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# World Energy Transition outside the West

A pragmatic stocktake of ten non-Western countries

**Jean-Michel Glachant**
FSR Global, New Delhi, and Florence School of Regulation, European University Institute

**Ramakrishnan Atreya**
FSR Global, New Delhi

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## Report: World Energy Transition outside the West: A pragmatic stocktake of ten non-Western countries

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# Executive summary

**Key messages**

1. The energy transition outside the West is real and measurable: nine of ten countries grew solar and wind faster than fossil fuels over 2013–2024, and six already have solar at 10–30 per cent of installed capacity.
2. It is not one transition but several: Chile leads on deployment and minerals with no manufacturing; Indonesia is the mirror image; India is strong downstream and absent upstream; only China is present at every step.
3. Seven of the ten countries are on a measurable transition path. The data to track it remain thin outside China and India, and this paper is a first stocktake, not a final score.

Is there an energy transition outside the West? This paper answers the question pragmatically. Rather than starting from pledges, targets and commitments, it measures what ten non-Western countries have actually built over the decade 2013–2024: new sources of primary energy, the manufacturing and adoption of the equipment that turns those sources into useful energy and give consumption its electricity consuming devices, plus the mining and refining of the minerals that this equipment requires. The ten countries are China, India and Indonesia in Asia; South Africa, Nigeria and Kenya in Africa; Saudi Arabia; and Brazil, Chile and Türkiye. Together they hold roughly half of the world's population.

We organise the evidence in three steps and 21 indicators. Step one measures the speed at which solar and wind energy are growing relative to fossil fuels, and the intensity of that growth per inhabitant, per unit of GDP and as a share of installed generating capacity. Step two follows the transition downstream into the economy: the domestic production of solar modules, wind turbines and lithium-ion batteries, and the uptake of electric two- and three-wheelers and electric cars. Step three goes upstream to the mining and refining of copper, nickel, cobalt and lithium. Nuclear power and hydropower are deliberately left out of the measurement, for reasons explained in Section 2.

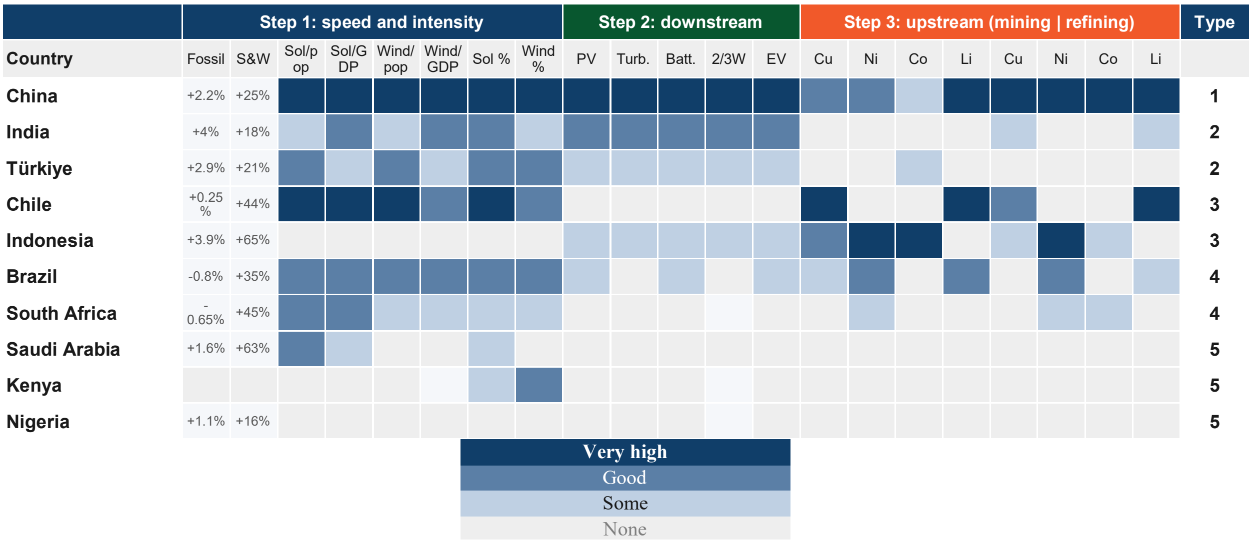
Three findings stand out. First, the transition is real and measurable. In nine of the ten countries, solar and wind consumption grew faster than fossil fuel consumption over the decade, and in six of them (Brazil, Chile, China, India, South Africa and Türkiye) solar and wind already represent a material share of installed capacity, between 10 and 30 per cent for solar and between 5 and 17 per cent for wind. China and Chile lead on every intensity measure.

Second, the transition is not one process but several. Chile is a leader in deploying new energy sources and a world leader in copper and lithium mining, yet has no domestic manufacturing of transition equipment. Indonesia is the mirror image: little solar and wind so far, but a rapidly growing manufacturing base for modules, turbines and batteries, and the world's first-ranked producer of mined and refined nickel. India is a strong and consistent challenger at steps one and two, but has almost no upstream position. China alone is present, and usually first, at every step of the chain.

Third, the data needed to track this transition are still poor outside China and India. Production statistics for transition equipment stop in 2022 for most countries in the UNIDO industrial database, no country publishes production of electric two- and three-wheelers on a comparable basis, and country rankings for refined minerals differ according to the definition used. We have been explicit about these gaps throughout, and we treat several of the downstream and upstream figures as indicative rather than final.

On this evidence we propose a provisional typology of five transition paths: a full-chain leader (China); two countries strong at steps one and two but weak upstream (India and Türkiye); two countries strong at this or that ends of the chain but absent in between (Chile and Indonesia); two lightweight performers (Brazil and South Africa); and three countries where the transition (as we conceive it) has barely begun (Saudi Arabia, Kenya and Nigeria). Seven of the ten countries are already on a measurable transition path. The typology is offered as a starting point for discussion and for a second edition that would add further countries, rare earths, and the missing production statistics.

## Figure ES1. The stocktake at a glance: ten countries, 21 indicators, five transition types




*Types: 1 full-chain leader; 2 strong downstream, weak upstream; 3 strong at one end of the chain, absent at the other; 4 partial performer; 5 not yet competing. Source: Tables 8 to 10; the placement rule is given in Section 7.*

# 1. Introduction: why a pragmatic stocktake

It is not easy to remember what the world looked like more than ten years ago, before the Paris Agreement and the first Trump administration, at the beginning of the Modi and Xi eras. The world has changed so deeply in a decade that we sometimes no longer recognise it. Why should the energy transition have changed any less?

At the Center on Global Energy Policy at Columbia University, Corbeau and Mitrova (2025) argued that the ‘energy transition’ cannot remain only a claim; it has to be built on realities observed in the real world. They proposed distinguishing two types of country in relation to the new energy push: the supporters, whom they call the ‘electrostates’, and the opponents, whom they call the ‘petrostates’. This was a step outside the normative and a step inside the positive. To be frank, it still kept a foot on each side. Oil- and gas-rich countries should be found on the petrostate side. Are they?

The IEA has taken another step: the world has entered the ‘age of electricity’, after the ‘golden age of gas’ it announced fifteen years earlier (IEA, 2011; IEA, 2024). Michael Liebreich, founder of New Energy Finance, now BloombergNEF, made the same point in the summer of 2025: even setting aside the grand commitments made at successive COP meetings, the comparative growth of fossil fuel consumption and of the new sources of electricity speaks loud and clear (Liebreich, 2025a; 2025b). Texas, the leading oil and gas state of the United States, is also a leader in renewable electricity and battery storage; in the spring of 2026 solar, wind and batteries together met most of ERCOT’s demand during the middle of the day. Norway, in Europe, is the undisputed leader in clean electricity generation, electric vehicles and heat pumps. Neither behaves as the petrostate label would predict.

This is the choice made for the present study, hosted by FSR Global in New Delhi. We set aside the normative approach (‘you should do this; you should do that’). We set aside the rivalry between the two Western camps, Europe and the United States. And we look only at the rest of humanity: roughly 85 to 90 per cent of people, who do not live in the West. Are they, in practice, in an energy transition? Are they developing and tapping new sources of primary energy? Can this be observed and measured, giving the facts of new energy sourcing priority over announced policies, intentions and commitments?

We are not the IEA or the World Bank, and our research resources are modest. That is no reason not to start. We reduce the task by reducing the number of countries to ten. Which ten? Asia is where most of humanity lives in this century (about 60 per cent of today’s world population), so we take three Asian giants: China and India, both coal-rich but dependent on imported oil and gas, and Indonesia, with a richer subsoil (among the world’s three largest coal producers with China and India, modest in oil, and among the fifteen largest producers of natural gas). Africa will hold about 40 per cent of humanity by the end of the century. It is a large and heterogeneous continent, and we take three countries from it: South Africa, a coal producer (among the world’s top seven) without oil and gas, and a democracy since 1994; Nigeria, a large oil and gas producer (among the top twenty for both); and Kenya, on the East African coast, with a power system built largely on geothermal and hydro. Two further places go to oil- and gas-rich countries: Saudi Arabia (among the top three for oil and top ten for gas) and Brazil (among the top ten for oil). The last two go to countries without oil and gas but with dynamic and ambitious energy policies: Chile and Türkiye. These are our ten.

# 2. Approach: three steps and 21 indicators

## 2.1 Step one: the speed and intensity of new energy sources

We first consider the growth of fossil fuel consumption against the growth of the two new primary energy sources, solar and wind, as an indicator of whether an energy transition is occurring at all, and where. We call this the energy transition speed (Section 3.1).

To gauge the weight of the transition where it occurs, we add signals of intensity: the solar and wind capacity installed per inhabitant and per unit of GDP, and the share of solar and wind in total national generating capacity. We call this the energy transition intensity (Sections 3.2 and 3.3).

To keep measurement and comparison simple, we deliberately leave aside nuclear power, although it too is a primary energy source that can substitute for fossil fuels. Entering nuclear generation is not easy and requires very long lead times. Even France, known everywhere as a nuclear champion, had no firm investment plan by the summer of 2026 for the new wave of reactors announced by its President in the spring of 2022, and the first new unit is not expected to feed the grid before 2038, if all goes well. We therefore prefer to wait before treating nuclear as an early sign of a new transition.

Hydropower is also a major primary energy source. But climate change is bringing new patterns of drought and heavy rain, which make statistics on hydro output growth more hazardous to interpret. We again simplify by leaving annual hydropower output aside. For a similar reason we leave aside geothermal, biomass and biofuels, which matter greatly in some of our countries (geothermal in Kenya, biofuels in Brazil) and which we flag where they affect the reading of a result.

## 2.2 Step two: the electrification downstream

The two new energy sources are ambitious and, in a sense, want to conquer the world: the world of fossil energy, its best practice and its records. But solar and wind energy reach users mainly through the secondary energy carrier that is electricity.

Because electricity is a secondary rather than a primary source of energy, it never grows at random. Dedicated equipment has to be designed with the appropriate technologies, and manufactured. People have to decide to move to electricity by investing, and by learning how to operate and use the new equipment, sometimes by doing.

Step one already covers the first stage of the new energy resources: the growth of their consumption and of their generating capacity.

It is striking how much this ‘electrified’ energy transition is, economically, an investment process: a building of assets and an accumulation of fixed costs. The first line of the wave is made of millions of photovoltaic panels and thousands of wind turbines. But the current transition aims at more than feeding the existing demand for electricity. It seeks to displace the strongest pillars of fossil fuel consumption.

On the second line of the supply wave come the batteries, which give the new energy sources the same ease of storage and dispatch that oil and gas enjoy in their tanks and reservoirs. Batteries are also the core component of a third line, the conquest of new uses through electric mobility: two- and three-wheelers, cars and trucks. This is the electrification of core energy demand.

The new energy transition is therefore also a process of asset accumulation on the demand side. We treat the manufacture and use of new mobility assets as another pragmatic and measurable indicator of a concrete transition.

## 2.3 Step three: the electrification upstream

This transition is such a large accumulation of new assets that it has a third step: the upstream of technologies and materials that shapes a new electrification supply chain.

It is not surprising that new technologies have been favoured in designing new assets. But the consequences are large when, as today, world trade is fragmenting into geopolitical clubs separated by privileges, tensions or open conflict. The three international bodies that have examined the question (IEA, 2025a; IRENA, 2024; OECD, 2026) all find the upstream to be a significant part of the new energy transition, and Ember’s annual reviews document the same trend on the electricity side (Ember, 2026). We concluded that we too should look at this upstream. A large accumulation of new assets cannot occur unless it is fed by the appropriate materials and minerals.

To keep this first, preliminary view tractable, we reduce the upstream to four materials: copper and nickel, the established metals of electrification, and lithium and cobalt, representatives of the newer battery minerals.

The results of the whole exercise are brought together in Section 6, where the 10 countries × 21 indicators are summarised in three scorecards, one per step. Section 7 draws a provisional typology of transition paths from those scorecards.

## 2.4 The ten countries

Before proceeding, we introduce the ten countries very briefly: not their political regimes or their official policies, only their basic dimensions (Table 1). First, population: five of the ten are among the world's ten most populous countries (India, China, Indonesia, Nigeria and Brazil) and a sixth, Türkiye, is in the top twenty. Second, GDP: three are among the ten largest economies at nominal exchange rates (China, India and Brazil), and two more (Indonesia and Türkiye) enter the top ten or its immediate vicinity when GDP is adjusted for purchasing power parity. A third way to introduce them is the World Bank's income classification for the fiscal year 2027. Lower-middle income: India, Kenya and Nigeria. Upper-middle income: Brazil, China, Indonesia, South Africa and Türkiye. High income: Chile and Saudi Arabia.

India would rise sharply if its GDP were measured at purchasing power parity. But our subject is mainly investment, industrial assets and capital goods, for which nominal values are the more relevant measure; PPP measurement is not perfect either. A corrective approach could be explored in a later edition. Our sample of ten is not a scientific condensate of today's non-Western world, but neither is it an arbitrary set.

