COMPENSATOR WITH THE FURNACE

For the Phase 1 furnace, the base case should be a STATCOM-type compensator with harmonic filters on the medium-voltage bus, sized after a flicker study at the actual 225 kV connection point. Treating power quality as an afterthought has led other rebar mills to retrofit compensators under regulatory pressure.

5.6 The electricity contract shapes how the furnace runs

How electricity is priced affects how a melt shop is operated, not only what it costs. Cameroon has no published regulated tariff above 10 MW: the country's six high-voltage customers are supplied under bilateral contracts, and their average realised price in 2025 was about 18.4 FCFA per kWh, a legacy level (derived from the regulator's report) [S51]. The highest published medium-voltage band, for loads of 9 to 10 MW, combines a monthly capacity charge per kW with a low energy charge, so that a customer who uses its contracted capacity for many hours pays less per kWh [S92]. The regulator's cost-reflective average for 2025 was 105.46 FCFA per kWh, against 83.46 FCFA actually collected from medium and low-voltage customers [S93].

A large new contract is therefore likely to be negotiated, and its structure matters to the furnace. A capacity charge rewards a high, steady load factor, which a single furnace running about 7,300 to 7,900 hours a year provides. The same utilisation defines the flexibility the furnace can offer the grid. It offers schedulable load: within a day, the energy-management system described in Chapter 8 can shift power-on periods by minutes to hours, delay a heat or hold steel in the ladle furnace so that melting avoids the grid's evening peak, which time-of-use pricing, if introduced, would reward. It does not offer interruptible load in any sustained sense. Phase 1's tonnage already needs most of the hours in a year, so each hour of curtailment costs roughly one heat, about 40 t of liquid steel, that cannot be recovered later. Contract clauses should therefore reward scheduling around peaks rather than curtailment, and limit any emergency load-shedding to rare events that allow the heat in progress to be finished safely. These terms should be agreed alongside the connection agreement before Gate 1.

5.7 Safety and environment are designed in, not added

The melt shop's main safety hazards are molten metal, water (which explodes on contact with liquid steel), oxygen and fuel gases, heavy lifting and high-voltage equipment. Fires and explosions are a recognised melt-shop hazard. International practice addresses these hazards through layout (separating water circuits from tapping and casting areas), water-leak detection in cooled panels, interlocks on oxygen lances, and training. The IFC's EHS Guidelines for steel mills set the baseline expected by development lenders [S44].

On the environmental side, the furnace's fume is captured by a direct off-gas system and a canopy hood and cleaned in a bag filter. EU best available techniques set a dust emission level below 5 mg/Nm³ for EAF fume treatment [S94]. The collected EAF dust, 10 to 20 kg per tonne of liquid steel (a planning range; the European reference document reports 10 to 30 kg) [S42], carries zinc, lead and cadmium from the scrap [S44] and has to be managed as hazardous waste: it must be stored securely and either treated or exported for zinc recovery. The furnace's solid residue, mostly slag, amounts to 110 to 180 kg per tonne of product [S44]; the slag can be processed into aggregate for roads and concrete when its stability is verified. Water circulates in closed cooling loops: RC-1 assumes make-up of 1.5 to 3.0 m³ per tonne of product [S03], against a 2024 sector-average water consumption of 2.3 m³ per tonne reported by worldsteel [S01].

5.8 What the melt shop design means for decision-makers

Three conclusions follow. First, a single furnace of the RC-1 size can carry most of Phase 1, with an expected sustained output of 270,000 to 300,000 t of finished products; the full nameplate needs high availability or a larger transformer. That puts a premium on reliability, maintenance and supply of consumables, and makes the transformer rating a front-end engineering decision rather than a given. Second, the electrical design is a joint task of the steelworks, the transmission operator and the zone's power infrastructure, and it must start before the furnace is ordered. Third, choices made now (continuous-charging capability, a compensator sized for future growth, space for a second furnace transformer and a direct-reduction module next to the shop) keep the later phases open at little extra cost.

CHAPTER 6

ROLLING LONG PRODUCTS: HOT BILLETS AND INDUCTION HEATING MAKE PHASE 1 AN ALL-ELECTRIC LINE

The rolling mills decide what Cameroon Steel sells, and much of the energy it uses outside the melt shop. Phase 1 plans a bar and wire-rod mill for rebar of 8 to 32 mm and wire rod of 5.5 to 12 mm, heated by induction from billets that arrive hot from the caster [S03]. Later phases add a light and medium section mill for angles, channels and flats, then a heavy-section mill for H-beams, both with gas-fired reheating furnaces [S03]. Charging billets hot saves about 0.55 GJ per tonne at 700 °C compared with a cold charge [S50], and one Italian mill cut reheating fuel by 40% after converting to hot charging [S95]. On Cameroon's 2024 grid, induction heating emits about as much CO₂ per tonne as an efficient gas furnace while removing the need for gas in Phase 1 (derived).

6.1 Rolling turns billets into the products customers specify

A long-products mill receives billets (or, for large sections, blooms and beam blanks) and turns them into bars, coils and profiles by successive hot deformation. Each stand of rolls reduces the cross-section and lengthens the stock; the shape of the rolls (the "pass design") determines the final profile. Figure 6.1 shows the logic of the Phase 1 mill: a common heating and roughing train, then two finishing routes, one producing straight rebar in bundles and the other producing wire rod in coils.

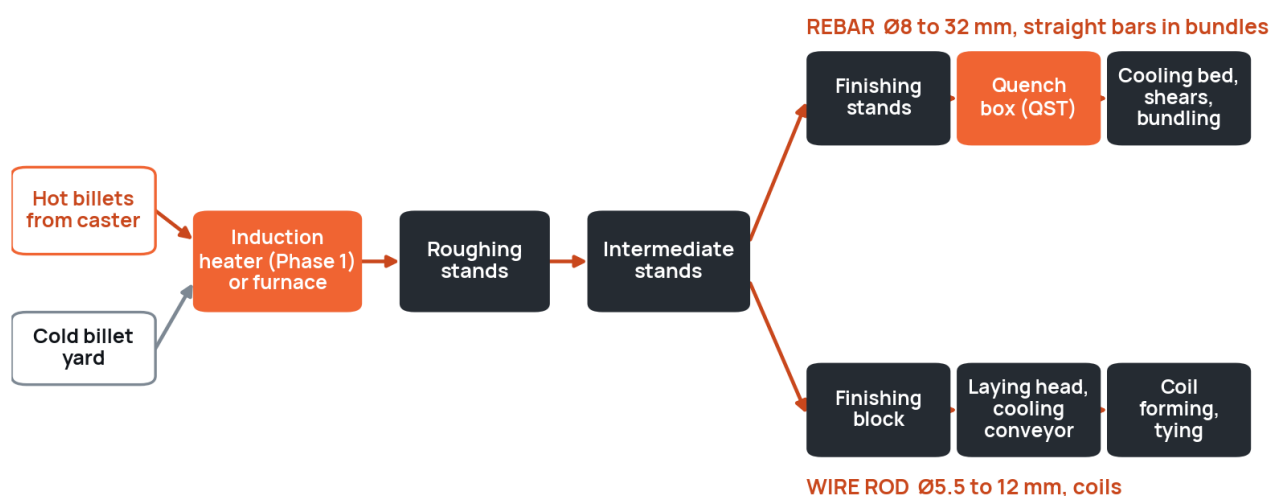
The rebar route

After the roughing and intermediate stands, the bar passes through finishing stands whose last pass rolls the ribs. Immediately after the last stand, a water box quenches the bar's surface. This quenching and self-tempering treatment, known by trade names such as TEMPCORE, gives a hard tempered-martensite rim and a ductile ferrite-pearlite core, and produces weldable high-strength bars from plain low-carbon, low-manganese steel without costly vanadium or niobium [S28]. CRM Group, which developed the process, reports more than 100 industrial installations, for bar diameters up to 75 mm [S28]. The bars then cool on a cooling bed, are cut to commercial lengths by cold shears, counted and bundled.

Smaller rebar sizes are often rolled in two or more strands at once by slitting the bar lengthwise in the finishing train, which raises mill output for the diameters where demand is largest. The 300,000 t/yr mill ordered by GSM in Tanzania in September 2026 combines 14 cartridge-type stands, a 10-pass finishing block for wire rod and in-line quenching and tempering, and makes rebar of 8 to 32 mm and wire rod of 5.5 to 6.5 mm from 150 mm billets at up to 50 t per hour [S08, S47].

One billet, two finishing routes: straight bars for rebar, coils for wire rod

Indicative bar and wire-rod mill of the Phase 1 type; section and beam mills follow the same logic with shaped rolls



Quality loop:

temperature, dimensions and quench parameters are logged per billet and per bundle or coil; tensile, bend and chemistry tests per cast lot feed the mill certificate (see Chapters 7 and 8).

Indicative. Product ranges: RC-1 Phase 1 planning basis. QST: quenching and self-tempering.

ILLUSTRATIVE Figure 6.1. Indicative layout of a bar and wire-rod mill of the Phase 1 type.

Source: Cameroon Steel; product ranges from the Cameroon Steel reference configuration RC-1 (planning estimate) [S03]; mill architecture as in the 2026 African mill orders [S08, S47].

The wire-rod route

Wire rod is rolled to small diameters in a high-speed finishing block, a compact group of stands driven together, then formed into rings by a laying head and cooled in a controlled way on a conveyor before being collected as coils. The cooling programme determines the rod's microstructure and therefore how easily it can be drawn into wire, mesh, nails and binding wire. Rod for fine drawing needs a clean steel with low residuals, which is one reason why DRI and HBI in the melt shop's charge matter for the wire-rod product (Chapter 3).

ROLLING IS WHERE A STEELWORKS MEETS ITS CUSTOMERS: SIZE, TOLERANCE, SURFACE AND STRENGTH ARE SET IN THE LAST FEW METRES OF THE MILL.

Cameroon Steel, technology pathway

6.2 Each phase adds a mill for products the region still imports

RC-1 sequences the mills so that each phase adds products rather than more of the same [S03]. Phase 1 serves the construction market with rebar and wire rod, but its mill is not the only outlet for its steel: domestic rebar capacity already exceeds demand by more than three times [S06], so Phase 1 output is planned to be flexible between rolled products and merchant billets for the existing re-rollers, and to displace imported billets and wire rod and reach CEMAC markets rather than add rebar to a saturated market (Chapter 9). Phase 2 adds a light and medium section mill for angles, channels and flats, used in building frames, roofs, towers, transmission structures and fabrication. Phase 3 adds a heavy-section mill for H-beams and I-beams, which are used in indus-

trial buildings, bridges and port structures. Sections and fabricated structures are still largely imported in Cameroon: in 2023 the country imported US\$26.3 million of sections (HS 7216) and 25,700 t of fabricated structures (HS 7308) [S05].

Table 6.1 Rolling mills by RC-1 phase (indicative)

Phase	Mill	Products	Indicative finished capacity	Feed	Heating
Phase 1	Bar and high-speed wire-rod mill	Rebar Ø8 to 32 mm in bundles; wire rod Ø5.5 to 12 mm in coils	Nameplate about 300,000 t/yr; expected sustained 270,000 to 300,000	Billets, hot from the caster or cold from the yard	Induction billet heating, partly hot-charged
Phase 2	Light and medium section mill	Angles, channels, flats	About 200,000 t/yr (150,000 to 200,000)	Billets from a second melt line	Gas-fired walking-beam furnace
Phase 3	Heavy-section mill	H-beams, I-beams, heavy sections	About 500,000 t/yr	Blooms or beam blanks from an expanded melt shop	Gas-fired walking-beam furnace
Reserve	Downstream processing	Wire drawing, welded mesh, cut-and-bend	To be defined	Wire rod, rebar	Not applicable

Source: Cameroon Steel reference configuration RC-1 (planning estimate), edition 10 October 2026 [S03]. Capacities are planned (Phase 1) or indicative (Phases 2 and 3).

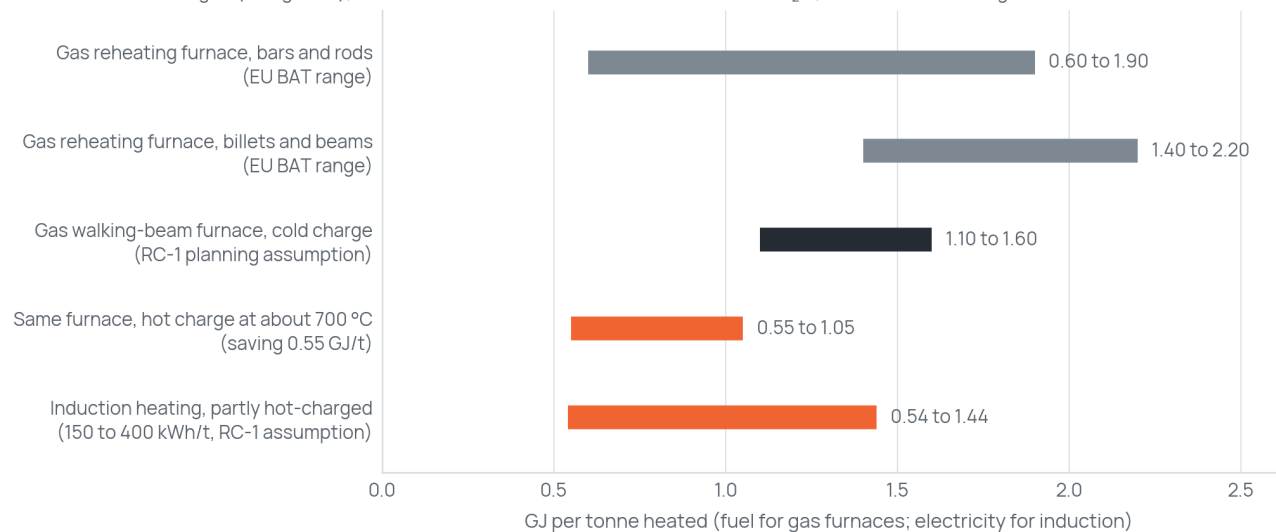
The heavy-section mill imposes requirements upstream. Wide-flange beams are rolled from larger, shaped semis, so Phase 3 requires a caster for blooms or beam blanks in addition to billets, and a melt-shop expansion. That is one reason why Phase 3 is the largest step in the pathway and comes after Phases 1 and 2 have proved the market and the operating team.

6.3 Heating is the mill's largest energy decision

Before rolling, steel must be brought back to a temperature at which it deforms easily; reheating furnaces typically discharge at about 1,250 °C [S50]. How that heat is supplied is the main energy decision in the mill. EU best available techniques associate bars and rods reheating with 0.6 to 1.9 GJ per tonne and the reheating of billets, blooms and beams with 1.4 to 2.2 GJ per tonne, while the rolling itself takes 0.1 to 0.5 GJ per tonne [S49]. RC-1 assumes a gas walking-beam furnace using 1.1 to 1.6 GJ per tonne for the later section mills [S03].

Hot charging and induction heating cut the energy spent between caster and mill

On Cameroon's 2024 grid (226 g/kWh), 300 kWh/t of induction heat emits about 0.07 t CO₂/t, similar to 1.3 GJ/t of gas



DERIVED Figure 6.2. Energy to heat billets for rolling: gas reheating ranges, hot charging and induction heating.

Source: EU BAT conclusions for ferrous metals processing [S49]; planning assumptions of the Cameroon Steel reference configuration RC-1 (planning estimate) [S03]; hot-charging saving [S50]; CO₂ comparison from the IPCC default factor for natural gas [S96] and Cameroon's 2024 grid intensity [S07].

Two techniques reduce heating energy substantially.

Hot charging. Billets that go from the caster to the furnace before they cool need much less fuel. A 2025 industry analysis estimates a saving of about 0.55 GJ per tonne for steel charged at 700 °C, a furnace productivity increase of about 28% and a CO₂ saving of about 27 kg per tonne; it also notes that gas-fired furnaces lose 0.5 to 1.0% of the steel as scale [S50]. In 2023, Acciaierie di Sicilia in Italy reported a 40% cut in fuel use on its 80 t per hour pusher furnace after Danieli installed direct hot-billet charging [S95]. Hot charging requires the caster and mill to be laid out and scheduled together, with a short transfer table and a buffer for interruptions.

Induction heating. Induction heaters warm billets electrically with coils whose power can be controlled one by one, which suits direct transfer from the caster: the billet only needs its temperature restored and equalised, not raised from cold. Danieli describes direct casting-rolling lines in which billets pass from the caster through induction heaters to the mill without any gas-fired furnace, reducing scale formation and emissions [S97]. RC-1 assumes 150 to 400 kWh per tonne for partly hot-charged induction heating in Phase 1, with a central value of 300 kWh [S03].

On Cameroon's grid, the carbon comparison is close. At the 2024 average intensity of about 226 g CO₂/kWh [S07], 300 kWh of induction heating emits about 0.068 t of CO₂ per tonne, while 1.3 GJ of natural gas in a reheating furnace emits about 0.073 t at the IPCC default factor of 56.1 t CO₂ per TJ [S96] (both derived). The case for induction in Phase 1 is therefore less about carbon than about simplicity: it needs no gas connection, starts and stops quickly, reduces scale loss and couples naturally to a caster next door. RC-1 accordingly plans Phase 1 with no gas use at all, adding about 260,000 GJ of gas a year with the Phase 2 section mill and about 910,000 GJ at full development [S03].

AN ALL-ELECTRIC PHASE 1

With induction billet heating and hot charging, Phase 1 needs no natural gas: its melting, refining, heating and rolling all run on electricity. That removes one of the two utility preconditions (gas) from the first phase and concentrates the utility risk on the 225 kV connection, which is being built for the zone.

6.4 Yield and quality are made in the mill as much as in the melt shop

Every tonne lost between the caster and the finished bundle is a tonne of iron units, energy and labour wasted. Losses arise from scale on the billet surface, crop ends cut from each bar, cobbles (bars that jam in the mill) and out-of-tolerance product. RC-1 assumes a combined casting and rolling yield of 0.94 t of finished product per tonne of liquid steel, within a range of 0.92 to 0.96, and about 20 kg of mill scale per tonne of product, which is collected and recycled [S03]. Hot charging and induction heating both reduce scale; good pass design, guides and automation reduce cobbles and crop losses.

Quality is controlled by measurement. Modern mills measure bar dimensions continuously with laser gauges after the finishing stands, log quench water flow and temperature for every bar, and test samples from each cast lot for tensile strength, elongation and bendability before the mill certificate is issued (Chapters 7 and 8). For wire rod, the cooling-conveyor settings and coil properties are recorded coil by coil. These records are not administrative overhead: they are what allows a customer, an inspector or a court to trace a bar back to the heat it came from.



ILLUSTRATIVE Illustrative view. Generated image of a hot bar on a rolling-mill roller table; not a photograph of any project, place or person.

6.5 Wire rod feeds a downstream cluster

Wire rod is an intermediate product. It is drawn into wire for binding, nails, fencing and welded mesh, and its customers are small and medium manufacturers whose productivity depends on rod that draws without breaking. Cameroon's recorded wire-rod imports fell from 50,800 t in 2019 to 7,800 t in 2023 [S05], and the industry now reports domestic capacity for wire rod and nails well above demand [S06]. A new rod mill therefore competes on quality, consistency and the range of grades it can supply, not on volume alone. Welded mesh and cut-and-bent rebar are a natural extension: they move value added from building sites to factories, reduce waste and improve accuracy on site. RC-1 keeps a reserve for downstream processing of this kind [S03]. A Kribi rod mill would supply both its own downstream units and independent drawers in the region.

6.6 Water, scale and the mill's utilities

A rolling mill uses water to cool rolls, to descale billets with high-pressure jets and, for rebar, to quench the bar after the last stand. IFC benchmarks for rolling mills give a wide range of water use, depending on the extent of recirculation [S44]. The water picks up scale and oil and must be settled, skimmed and cooled before it is reused; the scale is recovered and can be sold or recycled to the melt shop. RC-1 assumes closed cooling loops and a make-up of 1.5 to 3.0 m³ of water per tonne of product for the whole plant [S03]. Compressed air, lubrication and hydraulic systems complete the mill's utilities; all of them are electric in Phase 1.

6.7 Commissioning and ramp-up take months, not weeks

A new mill does not reach its design output on the first day. Cold tests of each stand and drive, hot trials with the first billets, calibration of pass schedules and quench settings for each product, and the training of crews on live equipment all take time. Supplier contracts should specify a progressive ramp-up, performance tests at defined output, yield and energy levels, and the supplier's presence on site until those tests are passed. The Gate 2 criterion in Chapter 10, twelve months at or near design performance, reflects this.

6.8 Flexibility in the mill keeps the market open

A long-products mill is more flexible than its name suggests. The bar mill can shift between rebar diameters within a shift, roll plain rounds or small flats, and supply wire rod to downstream drawing. The section mills can follow demand between angles, channels and flats. The billets themselves are a saleable product: when a mill is down for maintenance or demand is weak, the melt shop can sell billets to other rolling mills that currently import them (Chapter 3).

