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Sustainable Convergence

Sustainable development and global economic convergence: closing the gaps without repeating the mistakes of the past



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ABOUT THIS REPORT

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The concept. Sustainable Convergence is a concept developed by Hunter Hughes, Founder of H Heuristics, first set out in Hughes (2026a). It complements Polycrisis Resilience, also developed by Hunter Hughes.

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Data and methods. All data are public. Calculations, the Sustainable Convergence Index, scenarios and any errors are the author's. Blue text links to sources; figure, table and section references link within the document.

EXECUTIVE SUMMARY

Executive Summary

Billions of people still live with large gaps in income, health, technology and public services. Closing those gaps is the central task of this century. Doing it in a way that does not wreck the climate, the air and the systems everyone depends on is the second. Sustainable Convergence treats them as one task.

Most people alive today live in what is often called the Global South: the low- and middle-income economies of Africa, Asia, Latin America and the Middle East. They make up 83% of the world's population but earn, on average, less than a quarter of the income of people in high-income countries. For decades the debate about their future has been split in two. One camp asks how fast poorer countries can catch up with rich ones. The other asks how the world can stay within safe environmental limits. This report argues that the two questions have to be answered together, and it gives the combined answer a name: **Sustainable Convergence**, a concept developed by Hunter Hughes, Founder of H Heuristics (Hughes, 2026a).

23%
is the average income in the Global South as a share of the high-income level in 2024, up from 13% in 2000

78%
of people in developing economies live in countries that caught up between 2000 and 2022 while emissions per person grew at least half as fast as income

12 of 91
growing developing economies cut their CO_2 emissions in 2010–2022, against 34 of 45 high-income ones

819 Gt
of world CO_2 to 2100 if the Global South catches up on a clean path, against 3,084 Gt on a fossil path; the 2°C budget is about 1,050 Gt

Principal findings

- **Catch-up has happened, but unevenly.** Average income in the Global South rose from 13% of the high-income level in 2000 to 23% in 2024. Most of that came from China and India; without them the figure moved only from 18% to 20%. Low-income countries fell further behind, from 4.2% to 3.7% (Figure 4).
- **Relative progress hides absolute distance.** Even as the ratio rose, the dollar gap between the average person in the Global South and in a rich country widened from about $36,000 to $45,000 a year. Of 102 developing economies, 90 became richer, yet the absolute gap widened for 99. Absolute improvement is not the same as convergence (Section 5).
- **Access has converged faster than income.** Since 2000 the number of people in the Global South without electricity fell from 1.3 billion to 0.69 billion, and internet users went from a few percent to 66% of the high-income level. But 2.1 billion people still cook with polluting fuels, and 86% of those without power live in Sub-Saharan Africa (Figure 7).

- **So far, catching up has mostly followed the old, carbon-heavy path.** Between 2000 and 2022, 78% of people in developing economies lived in countries where income converged but emissions per person grew at least half as fast as income. Only 6% lived in countries that converged while emissions grew slowly or fell (Figure 15).
- **Latecomers already develop more cleanly.** Countries that reached $10,000 of income per person before 1970 emitted a median 4.4 tonnes of CO_2 per person when they crossed that line; those that crossed after 2000 emitted 2.9 tonnes. Solar modules are now about 1,101 times cheaper than in 1975, and new solar and wind power are among the cheapest electricity ever built (Figure 13, Figure 16).
- **Rich countries have decoupled; most developing ones have not yet.** Between 2010 and 2022, 34 of 45 growing high-income economies cut their territorial CO_2 emissions, against 12 of 91 developing ones. Decoupling is possible, but it has so far been a privilege of wealth (Figure 14).
- **A new index shows the trade-off clearly.** The H Heuristics Sustainable Convergence Index scores 184 economies on seven dimensions. Developing economies with stronger capabilities tend to score worse on the environment (correlation -0.43) but much better on resilience (correlation 0.88). High-income countries score only 50 out of 100 on the environmental dimension: no group is yet on a sustainable path (Section 9).
- **The route to 2100 decides the climate.** If the Global South closes the income gap at about 2% a year, its income reaches roughly 74% of the high-income level by 2100. On a fossil path that would push world emissions to about 3,084 billion tonnes of CO_2, nearly three times the 2°C budget. On a sustainable path, with the same income gains, the total is about 819 billion tonnes, within it (Section 12).

What Sustainable Convergence adds

Sustainable development and economic convergence are two of the most studied ideas in economics and policy, but they are usually discussed by different people in different rooms. Sustainable development, as defined by the Brundtland Commission in 1987, asks whether today's progress compromises the ability of future generations to meet their own needs (WCED, 1987). Convergence, a core question in growth economics, asks whether poorer economies grow faster than richer ones and so close the gap (Barro and Sala-i-Martin, 1992; Baumol, 1986). Sustainable Convergence joins them. It asks whether poorer economies are closing the gaps *and* whether they are doing so on a path the planet and their own societies can sustain. It treats convergence as the engine of human progress and sustainability as the condition that keeps that engine running.

The report makes four contributions. It sets out a clear definition and a seven-dimension framework (Sections 2 to 4). It measures the record since 2000 using public data for more than 200 economies, separating absolute improvement from true convergence (Sections 5 and 6). It examines the mechanisms that make clean catch-up possible: cheaper clean technology, leapfrogging and mutual reinforcement across dimensions (Sections 7 and 8). And it introduces a Sustainable Convergence Index, applies the framework to regions, identifies the barriers and models three pathways to 2100 (Sections 9 to 12), before closing with a strategy and research agenda (Sections 13 and 14).

CONCEPT

The definition used in this report

Sustainable Convergence is the process through which emerging and developing economies progressively narrow economic, technological, institutional, and human-development gaps with advanced economies while pursuing environmentally sustainable, socially inclusive, and systemically resilient development pathways.

It integrates economic convergence with sustainable development to support long-term improvements in productivity, living standards, technological capacity, environmental quality, and resilience to interconnected global risks.

Concept developed by Hunter Hughes, Founder of H Heuristics (Hughes, 2026a).

Six priorities for action

- **Make the cheapest path the cleanest path.** Cut the cost of capital for clean energy in developing economies, which today is often two to three times higher than in rich ones, through guarantees, local-currency lending and better project preparation (IEA, 2024a).
- **Finish the access agenda.** Universal electricity, clean cooking, safe water and sanitation are the foundations of every other dimension, and they are now achievable with distributed, low-carbon technology.
- **Build digital public infrastructure.** Open identity, payment and data-exchange systems lower the cost of reaching people, widen markets and strengthen public finances (UNDP, 2023).
- **Invest early in people.** Nutrition in the first 1,000 days of life, primary health care and foundational learning pay returns for decades (Hoddinott et al., 2008; World Bank et al., 2022).
- **Build resilience in from the start.** Infrastructure designed for future climate, early warning systems, adaptive social protection and disaster finance protect convergence gains from shocks (Hallegatte et al., 2019; Global Commission on Adaptation, 2019).
- **Measure what matters.** Track convergence in capabilities and sustainability together, in relative as well as absolute terms, using an index such as the one proposed here.

SECTION 01

Why Sustainable Convergence, and Why Now

The twenty-first century has to close a development gap that took two hundred years to open, and it has to do so within environmental limits that the countries that developed first did not face.

IN BRIEF

- The gap between rich and poor economies is one of the defining features of the modern world, and most of humanity still lives on the poorer side of it.
- The traditional route out of poverty ran through coal, oil and heavy pollution. Repeating it everywhere would overwhelm the climate and harm the people it is meant to help.
- Sustainable Convergence argues that closing the gaps and protecting the planet are parts of the same task, and that new technologies make it achievable.

1.1 A world divided by a two-hundred-year gap

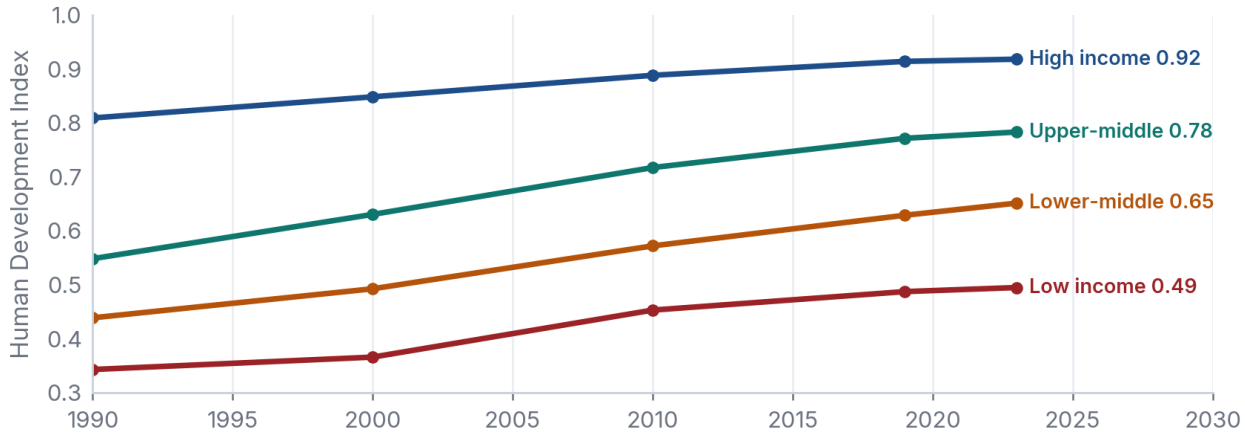
Until roughly 1800, the differences in living standards between the world's regions were modest. Then a small group of countries in Western Europe and North America industrialised, harnessing coal, steam and later oil and electricity. Their incomes, life expectancy and schooling rose steadily, while most of the world's population stayed poor. Historians call this the *Great Divergence* (Pomeranz, 2000). By the late twentieth century, the ratio between the richest and poorest countries' incomes had grown to levels never seen before, a pattern the economist Lant Pritchett summed up as "divergence, big time" (Pritchett, 1997).

The past few decades have begun to reverse that history. Since around 2000, many developing economies have grown faster than rich ones, and economists have started to speak of an era of convergence (Patel et al., 2021; Kremer et al., 2022). Average income in the Global South rose from 13% of the high-income level in 2000 to 23% in 2024. Electricity, mobile phones, the internet, vaccines and schooling spread faster than ever before. The Human Development Index of developing economies, which combines health, education and income, rose from 0.56 to 0.70 over roughly the same period (Figure 1).

Yet the gaps remain enormous. A person in a low-income country still earns, on average, less than 4% of what a person in a high-income country earns, and that share has slipped since 2000. About 0.69 billion people in developing economies lack electricity, 2.1 billion cook with polluting fuels, and 1.5 billion lack basic sanitation. The question of whether and how these gaps close is arguably the most important economic question of the century, because it decides the life chances of most of humanity.

Figure 1 **Human development has improved in every income group, but the gaps remain wide**

Human Development Index (0–1), population-weighted average by World Bank income group, 1990–2023



Source: H Heuristics calculations from UNDP Human Development Report composite indices time series (UNDP, 2025). Population-weighted averages; income groups are current World Bank classes (World Bank, 2025b).

1.2 The old route is closed

The countries that developed first followed a route that cannot be repeated at global scale. They built their prosperity on fossil fuels, cleared forests, polluted rivers and air, and cleaned up only once they were rich. High-income countries, home to about 17% of today's world population, account for about 63% of all the carbon dioxide emitted from fossil fuels and industry since the industrial revolution (Figure 12). If the remaining 80% of humanity followed the same path, the climate consequences would be severe. The world's remaining carbon budget for keeping warming to 1.5°C was estimated at about 130 billion tonnes of CO_2 at the start of 2025, roughly three years of current emissions; the budget for 2°C is about 1,050 billion tonnes (Forster et al., 2025).

The environmental costs of the old route also fall heavily on developing countries themselves. Air pollution from burning coal, diesel, crop waste and wood is one of the leading causes of early death worldwide, with the highest exposures in South Asia, the Middle East and Africa (Health Effects Institute, 2025). Climate change brings more frequent heatwaves, droughts, floods and storms, and the poorest countries have the least capacity to cope (IPCC, 2023; Hallegatte et al., 2016). Growing first and cleaning up later therefore means accepting decades of avoidable illness and climate damage, and building factories, power plants and cities that lock in high emissions for fifty years or more (Unruh, 2000).

1.3 A new route has opened

The good news is that the economics of development have changed. The price of solar modules has fallen about 1,101-fold since 1975 and about 21-fold since 2010 alone (Our World in Data, 2025b). New solar and onshore wind power are now cheaper than new fossil-fuel power in most of the world (IRENA, 2025). Batteries, electric two-wheelers, mobile money, digital identity systems, low-cost diagnostics and satellite data have opened routes to development that simply did not exist when today's rich countries industrialised. Developing economies can, in principle, skip the most polluting stages of development, much as many skipped landline telephones and went straight to mobile phones (Lee, 2019).

This is the central claim of Sustainable Convergence: that it is now possible for developing and emerging economies to close the gaps with advanced economies faster, more cheaply and more safely by following a clean, resilient path than by following the old one. It is a claim about possibility, not inevitability. As this report shows, most of the catch-up achieved so far has followed the conventional, carbon-intensive path. Turning the possibility into reality requires deliberate choices by governments, investors and international institutions.

DEFINITIONS

Who is the Global South in this report?

This report uses the World Bank's income classification (World Bank, 2025b). The **Global South** or **developing economies** means all 131 low-, lower-middle- and upper-middle-income economies. **Advanced economies** means the high-income group. In 2024 the Global South held 6.7 billion people, 83% of the world total, and produced about 53% of world output measured at purchasing power parity.

Two cautions apply. First, income groups are today's classes, so countries that have recently become high income (such as Chile, Uruguay and Costa Rica) appear in the high-income group throughout. Second, averages are weighted by population, so China and India, which together hold more than a third of the world's people, carry great weight.

1.4 Why this matters for resilience

H Heuristics has developed a second concept, *Polycrisis Resilience*, to describe how societies can withstand a world in which crises in climate, health, finance, food, energy and security increasingly arrive together and amplify one another (Hughes, 2026b; Lawrence et al., 2024; Tooze, 2022). The harm a shock does depends not only on the shock but on how vulnerable people are, and vulnerability falls sharply as societies develop: richer countries suffer far fewer deaths from comparable natural hazards because they have better buildings, health care, warning systems and public finances (Kahn, 2005; Toya and Skidmore, 2007; Formetta and Feyen, 2019). Convergence is therefore one of the most powerful long-run ways of reducing vulnerability (Hughes, 2026d).

But convergence can also raise vulnerability if it follows the wrong path: through polluted cities, rising emissions, unsustainable debt, depleted water and soils, or infrastructure built for yesterday's climate. Sustainable Convergence is the development pathway that avoids this trap. Polycrisis Resilience describes the overarching goal; Sustainable Convergence describes one of the main socioeconomic routes towards it (Section 2).

1.5 How the report is organised

Sections 2 to 4 define Sustainable Convergence, trace its intellectual roots and set out its seven dimensions. **Section 5** measures convergence in income and capabilities since 2000, and **Section 6** examines the environmental side of the record, including decoupling and the environmental Kuznets curve. **Sections 7 and 8** explain how clean technology and mutual reinforcement can make sustainable catch-up possible. **Section 9** presents the Sustainable Convergence Index and **Section 10** applies the framework to the regions of the Global South. **Section 11** discusses the barriers, **Section 12** models three pathways to 2100, **Section 13** sets out a strategy and **Section 14** proposes a research agenda and concludes.

SECTION 02

Defining Sustainable Convergence

A useful concept has to say clearly what it includes, what it excludes and how it differs from the ideas it builds on. This section does all three.

IN BRIEF

- Sustainable Convergence means closing economic, technological, institutional and human-development gaps on environmentally sustainable, socially inclusive and resilient paths.
- It is more than a new name for sustainable development or economic convergence: it asks how catch-up and sustainability can reinforce each other.
- Within H Heuristics' work, Polycrisis Resilience is the overarching objective and Sustainable Convergence is a major development pathway towards it.

2.1 The definition

Sustainable Convergence

Sustainable Convergence is the process through which emerging and developing economies progressively narrow economic, technological, institutional, and human-development gaps with advanced economies while pursuing environmentally sustainable, socially inclusive, and systemically resilient development pathways. It integrates economic convergence with sustainable development to support long-term improvements in productivity, living standards, technological capacity, environmental quality, and resilience to interconnected global risks.

Concept developed by Hunter Hughes, Founder of H Heuristics (Hughes, 2026a)

Each part of the definition does work. *Process* means that Sustainable Convergence is about movement over time, not a fixed state; it can be measured, accelerated, stalled or reversed. *Progressively narrow* means that what counts is the closing of gaps relative to advanced economies, not merely improvement in absolute terms. *Economic, technological, institutional and human-development gaps* means that income is only one of the things being compared: the ability to use modern technology, the quality of public institutions and the health and skills of people matter as much. *Environmentally sustainable, socially inclusive and systemically resilient* sets three conditions on the path: it must stay within environmental limits, it must reach the whole population rather than a privileged few, and it must leave societies better able to withstand shocks.

2.2 What is new about the concept

The concept should be more than a new label. Its distinctive claim is that economic catch-up and sustainable development can **reinforce one another** rather than trade off against each other. Renewable electricity can power industrialisation while reducing emissions and air pollution. Digital public infrastructure can widen economic participation while making government more efficient. Healthier, better-educated workers are more productive. Climate-resilient infrastructure protects the assets that growth builds. When these links are strong, investment in one dimension raises returns in the others, a dynamic the original monograph calls the *Compounding Convergence Flywheel* (Hughes, 2026a) (Section 8).

Three further ideas follow from this claim. First, the **Leapfrog Decoupling Frontier**: developing economies can industrialise, electrify and urbanise without the historical surge in pollution and emissions, by building directly on modern clean technologies (Hughes, 2026a). Second, the rejection of the **grow first, clean later** doctrine, often associated with the environmental Kuznets curve, on the grounds that many environmental harms are irreversible and that clean technology is now cheap (Section 6). Third, a long-run goal of **Planetary Capability Parity**: a world in which all societies have broadly comparable productive capacity, access to technology, human development and resilience, while operating within ecological limits (Hughes, 2026a).

Table 1 How Sustainable Convergence differs from related ideas

Concept	Core question	What it adds or leaves out	Relation to Sustainable Convergence
Economic convergence	Do poorer economies grow faster and close the income gap? (Barro and Sala-i-Martin, 1992)	Focuses on income and productivity; silent on the path's environmental cost	Supplies the catch-up goal and the relative-gap measurement
Sustainable development	Does today's progress protect future generations' ability to meet their needs? (WCED, 1987)	Balances economic, social and environmental goals; weak on closing gaps between countries	Supplies the sustainability condition
Green growth	Can output grow while environmental pressure falls? (OECD, 2011; World Bank, 2012)	Usually framed nationally; often silent on the cross-country gap	Sustainable Convergence applies it to catching up
Degrowth	Should rich economies shrink material throughput? (Kallis et al., 2018)	Concerns mainly rich countries; offers little to countries that still need more energy and output	Rejected as a path for developing economies, which need more energy services, not less
Polycrisis Resilience	How do societies withstand interacting crises? (Hughes, 2026b)	Focuses on vulnerability and recovery	Overarching objective; Sustainable Convergence is a pathway towards it
Sustainable Convergence	Are gaps closing on paths that are sustainable, inclusive and resilient? (Hughes, 2026a)	Combines catch-up, sustainability and resilience, measured relatively and absolutely	—

Source: H Heuristics. Citations point to representative statements of each idea.