**Table 1. Basic dimensions of the ten countries, 2024**

| Country | Population (m) | GDP (US$bn) | Total energy (TWh) | Electricity (TWh) | GDP per capita (US$) | Income group (FY2027) |
|---|---|---|---|---|---|---|
| Brazil | 212.00 | 2,185.8 | 3,048 | 751 | 10,310 | Upper-middle |
| Chile | 19.76 | 330.2 | 418 | 90 | 16,711 | High |
| China | 1,419.32 | 18,945.1 | 44,107 | 10,087 | 13,348 | Upper-middle |
| India | 1,450.94 | 3,760.8 | 10,783 | 2,037 | 2,592 | Lower-middle |
| Indonesia | 283.49 | 1,396.3 | 3,041 | 372 | 4,925 | Upper-middle |
| Kenya | 56.43 | 119.3 | n.a. | n.a. | 2,114 | Lower-middle |
| Nigeria | 232.68 | 252.1 | n.a. | n.a. | 1,084 | Lower-middle |
| Saudi Arabia | 33.96 | 1,254.1 | 3,280 | 458 | 36,930 | High |
| South Africa | 64.01 | 401.1 | 1,402 | 236 | 6,266 | Upper-middle |
| Türkiye | 87.47 | 1,358.2 | 1,946 | 355 | 15,528 | Upper-middle |

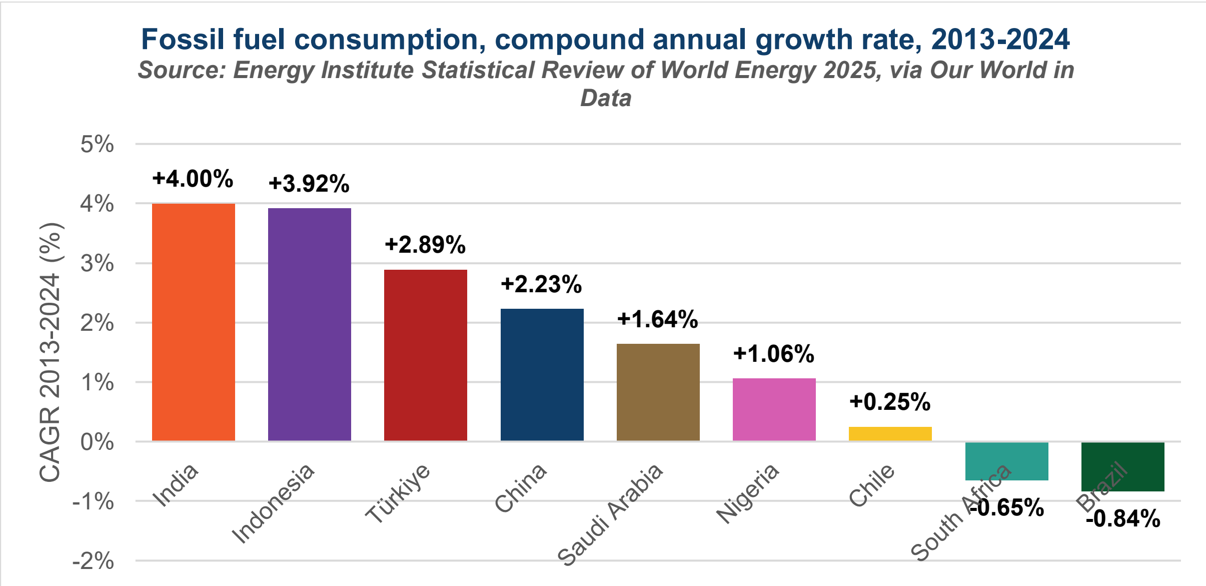
*Sources: population, UN DESA World Population Prospects 2024 (medium variant); GDP, IMF World Economic Outlook, April 2026 (current prices); total energy and electricity, Energy Institute Statistical Review of World Energy 2025 (converted from exajoules to TWh at 1 EJ = 277.78 TWh); income groups, World Bank country classifications FY2027. Kenya and Nigeria are not reported individually in the Energy Institute Statistical Review, included only in regional Africa aggregates, so total energy and electricity are left blank rather than estimated.*

# 3. Step one: new energy sources

## 3.1 Speed: fossil fuels against solar and wind, 2013–2024

We consider the growth of fossil fuel consumption against the growth of solar and wind consumption as an indicator of whether an energy transition is under way: whether new primary energy resources are being tapped and consumed.

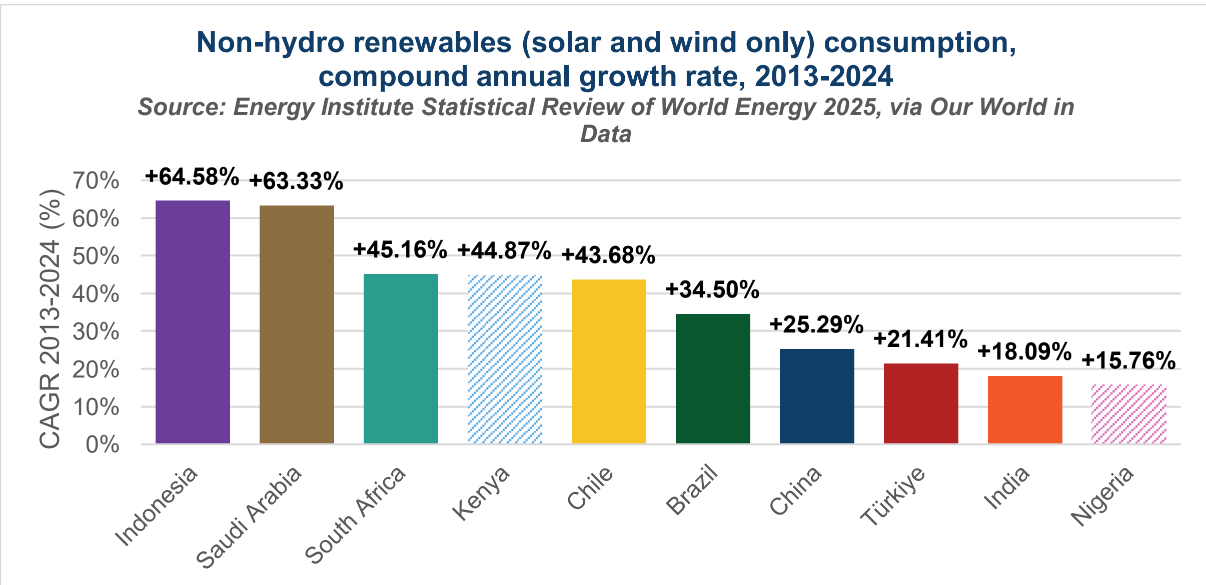
**Figure 1. Fossil fuel consumption, compound annual growth rate, 2013–2024**




Eight of the ten countries show positive annual growth in fossil fuel consumption (from +0.25 to +4.3 per cent a year) and two show a small decline (−0.6 to −0.8 per cent).

Only the growth rate of solar and wind consumption (the non-hydro renewables series in our data) can therefore tell us whether a transition to new energy resources is occurring.

**Figure 2. Solar and wind consumption, compound annual growth rate, 2013–2024**



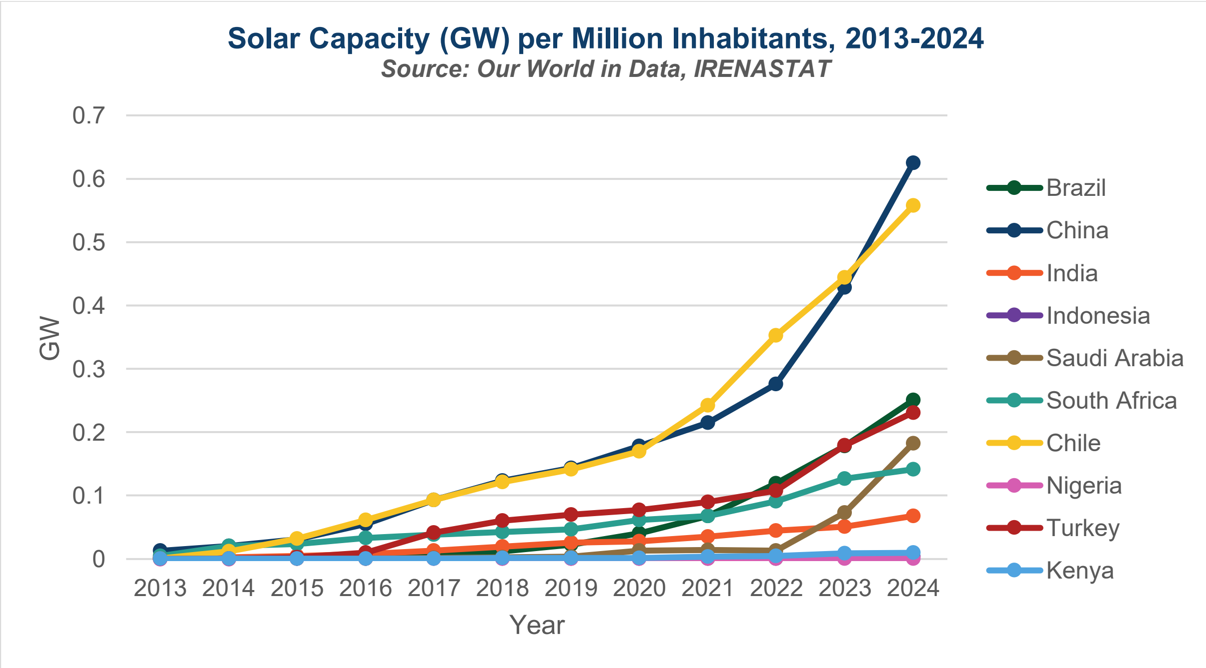

All ten countries show strongly positive annual growth in solar and wind, from +4 to +63 per cent. This first test therefore gives the same answer everywhere.

We also know, however, that very small phenomena can grow fast while remaining close to insignificant. Saudi Arabia's 63 per cent a year starts from almost nothing. We therefore need to look at the intensity of the change, to see whether it is a transition in energy sources or only a change of colour at the margin.

## 3.2 Intensity: installed capacity per inhabitant and per unit of GDP

To verify whether the change amounts to a transition, we use two signals of intensity: the solar and wind capacity installed per inhabitant and per unit of GDP (this section), and the share of solar and wind in the country's total generating capacity (Section 3.3).

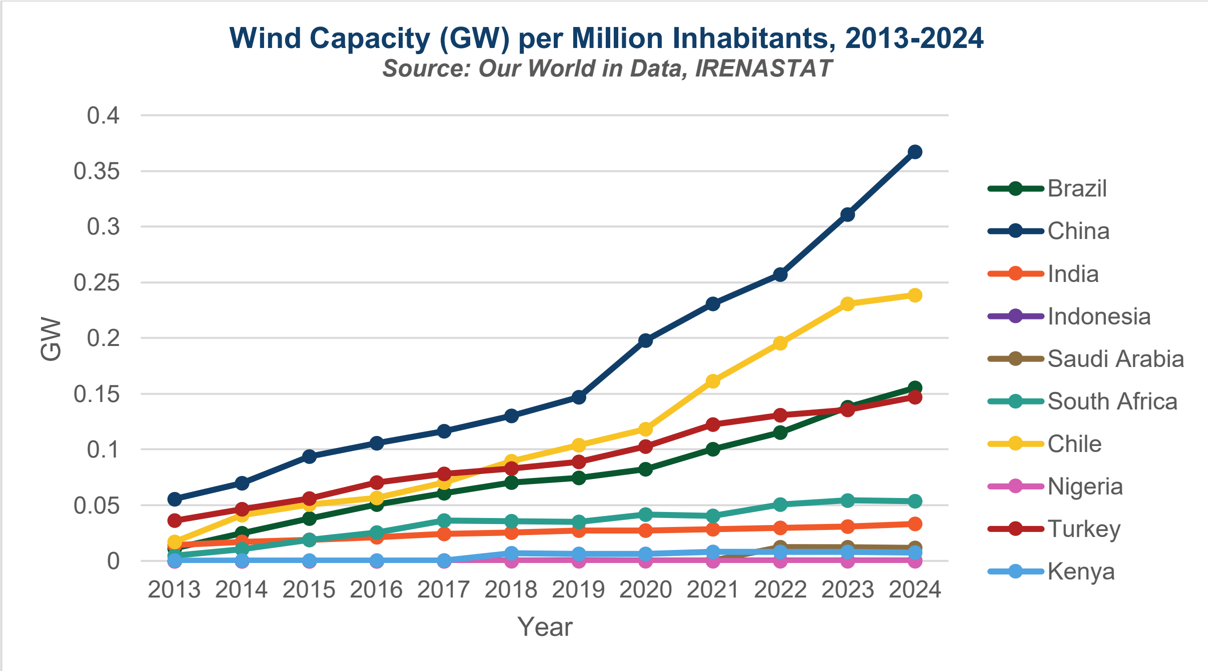
**Figure 3. Solar capacity installed per million inhabitants, 2013–2024 (GW)**




Four groups of countries appear for solar capacity per inhabitant at the end of the period:

1. Two strong leaders, China and Chile, at around 600 MW of solar per million inhabitants;
2. Four robust followers, Brazil, Türkiye, Saudi Arabia and South Africa, at 150 to 250 MW per million;
3. One growing learner, India, approaching 70 MW per million;
4. Three countries not yet competing: Indonesia, Nigeria and Kenya.

**Figure 4. Wind capacity installed per million inhabitants, 2013–2024 (GW)**

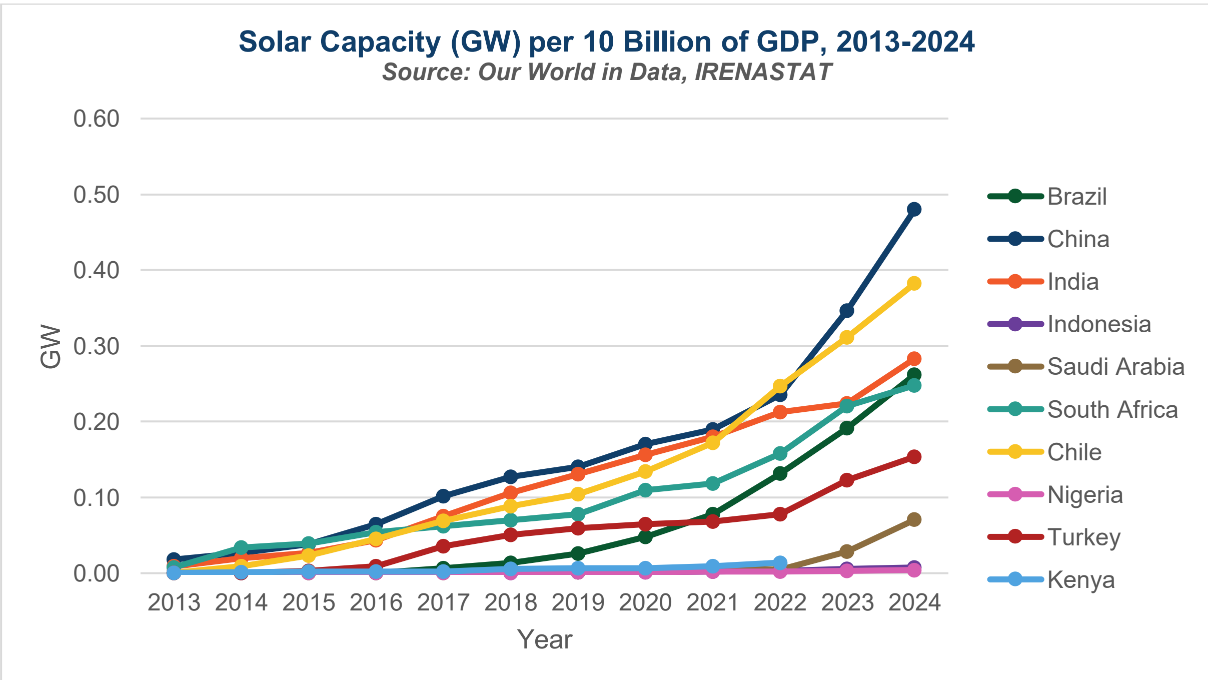



Five groups appear for wind capacity per inhabitant:

1. One very strong leader, China, above 350 MW of wind per million inhabitants;
2. One strong leader, Chile, at about 240 MW per million;
3. Two robust followers, Brazil and Türkiye, at about 150 MW per million;
4. Two learners, India and South Africa, at 30 to 55 MW per million;
5. Four countries not yet competing: Indonesia, Saudi Arabia, Nigeria and Kenya.

We now turn to the twin signal: solar and wind capacity installed per unit of GDP.