Three design choices protect that flexibility at modest cost: a cold-billet yard and loading table beside the hot-charge line, so that the mill can run when the melt shop is down; space and foundations for downstream processing (wire drawing, welded mesh, cut-and-bend), which RC-1 reserves [S03]; and a mill automation system that stores pass schedules and quench recipes for every product, so that changes are fast and repeatable.

CHAPTER 7

PRODUCT QUALITY FOR TROPICAL CONSTRUCTION: DUCTILE, CERTIFIED REBAR MATTERS MORE THAN STRENGTH ALONE

Rebar for Central Africa has to satisfy two sets of rules: Cameroon’s mandatory national standard for reinforcing steel, NC 236 [S26, S27], and the international grades that contractors and lenders specify, chiefly BS 4449 B500B or B500C and ASTM A615 Grade 60 [S29, S30]. All of them set a minimum strength; the better ones also set minimum ductility, the ability of a bar to stretch and harden before it fails, which is what gives a concrete structure warning and resilience. An electric melt shop with a ladle furnace and an in-line quench-and-self-temper mill can make weldable bars that meet these grades from plain carbon-manganese steel [S28]. In Kribi’s humid, salt-laden coastal climate, durability depends mostly on how the bar is protected in concrete, and coated or stainless bars are a niche for the most exposed structures.

7.1 A mandatory standard governs Cameroon’s rebar market

Cameroon regulates rebar closely. The national standard for reinforcing steel, in force as NC 236/2024/06, has been mandatory since a ministerial order of 20 April 2022, and the Fe450 grade is not in its catalogue [S26, S27]. In October 2024 the national standards agency, ANOR, withdrew a producer’s compliance certificate for Fe450 bars and ordered the recall of the product, after an industry association complained [S26, S27]. In January 2026 the Prime Minister’s office rejected a request to revise the standard, at a time when the poor quality of some construction materials, rebar included, was being linked to building collapses [S26, S27]. Rebar imports have been prohibited since 2016, a position Customs confirmed in April 2023 [S69].

The regulatory message is clear and favourable to a producer that invests in quality: the market rewards bars that meet the standard and penalises those that do not. For a new producer that also intends to supply public works, international contractors and neighbouring countries, certification to NC 236 is the minimum; capability to certify to the main international grades is the design target.

Table 7.1 Rebar grades that a Central African producer must be able to meet

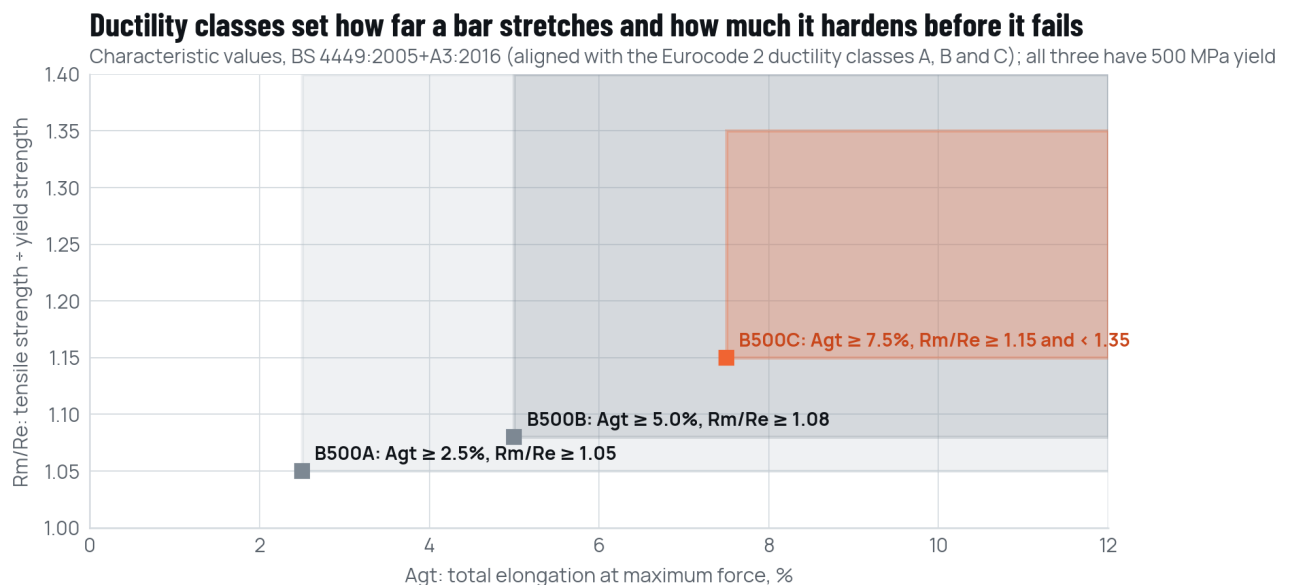
Standard and grade	Yield strength	Ductility requirements	Notes
NC 236/2024/06 (Cameroon)	Grades as listed in the standard	As set in the standard	Mandatory since 20 April 2022; Fe450 not in the standard [S26, S27]
BS 4449:2005+A3:2016, B500A	500 MPa (characteristic)	Rm/Re at least 1.05; Agt at least 2.5%	Low-ductility class [S29]
BS 4449:2005+A3:2016, B500B	500 MPa	Rm/Re at least 1.08; Agt at least 5.0%	Normal-ductility class, most widely specified [S29]

Standard and grade	Yield strength	Ductility requirements	Notes
BS 4449:2005+A3:2016, B500C	500 MPa	Rm/Re at least 1.15 and below 1.35; Agt at least 7.5%	High-ductility class [S29]
ASTM A615/A615M Grade 60 (420)	420 MPa minimum; tensile 620 MPa minimum	Elongation 7 to 9% depending on bar size; 180° bend test	Phosphorus at most 0.060% (cast) [S30]

Source: Cameroon standard as reported by Business in Cameroon and EcoMatin [S26, S27]; The Concrete Centre summary of BS 4449 [S29]; technical specification of an ASTM A615 Grade 60 TEMPCORE bar [S30]. Rm/Re: tensile to yield strength ratio; Agt: total elongation at maximum force.

7.2 Strength is necessary; ductility is decisive

Two numbers on a rebar certificate say more about a bar's behaviour than its yield strength. Agt, the total elongation at maximum force, measures how far the bar stretches before it begins to neck. Rm/Re, the ratio of tensile strength to yield strength, measures how much stronger the bar becomes after it yields. A bar with good values for both yields gradually, spreads damage along its length and gives visible warning before failure; a brittle bar can snap with little warning.



SOURCED Figure 7.1. The three ductility classes of BS 4449, aligned with the Eurocode 2 classes A, B and C.

Source: The Concrete Centre, Standards for reinforcement, summarising BS 4449:2005+A3:2016 [S29].

The three classes in Figure 7.1 share the same 500 MPa yield strength but differ in ductility: class A requires an Agt of at least 2.5%, class B 5.0% and class C 7.5%, with rising minimum ratios of tensile to yield strength [S29]. The three grades conform to the ductility classes recommended in Eurocode 2 [S29]. Class C also caps Rm/Re below 1.35 so that the bar does not become so much stronger after yielding that it overloads the surrounding concrete or connections.

For tropical construction, ductility matters for reasons beyond earthquakes. Buildings in fast-growing cities face overloading, uneven settlement on soft soils, impact and later alterations that were never designed for. Bars that can stretch before breaking give a structure the robustness to survive these, and give inspectors and occupants time to notice distress. The Cameroonian authorities' concern about building collapses [S26, S27] is, at bottom, a concern about this kind of resilience.

7.3 How the melt shop and mill deliver the properties

Rebar quality is the product of three controls that the electric route performs well.

Chemistry. The melt shop sets carbon, manganese and silicon in the ladle furnace and keeps phosphorus and sulphur low through slag practice in the arc furnace and desulphurisation in the ladle. ASTM A615 limits phosphorus to 0.060% in the cast [S30]. Induction furnaces fed with DRI struggle here: India's National Metallurgical Laboratory found phosphorus of 0.08 to 0.11% in most induction-furnace steel made from DRI, against 0.03 to 0.06% required by Indian and ASTM standards [S10]. DRI and HBI in the EAF charge also dilute copper and tin from scrap, which embrittle steel at high levels.

Thermomechanical treatment. The quench-and-self-temper process gives the bar its strength without expensive alloying (Figure 7.2). Water sprays chill the surface immediately after the last stand, forming martensite in an outer ring; heat from the still-hot core then tempers that ring; and the core transforms to ductile ferrite and pearlite on the cooling bed [S28]. The result is a bar with a strong rim and a ductile core, made from low-carbon, low-manganese steel that remains weldable [S28]. The mill in Tanzania ordered in September 2026 includes in-line quenching and tempering for this reason [S47].

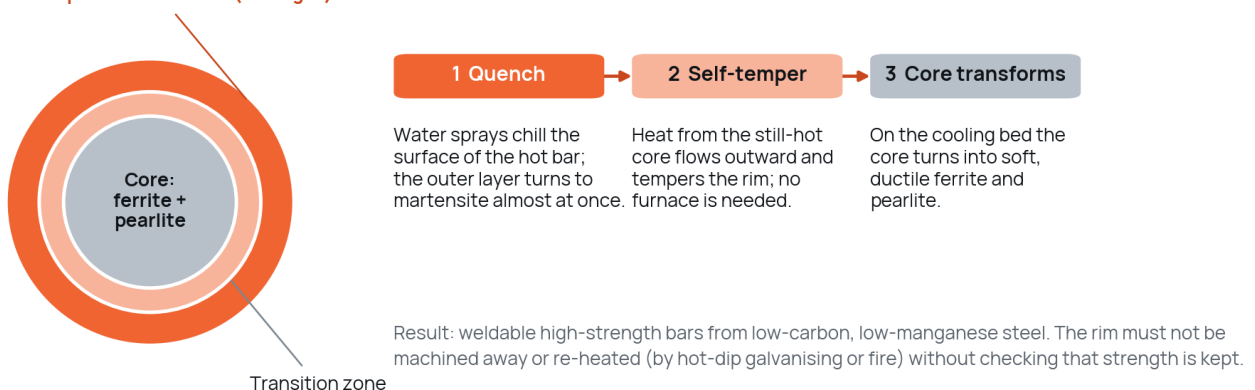


ILLUSTRATIVE Illustrative view. Generated image of a tensile test on a reinforcing bar; not a photograph of any project, place or person.

Quench and self-temper: a hard rim and a ductile core from plain carbon-manganese steel

TEMPCORE-type in-line treatment after the last rolling stand; no vanadium or niobium needed for 500 MPa grades

Rim: tempered martensite (strength)



ILLUSTRATIVE Figure 7.2. Quench and self-temper treatment: process steps and the resulting cross-section.

Source: Cameroon Steel, after CRM Group's description of the TEMPCORE process [S28].

The treatment has one practical caveat: a bar's properties depend on its heat history. Heat introduced later, for example by hot-dip galvanising at about 450 °C, can reduce the strength of steels whose properties come from thermomechanical processing [S98]. Galvanised quenched-and-tempered bars must therefore be tested after coating, and the same consideration applies to fire damage assessments.

Testing and certification. Each cast lot is sampled for chemistry and for tensile, elongation and bend tests, and the results feed a mill certificate that travels with the bundles (Chapter 8). Certification by ANOR for the national market, and by recognised third-party schemes for export markets that require them, closes the loop between the plant's records and the customer's acceptance.

A CERTIFICATE THAT A CONTRACTOR CAN TRUST, HEAT BY HEAT, IS PART OF THE PRODUCT. IN A MARKET THAT HAS SEEN BUILDING COLLAPSES, IT IS THE MOST VALUABLE PART.

Cameroon Steel, technology pathway

7.4 The mill laboratory and the testing regime

A rebar plant's laboratory is where quality becomes evidence. For every cast lot, the plant analyses chemistry with an optical emission spectrometer and tests samples of each size for yield strength, tensile strength and elongation (including Agt), bend or rebend performance, mass per metre and rib geometry, which governs the bond between bar and concrete. The results are compared with the limits of the standard to which the lot is certified, recorded against the heat and rolling-lot numbers and printed on the inspection certificate that accompanies the bundles (Chapter 8). Independent audits by the certification body check that the laboratory's equipment is calibrated and its procedures are followed.

For Phase 1 this means a laboratory specified with the mill, not after it: tensile machines with extensometers capable of measuring Agt, bend rigs for the full diameter range, a spectrometer, sample preparation and a data system linked to production. It also means trained staff and accreditation of the laboratory to recognised standards, so that the plant's certificates are trusted by contractors and lenders.

7.5 Site practice protects the product

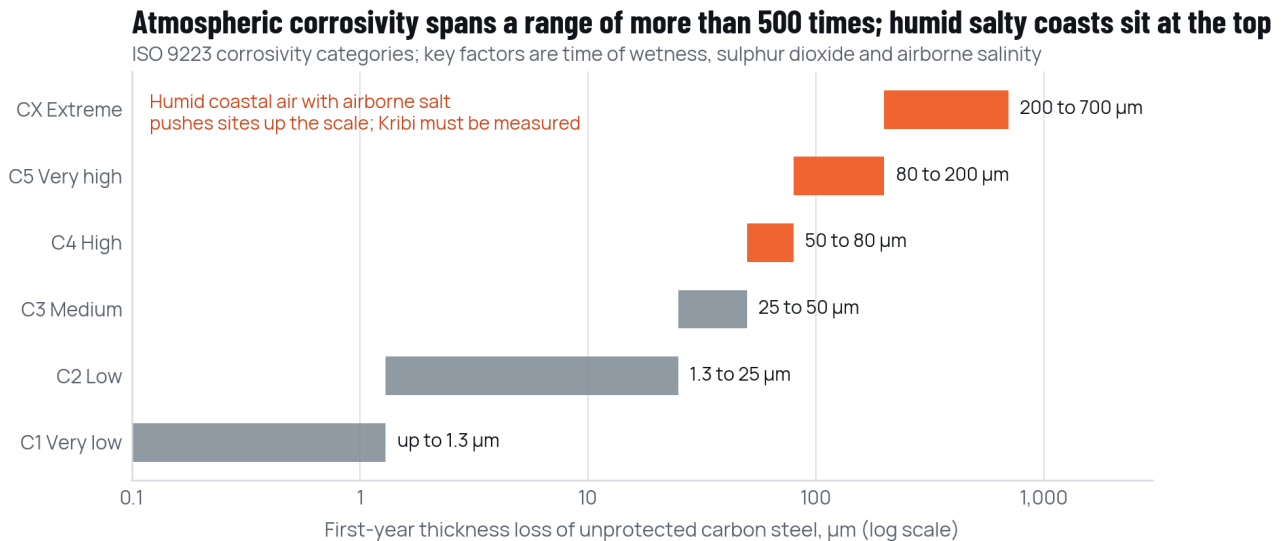
Bars that leave the mill to standard can be damaged on site. Three practices matter most. Bars should be cut and bent cold, on mandrels of the diameter the standard specifies, and not heated to make bending easier, because heat changes the properties of quench-and-self-tempered bars [S28, S98]. Welding of reinforcement should follow qualified procedures suited to the bar's chemistry. And bars should be stored off the ground, under cover and away from salt spray until they are fixed, particularly in coastal sites such as Kribi. Cameroon Steel's product guidance and its training for contractors should cover all three.

7.6 Wire rod and sections have their own quality drivers

Wire rod is sold to drawers who make wire, nails, mesh and binding wire. Their main requirements are clean steel (low inclusions and residuals, which cause breaks during drawing), consistent chemistry from coil to coil and a microstructure set by the controlled cooling after the laying head. Sections and beams are judged on dimensional tolerances (flange and web thickness, straightness, squareness) and on structural grades to EN 10025 or ASTM standards, which set strength, toughness and weldability. In each case, the melt shop's control of chemistry and the mill's measurement of dimensions and temperatures are what make consistent quality possible.

7.7 Corrosion: the climate at Kribi sets the protection strategy

Kribi has an equatorial coastal climate with about 2,836 mm of rain a year and daily maximum relative humidity of 92 to 96% [S99]. Steel corrodes in the atmosphere when its surface is wet and when chlorides from sea spray or sulphur dioxide from pollution are present. ISO 9223 classifies the corrosivity of atmospheres from C1 (very low) to CX (extreme) using exactly those factors: time of wetness, sulphur dioxide and airborne salinity [S100]. The first-year thickness loss of unprotected carbon steel ranges from up to 1.3 µm in category C1 to 200 to 700 µm in category CX, a range of more than 500 times (Figure 7.3) [S98].



SOURCED Figure 7.3. ISO 9223 atmospheric corrosivity categories and the corresponding first-year thickness loss of carbon steel.

Source: Šmak et al. (2021), Table 1, reproducing EN ISO 9223 [S98]; factors from the ISO 9223 description [S100].

No measured corrosivity classification for Kribi has been published. The combination of high humidity and proximity to the sea points towards the upper categories, but the classification should be measured on site with standard exposure specimens over a year, as ISO 9223 allows [S100]. That measurement matters for three things: the protection of the plant's own structures and equipment, the storage of products before dispatch, and the advice given to customers.

For reinforcement embedded in concrete, the atmosphere is only part of the story. Sound, dense concrete protects steel chemically for decades; corrosion starts when chlorides or carbonation penetrate the concrete cover and reach the bar. Durability therefore depends first on the depth and quality of the cover concrete, its water-cement ratio, its curing and its control of cracking, all of which Eurocode 2 and its companion concrete standard EN 206 govern through exposure classes for chloride-laden and marine environments. Coated or corrosion-resistant bars are a second line of defence for the most exposed structures:

- **Hot-dip galvanised rebar** (ISO 14657, ASTM A767) adds a sacrificial zinc layer; for quench-and-tempered bars, strength must be verified after coating [S98].
- **Fusion-bonded epoxy-coated rebar** (ASTM A775) forms a barrier but must be handled carefully to avoid coating damage on site.
- **Stainless steel rebar** (BS 6744) offers the highest resistance at a much higher price and is used selectively in splash zones and critical elements.

PROTECT THE BAR BEFORE IT REACHES THE CONCRETE

In Kribi's climate, rebar stored uncovered on the ground corrodes quickly. Cameroon Steel's product guidance should cover covered storage at the plant and on site, bundle labelling that survives the weather, and cover and concrete quality for coastal structures, so that bars that leave the mill to standard arrive in the structure to standard.

7.8 The plant itself lives in the same climate

The corrosivity that threatens customers' structures also threatens the steelworks. Melt-shop and mill buildings, crane rails, conveyors, cooling towers, pipe racks and the high-voltage substation are exposed to the same humid, salt-laden air, often with added heat, steam and dust. Their protective coating systems should be specified for the measured corrosivity category rather than for an inland default, with inspection and maintenance budgeted from the start. Finished products need the same care: bundles and coils waiting for dispatch should be stored under cover and off the ground, and the dispatch yard designed to drain quickly in the September to October rains. These are small design choices that protect yield, quality and the plant's own assets over decades.

7.9 What quality means for the route choice

Quality strengthens the case for the electric route with a ladle furnace. An arc furnace with refining slag, a ladle furnace and a quench-and-self-temper mill can make NC 236, BS 4449 and ASTM A615 grades consistently from a mix of scrap and DRI; an induction furnace without ladle refining has difficulty meeting phosphorus limits [S10]; and a re-roller that buys billets cannot control the chemistry of the steel it rolls. As domestic DRI enters the charge, the melt shop gains clean iron with low residuals, which improves wire-rod drawability and gives more room on chemistry. The specification of the Phase 1 mill should therefore include in-line quenching, continuous dimensional measurement and a laboratory able to test every cast lot, from the first day of production.