2.3 What Sustainable Convergence is not

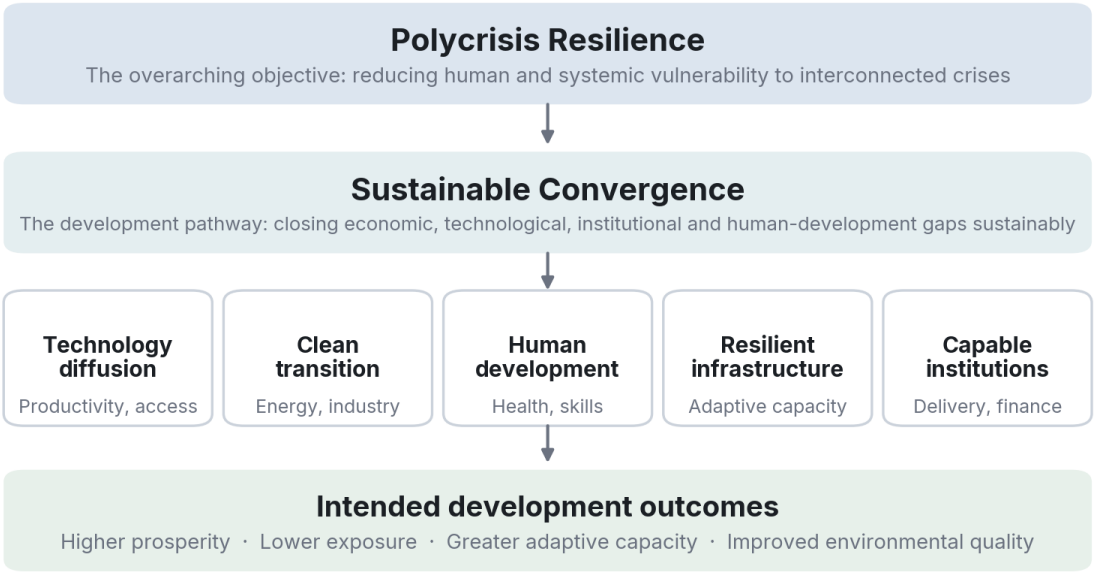
Four boundaries keep the concept precise. It is **not a call for developing countries to grow less.** Billions of people need more electricity, more transport, more housing and more manufactured goods than they have today; the energy needed to provide decent living standards for all is modest by rich-country standards but much larger than what the poorest consume now (Kikstra et al., 2021). It is **not a demand that poor countries carry the burden of decarbonisation**: the high-income world produced most historical emissions and must cut its own emissions fastest. It is **not the claim that convergence is automatic**; the record shows that it is not. And it is **not a single blueprint**: starting points, resources, demography and institutions differ widely, so the right path for Ethiopia is not the right path for Brazil.

2.4 The relationship with Polycrisis Resilience

Sustainable Convergence is the second major concept developed by Hunter Hughes at H Heuristics, and it is designed to complement the first, Polycrisis Resilience (Hughes, 2026a; Hughes, 2026b). The two have a clear hierarchy (Figure 2). Polycrisis Resilience is the overarching objective: reducing human and systemic vulnerability to interconnected crises. Sustainable Convergence is a development pathway for reaching that objective: it builds the material foundations, such as income, infrastructure, technology, health and institutions, that make societies less vulnerable.

Figure 2 Polycrisis Resilience is the objective; Sustainable Convergence is a pathway towards it

Conceptual hierarchy of the two H Heuristics concepts



Feedback: resilience protects convergence gains from shocks; convergence supplies the resources that resilience requires.

Source: H Heuristics, adapted from Hughes (2026a; 2026b) (Hughes, 2026a; Hughes, 2026b).

The relationship runs in both directions. Without convergence, resilience is very hard to achieve: a population without savings, health care, electricity or functioning institutions has little margin to absorb a flood, a pandemic or a spike in food prices. Without resilience, conver-

gence is fragile: disasters, financial crises and conflicts can wipe out decades of progress, and in many developing economies income losses after severe shocks are never fully recovered (Cerra and Saxena, 2008; Hsiang and Jina, 2014). The two concepts are therefore best understood as a feedback loop: convergence supplies the resources resilience requires, and resilience protects the gains convergence delivers.

Polycrisis Resilience

Polycrisis Resilience is the capacity of individuals, communities, institutions, economies, societies, and interconnected systems to anticipate, withstand, adapt to, recover from, and reduce their vulnerability to multiple interacting crises.

H Heuristics definition (Hughes, 2026b; Hughes, 2026c)

2.5 Three tests of Sustainable Convergence

The definition implies three practical tests that any development strategy, project or national record can be held to. The first is a **convergence test**: is the gap with advanced economies narrowing, in relative terms and, over time, in absolute terms, across the dimensions that matter for people's lives? The second is a **sustainability test**: is that progress being achieved without crossing environmental thresholds, such as safe levels of air pollution and a fair share of the remaining carbon budget, and without degrading the forests, water and soils on which future growth depends? The third is a **resilience and inclusion test**: are the gains reaching the whole population, and are they protected against the shocks most likely to undo them, from floods and heatwaves to price spikes and pandemics?

A country that passes only the first test is catching up on the old model. One that passes only the second is protecting the environment while its people remain poor. One that passes only the third is coping, but not advancing. Sustainable Convergence requires all three at once. The rest of this report is organised around them: Sections 5 and 6 apply the first two tests to the record since 2000, Section 9 combines all three in a single index, and Sections 12 and 13 ask what it would take to pass them over the rest of the century.

SECTION 03

Intellectual Foundations

Sustainable Convergence draws on five established bodies of research. Its original contribution is to integrate them into a single framework for catching up within environmental limits.

IN BRIEF

- Growth theory explains why poor economies can grow faster than rich ones, and why that often fails to happen.
- Sustainable development and planetary-boundary research define the environmental limits within which catch-up must occur.
- Development economics, technology diffusion and resilience research explain how catch-up happens and how it is protected from shocks.

Each of the five literatures summarised in Table 2 is large and mature. None, on its own, answers the question at the heart of this report: how can developing economies close the gaps with advanced economies while staying within environmental limits and becoming more resilient? The value of Sustainable Convergence lies in combining them, and in insisting that their findings be applied together.

Table 2 Five foundations of Sustainable Convergence

Foundation	Key question	Main contribution	Representative work
Economic convergence	Do poor economies catch up?	Closing income and productivity gaps; conditions for catch-up	(Solow, 1956; Barro and Sala-i-Martin, 1992; Patel et al., 2021)
Sustainable development	Can progress last?	Balancing economic, social and environmental progress within planetary limits	(WCED, 1987; Rockström et al., 2009; Raworth, 2012)
Development economics	How do economies transform?	Structural change from farms to factories and services; productivity growth	(Lewis, 1954; McMillan et al., 2014; Rodrik, 2016)
Technology diffusion	How fast do new technologies spread?	Accelerating adoption of productive and clean technologies	(Comin and Hobijn, 2010; Comin and Mestieri, 2018; Lee, 2019)
Polycrisis resilience	How do societies withstand interacting shocks?	Reducing vulnerability to interconnected systemic risks	(Lawrence et al., 2024; Hallegatte et al., 2016; Hughes, 2026b)

Source: H Heuristics.

3.1 Economic convergence: why catch-up is possible but not automatic

The idea that poor economies should grow faster than rich ones comes from the growth model developed by Robert Solow in the 1950s (Solow, 1956). If capital is scarce in a poor country, each new machine, road or school adds more to output there than in a rich country, where capital is already plentiful. Over time, poorer economies should therefore grow faster and incomes should converge. Later work showed that technology matters even more than capital: poorer countries can grow quickly by adopting ideas and techniques already used elsewhere, rather than inventing them from scratch (Romer, 1990; Abramovitz, 1986; Gerschenkron, 1962).

In practice, convergence did not happen for most of the twentieth century. Economists responded by distinguishing *unconditional* convergence, where all poor countries catch up, from *conditional* convergence, where only countries with the right conditions, such as education, stable institutions and openness, close the gap (Barro and Sala-i-Martin, 1992; Baumol, 1986). Differences in productivity, rather than in capital, explain most of the income gap between rich and poor countries (Hall and Jones, 1999; Caselli, 2005). Since around 2000 the pattern has changed: many more developing economies have grown faster than rich ones, partly because the conditions for growth have improved across much of the developing world (Patel et al., 2021; Kremer et al., 2022). The lesson for Sustainable Convergence is that catch-up is possible and has been happening, but it depends on building capabilities, and it can stall.

3.2 Sustainable development: progress within limits

The modern concept of sustainable development dates from the 1987 report *Our Common Future*, which defined it as development that meets the needs of the present without compromising the ability of future generations to meet their own (WCED, 1987). It was developed further at the 1992 Rio Earth Summit and in the 2015 Sustainable Development Goals, seventeen goals that span poverty, health, education, energy, cities, climate and nature (United Nations, 1992; United Nations, 2015). Progress has been disappointing: the United Nations reported in 2025 that only about a third of the measurable targets were on track or making moderate progress (United Nations, 2025).

A parallel line of research has defined the environmental limits more precisely. The planetary boundaries framework identifies nine Earth-system processes, including climate, biodiversity, land use and freshwater, within which humanity can operate safely; six were found to have been crossed by 2023 (Rockström et al., 2009; Richardson et al., 2023). The *doughnut* model adds a social foundation of basic needs below which no one should fall (Raworth, 2012). A study of 150 countries found that none met its citizens' basic needs at a globally sustainable level of resource use (O'Neill et al., 2018). This is precisely the gap Sustainable Convergence seeks to close: raising the social floor in poorer countries while bringing resource use within the ceiling everywhere.

3.3 Development economics: transformation, not just growth

Development economists have long emphasised that economies grow by changing their structure. In the classic model of Arthur Lewis, workers move from low-productivity farming to higher-productivity industry and modern services, raising average output even if no single sector becomes more productive (Lewis, 1954). This structural change explains much of the rapid growth in East Asia, and its absence or reversal explains slow growth elsewhere (McMillan et al., 2014). Manufacturing has historically been the fastest route to catch-up, because factory productivity tends to converge to world levels even when the rest of the economy does not (Rodrik, 2013).

Two findings from this literature shape Sustainable Convergence. The first is *premature deindustrialisation*: many developing countries are seeing manufacturing's share of jobs peak at much lower income levels than earlier industrialisers did, as automation and global competition change the economics of factories (Rodrik, 2016). The second is the *middle-income trap*: many countries grow quickly to middle income and then stall, because the strategies that work at low income, such as cheap labour and imported technology, stop working (World Bank, 2024). Both findings imply that tomorrow's catch-up will rely more on services, digital technology, clean-energy industries and higher productivity in agriculture, and less on simply copying yesterday's heavy industry.

3.4 Technology diffusion: the speed of adoption

New technologies now reach developing countries far faster than they once did, but they are used less intensively once they arrive. A study of technology adoption across 166 countries over two centuries found that the lag between invention and first adoption has shrunk from many decades to a few years, while gaps in how widely technologies are used have persisted (Comin and Hobijn, 2010; Comin and Mestieri, 2018). Mobile phones reached most of the developing world within two decades, yet broadband, modern manufacturing processes and digital business tools remain thinly spread (ITU, 2025; Cirera and Maloney, 2017).

Diffusion is also where the clean-energy opportunity lies. The steep decline in the costs of solar power, wind power and batteries follows a pattern of learning by doing: each doubling of cumulative production has cut costs by a roughly constant percentage (Way et al., 2022). Because these technologies are modular and can be built quickly, they can be deployed in places that never had large central power plants. Catching up in technology, rather than in fossil infrastructure, is the practical meaning of leapfrogging (Lee, 2019).

3.5 Polycrisis resilience: protecting gains from shocks

The fifth foundation is research on resilience and systemic risk. The world faces a growing number of interacting crises, from climate extremes and pandemics to financial shocks, conflicts and supply-chain disruptions, which are increasingly described as a *polycrisis* (Lawrence et al., 2024; Tooze, 2022). Developing economies are the most exposed. A single disaster can push millions of people into poverty, and shocks can set back education, health and growth for years (Hallegatte et al., 2016; Hallegatte et al., 2017). Within H Heuristics' work, Polycrisis Resilience provides the overarching framework for understanding how to reduce such vulnerability (Hughes, 2026b).

Resilience research adds two insights. First, growth that is repeatedly interrupted by shocks delivers far less than its headline rate suggests, because output lost in crises is often never regained

(Cerra and Saxena, 2008; Hsiang and Jina, 2014). Second, investing in resilience usually pays for itself: the Global Commission on Adaptation estimated that investing $1.8 trillion in five areas of adaptation between 2020 and 2030 could generate $7.1 trillion in net benefits, and the World Bank found that resilient infrastructure in developing countries returns about $4 for every $1 spent (Global Commission on Adaptation, 2019; Hallegatte et al., 2019). For Sustainable Convergence, resilience is therefore not a separate goal but a condition for convergence to last.

Resilience research also warns against a narrow view of development. Systems that are optimised for efficiency alone, with no spare capacity and tightly coupled parts, can fail suddenly when stressed (Lawrence et al., 2024). A power system built around a single large plant and long transmission lines, a food system dependent on one import route, or a public budget dependent on one commodity may look efficient in normal times but prove fragile in a crisis. Sustainable Convergence therefore favours diversified, modular and redundant systems, such as distributed renewable power, regional grids and trade links, and broad tax bases, which tend to be both cleaner and more resilient.

SYNTHESIS

The integrated contribution

Each of the five literatures answers part of the question. Growth theory explains catch-up but not its environmental cost. Sustainable development defines limits but says little about closing gaps between countries. Development economics explains transformation but has often assumed a fossil-fuelled industrial path. Technology diffusion explains speed but not direction. Resilience research explains protection but not progress.

Sustainable Convergence combines them into one proposition: **developing economies can close the gaps faster and more durably by building their economies on clean, digital, human and resilient foundations than by repeating the resource-intensive route of the past** (Hughes, 2026a).

SECTION 04

The Seven Dimensions of Sustainable Convergence

Convergence is not one gap but several. The framework tracks seven, and treats them as parts of a single system rather than as separate targets.

IN BRIEF

- The seven dimensions are economic, environmental, technological, human-development, infrastructure, institutional and resilience convergence.
- Five dimensions measure catching up in capabilities; two, environment and resilience, measure whether the path is sustainable.
- The dimensions are meant to reinforce one another: progress in one should make progress in the others easier and cheaper.

The original Sustainable Convergence monograph identified five core dimensions: economic, environmental, technological, human-development and resilience convergence (Hughes, 2026a). This report adds two enabling dimensions that are implicit in that framework and essential for measurement: **infrastructure**, the physical networks that deliver energy, water, sanitation and transport, and **institutions**, the public capacity to govern, regulate and deliver services. The result is the seven-dimension framework in Table 3. Each dimension has a clear meaning, measurable indicators and a direct link to the others.

4.1 Dimension 1: Economic convergence

Economic convergence is the narrowing of gaps in income per person, productivity, industrial capacity and economic opportunity. It is the dimension most familiar to economists and the one that pays for most of the others: higher incomes allow households to save and invest, and higher productivity widens the tax base that funds schools, hospitals and infrastructure. In 2022 the median high-income economy produced about $49,000 of output per person and $107,000 per worker at purchasing power parity. Because productivity explains most income differences (Hall and Jones, 1999), the heart of economic convergence is raising output per worker through better technology, management, skills and the movement of workers into more productive activities (Bloom et al., 2013; McMillan et al., 2014).

Table 3 The seven dimensions of Sustainable Convergence

Dimension	What converges	Indicators used in this report	Benchmark
1. Economic	Income per person, productivity, industrial capacity and economic opportunity	GDP per person and output per worker, PPP dollars (World Bank, 2026)	High-income median
2. Environmental	Air quality, carbon intensity, emissions per person and clean energy	PM2.5 exposure; CO_2 per person and per unit of GDP; renewable share of electricity (World Bank, 2026)	Sustainability thresholds
3. Technological	Access to and use of digital and productive technologies	Internet users; fixed broadband subscriptions (World Bank, 2026; ITU, 2025)	High-income median
4. Human development	Health, education, nutrition and living standards	Life expectancy; under-five mortality; mean years of schooling (World Bank, 2026; UNDP, 2025)	High-income median
5. Infrastructure	Electricity, clean cooking, water and sanitation	Access rates for electricity, clean cooking, basic water and basic sanitation (World Bank, 2026)	High-income median
6. Institutional	Governance, administrative capacity and regulation	Government effectiveness; regulatory quality (World Bank, 2025a)	High-income median
7. Resilience	Vulnerability and capacity to cope with shocks	INFORM vulnerability and lack-of-coping-capacity scores (European Commission JRC, 2026)	High-income median

Source: H Heuristics, building on the five dimensions of Hughes (2026a) (Hughes, 2026a). Scoring is explained in Section 9.

4.2 Dimension 2: Environmental convergence

Environmental convergence is the most distinctive dimension, and it works differently from the others. For income or schooling, the benchmark is the level already reached by advanced economies. For the environment, that benchmark would be wrong: high-income countries emit far more carbon per person than the planet can sustain. Environmental convergence therefore means converging *towards sustainability thresholds*, such as the World Health Organization's airquality guideline and emissions levels compatible with climate goals, from both directions. Poorer countries need to grow without crossing those thresholds; richer countries need to come down to them. It covers air pollution, carbon intensity, emissions per person, clean energy and, more broadly, the protection of forests, water and biodiversity (Rockström et al., 2009; Dasgupta, 2021).

4.3 Dimension 3: Technological convergence

Technological convergence means closing gaps in access to digital infrastructure, artificial intelligence, automation, advanced manufacturing and other productive technologies. Technology is the main channel through which poorer economies can catch up quickly, because ideas, unlike capital, can be copied at low cost (Romer, 1990). The digital economy has created new routes: mobile money has helped lift households out of poverty in Kenya, and the arrival of fast internet raised employment in African countries (Suri and Jack, 2016; Hjort and Poulsen, 2019). This report measures technological convergence with internet use and fixed broadband, which are available for nearly every country; the adoption of artificial intelligence and advanced manufacturing should be added as data improve.

4.4 Dimension 4: Human-development convergence

Human-development convergence means narrowing gaps in health, education, nutrition, housing and living standards. It is both an end in itself, as Amartya Sen argued in describing development as the expansion of people's freedoms, and a means to everything else (Sen, 1999). Healthier, better-educated people are more productive, adopt new technologies more readily and respond better to disasters (Lutz et al., 2014). Early childhood matters most: a nutrition programme in Guatemala in the 1970s raised the adult wages of men who received it as young children by almost half (Hoddinott et al., 2008). Yet about seven in ten ten-year-olds in low- and middle-income countries could not read and understand a simple text in 2022, and stunting still affects about one child in five worldwide (World Bank et al., 2022; UNICEF et al., 2023).