**Figure 5. Solar capacity installed per US$10 billion of nominal GDP, 2013–2024 (GW)**

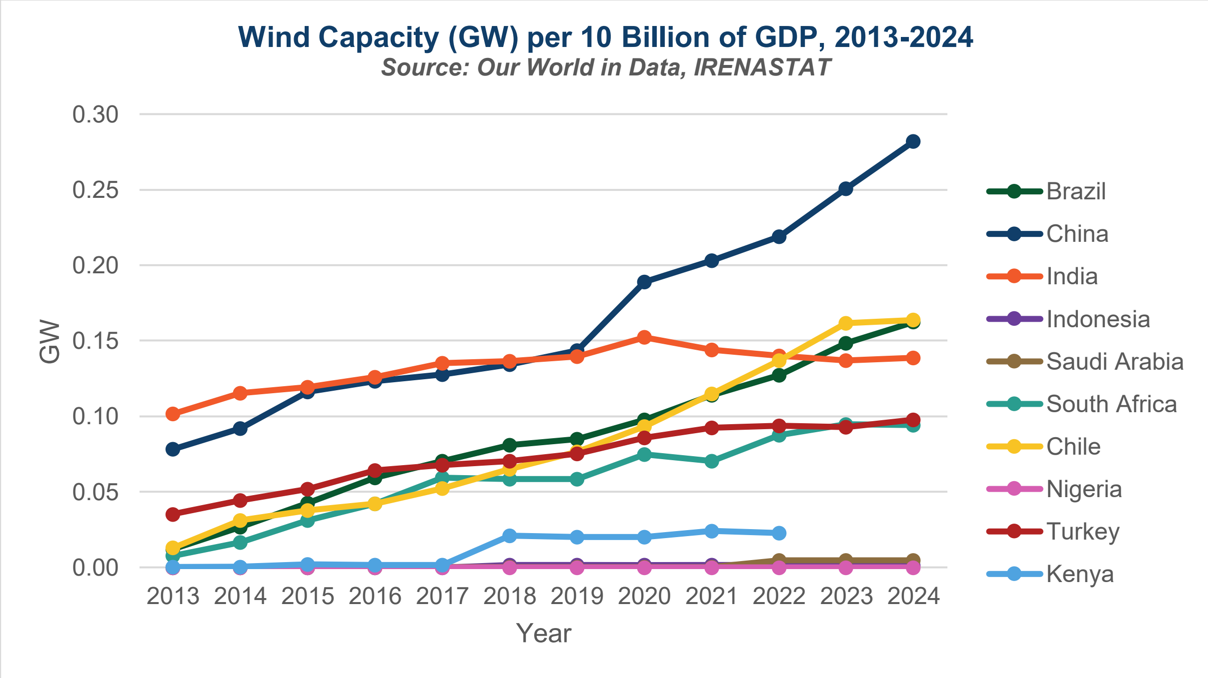



Five groups appear for solar capacity per unit of nominal GDP:

1. Two strong leaders, China and Chile, at 400 to 500 MW of solar per US$10 billion of GDP;

2. Three robust followers, India, Brazil and South Africa, approaching 300 MW;
3. One growing learner, Türkiye, at about 150 MW;
4. One slow learner, Saudi Arabia, below 100 MW;
5. Three countries not yet competing: Indonesia, Nigeria and Kenya.

**Figure 6. Wind capacity installed per US$10 billion of nominal GDP, 2013–2024 (GW)**



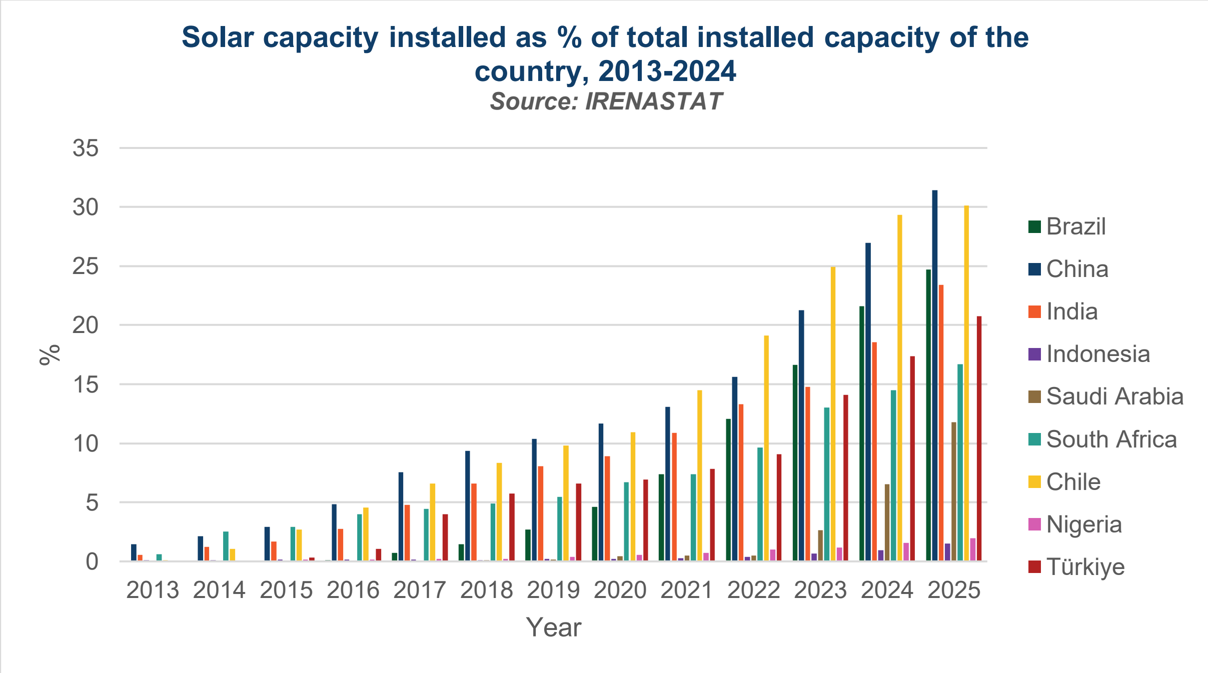

Five groups appear for wind capacity per unit of nominal GDP:

1. One strong leader, China, approaching 300 MW of wind per US$10 billion of GDP;
2. Three robust followers, Chile, Brazil and India, at about 150 MW;
3. Two growing learners, Türkiye and South Africa, at about 100 MW;
4. One slow learner, Kenya, at about 25 MW;
5. Two countries not yet competing: Indonesia and Nigeria.

## 3.3 Intensity: share of solar and wind in total generating capacity

We now turn to the second type of intensity indicator: the capacity of solar and wind generation as a share of the country's total electricity generating capacity.

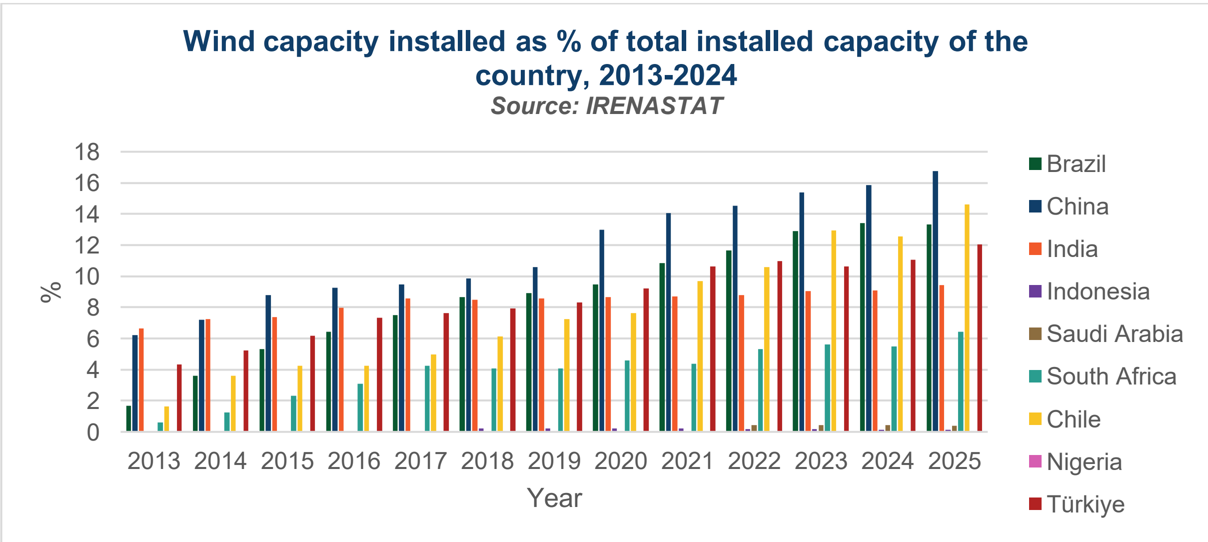
**Figure 7. Solar capacity as a share of total installed generating capacity, 2013–2024 (per cent)**




Four groups appear for the share of solar in total generating capacity:

1. Two strong leaders, China and Chile, at 30 per cent or more;
2. Three robust followers, Brazil, India and Türkiye, at 20 to 25 per cent;
3. Three growing learners, South Africa, Kenya and Saudi Arabia, above 10 per cent;
4. Two countries not yet competing: Indonesia and Nigeria.

**Figure 8. Wind capacity as a share of total installed generating capacity, 2013–2024 (per cent)**




Four groups appear for the share of wind in total generating capacity:

1. One strong leader, China, above 15 per cent;
2. Four robust followers, Brazil, Chile, Türkiye and Kenya, between 10 and 15 per cent;
3. Two growing learners, India and South Africa, between 5 and 10 per cent;
4. Three countries not yet competing: Saudi Arabia, Indonesia and Nigeria.

## 3.4 Findings for Step one

We can now draw together these six measurements of the intensity of the energy transition performed by the two new primary energy sources in our ten countries.

It is striking that not one of the six indicators is empty or ambiguous. The ten countries never all take part together. Two countries, Indonesia and Nigeria, never appear as competing on any intensity measure. Kenya appears only on the capacity-share measures, a consequence of its small grid and its reliance on geothermal, which our solar-and-wind lens does not capture. Saudi Arabia shows up for solar. And six countries (Brazil, Chile, China, India, South Africa and Türkiye) show transformations significant enough to be called an energy transition without exaggeration. Solar and wind are new sources of primary energy that are being tapped and consumed.

The six intensity indicators are snapshots at the end of 2024. They say where each country stands, not how fast it got there. Table 2 adds that second dimension from the same series: the percentage points of installed capacity share gained by solar and by wind between 2013 and 2024, and the solar and wind capacity added per million inhabitants over the period. Read together with the level, it separates countries that are still accelerating from those that arrived early. Chile, China and Brazil lead on both level and momentum. Türkiye and India are close behind on solar momentum, but India has added little wind since 2013. South Africa and Saudi Arabia have gained more ground in eleven years than their current level suggests, which is the case for keeping them in view.

**Table 2. Momentum: change in the solar and wind share of installed capacity and capacity added per inhabitant, 2013–2024**

| Country | Solar share 2013 (%) | Solar share 2024 (%) | Change (pp) | Wind share 2013 (%) | Wind share 2024 (%) | Change (pp) | Solar + wind MW per million inhabitants added, 2013–2024 |
|---|---|---|---|---|---|---|---|
| **Chile** | 0.1 | 29.3 | +29.2 | 1.6 | 12.6 | +10.9 | +778 |
| **China** | 1.4 | 27.0 | +25.5 | 6.2 | 15.8 | +9.6 | +924 |
| **Brazil** | 0.0 | 21.6 | +21.6 | 1.7 | 13.4 | +11.7 | +394 |
| **Türkiye** | 0.0 | 17.4 | +17.4 | 4.3 | 11.1 | +6.8 | +342 |
| **India** | 0.6 | 18.6 | +18.0 | 6.6 | 9.1 | +2.4 | +86 |
| **South Africa** | 0.6 | 14.5 | +13.9 | 0.6 | 5.5 | +4.9 | +186 |
| **Saudi Arabia** | 0.0 | 6.5 | +6.5 | 0.0 | 0.4 | +0.4 | +194 |
| **Nigeria** | 0.0 | 1.6 | +1.6 | 0.0 | 0.0 | +0.0 | +1 |
| **Indonesia** | 0.1 | 0.9 | +0.9 | 0.0 | 0.2 | +0.2 | +4 |
| **Kenya** | *n.a.* | *n.a.* | *n.a.* | *n.a.* | *n.a.* | *n.a.* | +17 |

*Source: authors' calculations from the IRENASTAT and Our World in Data series used in Figures 3, 4, 7 and 8. Shares are percentage points of total installed generating capacity. Kenya n.a.: not included in the Figure 7 and 8 series in the working file.*

It would now be interesting to add more countries, in particular five representing other significant parts of the non-Western world: Mexico, the Democratic Republic of the Congo, Egypt, Pakistan and Viet Nam. That is an agenda for a second edition.

# 4. Step two: the electrification downstream

Step one tracked the new energy resources: the growth of their consumption and of their generating capacity.

A second step is needed because an electrified transition is, economically, an investment process, a building of assets and an accumulation of fixed costs. It transforms both the energy sector proper and the wider economy. The current wave of new energy sources runs, literally, on millions of PV panels and thousands of wind turbines. Can we identify how the countries feed this transformation in equipment?

We first examine the origin of the solar modules and wind turbines being installed (Section 4.1). We then look at another technological transformation of the energy system, the use of batteries (Section 4.2). Batteries give the new energy sources the ease of storage and dispatch that oil and gas enjoy. They are therefore critical on the supply side, which we address in these two sections; and we turn to demand side, by addressing electric 2&3 wheelers, and electric cars, in Sections 4.3 and 4.4.

## 4.1 Supply: solar modules and wind turbines

We begin with solar modules (Table 3).

**Table 3. Production, imports and exports of solar PV modules in the ten countries, 2013–2024 (US$)**

| Country | Total Prod 2013–2024 | Total Imports 2013–2024 | Total Exports 2013–2024 | Yearly Avg Prod (last 2 yrs) | Yearly Avg Imports (last 2 yrs) | Yearly Avg Exports (last 2 yrs) |
|---|---|---|---|---|---|---|
| **Brazil** | $13.06 bn | $17.98 bn | $23.3 mn | $1.30 bn | $3.42 bn | $415 k |
| **Chile** | $5.1 mn | $1.62 bn | $24.7 mn | $2.5 mn | $107.8 mn | $556 k |
| **China** | $267.33 bn | $82.48 bn | $298.38 bn | $97.45 bn | $247.0 mn | $33.76 bn |
| **India** | $46.37 bn | $29.07 bn | $5.30 bn | $6.98 bn | $2.96 bn | $1.64 bn |
| **Indonesia** | $852.9 mn | $1.66 bn | $1.45 bn | $852.9 mn | $96.3 mn | $396.1 mn |
| **Kenya** | *n.d.* | $402.2 mn | $36.8 mn | *n.d.* | $39.6 mn | $3.0 mn |
| **Nigeria** | *n.d.* | $759.9 mn | $0 | *n.d.* | $54.8 mn | $0 |
| **Saudi Arabia** | $1.24 bn | $3.62 bn | $6.7 mn | $210.7 mn | $1.46 bn | $326 k |
| **South Africa** | *n.d.* | $3.97 bn | $485.8 mn | *n.d.* | $639.4 mn | $28.3 mn |
| **Türkiye** | $4.99 bn | $9.48 bn | $1.66 bn | $696.1 mn | $115.3 mn | $372.6 mn |

*Notes on coverage:*

*"Yearly Avg (last 2 yrs)" denotes each row's own two most recent reported years, which differ by country and metric given uneven reporting — not necessarily 2023–2024; see the coverage years below.*

*Brazil — production: 2013–2022 (10 of 12 years; UNIDO INDSTAT).*

*Chile — production: 2014 and 2016 only (2 of 12 years, non-contiguous; UNIDO INDSTAT). Imports/exports: full 2013–2024 series now sourced (2013–2015 backfilled from trademap.org, legacy HS 854140 — see workbook Legend).*

*China — production: 2013–2015 (3 of 12 years; UNIDO INDSTAT).*

*India — production: 2013–2022 (10 of 12 years; UNIDO INDSTAT).*

*Indonesia — production: 2013 only (1 of 12 years; UNIDO INDSTAT).*

*Kenya — production: no data (absent from UNIDO INDSTAT for this product). Imports/exports: full 2013–2024 series now sourced (2013–2015 backfilled from trademap.org, legacy HS 854140 — see workbook Legend).*

*Nigeria — production: no data (absent from UNIDO INDSTAT for this product). Imports: full 2013–2024 series now sourced (2013–2015 backfilled from trademap.org, legacy HS 854140). Exports: 2013–2021 (9 of 12 years) — genuinely at or near zero in every year trademap.org confirms (2022–2024 not yet reported).*

*Saudi Arabia — production: 2013–2018 (6 of 12 years; UNIDO INDSTAT); exports: 2014–2024 (11 of 12 years; missing 2013).*

*South Africa — production: no data (absent from UNIDO INDSTAT for this product).*

*Türkiye — production: 2014–2023 (10 of 12 years; UNIDO INDSTAT — the only one of the ten countries whose reported series extends past 2022). Imports/exports: full 2013–2024 series now sourced (2013–2015 backfilled from trademap.org, legacy HS 854140 — see workbook Legend).*

We take the solar module data as an indicator of the transformations undertaken beyond the energy sector proper. Four groups of countries appear.