CHAPTER 8

DIGITALISATION AND AUTOMATION: CONTROL SYSTEMS ARE PART OF THE PROCESS, NOT AN ADD-ON

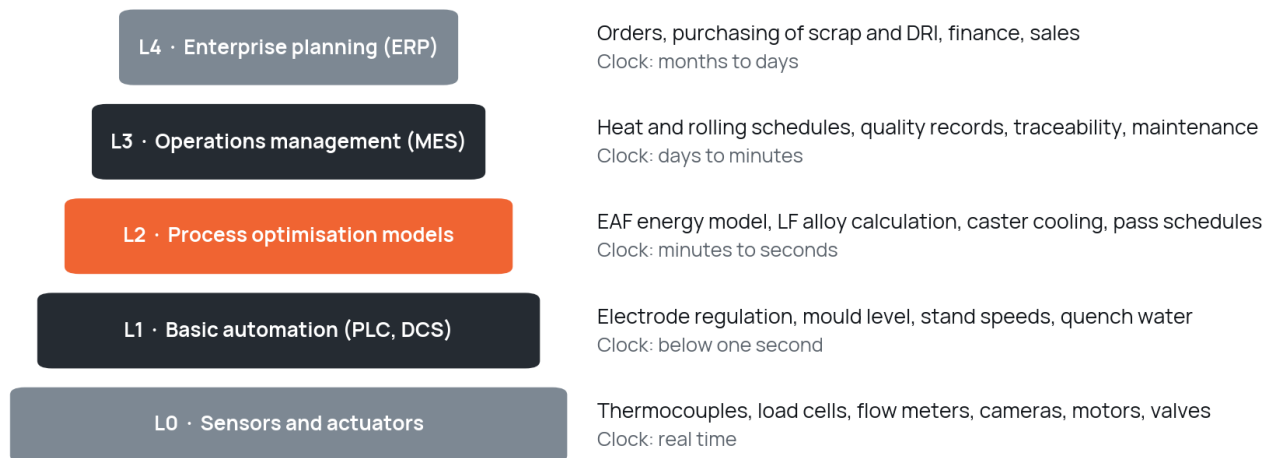
A modern melt shop and mill cannot reach their design yield, energy use and quality without automation, and a new plant has the advantage of designing it in from the start. Basic automation (Level 1) and process models (Level 2) control the furnace, the ladle, the caster and the mill second by second; a manufacturing execution system (Level 3) links every bundle to the heat it came from; and an energy-management system turns metering into savings. Manufacturing plants certified to ISO 50001 improved their energy performance by about 4.1% in the first year and still by about 3.4% a year twelve years later [S31]. For Phase 1's planned electricity use of about 289 GWh a year (about 302 GWh at the upper electricity value), a 4% improvement would be worth about 12 GWh a year (derived) [S03]. The same data thread is what customers, regulators and, for exports to Europe, carbon border rules increasingly require.

8.1 Five levels of control, each with its own clock

Industrial automation is usually described with the functional hierarchy of the ISA-95 standard (IEC 62264), shown in Figure 8.1. Level 0 is the physical process with its sensors and actuators. Level 1 is basic control in programmable logic controllers and distributed control systems, responding in fractions of a second. Level 2 is supervisory control and process optimisation. Level 3, manufacturing operations management, works on time frames of days, shifts, hours and minutes and covers scheduling, quality, maintenance and inventory. Level 4, enterprise planning and logistics, works in months, weeks and days through enterprise resource planning [S101].

Five levels of plant control, each with its own clock

ISA-95 / IEC 62264 functional hierarchy mapped to a melt shop and rolling mill



Definitions: OPC Foundation, ISA-95 common object model. Steel examples are indicative.

ILLUSTRATIVE Figure 8.1. The ISA-95 functional hierarchy mapped to a melt shop and rolling mill.

Source: Cameroon Steel; level definitions from the OPC Foundation's ISA-95 common object model [S101].

The value of the hierarchy is practical: it tells the plant's designers which system owns which decision and how data must flow between them. A recurring failure in steel plants is a gap between levels, for example a caster that records billet data that never reach the mill, or a laboratory whose test results are typed by hand into a certificate.

8.2 Levels 1 and 2 in the melt shop: models that save minutes and kilowatt-hours

In an electric arc furnace, Level 1 regulates the electrodes continuously to keep the arcs stable, controls the oxygen and carbon injectors and burners and protects the water-cooled panels. Level 2 adds models: an energy and mass balance that estimates the bath's temperature and chemistry between measurements, a power programme that chooses transformer taps through the heat, and, in the ladle furnace, an alloy calculation that finds the cheapest additions to reach the target chemistry. In the caster, Level 1 controls mould level and strand speed, while Level 2 calculates secondary cooling to avoid cracks.

Several suppliers offer these functions as packages. Tenova, for example, describes its iEAF system as a modular package built on full off-gas analysis, sensors, process models and advanced control, claiming savings in electricity, fuel, power-on time, tap-to-tap time, yield, electrodes and refractories [S102]. Claims of this kind vary widely between plants; the right approach for a new plant is to specify the measurements and models in the furnace contract and to agree performance tests.

For the Phase 1 furnace, where a single EAF must run about 7,300 to 7,900 hours a year to reach nameplate (Chapter 5), every minute of power-on time saved is capacity gained. A model that helps the operator tap at the right temperature, avoid over-heating and charge the right mix of scrap and DRI is worth more in a single-furnace shop than in a large multi-furnace plant.

8.3 Level 2 in the mill: pass schedules, quench control and measurement

In the rolling mill, Level 2 stores a pass schedule for every product, sets roll gaps and speeds, controls the tension between stands and runs the quench water for rebar according to bar size and target properties. Laser gauges after the finishing stands measure every bar's dimensions; pyrometers measure temperature before and after the quench. For wire rod, the controlled-cooling conveyor runs a recipe for each grade. These systems make product changes fast and repeatable, which is what allows a mill to serve a market of many diameters without long stops.



ILLUSTRATIVE Illustrative view. Generated image of the control room of a steel plant; not a photograph of any project, place or person.

8.4 Energy management turns metering into savings

Energy is the largest variable cost of an electric steelworks after iron units, and it is also the largest source of its emissions. An energy-management system meters electricity by unit (furnace, ladle furnace, caster, heater, mill, utilities), links consumption to production and identifies deviations. Certification to ISO 50001 formalises the process. A study of 83 certified manufacturing facilities found average energy performance improvements of about 4.1% in the first year and about 3.4% a year twelve years after implementation [S31].

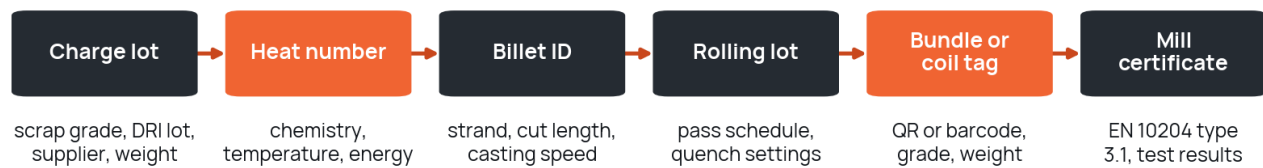
RC-1 estimates Phase 1 electricity use at about 289 GWh a year and an average load of about 36 MW at the planning value of 450 kWh per tonne in the furnace, or about 302 GWh and 38 MW at the upper value of 490 kWh [S03]. On that basis, a 4% improvement would save about 12 GWh a year (derived). The same system serves the power-system relationship described in Chapter 5: it can schedule furnace power-on periods around the grid's peaks and within the plant's contracted capacity on the 225 kV line, coordinate with the compensator and report power quality at the connection point.

8.5 Traceability: every bundle back to its heat

Traceability is where automation meets the customer. Figure 8.2 shows the chain of identifiers that a long-products plant maintains: the charge lot of scrap and DRI, the heat number with its chemistry and temperatures, the billet with its strand and casting data, the rolling lot with its pass and quench settings, the tag on each bundle or coil, and the mill certificate, usually a type 3.1 inspection certificate under EN 10204, that accompanies the delivery.

Every bundle traces back to a heat: the data thread from scrap yard to building site

Indicative identifiers and records; each arrow is a data hand-off that must not break



Why it matters: a failed site test can be traced to the heat and billet that made it, and every bar from that heat can be located. Regulators and lenders increasingly ask for the same thread to carry energy and CO₂ data per tonne.

ILLUSTRATIVE Figure 8.2. The traceability thread from charge lot to mill certificate.

Source: Cameroon Steel.

In Cameroon, where the standards agency has withdrawn a compliance certificate and ordered the recall of non-compliant rebar [S26, S27], traceability protects the honest producer: a failed site test can be traced to its heat, the other bars from that heat located and tested, and the cause found. It also supports certification by ANOR and by export certification schemes.

The same thread will carry carbon data. The EU Carbon Border Adjustment Mechanism, in its definitive phase since 1 January 2026, requires importers of iron and steel products to declare the emissions embedded in them [S53]. Producers that can report verified, installation-specific emissions per tonne avoid being assessed on default values, and the importer's charge depends on those emissions. Measuring CO₂ per heat and per product from the first day of operation is therefore a commercial asset for any export to Europe, and a requirement that lenders are likely to set in any case.

Table 8.1 Digital systems for the Kribi steelworks, by level and value

Level	System	Main functions	Value for the plant	Phase
0 and 1	Sensors, electrode regulation, PLC and DCS	Stable arcs, mould level, stand speed, quench water, safety interlocks	Safe, stable operation; the basis of every other level	Phase 1, built in
2	EAF and ladle-furnace process models	Energy and mass balance, power programme, alloy calculation	Shorter power-on time, fewer re-blow, lower alloy cost	Phase 1
2	Caster and mill models	Secondary cooling, pass schedules, quench recipes, laser gauging	Yield, dimensional quality, repeatable product changes	Phase 1
2 and 3	Power-quality and energy management (ISO 50001)	Metering by unit, demand control, flicker and harmonics monitoring	About 4% energy improvement in the first year in certified plants [S31]; grid compliance	Phase 1
3	Manufacturing execution system and laboratory system	Heat and rolling schedules, traceability, certificates, maintenance	Certified product, recall capability, reliability	Phase 1
3	Emissions monitoring, reporting and verification	CO ₂ per heat and product, carbon footprint	CBAM declarations based on actual data [S53]; lender reporting	Phase 1, extended with DRI

Level	System	Main functions	Value for the plant	Phase
4	Enterprise resource planning	Orders, metallics purchasing, finance, logistics	Working capital, supply security	Phase 1

Source: Cameroon Steel; functions per ISA-95 levels [S101].

8.6 Carbon accounting from the first heat

Measuring CO₂ is an engineering task before it is a reporting task. The international method for calculating the CO₂ intensity of steel production, ISO 14404, counts the carbon in every input (electrodes, charge carbon, natural gas, purchased DRI and electricity) and in every output (steel, slag, dust), and allocates emissions across the plant's boundary. A plant that meters each input, weighs each output and links both to heats and rolling lots can produce a footprint for each product, rather than a site average.

That capability matters for three audiences. EU importers must declare the emissions embedded in iron and steel products under the CBAM regulation, and actual, verified data are preferable to default values [S53]. Development lenders increasingly require project-level greenhouse-gas reporting. And domestic buyers, notably public works and international contractors, are beginning to ask for product carbon footprints. RC-1's estimated intensities, about 0.32 t CO₂ per tonne of finished product for scope 1 and 2 in Phase 1 and about 0.33 t at full build-out [S03], will be replaced by measured values once the plant runs.

8.7 Simulation before construction, and for training

Two kinds of model reduce risk before the plant is built. The first is an electrical model of the grid connection, the furnace and its compensator, used for the flicker and harmonics study that Gate 1 requires (Chapter 10). The second is a set of process simulators for the furnace, the caster and the mill, which suppliers use to train operators before hot commissioning. Operators who have practised power programmes, breakouts and cobbles on a simulator make fewer costly mistakes on live equipment.

8.8 Phasing the digital investment

Not every system needs to be complete on the first day. The Phase 1 core is non-negotiable: Level 1 control and safety systems, Level 2 models for the furnace, ladle furnace, caster and mill, the laboratory information system, traceability from charge lot to certificate, and energy and emissions metering. Advanced analytics, predictive maintenance models and plant-wide optimisation can follow once the plant has a year of reliable data. What must be right from the start is the architecture: consistent identifiers, a single data model and network segregation, so that later systems can be added without rebuilding the foundations.

8.9 Reliability: maintenance driven by data

A single-furnace melt shop with high utilisation is vulnerable to unplanned stops. Condition monitoring of the furnace transformer, the water-cooled panels and roof, the hydraulic systems and the mill drives allows maintenance to be scheduled before failure. A computerised maintenance system, linked to Level 3, records every intervention and every spare part. The same principle applies to the compensator and the high-voltage substation, whose failure would stop the whole plant.

8.10 Cybersecurity and architecture

Connecting control systems to business systems and to suppliers' remote-support platforms creates exposure to cyber attack. The ISA-95 hierarchy provides a natural architecture for defence: separate networks for control (Levels 0 to 2) and business (Levels 3 and 4), controlled interfaces between them, and remote access only through monitored gateways. The IEC 62443 series of standards for industrial automation security should be part of the automation specification from the start, because retrofitting security to a running plant is costly.

8.11 People make the systems work

Automation does not reduce the need for skilled people; it changes their skills. A plant of this kind needs automation engineers, instrument and electrical technicians, process engineers who understand both metallurgy and models, and data specialists. Cameroon has a base to build on: the National Advanced School of Engineering in Yaoundé teaches industrial and mechanical engineering, electrical engineering and civil engineering, but has no dedicated metallurgy department [S39], and the University Institute of Technology in Douala trains technicians in mechanical and production engineering, industrial maintenance, thermal engineering and electrical engineering [S103]. Vendor training, simulator-based training for furnace and mill operators, and partnerships with these institutions should be part of the technology contract.

THE MILL CERTIFICATE IS THE LAST LINE OF A DATA THREAD THAT STARTS IN THE SCRAP YARD. IF ANY LINK IS MISSING, THE CERTIFICATE IS ONLY A PROMISE.

Cameroon Steel, technology pathway

8.12 Records that outlive the plant's first owners

The records of a rebar plant are needed for as long as the buildings that contain its bars stand. A structural engineer assessing a damaged building, or an investigator after a collapse, may need to know what a bar's chemistry and tensile results were decades after it was rolled. The plant's data policy should therefore define what is kept (heat chemistry, test results, certificates, quench parameters), for how long, in what format and with what back-up, and who may access it. The same policy should govern the process data that technology suppliers collect through remote-support connections: Cameroon Steel should own its operating data, decide what leaves the plant, and require suppliers to protect it.

8.13 What digitalisation means for the decision

Digital systems are a small part of the capital cost of a steelworks but a large part of its performance. The decision-maker's checklist is short: Level 1 and Level 2 functions and their performance tests written into the furnace, caster and mill contracts; a single plant-wide identifier scheme from charge lot to certificate; metering sufficient for ISO 50001 and for product carbon footprints; and an automation architecture designed for security. All of them are cheaper to specify at the start of Phase 1 than to add later.

CHAPTER 9

THE PHASED PATHWAY APPLIED: HOW RC-1 REACHES 1 MTPA IN FOUR STEPS

Cameroon Steel's reference configuration, RC-1, applies the phased electric pathway to the Kribi project. Phase 1 (planned) is a single electric arc furnace with a ladle furnace, a billet caster and a bar and wire-rod mill, with a nameplate capacity of 0.3 Mtpa and an expected sustained output of 270,000 to 300,000 t a year; works are targeted to start in 2029, with a first heat in the second half of 2030 and ramp-up in 2031 [S03]. Phase 2 (indicative) adds a second melt line and a light and medium sections mill for about 0.2 Mtpa of angles, channels and flats, indicatively 2032 to 2034. Phase 3 (indicative) adds melt-shop capacity and a heavy-section mill after 2034, bringing the plant to its design capacity of about 1 Mtpa, subject to markets and financing. A site reserve is kept for a direct-reduction (DR) module for Cameroonian ore, which would follow later, subject to ore, gas and approvals [S03]. Phase 1 fits within the initial 100 MW stage of the zone's 225 kV line and needs no natural gas; full development needs the line's later 330 to 400 MW stage [S03, S25]. This chapter presents those planning values with their status, explains where Phase 1 tonnage can be sold, and gives no investment amounts, which will be set by engineering and financing.

9.1 The project on the public record

Cameroon Steel is developing a steel complex at Mboro, in the Kribi industrial-port zone. The foundation stone was laid on 30 December 2024 by the Prime Minister, representing the Head of State [S77, S104]. The design capacity reported by Cameroon Tribune in January 2025 is 1 Mt of steel a year, to be reached in phases [S105], and the first phase focuses on reinforcing bar and wire rod made in an electric arc furnace melt shop. Cameroon Mining Company, Cameroon Steel's sister company, holds the Mbalam exploitation permit [S77]. The zone's development company lists "steelmaking linked to mineral exports" among the industrial clusters it plans for the zone [S38].

RC-1, cited in this paper as the Cameroon Steel reference configuration RC-1 (planning estimate), is the engineering basis that translates that public description into units, capacities and utilities. It is a Class 5 planning configuration (an order-of-magnitude definition used before front-end engineering) and every value in it carries a qualifier, planned, target or indicative, defined in Annex A [S03]. This edition uses the values as revised on 10 October 2026, including a domestic-scrap assumption of about 30,000 t a year and the schedule below.

9.2 Four steps, one melt-shop logic

Table 9.1 RC-1 phases (Cameroon Steel planning basis, edition 10 October 2026)

Step	Main units	Products	Finished capacity	Liquid steel	Status
Phase 1: bar and wire-rod works	One EAF of the 40 t class; one ladle furnace; billet caster; induction billet heating; rebar mill; high-speed wire-rod mill	Billets; rebar Ø8 to 32 mm; wire rod Ø5.5 to 12 mm	Nameplate about 300,000 t/yr; expected sustained 270,000 to 300,000	About 320,000 t/yr at nameplate	Planned
Phase 2: sections	Second melt line (EAF, ladle furnace, caster); light and medium section mill	Angles, channels, flats	About 200,000 t/yr (150,000 to 200,000)	About 215,000 t/yr	Indicative
Phase 3: heavy sections to 1 Mtpa	Melt-shop expansion; H-beam and heavy-section mill	H-beams, I-beams, heavy sections	About 500,000 t/yr	About 535,000 t/yr	Indicative
Reserve: direct reduction	Gas-based, hydrogen-ready DR module; pellet yard	DRI or hot DRI for the melt shop	About 1 Mt DRI/yr (0.8 to 1.1)	Not applicable	Indicative; subject to ore quality, gas and approvals

Source: Cameroon Steel reference configuration RC-1 (planning estimate) [S03]. Values are planning figures, to be confirmed in front-end engineering.

Each step reuses what the previous one built. The Phase 1 caster and mill continue to run when the second melt line arrives; the melt shop's charge shifts from purchased to domestic iron units without any change to the furnaces; the substation and compensator are sized so that a second furnace transformer can be added. The pathway is therefore not a series of separate projects but one plant that grows by adding modules.

9.3 The timeline: a first heat in 2030, domestic DRI as an option after 2034

Figure 9.1 shows the RC-1 schedule. Front-end engineering for Phase 1 and the utility agreements are targeted for 2027. The field baseline for the environmental and social impact assessment covers the wet and dry seasons of 2027 and 2028, with public hearings in the third quarter of 2028 and the certificate of environmental compliance in the fourth quarter; financing is targeted for 2028, and no construction works start before the certificate [S03]. Phase 1 works are targeted to start in the first quarter of 2029, with a first heat in the second half of 2030 and ramp-up through 2031 towards the nameplate of 0.3 Mtpa [S03]. Phase 2 (second melt line and light and medium sections mill) is indicative for 2032 to 2034, and Phase 3 (melt-shop expansion and heavy-section mill), which brings the plant to 1 Mtpa, for after 2034, both subject to market and financing; the direct-reduction module would follow later, subject to ore quality, gas supply and approvals [S03].

Three features of this schedule deserve scrutiny. First, it allows about 18 to 24 months from the start of works to the first heat for a greenfield melt shop, caster and two mills. That is achievable only if long-lead equipment (the furnace transformer, the caster and the mill stands) is ordered at financial close and the 225 kV supply is available on time; a longer construction period would move the first heat into 2031 without changing the pathway. Second, development lenders disclose a project's environmental and social review before their boards approve it: IFC, for example, does so 60 days before board consideration for its highest-risk category and 30 days for others [S106]. A certificate in the fourth quarter of 2028 leaves little room before financing, so the disclosure period is one of the Gate 1 conditions (Chapter 10). Third, Gate 2 requires twelve months of Phase 1 at design performance, so a Phase 2 investment decision is unlikely before 2032, which places Phase 2 towards the end of its indicative 2032 to 2034 window.

A first heat in 2030 and ramp-up in 2031; domestic DRI is a post-2034 option, not a precondition

RC-1 (planning estimate); 'target' and 'indicative' dates depend on approvals, financing and markets



ASSUMED Figure 9.1. RC-1 schedule by status: target dates for Phase 1, indicative dates for later steps.

Source: Cameroon Steel reference configuration RC-1 (planning estimate), schedule [S03]. "Target" and "indicative" dates depend on approvals, financing and markets.

The order matters. The steps that depend only on Cameroon Steel and its suppliers (engineering, the melt shop, the mill) come first. The steps that depend on other parties' projects (a concentrator and pellet plant, a long-term gas supply, the later stage of the 225 kV line) come later and are gated by evidence (Chapter 10). Nothing in Phase 1 depends on the timing of the Mbalam mine or of new gas developments.

9.4 Utilities by phase: Phase 1 is all-electric and fits the zone's first 100 MW

RC-1 derives indicative utility balances by multiplying planned capacities by benchmark consumption values [S03]. They are summarised in Table 9.2 and Figure 9.2.