4.5 Dimension 5: Infrastructure convergence

Infrastructure convergence means expanding access to reliable electricity, clean water, sanitation, transport, housing and resilient urban systems. These networks are the physical backbone of development. Rural electrification in South Africa raised women's employment; reliable power and roads allow firms to grow and farmers to reach markets (Dinkelman, 2011; Lee et al., 2020). Much of the infrastructure that developing economies will need by mid-century has not yet been built (New Climate Economy, 2016). That is both a challenge and an opportunity: building it right the first time, clean and climate-resilient, is far cheaper than retrofitting it later (Hallegatte et al., 2019).

4.6 Dimension 6: Institutional convergence

Institutional convergence means strengthening governance, administrative capacity, financial systems and public-service delivery. Institutions decide whether resources become roads and clinics or are wasted, whether rules encourage investment, and whether governments can respond when crises hit. Countries with more effective governments had better outcomes in the COVID-19 pandemic, even after accounting for income (COVID-19 National Preparedness Collaborators, 2022). Digital tools now offer new ways to strengthen institutions quickly, for example by paying benefits directly into accounts, digitising tax and procurement, and linking public registries, provided that privacy and accountability are protected (UNDP, 2023).

4.7 Dimension 7: Resilience convergence

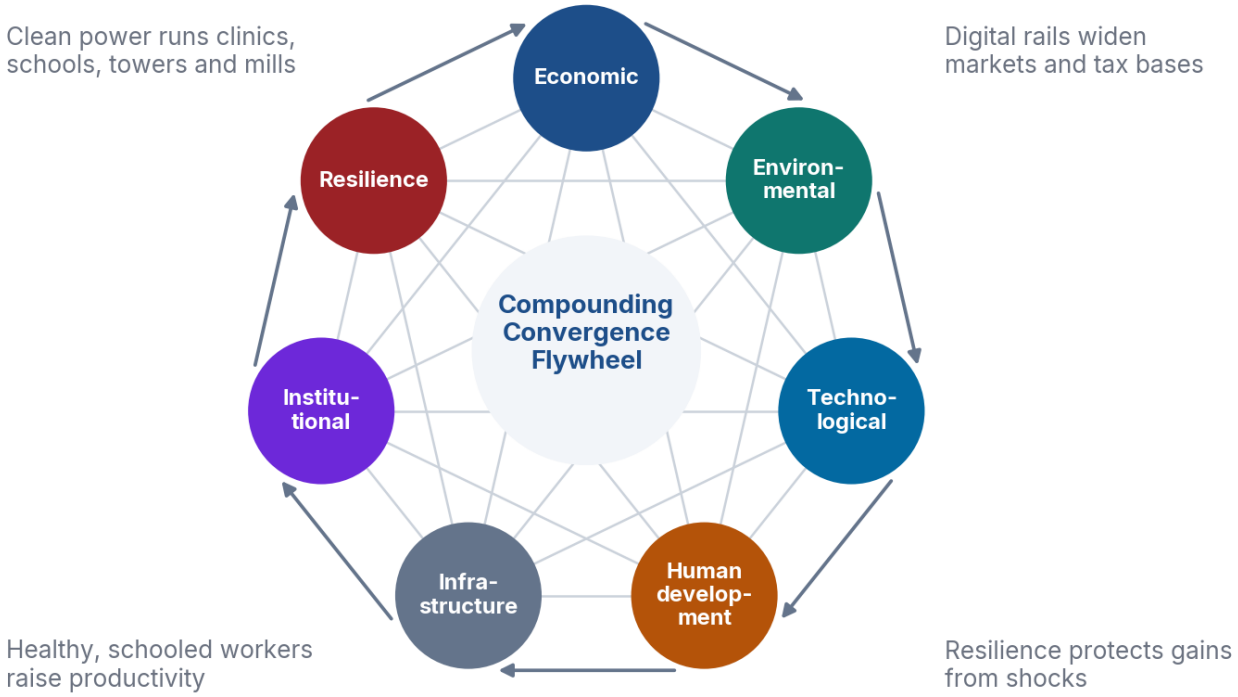
Resilience convergence means narrowing gaps in vulnerability and adaptive capacity, so that economies and people in developing countries become as able to withstand climate, environmental, economic and systemic shocks as those in advanced economies. Today the gap is wide: on the INFORM risk index, the median high-income country scores 2.4 out of 10 on lack of coping capacity, while the population-weighted average in low-income countries is 7.1 (European Commission JRC, 2026). Resilience convergence is where Sustainable Convergence connects most directly with Polycrisis Resilience. It covers early warning systems, climate-proofed infrastructure, adaptive social protection, disaster insurance and the institutional capacity to coordinate responses (UNDRR and WMO, 2023; Bowen et al., 2020; Clarke and Dercon, 2016).

4.8 Seven dimensions, one system

The seven dimensions are meant to be mutually reinforcing rather than treated as seven independent targets. Renewable energy supports industrialisation while reducing emissions. Digital public infrastructure improves economic participation and institutional efficiency. Technology diffusion raises productivity while improving access to services. Climate adaptation protects infrastructure, livelihoods and growth. Human development improves workforce skills and longterm productivity. Figure 3 illustrates this idea, which Section 8 tests against the data.

Figure 3 The Compounding Convergence Flywheel: progress in each dimension supports the others

Conceptual diagram of the seven dimensions and their links



Source: H Heuristics, adapted from Hughes (2026a) (Hughes, 2026a).

The framework has one important asymmetry. Five dimensions, economic, technological, human development, infrastructure and institutions, measure capabilities in which developing economies are catching up with advanced ones. Two, environment and resilience, measure whether the path is sustainable. A country can score well on the first five while scoring poorly on the environment; the history of industrialisation in today's rich countries is an example. The high-income group's average environmental score in this report is only 50 out of 100. Sustainable Convergence requires progress on all seven at once, which is why the index in Section 9 penalises imbalance rather than letting strength in one dimension hide weakness in another.

SECTION 05

The Record: How Far Has Convergence Come?

Since 2000 the developing world has grown faster than the rich world, and access to basic services has spread rapidly. But the gains are concentrated, the poorest countries have fallen behind, and the dollar distance between rich and poor has kept growing.

IN BRIEF

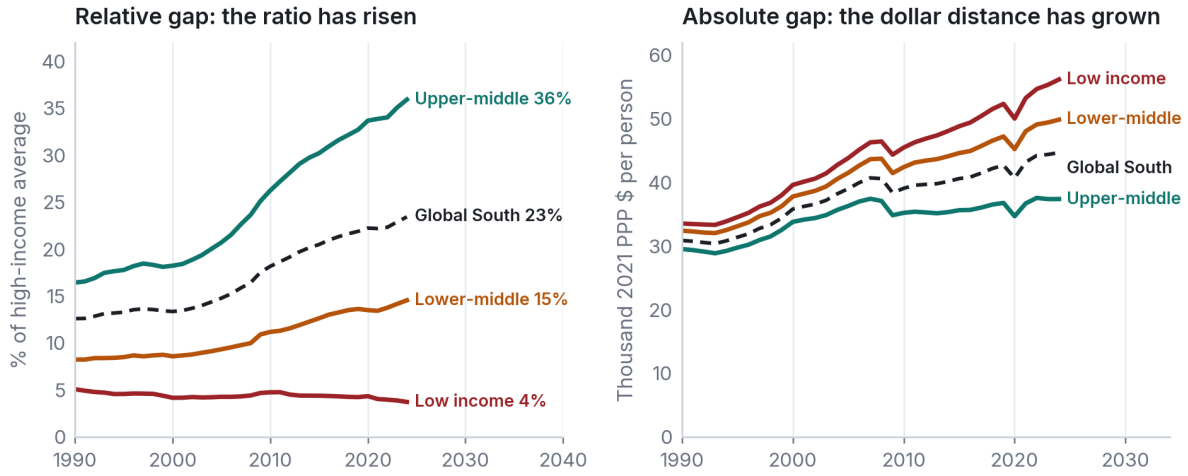
- Global South income rose from 13% to 23% of the high-income level between 2000 and 2024, mostly because of China and India.
- The absolute gap widened from about $36,000 to $45,000 per person: improvement and convergence are not the same thing.
- Access to electricity, water and the internet has converged far faster than income, productivity or schooling.

5.1 Income: a real but concentrated catch-up

The most basic measure of convergence is the ratio of average income in developing economies to average income in advanced ones. On this measure, the past quarter-century has been the best in modern history for the developing world. Average income in the Global South, adjusted for differences in prices, rose from 13.4% of the high-income average in 2000 to 23.4% in 2024. Upper-middle-income countries, which include China, Brazil, Indonesia and Mexico, rose from 18% to 36%; lower-middle-income countries, which include India, Bangladesh, Nigeria and the Philippines, from 9% to 15% (Figure 4).

Figure 4 The ratio has risen, but the dollar gap has kept widening

Left: average income per person as % of the high-income average. Right: high-income average minus group average, thousand 2021 PPP dollars per person, 1990–2024

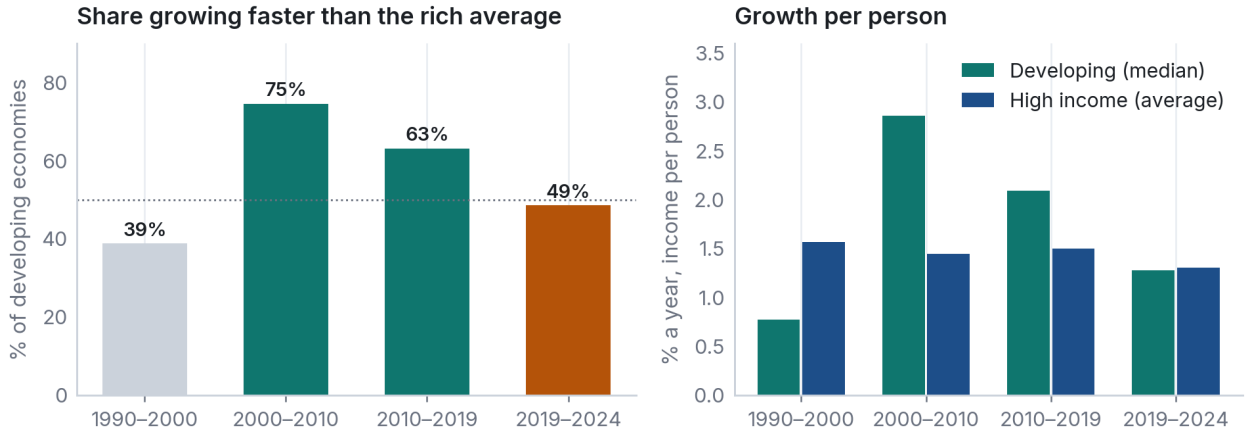


Source: H Heuristics calculations from World Development Indicators, GDP per person in 2021 PPP dollars (World Bank, 2026). Population-weighted group averages; current World Bank income groups.

The aggregate hides who moved. China's income rose from about a tenth to more than a third of the high-income level in two decades, and India's roughly doubled in relative terms. Without these two countries, the Global South's relative income moved only from 17.7% to 19.7%. Low-income countries, most of them in Sub-Saharan Africa, went backwards: from 4.2% to 3.7% of the high-income level. The share of developing economies growing faster than the rich-country average rose from 39% in the 1990s to 75% in 2000–2010, then fell to 63% in 2010–2019 and 49% in 2019–2024, a period that included the pandemic, the energy and food price shocks and a sharp rise in borrowing costs (Figure 5).

Figure 5 The convergence boom of the 2000s has faded

Left: share of developing economies whose income per person grew faster than the high-income average. Right: median annual growth of income per person, developing economies vs high-income average



Source: H Heuristics calculations from World Development Indicators (World Bank, 2026). Developing economies with more than one million people and data at both ends of each period (n = 103 in 2019–24).

Productivity tells a similar story. Output per worker in developing economies rose from 16% of the high-income level in 2000 to 26% in 2024, but in low-income countries it slipped from 6.6% to 6.4%. Most of the world's poorest workers remain in small farms and informal businesses with very low output per hour, and the movement of workers into more productive jobs has been slower than in East Asia's earlier growth miracles (Gollin et al., 2014; McMillan et al., 2014; Dieppe (ed.), 2021). Since the pandemic, the World Bank has warned that potential growth in developing economies is on course for its weakest decade in thirty years (Kose and Ohnsorge, 2024).

5.2 Absolute progress is not the same as convergence

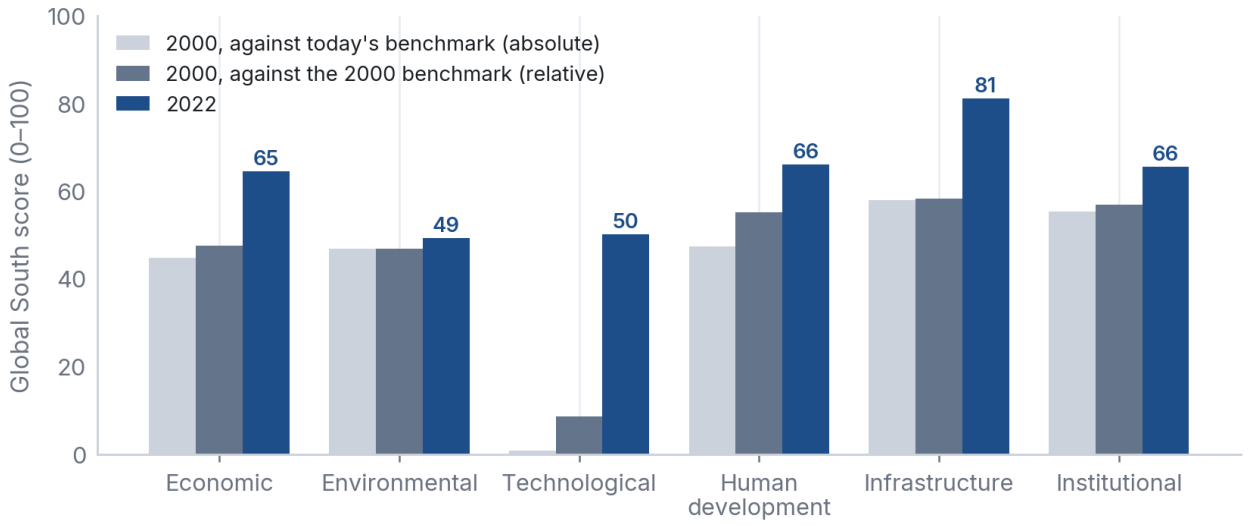
A crucial methodological distinction runs through this report: **absolute improvements are not necessarily convergence**. A developing country can become richer, healthier and better connected while the gap between it and advanced economies widens, because advanced economies are improving too. Of 102 developing economies with data, 90 raised their income per person between 2000 and 2022, but 24 of those still lost ground relative to the high-income average. And because rich countries start from a much higher base, even a rising ratio can mean a widening dollar gap: the absolute distance between the average person in the Global South and in a high-income country grew from about $35,820 to $44,695, and it widened for 99 of the 102 economies.

The same is true of other dimensions. To separate the two ideas, this report scores each dimension twice for the year 2000: once against the high-income benchmark of today (which measures

absolute progress since 2000) and once against the benchmark of 2000 (which measures the *relative* position at that time). Figure 6 shows the result for the Global South. Technological convergence shows the largest gap between the two: measured against today's benchmark, the Global South scored almost nothing in 2000, but measured against the much lower rich-country benchmark of 2000 it scored 9. Today it scores 50. Infrastructure rose from 58 to 81, while the environmental score barely changed, from 47 to 49.

Figure 6 Capabilities improved fast; the environmental score barely moved

Global South dimension scores (0–100) in 2000, scored against today's and against the 2000 high-income benchmark, and in 2022



Source: H Heuristics Sustainable Convergence Index (Section 9). Population-weighted Global South averages of dimension scores. Resilience is excluded because comparable data for 2000 are not available.

METHOD

Measuring convergence correctly

Relative convergence asks whether the ratio between a developing economy and the advanced-economy benchmark is rising. It is the standard measure in growth economics.

Absolute convergence asks whether the gap in absolute units, dollars, years of life or percentage points of access, is shrinking. For bounded indicators such as access rates, relative and absolute convergence usually coincide once rich countries reach 100%. For unbounded ones such as income, they can diverge for decades.

Absolute progress asks whether a country is better off than it was. It is necessary for convergence but not sufficient.

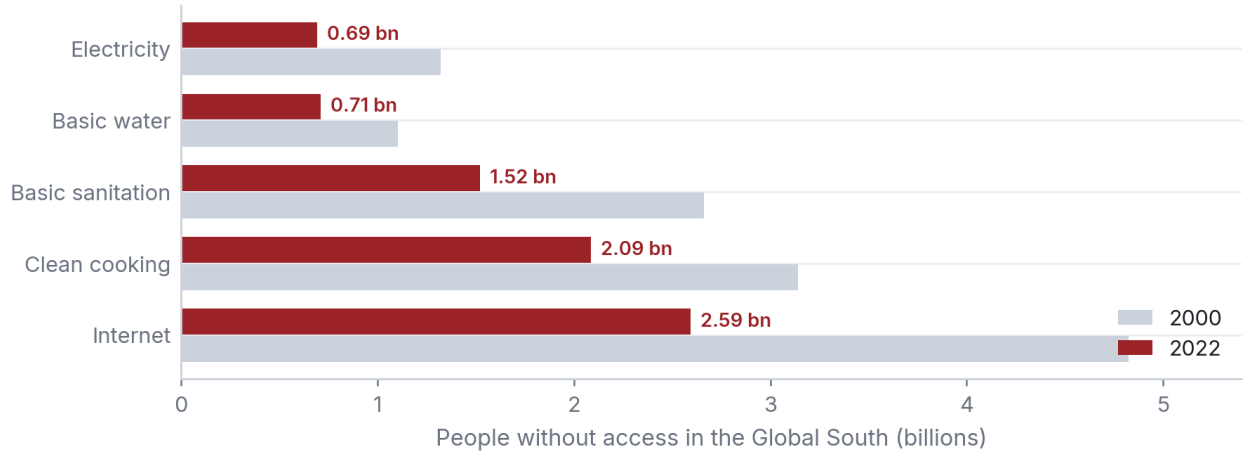
Sustainable Convergence research should report all three, and should report them separately for each dimension, because countries can converge in average income while diverging in environmental quality or resilience.

5.3 Capabilities: access has converged faster than income

Looking beyond income reveals a more encouraging picture for access to basic services and connectivity. In lower-middle-income countries, electricity access rose from 57% to 90% of the high-income level between 2000 and 2022, and internet use from 2% to 56% (Figure 8). Clean cooking and basic sanitation also made large gains. Income per person and output per worker, by contrast, rose only from 9% to 14% and from 12% to 18% of the high-income level. Technologies and services move across borders quickly; the productive capacity that generates income moves slowly.