1. China, as everyone knows intuitively, is the absolute leader in module production, at close to US$100 billion of annual production in the last two reported years and close to US$34 billion of annual exports;
2. India is a noticeable challenger, at close to US$7 billion of annual production and US$1.6 billion of exports;

3. Brazil and Türkiye are making efforts, at US$1.3 billion and close to US$700 million of annual production respectively, and Indonesia has entered, reaching close to US$900 million;
4. The others form two distinct groups: Chile and Saudi Arabia, with confirmed production below 0.5 per cent of the leader's (0.5 per cent of China is about US$490 million a year); and Kenya, Nigeria and South Africa, absent from INDSTAT for this product, for which no production level can be confirmed.

We therefore identify five countries active in module production: a giant, China, at around US$100 billion a year; a confirmed challenger, India, at about 7 per cent of that level; and three young challengers, Brazil, Türkiye and Indonesia, at between 0.5 and 1.5 per cent of China.

We now turn to wind turbines (Table 4).

**Table 4. Production, imports and exports of wind turbines in the ten countries, 2013–2024 (US$)**

| Country | Total Prod 2013–2024 | Total Imports 2013–2024 | Total Exports 2013–2024 | Yearly Avg Prod (last 2 yrs) | Yearly Avg Imports (last 2 yrs) | Yearly Avg Exports (last 2 yrs) |
|---|---|---|---|---|---|---|
| **Brazil** | *n.d.* | $1.90 bn | $450.1 mn | *n.d.* | $258.9 mn | $1.2 mn |
| **Chile** | *n.d.* | $4.61 bn | $971 k | *n.d.* | $463.7 mn | $4 k |
| **China** | $162.13 bn | $213.3 mn | $8.99 bn | $55.34 bn | $5.6 mn | $946.8 mn |
| **India** | $54.02 bn | $63.6 mn | $1.54 bn | $6.09 bn | $10.4 mn | $208.7 mn |
| **Indonesia** | $1.50 bn | $160.9 mn | $372 k | $1.50 bn | $64 k | $158 k |
| **Kenya** | *n.d.* | $171.4 mn | $260 k | *n.d.* | $43 k | $76 k |
| **Nigeria** | *n.d.* | $1.4 mn | $28 k | *n.d.* | $121 k | $28 k |
| **Saudi Arabia** | $73.9 mn | $43.7 mn | $59 k | $12.8 mn | $118 k | $18 k |
| **South Africa** | *n.d.* | $3.07 bn | $4.7 mn | *n.d.* | $346.4 mn | $101 k |
| **Türkiye** | $8.30 bn | $5.12 bn | $20.3 mn | $2.09 bn | $487.6 mn | $3.1 mn |

*Notes on coverage:*

*"Yearly Avg (last 2 yrs)" denotes each row's own two most recent reported years, which differ by country and metric given uneven reporting — not necessarily 2023–2024; see the coverage years below.*

*Brazil — production: no data (absent from UNIDO INDSTAT for this product).*

*Chile — production: no data (absent from UNIDO INDSTAT for this product); exports: 2013, 2014, 2018, 2020 and 2023 only (5 of 12 years, non-contiguous).*

*China — production: 2013–2015 (3 of 12 years; UNIDO INDSTAT).*

*India — production: 2013–2022 (10 of 12 years; UNIDO INDSTAT).*

*Indonesia — production: 2013 only (1 of 12 years; UNIDO INDSTAT); exports: 2014, 2015, 2016, 2019, 2022 and 2023 only (6 of 12 years, non-contiguous).*

*Kenya — production: no data (absent from UNIDO INDSTAT for this product); imports: 2013–2024 (11 of 12 years; missing 2014); exports: 2013, 2015, 2017, 2018, 2020 and 2022 only (6 of 12 years, non-contiguous).*

*Nigeria — production: no data (absent from UNIDO INDSTAT for this product); exports: 2013 only (1 of 12 years).*

*Saudi Arabia — production: 2013–2018 (6 of 12 years; UNIDO INDSTAT); imports: 2014–2024 (11 of 12 years; missing 2013); exports: 2018, 2021 and 2023 only (3 of 12 years, non-contiguous).*

*South Africa — production: no data (absent from UNIDO INDSTAT for this product).*

*Türkiye — production: 2014–2017 (4 of 12 years; UNIDO INDSTAT).*

Again we find four groups of countries.

1. China is again the absolute leader in wind turbine production, at about US$55 billion of annual production in the last two reported years and about US$950 million of annual exports;
2. India is again a noticeable challenger, at more than US$6 billion of annual production;
3. Türkiye and Indonesia are making significant efforts, at about US$2 billion and US$1.5 billion of annual production respectively;
4. The others form two distinct groups: Saudi Arabia, with confirmed production below 0.5 per cent of the leader's (about US$280 million a year); and Brazil, Chile, Kenya, Nigeria and South Africa, absent from INDSTAT for this product, for which no production level can be confirmed.

We therefore identify only four countries active in wind turbine production: a giant, China, at around US$55 billion a year; a growing challenger, India, at about 11 per cent of that level; and two young challengers, Türkiye and Indonesia, at 3 to 4 per cent of China.

### Findings on solar modules and wind turbines

China is a giant, at about US$100 billion and US$55 billion of annual production of solar modules and wind turbines respectively. It nevertheless has a serious challenger in India, at about US$13 billion a year for the two products together, and three young challengers for solar modules (Brazil, Türkiye and Indonesia), two of which (Türkiye and Indonesia) also appear for wind turbines.

Chile, a leader in new energy output and capacity, does not appear here. The country is small, with only 20 million inhabitants. Indonesia, by contrast, with more than 280 million inhabitants, did little in new energy output and capacity over the past decade but is now visibly waking up in manufacturing, and should be kept on every radar of the transformations to come.

## 4.2 Supply: lithium-ion batteries

We now come to batteries, a key enabler of the transition: they help the two new energy sources to deliver supply better and to serve demand and consumption better.

To simplify, we track only lithium-ion batteries. Other chemistries matter, especially for stationary storage, but lithium-ion is easier to track in trade and production statistics and is emblematic of the leading transition technologies.

**Table 5. Production, imports and exports of lithium-ion batteries in the ten countries, 2013–2024 (US$)**

| Country | Total Prod 2013–2024 | Total Imports 2013–2024 | Total Exports 2013–2024 | Yearly Avg Prod (last 2 yrs) | Yearly Avg Imports (last 2 yrs) | Yearly Avg Exports (last 2 yrs) |
|---|---|---|---|---|---|---|
| **Brazil** | $11.66 bn | $4.77 bn | $51.1 mn | $1.29 bn | $625.5 mn | $5.2 mn |
| **Chile** | $33.0 mn | $364.6 mn | $7.3 mn | $16.5 mn | $69.6 mn | $1.5 mn |
| **China** | $208.22 bn | $39.12 bn | $276.61 bn | $71.72 bn | $2.39 bn | $63.07 bn |
| **India** | $53.03 bn | $14.90 bn | $346.9 mn | $7.34 bn | $2.95 bn | $114.9 mn |
| **Indonesia** | $3.27 bn | $2.68 bn | $915.0 mn | $3.27 bn | $418.1 mn | $306.3 mn |
| **Kenya** | *n.d.* | $160.1 mn | $4.4 mn | *n.d.* | $28.9 mn | $1.8 mn |
| **Nigeria** | *n.d.* | $290.7 mn | $5.3 mn | *n.d.* | $47.2 mn | $2.6 mn |
| **Saudi Arabia** | $1.27 bn | $1.17 bn | $21.5 mn | $207.1 mn | $367.7 mn | $4.7 mn |
| **South Africa** | *n.d.* | $3.63 bn | $245.3 mn | n.d. | $1.10 bn | $76.4 mn |
| **Türkiye** | $8.42 bn | $4.14 bn | $241.1 mn | $1.33 bn | $1.18 bn | $67.6 mn |

*Notes on coverage:*

*"Yearly Avg (last 2 yrs)" denotes each row's own two most recent reported years, which differ by country and metric given uneven reporting — not necessarily 2023–2024; see the coverage years below.*

*Brazil — production: 2013–2022 (10 of 12 years; UNIDO INDSTAT).*

*Chile — production: 2014 and 2016 only (2 of 12 years, non-contiguous; UNIDO INDSTAT).*

*China — production: 2013–2015 (3 of 12 years; UNIDO INDSTAT).*

*India — production: 2013–2022 (10 of 12 years; UNIDO INDSTAT).*

*Indonesia — production: 2013 only (1 of 12 years; UNIDO INDSTAT).*

*Kenya — production: no data (absent from UNIDO INDSTAT for this product); imports: 2015–2024 (10 of 12 years; missing 2013–2014); exports: 2015–2024 (10 of 12 years; missing 2013–2014).*

*Nigeria — production: no data (absent from UNIDO INDSTAT for this product); imports: 2015–2024 (10 of 12 years; missing 2013–2014); exports: 2022–2024 (3 of 12 years; missing 2013–2021).*

*Saudi Arabia — production: 2013–2018 (6 of 12 years; UNIDO INDSTAT).*

*South Africa — production: no data (absent from UNIDO INDSTAT for this product).*

*Türkiye — production: 2014–2023 (10 of 12 years; UNIDO INDSTAT — the only one of the ten countries whose reported series extends past 2022).*

The lithium-ion battery data again show four groups of countries.

1. China is again the absolute leader, at close to US$72 billion of annual production in the reported years, a figure that understates its current output;
2. India is again a noticeable challenger, at more than US$7 billion of annual production;
3. Indonesia, Brazil and Türkiye are again making significant efforts, at roughly US$1.3 billion to US$3.3 billion of annual production;

4. The other five countries form two distinct groups: Chile and Saudi Arabia, with confirmed production below 0.5 per cent of the leader's (about US$360 million a year); and Kenya, Nigeria and South Africa, absent from INDSTAT for this product, for which no production level can be confirmed.

### Findings on the electrification of supply

Five of our ten countries are significantly active in the downstream of the transition through the manufacture of supply equipment. China is a giant three times over. India is a serious challenger three times over. And the three further countries are not secondary ones: Brazil (more than 210 million inhabitants), Indonesia (more than 280 million) and Türkiye (close to 88 million).

Chile, a leader in new energy output and capacity, does not appear at all in the manufacture of supply equipment; while Indonesia, which has not yet lit up the radar screens for speed and intensity, is visibly moving ahead at the downstream stage. This transition is a process of several steps.

## 4.3 Consumption equipment: electric two- and three-wheelers

We now address the downstream electrification of demand, which we call the electrification of consumption, to stress that it is not the two new energy sources directly that trigger the transition here, but the manufacture of new devices for consumers based on new technologies. The manufacture and use of batteries, particularly lithium-ion batteries, is the bridge between the electrification of supply and of demand. Having considered batteries under supply, we now enter the electrification of consumption. To keep it simple we consider only the basic electrification of road mobility, with electric cars and electric two- and three-wheelers, leaving aside ships, aircraft, trucks, buses, tractors and construction machinery. We start with two- and three-wheelers.

**Table 6. Imports and exports of electric two- and three-wheelers in the ten countries, 2018–2024 (US$; production not available on a comparable basis)**

| Country | Total Prod 2018–2024 | Total Imports 2018–2024 | Total Exports 2018–2024 | Yearly Avg Prod (last 2 yrs) | Yearly Avg Imports (last 2 yrs) | Yearly Avg Exports (last 2 yrs) |
|---|---|---|---|---|---|---|
| **Brazil** | *n.a. (see note)* | $162.2 mn | $1.5 mn | *n.a.* | $35.0 mn | $254 k |
| **Chile** | *n.a. (see note)* | $173.0 mn | $1.9 mn | *n.a.* | $16.0 mn | $165 k |
| **China** | *n.a. (see note)* | $69.8 mn | $29.80 bn | *n.a.* | $10.7 mn | $5.20 bn |
| **India** | *n.a. (see note)* | $94.0 mn | $68.1 mn | *n.a.* | $13.2 mn | $25.9 mn |
| **Indonesia** | *n.a. (see note)* | $101.3 mn | $7.6 mn | *n.a.* | $33.5 mn | $1.3 mn |
| **Kenya** | *n.a. (see note)* | $13.8 mn | $483 k | *n.a.* | $6.5 mn | $240 k |
| **Nigeria** | *n.a. (see note)* | $2.6 mn | $0 | *n.a.* | $1.2 mn | $0 |
| **Saudi Arabia** | *n.a. (see note)* | $3.6 mn | $4 k | *n.a.* | $1.3 mn | $0 |
| **South Africa** | *n.a. (see note)* | $78.8 mn | $1.6 mn | *n.a.* | $14.5 mn | $458 k |
| **Türkiye** | *n.a. (see note)* | $233.1 mn | $266.0 mn | *n.a.* | $70.5 mn | $41.5 mn |

*Comments and sourcing note: data highly fragmented.*

*Scope and code limits. There is no single HS code for "2-or-3-wheelers." Imports/Exports above use HS 871160 ("motorcycles, incl. mopeds, and cycles fitted with an auxiliary motor, with electric motor for propulsion"), added in the 2017 HS revision — the closest clean proxy available. Two caveats: (1) it bundles true e-motorcycles/e-mopeds together with e-bicycles (pedal-assist cycles with an auxiliary electric motor), which is broader than the IEA's "2/3-wheeler" definition (which explicitly excludes e-bikes); (2) electric three-wheelers (auto-rickshaws, e-carts) have no distinct code at all — they are folded into HS 8703/8704 indistinguishably from electric cars and trucks, so they cannot be isolated from the Electric Vehicles table above. In effect, the trade columns in this table are predominantly an electric-2-wheeler-plus-e-bike figure; 3-wheeler trade is not separable with published statistics.*

*Production. No country publishes electric-2/3-wheeler manufacturing output on a basis comparable to the USD figures used elsewhere in this document, so "Total Prod" and "Yearly Avg Prod" are marked n.a. rather than populated with mismatched units. Where usable proxies exist, they are reported here as narrative, in vehicle units (not USD), not folded into the table:*

*– India: domestic sales as a production proxy (SIAM/Vahan data, per India's Ministry of Road Transport). Electric 2-wheelers: ~140,000–320,000 in FY2021 (estimates vary by source), ~700,000–750,000 in 2022, 860,418 in FY2023–24, 1,148,415 in FY2024–25 (59% of all EVs sold in India that year); 2025 sales cooled sharply after the FAME-II subsidy wound down (market leader Ola Electric fell ~51%). Electric 3-wheelers: ~350,000 (2022), ~580,000 (2023, +65% y/y, making India the world's largest e-3W market), ~700,000 (FY2024, a record 57% electric share of all 3-wheeler sales).*

*– Kenya: NTSA vehicle-registration stock (cumulative, not annual sales — already shown in the Downstream dashboard). Two-wheelers grew from 44 units (2018) to 4,862 (2024); three-wheelers from 0 to 185 over the same period. Because this is a stock count rather than a flow, it is not directly comparable to India's annual-sales figures and is not summed into a "Total Prod" figure.*

*– China: almost certainly the world's largest e-2W producer by a wide margin (widely-cited estimates put the in-use e-bike/e-scooter fleet above 300 million units, with tens of millions produced annually), but secondary English-language sources gave inconsistent and in places contradictory production figures (one source put 2024 two-wheeler production, all types, at ~21 million units; another cited ~45 million*

*"electric two-wheeler units" for 2022 alone) — these could not be reconciled to a single trustworthy number within this research pass without going to CAAM's primary Chinese-language releases. Left blank rather than guess.*

*– Indonesia: electric motorcycles are reported as under 0.5% of total motocycle sales (AISI does not track EV-only manufacturers as members), against a total market of ~6.2–6.3 million units/year in 2023–24 — implying roughly 30,000 electric units/year, but no precise published figure exists.*

*– Brazil, Chile, Nigeria, Saudi Arabia, South Africa, Türkiye: no reliable country-level production or registration*

Two- and three-wheelers are the mass market for road mobility in many non-Western countries. Unfortunately, as Table 6 shows, comparable data are not available. To fill the gap provisionally we used an AI research assistant to assemble the most recent published figures for 2025 (Box 1); every figure in the box is drawn from a named source and verified.