Table 9.2 Indicative utility, by-product and emissions balances by RC-1 phase (derived)

Item	Phase 1	Phases 1 and 2	Full, 1 Mtpa
Finished products, t/yr	300,000	500,000	1,000,000
Liquid steel, t/yr	319,000	532,000	1,064,000
Iron units (metallics), t/yr	363,000	604,000	1,209,000
of which DRI/HBI at 30% of charge, t/yr	109,000	181,000	363,000
Electricity, GWh/yr	289	422	753
Electricity at the upper value of 490 kWh/t, GWh/yr	302	443	796
Average electrical load, MW (upper value in brackets)	36 (38)	53 (55)	94 (99)
Maximum demand, MVA (assumed; Phases 1 and 2 interpolated)	About 55 (45 to 65)	About 100 (85 to 110), derived	About 160 (130 to 190)
Natural gas for reheating, GJ/yr	0	260,000	910,000
Water make-up, m³/yr	600,000	1,000,000	2,000,000
Oxygen, million Nm³/yr	11.2	18.6	37.2
EAF slag, t/yr	44,700	74,500	148,900

Item	Phase 1	Phases 1 and 2	Full, 1 Mtpa
EAF dust (hazardous), t/yr	4,800	8,000	16,000
Scope 1 and 2 CO ₂ , t per t finished (upper value in brackets)	0.32 (0.33)	0.33 (0.34)	0.33 (0.34)
Including upstream of imported DRI, t per t finished	0.58 (0.59)	0.58 (0.59)	0.58 (0.59)

Source: Cameroon Steel reference configuration RC-1 (planning estimate), indicative balances at 450 kWh per tonne in the furnace [S03]; upper-value rows and bracketed values at 490 kWh per tonne (derived); the Phases 1 and 2 maximum demand is interpolated (derived): about 85 MVA pro rata to output between the Phase 1 and full-development values, and up to about 110 if the second melt line draws as much as the first; Figure 9.2 plots about 100 MVA. Benchmark inputs as listed in Annex A. Rounded.

Three points stand out. First, Phase 1's average load of about 36 to 38 MW and maximum demand of about 55 MVA sit within the 100 MW that the Port Autonome de Kribi's 225 kV line is designed to deliver at first [S25]. Full development, at about 94 to 99 MW average and about 160 MVA maximum demand, needs the line's later stage of 330 to 400 MW [S25, S34]. The power path is therefore phased in the same way as the plant.

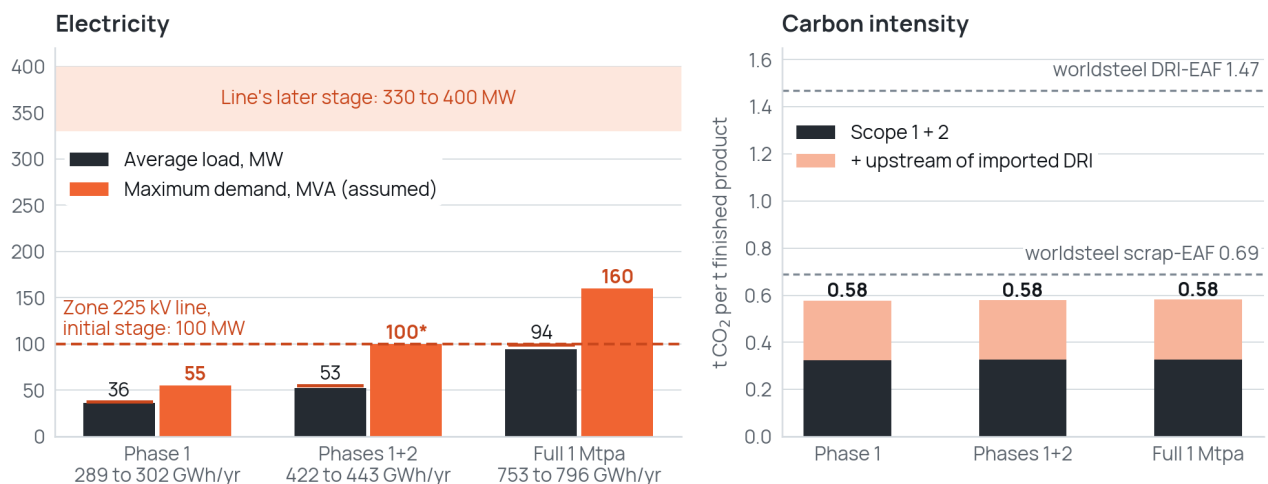
Second, Phase 1 needs no natural gas: induction heating replaces a gas reheating furnace (Chapter 6). Gas enters only with the Phase 2 section mill, at about 260,000 GJ a year, and reaches about 910,000 GJ at full development, before any direct-reduction module [S03]. A DR module of 1 Mt a year would need about ten times that quantity (Chapter 4).

Third, the carbon intensity of the planned product mix is low by international standards. With 30% imported DRI or HBI in the charge, RC-1 estimates scope 1 and 2 emissions of about 0.32 to 0.34 t of CO₂ per tonne of finished product, and about 0.58 to 0.59 t including the upstream emissions of the imported DRI, the higher figures at the upper electricity value [S03]. Those figures compare with worldsteel's 2024 averages of 0.69 t for scrap-EAF and 1.47 t for DRI-EAF crude steel [S01], although the boundaries differ (Annex A).

Phase 1 fits the zone's initial 100 MW; 1 Mtpa needs the line's later 330 to 400 MW stage

RC-1 indicative balances at 450 kWh/t; red ticks and upper GWh at 490 kWh/t.

*Phases 1+2 maximum demand interpolated (derived; 85 to 110). Intensities exclude a domestic DRI module.



DERIVED Figure 9.2. Electricity demand and carbon intensity by RC-1 phase, against the zone's 225 kV line stages and worldsteel route averages.

Source: Cameroon Steel reference configuration RC-1 (planning estimate), indicative balances [S03]; zone 225 kV line and substation stages [S25, S34]; worldsteel route averages [S01].

When the direct-reduction module runs, its emissions move inside the plant's boundary. On the RC-1 benchmarks, a full plant with 70% domestic gas-based DRI in the charge would emit about 0.8 t of CO₂ per tonne of finished product, excluding pellet production and mining (derived; Annex A). Blending hydrogen into the shaft furnace, as hydro-based electricity allows, would bring that figure down progressively (Chapter 4).

9.5 Logistics, jobs and land follow the same phasing

RC-1 estimates inbound port tonnage of about 351,000 t a year in Phase 1 for imported metallics and consumables, rising to about 1.24 Mt at full development before any domestic DRI, and outbound finished products of 0.3 Mt rising to 1 Mt; moved entirely by road before any rail siding, Phase 1 would generate about 74 truck loads a day [S03] (all derived). A rail siding and logistics corridor are kept in the site reserve [S03].

RC-1 plans about 500 direct jobs in Phase 1 (450 to 550) and about 1,000 indirect jobs, rising to about 1,100 direct jobs at full development (indicative range 900 to 1,300), with a target of about 90% Cameroonian nationals in operations by the fifth year [S03]. Those figures are planning values that the employment study will refine.

The site layout keeps space for each later step: melt-shop expansion, the section and heavy-section mills, stockyard expansion, the direct-reduction module and pellet yard next to the melt shop, downstream processing, a rail siding and a permanent environmental buffer [S03].



ILLUSTRATIVE Illustrative view. Generated image of structural sections in a stockyard; not a photograph of any project, place or person.

9.6 How RC-1 performs on the four criteria

The phased pathway was chosen to balance capital intensity, flexibility, emissions and speed (Chapter 2). RC-1 shows how that balance looks in practice.

Capital. The first commitment is a single melt line and one mill for about 0.3 Mtpa [S03], a scale at which comparable bar and rod mills are being ordered in Africa today [S08, S09]. Each later step is a separate decision, financed on the results of the previous one.

Flexibility. The melt shop accepts any mix of scrap, DRI, HBI and pig iron; the mill can move between rebar sizes and wire rod; and Phase 1 output is flexible between rolled products and merchant billets for the existing re-rollers, which import most of their charge, so Phase 1 does not depend on adding rebar to a market whose capacity is already more than three times demand [S06]. Each later phase adds a product family (sections, then heavy sections) rather than more of the same.

Emissions. With 30% imported DRI or HBI and Cameroon's grid, RC-1 estimates about 0.32 t of CO₂ per tonne of finished product for scope 1 and 2, and about 0.58 t including the upstream of imported DRI [S03], well below worldsteel's route averages [S01]. Domestic DRI raises the plant's own emissions but replaces imported iron whose emissions occur elsewhere; hydrogen blending then lowers them.

Speed. Phase 1's first heat is targeted for the second half of 2030 [S03] and depends only on the plant, its suppliers, its permits and the zone's 225 kV line, not on a mine, a pellet plant or a gas field.

9.7 Interfaces with the zone's infrastructure

The plant is designed to fit the infrastructure that the zone is building. The Port Autonome de Kribi's 225 kV line and 225/30 kV substation are designed for 100 MW at first and 330 to 400 MW later [S25]; in August 2026 the port also reported a water plant for the Mboro area due in early 2027 [S34]. The deep-water port's existing terminals can handle Phase 1's imported iron units and consumables; a mineral terminal of 125 Mt a year is at the stage of a memorandum of understanding signed on 4 November 2025, with completion expected within five to six years [S37, S38]. The zone's development company lists steelmaking linked to mineral exports among its planned clusters [S38], which places a steelworks and a future direct-reduction plant in the zone's own logic. RC-1 keeps a rail siding in reserve for the day a rail link reaches the port [S03].

9.8 Skills and jobs follow the technology

The electric route shapes the plant's workforce as much as its equipment. A melt shop and mill need furnace and caster operators, roll-shop technicians, electrical and instrument technicians able to maintain high-voltage equipment and power electronics, laboratory analysts and process engineers. RC-1 plans about 500 direct jobs in Phase 1 [S03], most of them in these trades. Cameroon's engineering schools train mechanical, electrical and industrial engineers but have no dedicated metallurgy department [S39], and the University Institute of Technology in Douala trains maintenance, thermal and electrical technicians [S103]. The gap is therefore in steel-specific process skills, which suppliers' training packages, simulators and a plant training centre can fill. Cameroon's Mining Code also reserves 95% of non-skilled jobs in mining companies for nationals [S107]; although it governs mines rather than steelworks, it signals the local-content expectations that the steel chain linked to Cameroonian ore will face. Each later phase adds trades: gas-fired furnaces with Phase 2, heavy-section rolling with Phase 3, and process-gas, reformer and pellet-handling skills with a direct-reduction module.

9.9 What stays fixed and what remains open

The pathway fixes the decisions that are hard to reverse and leaves open those that depend on external evidence.

Fixed at Phase 1: the electric route; the melt-shop building, crane and caster layout with space for a second furnace; a substation and compensator designed for growth; the rebar and wire-rod mill with in-line quenching; the automation and traceability architecture; and the site reserve for a direct-reduction module next to the melt shop.

Open until their gates: the size and timing of the second melt line; the heavy-section mill's product range and the caster for blooms or beam blanks; and every element of domestic ironmaking (pellet source, DR technology supplier, module size, gas contract and hydrogen blending schedule).

ONE PLANT THAT GROWS BY MODULES

RC-1 is not a sequence of separate projects. Phase 1 provides the melt shop, caster, mill, substation and data systems that every later phase reuses; later phases add mills and furnaces; domestic ironmaking replaces purchased iron units without changing the melt shop. Each step can be financed and justified on its own results.

9.10 Where Phase 1 tonnage goes: billets, rolled products and exports

A melt shop with a caster can sell billets as well as roll them, and in Cameroon's market that option is central rather than incidental. Domestic rebar capacity, about 627,000 t a year, is more than three times rebar demand of about 180,000 t, and capacity for wire rod and nails, about 72,000 t, is twice demand [S06]. Rebar is therefore a saturated market in which new capacity alone closes no gap. What the country lacks is steel to roll: local scrap covers only about 40% of the existing mills' needs, so they import most of their charge [S32, S33], and Cameroon imported 161,400 t of billets in 2023 [S05].

Phase 1's melt shop makes billets, and its output is planned to be flexible between three outlets: merchant billets sold to the existing re-rolling mills in place of imports; wire rod and rebar from its own mill, certified to NC 236 and to the international grades that contractors and lenders specify; and exports of billets and rolled products within CEMAC. The split between them will follow prices and contracts, not a fixed plan. Table 9.3 sets out the logic; White paper 04 examines each market and gives an indicative cost of a Kribi billet against a delivered import.

Table 9.3 Where Phase 1 output can go (illustrative)

Outlet	Market evidence	What Phase 1 offers	Condition
Merchant billets for existing re-rollers	161,400 t of billets imported in 2023; local scrap covers about 40% of mill needs [S05, S32, S33]	Billets cast at Kribi and delivered by road	Price at or below delivered imports; quality agreements
Wire rod	Imports fell to 7,800 t in 2023; domestic capacity above demand [S05, S06]	Clean rod for drawing, from a charge with DRI or HBI	Drawing quality and consistency
Certified rebar	Mandatory NC 236; capacity more than three times demand [S06, S26]	Bars certified to NC 236, BS 4449 and ASTM A615	Replaces imported and non-compliant product, not compliant domestic supply
Exports within CEMAC	Neighbouring markets import long products (White paper 04, Chapter 6)	Billets and rolled products by road and sea	Logistics cost and regional trade rules

Source: Cameroon Steel assessment from the sources cited; illustrative, not a sales plan.

The option costs little to keep: billet storage, weighing and a loading point. It also strengthens the case for the melt shop as the core of the plant: whichever outlet pays best, the value lies in making steel, the step that the country lacks.

CHAPTER 10

TECHNOLOGY RISKS AND DECISION CRITERIA: RETIRE THE BIG RISKS BEFORE EACH COMMITMENT

The phased electric route is lower-risk than the alternatives, but it is not risk-free. Its technology risks are concentrated at a few interfaces: the plant's connection to a grid that already leaves 150 MW of industrial demand unmet [S89]; the supply of iron units in a market where DR-grade feed is expected to tighten [S17]; the quality of Cameroonian ore, which reaches DR grade only in testwork [S19]; the gas supply that a direct-reduction module would need; and the reliability of a single furnace that must run most of the year. Each of these can be reduced before money is committed, by studies, pilot tests and contracts. This chapter sets out a technology risk register, a four-gate decision process and a checklist that ministers' advisers, lenders, engineers and journalists can use to test the project's progress.

10.1 Technology risk is concentrated at a few interfaces

Most of the equipment in a long-products steelworks is mature: arc furnaces, ladle furnaces, billet casters and bar mills have been built in large numbers for decades, including recently in Africa [S08, S09]. The risks lie where the plant depends on systems outside its fence (the grid, the gas network, the mine, the port) and where a new organisation must learn to run complex equipment. Table 10.1 lists the main technology risks, the evidence behind each, the early signals to watch and the mitigations.

Table 10.1 Technology risk register for the phased electric pathway

Risk	Why it matters (evidence)	Early indicator	Mitigation	Decided at
Grid strength and power quality	Arc furnaces cause flicker and harmonics; other EAF rebar mills had to retrofit compensators under regulatory pressure [S23, S24]	Short-circuit level at the 225 kV connection; results of the flicker study	Flicker study before ordering; STATCOM and filters specified with the furnace	Gate 1
Firm power supply	150 MW of industrial demand unmet in October 2026 [S89]; hydro output varies with rainfall [S51]; the zone line delivers 100 MW at first [S25]	Commissioning of the 225 kV line and substation; connection contract terms	Capacity contract on the zone line; schedulable melting around peaks rather than curtailment; emergency supply for critical systems	Gate 1, then Gate 3

Risk	Why it matters (evidence)	Early indicator	Mitigation	Decided at
Iron-unit supply and price	Domestic scrap about 0.1 Mt a year (derived), of which RC-1 assumes about 30,000 t for the plant [S03]; seaborne DR-grade pellet deficits forecast [S17]; scrap prices up about 30% in a year [S32]	Term-contract offers; spread between delivered billet prices and the cost of the metallic charge (White paper 04, Chapter 8)	Two suppliers per iron unit; covered storage; charge-mix flexibility; formal scrap collection	Gate 1, reviewed yearly
Single-furnace capacity and reliability	About 8,000 heats need about 7,300 to 7,900 furnace hours a year at 450 to 490 kWh/t; expected sustained output 270,000 to 300,000 t (derived)	Supplier time balance; planned and unplanned downtime in commissioning	Capacity guarantee; transformer rating set in front-end engineering; maintenance system; critical spares (transformer, panels, electrodes); cold-billet yard for the mill	Gate 1, proven before Gate 2
Product certification	Mandatory NC 236; a certificate withdrawn and non-compliant rebar recalled in 2024 [S26, S27]	Laboratory accreditation; first certification audits	In-line quenching; laboratory testing each cast lot; traceability system	Gate 1
Supplier capability and scope gaps	First-of-a-kind plants have overrun costs, as at Stegra [S62]	Supplier references for similar plants; completeness of scope	Proven designs; performance guarantees; independent owner's engineer	Gate 1
Skills	No dedicated metallurgy department at the main engineering school [S39]	Recruitment and training progress against plan	Vendor training, simulators, partnerships with engineering schools [S39, S103]	Gate 1 onward
DR-grade ore	Mbalam DR concentrate exists only in testwork [S19]; direct-shipping ore is not DR grade [S18]	Pilot-plant results; concentrator and pellet-plant plans	Pilot-scale proof; bridging contract for imported DR pellets	Gate 4
Gas for direct reduction	Reserves of the producing field not public; main new resource without investment decision [S35]	Reserve audit; gas sales agreement terms	Audited reserves; long-term contract; smaller first module	Gate 4
Hydrogen availability	100% hydrogen for 1 Mt DRI would need about 2.7 TWh a year (derived), about a third of 2025 generation [S51]	New hydro and transmission projects	Hydrogen-ready furnace; blend as low-carbon power becomes available	Gate 4 and later
Carbon rules in export markets	CBAM definitive phase from 2026; certificate price €82.32 in Q3 2026 [S53, S54]	Share of exports to carbon-priced markets	Measured emissions per product from day one; low-carbon power	All gates
By-product management	EAF dust carries zinc, lead and cadmium [S44]; slag must be stable for reuse	Treatment route agreed; slag test results	Dust management plan; slag processing and certification	Gate 1

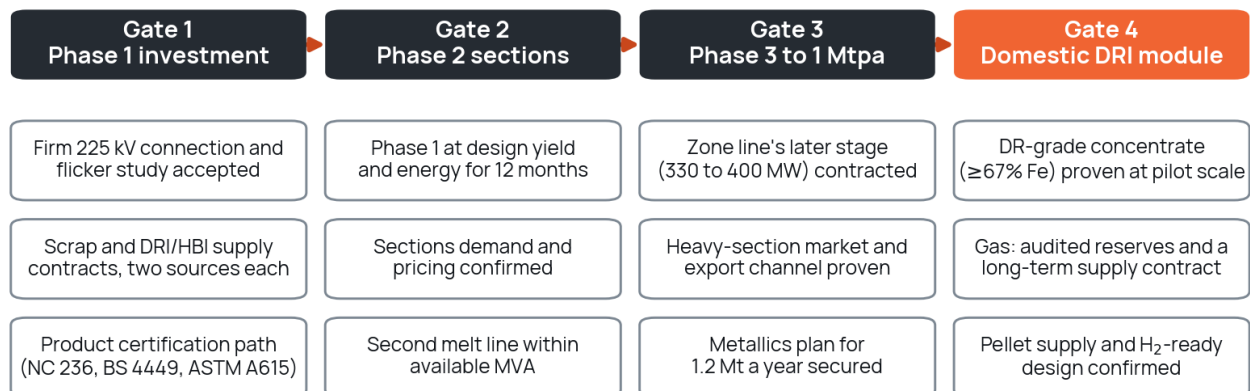
Source: Cameroon Steel assessment, using the evidence cited in each row.

10.2 Four gates, each opened by evidence rather than by date

A phased pathway is only as good as the discipline with which each step is decided. Figure 10.1 sets out four decision gates. At each gate, the decision is "go" if the evidence meets the criteria, "hold" if it is incomplete and "redesign" if it shows that the plan must change. The gates are linked to evidence, not to dates: the schedule in Chapter 9 shows when each gate is targeted, not when it must be passed.

Four gates, each opened by evidence rather than by date

Indicative gate sequence for the phased pathway; each gate can return 'go', 'hold' or 'redesign'



Gate criteria are illustrative of the evidence decision-makers should require; they are not commitments.

ILLUSTRATIVE Figure 10.1. Indicative decision gates for the phased electric pathway, with the evidence each requires.

Source: Cameroon Steel.

Gate 1, the Phase 1 investment decision, is the most consequential. It requires a firm connection to the zone's 225 kV supply, with a flicker and harmonics study accepted by the grid operator; term contracts or binding offers for scrap and DRI or HBI from at least two sources each, at prices that leave a positive spread against delivered billet imports; a product certification path for NC 236 and the main international grades; completed site studies and an approved environmental and social impact assessment, disclosed for the period that lenders require before board approval (60 days for IFC's highest-risk category) [S106]; and a supplier scope with performance guarantees for electricity per tonne at the planned DRI share, furnace availability, yield and capacity, with a transformer rating that delivers the expected sustained output of 270,000 to 300,000 t.