Figure 7 Billions have gained access since 2000, but billions still lack the basics

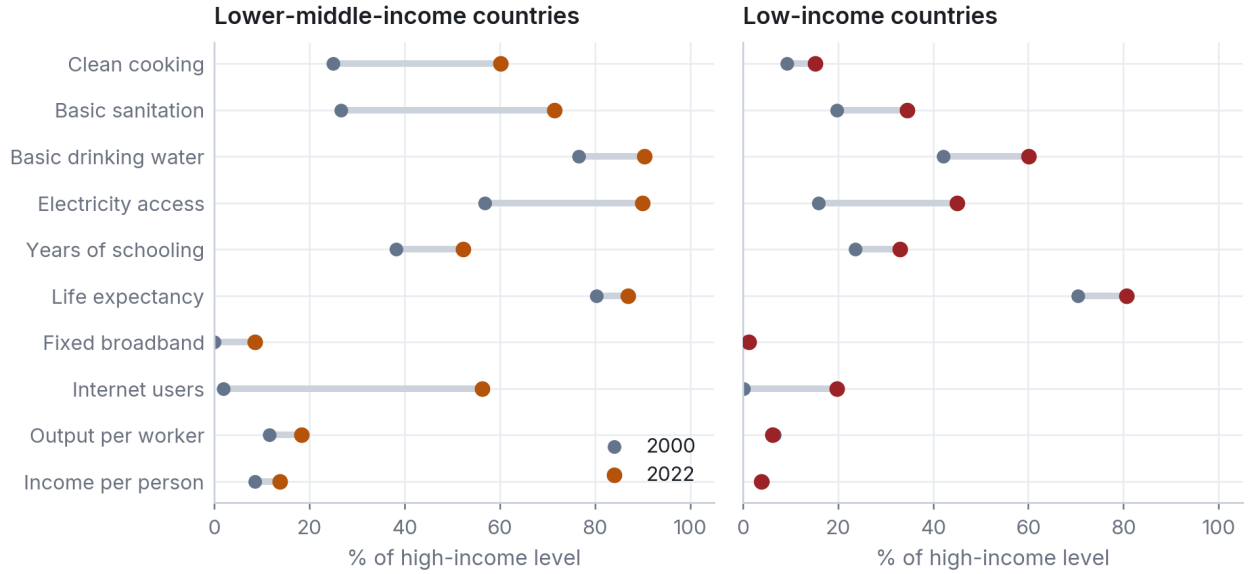
People without access in the Global South, billions, 2000 and 2022



Source: H Heuristics calculations from World Development Indicators (World Bank, 2026). Sum over low- and middle-income economies of population × (100 − access rate).

Figure 8 Access to services and connectivity has converged far faster than income

Indicator level as % of the high-income level, 2000 (grey) and 2022 (colour)



Source: H Heuristics calculations from World Development Indicators and UNDP (World Bank, 2026; UNDP, 2025). Population-weighted averages, 2000 and 2022.

Low-income countries show the same pattern at a much lower level. Their electricity access rose from 16% to 45% of the high-income level and internet use from almost zero to 20%, but clean cooking reached only 15% and fixed broadband barely registers. Life expectancy, which depends heavily on cheap public-health measures such as vaccines and bed nets, is the most converged indicator: 81% of the high-income level in low-income countries and 87% in lower-middle-income ones. Schooling, by contrast, has converged slowly.

Figure 7 translates these rates into people. Between 2000 and 2022, the number of people in the Global South without electricity fell by almost half, from 1.3 billion to 0.69 billion, and the number without basic sanitation from 2.7 billion to 1.5 billion. Even so, 2.1 billion people still cook with wood, charcoal, dung or kerosene, exposing themselves to smoke that the World Health Organization links to millions of early deaths each year (WHO, 2024). And the remaining gaps are increasingly concentrated: 86% of people without electricity in the Global South now live in Sub-Saharan Africa (IEA et al., 2026).

Why has access converged so much faster than income? Part of the answer is that access indicators have a ceiling: once rich countries reach 100%, every gain in a poorer country narrows the gap. But the main reason is that the technologies involved have become cheap, modular and easy to deliver. A mobile network, a solar home system or a vaccination campaign can reach millions of people in a few years, whereas raising the productivity of millions of farms and small firms takes decades of investment in skills, capital, markets and institutions. This difference is central to Sustainable Convergence. Access to modern services is the foundation on which productive convergence is built, and the fact that it can now be extended quickly, and with clean technology, is one of the main reasons for optimism. The challenge for the next two decades is to turn access into productivity: to use electricity, connectivity and better health to raise what people can earn.

SECTION 06

Two Development Trajectories

Must developing countries pollute first and clean up later? The evidence shows that each generation of developers has emitted less on the way up, but that most of today's catch-up still follows the carbon-intensive path.

IN BRIEF

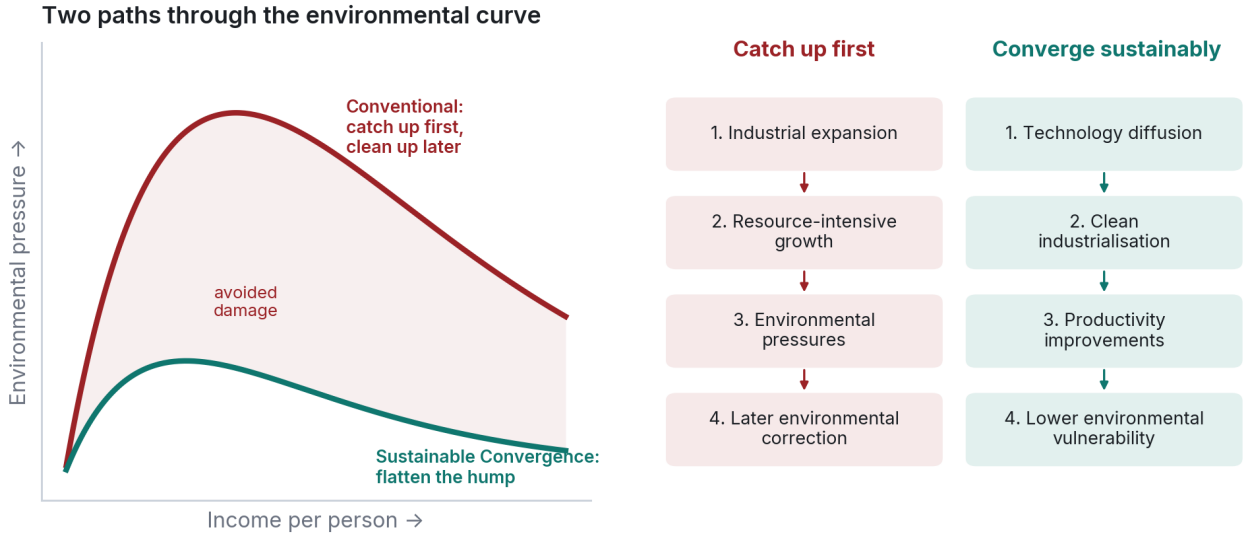
- Local air pollution tends to peak at middle income; carbon emissions have so far risen steadily with income.
- Countries crossing $10,000 per person after 2000 emitted a median 2.9 tonnes of CO_2 per person, against 4.4 tonnes for those that crossed before 1970.
- Most growing rich economies have cut emissions since 2010; only 12 of 91 growing developing economies have done so.

6.1 Catch up first, clean up later

One of the most important propositions of Sustainable Convergence is that developing economies do not need to follow the resource-intensive development path historically followed by advanced economies. That path typically involved fossil-fuel-intensive industrialisation, heavy pollution during urbanisation, resource-intensive infrastructure expansion, and environmental degradation that preceded environmental improvement. Sustainable Convergence instead emphasises faster access to cleaner technologies, more efficient infrastructure and modern productive systems (Figure 9).

Figure 9 Two development trajectories: catch up first, or converge sustainably

Stylised environmental pressure along the development path (left) and the sequence of each trajectory (right)



Source: H Heuristics, adapted from Hughes (2026a) (Hughes, 2026a). Conceptual comparison, not a claim that all historical or contemporary economies follow either trajectory.

The conventional view has a respectable intellectual pedigree. In the 1990s, economists found that some pollutants, such as sulphur dioxide and smoke, rise as countries industrialise and then fall as they grow richer, tracing an inverted U (Grossman and Krueger, 1995). The pattern was named the *environmental Kuznets curve*, after Simon Kuznets' earlier conjecture about inequality (Kuznets, 1955). It was quickly turned into a policy argument: if pollution falls naturally with wealth, the best environmental policy for a poor country is to grow. The original monograph calls this the *Environmental Kuznets Fallacy* (Hughes, 2026a). Later research found the curve to be much weaker and less universal than first claimed, holding for some local pollutants but not for carbon dioxide or biodiversity loss, and showed that the downturn reflects deliberate regulation and technology rather than an automatic effect of income (Stern, 2004; Dasgupta et al., 2002).

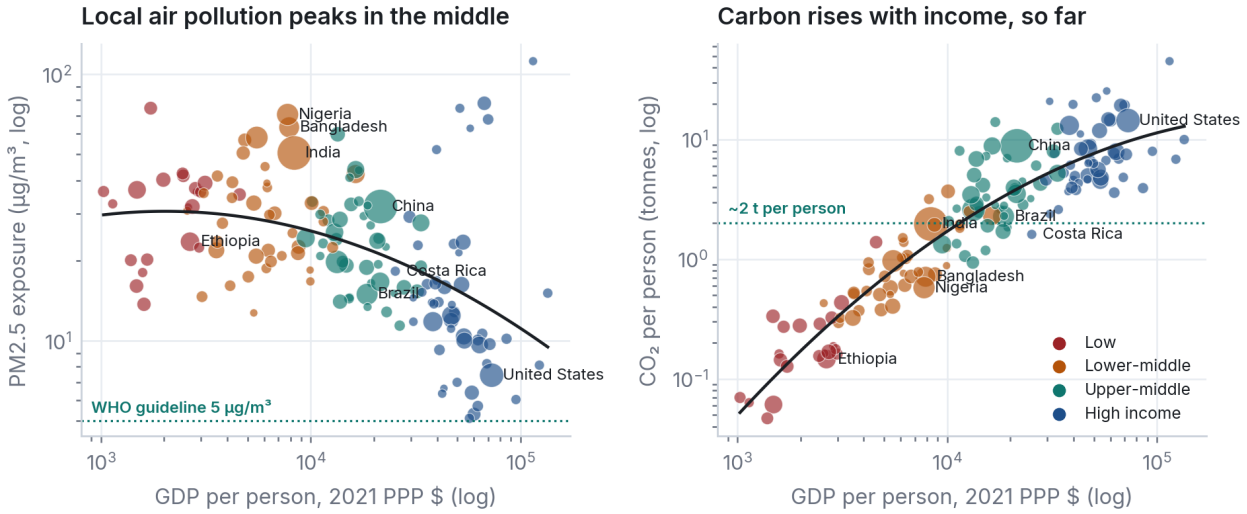
The argument has three further weaknesses. Many environmental harms are irreversible: species lost, glaciers melted and carbon emitted cannot be recovered. The costs of pollution fall during the decades of high pollution, on the people least able to bear them. And infrastructure built during the dirty phase, from coal plants to car-dependent cities, locks in emissions for decades and makes the later clean-up more expensive (Unruh, 2000; Acemoglu et al., 2012).

6.2 What the data show

Cross-country data today show both parts of the story (Figure 10). Local air pollution does peak in the middle of the income distribution: the population-weighted concentration of fine particles (PM2.5) averages about 48 micrograms per cubic metre in lower-middle-income countries, against 31 in low-income, 27 in upper-middle-income and 13 in high-income countries. Every group is above the World Health Organization's guideline of 5 micrograms, and 42% of people in the Global South breathe air above 35 micrograms, seven times the guideline. Carbon dioxide, by contrast, rises steadily with income: across 150 countries, a 10% difference in income goes with roughly an 11% difference in emissions per person, and income alone explains 83% of the variation.

Figure 10 Air pollution peaks at middle income; carbon emissions still rise with income

PM2.5 exposure (left) and CO_2 emissions per person (right) against GDP per person, 2022

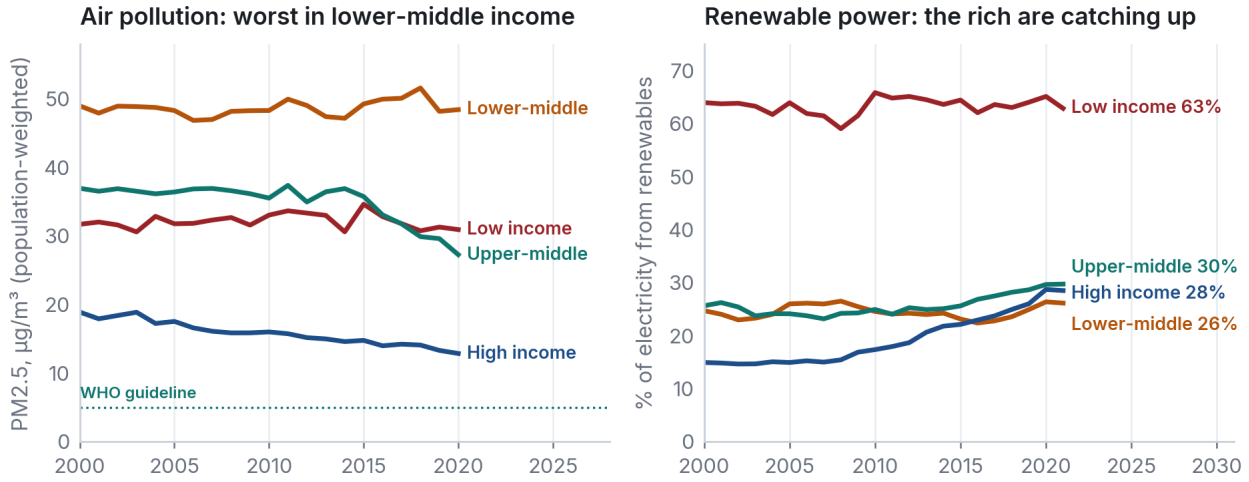


Source: H Heuristics calculations from World Development Indicators, 2022 (World Bank, 2026). Countries with more than one million people (n = 150); bubble size reflects population; line is a quadratic fit in logs.

There are encouraging signs. Air pollution in upper-middle-income countries fell from 37 to 27 micrograms between 2000 and 2020, driven largely by China's clean-air campaign, showing how quickly deliberate policy can bend the curve (Figure 11). And the share of electricity from renewable sources in high-income countries has nearly doubled since 2000, from 15% to 28%. In developing economies the share rose only from 28% to 32%: hydropower has long given many poorer countries a high renewable share, but much of the new power built in Asia in the 2000s and 2010s was coal-fired.

Figure 11 Air pollution is falling only slowly; the rich world is greening its power faster

Left: PM2.5 exposure, µg/m³, 2000–2020. Right: renewable share of electricity generation, %, 2000–2021



Source: H Heuristics calculations from World Development Indicators (World Bank, 2026). Population-weighted averages by current World Bank income group.

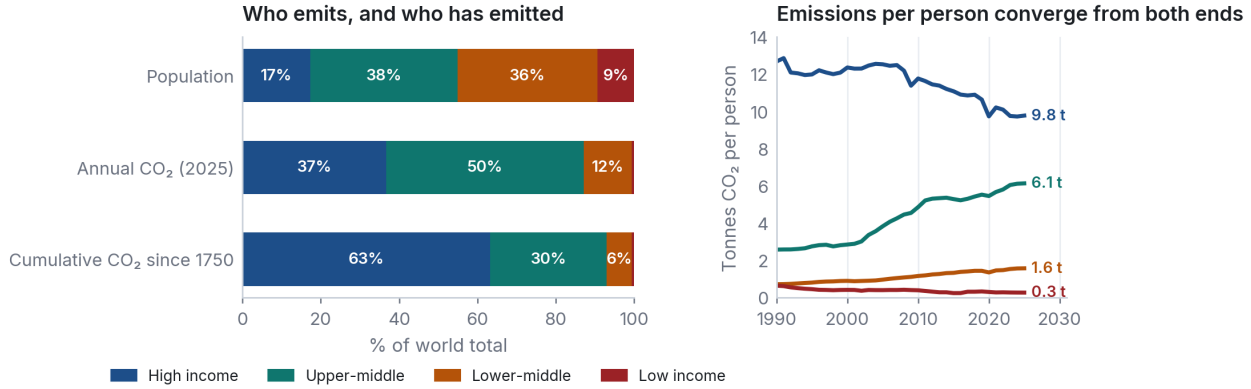
6.3 Who emits, and who has emitted

Any discussion of sustainable development paths must start from the unequal history of emissions (Figure 12). High-income countries hold about 17% of the world's population, produce about 37% of current fossil CO_2 emissions and are responsible for about 63% of all such emissions since the industrial revolution (Our World in Data, 2025; Friedlingstein et al., 2025). Low-income countries, with 9% of the world's people, account for less than 1% of both. An average person in a high-income country emits about 9.8 tonnes of CO_2 a year, compared with 1.6 tonnes in lower-middle-income and 0.3 tonnes in low-income countries.

The right-hand panel of Figure 12 shows something new: emissions per person are converging from both ends. In high-income countries they fell from 12.4 tonnes in 2000 to 9.8; in upper-middle-income countries, led by China, they more than doubled to 6.1. Upper-middle-income countries now produce about 50% of the world's annual emissions. This is the crux of the matter: the decisions developing economies take about how to power their growth over the next two decades will decide whether the world meets its climate goals.

Figure 12 The rich world built up most past emissions; today's growth is in the middle

Left: shares of world population, annual and cumulative CO_2. Right: CO_2 per person by income group, tonnes, 1990–2025



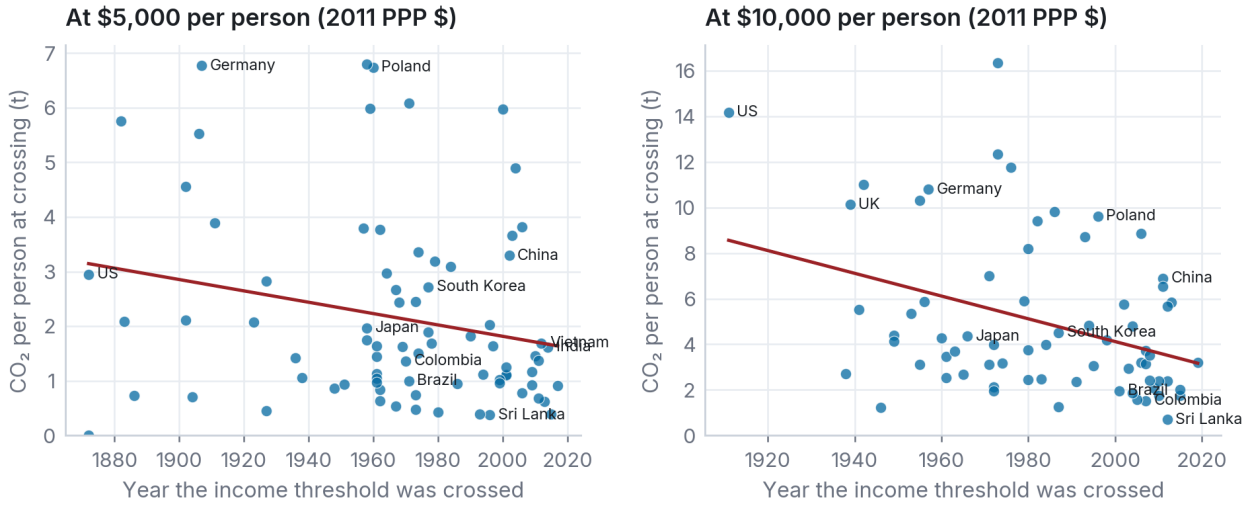
Source: H Heuristics calculations from Our World in Data and the Global Carbon Project (Our World in Data, 2025; Friedlingstein et al., 2025). Fossil fuel and industry CO_2, 2025; income groups as defined by Our World in Data from World Bank classes.