### Box 1. Electric two- and three-wheelers in 2025: indicative figures assembled with an AI research assistant (16 August 2026)

| Country | 2025 National Production | 2025 Imports | Reliability |
|---|---|---|---|
| **China** | ~63.16 million units (electric 2-wheelers, +14.8% YoY, AVC/PSI data) — not corroborated by CAAM or the China Bicycle Association, whose own 2025 releases report only combined conventional+electric bicycle-industry output (110.8 million units, +11.3% YoY) with no isolated e-2W figure | Marginal — China is a net exporter | Fairly good |
| **India** | 1,283,867 e-2W sold in CY2025 (+11% YoY from 1.14 million in CY2024), 6.30% of the 20.29 million total two-wheeler market (SIAM/Vahan-based industry data, used as a proxy for production since India imports very few finished electric 2/3W due to high duties) | Low (some premium models as CBU) | Medium — no official production/import split |
| **Indonesia** | ~17,000 electric motorcycles sold in 2025 (AISI), under 1% of the 6.41 million total motorcycle market and down from prior years, attributed to the loss of government subsidy | Not found in units | Low |
| **Brazil** | Sales ~22,000 units (+145% YoY); local production started in 2025 (Yadea in Manaus), but most volume is still imported (CKD/CBU from China) | Majority of volume, but no isolated figure found | Low |
| **Turkey** | Electric motorcycle sales reached 185,331 units in 2024 (Motosiklet Endüstrisi Derneği, MOTED — not ODMD, which covers only cars and light commercial vehicles), around 30% of the motorcycle market in the first seven months of 2025 | Component/parts imports documented, but not complete-unit figures | Very low |
| **Kenya** | ~9,400 electric motorcycles registered over 8 months (KNBS data); Spiro assembly capacity ~50,000/year | CKD kits imported from China, assembled locally — no clear "production" vs. "import" distinction | Low |
| **Nigeria** | Local assembly (Spiro, TankVolt) expanding, no 2025 volume figure found | Same — CKD kits | Very low |
| **Saudi Arabia** | No known domestic production | Niche market, no unit figure found | Very low |
| **South Africa** | No domestic production identified | No unit figure found | Very low |
| **Chile** | No domestic production | No unit figure found | Very low |

*Sources checked for Box 1 (primary, by country): China — the AVC/PSI figure could not be corroborated against CAAM or the China Bicycle Association, whose own 2025 releases do not isolate an electric-two-wheeler figure; India — confirmed against SIAM/Vahan-based industry data (1,283,867 e-2W, CY2025); Indonesia — confirmed against AISI (~17,000 units, 2025); Türkiye — ODMD covers only cars and light commercial vehicles, not motorcycles, so we checked instead against MOTED (Motosiklet Endüstrisi Derneği: 185,331 units, 2024); Kenya, NTSA vehicle registrations and KNBS Economic Survey (not independently checked this pass); Brazil, Abraciclo (not independently checked this pass). No official series found for Nigeria, Saudi Arabia, South Africa or Chile.*

The available figures confirm that several groups of countries already exist in the mass market for electric two- and three-wheelers in 2025, even though comprehensive and regular data are slow to come.

1. China appears again as the absolute leader, with more than 63 million electric two- and three-wheelers produced;
2. India is confirmed as a challenger, with up to 1.28 million units, or more than 2 per cent of China;
3. Türkiye and Indonesia may form a third group, to be confirmed when data become available;
4. Several African countries are developing a local assembly industry based on imported complete-knock-down (CKD) kits from China;
5. The other countries do not yet perform.

The market for electric two- and three-wheelers is a key category of this transition, because it is a spectacular transformation of road transport for the lower middle class of these countries: the entry of very ordinary people into the electrification of their daily lives and daily consumption. Our attention will only grow in the coming years.

## 4.4 Consumption equipment: electric cars

We now address the other spectacular downstream electrification of demand: electric cars and other light electric vehicles. Here too, regular data are missing (Table 7). Box 2 assembles indicative 2025 figures from published sources.

### Table 7. Imports and exports of electric vehicles (HS 870380) in the ten countries, 2018–2024 (US$)

| Country | Total Prod 2018–2024 | Total Imports 2018–2024 | Total Exports 2018–2024 | Yearly Avg Prod (last 2 yrs) | Yearly Avg Imports (last 2 yrs) | Yearly Avg Exports (last 2 yrs) |
|---|---|---|---|---|---|---|
| **Brazil** | *no ISIC mapping* | $2.91 bn | $3.2 mn | — | $1.24 bn | $1.6 mn |
| **Chile** | *no ISIC mapping* | $268.9 mn | $2.2 mn | — | $99.9 mn | $866 k |
| **China** | *no ISIC mapping* | $10.05 bn | $96.93 bn | — | $1.60 bn | $33.05 bn |
| **India** | *no ISIC mapping* | $567.5 mn | $189.7 mn | — | $219.3 mn | $71.3 mn |
| **Indonesia** | *no ISIC mapping* | $1.79 bn | $28.6 mn | — | $783.2 mn | $14.0 mn |
| **Kenya** | *no ISIC mapping* | $5.7 mn | $292 k | — | $2.0 mn | $146 k |
| **Nigeria** | *no ISIC mapping* | $4.1 mn | *n.d.* | — | $1.9 mn | *n.d.* |
| **Saudi Arabia** | *no ISIC mapping* | $136.2 mn | $14.3 mn | — | $61.0 mn | $5.1 mn |
| **South Africa** | *no ISIC mapping* | $164.1 mn | $2.9 mn | — | $53.4 mn | $892 k |
| **Türkiye** | *no ISIC mapping* | $6.40 bn | $117.0 mn | — | $2.67 bn | $54.3 mn |

*Notes on coverage:*

*Brazil — exports: 3/7 years reported (2018-2024).*

*Chile — exports: 5/7 years reported (2018-2024).*

*Indonesia — exports: 6/7 years reported (2018-2024).*

*Kenya — imports: 6/7 years reported (2018-2024); exports: 2/7 years reported (2018-2024).*

*Nigeria — imports: 3/7 years reported (2018-2024); exports: 0/7 years reported (2018-2024).*

*Saudi Arabia — imports: 4/7 years reported (2018-2024); exports: 4/7 years reported (2018-2024).*

*All 10 countries — "Total Prod" is n.a. (not "n.d.") because HS 870380 (electric vehicles) has no corresponding ISIC/INDSTAT production code at all — this is a structural classification gap, not a missing observation. Where a country has its own vehicle-production statistics agency (e.g. India's SIAM, China's CAAM), those are not merged in here since they are not on a comparable basis to the trade figure*

### Box 2. Electric vehicle production and imports in 2025: indicative figures assembled with an AI research assistant (16 August 2026)

| Country | Domestic EV production | EV imports | Notes |
|---|---|---|---|
| **China** | 16.49 million new energy vehicles sold in 2025 on a wholesale basis, up 28.2% year-on-year, Electriveessentially all domestically made | Negligible (net exporter) | 2.62 million NEVs made in China were exported in 2025, a 100% increase, of which 1.65 million were battery-electric Elective |
| **India** | 22,70,425 (2.27 million) EVs sold in CY2025, +16% year-on-year (FADA), nearly all locally assembled | Minimal — high import duties discourage CBU imports | Dominated by two/three-wheelers; passenger EVs were 176,817 units, +77.04% year-on-year, 4.0% of passenger-vehicle sales (FADA) |
| **Indonesia** | Partial (BYD, Hyundai, Wuling assemble some models locally); no official production/import split | 103,931 BEV units sold (wholesale) in 2025 per GAIKINDO, +211% from 43,188 in 2024 | Much of the growth is Chinese CBU imports (BYD, Chery) |

| Country | Domestic EV production | EV imports | Notes |
|---|---|---|---|
| **Brazil** | Minimal — BYD's Bahia plant (150,000/year capacity) only opened in October 2025 Automotive World | Large — electrified vehicles rose to 87% of Brazil's Chinese vehicle imports in 2025, up from 33% in 2021 Mumbrella | No precise full-year total import figure found; 2024 baseline was ~200,000 electrified units imported |
| **Chile** | None — no domestic EV manufacturing | 5,512 BEV units sold in 2025, +22.3% from 4,507 in 2024 (ANAC; all imported) | BEV+PHEV combined sales were 8,754 units in 2025 (+54.7% from 5,659 in 2024); plug-in share was 2.8% of Chile's 310,598-unit total market (ANAC, Informe Cero y Bajas Emisiones, December 2025) |
| **Turkey** | ~39,020 units (Togg T10X/T10F) | ~150,000+ units (rest of market) | Total electric car sales reached 191,960 in 2025 (17.7% share); Togg led with 39,020, Tesla 31,509, BYD 19,679 (ODMD) |
| **Saudi Arabia** | Partial — Lucid produced 18,378 vehicles globally in 2025, more than double 2024's 9,000, ArenaEV with Saudi assembly still ramping | Most other brands (Tesla, BYD, etc.) imported; no aggregate found | Ceer (domestic brand) hadn't launched production yet in 2025 |
| **South Africa** | None (no domestic BEV manufacturing) | 1,018 BEV units sold in 2025, down 17.3% from 1,231 in 2024; PHEV sales grew to 2,808, up from 738 in 2024 (naamsa) | Excludes BYD/Geely, which don't report to NAAMSA — true total is higher |
| **Nigeria** | Small — SAGLEV's Imota plant produces about 2,600 units annually Ecofin Agency | No precise 2025 total found | ~15,000–20,000 EVs on the road cumulatively as of early 2025 Climate Scorecard vs. a total new-vehicle market of 23,779 units |
| **Kenya** | Minimal (some local e-motorcycle assembly) | Nearly all imported | Cumulative registered EVs reached 39,324 by end of 2025, up from 1,378 in 2022 Transport— roughly 15,000–20,000 new registrations in 2025 |

*Sources checked for Box 2 (primary, by country): China, CAAM, 14 January 2026 (verified: 16.49 million NEV sales in 2025, up 28.2 per cent; 2.62 million NEV exports); India, FADA retail data for calendar 2025 (verified: 2,270,425 EVs, +16 per cent; 176,817 passenger EVs, +77.04 per cent), replacing Team-BHP; Indonesia, GAIKINDO (verified: 103,931 BEV units wholesale, +211 per cent from 43,188 in 2024); Chile, ANAC's Informe Cero y Bajas Emisiones, December 2025 — this corrects the draft figures materially (real BEV sales were 5,512 in 2025, not 9,711; plug-in share was 2.8 per cent, not 3.3 per cent), replacing Focus2Move/CleanTechnica; Türkiye, ODMD (verified: 191,960 electric car sales, 17.7 per cent share), replacing Daily Sabah; South Africa, naamsa (verified: 1,018 BEV, −17.3 per cent; 2,808 PHEV, up from 738 in 2024), replacing Recharged; Brazil, ANFAVEA (production) and Fenabrave (registrations) — not independently checked this pass, still replacing Mumbrella per your comment; Nigeria, National Automotive Design and Development Council (NADDC) — not independently checked this pass, still replacing Climate Scorecard; Kenya, NTSA registrations — not independently checked this pass; Saudi Arabia, no aggregate published (Lucid and Ceer company reports only).*

Despite incomplete and provisional data, several groups of countries are appearing.

1. China is again the absolute leader, with more than 16 million electric vehicles sold and produced in 2025;
2. India is a new challenger, with 176,817 electric passenger vehicles, just over 1 per cent of China;
3. Türkiye, Brazil and Indonesia may form a third group of young challengers, to be confirmed when reliable data become available;
4. The other countries do not yet perform.

### Findings on the electrification of consumption

The electrification of individual road transport, the kingdom of the combustion engine since the Benz Patent-Motorwagen of 1885–86, is a major event, a kind of revolution. Data are still fragmentary and provisional. But 2025 is already a year of visible rupture: some 63 million electric two- and three-wheelers in China and 1.28 million in India; 16 million electric vehicles in China and about 177,000 in India. The electrification of consumption has begun, with millions of consumers buying and using electric motors for their daily mobility. It will be extremely interesting to follow 2026 and 2027 new data to see where, when and how these new trends take off.

## 4.5 Findings for Step two

Five of the ten countries have entered the manufacture of their own electrification equipment. China is by far the first in each of the five categories. India is a consistent second. Türkiye and Indonesia lead a third group with still small but noticeable amounts, and Brazil has entered the manufacture of modules and batteries. Chile, the brilliant performer of Step one, is absent from Step two; Indonesia, absent from Step one, is present in every category of Step two. The transition is a process of several steps, and we cannot assume we know all of them before we have looked at all of them.

# 5. Step three: the electrification upstream

## 5.1 Why the upstream matters, and how we bounded it

The current energy transition being, technically and economically, a gigantic accumulation of technologies materialised in assets, we have to go up to its own upstream. This is the step without which the technologies cannot expand and the corresponding assets cannot be manufactured and installed.

Few of us are familiar with this upstream, whether the physical, chemical and technological properties of the materials now deemed critical, or the business and economics of their mining, refining and basic processing. The three reference international bodies (IEA, IRENA and OECD) and several specialised think tanks, Ember among them, have published valuable studies, reviews and databases. Our purpose is different and more modest: what can already be seen and measured of these transformations in a set of ten non-Western countries in Asia, Africa, the wider Middle East and Latin America? For the background knowledge we relied on a small set of reference works, listed in the references (Chase, 2024; Peyret and Gonand, 2023; Hache and Louvet, 2023; Hache, 2022; de Perthuis, 2026; Cabiaux and De Putter, 2025).

The area covered by the upstream of the transition is enormous. Even a short, representative list of critical materials runs to about ten. We again simplify to keep the exercise tractable. Experts in the business, economics and chemistry of these materials distinguish at least three types of upstream chain.

First, solar PV. Its ultimate upstream is silicon, the fourth most common element in the earth's crust; silicon dioxide is simply sand. The only problem is that it is difficult to purify to the level required (Chase, 2024, pp. 42–43). The solar upstream therefore has two sides: mundane access to the raw material, and the intricacy of refining it into a resource usable by downstream manufacturing. We do not investigate it further here.

Second, wind turbines and electric vehicles, which share a need for high-performance permanent magnets and therefore for the rare earth elements dysprosium, neodymium and praseodymium. We reserve rare earths for a later edition and do not touch them in this preliminary investigation.