Gate 2, the Phase 2 section mill and second melt line, should require twelve months of Phase 1 operation at or near design yield, energy and capacity; confirmed demand and prices for angles, channels and flats; and confirmation that the second melt line fits within the available electrical capacity and compensator.

Gate 3, Phase 3 to 1 Mtpa, requires the zone line's later stage of 330 to 400 MW to be contracted [S25]; a proven market and export channel for heavy sections; a caster solution for blooms or beam blanks; and a metallics plan for about 1.2 Mt of iron units a year.

Gate 4, the domestic direct-reduction module, requires DR-grade concentrate of at least 67% iron, with low gangue, proven at pilot scale from a defined ore body; a secured pellet supply; audited gas reserves and a long-term gas contract for the module's life; and a hydrogen-ready shaft-furnace design with a monitoring, reporting and verification plan for CO₂.

A GATE IS A PROMISE TO DECIDE ON EVIDENCE. ITS VALUE IS THAT IT CAN SAY "HOLD" WITHOUT SAYING "NEVER".

Cameroon Steel, technology pathway

10.3 The alternatives carry larger risks

Decision-makers should weigh the pathway's risks against those of the alternatives, not against an imaginary risk-free option.

A **re-rolling mill without a melt shop** would be cheaper and faster, but it would add rolling capacity to a market that already has more than it uses [S06] and would depend entirely on imported billets, whose supply and prices it cannot control [S05, S72]. It would add the least value and transfer the most risk to the State's foreign-exchange balance.

A **blast-furnace works** would need several million tonnes a year of capacity to be efficient, imported coking coal and the highest carbon intensity of any route, 2.34 t of CO₂ per tonne on worldsteel's 2024 average [S01]. It would commit all of its capital before producing a tonne, and it could not easily scale down if demand disappointed.

An **induction-furnace plant** would be cheap, but it would struggle to meet phosphorus limits and the ductility requirements of modern rebar standards without additional refining [S10], in a market whose regulators are actively enforcing quality [S26, S27].

A **direct-reduction plant built first** would tie the start of steelmaking to the readiness of a concentrator, a pellet plant and a gas contract, none of which exists today (Chapter 4). It would postpone production by years and raise the capital required before any revenue.

The phased electric route is the only option that starts producing within a few years, uses capital in steps, meets quality standards with proven equipment and keeps the path to Cameroonian iron open.

10.4 Who carries which risk

A risk is best carried by the party that can control it. For the phased pathway, the allocation is broadly clear.

The **technology supplier** carries the performance of the equipment: capacity, yield, energy use and availability, backed by guarantees and tests. The **grid operator and the zone** carry the delivery of the connection at the agreed capacity and, with the plant, the agreed power-quality limits. **Cameroon Steel** carries operations, metal-lics procurement, product quality, safety and environmental performance. The **mining company** carries the proof of a DR-grade concentrate, and the **gas producer and the State** the availability, pricing and taxation of gas for any direct-reduction module. **Lenders** will expect each of these allocations to be written into contracts before they commit.

Some risks cannot be transferred: market demand, the price of imported iron units and the evolution of carbon rules. The pathway handles them by keeping each commitment small enough to be justified on its own results.

10.5 Indicators to watch after start-up

Once Phase 1 runs, a small set of indicators will show whether the technology choice is delivering. They should be reported regularly to the board and, in summary, to lenders and the public:

- electricity per tonne of liquid steel, against the guaranteed value, and the DRI share of the charge;
- tap-to-tap time and furnace availability, against the 55 to 59 minutes and 7,000 to 7,700 operating hours a year that Phase 1 planning assumes;
- metallic yield and casting-and-rolling yield, against the RC-1 assumptions of 0.88 and 0.94 [S03];
- flicker (Pst and Plt) and harmonic distortion at the connection point, against the limits in the connection agreement;
- the share of cast lots certified first time to NC 236 and international grades;

- CO₂ per tonne of product, measured, against the RC-1 estimate [S03];
- lost-time injuries and process-safety incidents.

10.6 A checklist for decision-makers

The questions in Table 10.2 are designed to be asked at any stage of the project by anyone who needs to judge its technical progress: a ministry adviser reviewing incentives, a development-finance officer preparing a credit paper, an engineer reviewing a design or a journalist following the project.

Table 10.2 Checklist for decision-makers reviewing the Kribi steelworks

Question	Evidence that answers it	Relevant gate
Is the plant's grid connection firm, and does it come with an accepted flicker and harmonics study?	Connection agreement; study report accepted by the grid operator; compensator specification	Gate 1
Does the plant have at least two sources for each iron unit, under contract?	Term contracts or binding offers for scrap and HBI; storage design	Gate 1
Can the furnace, caster and mill deliver the planned tonnage with realistic utilisation?	Supplier time balance at the guaranteed kWh per tonne; transformer rating; capacity guarantee; maintenance plan	Gate 1
Will the rebar be certified to NC 236 from the first month, and capable of BS 4449 and ASTM A615 grades?	Mill design with in-line quenching; laboratory plan; certification schedule with ANOR	Gate 1
Are energy, yield and capacity guaranteed by the technology supplier?	Performance-guarantee schedule; test protocol; owner's engineer's review	Gate 1
Are the environmental and social impact assessment and its management plan approved, including EAF dust and slag, and disclosed in time for lenders?	Certificate of environmental compliance; waste management plan; lender disclosure record	Gate 1
Is there a training plan that will staff the plant with qualified nationals?	Training plan; agreements with schools and suppliers; simulator plan	Gate 1
Has Phase 1 reached design yield, energy and output for twelve months?	Operating reports; energy-management data	Gate 2
Is the electrical capacity for 1 Mtpa contracted?	Contract for the zone line's later stage; updated flicker study	Gate 3
Has a Cameroonian DR-grade concentrate been proven at pilot scale?	Pilot-plant report with chemistry, yield and pellet tests from a defined ore body	Gate 4
Is gas for a DR module secured for its life?	Independent reserve audit; long-term gas sales agreement; tax treatment	Gate 4
Is the DR module hydrogen-ready, and are emissions measured per product?	Furnace specification; monitoring, reporting and verification plan	Gate 4

Source: Cameroon Steel.

MOST TECHNOLOGY RISK CAN BE RETIRED BEFORE COMMITMENT

The largest technology risks of the phased pathway are interface risks: grid, metallics, ore and gas. Each can be reduced with a study, a pilot test or a contract before the corresponding investment is committed. The four gates turn that principle into a decision rule.

10.7 What the decision criteria mean for the route choice

The decision criteria reinforce the conclusion of this paper. The electric route allows the project's first commitment to rest on evidence that can be obtained now, about the grid, the iron units, the equipment and the product, while the evidence for domestic ironmaking (ore, pellets, gas) is still being built. No other route allows the same separation. That is why an electric arc furnace, fed first with scrap and imported DRI or HBI and later with direct-reduced iron from concentrated Cameroonian ore, offers the best balance of capital intensity, flexibility, emissions and speed for a new Central African producer.

10.8 What would change the conclusion

A recommendation is only as strong as the conditions under which it holds. Four developments would change the balance described in this paper, and decision-makers should watch for them.

A **much larger market with a coal supply chain** would reopen the case for a blast furnace. If regional demand for long and flat products grew to several million tonnes a year and a secure source of coking coal and port capacity for it were developed, an integrated works could become economic, although its carbon intensity would weigh more heavily each year as carbon border measures tighten [S53, S55].

A **prolonged shortage of traded iron units** would slow the pathway. If HBI and scrap became scarce or very expensive before domestic DRI was ready, Phase 1 would run below capacity or with a lower DRI share, and the case for bringing the direct-reduction gate forward would strengthen, subject to the same evidence on ore and gas.

No long-term gas would change the form of domestic ironmaking rather than the route. Without a gas contract, a direct-reduction module could only run on hydrogen, which would have to wait for new low-carbon generation (Chapter 4).

A **grid connection that cannot carry an arc furnace** would require captive or dedicated generation and a larger compensator, raising costs but not changing the steelmaking technology.

None of these developments is the central case on the evidence available in October 2026. Each would be visible early, and the gate structure allows the plan to respond without stranding the investments already made.

CHAPTER 11

EVIDENCE GAPS: WHAT IS NOT YET KNOWN, AND HOW IT WILL BE RESOLVED

This paper rests on published sources and on Cameroon Steel's planning basis. Several facts that matter to the technology choices are not yet known, or are known only from old, partial or modelled data. None of them changes the conclusion that a phased electric route is the right one; each affects the size, timing or design of a step. This chapter lists the gaps, explains why each matters and states how, by whom and when it will be closed. The gaps map onto the decision gates of Chapter 10.

11.1 Gaps about the grid and power

The most important technical unknown for Phase 1 is the short-circuit strength of the electricity network at the plant's 225 kV connection point. It determines how much flicker the arc furnace will cause and therefore the size and type of compensator needed (Chapter 5). It can only be established once the zone's 225 kV line and substation are commissioned and modelled with the transmission operator. A related gap is the firm capacity that the zone line will reserve for the plant at each stage, beyond the published design values of 100 MW at first and 330 to 400 MW later [S25].

The second gap is the plant's actual electricity consumption. RC-1 plans on a benchmark value of 450 kWh per tonne for the furnace, within 347 to 500 [S03]; this paper adds an upper planning value of about 490 kWh with 30% DRI or HBI in the charge, which adds about 13 GWh a year to Phase 1 and about four minutes to each heat (Chapter 5). The technology supplier's guaranteed values and the transformer rating will replace these benchmarks in front-end engineering, and with them settle whether one furnace delivers the nameplate of 0.3 Mtpa or the expected sustained output of 270,000 to 300,000 t.

11.2 Gaps about iron units

No survey of Cameroon's scrap arising has been published since the 2007 study, whose data date from 2006 [S13]. The estimate in this paper that about 0.1 Mt of scrap is collected each year is a derived order of magnitude (Annex A); RC-1 plans on only about 30,000 t a year of domestic scrap for the plant, within 0 to 60,000 t [S03]. A national scrap survey, ideally with the industry associations and the customs authority, would establish the volume, the grades and the collection chain.

Prices and contract terms for imported HBI and scrap over the life of Phase 1 are not known. They depend on markets in which DR-grade feed is forecast to tighten [S17], and, with the price of imported billets, they set the spread on which the melt shop's case rests (White paper 04, Chapter 8). Binding offers from at least two suppliers per iron unit will be sought before the Phase 1 investment decision.

11.3 Gaps about ore and ironmaking

The DR-grade concentrate that would feed a Kribi direct-reduction module has been produced only in testwork [S19]. Pilot-scale production from a defined ore body, with pellet strength and reducibility tests, is needed. No concentrator or pellet plant for DR-grade product is in any published plan [S36, S81]. The location, ownership and timing of such a plant are open.

The remaining reserves of Cameroon's producing gas field are not public, and the main undeveloped resource has no investment decision [S35]. Gas taxation for industrial users and the price at which gas could be contracted for a direct-reduction module's life are also unknown. An independent reserve audit and negotiations with the national oil company would close these gaps before Gate 4.

11.4 Gaps about the site, climate and products

No measured atmospheric corrosivity classification under ISO 9223 has been published for Kribi [S100]. The humidity and coastal setting suggest the upper categories, but a year of on-site exposure tests is needed to classify the site properly, both for the plant's own structures and for customer guidance.

The national rebar standard NC 236 is reported in the press but its full text was not consulted for this paper [S26, S27]. Before Phase 1, Cameroon Steel will obtain the standard from ANOR and map its requirements against BS 4449 and ASTM A615 in the mill's design specifications.

11.5 Gaps about technology costs

This paper deliberately gives no investment amounts for Cameroon Steel's plant, and the public benchmarks it uses come from other regions and other years. No public, recent cost data were found for Chinese-supplied bar and wire-rod mills in Africa, for African direct-reduction modules or for pellet plants of the size that a Kribi DR module would need. Those costs will be established by competitive vendor quotations during front-end engineering and reviewed by an independent engineer before each gate, rather than inferred from benchmarks.

Table 11.1 Evidence gaps: why they matter, how they will be resolved, by whom and when

Gap	Why it matters	How it will be resolved	Who	When (target)	Before
Short-circuit level and firm capacity at the 225 kV connection	Sets flicker, compensator size and Phase 1 power security	Grid study with the transmission operator; connection agreement	Transmission operator; port authority; Cameroon Steel	2027 to 2028, before financing	Gate 1
Supplier-guaranteed electricity per tonne (planning range 450 to 490 kWh/t), furnace hours, yield and capacity	Decides whether one furnace reaches nameplate or 270,000 to 300,000 t; drives power demand and operating cost	Front-end engineering; performance-guarantee schedule; transformer rating	Cameroon Steel; technology supplier	2027, during front-end engineering	Gate 1
Lender disclosure period for the impact assessment	A certificate in the fourth quarter of 2028 leaves little time before financing [S106]	Disclosure plan agreed with lenders; assessment published on approval	Cameroon Steel; lenders	2028	Gate 1
Current domestic scrap arising and collection	Sets the domestic share of the charge and the collection strategy	National scrap survey with industry and customs	Cameroon Steel; industry associations; customs	2027	Gate 1
Long-term prices and terms for imported HBI and scrap	Sets the spread against delivered billet imports and supply security	Binding offers from at least two suppliers per iron unit	Cameroon Steel; suppliers	2027 to 2028, during front-end engineering	Gate 1
Full text and test requirements of NC 236	Defines certification for the home market	Obtain from ANOR; compliance mapping	Cameroon Steel; ANOR	2027	Gate 1

Gap	Why it matters	How it will be resolved	Who	When (target)	Before
Treatment route for EAF dust	Hazardous waste must have a lawful, safe destination	Waste management plan within the impact assessment	Cameroon Steel; environmental authority	2027 to 2028, with the impact assessment	Gate 1
Measured corrosivity at Kribi (ISO 9223)	Plant durability, storage practice, customer guidance	One-year on-site exposure programme	Cameroon Steel; testing laboratory	2029 to 2030	Gate 2
Market for sections and heavy sections	Sizing and timing of Phases 2 and 3	Market study; offtake discussions	Cameroon Steel	2031 to 2032 (sections); 2033 to 2034 (heavy sections)	Gates 2 and 3
DR-grade concentrate at pilot scale	Precondition for domestic DRI	Pilot plant on a defined ore body; pellet tests	Mining company with Cameroon Steel; independent laboratory	2027 to 2030	Gate 4
Pellet plant: location, owner, timing	Precondition for domestic DRI	Agreement between mine and steelworks; feasibility study	Mining company; Cameroon Steel	2028 to 2032	Gate 4
Remaining gas reserves and long-term gas price	Precondition for a gas-based DR module	Independent reserve audit; gas sales agreement	National oil company; field operator; Cameroon Steel	2026 to 2028 (audit); contract before Gate 4	Gate 4
Low-carbon electricity for hydrogen blending	Sets the pace of decarbonising DRI	Power-sector planning; long-term power contracts	Ministry of Water and Energy; power producers; Cameroon Steel	With the decision on the DR module	After Gate 4

Source: Cameroon Steel. Target dates are Cameroon Steel's planning targets, tied to the RC-1 schedule (edition 10 October 2026); dates for public bodies and other parties are proposals, not their commitments.

11.6 How the gaps will be closed and reported

Cameroon Steel intends to close the Gate 1 gaps during front-end engineering and the impact assessment, which RC-1 targets for 2027 to 2028, with the certificate in the fourth quarter of 2028 [S03], and to update this paper when the results are available. Where a gap is closed by a third party (the transmission operator, the national oil company, the mining company or the standards agency), the update will cite that party's published document. Where a gap remains open at a gate, the gate's decision will be "hold" for the dependent step, as Chapter 10 describes.

Three principles govern the updates. First, measured data replace benchmarks as soon as they exist, and the status chip on each figure changes accordingly. Second, a derived value is always shown with its inputs, so that readers can recompute it when an input changes. Third, nothing that cannot be sourced is printed: where this paper says that a value is not known, it is because no reliable public source was found.

ANNEX A

METHOD, ASSUMPTIONS AND DERIVATIONS

This annex explains how the paper was prepared, the conventions it uses, the planning assumptions behind every project figure, and the arithmetic behind every value marked "derived". A reader with the cited sources can reproduce each derived number.

A.1 Approach and conventions

The paper was prepared by Cameroon Steel from published sources consulted up to 10 October 2026, listed in Annex C, and from Cameroon Steel's reference configuration RC-1 (edition 10 October 2026), a Class 5 planning basis cited as the Cameroon Steel reference configuration RC-1 (planning estimate). This edition uses the RC-1 values as revised on 10 October 2026: domestic scrap available to the plant of about 30,000 t a year (range 0 to 60,000); a Phase 1 nameplate of 300,000 t of finished products with an expected sustained output of 270,000 to 300,000 t; Phase 1 inbound port tonnage of about 351,000 t a year; and a schedule with works from 2029, a first heat in the second half of 2030 and ramp-up in 2031. Every number carries a unit, a year or date and a source marker. Figures carry one of four status chips: sourced (read directly from a published source), derived (arithmetic on sourced inputs, shown below), assumed (a stated planning assumption) or illustrative (a diagram or scenario, not a forecast).

Project figures from RC-1 also carry one of three qualifiers, used only for RC-1 values and never as figure statuses: planned (a value of the current configuration that Cameroon Steel intends to build, such as the Phase 1 units and nameplate), target (a date or performance that the plan aims for but that depends on approvals, financing or suppliers, such as the first heat) and indicative (a value for a later phase or option that is not committed and may change substantially, such as Phases 2 and 3 and the direct-reduction module).

Units are metric. "t" is the metric tonne; "Mt" a million tonnes; "Mtpa" million tonnes a year; "kt" thousand tonnes. Energy is in GJ, MWh, GWh or TWh; 1 MWh equals 3.6 GJ. Natural gas volumes follow the Cameroonian industry convention of standard cubic feet: 1 Mscf is a thousand cubic feet and 1 bcf a billion. For conversions this paper uses 1.094 GJ per Mscf (about 1.037 MMBtu per Mscf at 1.055 GJ per MMBtu), an assumption appropriate for pipeline-quality gas. Money is quoted in the currency and year of the source; FCFA is converted to US dollars only where stated, at the RC-1 planning rate of 600 FCFA per US dollar (range 560 to 650) [S03]. The paper gives no investment amounts for Cameroon Steel.

worldsteel and the IEA measure energy and CO₂ on different boundaries. worldsteel route averages include direct emissions, emissions from purchased electricity and upstream emissions of materials, and count electricity as primary energy; the IEA reports final energy and, for indirect emissions, uses a 2019 world-average grid factor of 538 g CO₂/kWh [S01, S02]. RC-1 intensities are expressed per tonne of finished product, not per tonne of crude steel, and use Cameroon's grid factor. Comparisons between these bases are indicative.

A.2 RC-1 planning assumptions

Table A.1 RC-1 benchmark and planning assumptions used in the paper (planning value and range)

Parameter	Planning value	Range	Status and basis
Phase 1 finished capacity (nameplate)	300,000 t/yr	250,000 to 300,000	Planned [S03]
Phase 1 expected sustained output	285,000 t/yr	270,000 to 300,000	Derived [S03]; D18
Phase 2 additional capacity	200,000 t/yr	150,000 to 200,000	Indicative [S03]
Phase 3 additional capacity	500,000 t/yr	Not stated	Indicative [S03]
DRI module (reserve)	1,000,000 t DRI/yr	800,000 to 1,100,000	Assumed [S03]
EAF electricity, planning value	450 kWh/t liquid	347 to 500	IFC benchmark [S03, S44]
EAF electricity, upper planning value with 30% DRI/HBI	About 490 kWh/t liquid	Not applicable	Derived (D9) [S20]
Auxiliary electricity (LF, caster, oxygen, water, air)	70 kWh/t liquid	50 to 100	Assumed [S03]
Rolling electricity	110 kWh/t product	70 to 140	IFC benchmark [S03, S44]
Induction billet heating (Phase 1)	300 kWh/t product	150 to 400	Assumed [S03]
Gas reheating (Phases 2 and 3)	1.3 GJ/t product	1.1 to 1.6	Assumed [S03]
Water make-up	2.0 m ³ /t product	1.5 to 3.0	Assumed [S03]
Oxygen	35 Nm ³ /t liquid	25 to 45	Assumed [S03]
EAF slag	140 kg/t liquid	110 to 180	Assumed [S03]; range from the IFC benchmark for solid residue, mostly slag [S44]
EAF dust	15 kg/t liquid	10 to 20	Assumed [S03]; the European reference document reports 10 to 30 [S42]
Mill scale	20 kg/t product	15 to 25	Assumed [S03]
Metallic yield	0.88 t liquid/t metallics	0.85 to 0.91	Assumed [S03]
Casting and rolling yield	0.94 t product/t liquid	0.92 to 0.96	Assumed [S03]
DRI/HBI share of charge (Phases 1 to 3)	30%	20 to 50%	Assumed [S03]
Domestic scrap available to the plant	30,000 t/yr	0 to 60,000	Assumed, bounded by the 2006 study [S03, S13]
Grid carbon intensity	226 g CO ₂ /kWh	200 to 300	2024 average [S03, S07]
Natural-gas emission factor	0.0561 t CO ₂ /GJ	Not applicable	IPCC 2006 default [S96]
EAF direct emissions (electrodes, charge carbon, lime)	0.10 t CO ₂ /t liquid	0.06 to 0.15	Assumed [S03]
Upstream emissions of imported DRI	0.7 t CO ₂ /t DRI	0.5 to 0.9	Assumed [S03]

Parameter	Planning value	Range	Status and basis
Gas for direct reduction	10.0 GJ/t DRI	9.2 to 10.0	Assumed [S03]; published range [S20, S48]
FCFA per US dollar (planning)	600	560 to 650	Assumed [S03]
EAF average power factor (this paper)	About 0.8	Not stated	Assumed for the tap-to-tap derivation
Furnace active power (this paper)	About 25 MW	24 to 26 MW (30 to 33 MVA class)	Assumed for the tap-to-tap derivation
Operating hours of the Phase 1 furnace (this paper)	7,000 to 7,700 h/yr	Not applicable	Assumed for the output range (D18)
Electrolyser consumption (this paper)	50 MWh/t H ₂	Not stated	Assumed for the hydrogen derivation

Source: Cameroon Steel reference configuration RC-1 (planning estimate), edition 10 October 2026 [S03], and benchmarks as cited.