6.4 The latecomer advantage

If the old path were the only path, every country should emit roughly the same amount of carbon at the same level of income. It does not. Using long-run data on income and emissions, this report identifies the year in which each country first sustained an income above $5,000 and $10,000 per person (in 2011 prices) and records its emissions per person at that time (Figure 13).

Figure 13 Each generation of developers has emitted less on the way up

CO_2 emissions per person in the year a country first sustained an income above each threshold (2011 PPP dollars), by year of crossing



Source: H Heuristics calculations from Our World in Data CO_2 dataset, which uses Maddison Project GDP estimates (Our World in Data, 2025; Bolt and van Zanden, 2024). Countries with more than three million people; major oil exporters excluded. n = 79 ($5,000) and 69 ($10,000).

The result is clear. The United States crossed $10,000 per person in 1911 while emitting about 14 tonnes of CO_2 per person; the United Kingdom in 1939 at about 10 tonnes; Japan in 1966 at 4.4. Brazil crossed the same line in 2001 at 2.0 tonnes, Colombia in 2007 at 1.5, Indonesia in 2015 at 2.0 and Sri Lanka in 2012 at 0.7. Across all countries, the median emissions at crossing fell from 4.4 tonnes for those that crossed before 1970 to 2.9 tonnes for those that crossed after 2000, and the

fitted trend falls by about 0.5 tonnes per decade. China is a notable exception: it crossed in 2011 at 6.9 tonnes, reflecting its coal-heavy industrial boom.

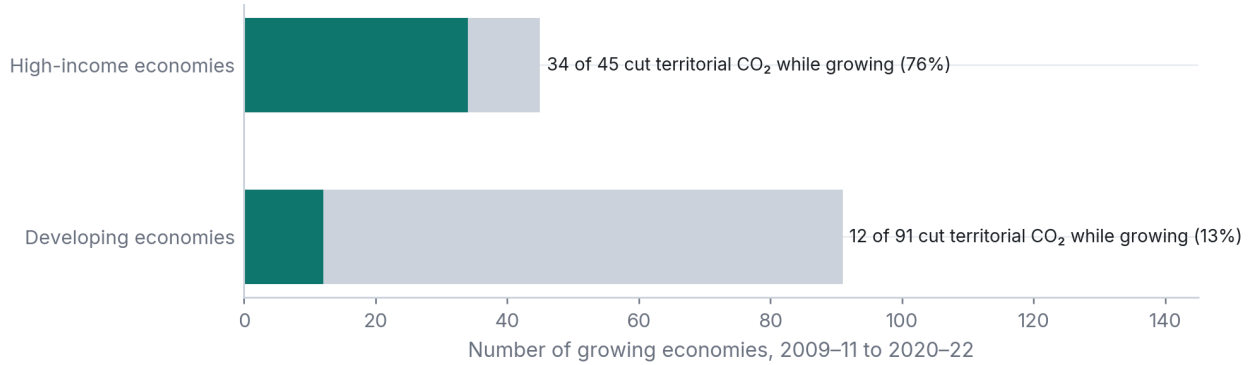
The spread around the trend is wide, and the pattern partly reflects the shift of heavy industry to other countries and the growth of services. Even so, it is consistent with the core claim of Sustainable Convergence: latecomers can use more efficient technologies than pioneers did, and the cleaner those technologies become, the lower the emissions cost of development. Today's cost of solar and wind power is far below anything available even fifteen years ago (Section 7), so the latecomer advantage should now be larger than ever.

6.5 Decoupling: possible, but so far a privilege of wealth

Decoupling means that an economy grows while its environmental pressure falls. Using data on both production-based (territorial) and consumption-based emissions, which count the carbon embedded in imports, this report counts the economies that grew by more than 5% between 2009–11 and 2020–22 while cutting emissions (Figure 14). Of 136 growing economies, 46 reduced territorial CO_2 and 29 reduced both territorial and consumption-based CO_2. But the split by income is stark: 34 of 45 high-income economies cut territorial emissions while growing, against only 12 of 91 developing ones, and only 1 developing economy cut both measures.

Figure 14 Most rich economies now grow while cutting emissions; few developing economies do

Growing economies that reduced territorial CO_2 emissions, by income group



Source: H Heuristics calculations from Our World in Data CO_2 dataset (Our World in Data, 2025). Economies with more than one million people whose GDP grew by more than 5% between 2009–11 to 2020–22; three-year averages.

These findings match the broader research literature, which finds that absolute decoupling has occurred in a growing number of countries, mainly rich ones, but has rarely been fast enough to meet climate goals (Haberl et al., 2020; Hubacek et al., 2021). For developing economies, the more relevant goal in the near term is strong *relative* decoupling, in which emissions grow much more slowly than income while energy use rises to meet basic needs, followed by an absolute decline as clean energy takes over.

6.6 How countries have actually converged

Combining the two halves of the story produces a simple typology of the convergence pathways that developing economies actually followed between 2000 and 2022 (Figure 15, Table 4). Each economy is classified first by whether its income converged on the high-income average, and then, if it converged, by how fast its emissions per person grew relative to its income.

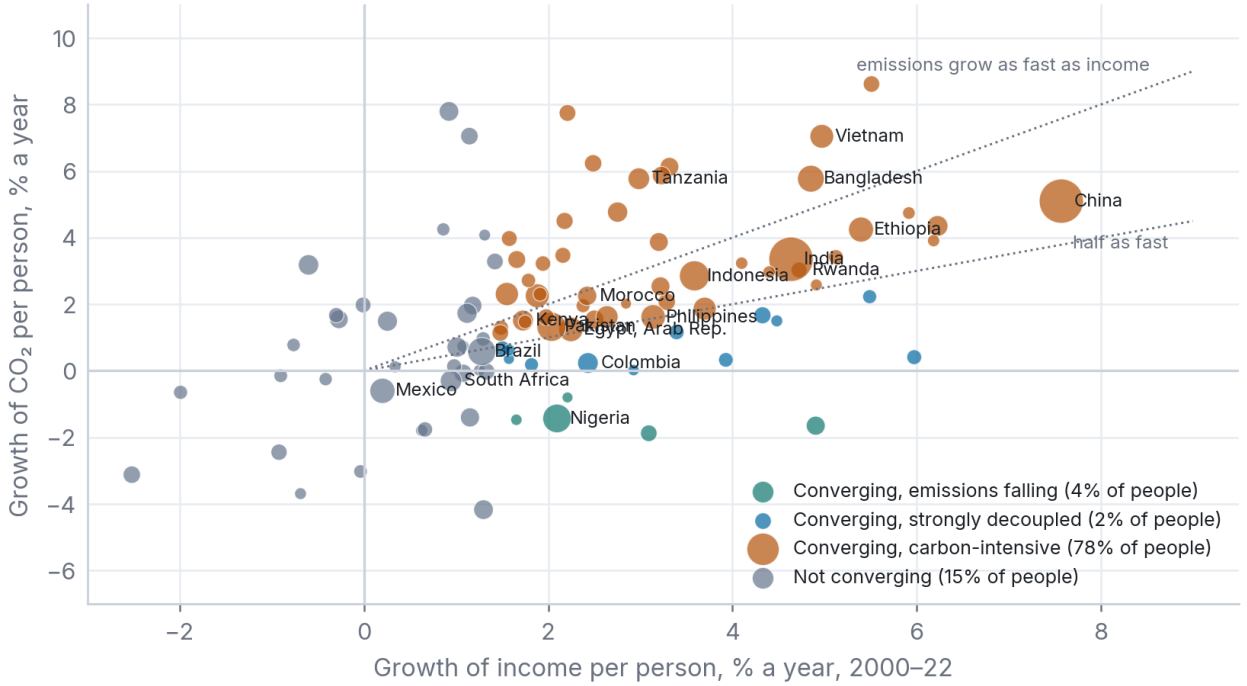
Table 4 Four convergence pathways, 2000–2022

Pathway	Definition	Economies	Share of people	Largest examples
Converging, emissions falling	Income caught up while CO_2 per person fell	5	4%	Nigeria, Uzbekistan, Somalia, Equatorial Guinea, Eswatini
Converging, strongly decoupled	Income caught up; CO_2 per person grew less than half as fast as income	12	2%	Colombia, Kazakhstan, Tunisia, Dominican Republic, Azerbaijan
Converging, carbon-intensive	Income caught up; CO_2 per person grew at least half as fast as income	48	78%	India, China, Indonesia, Pakistan, Bangladesh
Not converging	Income fell further behind the high-income average	35	15%	Brazil, Mexico, South Africa, Sudan, Algeria

Source: H Heuristics calculations from World Development Indicators (World Bank, 2026). 100 developing economies with more than one million people and data for 2000 and 2022.

Figure 15 Most of the developing world converged on a carbon-intensive path

Annual growth of income per person and of CO_2 per person, developing economies, 2000–2022



Source: H Heuristics calculations from World Development Indicators (World Bank, 2026). Bubble size reflects population. Dotted lines show emissions growing as fast as, and half as fast as, income.

The result is sobering. 48 economies, home to 78% of the population analysed, converged on a carbon-intensive path; they include China, India, Indonesia, Bangladesh, Vietnam and Ethiopia. In Vietnam and Bangladesh, emissions per person actually grew faster than income (7.0% and 5.8% a year against income growth of 5.0% and 4.9%), in both cases starting from very low levels. Only 17 economies, with 6% of the population, converged with slow-growing or falling emissions, and some of them, such as Nigeria, owe the fall partly to less gas flaring rather than to a cleaner growth model. A further 35 economies, including Brazil, Mexico and South Africa, did not converge at all.

This is not an indictment of the countries concerned. Most started from very low emissions, and over this period coal was often the cheapest and most reliable way to expand power supply quickly. But it shows that Sustainable Convergence is not yet the norm. The opportunity lies in the next two decades, during which the cost advantage has shifted decisively towards clean energy.

Two further points temper the picture. Air pollution rose in 39 of the 100 economies analysed, so the carbon-intensive path has also been, in many places, a path of dirtier air. And the countries whose emissions grew fastest generally started from the lowest levels, so their emissions per person remain far below those of rich countries. The policy question is therefore not whether these countries should have grown, but how the next phase of growth can be powered differently. The evidence on latecomers, falling technology costs and decoupling in rich countries suggests that it can.

CASE STUDY

Costa Rica: converging on a clean path

In the 1980s Costa Rica was losing its forests rapidly to cattle ranching. It responded with a ban on clearing natural forest and, from 1997, a national programme of payments to landowners for environmental services, financed partly by a fuel tax (UNEP, 2019).

Forest cover recovered to about 59% of the country's land by 2024, and renewable sources, mainly hydropower, geothermal and wind, supplied more than 99% of its electricity in 2021 (World Bank, 2026). Over the same period, income per person rose steadily and the country is now classified as high income (World Bank, 2025b).

Costa Rica's emissions per person, about 1.6 tonnes of CO_2 in 2024, are among the lowest of any economy at its income level. Its experience shows that conservation, clean power and convergence can go together, though its small size, abundant hydropower and long tradition of public investment in health and education make it easier than most to replicate.

SECTION 07

Leapfrogging: Clean Technology and Digital Rails

Developing economies today can build on technologies that did not exist when rich countries industrialised. Clean power, digital public infrastructure and distributed services make a cleaner and faster route to catch-up possible, but not automatic.

IN BRIEF

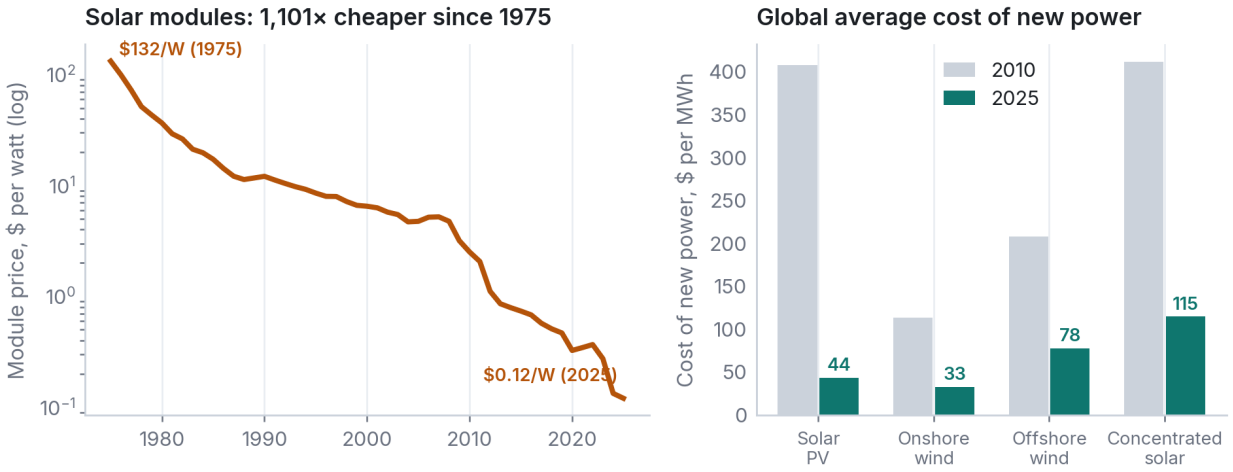
- New solar power cost about $44 per megawatt-hour in 2025, down from $408 in 2010; onshore wind fell from $114 to $33.
- Open digital systems for identity and payments have brought hundreds of millions of people into the formal economy within a decade.
- Leapfrogging works best when it builds on, rather than replaces, basic infrastructure, skills and institutions.

7.1 The changing economics of clean energy

The single most important change behind Sustainable Convergence is the collapse in the cost of clean energy. Solar modules that cost about $132 per watt in 1975 cost about $0.12 in 2025, a fall of more than a thousand-fold (Our World in Data, 2025b). The global average cost of electricity from new solar power plants fell from about $408 per megawatt-hour in 2010 to $44 in 2025, and from new onshore wind farms from $114 to $33 (Figure 16). In most of the world, new solar and wind power are now cheaper than new coal or gas power, and battery storage has followed a similar path (IRENA, 2025; Our World in Data, 2025c).

Figure 16 Clean power has become the cheapest power

Left: solar PV module price, $ per watt (log scale), 1975–2025. Right: global average cost of electricity from new plants, $ per MWh, 2010 and 2025



Source: Our World in Data, based on Nemet (2009), Farmer and Lafond (2016) and IRENA (Our World in Data, 2025b; Our World in Data, 2025c; IRENA, 2025). Levelised cost of electricity, global weighted average for new plants, 2024 US dollars.

These cost curves follow a pattern called *learning by doing*: each time cumulative production doubles, costs fall by a roughly constant percentage. Researchers at Oxford who studied fifty years of such curves concluded that a rapid shift to clean energy is likely to save the world trillions of dollars compared with continuing to rely on fossil fuels, rather than costing extra (Way et al., 2022). For developing economies this changes the arithmetic of development. A country that builds solar, wind and storage instead of imported coal or diesel avoids fuel import bills, reduces exposure to volatile global fuel prices and cuts air pollution, while gaining power that can be built in months rather than years.

The change is already visible. Imports of solar panels into Africa rose sharply in the year to mid-2025, spread across a wide range of countries, as households and firms turned to solar to escape unreliable grids and expensive diesel (Ember, 2025). Pakistan saw a similar surge after 2022, much of it installed by households and businesses rather than by the state. The World Bank and African Development Bank have launched Mission 300, which aims to connect 300 million Africans to electricity by 2030, with a large role for distributed renewables and mini-grids (World Bank, 2024).

CASE STUDY

Bangladesh: solar power for millions of homes

In 2000, about 32% of Bangladeshis had electricity. Through a government-backed programme managed by the Infrastructure Development Company Limited (IDCOL), more than four million solar home systems were installed in rural areas, providing power to about 20 million people (World Bank, 2021).

The programme combined small loans, a network of local partner organisations, technical standards and quality checks. It created tens of thousands of jobs and allowed households to light homes, charge phones and run small appliances long before the grid arrived.

As the grid extended, near-universal access was reached by the early 2020s (World Bank, 2026). The lesson is that distributed clean energy can be a bridge to, and complement of, the grid rather than a substitute for it, and that finance and delivery systems matter as much as the technology.

7.2 Clean cooking: the forgotten energy gap

About 2.1 billion people in the Global South still cook with wood, charcoal, dung, crop waste or kerosene. The smoke causes millions of deaths each year, mostly among women and young children; collecting fuel takes hours of women's and girls' time; and the demand for charcoal drives forest loss around African cities (WHO, 2024; IEA, 2025). Clean cooking is therefore a test case for Sustainable Convergence: it combines human development, environmental and infrastructure gains in a single investment.

The options include liquefied petroleum gas (LPG), electric cooking, biogas and improved biomass stoves. Their health benefits depend on how fully they replace smoky fuels; a large trial in four countries found that free LPG stoves and fuel sharply reduced household air pollution, although the measured health effects in infants were smaller than hoped, partly because outdoor pollution remained high (HAPIN Investigators, 2024). The International Energy Agency estimates that universal access to clean cooking in Africa would cost around $4 billion a year, a small sum relative to its benefits (IEA, 2025). Electric cooking, powered by cheap solar, is likely to grow in importance as grids and mini-grids expand.

7.3 Digital public infrastructure

The second great leapfrogging opportunity is digital. *Digital public infrastructure* (DPI) means shared, interoperable digital systems for identity, payments and data exchange that are open for public and private services to build on, much as roads are (UNDP, 2023). India built a digital identity system, Aadhaar, covering more than a billion people, and an instant payment network, the Unified Payments Interface (UPI), which handled more than 18 billion transactions a month in 2025 (NPCI, 2025). Brazil's central bank launched Pix in 2020; within a few years it was used by most of the adult population and had become the country's most popular payment method (Banco Central do Brasil, 2025). Open-source platforms such as MOSIP allow other countries, including the Philippines, Ethiopia and Morocco, to build national identity systems without being locked into proprietary vendors (MOSIP, 2025).