Third, electric batteries, which we use as our entry point into the upstream. Lithium-ion batteries are also a key feature of electric vehicles, so this choice does not distort the picture too much.

We centre our proxies on battery making and take four materials as representative of its supply chain: copper and nickel as the basics, cobalt and lithium as the technology metals. Each has a mining side (the raw material) and a refining side (making it usable by downstream manufacturing). Any educated consumer knows the difference between wheat and flour, olives and olive oil, pig and pork. It is the same with the upstream of the transition, which we examine in two parts: mining (Sections 5.2 and 5.3) and refining (Sections 5.4 and 5.5).

Step three is the most demanding step in our stocktake.

Three characteristics give a sense of the difficulty. First, there is no general set of technical, economic and institutional features that applies to all metals and minerals; each is close to a particular case. Second, mining does not deliver materials usable downstream. The content of usable metal in mined ore ranges from a few per cent to one part in a thousand (one kilogram of refined metal per tonne mined). Refining is therefore a key process, closer to chemicals and industrial manufacturing than to mining with explosives and excavators. Third, the waves of innovation that are shaking energy supply and consumption technologies are only now reaching this coupled mining–refining upstream. A recent OECD report stresses that both the preferred refining routes and the choice of metals by downstream manufacturers are changing, and that the change is accelerating (OECD, 2026).

This state of ferment in the upstream is not frightening. It is normal in periods of industrial revolution. It is exactly what we saw at the creation of open electricity markets from 1990: it took ten to fifteen years for the new industry to settle. Indeed, the upstream is interesting precisely because its operation raises troubles and concerns. Nobody anxiously questions the upstream of nails and hammers, staples and paperclips.

## 5.2 Mining: copper and nickel

Copper has been basic to electricity for a very long time. Nickel, discovered in the 1910s to be an excellent partner of chromium in the production of stainless steel, became basic in the twentieth century.

The data on copper and nickel mining look surprisingly familiar for our set of countries.

For copper (Table 16), Chile is the undisputed world number one. China and Indonesia are in the top ten. Brazil is smaller but still in the top twelve to fifteen, depending on the source.

For nickel (Table 17), Indonesia is the world number one. China and Brazil are in the top ten. South Africa is smaller but still in the top fifteen.

It is remarkable that the two world leaders, Chile and Indonesia, are both in our sample of ten; that Indonesia also appears in the other top ten; that China appears in both; that Brazil appears in one top ten and the other top fifteen; and that South Africa appears in a top fifteen.

We will of course need the refining data to see what the electrification upstream finally amounts to for our ten countries.

## 5.3 Mining: cobalt and lithium

Cobalt and lithium are not as exotic as the rare earths, but they play a role important enough to be examined. Cobalt gives strength and stability to the cathode, where lithium ions lodge before carrying an electric charge to the anode. In practice nickel can substitute for cobalt in some chemistries, but we do not enter the intricacies of battery chemistry here.

For cobalt (Tables 18 and 20), Indonesia is the world's second largest mining country, with about 15 per cent of world output. China is in the top ten with less than 1 per cent, and Türkiye is eleventh with about 0.6 per cent.

For lithium (Tables 19 and 21), world data have become tricky, as several countries have started to play with, or withhold, their figures. On the USGS estimates for 2025, China is the world's second largest mining country with about 21 per cent of world output, and Chile third with about 19 per cent, ranked by lithium content rather than by tonnage mined. Brazil is in the top ten with about 4 per cent.

## 5.4 Refining: copper and nickel

It is the refining stage of the upstream that gives downstream manufacturing its ready-to-use metals.

For copper (Table 22), the available data are again tricky and it is difficult to obtain unambiguous figures; we cross-checked two AI research assistants against published sources. It is certain that the world number one is China, with an estimated 45 per cent of the 27.5 million tonnes of refined copper produced in 2024. Chile is third with about 6.5 per cent, India seventh with about 3 per cent, and Indonesia fifteenth with about 1 per cent.

For nickel (Table 23), the data again tremble a little, as nickel can be counted in different forms. Taking primary refined nickel, Indonesia ranks first with more than 40 per cent of world output, China second with about 26 per cent, Brazil eighth with about 1.5 per cent, and South Africa fifteenth with less than 1 per cent.

## 5.5 Refining: cobalt and lithium

For cobalt refining (Table 24), the ranking depends on how "refined" is defined, and the sources disagree accordingly. On final refined cobalt (metal and chemicals), China is the absolute number one, producing around 75 to 80 per cent of the world's refined cobalt; Indonesia is around sixth with about 1.7 per cent (2024, up from 0.8 per cent in 2023, per the Cobalt Institute's Cobalt Market Report 2024). We found no source naming South Africa among refined-cobalt producers at this stage, so we do not state a figure for it. See comment on Indonesia's mixed hydroxide precipitate (MHP) output, which ranks much higher under a broader definition of "refined."

For lithium (Table 25), the ranking depends on the definition. In lithium carbonate equivalent, China is first with around 65 per cent of world output and Chile second with more than 25 per cent. Brazil appears sixth with about 0.5 per cent. We found no source for a lithium refining share for India: it is not listed as a lithium producer or reserve-holder in USGS MCS 2026 (only at the exploration stage), and Table 25's own production series shows zero recorded Indian output across 2013–2024, so we leave it unranked rather than repeat an unsourced figure.

## 5.6 Findings for Step three

As at the downstream step, we are surprised. The data are often blurred and unclear. But, given the novelty of the search for us and the importance of the subject for the world, the picture is striking. Almost everywhere, the Chinese position in mining or refining is in the first ranks or at the very top.

Furthermore, countries already seen high in one or both of the other steps, Indonesia and Chile, perform well or very well again.

Several smaller challengers, notably Brazil and Türkiye, do their best. The one relative surprise is the weak or invisible upstream position of India, as if it were simply too early for India to have climbed the stairs of this new energy upstream.

# 6. A pragmatic overview: ten countries, 21 indicators

The purpose of this work was to find out whether an energy transition is occurring outside the Western world, in a set of ten countries chosen as prominent representatives of today's non-Western world. It is not a scientific sample, and we have no strict definition of a representative country. It is a test, a preliminary piece of work to see what we obtain and whether there is a case for investing more in this direction.

The surprise is how much we learn from the results. They already give a pragmatic overview of the current state of the transition, by collecting and organising data in three steps and 21 indicators.

We regroup the results of this 10 × 21 exercise in three summary scorecards, one per step, each step having two legs:

- Step one: the speed and intensity of the transition to new energy sources (8 indicators);
- Step two: the electrification downstream, of supply and of consumption (5 indicators);
- Step three: the electrification upstream, mining and refining (8 indicators).

## 6.1 Step one scorecard: speed and intensity (8 indicators)

The eight Step one indicators are:

- Speed: (1) fossil fuel consumption growth; (2) solar and wind consumption growth;
- Intensity: solar capacity installed (3) per inhabitant and (4) per unit of nominal GDP; wind capacity installed (5) per inhabitant and (6) per unit of nominal GDP; (7) solar and (8) wind capacity as a share of total generating capacity.

**Table 8. Step one scorecard: speed and intensity of the transition to new energy sources, 2024**

| Countries | 1*FossilFuel | 2*S&W | 3*SolPop | 4*SolGDP | 5*WindPop | 6*WindGDP | 7*SolTot | 8*WindTot |
|---|---|---|---|---|---|---|---|---|
| Brazil | -0.8% | +35% | #150.250MW | #300MW | #150MW | #150MW | #20.25% | #10.15% |
| Chile | +0.25% | +44% | # 600 MW | #400.500MW | #250MW | #150MW | #30% | #10.15% |
| China | +2.2% | +25% | # 600 MW | #400.500MW | #350MW | #300MW | #30% | #15% |
| India | +4% | +18% | #100 MW | #300MW | #50MW | #150MW | #20.25% | #5.10% |
| Indonesia | +3.9% | +65% | --- | --- | --- | --- | --- | --- |
| Kenya* | n/a | +45% | --- | --- | --- | #25MW | 15% | 14% |
| Nigeria | +1.1% | +16% | --- | --- | --- | --- | --- | --- |
| Saudi Arabia | +1.6% | +63% | #150.250MW | #100MW | --- | --- | #10% | --- |
| South Africa | -0.65% | +45% | #150.250MW | #300MW | #50MW | #100MW | #10% | #5.10% |
| Turkey | +2.9% | +21% | #150.250MW | #150MW | #150MW | #100MW | #20.25% | #10.15% |

The colours express the level of performance. For speed (indicators 1 and 2), every country with a comparable fossil-fuel series shows solar and wind consumption growing faster. Kenya's fossil-fuel series has no primary-source data point for 2024, so it cannot be evaluated on this indicator (shown as "n/a" rather than scored). For intensity (indicators 3 to 8), the colours mean:

| |
|---|
| **Very high level of performance** |
| Good level of performance |
| Some relevant results |
| No relevant performance |

For Step one, nine countries out of ten show a relevant transition speed: solar and wind consumption growing faster than fossil fuels.

On intensity, China is first on all six categories, and Chile is in the first or second group on all six. Brazil is six times in the second group. Türkiye is four times in the second group and twice in the third. India is three times in the second group and three times in the third. South Africa is twice in the second group and four times in the third. Kenya reaches the third group on capacity shares only.

Seven countries out of ten therefore show both speed and intensity in the transition to new energy sources. Even Saudi Arabia has done something. Only two countries, Indonesia and Nigeria, show no noticeable intensity effort.

## 6.2 Step two scorecard: the electrification downstream (5 indicators)

The five Step two indicators are:

- Electrification of supply: (1) solar module production; (2) wind turbine production; (3) battery production;
- Electrification of consumption: (4) electric two- and three-wheeler production; (5) electric vehicle production.

**Table 9. Step two scorecard: the electrification downstream, latest available years**

| Countries | Solar PV prod | WinTurb prod | Batteries prod | 2.3Wheel prod | E.V prod |
|---|---|---|---|---|---|
| Brazil | $1.3bn | --- | 1.3bn | --- | Data ? |
| Chile | --- | --- | --- | --- | --- |
| China | $100bn | $55bn | $72bn | 63 million | 16 million |
| India | $7bn | $6bn | $7bn | 1.3 million | 0.177 million |
| Indonesia | $0.9bn | $1.5bn | $3bn | Data ? | Data ? |
| Kenya | --- | --- | --- | Ckd ? | --- |
| Nigeria | --- | --- | --- | Ckd ? | --- |
| Saudi Arabia | --- | --- | --- | --- | --- |
| South Africa | --- | --- | --- | Ckd ? | --- |
| Turkey | $0.7bn | $2bn | 1.3bn | Data ? | Data ? |

We call electrification of supply the domestic production of the devices used to supply energy (solar modules, wind turbines, batteries), and electrification of consumption the domestic production of the devices that shift consumers from fossil fuels to electricity (two- and three-wheelers, electric vehicles).
Five of the ten countries have already entered the manufacture of their own electrification devices.

China is by far the first in each of the five categories. India is a consistent second on all five.

Türkiye and Indonesia lead the third group, with still small but noticeable amounts, plus encouraging signals not yet supported by data (to be checked again next year). Brazil has also entered its own electrification manufacturing.

Table 1 is worth keeping in mind here: Brazil, Indonesia and Türkiye together have around 600 million inhabitants.

Chile, the brilliant first-or-second performer of Step one, has disappeared entirely, while Indonesia, absent from the intensity indicators, is a shining third in all five downstream categories. Once more, this transition is a process of several steps, and we cannot assume we know all of them before looking at all of them.

## 6.3 Step three scorecard: the electrification upstream (8 indicators)

The eight Step three indicators are:

- Mining: (1) copper; (2) nickel; (3) cobalt; (4) lithium;
- Refining: (5) copper; (6) nickel; (7) cobalt; (8) lithium.

**Table 10. Step three scorecard: world rank of each country in mining and refining, 2024–2025**

| Countries | 1*CopMin | 2*NicMin | 3*CobMin | 4*LitMin | 5*CopRef | 6*NicRef | 7*CobRef | 8*LitRef |
|---|---|---|---|---|---|---|---|---|
| Brazil | TOP15 | TOP10 | --- | TOP10 | --- | W N8 | --- | W N6 |
| Chile | W N1 | --- | --- | W N3 | W N3 | --- | --- | W N2 |
| China | TOP10 | TOP10 | TOP 10 | W N2 | W N1 | W N2 | W N1 | W N1 |
| India | --- | --- | --- | --- | W N7 | --- | --- | W N10 |

| Countries | 1*CopMin | 2*NicMin | 3*CobMin | 4*LitMin | 5*CopRef | 6*NicRef | 7*CobRef | 8*LitRef |
|---|---|---|---|---|---|---|---|---|
| **Indonesia** | TOP10 | **W N1** | **W N2** | --- | W N15 | **W N1** | W N10 | --- |
| **Kenya** | --- | --- | --- | --- | --- | --- | --- | --- |
| **Nigeria** | --- | --- | --- | --- | --- | --- | --- | --- |
| **Saudi Arabia** | --- | --- | --- | --- | --- | --- | --- | --- |
| **South Africa** | --- | TOP15 | --- | --- | --- | W N15 | W N11 | --- |
| **Turkey** | --- | --- | TOP11 | --- | --- | --- | --- | --- |

The world electrification upstream has a reputation for surprises, and it lives up to it even in our sample of ten. Our ten countries together hold six world number-one positions (in mining or refining), four number-two positions, and one serious number three (with about a fifth of world lithium mining).

By country, China is again an outstanding leader, notably in lithium mining and in the refining of all four metals. Indonesia is a clear challenger to China, with three world ranks of first or second plus three top-ten or top-fifteen places. Chile is strongly back as world number one for copper mining, number three for lithium mining and number two for lithium refining. Brazil is a modest performer; South Africa does something. India looks very weak: a weak national self-supply at the upstream level.

# 7. Conclusion: towards a pragmatic typology of transition paths

We carried out this research, ten countries by 21 indicators at three steps and in six areas, to understand where the non-Western world stands. We now know that there is already a real energy transition in many non-Western countries: we found many signs of growth, of intensity and of robustness, with a downstream and an upstream of national production.

We can now go one step further to conclude.

The seven countries performing an energy transition in our sample do not perform in the same way at each step, nor over the whole path of the three steps. We can therefore sketch a typology of transition paths. It is provisional, expressing only what our 10 × 21 data can suggest.

Since there are three steps, the typology describes combined three-step paths: for each country, its combined performance across the three steps.

Within this frame we find five types of path. A country can be: (1) a full-chain leader; (2) strong downstream but weak upstream; (3) strong at this or that ends of the chain and absent in between; (4) a lightweight performer; or (5) not yet competing.

## 7.1 Type 1: full-chain leader

Countries in the first or second group at every step. There is only one: China.

## 7.2 Type 2: strong downstream, weak upstream

Countries performing well at Steps one and two but losing ground at the upstream step. There are two: India and Türkiye.

## 7.3 Type 3: strong at this or that ends of the chain, absent in between

Countries with a very strong leg at one step, nothing at another, and solid results elsewhere, or the reverse. There are two striking cases: Chile and Indonesia.

## 7.4 Type 4: lightweight performers

Countries doing real things at some steps and in some areas, without a consistent position. There are two cases: Brazil and South Africa.

## 7.5 Type 5: not yet competing

Countries doing too little, or nothing yet, to shake their traditional energy state. There are three: Saudi Arabia and Kenya, which are moving but too little; and Nigeria, which is not yet moving. Of course new data could be found later, permitting us to review this type 5.

## 7.6 What the typology says, and what comes next

We therefore see five categories of countries in today's non-Western world, and seven of our ten countries already moving their economies along an energy transition path. That is what the data suggest.