A.3 Derivations

D1. Route capex ranges (Chapter 2, Figure ES.1, Figure 2.3). The IEA gives annualised capital costs of US\$52 to 94 per tonne of output a year for the blast-furnace route, US\$53 to 136 for gas DRI-EAF and US\$34 to 58 for scrap-EAF, at an 8% discount rate, 25 years and a 90% capacity factor [S02]. The capital recovery factor at 8% over 25 years is 0.0937. Overnight capex per tonne of annual capacity equals the annualised cost multiplied by the capacity factor and divided by the recovery factor: for example $52 \times 0.9 \div 0.0937 \approx \text{US\$}500$. The resulting ranges are about US\$500 to 900, 510 to 1,310 and 330 to 560 per tonne, in about 2019 dollars. They are not escalated to current prices; budgets announced between 2020 and 2026 (Figure 2.3), which are broader in scope, run from about US\$660 to 1,560 per tonne. The ranges serve to compare routes, not to price a plant. Each project benchmark is the announced budget divided by the announced capacity. The three US announcements give capacity in short tons (1 short ton = 0.9072 t), which are converted to tonnes: US\$300 million for 500,000 short tons, or 0.454 Mt, gives about US\$660 per tonne [S58]; US\$350 million for 430,000 short tons, or 0.390 Mt, about US\$900 [S57]; and US\$450 million for 500,000 short tons about US\$990 [S59].

D2. CO₂ reduction of electric routes (Figure ES.1, the executive summary and Chapter 2). $1 \text{ minus } 1.47 \div 2.34 = 37\%$; $1 \text{ minus } 0.69 \div 2.34 = 71\%$ [S01].

D3. Gross CBAM charge (Chapter 2). Route-average intensity multiplied by the Q3 2026 certificate price of €82.32 per tonne [S54]: $2.34 \times 82.32 \approx \text{€}193$; $1.47 \times 82.32 \approx \text{€}121$; $0.69 \times 82.32 \approx \text{€}57$ per tonne, before deductions for EU free allocation and any carbon price paid in the country of origin. Because worldsteel averages include purchased electricity and upstream materials, which CBAM does not price for iron and steel, these are upper bounds, not estimates of an exporter's charge; White paper 06 (Table 5.2) computes the charge on the CBAM boundary.

D4. Grid emissions of EAF electricity (Chapter 2). $450 \text{ kWh} \times 0.226 \text{ kg CO}_2/\text{kWh} \approx 0.10 \text{ t CO}_2$ per tonne of liquid steel [S03, S07].

D5. Domestic scrap collected (Chapter 3, Figure 3.2). Domestic production of about 260,000 t (2022) [S74] $\times$ about 1.21 t of metallic charge per tonne of product ($1 \div (0.88 \times 0.94)$, the RC-1 yields) $\times$ about 40% local scrap share [S32, S33] $\approx 125,000 \text{ t}$, reported as "of the order of 0.1 Mt". The result is an order of magnitude, sensitive to each input; White paper 04 derives about 108 kt from 2023 billet imports (range 80 to 135 kt).

D6. RC-1 balances (Chapters 3 and 9). Liquid steel = finished products $\div 0.94$; metallics = liquid steel $\div 0.88$; DRI/HBI = 30% of metallics; scrap = the balance. Electricity = liquid steel $\times (450 + 70) \text{ kWh}$ + finished products $\times 110 \text{ kWh}$ + Phase 1 products $\times 300 \text{ kWh}$ for induction heating. Gas = Phase 2 and 3 products $\times 1.3 \text{ GJ}$. Scope 1 = liquid steel $\times 0.10 \text{ t}$ + gas $\times 0.0561 \text{ t/GJ}$; scope 2 = electricity $\times 0.226 \text{ t/MWh}$; upstream of imported DRI = DRI $\times 0.7$

t [S03]. For Phase 1: $300,000 \div 0.94 = 319,149$ t liquid; $+ 0.88 = 362,669$ t metallics; $30\% = 108,801$ t DRI; electricity = $319,149 \times 0.520 + 300,000 \times 0.410 = 288,957$ MWh (average 33 MW over 8,760 hours; RC-1 reports 36 MW on an 8,000-hour operating basis); scope 1 + 2 = $(31,915 + 65,304) \div 300,000 = 0.324$ t per tonne; including upstream DRI ($76,161$ t) = 0.578 t. RC-1 electricity balances use 450 kWh/t in the furnace. At the upper planning value of about 490 kWh/t (D9), electricity rises by 40 kWh per tonne of liquid steel: about 13 GWh in Phase 1 (302 GWh; 38 MW on the 8,000-hour basis), 21 GWh for Phases 1 and 2 (443 GWh; 55 MW) and 43 GWh at full development (796 GWh; 99.5 MW). Scope 1 + 2 intensity rises by $40 \times 0.226 \div 0.94 \approx 0.01$ t per tonne of product, to about 0.33 t in Phase 1 and 0.34 t at full development, and to about 0.59 t including upstream DRI.

D7. Billet share of chapter 72 imports (Figure 3.1). $161,400$ t of HS 7207 [S05] $+ 304,062$ t of chapter 72 imports in 2023 [S71] $\approx 53\%$. The two sources use different reporting systems, so the share is indicative.

D8. Tap-to-tap time and furnace hours (Chapter 5, Figure 5.2). Heat energy = about 40 t $\times 450$ kWh/t = 18 MWh at the planning value, or about 40 t $\times 490$ kWh/t = 19.6 MWh at the upper value. Active power: about 25 MW, assumed for a furnace transformer in the 30 to 33 MVA class at an average power factor of about 0.8 (24 to 26 MW). Power-on time is about 43 minutes at 18 MWh and about 47 minutes at 19.6 MWh. Power-off times as in the published benchmark design [S75], with one extra minute for charging a smaller bucket: 12 minutes. Tap-to-tap is about 55 or 59 minutes. Heats at nameplate = $320,000$ t $\div$ about 40 t = about 8,000. Furnace hours = about $8,000 \times$ tap-to-tap time $\div 60$: $8,000 \times 55 \div 60 \approx 7,300$ at the planning value and $8,000 \times 59 \div 60 \approx 7,900$ at the upper value, out of the 8,760 hours in a year. Specific transformer power of the benchmark design = 156 MVA $\div 150$ t ≈ 1.04 MVA per tonne [S75]; the Phase 1 furnace's is lower.

D9. EAF electricity and DRI share (Chapter 5, Figure 5.3). Electricity = 450 kWh/t, read as an all-scrap value, + 14.5 kWh/t for each 10 percentage points of DRI in the charge, the ENERGIRON reference [S20]: 493.5 kWh/t at 30%, used as the upper planning value of about 490 kWh/t, and 551.5 kWh/t, about 550, at 70%. RC-1's planning value of 450 kWh/t lies within the IFC range of 347 to 500 kWh/t, which already spans common charges; the penalty is applied only to derive the upper value.

D10. Gas demand of a DRI module (Chapter 4, Figure 4.4). Gas = DRI tonnage $\times 10$ GJ/t [S20]; 1 Mt DRI $\rightarrow 10$ PJ $\div 1.094$ GJ per Mscf ≈ 9.14 million Mscf ≈ 9.1 bcf; 0.5 Mt $\rightarrow 4.6$ bcf. Share of 2025 national production (75.475 bcf) [S21]: $9.14 \div 75.475 \approx 12\%$. LNG feed in 2025 = $17.905 + 53.716 = 71.6$ bcf $\approx 95\%$ of output [S21].

D11. Gas cost per tonne of DRI (Chapter 4). 9.14 Mscf per tonne $\times 1,830$ FCFA (power-plant price) $\approx 16,700$ FCFA; $\times 3,135$ FCFA (industrial price) $\approx 28,700$ FCFA [S21]; at 600 FCFA per US dollar, about US\$28 to 48 per tonne. Chapter 4 quotes the range of White paper 05, Chapter 7: US\$27 to 51.

D12. Ore, concentrate and pellets per tonne of DRI (Chapter 4, Figure 4.3). Pellets per tonne of DRI ≈ 1.45 , implied by the BloombergNEF figures cited by IEEFA (210 Mt of pellet supply capping DRI at about 145 Mt in 2030; 252 Mt capping DRI at about 174 Mt in 2040) [S17]. Concentrate $\approx$ pellets (binder and moisture ignored). Ore = concentrate $\div 0.45$ mass yield [S19] ≈ 3.2 t per tonne of DRI. For 1 Mt of DRI: about 1.45 Mt of pellets and 3.2 Mt of itabirite a year.

D13. Electricity for hydrogen-based DRI (Chapter 4). 54 kg of hydrogen per tonne of DRI [S85] $\times 50$ MWh per tonne of hydrogen (assumed) = 2.7 MWh per tonne of DRI; for 1 Mt, 2.7 TWh a year, against national generation of 8.12 TWh in 2025 [S51], about 33%.

D14. Reheating CO₂ (Chapter 6, Figure 6.2). Induction: 300 kWh $\times 0.226$ kg/kWh ≈ 0.068 t CO₂ per tonne. Gas: 1.3 GJ $\times 0.0561$ t/GJ ≈ 0.073 t CO₂ per tonne [S03, S07, S96]. Hot charge at 700 °C: 1.1 to 1.6 GJ minus 0.55 GJ [S50] = 0.55 to 1.05 GJ per tonne.

D15. Energy-management saving (Chapter 8). 4.1% first-year improvement [S31] $\times 289$ GWh [S03] ≈ 12 GWh a year; presented as "about 4%".

D16. Full plant with domestic DRI (Chapter 9). At 1 Mtpa with 70% DRI in the charge: $\text{DRI} = 0.70 \times 1,208,897 \approx 846,000$ t. Shaft-furnace emissions from gas = $846,000 \times 10 \text{ GJ} \times 0.0561 \approx 475,000$ t [S20, S96]; its electricity is counted below, with the plant's. EAF direct = $1,063,830 \times 0.10 \approx 106,000$ t. Reheating gas = $910,000 \text{ GJ} \times 0.0561 \approx 51,000$ t. Electricity = $753 \text{ GWh (RC-1)} + 1,063,830 \times 58 \text{ kWh}$ (four further steps of 14.5 kWh/t from 30% to 70% DRI) $\approx 62 \text{ GWh} + 846,000 \times 73 \text{ kWh}$ for the shaft furnace $\approx 62 \text{ GWh} \approx 877 \text{ GWh} \times 0.226 \text{ kg [S07]} \approx 198,000$ t. Total $\approx 830,000 \text{ t} \div 1,000,000 \text{ t of product} \approx 0.83$, reported as "about 0.8 t CO₂ per tonne", excluding pellet production and mining.

D17. Iron units relative to domestic scrap (Chapter 3, findings). $1,208,897 \text{ t} \div \text{about } 125,000 \text{ t (D5)} \approx 9.7$, reported as "roughly ten times". Phase 1: $362,669 \div 125,000 \approx 2.9$, or about 3.6 against the rounded order of magnitude of 0.1 Mt, reported as "between three and four times"; $362,669 \div 53,000$ to $61,833 \approx 5.9$ to 6.8 ("about six times").

D18. Phase 1 output range and transformer rating (Chapter 5, Finding 09). Heats = operating hours $\times 60 \div$ tap-to-tap time (D8). At 7,000 to 7,700 operating hours: about 7,640 to 8,400 heats at about 55 minutes, or about 305,000 to 336,000 t of liquid steel; about 7,120 to 7,830 heats at about 59 minutes, or about 285,000 to 313,000 t. Finished products = liquid steel $\times 0.94$, capped at the mill's nameplate of 300,000 t: about 287,000 to 300,000 t at 450 kWh/t and about 268,000 to 294,000 t at 490 kWh/t, reported as about 270,000 to 300,000 t, consistent with RC-1's expected sustained output [S03]. Transformer for 320,000 t of liquid steel in 7,000 hours at 490 kWh/t: tap-to-tap = $7,000 \times 60 \div \text{about } 8,000 \approx 52.5$ minutes; power-on = 52.5 minus 12 = 40.5 minutes; active power = $19.6 \text{ MWh} \div 0.675 \text{ h} \approx 29 \text{ MW}$; $\div \text{about } 0.8 \approx 36 \text{ MVA}$, reported as about 36 to 40 MVA. Curtailment: at 55 to 59 minutes per heat, one hour of lost furnace time costs roughly one heat of about 40 t.

D19. Port inbound tonnage (Chapters 3 and 9). Inbound = metallics minus domestic scrap (30,000 t) plus about 6% of finished products for consumables (lime, alloys, electrodes, refractories) [S03]: $362,669$ minus $30,000 + 18,000 \approx 351,000$ t in Phase 1; $1,208,897$ minus $30,000 + 60,000 \approx 1,239,000$ t at full development, before any domestic DRI. Imported scrap in Phase 1 = $253,868$ minus $30,000 \approx 224,000$ t.

D20. Iron units per tonne of billet (Chapter 2). $1 \div 0.88$ metallic yield ≈ 1.14 t of iron units per tonne of liquid steel [S03]; with casting losses of about 1% (assumed), about 1.15 t per tonne of billet.

A.4 Limits of the analysis

The paper uses published benchmarks and a Class 5 planning configuration. Supplier-specific designs, site conditions and contract terms will change many values, and some inputs rest on dated or press sources (for example the 2006 scrap data and the industry's reported scrap share). Capex values are benchmarks for comparing routes; they are not estimates of the cost of Cameroon Steel's plant. Emissions estimates for future phases depend on the grid's evolution, on hydrogen blending and on the boundary chosen; they will be replaced by measured values once the plant operates.

ANNEX B

GLOSSARY

The glossary explains the technical terms and abbreviations used in this paper, in plain language.

Term	Meaning
Agt	Total elongation at maximum force: how far a reinforcing bar stretches, in per cent, before it starts to neck in a tensile test. A key measure of ductility.
ANOR	Agence des Normes et de la Qualité, Cameroon's standards and quality agency, which certifies conformity with national standards such as NC 236.
Basic oxygen furnace (BOF)	A converter in which pure oxygen is blown onto liquid hot metal to remove carbon and impurities. Paired with the blast furnace.
bcf, Mscf	Billion cubic feet and thousand cubic feet of natural gas, at standard conditions.
Billet	A semi-finished cast steel bar, usually of square section, rolled into rebar, wire rod or light sections.
Blast furnace (BF)	A tall shaft furnace that reduces iron ore with coke and produces liquid hot metal.
Bloom, beam blank	Larger semi-finished sections used to roll heavy sections and beams.
CBAM	The EU Carbon Border Adjustment Mechanism, which charges importers for the CO ₂ embedded in covered goods, including iron and steel.
Concentrate	Ore that has been ground and separated to raise its iron content and remove gangue.
Continuous caster	Plant that solidifies liquid steel continuously into billets, blooms or slabs.
Direct reduction (DR)	Removal of oxygen from iron ore in the solid state, usually with a gas rich in hydrogen and carbon monoxide.
DRI	Direct-reduced iron, the porous metallic iron produced by direct reduction. Also called sponge iron.
DR grade	Ore or pellets rich enough in iron and low enough in gangue for direct reduction; typically 67 to 68% iron in traded pellets.
DSO	Direct-shipping ore: ore that can be sold after crushing and screening, without concentration.
EAF	Electric arc furnace, which melts scrap, DRI, HBI or pig iron with electric arcs from graphite electrodes.
EAF dust	Fine dust collected from furnace fume, rich in zinc and lead and classified as hazardous waste.
Flicker (Pst, Plt)	Rapid voltage fluctuations visible as flickering light, measured as short-term (Pst) and long-term (Plt) severity indices.
Gangue	The non-iron minerals in ore, mostly silica and alumina, which end up as slag.
HBI	Hot-briquetted iron: DRI compacted while hot into dense briquettes that are safer to ship and store.
Hot charging	Sending billets from the caster to the mill's heating stage while still hot, to save energy.
Hot metal	Liquid iron from a blast furnace, with about 4% carbon.
Induction furnace	A furnace that melts metal in a crucible by electromagnetic induction; simple but limited in refining.
Induction heater	Equipment that heats billets electrically by induction before rolling.

Term	Meaning
Iron units, metallics	All iron-bearing materials charged to a steel furnace: scrap, DRI, HBI, pig iron.
ISA-95	International standard (also IEC 62264) defining the levels of manufacturing control, from sensors (Level 0) to enterprise planning and logistics (Level 4).
Itabirite	A banded iron formation of fine iron oxides interlayered with silica, which must be ground and concentrated.
JORC Code	The Australasian code for reporting mineral resources and ore reserves.
Ladle furnace (LF)	A secondary-metallurgy station that reheats steel in the ladle and adjusts its chemistry.
Merchant billet	A billet sold to another mill for rolling, rather than rolled by the plant that cast it.
Metallisation	The share of iron in DRI or HBI that is metallic rather than oxide.
MES	Manufacturing execution system (ISA-95 Level 3): schedules, quality records, traceability.
NC 236	Cameroon's mandatory national standard for concrete reinforcing steel.
Pellet	A hardened ball of iron-ore concentrate and binder, the usual feed of a shaft furnace.
Pig iron	Solidified hot metal, with 3.5 to 4.5% carbon, used as a clean iron unit in EAFs.
QST, TEMPCORE	Quenching and self-tempering: in-line water quenching of rebar after the last stand, giving a hard rim and ductile core.
RC-1	Cameroon Steel's reference configuration, a Class 5 planning basis for the Kribi steelworks (edition 10 October 2026).
Re-roller	A rolling mill without a melt shop, which buys billets (imported or merchant) and rolls them into bars, rod or sections.
Rm/Re	Ratio of tensile strength to yield strength of a bar; a measure of strain hardening and ductility.
Schedulable load	Electrical load whose timing can be shifted within the day, for example melting around the grid's peaks, without reducing annual output; unlike interruptible load, which the grid operator can cut for longer periods.
Scope 1, 2, 3	Direct emissions; emissions from purchased electricity; other indirect emissions, including upstream materials.
Scrap (home, prompt, obsolete)	Steel for recycling: generated in the steelworks, in manufacturing, or from end-of-life products and buildings.
Shaft furnace	The vertical reactor of a gas-based direct-reduction plant.
Slag	Molten oxide layer that collects impurities; solidified EAF slag can be processed into aggregate.
Smelting reduction	Processes (COREX, FINEX, HIsarna) that reduce and melt ore with non-coking coal.
STATCOM, SVC	Static synchronous compensator and static var compensator: power-electronic devices that supply fast reactive power to limit flicker and voltage swings.
Tap-to-tap time	The time from one tapping of a furnace to the next, including power-on and power-off periods.
Tundish	Refractory-lined vessel between the ladle and the caster moulds.
Wire rod	Hot-rolled steel of small round section delivered in coils, drawn into wire, mesh and nails.

Source: Cameroon Steel.

ANNEX C

SOURCES

Every source cited in the text with an [S-id] marker is listed below, numbered in order of first citation. Web addresses were accessed between 1 and 10 October 2026. Press and company sources are used for facts they report, not for opinions. Documents of the Port Autonome de Kribi are cited by title and date only. Data from the previous holder of the Mbalam permit are its public disclosures under the JORC Code.