These systems matter for convergence in several ways. They lower the cost of financial services, so that people can save, borrow and receive payments safely; mobile money in Kenya, for example, helped an estimated 2% of households leave extreme poverty (Suri and Jack, 2016; Jack and Suri, 2014). They allow governments to pay social benefits directly into accounts, reducing leakage and speeding up crisis response. They create digital records that help small firms access credit and enter the tax system. And they widen markets, letting farmers and traders compare prices and sell further afield (Jensen, 2007; Aker and Mbiti, 2010). The share of adults with an account in developing economies has risen strongly over the past decade, driven largely by mobile phones (World Bank, 2025).

Digital infrastructure also carries risks: exclusion of people who lack documents, connectivity or digital skills; surveillance and data misuse; cyberattacks; and dependence on a few foreign technology providers. Sustainable Convergence calls for open, interoperable and privacy-protecting systems, with strong legal safeguards and offline alternatives for those who need them.

7.4 Clean industrialisation

Leapfrogging is not only about consumption. Developing economies also have an opportunity to build industries around the clean economy. Demand for critical minerals such as lithium, cobalt, nickel, copper and rare earths is rising rapidly, and many of the largest deposits are in developing countries (IEA, 2025). Today, value is mostly added elsewhere: China accounts for more than 80% of global capacity in each stage of solar panel manufacturing, from polysilicon to modules (IEA, 2022). Countries such as Indonesia, with nickel processing for batteries, Morocco, with solar power and fertiliser, and Chile, with lithium and green hydrogen, are trying to capture more of that value chain.

At the same time, trade measures in rich countries are changing the rules. The European Union's Carbon Border Adjustment Mechanism will put a carbon price on imports of steel, aluminium, cement, fertiliser, hydrogen and electricity from 2026 (European Commission, 2025). For exporters with carbon-intensive production this is a threat; for those that can produce with clean power, it is an opportunity to turn a sustainable energy system into a competitive advantage. Clean industrial policy, including power-intensive industries located near cheap renewable energy, is likely to become a central part of convergence strategies.

Table 5 Leapfrog technologies: what they bypass and what they still require

Technology	What it can bypass	Main benefits	Preconditions
Distributed solar, batteries, mini-grids	Slow, costly grid extension; diesel generators	Power for homes, clinics, schools, pumps and small firms	Finance, standards, maintenance, links to the grid over time
Utility-scale solar and wind	New coal and oil power plants	Cheapest new power; no fuel imports; cleaner air	Grid investment, storage, low cost of capital
Mobile money and instant payments	Bank branches and cash	Savings, credit, remittances, social transfers	Mobile coverage, ID, regulation, consumer protection
Digital identity and data exchange	Paper registries	Access to services; cheaper, faster government	Privacy law, inclusion, cybersecurity
Electric two- and three-wheelers, buses	Petrol vehicle fleets and fuel imports	Lower costs, less pollution	Charging, power supply, finance
Electric and LPG cooking	Wood, charcoal and kerosene	Health, time savings, forests	Affordable fuel or power; appliances
Digital learning and telemedicine	Some shortages of teachers and doctors	Wider access to knowledge and care	Devices, connectivity, trained staff; does not replace schools and clinics

Source: H Heuristics, drawing on Lee (2019), IRENA (2025) and UNDP (2023) (Lee, 2019; IRENA, 2025; UNDP, 2023).

7.5 The limits of leapfrogging

Leapfrogging is real but limited. Mobile phones did not remove the need for roads, and solar panels do not remove the need for grids, factories, clinics or schools. Most of the gains from technology come not from first access but from intensive use, which depends on skills, complementary investment and good management (Comin and Mestieri, 2018; Cirera and Maloney, 2017). Rigorous evidence from rural Kenya found that connecting households to the grid did not by itself produce large short-run economic gains; the benefits of electricity depend on what people and firms can do with it (Lee et al., 2020). Sustainable Convergence therefore treats leapfrogging as a way of accelerating convergence across all seven dimensions, not as a shortcut around them.

SECTION 08

The Compounding Convergence Flywheel

The framework's central mechanism is that progress in one dimension makes progress in the others easier. This section examines the evidence for that claim and what it implies for policy.

IN BRIEF

- Household and firm studies show strong complementarities: power makes connectivity, health care and small businesses more productive; nutrition raises lifetime earnings.
- At national level the bundles are real but modest: across 101 developing economies, gains in different dimensions moved together only weakly after accounting for growth.
- The flywheel is not automatic. It has to be engineered through coordinated planning and investment.

8.1 The idea

The original Sustainable Convergence monograph describes a *Compounding Convergence Flywheel*: a self-reinforcing dynamic in which simultaneous investments in clean energy, digital infrastructure, human capital and climate resilience strengthen one another, producing a combined result greater than the sum of separate sectoral efforts (Hughes, 2026a). The monograph illustrates this with the example of a solar mini-grid. Once a rural district has clean, reliable power, telecommunications towers can operate without diesel, clinics can refrigerate vaccines and work at night, schools can use lights, fans and computers, and farmers can run mills, pumps and cold stores. Each of these in turn raises incomes, which raises demand for power and makes the mini-grid more viable.

This idea has deep roots in development economics, from theories of *balanced growth* and *big pushes* to the more recent concept of *multisolving*. It also offers a simple explanation for why development often appears to happen in bursts: once several capabilities are in place, each new investment pays off more. It is, however, a hypothesis that needs testing. The monograph estimates a combined multiplier of 2.35 to 3.25 times for integrated over siloed investment (Hughes, 2026a); this section examines what currently available evidence can and cannot say about such complementarities.

8.2 Evidence from households and firms

The strongest evidence for complementarity comes from studies of specific places and programmes. Electrification of rural South Africa raised women's employment by freeing time from fuel collection and home production (Dinkelman, 2011). The arrival of fast internet in Africa raised employment, especially in skilled jobs, in the areas connected first (Hjort and Poulsen, 2019). Mobile money helped Kenyan households cope with shocks by making it cheaper to receive help from relatives, and over time reduced poverty, especially among women (Jack and Suri, 2014; Suri and Jack, 2016). Better nutrition in early childhood raised adult earnings decades later (Hoddinott et al., 2008), and more education improves how people respond to disasters (Lutz et al., 2014). Better management practices raised productivity substantially in Indian textile firms (Bloom et al., 2013).

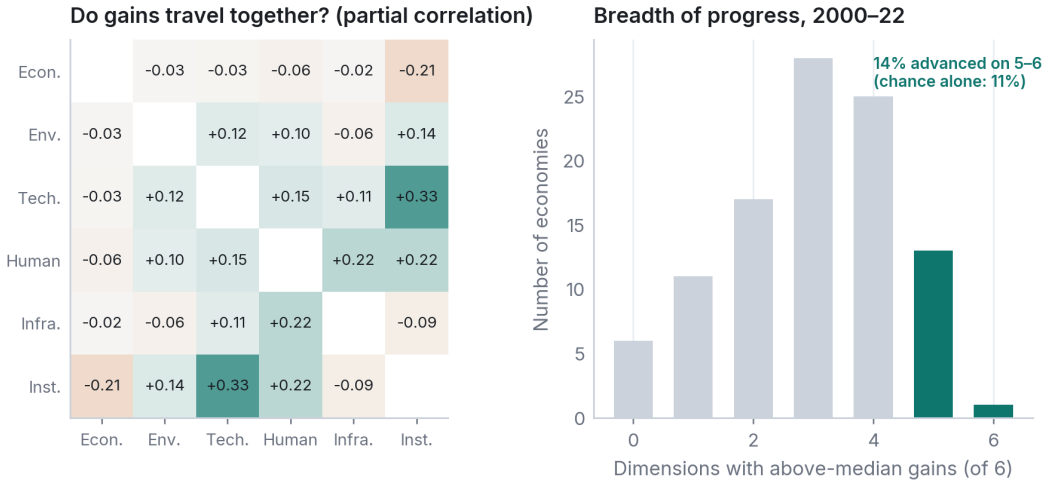
These studies also show that complementarities have to be present for gains to appear. Grid connections in rural Kenya produced few measurable economic gains in the short run, partly because households lacked the appliances, skills and markets to make productive use of power (Lee et al., 2020). In other words, one dimension does not automatically pull the others along; the links work when the pieces are put in place together.

8.3 Evidence across countries

This report tests the flywheel at national level. For 101 developing economies, it measures the change in each of six dimension scores between 2000 and 2022 and asks whether economies that advanced faster in one dimension also advanced faster in others, after accounting for income growth and starting levels (Figure 17). The answer is a qualified yes. Most pairs of dimensions move together positively, but weakly: the average partial correlation is +0.06, and 8 of the 15 pairs are positive. The strongest links are between technology and institutions (+0.33), and between human development and both infrastructure (+0.22) and institutions (+0.22). Faster gains in capabilities were not associated with environmental deterioration; if anything, the reverse (correlation +0.17).

Figure 17 Progress across dimensions travels together, but only modestly

Left: partial correlation of gains between dimensions. Right: number of economies by count of dimensions with above-median gains



Source: H Heuristics Sustainable Convergence Index. 101 developing economies with more than one million people. Partial correlations of 2000–2022 changes in dimension scores, controlling for growth of income per person and each dimension's starting level.

The breadth of progress points the same way. If gains in different dimensions were unrelated, about 11% of economies would beat the developing-country median on five or six of the six dimensions by chance. In fact 14% did, while 17% advanced quickly on at most one. Bundling exists, but it is far from the strong, automatic compounding that a literal flywheel implies. Two cautions apply. National averages over two decades can hide strong local complementarities, and the indicators available for every country are crude. The evidence neither confirms nor rules out multipliers of the size proposed in the monograph; it suggests that complementarities are real, uneven and, above all, dependent on design.

8.4 Engineering the flywheel

If complementarities do not arise automatically, they must be built. The practical implication is integrated planning: designing investments in energy, digital systems, health, education and resilience so that each makes the others more effective. Development practice has often worked in the opposite way, with power projects planned without telecom operators, clinics built without electricity and schools without water (Hughes, 2026a). Table 6 sets out five combinations where the evidence for complementarity is strongest.

Table 6 Five high-leverage combinations for the Compounding Convergence Flywheel

Combination	How the pieces reinforce one another	Evidence
Clean power + health and schools	Reliable power enables vaccine cold chains, night deliveries, lighting, fans and digital learning	(Dinkelman, 2011; IEA et al., 2026)
Clean power + productive use	Power is most valuable when paired with appliances, credit and markets for irrigation, milling and cold storage	(Lee et al., 2020; World Bank, 2024)
Digital ID + payments + social protection	Direct transfers reach people quickly in crises; accounts support saving and credit	(Suri and Jack, 2016; Bowen et al., 2020; UNDP, 2023)
Early nutrition + schooling + jobs	Healthy children learn more and earn more; skilled workers attract investment	(Hoddinott et al., 2008; Lutz et al., 2014)
Early warning + resilient infrastructure + insurance	Warnings save lives; robust networks limit damage; fast finance speeds recovery	(UNDRR and WMO, 2023; Hallegatte et al., 2019; Clarke and Dercon, 2016)

Source: H Heuristics.

Coordinated investment also has a fiscal logic. Clean power reduces fuel import bills and exposure to price shocks; digital systems widen the tax base and cut leakage; healthier, better-educated populations pay more tax and need less emergency spending; resilient infrastructure reduces repair costs after disasters. Over time, these savings can finance further investment. This is the macroeconomic version of the flywheel, and it is why Sustainable Convergence argues for planning across ministries and sectors rather than within them.

SECTION 09

Measuring Progress: The Sustainable Convergence Index

To make the framework testable, H Heuristics proposes a Sustainable Convergence Index (SCI) that scores economies on all seven dimensions, separates convergence from sustainability, and rewards balanced progress.

IN BRIEF

- The index covers 184 economies, including 124 developing ones, using seventeen public indicators and the INFORM risk index.
- Scores rise with income: low-income 32, lower-middle 56, upper-middle 73 and high-income 87 out of 100.
- Capabilities and environmental performance pull in opposite directions (correlation -0.43); capabilities and resilience go together (0.88).

9.1 Why an index

An idea that cannot be measured is hard to manage. The Sustainable Convergence Index (SCI) is designed to answer two questions at once: whether developing economies are narrowing their gaps with relevant advanced-economy benchmarks (**convergence**), and whether that progress is occurring without unacceptable increases in environmental damage and systemic vulnerability (**sustainability**). It complements, rather than replaces, existing measures such as the Human Development Index and the Sustainable Development Goals index, by focusing explicitly on gaps between economies and on the balance between catching up and staying within limits.

9.2 How the index is built

The index has four layers. First, seventeen indicators are grouped into six dimensions, with resilience measured by the INFORM risk index (Table 3). Second, each indicator is turned into a score from 0 to 100 that measures the distance to a benchmark. For the five capability dimensions the benchmark is the median of high-income economies: for example, a life expectancy of 80.5 years, internet use of 92% or income of $49,117 per person in 2022. For the environmental dimension the benchmark is a sustainability threshold, because rich countries are not a sustainable model: the WHO air-quality guideline of 5 μg/m^3, about 2 tonnes of CO_2 per person, low carbon intensity and fully renewable electricity. Third, indicator scores are averaged into seven dimension scores. Fourth, the dimension scores are combined using a geometric mean, which means that a very low score in one dimension cannot be fully offset by high scores elsewhere (Table 7).

The index also reports two components. The **convergence component** is the average of the five capability dimensions; the **sustainability component** is the average of the environmental and resilience dimensions. Replacing the geometric mean with a simple average changes little in the

Table 7 How the Sustainable Convergence Index scores each indicator

Indicator type	Examples	Scoring rule	Benchmark (100 points)
Income and productivity	GDP per person; output per worker	Log distance from a floor ($700; $1,500) to the benchmark	High-income median ($49k; $107k)
Access and use rates	Electricity, water, sanitation, cooking, internet, broadband, schooling	Share of the benchmark level	High-income median
Health outcomes	Life expectancy; under-five mortality	Linear from 40 years; log distance from 250 deaths per 1,000	High-income median (80 years; 4.3 per 1,000)
Governance	Government effectiveness; regulatory quality	Position on the −2.5 to 2.5 scale relative to the benchmark	High-income median
Environmental pressure	PM2.5; CO_2 per person; CO_2 per unit of GDP	Log distance between a ceiling (75 µg; 25 t; 1 kg/$) and a threshold	5 µg/m³; 2 t; 0.05 kg per $
Clean energy	Renewable share of electricity	Share of 100%	100%
Resilience	INFORM vulnerability; lack of coping capacity	Distance from 10 (worst) to the benchmark	High-income median (2.6; 2.4)

Source: H Heuristics. Scores are capped at 0 and 100. Dimension scores need at least half their indicators. The index is the geometric mean of the seven dimension scores.

ranking (correlation 0.99), but the geometric mean makes the principle explicit: Sustainable Convergence requires balanced progress.

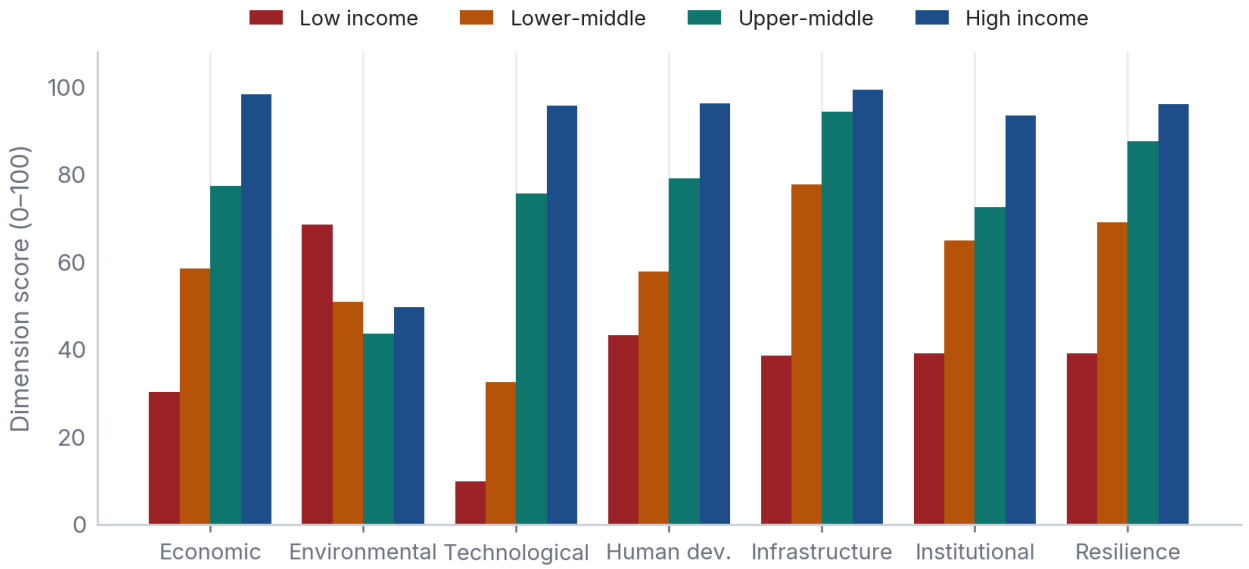
9.3 Results by income group

The index rises with income, as expected (Figure 18). Low-income economies average 32, lower-middle-income 56, upper-middle-income 73 and high-income 87. The largest gaps are in technology, where low-income economies score 10 against 96 for high-income ones, and in the economic dimension (30 against 98). The environmental dimension is the exception: low-income economies score highest (69), because they emit little carbon and much of their electricity is hydropower, while upper-middle-income economies score lowest (44) and high-income economies only 50.

This pattern captures the central challenge in one picture. Developing economies are catching up on capabilities, but as they do so, their environmental scores tend to fall. High-income economies score well on everything except the environment. No income group is yet on a path that combines high capabilities with environmental sustainability, which is why environmental convergence must happen from both ends.

Figure 18 Every group lags on the environment; the poorest lag on everything else

Dimension scores (0–100) by income group



Source: H Heuristics Sustainable Convergence Index, latest data (mostly 2022; resilience 2026). Population-weighted averages by World Bank income group.

Table 8 Highest-scoring developing economies on the Sustainable Convergence Index

Economy	SCI	Convergence component	Sustainability component	GDP per person (PPP $)
Mauritius	84	88	79	25,005
Georgia	84	87	76	20,967
Albania	83	82	86	19,389
North Macedonia	80	87	69	22,822
Argentina	80	85	72	27,825
Malaysia	78	87	66	32,129
Brazil	78	78	79	18,554
Serbia	78	87	62	24,652
Colombia	77	79	74	18,459
Belarus	77	85	70	26,538

Source: H Heuristics Sustainable Convergence Index. Low- and middle-income economies with more than one million people. Latest data, mostly 2022.