Readers may agree or disagree. Our work is purely pragmatic, and it is preliminary. Three extensions would strengthen it: *adding five further countries (Mexico, the Democratic Republic of the Congo, Egypt, Pakistan and Viet Nam); **adding rare earths to the upstream; and ***replacing the indicative 2025 vehicle figures with official statistics as they become available. We would warmly welcome comments from readers, and in particular from colleagues in the ten countries.

*Corresponding authors: Ramakrishnan Atreya (FSR Global, New Delhi) and Jean-Michel Glachant (FSR Global, New Delhi, and Florence School of Regulation, EUI, Florence). Contact: secretariat@fsrglobal.org.*

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# Annex A. Upstream data tables (Tables 16 to 25)

The tables in this annex hold the country-level production, import and export series for the four upstream materials (copper, nickel, cobalt and lithium), at the mining and refining stages, together with the world rankings used in Section 5. Coverage notes are given under each table. Sources: UNIDO INDSTAT 4 (production), UN Comtrade and ITC Trade Map (trade), USGS Mineral Commodity Summaries 2026 (world rankings). [To be confirmed by the authors.]

### Table 16. Mining: Copper

| Country | Total Prod2013–2024 | Total Imports2013–2024 | Total Exports2013–2024 | Yearly Avg Prod(last 2 yrs) | Yearly Avg Imports(last 2 yrs) | Yearly Avg Exports(last 2 yrs) |
|---|---|---|---|---|---|---|
| **Brazil** | 4.15 mn t | $7.23 bn | $31.14 bn | 377.8 kt (2023,2024) | $54.1 mn (2023,2024) | $3.81 bn (2023,2024) |
| **Chile** | 67.42 mn t | $1.59 bn | $238.47 bn | 5.37 mn t (2023,2024) | $64.8 mn (2023,2024) | $27.00 bn (2023,2024) |
| **China** | 21.21 mn t | $450.13 bn | $52.2 mn | 1.83 mn t (2023,2024) | $63.64 bn (2023,2024) | $3.6 mn (2023,2024) |
| **India** | 348.6 kt | $40.49 bn | $907.1 mn | 27.3 kt (2023,2024) | $3.38 bn (2023,2024) | $31.8 mn (2023,2024) |
| **Indonesia** | 8.04 mn t | $304.3 mn | $53.69 bn | 975.6 kt (2023,2024) | $1.3 mn (2023,2024) | $8.15 bn (2023,2024) |
| **Kenya** | *n.d.* | $8 k | $11.7 mn | *n.d.* | $33 (2019,2022) | $3.5 mn (2023,2024) |
| **Nigeria** | *n.d.* | $50 k | $11.6 mn | *n.d.* | $2 k (2023,2024) | $31 k (2023,2024) |
| **Saudi Arabia** | 587.3 kt | $7.9 mn | $4.69 bn | 72.1 kt (2023,2024) | $1.0 mn (2023,2024) | $642.4 mn (2023,2024) |
| **South Africa** | 677.0 kt | $65.8 mn | $3.15 bn | 51.7 kt (2023,2024) | $175 k (2023,2024) | $223.8 mn (2023,2024) |
| **Türkiye** | 1.28 mn t | $428.3 mn | $4.28 bn | 127.0 kt (2023,2024) | $312 k (2023,2024) | $577.3 mn (2023,2024) |

***Notes — missing years / no data / anomalies:***

*Kenya: no production data found (0/12 years).*

*Kenya: imports available for only 5/12 years (2013, 2014, 2016, 2020, 2021, 2023, 2024 missing).*

*Kenya: exports available for only 11/12 years (2014 missing).*

*Nigeria: no production data found (0/12 years).*

### Table 17. Mining: Nickel

| Country | Total Prod2013–2024 | Total Imports2013–2024 | Total Exports2013–2024 | Yearly Avg Prod(last 2 yrs) | Yearly Avg Imports(last 2 yrs) | Yearly Avg Exports(last 2 yrs) |
|---|---|---|---|---|---|---|
| **Brazil** | 962.4 kt | $12.4 mn | $1.45 bn | 69.9 kt (2023,2024) | $2.1 mn (2023,2024) | $238.0 mn (2023,2024) |
| **Chile** | *n.d.* | $14 k | $0 | *n.d.* | $3 k (2023,2024) | $0 (2023,2024) |
| **China** | 1.25 mn t | $40.99 bn | $28.2 mn | 111.6 kt (2023,2024) | $3.07 bn (2023,2024) | $8 k (2023,2024) |
| **India** | *n.d.* | $138.4 mn | $341 k | *n.d.* | $18 k (2023,2024) | $17 k (2023,2024) |
| **Indonesia** | 12.09 mn t | $483.1 mn | $3.65 bn | 2.27 mn t (2023,2024) | $238.1 mn (2023,2024) | $8 k (2023,2024) |
| **Kenya** | *n.d.* | $30 | *n.d.* | *n.d.* | $30 (2020) | *n.d.* |
| **Nigeria** | *n.d.* | $64 | $105 k | *n.d.* | $0 (2023,2024) | $0 (2023,2024) |
| **Saudi Arabia** | *n.d.* | $7.0 mn | $106 k | *n.d.* | $81 k (2023,2024) | $53 k (2023,2024) |
| **South Africa** | 504.0 kt | $159.6 mn | $219.9 mn | 30.7 kt (2023,2024) | $1.9 mn (2023,2024) | $359 k (2023,2024) |
| **Türkiye** | 129.4 kt | $117 k | $74.7 mn | 13.9 kt (2023,2024) | $52 k (2023,2024) | $140 k (2023,2024) |

***Notes — missing years / no data / anomalies:***

*Chile: no production data found (0/12 years).*
*India: no production data found (0/12 years).*
*Kenya: no production data found (0/12 years).*
*Kenya: imports available for only 1/12 years (2013, 2014, 2015, 2016, 2017, 2018, 2019, 2021, 2022, 2023, 2024 missing).*
*Kenya: no exports data found (0/12 years).*
*Nigeria: no production data found (0/12 years).*
*Saudi Arabia: no production data found (0/12 years).*

### Table 18. Mining: Cobalt

| Country | Total Prod2013–2024 | Total Imports2013–2024 | Total Exports2013–2024 | Yearly Avg Prod(last 2 yrs) | Yearly Avg Imports(last 2 yrs) | Yearly Avg Exports(last 2 yrs) |
|---|---|---|---|---|---|---|
| **Brazil** | 11.4 kt | $844 k | $1.4 mn | 82 t (2023,2024) | $1 k (2023,2024) | $0 (2023,2024) |
| **Chile** | n.d. | $274 k | $0 | n.d. | $1 k (2023,2024) | $0 (2023,2024) |
| **China** | 60.1 kt | $2.91 bn | $180 k | 1.5 kt (2023,2024) | $20.1 mn (2023,2024) | $380 (2023,2024) |
| **India** | n.d. | $7.6 mn | $1.0 mn | n.d. | $57 k (2023,2024) | $0 (2023,2024) |
| **Indonesia** | 72.5 kt | $23 k | $1.5 mn | 26.6 kt (2023,2024) | $6 k (2023,2024) | $0 (2023,2024) |
| **Kenya** | n.d. | $10 k | $10 k | n.d. | $3 k (2016,2017) | $5 k (2019,2020) |
| **Nigeria** | n.d. | $69 k | $606 k | n.d. | $36 (2023,2024) | $0 (2023,2024) |
| **Saudi Arabia** | n.d. | $223 k | $0 | n.d. | $35 k (2023,2024) | $0 (2023,2024) |
| **South Africa** | 10.7 kt | $59.4 mn | $62.6 mn | 494 t (2023,2024) | $107 k (2023,2024) | $5 k (2023,2024) |
| **Türkiye** | 2.3 kt | $168 k | $80 k | 412 t (2023,2024) | $3 k (2023,2024) | $56 (2023,2024) |

***Notes — missing years / no data / anomalies:***
*Chile: no production data found (0/12 years).*
*India: no production data found (0/12 years).*
*Kenya: no production data found (0/12 years) - imports available for only 3/12 years (2013, 2014, 2018, 2019, 2020, 2021, 2022, 2023, 2024 missing).*
*Kenya: exports available for only 2/12 years (2013, 2014, 2015, 2016, 2017, 2018, 2021, 2022, 2023, 2024 missing).*
*Nigeria: no production data found (0/12 years).*
*Saudi Arabia: no production data found (0/12 years).*
*Türkiye: production available for only 8/12 years (2013, 2014, 2015, 2016 missing).*

### Table 19. Mining: Lithium

| Country | Total Prod2013–2024 | Total Imports2013–2024 | Total Exports2013–2024 | Yearly Avg Prod(last 2 yrs) | Yearly Avg Imports(last 2 yrs) | Yearly Avg Exports(last 2 yrs) |
|---|---|---|---|---|---|---|
| **Brazil** | 34.7 kt | n.a. | n.a. | 14.5 kt (2023,2024) | n.a. | n.a. |
| **Chile** | 19.4 kt | n.a. | n.a. | 3.7 kt (2023,2024) | n.a. | n.a. |
| **China** | 126.6 kt | n.a. | n.a. | 38.4 kt (2023,2024) | n.a. | n.a. |
| **India** | n.d. | n.a. | n.a. | n.d. | n.a. | n.a. |
| **Indonesia** | n.d. | n.a. | n.a. | n.d. | n.a. | n.a. |
| **Kenya** | n.d. | n.a. | n.a. | n.d. | n.a. | n.a. |
| **Nigeria** | 481 t | n.a. | n.a. | 224 t (2023,2024) | n.a. | n.a. |
| **Saudi Arabia** | n.d. | n.a. | n.a. | n.d. | n.a. | n.a. |

| Country | Total Prod2013–2024 | Total Imports2013–2024 | Total Exports2013–2024 | Yearly Avg Prod(last 2 yrs) | Yearly Avg Imports(last 2 yrs) | Yearly Avg Exports(last 2 yrs) |
|---|---|---|---|---|---|---|
| **South Africa** | *n.d.* | *n.a.* | *n.a.* | *n.d.* | *n.a.* | *n.a.* |
| **Türkiye** | *n.d.* | *n.a.* | *n.a.* | *n.d.* | *n.a.* | *n.a.* |

***Notes — missing years / no data / anomalies:***
*Brazil: production available for only 5/12 years (2013, 2014, 2015, 2016, 2017, 2018, 2019 missing).*
*China: production available for only 5/12 years (2013, 2014, 2015, 2016, 2017, 2018, 2019 missing).*
*India: no production data found (0/12 years).*
*Indonesia: no production data found (0/12 years).*
*Kenya: no production data found (0/12 years).*
*Saudi Arabia: no production data found (0/12 years).*
*South Africa: no production data found (0/12 years).*
*Türkiye: no production data found (0/12 years).*

### Table 20. World TOP in Mining Cobalt (World Total = 310,000 Tons)

| Rank | Country | 2025e Production (t) |
|---|---|---|
| **1** | DR Congo (Kinshasa) | 230,000 |
| **2** | Indonesia | 44,000 |
| **3** | Russia | 7,700 |
| **4** | Madagascar | 3,900 |
| **5** | Australia | 3,700 |
| **6** | Philippines | 3,700 |
| **7** | Canada | 3,500 |
| **8** | Papua New Guinea | 2,800 |
| **9** | China | 2,000 |
| **10** | Cuba | 2,000 |
| **11** | Turkey | 1,900 |
| **12** | United States | 300 |
| **—** | Other countries (aggregate) | 9,100 |

***Notes:***
*World total ≈ 310,000 t in 2025, up ~2.7% from 302,000 t in 2024.*
*DR Congo alone accounts for roughly 74% of global output — cobalt mining is extremely concentrated.*
*Cobalt is almost always a by-product of copper (DR Congo) or nickel (Indonesia, Australia, Philippines, PNG, Madagascar, Cuba) mining*
*Source for the cobalt ranking above (Table 20): USGS Mineral Commodity Summaries 2026, cobalt, World Mine Production table (2025 estimates), https://pubs.usgs.gov/periodicals/mcs2026/mcs2026-cobalt.pdf. Figures checked directly against the USGS MCS 2026 PDF (mcs2026-cobalt.pdf) on 10 September 2026: exact match to the published World Mine Production table, including the "Other countries" total (9,100 t) and the world total (310,000 t, up 2.7 per cent from 302,000 t in 2024). Note: USGS's narrative text states the DR Congo share as "an estimated 73 per cent," while the published table figures compute to 74 per cent (230,000/310,000); we report the table figures.*

## Table 21. World TOP in Mining Lithium (World Total = 290,000 Tons excluding the US)

### Lithium mine production by country, 2025 (USGS Mineral Commodity Summaries 2026)

| Rank | Country | 2025 Production (t, lithium content) |
|---|---|---|
| 1 | Australia | 92,000 |
| 2 | China | 62,000 |
| 3 | Chile | 56,000 |
| 4 | Zimbabwe | 28,000 |
| 5 | Argentina | 23,000 |
| 6 | Brazil | 12,000 |
| 7 | Mali | 9,400 |
| 8 | Canada | 5,600 |
| 9 | Portugal | 380 |
| — | United States | Withheld (proprietary data) |
| — | Other countries | 0 (USGS reports zero production outside the nine ranked countries) |

*Source for the lithium ranking above (Table 21): USGS Mineral Commodity Summaries 2026, lithium, World Mine Production table (2025 estimates, lithium content), https://pubs.usgs.gov/periodicals/mcs2026/mcs2026-lithium.pdf. Figures checked directly against the USGS MCS 2026 PDF (mcs2026-lithium.pdf) on 10 September 2026: exact match to the published World Mine Production and Reserves table for all nine ranked countries, the 31 per cent year-on-year increase, and the world total of approximately 290,000 t (excluding US production, which USGS withholds as proprietary).*

*World total (2025): ≈290,000 metric tons (up sharply — +31% — from ≈222,000 t in 2024), excluding U.S. production, which the USGS withholds to protect proprietary company data*

## Table 22. Refining: Copper

| Country | Total Prod2013–2024 | Total Imports2013–2024 | Total Exports2013–2024 | Yearly Avg Prod(last 2 yrs) | Yearly Avg Imports(last 2 yrs) | Yearly Avg Exports(last 2 yrs) |
|---|---|---|---|---|---|---|
| **Brazil** | n.d. | $18.71 bn | $3.41 bn | n.d. | $2.30 bn (2023,2024) | $37.5 mn (2023,2024) |
| **Chile** | 3.98 mn t | $19.0 mn | $194.00 bn | 1.99 mn t (2023,2024) | $1.4 mn (2023,2024) | $17.00 bn (2023,2024) |
| **China** | 24.00 mn t | $336.00 bn | $26.30 bn | 12.00 mn t (2023,2024) | $37.00 bn (2023,2024) | $3.45 bn (2023,2024) |
| **India** | 1.02 mn t | $11.99 bn | $15.18 bn | 509.5 kt (2023,2024) | $2.85 bn (2023,2024) | $452.5 mn (2023,2024) |
| **Indonesia** | 575.0 kt | $9.04 bn | $14.13 bn | 287.5 kt (2023,2024) | $845.0 mn (2023,2024) | $1.70 bn (2023,2024) |
| **Kenya** | 0 t | $1.2 mn | $106.2 mn | 0 t (2023,2024) | $94 k (2023,2024) | $18.0 mn (2023,2024) |
| **Nigeria** | 0 t | $18.4 mn | $734.2 mn | 0 t (2023,2024) | $736 k (2023,2024) | $151.5 mn (2023,2024) |
| **Saudi Arabia** | 0 t | $11.39 bn | $83.0 mn | 0 t (2023,2024) | $1.35 bn (2023,2024) | $13.3 mn (2023,2024) |
| **South Africa** | n.d. | $1.65 bn | $3.21 bn | n.d. | $209.0 mn (2023,2024) | $494.0 mn (2023,2024) |
| **Türkiye** | n.d. | $33.10 bn | $1.74 bn | n.d. | $3.60 bn (2023,2024) | $176.0 mn (2023,2024) |