Table C.1 Sources cited in this paper

Id	Title	Publisher	Date	Address
S01	Sustainability Indicators 2025 report (2024 data; route table added Feb 2026)	worldsteel	Nov 2025, updated Feb 2026	https://worldsteel.org/wider-sustainability/sustainability-indicators/
S02	Iron and Steel Technology Roadmap	International Energy Agency	Oct 2020	https://iea.blob.core.windows.net/assets/eb0c8ec1-3665-4959-97d0-187ceca189a8/Iron_and_Steel_Technology_Roadmap.pdf
S03	Cameroon Steel reference configuration RC-1 (planning estimate): phases, benchmarks with ranges and indicative balances for the Kribi steelworks (Class 5), edition 10 October 2026, values as revised on that date	Cameroon Steel	10 Oct 2026	Planning values summarised in this paper (Annex A; plotted values in Annex D)
S04	2025 World Direct Reduction Statistics	Midrex Technologies	Sep 2026	https://www.midrex.com/world-dri-statistics/world-dri-production-reaches-151-0-mt-in-2025/Midrex-STATS-book-2025-FINAL.pdf
S05	UN Comtrade public API: Cameroon (reporter 120), HS 72 and 73 and six-digit lines, 2019 to 2023	United Nations Statistics Division	Accessed 10 Oct 2026	https://comtradeapi.un.org/public/v1/preview/C/A/HS?reporterCode=120&period=2023&partnerCode=0&flowCode=M&cmdCode=72,73,7207,7213,7214,7216,7308
S06	Production: les acteurs en présence	Cameroon Tribune	11 May 2026	https://cameroon-tribune.cm/article.html/76600/fr.html/details_2
S07	Carbon intensity of electricity generation (Ember data)	Our World in Data	Dataset accessed Oct 2026	https://ourworldindata.org/grapher/carbon-intensity-electricity
S08	GSM Tanzania selects Danieli for new rebar and wire-rod mill	Danieli	14 Sep 2026	https://www.danieli.com/en/GSM-Tanzania-selects-Danieli-for-new-rebar-and-wirerod-mill_37_1098.htm
S09	B5Plus Group awards Danieli bar and wire-rod mill project	Danieli	23 Sep 2026	https://www.danieli.com/en/B5Plus-Group-awards-Danieli-bar-and-wirerod-mill-project_37_1099.htm
S10	Development of synthetic flux and a process for de-phosphorization of steel in induction furnace	CSIR National Metallurgical Laboratory, India	Undated, accessed Oct 2026	https://www.nmlindia.org/node/288
S11	Plaul F. J., Böhm C., Schenk J. L., Fluidized-bed technology for the production of iron products for steelmaking. Journal of the SAIMM 109(2)	Southern African Institute of Mining and Metallurgy	Feb 2009	https://www.scielo.org.za/pdf/jsaimm/v109n2/05.pdf
S12	Tata Steel invests \$1.2 billion in green steel technology in Jharkhand	GMK Center	20 Jan 2026	https://gmk.center/en/news/tata-steel-invests-1-2-billion-in-green-steel-technology-in-jharkhand/

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S13	Bidoung J., Fomethe A., Yantio G., Melo U., La récupération et le recyclage des déchets ferromagnétiques: analyse de la situation au Cameroun, Déchets, Revue francophone d'écologie industrielle n°48	ENSP Yaoundé and MIPROMALO	Q4 2007	https://eid.episciences.org/7942/pdf
S14	Direct Reduced Iron (DRI): specifications and handling	International Iron Metalics Association	Undated, accessed Oct 2026	https://www.metallics.org/dri.html
S15	Hot Briquetted Iron (HBI): specifications and handling	International Iron Metalics Association	Undated, accessed Oct 2026	https://www.metallics.org/hbi.html
S16	Climate change and the production of iron and steel (policy paper)	worldsteel	Accessed 10 Oct 2026	https://worldsteel.org/climate-action/climate-change-and-the-production-of-iron-and-steel/
S17	Global high-grade iron ore market is set to grow (S. Basirat)	Institute for Energy Economics and Financial Analysis (IEEFA)	Mar 2026	https://ieefa.org/sites/default/files/2026-03/IEEFA_Global%20high-grade%20iron%20ore%20market%20is%20set%20to%20grow_March%202026_0.pdf
S18	Mbalam-Nabebe resources and reserves as at 20 May 2015 (JORC Code)	Previous holder of the Mbalam permit (ASX-listed company disclosure)	2015	Company disclosure under the JORC Code; cited by title and date
S19	Mbalam iron ore project: presentation to Mining Indaba 2014 (metallurgical testwork on itabirite)	Previous holder of the Mbalam permit (ASX-listed company disclosure)	Feb 2014	Company presentation; cited by title and date
S20	ENERGIRON technology: DRI-EAF production route using natural gas or H2	European Commission, Innovation Centre for Industrial Transformation	Referenced 12 Feb 2026	https://innovation-centre-for-industrial-transformation.ec.europa.eu/innovative-techniques/energiron-technology-drieaf-production-route-using-natural-gas-or-h2
S21	Données pétrolières 2025	Société Nationale des Hydrocarbures (SNH)	Jun 2026	https://snh.cm/wp-content/uploads/2026/06/Donnees-petrolieres-2025.pdf
S22	MIDREX Flex: minimizing technology risks in the transition to carbon-free steelmaking (V. Chevrier), worldsteel Breakthrough Technology Conference	Midrex Technologies, hosted by worldsteel	6 Dec 2023	https://worldsteel.org/wp-content/uploads/Presentation_Vincent-CHEVRIER-Midrex.pdf
S23	Gerdau plant in Charlotte, US: SVC Light for EAF flicker mitigation (customer story)	Hitachi Energy	Undated, accessed Oct 2026	https://www.hitachienergy.com/news-and-events/customer-stories/gerdau-plant-in-charlotte-us
S24	Modular multilevel converter based STATCOM for electrical arc furnace application: Metalfer steel mill, Serbia (case study GEA34872)	GE Vernova Power Conversion	Rev. 20 Feb 2024	https://www.gevernova.com/power-conversion/sites/default/files/2024-02/GEA34872_PowerQ_CS_STATCOM-for-EAF-application-Metalfer_EN_20240220_Rev2.pdf
S25	Kribi franchit la ligne électrique 225 kV	Port Autonome de Kribi	6 Aug 2025	Cited by title and date; the publisher's website is not linked
S26	Cameroon rejects fresh push to revise rebar standard	Business in Cameroon	26 Jan 2026	https://www.businessincameroon.com/construction/2601-15657-cameroon-rejects-fresh-push-to-revise-rebar-standard
S27	Cameroun: le gouvernement rejette une demande de révision de la norme du fer à béton	EcoMatin	5 Feb 2026	https://ecomatin.net/cameroun-le-gouvernement-rejette-une-demande-de-revision-de-la-norme-du-fer-a-beton
S28	TEMPCORE: quench and self-tempering process for reinforcing bars	CRM Group	Undated, accessed Oct 2026	https://www.old.crmgroup.be/en/industrialised-results/bulk-processes/tempcore
S29	Standards for reinforcement (BS 4449:2005+A3:2016 grades)	The Concrete Centre	Undated, accessed Oct 2026	https://concretecentre.com/Codes/European-standards-for-reinforcement.aspx
S30	Technical specification SPB300: deformed steel bars, ASTM A615 Grade 60	Pittini Group (Siderpotenza)	1 Jan 2020	https://www.pittini.it/wp-content/uploads/Pittini-Group-rebar-SPB300.pdf

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S32	Cameroun: Prometal décroche 26,2 milliards FCFA d'Afreximbank	Camer.be	1 Oct 2026	https://www.camer.be/actualites/economie/cameroun-prometal-decroche-262-milliards-fcfa-dafreximbank.html
S33	40 millions d'euros d'Afreximbank: Prometal sécurise ses billettes d'acier alors que la ferraille camerounaise s'épuise	Cameroun24	10 Oct 2026	https://cameroun24.net/article/76267-40-millions-d-euros-d-afreximbank-prometal-securise-ses-billettes-d-acier-alors-que-la-ferraille-camerounaise-s-epuise.html
S34	Énergie et infrastructures: un nouvel élan pour la compétitivité du Port de Kribi	Port Autonome de Kribi	19 Aug 2026	Cited by title and date; the publisher's website is not linked
S35	Cameroon's SNH eyes Yoyo-Yolanda and new exploration blocks to sustain gas growth	Business in Cameroon	6 Jul 2026	https://www.businessincameroon.com/energy/0607-16422-cameroon-s-snh-eyes-yoyo-yolanda-and-new-exploration-blocks-to-sustain-gas-growth
S36	Cameroon Mining Company confirme l'entrée du projet Mbalam dans sa phase irréversible d'exécution	Camer.be via AllAfrica	12 Dec 2025	https://fr.allafrica.com/stories/202512120475.html
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S38	Zone industrielo-portuaire de Kribi (KPIZ): jusqu'à +8 points de croissance et 150 000 emplois attendus sur 15 ans	Investir au Cameroun	4 Mar 2026	https://www.investiraucameroun.com/gestion-publique/0403-23163-zone-industrialo-portuaire-de-kribi-kpiz-jusqu-a-8-points-de-croissance-et-150-000-emplois-attendus-sur-15-ans
S39	École Nationale Supérieure Polytechnique de Yaoundé: départements	ENSP Yaoundé	Undated, accessed Oct 2026	https://polytechnique.cm/
S40	December 2025 crude steel production and 2025 global totals	worldsteel	23 Jan 2026	https://worldsteel.org/media/press-releases/2026/december-2025-crude-steel-production-2025-global-crude-steel-production/
S41	World Steel in Figures 2026	worldsteel	4 Jun 2026	https://worldsteel.org/data/world-steel-in-figures/world-steel-in-figures-2026/
S42	Best Available Techniques Reference Document for Iron and Steel Production (EUR 25521)	European Commission, Joint Research Centre	2013	https://bureau-industrial-transformation.jrc.ec.europa.eu/sites/default/files/2019-11/IS_Adopted_03_2012.pdf
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S44	Environmental, Health, and Safety Guidelines for Integrated Steel Mills	IFC, World Bank Group	30 Apr 2007	https://www.ifc.org/content/dam/ifc/doc/2000/2007-integrated-steel-mills-ehs-guidelines-en.pdf
S45	Pedal to the Metal 2026	Global Energy Monitor	May 2026	https://globalenergymonitor.org/sites/default/files/2026-05/Pedal%20to%20the%20Metal%202026.pdf
S46	Siemens puts twin ladle furnace into operation for ArcelorMittal Bremen	AIST	Apr 2013	https://www.aist.org/siemens-puts-twin-ladle-furnace-into-operation-for-arcelormittal-bremen
S47	GSM Tanzania selects Danieli Technologies for new rebar and wire rod mill	SteelOrbis	15 Sep 2026	https://www.steelorbis.com/steel-news/latest-news/gsm-tanzania-selects-danieli-technologies-for-new-rebar-and-wire-rod-mill-1477389.htm
S48	Suez Steel sets new benchmark in energy consumption for DRI production	Danieli	16 Apr 2026	https://www.danieli.com/en/news-media/news/suez-steel-sets-new-benchmark-energy-consumption-dri-production_37_1051.htm
S49	Commission Implementing Decision (EU) 2022/2110, BAT conclusions for the ferrous metals processing industry	European Commission, Official Journal L 284	11 Oct 2022	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32022D2110

Id	Title	Publisher	Date	Address
S50	Hot charging of steel billets and slabs: impact on energy costs and emissions (S. W. Hesling)	Steelonthenet	1 Jan 2025	http://steelonthenet.com/insights/hot-charging.html
S51	Rapport d'activités 2025	Agence de Régulation du Secteur de l'Électricité (ARSEL)	7 Sep 2026	https://arsel-cm.org/wp-content/uploads/2026/09/Rapport-ARSEL-2025.pdf
S52	Achieving Net Zero Heavy Industry Sectors in G7 Members	International Energy Agency	19 May 2022	https://iea.blob.core.windows.net/assets/c4d96342-f626-4aea-8dac-df1d1e567135/AchievingNetZeroHeavyIndustrySectorsinG7Members.pdf
S53	Regulation (EU) 2023/956 establishing a carbon border adjustment mechanism, Annex I	EUR-Lex, Official Journal L 130	16 May 2023	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023R0956
S54	Price of CBAM certificates	European Commission, DG TAXUD	5 Oct 2026 (latest quarterly price)	https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism/price-cbam-certificates_en
S55	Directive (EU) 2023/959 amending the EU emissions trading system	EUR-Lex, Official Journal L 130	16 May 2023	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32023L0959
S56	Making Net-Zero Steel Possible	Mission Possible Partnership	Sep 2022	https://missionpossiblepartnership.org/wp-content/uploads/2026/10/Making-Net-Zero-Steel-possible-steel.pdf
S57	Nucor to build new rebar micro mill in North Carolina	Nucor Corporation	7 Apr 2022	https://nucor.com/news-release/nucor-to-build-new-rebar-micro-mill-in-north-carolina-122541
S58	Commercial Metals Company to invest \$300 million in its third micro mill (project announced in August 2020)	Steel Technology	Undated, accessed Oct 2026	https://www.steel-technology.com/projects/commercial-metals-company-to-invest-300-million-inits-third-micro-mil
S59	West Virginia announces Commercial Metals Company to build \$450 million micro steelmaking mill in Berkeley County	WV Press	8 Dec 2022	https://wvpress.org/breaking-news/west-virginia-announces-commercial-metals-company-to-build-450-million-micro-mill-in-berkeley-county/
S60	Le turc Tosyali va construire un nouveau complexe sidérurgique en Algérie	Managers.tn	27 Apr 2026	https://managers.tn/2026/04/27/lalgerie-attire-les-grands-le-turc-tosyali-va-y-construire-un-nouveau-complexes-siderurgiques/
S61	H2 Green Steel secures EUR 6.5 billion	North Sweden Business	22 Jan 2024	https://northswedenbusiness.com/news/2024/januari/h2-green-steel-secures-eur-6-5-billion/
S62	Stegra requires additional funding for the construction of a green plant	GMK Center	1 Oct 2026	https://gmk.center/en/news/stegra-requires-additional-funding-for-the-construction-of-a-green-plant/
S63	Algeria's steel industry: why is it growing	GMK Center	28 Jul 2026	https://gmk.center/en/posts/algeria-s-steel-industry-why-is-it-growing/
S64	Global scrap consumption rose by 4.5% y/y in 2025 (BIR World Steel Recycling in Figures)	GMK Center	4 Jun 2026	https://gmk.center/en/news/global-scrap-consumption-rose-by-4-5-y-y-in-2025-bir/
S65	Protecting the steel market: how it's done in North Africa	GMK Center	2 Sep 2026	https://gmk.center/en/posts/protecting-the-steel-market-how-it-s-done-in-north-africa/
S66	Update: final wind-down decision relating to the long steel business	ArcelorMittal South Africa	28 Feb 2025	https://arcelormittalsa.com/Portals/0/NEWS%20RELEASE%20-%20UPDATE%20-%20FINAL%20WIND%20DOWN%20DECISION%20RELATING%20TO%20THE%20LONG%20STEEL%20BUSINESS%20%28%E2%80%9CLONGS%20BUSINESS%E2%80%9D%29_v2.pdf
S67	Commerce extérieur du Cameroun en 2020	Institut National de la Statistique (INS), Cameroon	Jul 2021	https://ins-cameroun.cm/wp-content/uploads/2025/07/Note-Commerce-exterieur-2020_VF-4.pdf
S68	Évolution du commerce extérieur en 2025 (version provisoire)	Institut National de la Statistique (INS), Cameroon	Feb 2026	https://ins-cameroun.cm/wp-content/uploads/2026/04/Note-sur-le-commerce-exterieur-en-2025-version-provisoire_FR.pdf
S69	Métallurgie: les importations du fer à béton interdites jusqu'à nouvel ordre	EcoMatin	10 Apr 2023	https://ecomatin.net/metallurgie-les-importations-du-fer-a-beton-interdites-jusqua-nouvel-ordre

Id	Title	Publisher	Date	Address
S70	Note sur le commerce extérieur 2022	Institut National de la Statistique (INS), Cameroon	Dec 2023, revised 13 Feb 2024	https://ins-cameroun.cm/wp-content/uploads/2025/07/Note-sur-le-Commerce-Exterieur-2022_VF-du-13-fev-2024-Rev-DG-1.pdf
S71	Commerce extérieur du Cameroun en 2023	Institut National de la Statistique (INS), Cameroon	Apr 2024	https://ins-cameroun.cm/wp-content/uploads/2025/07/Note-sur-le-Commerce-Exterieur-2023-c-1.pdf
S72	Cameroun: le groupe Prometal décroche 26 milliards FCFA auprès d'Afreximbank	Sikafinance	30 Sep 2026	https://www.sikafinance.com/marches/cameroun-le-groupe-prometal-decroche-26-milliards-fcfa-aupres-dafreximbank-pour-renforcer-sa-production-dacier-et-conquerir-de-nouveaux-marches_64623
S73	Matériaux de construction: l'offensive locale	Cameroon Tribune	24 Apr 2023	https://www.cameroon-tribune.cm/article.html/56766/en.html/details_2
S74	Métallurgie: les industriels dénoncent la présence du fer à béton contrefait	EcoMatin	22 Jun 2023	https://ecomatin.net/metallurgie-les-industriels-du-secteur-denoncent-la-presence-du-fer-a-beton-contrefait-sur-le-marche-camerounais
S75	BSE-EAF: future-proof melting automated system for safe, reliable and efficient steelmaking (R. Schweikle, J. Apfel, A. Pezza), DOI 10.36146/2026_06_50	La Metallurgia Italiana (AIM)	Jun 2026	https://www.aimnet.it/la_metallurgia_italiana/2026/giugno/Aim_giugno2026_6.pdf
S76	La Lettre du PAK n°254	Port Autonome de Kribi	May 2025	Cited by title and date; the publisher's website is not linked
S77	Kribi: le Premier ministre, chef du gouvernement est là	Cameroon Tribune	30 Dec 2024	https://cameroon-tribune.cm/article.html/68499/fr.html/details_2
S78	15 Insights on the Global Steel Transformation	Agora Industry	15 Jun 2023	https://www.agora-industry.org/publications/15-insights-on-the-global-steel-transformation
S79	Mbalam iron ore mine delays first exports to early 2026	Business in Cameroon	13 Dec 2025	https://www.businessincameroon.com/public-management/1312-15495-mbalam-iron-ore-mine-delays-first-exports-to-early-2026
S80	Exploitations: la revue des gisements	Cameroon Tribune	11 May 2026	https://www.cameroon-tribune.cm/articles/11125/fr/details_2
S81	Sinosteel reporte les exportations du fer de Kribi-Lobé à 2027 malgré 120 milliards FCFA déjà investis	EcoMatin	11 Mar 2026	https://ecomatin.net/cameroun-sinosteel-reporte-les-exportations-du-fer-de-kribi-lobe-a-2027-malgre-120-milliards-fcfa-deja-investis
S82	Le navire usine quitte le Cameroun, le gaz s'arrête	Camer.be	9 Jul 2026	https://www.camer.be/93911/12:1/le-navire-usine-quitte-le-cameroun-le-gaz-sarrete-cameroon.html
S83	MAEGMA Minerals partners with Primetals Technologies for MIDREX Flex plant	Primetals Technologies	10 Jun 2025	https://www.primetals.com/en/news/maegma-minerals-partners-with-primetals-technologies-for-midrex-flex-plant/
S84	DRI-EAF implementation at Saarstahl and Dillinger steelworks (POWER4STEEL)	European Commission, Innovation Centre for Industrial Transformation	Referenced Jul 2025	https://innovation-centre-for-industrial-transformation.ec.europa.eu/innovative-techniques/drieaf-implementation-saarstahl-dillinger-steelworks-power4steel
S85	Hydrogen uses in ironmaking (V. Chevrier, Midrex), H2@Scale kick-off	US Department of Energy	1 Aug 2018	https://www.energy.gov/sites/prod/files/2018/08/f54/fcto-h2-scale-kickoff-2018-8-chevrier.pdf
S86	Cameroon: Energy (Country Commercial Guide)	US International Trade Administration	13 Apr 2026	https://www.trade.gov/country-commercial-guides/cameroon-energy
S87	Global Gateway: Namibia becomes pioneer for Africa's green transition	European Commission, DG INTPA	11 Apr 2025	https://international-partnerships.ec.europa.eu/news-and-events/news/global-gateway-namibia-becomes-pioneer-africas-green-transition-2025-04-11_en
S88	Midrex history	Midrex Technologies	Undated, accessed Oct 2026	https://www.midrex.com/history/
S89	Nachtigal power line delays leave 150 MW of industrial demand unmet	Business in Cameroon	9 Oct 2026	https://www.businessincameroon.com/public-management/0910-16939-nachtigal-power-line-delays-leave-150-mw-of-industrial-demand-unmet