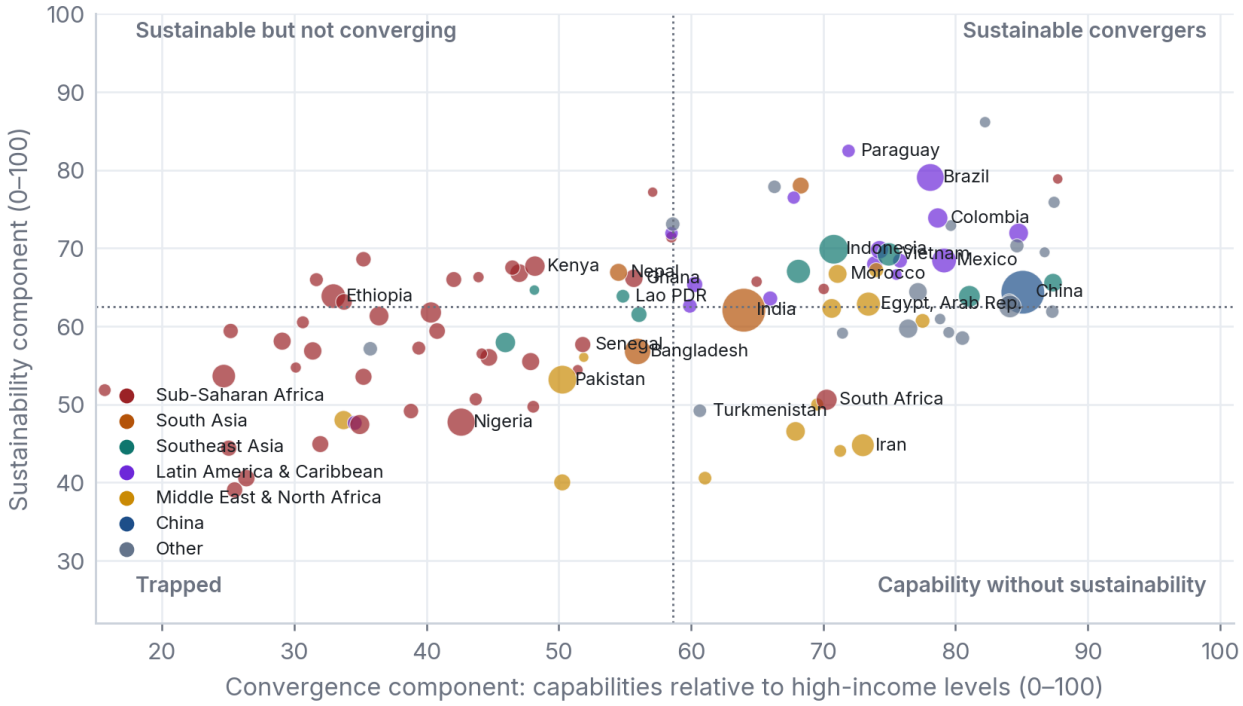
9.4 Convergence and sustainability

Figure 19 plots each developing economy's convergence component against its sustainability component. The two are positively related overall (correlation 0.50), mainly because resilience rises strongly with capabilities. Splitting the economies at the median of each component gives four groups. 36 of 103 economies are *sustainable convergers*, above the median on both, including Brazil, Colombia, Indonesia and Vietnam. 35 are *trapped*, below the median on both, most of them

in Sub-Saharan Africa and South Asia. 16 show *capability without sustainability*, among them South Africa, Iran and Turkmenistan, whose economies depend heavily on coal, oil or gas. And 16 are *sustainable but not yet converging*: low-emitting, largely rural economies such as Ethiopia and Kenya, which have the chance to grow without ever becoming high emitters.

Figure 19 Four groups of developing economies: convergers, trapped, carbon-heavy and not-yet-converging

Convergence component (capabilities) and sustainability component (environment and resilience), 0–100



Source: H Heuristics Sustainable Convergence Index. 103 developing economies with more than one million people and complete data. Dotted lines mark the medians; bubble size reflects population.

9.5 Doing better, or worse, than income predicts

Income explains 83% of the variation in the index among developing economies; each doubling of income goes with about 12 points more. The remainder shows where countries do better or worse than their income would predict (Figure 20). Over-performers include the Kyrgyz Republic (+15), Tajikistan, Albania, Lesotho, Morocco and Jordan, many of which combine hydropower or other low-carbon electricity with relatively strong human development and access to services. Under-performers include Turkmenistan (-24), Equatorial Guinea, Sudan, Nigeria, Libya and Chad: mostly economies dominated by oil and gas or affected by conflict, where income has not been converted into broad capabilities or a clean energy system.

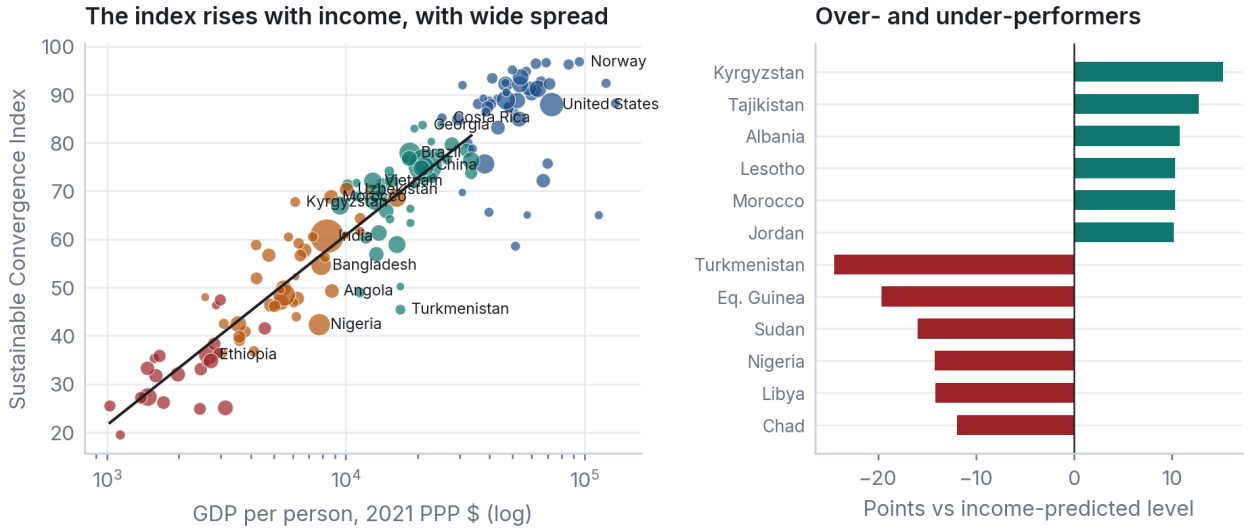
METHOD

Limitations of the index

The index is a first version. Indicators are limited to those available for nearly every country, so important aspects of the framework, such as the adoption of artificial intelligence, the quality of education, biodiversity, water stress and financial resilience, are not yet included.

Figure 20 **Income matters, but policy and resources create wide differences**

Sustainable Convergence Index against GDP per person, and the largest over- and under-performers



Source: H Heuristics Sustainable Convergence Index. Left: all economies with more than one million people; line fitted to developing economies. Right: residuals from that fit, largest positive and negative.

Resilience is measured with the INFORM index for 2026, so it cannot yet be tracked over time. Environmental scores use territorial emissions; consumption-based measures would lower the scores of rich importers and raise those of exporters.

Benchmarks and floors involve judgement. Results are robust to using an arithmetic rather than a geometric mean, but future versions should test alternative benchmarks, weights and indicators, and publish country scores with uncertainty ranges.

SECTION 10

Regional Pathways in the Global South

The Global South is not one place. Starting points, resources, demography and institutions differ enormously, so Sustainable Convergence has to be tailored to each region rather than prescribed as a single universal pathway.

IN BRIEF

- Sub-Saharan Africa has the lowest index score (40) but the cleanest starting point; its task is to build capabilities without building in high emissions.
- South Asia has achieved near-universal electricity but faces the world's worst air pollution and intense heat and water stress.
- Southeast Asia and Latin America are closest to converging sustainably; China shows both the speed of catch-up and the cost of a coal-heavy path.

The Global South should be a major application of the framework. Figure 21 shows the seven dimension scores for six regions and the high-income benchmark, and Table 9 summarises key indicators. The regional profiles differ sharply. The framework should therefore account for differences in national starting conditions, demographics, institutional capacity, geography and environmental exposure, rather than prescribe one universal development pathway (Hughes, 2026a).

Figure 21 Each region has a distinct profile of strengths and gaps

Dimension scores and overall index (0–100) by region, latest data

	Economic	Environment	Technology	Human dev.	Infrastr.	Institutions	Resilience	SCI
Sub-Saharan Africa	43	65	17	44	44	49	46	**40**
South Asia	60	46	34	62	85	74	77	**60**
Southeast Asia	67	53	52	71	89	73	81	**68**
Latin America & Carib.	76	67	67	76	94	65	78	**74**
Middle East & N. Africa	65	44	40	61	86	48	62	**56**
China	79	33	91	83	95	77	96	**75**
High-income benchmark	98	50	96	96	99	93	96	**87**

Source: H Heuristics Sustainable Convergence Index. Population-weighted averages of low- and middle-income economies in each region. Following the World Bank's current regions, Afghanistan and Pakistan are grouped with the Middle East and North Africa.

Table 9 Key indicators by region, latest data

Region	GDP per person ($k PPP)	Power access (%)	Clean cooking (%)	Internet (%)	Under-5 deaths per 1,000	CO_2 per person (t)	PM2.5 (µg/m³)	SCI
Sub-Saharan Africa	4.8	52	21	31	75	0.7	37	40
South Asia	8.3	99	69	54	29	1.8	52	60
Southeast Asia	13.5	97	78	72	21	2.7	23	68
Latin America & Caribbean	18.5	99	89	77	16	2.5	18	74
Middle East, N. Africa, Afg. & Pak.	10.1	95	75	57	36	2.7	45	56
China	21.5	100	88	76	7	8.9	32	75
High-income benchmark	57.0	100	99	91	5	10.2	14	87

Source: H Heuristics calculations from World Development Indicators and the Sustainable Convergence Index (World Bank, 2026). Population-weighted averages of low- and middle-income economies, mostly 2022.

10.1 Sub-Saharan Africa: powering the century's demographic engine

Sub-Saharan Africa is where the convergence challenge is greatest and where the stakes for the century are highest. Its population is projected to more than double by 2100, and it will account for most of the growth in the world's working-age population in the coming decades (United Nations, 2024). Today its income per person is about 8% of the high-income level, the same share as in 2000. Only 52% of its people have electricity, 21% cook cleanly and 31% use the internet, and under-five mortality, at 75 per 1,000 births, is about fifteen times the high-income level.

Yet the region also has the cleanest starting point. Emissions per person are about 0.7 tonnes, and more than half its electricity already comes from renewable sources, mostly hydropower. It has some of the world's best solar resources and large reserves of the minerals needed for the energy transition. Sustainable Convergence in Africa therefore means building capabilities, in power, digital infrastructure, health, schooling and institutions, fast enough to absorb a growing workforce, while avoiding locking in high emissions. Priorities include universal electricity through grids and distributed solar, clean cooking, productive uses of power in agriculture and small industry, digital public infrastructure, regional power trade, and adding value to mineral exports (World Bank, 2024; IEA, 2025; IEA, 2025). Resilience is critical: the region's average INFORM score for lack of coping capacity, 6.7 out of 10, is the weakest of any region.

10.2 South Asia: resolving the heat, air and water nexus

South Asia, dominated by India, has made some of the fastest progress on access anywhere: electricity reached about 99% of the population by 2022, up from 57% in 2000, and clean cooking rose from 20% to 69%. Income relative to the high-income level doubled, from 7% to 15%. India's digital public infrastructure has become a model for other countries (NPCI, 2025). But the region faces the world's worst air pollution, averaging about 52 µg/m³ of PM2.5, more than ten times the WHO guideline, as well as extreme heat, water stress and high exposure to floods and cyclones (Health Effects Institute, 2025; IPCC, 2023).

Sustainable Convergence in South Asia means growing manufacturing and services employment for a large young workforce while cleaning the air and adapting to heat. Priorities include rapid

growth of solar, wind and storage to meet rising power demand without new coal; clean industry and transport; cooling and heat-action plans; water efficiency in agriculture; and early warning systems. Bangladesh's dramatic reduction in cyclone deaths, from hundreds of thousands in 1970 and 1991 to a few thousand or fewer in recent storms, shows how much preparedness can achieve (Haque et al., 2012).

10.3 Southeast Asia: industrial upgrading on clean power

Southeast Asia has combined fast growth with high access: electricity is near-universal, clean cooking reaches 78% of people, and income rose from 15% to 24% of the high-income level since 2000. Its index score of 68 is among the highest in the developing world. The main risk is that its manufacturing-led growth continues to rely on coal: emissions per person roughly doubled between 2000 and 2022, and in Vietnam they grew faster than income (Figure 15).

Priorities include upgrading from assembly to higher-value manufacturing, decarbonising power through solar, wind and regional grid connections, using critical minerals such as Indonesia's nickel to build battery and electric-vehicle supply chains, and protecting coastal cities and deltas from sea-level rise and storms. Vietnam's rapid build-out of solar power around 2019–2020 showed how fast deployment can happen when prices and policies align.

10.4 Latin America: productivity, institutions and bio-sovereignty

Latin America faces the opposite problem from Africa. It has high access to services, relatively clean electricity (56% renewable) and moderate emissions, but its income has not converged: it fell from 35% to 33% of the high-income level between 2000 and 2022. The region's institutional score (65) is weaker than its other capabilities, and productivity growth has been slow for decades (Dieppe (ed.), 2021).

Sustainable Convergence in Latin America therefore means raising productivity and diversifying economies beyond commodities, strengthening institutions and tax systems, and turning the region's environmental assets, including clean power, forests and biodiversity, into sources of value rather than of depletion. Brazil's Pix shows the region's capacity for digital innovation, while Costa Rica and Uruguay show that clean electricity and convergence can go together (Banco Central do Brasil, 2025; UNEP, 2019). Protecting the Amazon, which may be approaching a tipping point, is essential for the region and the planet (Armstrong McKay et al., 2022).

10.5 China, the Middle East and North Africa

China is the most dramatic convergence story of modern times: its income rose from about 10% to 38% of the high-income level between 2000 and 2022, and its technological and resilience scores now match those of rich countries. But it followed a coal-heavy path, and its emissions per person (8.9 tonnes) are now close to the high-income average. China is also the world's leading producer of solar panels, batteries and electric vehicles, and its choices will shape the cost of clean technology everywhere (IEA, 2022).

The Middle East and North Africa, grouped here with Afghanistan and Pakistan as in the World Bank's current regions, scores 56 on the index, held back by weak institutions, high air pollution and dependence on fossil fuels. Its solar resources are among the best in the world. Diversifying

away from oil and gas, managing scarce water and adapting to extreme heat are central challenges.

10.6 Regional priorities at a glance

Table 10 summarises the starting point and leading priorities for each region. The common thread is that every region has a different binding constraint: in Africa it is basic capabilities, in South Asia environmental quality and heat, in Southeast Asia the carbon intensity of industry, in Latin America productivity and institutions, and in the Middle East and North Africa diversification and governance.

Table 10 Starting points and priorities for Sustainable Convergence by region

Region	Starting point	Leading priorities
Sub-Saharan Africa	Lowest capabilities; lowest emissions; fastest population growth	Universal power and clean cooking; productive uses of energy; DPI; health and learning; mineral value addition
South Asia	Near-universal power; worst air pollution; extreme heat and water stress	Clean power for rising demand; clean air; cooling and heat plans; water efficiency; early warning
Southeast Asia	High access; fast growth; rising coal use	Decarbonise power and industry; battery and EV supply chains; coastal resilience
Latin America	High access; clean power; stalled productivity	Productivity and diversification; institutions and tax; forest protection and bio-economy
Middle East, N. Africa, Afg. and Pak.	Fossil dependence; weak institutions; water scarcity	Diversification; solar-powered industry; water management; governance
China	Rapid convergence; coal-heavy; clean-tech leader	Peak and cut coal; clean industry; share technology and finance

Source: H Heuristics.

SECTION 11

Barriers and Risks

Clean catch-up is possible, but it is not easy. High financing costs, debt, weak institutions, shifting trade rules, technology concentration and climate damage itself can all stall it.

IN BRIEF

- Capital for clean energy costs two to three times more in developing economies than in advanced ones.
- Debt service crowds out investment: billions of people live in countries that spend more on interest than on health or education.
- Climate change, conflict and premature deindustrialisation can stall convergence even where policies are sound.

11.1 The cost of capital

Clean energy is cheap to run but expensive to build: almost all of its cost is paid up front. That makes it very sensitive to the cost of borrowing. The International Energy Agency finds that the cost of capital for clean energy projects in emerging and developing economies is often two to three times higher than in advanced economies, reflecting currency, political and regulatory risks as perceived by investors (IEA, 2024a; IEA, 2023). A solar farm that is the cheapest source of power in Germany can therefore be more expensive than a gas plant in Nigeria, not because of the sun or the technology but because of finance. The original monograph calls this the *cost-ofcapital penalty* (Hughes, 2026a). Reducing it, through guarantees, blended finance, local-currency lending, better project preparation and stronger regulation, is arguably the single most powerful lever for Sustainable Convergence.

11.2 Debt and fiscal space

Many developing countries face a debt squeeze. In 2024 about 3.4 billion people lived in countries that spent more on interest payments than on either health or education (UNCTAD, 2025). Official development assistance fell sharply in 2025 (OECD, 2026). High debt service limits public investment in exactly the areas that drive Sustainable Convergence: infrastructure, schools, health and resilience. Proposals to reform the international financial architecture, such as the Bridgetown Initiative, call for more lending by multilateral development banks, cheaper long-term finance, pause clauses that suspend debt payments after disasters, and new sources of concessional funding (Government of Barbados, 2023; Songwe et al., 2022). An expert group convened for the COP climate summits estimated that emerging and developing economies other than China need investment in climate and development of around $2.4 trillion a year by 2030 (Songwe et al., 2022).

Table 11 Barriers to Sustainable Convergence and possible responses

Barrier	How it slows convergence	Possible responses
High cost of capital	Makes capital-intensive clean energy more expensive than fossil alternatives	Guarantees, blended finance, local-currency lending, stronger regulation (IEA, 2024a)
Debt burdens	Crowds out investment in infrastructure, people and resilience	Debt restructuring, disaster pause clauses, more multilateral lending (UNCTAD, 2025; Government of Barbados, 2023)
Premature deindustrialisation	Fewer manufacturing jobs for growing workforces	Services, agro-processing, clean industries, skills (Rodrik, 2016)
Weak institutions	Projects stall, funds leak, regulation deters investment	Digital government, procurement reform, capacity building (UNDP, 2023; World Bank, 2025a)
Technology concentration	Supply risks; value captured elsewhere	Regional manufacturing, technology partnerships, mineral processing (IEA, 2025)
Climate and disaster damage	Destroys assets; interrupts growth	Resilient infrastructure, early warning, insurance (Hallegatte et al., 2019; UNDRR and WMO, 2023)
Conflict and fragility	Reverses gains; blocks investment	Security, basic services, humanitarian-development links

Source: H Heuristics.