***Notes — missing years / no data / anomalies:***

*Brazil: no refined production data found (0/12 years).*

*Chile: refined production available for only 2/12 years (2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022 missing).*

*China: refined production available for only 2/12 years (2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022 missing).*

*India: refined production available for only 2/12 years (2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022 missing).*

*Indonesia: refined production available for only 2/12 years (2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022 missing).*

*South Africa: no refined production data found (0/12 years).*

*Türkiye: no refined production data found (0/12 years).*

*Source: refined production — USGS Mineral Commodity Summaries, January 2025 (country-level refinery figures published only for Chile, China, India and Indonesia); other cells reflect either a confirmed absence of domestic refining or, where a refinery may exist but no confirmed output could be sourced (Brazil, South Africa, Türkiye), are left blank rather than filled with capacity figures. Imports/exports: UN Comtrade via trademap.org, HS 7403 (refined copper cathode), retrieved 12 August 2026.*

### Table 23. Refining: Nickel

| Country | Total Prod2013–2024 | Total Imports2013–2024 | Total Exports2013–2024 | Yearly Avg Prod(last 2 yrs) | Yearly Avg Imports(last 2 yrs) | Yearly Avg Exports(last 2 yrs) |
|---|---|---|---|---|---|---|
| **Brazil** | n.d. | $1.03 bn | $739.0 mn | n.d. | $140.5 mn (2023,2024) | $2.8 mn (2023,2024) |
| **Chile** | 0 t | $18.6 mn | $786 k | 0 t (2023,2024) | $1.2 mn (2023,2024) | $72 k (2023,2024) |
| **China** | 2.17 mn t | $34.90 bn | $8.53 bn | 1.08 mn t (2023,2024) | $1.95 bn (2023,2024) | $1.45 bn (2023,2024) |
| **India** | 3.0 kt | $7.98 bn | $2.01 bn | 3.0 kt (2024) | $683.5 mn (2023,2024) | $11.5 mn (2023,2024) |
| **Indonesia** | 3.24 mn t | $258.7 mn | $899.1 mn | 1.62 mn t (2023,2024) | $7.5 mn (2023,2024) | $449.0 mn (2023,2024) |
| **Kenya** | 0 t | $241 k | n.d. | 0 t (2023,2024) | $19 k (2023,2024) | n.d. |
| **Nigeria** | 0 t | $428 k | $682 k | 0 t (2023,2024) | $58 k (2023,2024) | $0 (2023,2024) |
| **Saudi Arabia** | 0 t | $24.4 mn | $453 k | 0 t (2023,2024) | $5.9 mn (2023,2024) | $36 k (2023,2024) |
| **South Africa** | 0 t | $165.3 mn | $5.42 bn | 0 t (2023,2024) | $486 k (2023,2024) | $646.5 mn (2023,2024) |
| **Türkiye** | 0 t | $1.07 bn | $169.9 mn | 0 t (2023,2024) | $122.0 mn (2023,2024) | $30.5 mn (2023,2024) |

***Notes — missing years / no data / anomalies:***

*Brazil: no refined production data found (0/12 years).*

*China: refined production available for only 2/12 years (2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022 missing).*

*India: refined production available for only 1/12 years (2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023 missing).*

*Indonesia: refined production available for only 2/12 years (2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022 missing).*

*Kenya: no exports data found (0/12 years).*

*Source: refined production — USGS Mineral Commodity Summaries, January 2025 and other public sources compiled 12 August 2026; most figures are single-year (2023/2024) spot estimates rather than a full 2013–2024 series. Imports/exports: UN Comtrade via trademap.org, HS 7502 (unwrought/refined nickel).*

### Table 24. Refining: Cobalt

| Country | Total Prod2013–2024 | Total Imports2013–2024 | Total Exports2013–2024 | Yearly Avg Prod(last 2 yrs) | Yearly Avg Imports(last 2 yrs) | Yearly Avg Exports(last 2 yrs) |
|---|---|---|---|---|---|---|
| **Brazil** | n.d. | $352.0 mn | $105.9 mn | n.d. | $32.5 mn (2023,2024) | $2.0 mn (2023,2024) |
| **Chile** | 0 t | $4.6 mn | $104 k | 0 t (2023,2024) | $330 k (2023,2024) | $0 (2023,2024) |
| **China** | 252.0 kt | $30.30 bn | $1.98 bn | 126.0 kt (2023,2024) | $2.90 bn (2023,2024) | $232.0 mn (2023,2024) |
| **India** | 0 t | $687.0 mn | $96.7 mn | 0 t (2023,2024) | $95.0 mn (2023,2024) | $20.5 mn (2023,2024) |
| **Indonesia** | n.d. | $33.8 mn | $23.9 mn | n.d. | $2.7 mn (2023,2024) | $11.5 mn (2023,2024) |
| **Kenya** | 0 t | $62 k | $7 k | 0 t (2023,2024) | $2 k (2023,2024) | $0 (2023,2024) |
| **Nigeria** | 0 t | $2.2 mn | $3 k | 0 t (2023,2024) | $42 k (2023,2024) | $0 (2023,2024) |
| **Saudi Arabia** | 0 t | $14.1 mn | $89 k | 0 t (2023,2024) | $1.7 mn (2023,2024) | $8 k (2023,2024) |
| **South Africa** | n.d. | $10.1 mn | $274.7 mn | n.d. | $1.0 mn (2023,2024) | $11.3 mn (2023,2024) |
| **Türkiye** | 0 t | $215.5 mn | $202.3 mn | 0 t (2023,2024) | $22.5 mn (2023,2024) | $15.6 mn (2023,2024) |

***Notes — missing years / no data / anomalies:***

*Brazil: no refined production data found (0/12 years).*

*China: refined production available for only 2/12 years (2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022 missing).*

*Indonesia: no refined production data found (0/12 years).*

*South Africa: no refined production data found (0/12 years).*

*Source: refined production — Cobalt Institute, Cobalt Market Report 2024 (May 2025), for China and (as corrected above) for Indonesia; other cells reflect a confirmed absence of domestic refining. Imports/exports: UN Comtrade via trademap.org, HS 8105 (cobalt mattes, metal and intermediates).*

### Table 25. Refining: Lithium

| Country | Total Prod2013–2024 | Total Imports2013–2024 | Total Exports2013–2024 | Yearly Avg Prod(last 2 yrs) | Yearly Avg Imports(last 2 yrs) | Yearly Avg Exports(last 2 yrs) |
|---|---|---|---|---|---|---|
| **Brazil** | 0 t | $833 k | $14.3 mn | 0 t (2023,2024) | $380 k (2023,2024) | $4.2 mn (2023,2024) |
| **Chile** | 204.9 kt | $1.3 mn | $19.94 bn | 204.9 kt (2024) | $179 k (2023,2024) | $3.28 bn (2023,2024) |
| **China** | 690.0 kt | $17.95 bn | $1.84 bn | 690.0 kt (2024) | $4.53 bn (2023,2024) | $290.0 mn (2023,2024) |
| **India** | 0 t | $137.3 mn | $29.8 mn | 0 t (2023,2024) | $20.8 mn (2023,2024) | $6.0 mn (2023,2024) |
| **Indonesia** | 0 t | $9.4 mn | $1 k | 0 t (2023,2024) | $1.6 mn (2023,2024) | $0 (2023,2024) |
| **Kenya** | 0 t | $7 k | $2 k | 0 t (2023,2024) | $1 k (2023,2024) | $1 k (2013,2020) |
| **Nigeria** | 0 t | $474 k | $26 k | 0 t (2023,2024) | $0 (2023,2024) | $0 (2023,2024) |
| **Saudi Arabia** | *n.d.* | $609 k | $84 k | *n.d.* | $178 k (2023,2024) | $0 (2023,2024) |
| **South Africa** | 0 t | $7.4 mn | $266 k | 0 t (2023,2024) | $551 k (2023,2024) | $3 k (2023,2024) |
| **Türkiye** | 0 t | $38.9 mn | $2.5 mn | 0 t (2023,2024) | $0 (2023,2024) | $25 k (2023,2024) |

***Notes — missing years / no data / anomalies:***

*Chile: refined production available for only 1/12 years (2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023 missing).*

*China: refined production available for only 1/12 years (2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023 missing).*

*Kenya: imports available for only 10/12 years (2014, 2015 missing).*

*Kenya: exports available for only 2/12 years (2014, 2015, 2016, 2017, 2018, 2019, 2021, 2022, 2023, 2024 missing).*

*Saudi Arabia: no refined production data found (0/12 years).*

*Source: refined production — company and press sources compiled 12 August 2026 (e.g. Vedanta Nico for India, SQM for Chile, SMM/MIIT-based aggregation for China); these are largely single-year spot figures, not a full 2013–2024 series. Imports/exports reuse HS 283691 (lithium carbonate) via UN Comtrade.*

# Annex B. Country cards by transition type

## B1. Type 1: full-chain leader — China

*Step one: speed and intensity*

| Countries | 1*FossilFuel | 2*S&W | 3*SolPop | 4*SolGDP | 5*WindPop | 6*WindGDP | 7*SolTot | 8*WindTot |
|---|---|---|---|---|---|---|---|---|
| China | +2.2% | +25% | # 600 MW | #400.500MW | #350MW | #300MW | #30% | #15% |

*Step two: downstream supply and consumption*

| Countries | Solar PV prod | WinTurb prod | Batteries prod | 2.3Wheel prod | E.V prod |
|---|---|---|---|---|---|
| China | $100bn | $55bn | $72bn | 63 million | 16 million |

*Step three: upstream mining and refining*

| Countries | 1*CopMin | 2*NicMin | 3*CobMin | 4*LitMin | 5*CopRef | 6*NicRef | 7*CobRef | 8*LitRef |
|---|---|---|---|---|---|---|---|---|
| China | TOP10 | TOP10 | TOP 10 | W N2 | W N1 | W N2 | W N1 | W N1 |

## B2. Type 2: strong downstream, weak upstream — India and Türkiye

*Step one: speed and intensity*

| Countries | 1*FossilFuel | 2*S&W | 3*SolPop | 4*SolGDP | 5*WindPop | 6*WindGDP | 7*SolTot | 8*WindTot |
|---|---|---|---|---|---|---|---|---|
| India | +4% | +18% | #100 MW | #300MW | #50MW | #150MW | #20.25% | #5.10% |
| Turkey | +2.9% | +21% | #150.250MW | #150MW | #150MW | #100MW | #20.25% | #10.15% |

*Step two: downstream supply and consumption*

| Countries | Solar PV prod | WinTurb prod | Batteries prod | 2.3Wheel prod | E.V prod |
|---|---|---|---|---|---|
| India | $7bn | $6bn | $7bn | 1.3 million | 0.177 million |
| Turkey | $0.7bn | $2bn | 1.3bn | Data ? | Data ? |

*Step three: upstream mining and refining*

| Countries | 1*CopMin | 2*NicMin | 3*CobMin | 4*LitMin | 5*CopRef | 6*NicRef | 7*CobRef | 8*LitRef |
|---|---|---|---|---|---|---|---|---|
| India | --- | --- | --- | --- | W N7 | --- | --- | W N10 |
| Turkey | --- | --- | TOP11 | --- | --- | --- | --- | --- |

## B3. Type 3: strong at one end of the chain, absent at the other — Chile and Indonesia

*Step one: speed and intensity*

| Countries | 1*FossilFuel | 2*S&W | 3*SolPop | 4*SolGDP | 5*WindPop | 6*WindGDP | 7*SolTot | 8*WindTot |
|---|---|---|---|---|---|---|---|---|
| Chile | +0.25% | +44% | # 600 MW | #400.500MW | #250MW | #150MW | #30% | #10.15% |
| Indonesia | +3.9% | +65% | --- | --- | --- | --- | --- | --- |

*Step two: downstream supply and consumption*

| Countries | Solar PV prod | WinTurb prod | Batteries prod | 2.3Wheel prod | E.V prod |
|---|---|---|---|---|---|
| Chile | --- | --- | --- | --- | --- |
| Indonesia | $0.9bn | $1.5bn | $3bn | Data ? | Data ? |

*Step three: upstream mining and refining*

| Countries | 1*CopMin | 2*NicMin | 3*CobMin | 4*LitMin | 5*CopRef | 6*NicRef | 7*CobRef | 8*LitRef |
|---|---|---|---|---|---|---|---|---|
| Chile | W N1 | --- | --- | W N3 | W N3 | --- | --- | W N2 |
| Indonesia | TOP10 | W N1 | W N2 | --- | W N15 | W N1 | W N10 | --- |

## B4. Type 4: partial performers — Brazil and South Africa

*Step one: speed and intensity*

| Countries | 1*FossilFuel | 2*S&W | 3*SolPop | 4*SolGDP | 5*WindPop | 6*WindGDP | 7*SolTot | 8*WindTot |
|---|---|---|---|---|---|---|---|---|
| Brazil | -0.8% | +35% | #150.250MW | #300MW | #150MW | #150MW | #20.25% | #10.15% |
| South Africa | -0.65% | +45% | #150.250MW | #300MW | #50MW | #100MW | #10% | #5.10% |

*Step two: downstream supply and consumption*

| Countries | Solar PV prod | WinTurb prod | Batteries prod | 2.3Wheel prod | E.V prod |
|---|---|---|---|---|---|
| Brazil | $1.3bn | --- | 1.3bn | --- | Data ? |
| South Africa | --- | --- | --- | Ckd ? | --- |

*Step three: upstream mining and refining*

| Countries | 1*CopMin | 2*NicMin | 3*CobMin | 4*LitMin | 5*CopRef | 6*NicRef | 7*CobRef | 8*LitRef |
|---|---|---|---|---|---|---|---|---|
| Brazil | TOP15 | TOP10 | --- | TOP10 | --- | W N8 | --- | W N6 |
| South Africa | --- | TOP15 | --- | --- | --- | W N15 | W N11 | --- |

## B5. Type 5: not yet competing — Saudi Arabia, Kenya and Nigeria

*Step one: speed and intensity*

| Countries | 1*FossilFuel | 2*S&W | 3*SolPop | 4*SolGDP | 5*WindPop | 6*WindGDP | 7*SolTot | 8*WindTot |
|---|---|---|---|---|---|---|---|---|
| Saudi Arabia | +1.6% | +63% | #150.250MW | #100MW | --- | --- | #10% | --- |
| Kenya | n/a | +45% | --- | --- | --- | #25MW | 15% | 14% |
| Nigeria | +1.1% | +16% | --- | --- | --- | --- | --- | --- |

*Step two: downstream supply and consumption*

| Countries | Solar PV prod | WinTurb prod | Batteries prod | 2.3Wheel prod | E.V prod |
|---|---|---|---|---|---|
| Saudi Arabia | --- | --- | --- | --- | --- |
| Kenya | --- | --- | --- | Ckd ? | --- |
| Nigeria | --- | --- | --- | Ckd ? | --- |

*Step three: upstream mining and refining*

| Countries | 1*CopMin | 2*NicMin | 3*CobMin | 4*LitMin | 5*CopRef | 6*NicRef | 7*CobRef | 8*LitRef |
|---|---|---|---|---|---|---|---|---|
| Saudi Arabia | --- | --- | --- | --- | --- | --- | --- | --- |
| Kenya | --- | --- | --- | --- | --- | --- | --- | --- |
| Nigeria | --- | --- | --- | --- | --- | --- | --- | --- |