Id	Title	Publisher	Date	Address
S90	Enhanced EAF steelmaking through continuous charging, scrap preheating (Consteel)	European Commission, Innovation Centre for Industrial Transformation	Undated, accessed Oct 2026	https://innovation-centre-for-industrial-transformation.ec.europa.eu/innovative-techniques/enhanced-eaf-steelmaking-through-continuous-charging-scrap-preheating-and
S91	Prometal, Acero Metal, Acieries du Cameroun... qui est le plus gros consommateur d'électricité de la métallurgie camerounaise	EcoMatin	15 Jul 2026	https://ecomatin.net/prometal-acero-metal-acieries-du-cameroun-qui-est-le-plus-gros-consommateur-deelectricite-de-la-metallurgie-camerounaise
S92	Tableaux tarifaires, Décision ARSEL N°00000427 (tarifs moyenne tension 2023 à 2025)	Agence de Régulation du Secteur de l'Électricité (ARSEL)	Uploaded Jan 2026	http://arsel-cm.org/wp-content/uploads/2026/01/TABLEAUX-TARIFAIRES-decision-MT-2023-2025.pdf
S93	Décision fixant le montant du revenu maximum autorisé (RMA) d'ENEO au titre de l'exercice 2025 (réajustée)	Agence de Régulation du Secteur de l'Électricité (ARSEL)	19 Dec 2025	http://arsel-cm.org/wp-content/uploads/2026/01/Decision-fixant-le-Montant-de-le-RMA-Eneo-au-titre-de-leexercice-2025-du-19-12-2025.pdf
S94	Commission Implementing Decision 2012/135/EU establishing BAT conclusions for iron and steel production	EUR-Lex	28 Feb 2012	https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32012D0135
S95	Danieli implements new hot billet charging system at Acciaieria di Sicilia	AIST	10 Aug 2023	https://aist.org/danieli-implements-new-hot-billet-charging-system-at-acciaieria-di-sicilia
S96	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 (Energy), Chapter 1, default CO2 emission factor for natural gas (56,100 kg/TJ)	Intergovernmental Panel on Climate Change	2006	https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf
S97	Electric heating systems (Q-Heat induction heaters)	Danieli	Undated, accessed Oct 2026	https://www.danieli.com/en/danieli-green-metal/electric-heating-systems.htm
S98	Šmak M., Kubiček J., Kala J., Podany K., Vaněrek J., The influence of hot-dip galvanizing on the mechanical properties of high-strength steels, Materials 14(18):5219, doi:10.3390/ma14185219	MDPI (via PubMed Central PMC8467660)	2021	https://pmc.ncbi.nlm.nih.gov/articles/PMC8467660/
S99	Olivry J.-C., Monographie du Nyong et des fleuves côtiers, tome 1	ORSTOM / IRGM	Jul 1979	https://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers11-03/01948.pdf
S100	ISO 9223:2012 Corrosion of metals and alloys: corrosivity of atmospheres (resource description)	Standards New Zealand, Building Code Hub	Accessed Oct 2026	https://codehub.building.govt.nz/assets/_generated_pdfs/iso-92232012-7236.pdf
S101	OPC UA Common Object Model: ISA-95 concept	OPC Foundation	Undated, accessed Oct 2026	https://reference.opcfoundation.org/specs/OPC-10030/4
S102	Intelligent EAF (iEAF) technology	Tenova	Undated, accessed Oct 2026	https://tenova.com/technologies/intelligent-eaf-ieaf-technology
S103	Institut Universitaire de Technologie de Douala: departments	IUT Douala	Undated, accessed Oct 2026	https://www.iut-dla.cm/
S104	Cameroun: Complexe moderne de sidérurgie de Kribi, le PM Joseph Dion Ngute effectue la pose de la première pierre	Camer.be	5 Jan 2025	https://www.camer.be/87795/12:1/cameroun-complexe-moderne-de-siderurgie-de-kribi-le-pm-joseph-dion-ngute-effectue-la-pose-de-la-premiere-pi-cameroon.html
S105	Industrialisation: la voie royale de l'émergence	Cameroon Tribune	2 Jan 2025	https://cameroon-tribune.cm/article.html/68558/fr.html/details_2
S106	IFC Access to Information Policy: disclosure of the Summary of Investment Information and the Environmental and Social Review Summary 60 days (Category A) or 30 days before Board consideration	IFC, World Bank Group	Effective 1 Jan 2012	https://www.ifc.org/en/insights-reports/2012/ifc-access-to-information-policy
S107	Mining 2026: Cameroon (Chazai Wamba), practice guide on Law No. 2023/014 of 19 December 2023 (Mining Code)	Chambers Global Practice Guides	Updated 27 Jan 2026	https://practiceguides.chambers.com/practice-guides/mining-2026/cameroon

ANNEX D

DATA TABLES

This annex lists the values plotted in every chart of the paper, so that readers can check them, reuse them and reproduce the figures. Each table gives units, the status of the values (sourced, derived, assumed or illustrative, as defined in Annex A) and the source identifiers listed in Annex C. The same values are published as machine-readable files with the web edition of this paper. Diagrams that carry no plotted values (Figures 1.1, 2.1, 4.1, 5.1, 6.1, 7.2, 8.1, 8.2 and 10.1) are not repeated here.

D.1 Executive summary and Chapters 1 to 3: routes, energy and capital

Table D.1 Data behind Figure ES.1: CO₂ intensity and indicative capex by route

Route	CO ₂ , t per t crude steel	Capex low, US\$/t capacity	Capex high, US\$/t capacity	Status
Blast furnace + basic oxygen furnace (BF-BOF)	2.34	500	900	CO ₂ sourced; capex derived
Gas direct reduction + EAF (DRI-EAF)	1.47	510	1,310	CO ₂ sourced; capex derived
Scrap + EAF	0.69	330	560	CO ₂ sourced; capex derived
World average	1.92			Sourced
Kribi pathway (RC-1): Phase 1, scope 1+2, t CO ₂ per t finished product	0.32	Not shown	Not shown	Derived (estimated)
Kribi pathway (RC-1): Phase 1, with imported DRI, t CO ₂ per t finished product	0.58	Not shown	Not shown	Derived (estimated)
Kribi pathway (RC-1): 1 Mtpa, 70% domestic DRI, t CO ₂ per t finished product	0.83	Not shown	Not shown	Derived (estimated)

Source: worldsteel 2024 data [S01]; capex derived from IEA annualised costs, about 2019 US dollars, not escalated [S02]; method D1 in Annex A. Pathway values: Cameroon Steel reference configuration RC-1 (planning estimate) [S03], per tonne of finished product on Cameroon's grid, a different boundary from the route averages; methods D6 and D16 (the last value, 0.83, is shown as about 0.8). No capex is given for the project.

Table D.2 Data behind Figure 1.2: iron content of iron oxides

Phase	Formula	Iron, % by mass	Status
Hematite	Fe ₂ O ₃	69.9	Derived (stoichiometry)
Magnetite	Fe ₃ O ₄	72.4	Derived (stoichiometry)
Wüstite	FeO	77.7	Derived (stoichiometry)
Metallic iron	Fe	100.0	Definition

Source: Cameroon Steel, from atomic masses Fe 55.845 and O 15.999.

Table D.3 Data behind Figure 1.3: steel production by process and projects under construction

Series	Process	Share, %	Status
World crude steel, 2025	Basic oxygen	69.4	Sourced
World crude steel, 2025	Electric	30.3	Sourced
World crude steel, 2025	Other	0.3	Sourced
Africa crude steel, 2025	Basic oxygen	11.0	Sourced
Africa crude steel, 2025	Electric	89.0	Sourced
Projects under construction worldwide, 2026 (count)	Electric arc	71.0	Sourced
Projects under construction worldwide, 2026 (count)	Other routes	29.0	Sourced

Source: worldsteel, World Steel in Figures 2026 [S41]; Global Energy Monitor, Pedal to the Metal 2026 [S45].

Table D.4 Data behind Figure 2.2: CO₂ and energy intensity by route

Route	CO ₂ , worldsteel 2024, t/t	CO ₂ , IEA direct + indirect, t/t	Energy, worldsteel 2024, GJ/t	Final energy, IEA, GJ/t
BF-BOF	2.34	2.2	23.88	21.4
Gas DRI-EAF	1.47	1.4	23.30	17.1
Scrap-EAF	0.69	0.3	9.84	2.1

Source: worldsteel Sustainability Indicators 2025 [S01]; IEA Iron and Steel Technology Roadmap [S02]. Status: sourced. worldsteel counts electricity as primary energy and includes upstream emissions; the IEA uses final energy and a 538 g CO₂/kWh grid.

Table D.5 Data behind Figure 2.3: capex ranges and project benchmarks, US\$ per tonne of annual capacity

Route or project	Value	Basis	Status and source
Scrap-EAF (IEA-derived)	330 to 560	Range	Derived [S02]
BF-BOF (IEA-derived)	500 to 900	Range	Derived [S02]
Gas DRI-EAF (IEA-derived)	510 to 1,310	Range	Derived [S02]
CMC Arizona 2 micro-mill (US, 2020)	660	Announced budget + announced capacity	Derived [S58]
Nucor Lexington rebar micro-mill (US, 2022)	900	Announced budget + announced capacity	Derived [S57]
CMC Berkeley County micro-mill (US, 2022)	990	Announced budget + announced capacity	Derived [S59]
New integrated BF-BOF (MPP, 2022)	1,200	Announced budget + announced capacity	Derived [S56]
Tosyali DRI-EAF complex incl. rolling (Algeria, 2026)	1,560	Announced budget + announced capacity	Derived [S60]

Source: As listed. Project values are nominal in the currency year of each announcement; US capacities, announced in short tons, are converted to tonnes (1 short ton = 0.9072 t; method D1). None is a Cameroon Steel estimate.

D.2 Chapters 3 and 4: metallics, ore and gas

Table D.6 Data behind Figure 3.1: Cameroon's chapter 72 imports and billet imports, thousand tonnes

Year	Billets and semis (HS 7207), kt	All chapter 72 imports, kt	Billet share,% (derived)
2019	52.5	182.9	28.7
2020	89.9	279.0	32.2
2021	110.5	297.6	37.1
2022	151.2	283.6	53.3
2023	161.4	304.1	53.1

Source: UN Comtrade for HS 7207 [S05]; INS Cameroun for chapter 72 [S67, S70, S71]. Status: sourced; shares derived. The two sources use different reporting systems.

Table D.7 Data behind Figure 3.2: iron units by RC-1 phase and domestic scrap, thousand tonnes a year

Case	Iron units, kt	of which DRI/HBI, kt	of which scrap, kt
Phase 1 0.3 Mtpa	362.7	108.8	253.9
Phases 1+2 0.5 Mtpa	604.4	181.3	423.1
Full 1.0 Mtpa	1,209	362.7	846.2
Full, domestic DRI at 70%	1,209	846.2	362.7
Domestic scrap arising, 2006 study	53 to 61.8		Sourced [S13]
Domestic scrap collected today (order of magnitude)	125		Derived (method D5)
Domestic scrap RC-1 assumes for the plant	30 (0 to 60)		Assumed [S03]

Source: Cameroon Steel reference configuration RC-1 (planning estimate), indicative balances [S03] (metallic yield 0.88, casting and rolling yield 0.94, DRI 30% of the charge; last case 70%); scrap study [S13]; derivation inputs [S32, S33, S74]. Status: derived.

Table D.8 Data behind Figure 4.2: Mbalam products against DR-grade thresholds

Product or threshold	Iron,%	Silica + alumina,%
Mbalam DSO reserve (JORC, 2015)	62.2	7.26
Mbalam itabirite BF-grade concentrate (testwork, 2014)	66.6	3.80
Mbalam itabirite DR-grade concentrate (testwork, 2014)	68.0	2.00
worldsteel minimum iron for DR processes	64	Not stated
Typical traded DR grade	67 to 68	Low

Source: JORC reserve, 2015 [S18]; testwork, 2014 [S19]; worldsteel [S16]; IEEFA [S17]. Status: sourced.

Table D.9 Data behind Figure 4.3: indicative mass flow per tonne of DRI

Item	Value	Unit	Basis
Itabirite ore	3.2	t per t DRI	Concentrate ÷ 45% mass yield [S19]; derived
DR-grade concentrate	1.45	t per t DRI	Equal to pellets, binder ignored; derived
DR pellets	1.45	t per t DRI	Implied by BNEF figures cited by IEEFA [S17]; derived
Natural gas	10	GJ per t DRI	ENERGIRON reference [S20]

Item	Value	Unit	Basis
Grind size (testwork)	53	µm, P80	Testwork [S19]
Iron recovery (testwork)	81	%	Testwork [S19]
DRI metallisation	92 to 96	%	IIMA [S14]

Source: As listed. Status: derived from sourced inputs; method D12 in Annex A.

Table D.10 Data behind Figure 4.4: gas volumes and DRI gas demand, billion cubic feet a year

Item	bcf per year	% of 2025 national production
National production, 2025	75.47	100
Sold as LNG feed, 2025	71.62	95
Kribi power plant, 2025	4.92	7
Industrial buyer (KEDA), 2025	3.09	4
DRI module 0.5 Mtpa	4.57	6
DRI module 1.0 Mtpa	9.14	12

Source: SNH, Données pétrolières 2025 [S21]; DRI demand at 10 GJ per tonne [S20] and 1.094 GJ per thousand cubic feet. Status: 2025 volumes sourced; DRI demand derived (method D10).

D.3 Chapters 5 to 7: melt shop, rolling and product quality

Table D.11 Data behind Figure 5.2: tap-to-tap time balance, minutes per heat

Element	Phase 1 at 450 kWh/t (heat of about 40 t)	Phase 1 at 490 kWh/t (heat of about 40 t)	Published design (150 t, 156 MVA)
Power-on	43	47	29.3
Charging	4.0	4.0	3.0
Tapping	3.0	3.0	3.0
Tap-hole preparation	1.5	1.5	1.5
Electrodes	1.0	1.0	1.0
Furnace preparation	0.5	0.5	0.5
Unplanned delay	2.0	2.0	2.0
Net tap-to-tap	55	59	40.3
Furnace hours for about 8,000 heats	About 7,300	About 7,900	
Finished products at 7,000 to 7,700 h, t	287,000 to 300,000	268,000 to 294,000	

Source: Phase 1 derived from RC-1 [S03]: heats of about 40 t; about 25 MW of active power, assumed for a 30 to 33 MVA class transformer at a power factor of about 0.8; times rounded to whole minutes and furnace hours to the nearest hundred; about 8,000 heats at nameplate; finished products capped at the 300,000 t nameplate (methods D8 and D18); benchmark design [S75]. Status: derived and sourced.

Table D.12 Data behind Figure 5.3: EAF electricity by DRI share of the charge, kWh per tonne of liquid steel

DRI/HBI share	Line (450 plus DRI penalty)	Low	High
0%	450	347	500
20%	479	376	529
30%	494	390	544
50%	522	420	572
70%	552	448	602
100%	595	492	645

Source: RC-1 planning value 450 kWh/t [S03], within the IFC range of 347 to 500 [S44], read as all-scrap, plus 14.5 kWh/t per 10% DRI [S20]; at 30% DRI the result, 493.5, is the upper planning value of about 490 kWh/t; EU melt-shop range 404 to 748 kWh/t shown for reference [S42]. Status: derived (method D9).

Table D.13 Data behind Figure 6.2: heating energy for rolling, GJ per tonne

Option	Low	High	Source
Gas reheating furnace, bars and rods (EU BAT range)	0.60	1.90	S49
Gas reheating furnace, billets and beams (EU BAT range)	1.40	2.20	S49
Gas walking-beam furnace, cold charge (RC-1 planning assumption)	1.10	1.60	S03
Same furnace, hot charge at about 700 °C (saving 0.55 GJ/t)	0.55	1.05	S50; derived
Induction heating, partly hot-charged (150 to 400 kWh/t, RC-1 assumption)	0.54	1.44	S03
Rolling (deformation) energy, bars and rods	0.10	0.50	S49

Source: As listed; induction values converted at 3.6 GJ per MWh. CO₂ comparison (method D14): gas 1.3 GJ/t $\approx$ 0.073 t CO₂/t; induction 300 kWh/t at 226 g/kWh $\approx$ 0.068 t CO₂/t. Status: sourced, assumed and derived as marked.

Table D.14 Data behind Figure 7.1: ductility classes of BS 4449

Grade	Characteristic yield, MPa	Agt minimum, %	Rm/Re minimum	Rm/Re maximum
B500A	500	2.5	1.05	No limit
B500B	500	5.0	1.08	No limit
B500C	500	7.5	1.15	1.35

Source: The Concrete Centre summary of BS 4449:2005+A3:2016 [S29]. Status: sourced. Below 8 mm diameter, class A values differ.

Table D.15 Data behind Figure 7.3: first-year corrosion of carbon steel by ISO 9223 category

Category	Thickness loss, μm	Mass loss, g/m ²
C1 Very low	up to 1.3	up to 10
C2 Low	1.3 to 25.0	10 to 200
C3 Medium	25.0 to 50.0	200 to 400
C4 High	50.0 to 80.0	400 to 650
C5 Very high	80.0 to 200.0	650 to 1,500
CX Extreme	200.0 to 700.0	1,500 to 5,500

Source: Šmak et al. (2021), Table 1, reproducing EN ISO 9223 [S98]. Status: sourced. Lower bounds are exclusive.

D.4 Chapter 9: the phased pathway

Table D.16 Data behind Figure 9.1: RC-1 schedule by status

Step	Start (year)	Bar end (start of year)	Status
Front-end engineering, Phase 1; utility agreements	2027	2028	target
ESIA baseline; hearings Q3 2028; certificate Q4 2028	2027	2029	target
Financing; no works before the certificate	2028	2029	target
Phase 1 works, from Q1 2029 to first heat	2029	mid-2030	target
First heat H2 2030; ramp-up through 2031	mid-2030	2032	target
Phase 2: second melt line, light and medium sections	2032	2035	indicative
Phase 3 to 1 Mtpa: melt-shop expansion, heavy sections	after 2034	open	indicative
Direct-reduction module for Cameroonian ore (later)	after 2034	open	indicative

Source: Cameroon Steel reference configuration RC-1 (planning estimate), schedule as revised 10 October 2026 [S03]. Bars run to the start of the following year; 'mid-2030' marks the second half of 2030; Phase 2 is indicative for 2032 to 2034; Phase 3 and the DRI module, which follows later, are shown in the open band 'after 2034'.

Table D.17 Data behind Figure 9.2: electricity demand and carbon intensity by RC-1 phase

Phase	Electricity, GWh/yr (at 490 kWh/t)	Average load, MW (at 490 kWh/t)	Maximum demand, MVA	Scope 1 + 2, t CO ₂ /t	Incl. upstream of imported DRI, t CO ₂ /t
Phase 1	289.0 (301.7)	36.1 (37.7)	55	0.324	0.578
Phases 1+2	421.6 (442.9)	52.7 (55.4)	≈100 (85 to 110; interpolated, derived)	0.326	0.580
Full 1 Mtpa	753.2 (795.7)	94.1 (99.5)	160	0.328	0.582

Source: Cameroon Steel reference configuration RC-1 (planning estimate), indicative balances at 450 kWh/t in the furnace [S03]; values in brackets at the upper planning value of 490 kWh/t (method D6; intensities then rise by about 0.01 t); average load on an 8,000-hour basis; maximum demand assumed; zone 225 kV line: 100 MW initially, 330 to 400 MW later [S25, S34]; worldsteel benchmarks 0.69 and 1.47 t CO₂/t [S01]. Status: derived and assumed.

Table D.18 Data behind Table 9.2: RC-1 indicative balances in absolute values

Item	Unit	Phase 1	Phases 1 and 2	Full, 1 Mtpa
Finished products	t/yr	300,000	500,000	1,000,000
Liquid steel	t/yr	319,149	531,915	1,063,830
Iron units (metallics)	t/yr	362,669	604,449	1,208,897
DRI/HBI (30% of charge)	t/yr	108,801	181,335	362,669
Scrap	t/yr	253,868	423,114	846,228
Electricity	MWh/yr	288,957	421,596	753,191
Natural gas (reheating)	GJ/yr	0	260,000	910,000
Water make-up	m ³ /yr	600,000	1,000,000	2,000,000
Oxygen	million Nm ³ /yr	11.2	18.6	37.2
EAF slag	t/yr	44,681	74,468	148,936

Item	Unit	Phase 1	Phases 1 and 2	Full, 1 Mtpa
EAF dust	t/yr	4,787	7,979	15,957
Mill scale	t/yr	6,000	10,000	20,000
Scope 1 CO ₂	t/yr	31,915	67,777	157,434
Scope 2 CO ₂	t/yr	65,304	95,281	170,221
Upstream CO ₂ of imported DRI	t/yr	76,161	126,934	253,868

Source: Cameroon Steel reference configuration RC-1 (planning estimate), edition 10 October 2026 [S03]; method D6 in Annex A. Status: derived from planned capacities and the benchmark assumptions in Table A.1, with the furnace at 450 kWh/t. Values are unrounded model outputs and should be read to two significant figures.

CAMEROON STEEL

FROM MINERAL RESOURCE TO INDUSTRIAL VALUE

Cameroon Steel is developing a steel complex at Mboro, in the Kribi industrial-port zone, to turn scrap, imported iron and, in time, Cameroonian ore into the bars, rods and sections that Central Africa builds with. This paper is published for information and does not constitute an offer or a commitment.