11.3 Premature deindustrialisation and the jobs challenge

Historically, manufacturing provided millions of relatively well-paid jobs for workers leaving agriculture. Today many developing countries see manufacturing employment peak earlier and lower, as automation and global competition change the economics of factories (Rodrik, 2016). At the same time, Africa and South Asia will add hundreds of millions of people to their working-age populations. Sustainable Convergence needs new engines of job creation: modern services, agro-processing, construction and installation of clean energy and resilient infrastructure, tourism and the digital economy, as well as clean manufacturing where countries have a competitive edge.

11.4 Technology concentration and trade rules

The supply chains for clean technology are highly concentrated: a single country dominates solar manufacturing, battery production and the processing of many critical minerals (IEA, 2022; IEA, 2025). This has driven costs down, but it creates risks of supply disruption and trade conflict. Carbon border taxes in rich markets could penalise exporters that have not decarbonised (European Commission, 2025). Developing economies need access to affordable technology, to the knowledge needed to install and maintain it, and to fair trade rules that let them add value rather than only export raw materials.

11.5 Political economy and a just transition

Not all barriers are technical or financial. In many countries, powerful interests are tied to the existing energy system: state-owned utilities with long-term coal contracts, fuel subsidies that benefit the middle class, and regions whose jobs and public revenues depend on mining or oil. Fossil fuel subsidies are popular and hard to remove, and in many developing economies they cost more than public spending on health. Reform is possible, but it needs to be paired with visible benefits, such as cash transfers, cheaper clean alternatives and new jobs, and with support for workers and regions that lose out.

A related risk is a backlash against the transition itself. If clean-energy policies raise costs for poor households, are perceived as imposed from abroad, or benefit mainly foreign firms, public support can collapse. Sustainable Convergence has to be visibly inclusive: it should lower energy bills, create local jobs, improve air quality and services, and be designed and owned by national governments and communities rather than by donors. Inclusion is not an optional extra; it is part of the definition and a condition for lasting progress.

11.6 Climate damage, conflict and fragility

Climate change itself threatens convergence. Disasters destroy assets and set back growth for years, and the poorest countries are both the most exposed and the least able to cope (Hsiang and Jina, 2014; Hallegatte et al., 2016). Adaptation finance remains far below estimated needs (UNEP, 2025). Conflict and fragility are even more damaging: many of the countries at the bottom of the index, such as Sudan, Chad, the Central African Republic and Somalia, are affected by conflict. In these settings, Sustainable Convergence starts with security, basic services and humanitarian-development cooperation.

SECTION 12

Pathways to 2100

What would the world look like at the end of the century under different paths? Three illustrative scenarios show that the speed of convergence decides how prosperous the Global South becomes, and the route decides whether the climate remains manageable.

IN BRIEF

- With convergence at about 2% of the gap a year, Global South income reaches about 43% of the high-income level by 2050 and 74% by 2100.
- On a fossil path, world CO_2 emissions to 2100 would total about 3,084 billion tonnes, roughly three times the 2°C budget.
- On a sustainable path, the same income gains are compatible with about 819 billion tonnes, within the 2°C budget.

12.1 Three scenarios

To show what is at stake, this report models three stylised pathways for the Global South as a whole from 2025 to 2100. All three use the United Nations' medium population projection (United Nations, 2024) and assume that income per person in high-income countries grows by 1.2% a year and that their emissions fall in a straight line to net zero in 2050. They differ in two respects: how fast the Global South closes its income gap, and how fast the carbon intensity of its economies falls (Table 12). The scenarios are illustrations of the logic of the framework, not forecasts.

Table 12 Three illustrative pathways for the Global South, 2025–2100

	Stalled convergence	Fossil catch-up	Sustainable Convergence
Income convergence	None: Global South grows at the high-income rate	2% of the remaining log gap closed each year	2% of the remaining log gap closed each year
Carbon intensity of GDP	Falls 2% a year	Falls 1.2% a year to 2050, then 4%	Falls 4% a year in 2025, rising to 10% by 2045
Income, % of high-income, 2050	23%	43%	43%
Income, % of high-income, 2100	23%	74%	74%
Global South CO_2 in 2050 (Gt)	24	52	10
Global South CO_2, 2025–2100 (Gt)	1,655	2,905	640
World CO_2, 2025–2100 (Gt)	1,834	3,084	819

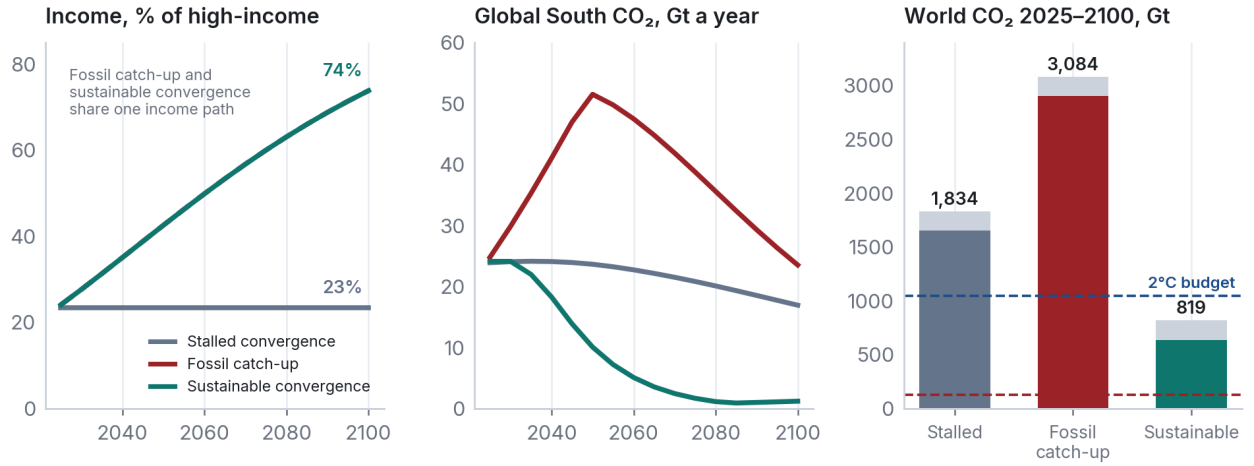
Source: H Heuristics scenarios. Starting point: Global South income $13,675 per person (2021 PPP) and 23.9 Gt CO_2 from fossil fuels and industry; high-income emissions 14.3 Gt falling linearly to zero in 2050 (adding 179 Gt). Remaining budgets from 2025: about 130 Gt for 1.5°C and 1,050 Gt for 2°C (50% chance) (Forster et al., 2025).

12.2 Results

In the **stalled convergence** pathway, the Global South grows only as fast as rich countries, so its income stays at about 23% of the high-income level for the rest of the century. Even so, because carbon intensity falls only slowly, its emissions stay above 15 billion tonnes a year, and world emissions to 2100 total about 1,834 billion tonnes, well above the 2°C budget (Figure 22). Stagnation does not save the climate; it simply combines poverty with continued emissions.

Figure 22 The speed of convergence decides prosperity; the route decides the climate

Global South income as % of the high-income level; Global South CO_2 emissions, Gt a year; cumulative world CO_2 2025–2100, Gt



Source: H Heuristics scenarios (see Table notes). Carbon budgets from Forster et al. (2025) (Forster et al., 2025). In the right panel, the grey segment is high-income emissions.

In the **fossil catch-up** pathway, the Global South closes 2% of its remaining income gap each year, a pace similar to the conditional convergence rates found in growth research (Barro and Sala-i-Martin, 1992). Its income reaches 43% of the high-income level by 2050 and 74% by 2100, a transformation in living standards for more than eight billion people. But because the economies remain carbon-intensive until mid-century, Global South emissions more than double to about 52 billion tonnes a year by 2050, and world emissions to 2100 reach about 3,084 billion tonnes, nearly three times the 2°C budget. The climate damage would, in turn, threaten the convergence itself.

In the **Sustainable Convergence** pathway, the Global South achieves exactly the same income gains, but carbon intensity falls rapidly as clean power, electrified transport and clean industry take over. Global South emissions peak almost immediately and fall to about 10 billion tonnes by 2050 and near zero by 2100. World emissions to 2100 total about 819 billion tonnes, within the 2°C budget of about 1,050 billion tonnes, though far above the 1.5°C budget, which is now almost exhausted (Forster et al., 2025). The results are robust to the pace of convergence: closing 1% of the gap a year gives income of 51% of the high-income level by 2100 with 718 billion tonnes of world emissions; closing 3% gives 88% with 916 billion tonnes.

12.3 What the scenarios imply

Three lessons follow. First, convergence and climate stability are compatible, but only if the carbon intensity of developing economies falls much faster than it has so far: by around 7–10% a year from the 2030s, compared with roughly 2% historically. Second, the two decades from 2025 to 2045 are decisive, because that is when most of the power plants, factories, buildings and transport systems of a converging Global South will be built. Third, the cost of the sustainable path depends heavily on finance. If clean energy can be financed at rich-country interest rates, the sustainable path is likely to be cheaper than the fossil one, because clean energy now costs less to generate and saves on fuel and health costs (Way et al., 2022; IEA, 2024a).

These scenarios also connect to the long-run goal described in the original monograph: *Planetary Capability Parity*, a state in which all societies have broadly comparable productive capacity, technology, human development and resilience while operating within ecological limits (Hughes, 2026a). On the Sustainable Convergence pathway, the Global South would reach roughly three-quarters of high-income living standards by 2100, a world much closer to parity than today's, at a carbon cost the planet can bear.

METHOD

How to read the scenarios

The scenarios treat the Global South as a single aggregate and ignore differences between countries, the feedback from climate damage to growth, emissions from land use and other greenhouse gases, and the role of carbon removal. Their purpose is to show the logic of the framework, not to predict the future.

Two simplifications favour the fossil pathway: it assumes that convergence proceeds at the same pace despite much higher climate damage, and it ignores the health costs of air pollution. Two favour the sustainable pathway: it assumes that clean technology can be financed and deployed at the required speed, and that residual emissions in hard-to-abate sectors are small. A fuller analysis would model these factors explicitly.

SECTION 13

A Strategy for Sustainable Convergence

Turning the possibility of clean, resilient catch-up into reality requires action by national governments, international institutions, investors and researchers. This section sets out the main elements.

IN BRIEF

- National strategies should plan the seven dimensions together, with clean power and digital public infrastructure as the backbone.
- International finance must lower the cost of capital, ease debt burdens and reward resilience.
- Progress should be measured with indicators of both convergence and sustainability, in relative as well as absolute terms.

13.1 Principles

- **Integrate, do not silo.** Plan energy, digital systems, health, education, infrastructure and resilience together so that each investment strengthens the others (Section 8).
- **Build clean and resilient the first time.** It is far cheaper to build infrastructure that is low-carbon and climate-ready than to retrofit it later (Hallegatte et al., 2019; New Climate Economy, 2016).
- **Put people first.** Invest in early childhood, health and foundational learning, which pay returns across every dimension for decades (Hoddinott et al., 2008; World Bank et al., 2022).
- **Leave no one behind.** Inclusion is part of the definition: access programmes should reach the poorest regions and households first, not last.
- **Respect national ownership.** Strategies should be designed by countries for their own conditions, not imposed as a single blueprint.
- **Share the burden fairly.** High-income countries, responsible for most past emissions, should cut their own emissions fastest and help finance the transition elsewhere.

13.2 What national governments can do

National governments hold most of the levers. Table 13 sets out a practical agenda across the seven dimensions. The common thread is that each action is designed to advance several dimensions at once: clean power that also supplies clinics and firms, digital systems that also strengthen tax collection and social protection, and infrastructure that is also built to withstand future climate.

The sequencing matters. In low-income countries, the first priorities are usually universal access to power, clean cooking, water and sanitation; basic digital infrastructure; and investment in early childhood and primary health care. In lower-middle-income countries, the focus shifts to productive uses of power, job-rich industries, skills, cleaner air and urban resilience. In upper-mid-

Table 13 A national action agenda across the seven dimensions

Dimension	Priority actions
Economic	Raise productivity through skills, management and technology adoption; develop clean industries and services that create jobs; strengthen domestic revenue
Environmental	Set clean-air standards; phase out new unabated coal; price or regulate pollution; protect forests, water and biodiversity
Technological	Build open digital public infrastructure for identity, payments and data; expand affordable broadband; support adoption of AI and modern production tools
Human development	Fund the first 1,000 days, primary health care and foundational learning; extend social protection
Infrastructure	Achieve universal electricity and clean cooking with grids and distributed solar; expand water, sanitation and clean transport
Institutional	Digitise tax and procurement; strengthen regulators; improve project preparation; protect data and privacy
Resilience	Expand early warning systems; climate-proof infrastructure; build adaptive social protection and disaster finance

Source: H Heuristics.

dle-income countries, the central tasks are decarbonising power and industry, raising productivity through innovation and avoiding the middle-income trap (World Bank, 2024).

13.3 What the international system can do

International action is essential because the main barriers, the cost of capital, debt, technology access and trade rules, are partly set outside developing countries. Priorities include:

- **Lower the cost of capital** through larger multilateral development bank balance sheets, first-loss guarantees, currency-risk instruments and support for country platforms that bundle clean-energy projects (IEA, 2024a; Songwe et al., 2022).
- **Ease debt burdens** through faster restructuring, climate-resilient debt clauses that pause repayments after disasters, and debt-for-climate or debt-for-nature swaps (Government of Barbados, 2023; UNCTAD, 2025).
- **Expand concessional finance and adaptation funding** for the poorest countries, reversing recent cuts in aid (OECD, 2026; UNEP, 2025).
- **Support technology and skills transfer**, including regional manufacturing of clean technologies and processing of critical minerals (IEA, 2025).
- **Design fair trade rules**, such as carbon border measures that recognise developing countries' circumstances and help them decarbonise exports (European Commission, 2025).
- **Scale disaster risk finance** through regional insurance pools and parametric cover that pays out quickly after shocks (CCRIF SPC, 2025; African Risk Capacity, 2025; Clarke and Dercon, 2016).

13.4 What investors and businesses can do

Private investors and firms will provide much of the capital and technology that Sustainable Convergence requires. They can direct more investment to clean energy, digital infrastructure and resilient assets in developing economies, work with public institutions to share risks, and build local supply chains and skills. Businesses that operate across borders can also help spread better management practices and technologies, which are among the most important drivers of productivity convergence (Bloom et al., 2013; Cirera and Maloney, 2017).

13.5 Measure, monitor and learn

Finally, progress needs to be measured in a way that captures both halves of the concept. The Sustainable Convergence Index proposed in Section 9 is a starting point. Governments and international organisations should track convergence in each of the seven dimensions, in relative as well as absolute terms, and report how much of their growth is being achieved through clean and resilient means. What gets measured gets managed; for too long, development has been measured mainly by income growth, and sustainability mainly by emissions, as if they were separate stories.

TOOLKIT

A Sustainable Convergence checklist for projects and policies

- **Convergence:** Does it raise productivity, incomes or access to services for people who are behind?
- **Environment:** Does it avoid locking in high emissions or pollution for decades, and protect forests, water and soils?
- **Technology:** Does it use the cheapest clean and digital options available today rather than yesterday's?
- **People:** Does it improve health, skills or living standards, especially for women, children and the poorest?
- **Institutions:** Does it strengthen public capacity, transparency and fiscal sustainability?
- **Resilience:** Is it designed for the climate of 2050 and for the shocks most likely to hit it?
- **Links:** Does it make investments in other dimensions more effective?

SECTION 14

Research Agenda and Conclusion

Sustainable Convergence is a framework for one of the defining questions of the century. It is also an invitation to further research.

IN BRIEF

- The concept needs better data on technology adoption, resilience over time, consumption-based emissions and the quality of services.
- The flywheel hypothesis should be tested with project-level and quasi-experimental evidence.
- The central conclusion: closing the gaps and protecting the planet are one task, and the next two decades will decide whether it succeeds.

14.1 A research agenda

This report has offered a definition, a framework, an index and illustrative scenarios. Each can be developed further. Six research questions stand out:

- **Measurement.** How can the Sustainable Convergence Index be extended to include artificial intelligence and advanced technology adoption, the quality of education and health care, biodiversity, water stress and financial resilience, and how sensitive are its results to benchmarks and weights?
- **Complementarity.** How large are the complementarities between dimensions in practice? Project-level evaluations, natural experiments and detailed regional data could test the Compounding Convergence Flywheel far more precisely than national averages.
- **Decoupling in developing economies.** Under what conditions can fast-growing economies reduce emissions while energy use rises to meet basic needs, and how do consumption-based measures change the picture?
- **Finance.** Which instruments most effectively lower the cost of capital for clean energy in developing economies, and at what cost to the public sector?
- **Jobs.** Which sectors can provide large-scale employment for the growing workforces of Africa and South Asia on a clean development path?
- **Resilience over time.** How can resilience be measured consistently over time, so that resilience convergence can be tracked alongside the other dimensions?

14.2 Conclusion

The twenty-first century has inherited a world divided by a two-hundred-year gap. Most of humanity lives in developing economies whose average income is still less than a quarter of the high-income level, and billions still lack reliable electricity, clean cooking, sanitation or the internet. Closing that gap is a moral and economic imperative, and the past quarter-century has shown that it is possible: income, health, access and connectivity have converged faster than ever before.

Table 14 Research priorities and data needs

Area	Key question	Data and methods needed
Measurement	Is the index robust and complete?	New indicators; sensitivity analysis; uncertainty ranges
Flywheel	How strong are cross-dimension effects?	Project evaluations; natural experiments; subnational data
Decoupling	Can growing economies cut emissions early?	Consumption-based accounts; sector-level energy data
Finance	What lowers the cost of capital?	Project finance data; evaluations of guarantees and platforms
Jobs	Where will employment come from?	Labour force surveys; firm-level data; sector studies
Resilience	Is vulnerability converging?	Consistent time series of vulnerability and losses

Source: H Heuristics.

But the record also shows that catch-up has so far mostly followed the old route. 78% of people in developing economies live in countries that converged on a carbon-intensive path, and few developing economies have yet decoupled growth from emissions. If that route continued, the climate damage would threaten the very gains that convergence delivers. At the same time, the economics of development have changed: clean power is now the cheapest power, digital public infrastructure can transform access to services, and each generation of developers has emitted less on the way up.

Sustainable Convergence brings these strands together. It defines development as the narrowing of economic, technological, institutional and human-development gaps on paths that are environmentally sustainable, socially inclusive and systemically resilient. It provides a seven-dimension framework, a way of measuring progress that distinguishes absolute improvement from true convergence, and a set of priorities for national and international action. And it complements Polycrisis Resilience: convergence builds the capabilities that make societies less vulnerable, and resilience protects those gains from the shocks of an interconnected world.

The scenarios in this report show that the choice is real. The Global South can reach roughly three-quarters of high-income living standards by the end of the century on a fossil path that blows through the carbon budget several times over, or on a sustainable path that stays within it. The difference lies not in how fast developing economies grow but in how they grow, and the decisive period is the next twenty years. Sustainable Convergence is the name for choosing the second path.

CONCEPT

The definition, restated

Sustainable Convergence is the process through which emerging and developing economies progressively narrow economic, technological, institutional, and human-development gaps with advanced economies while pursuing environmentally sustainable, socially inclusive, and systemically resilient development pathways.

Concept developed by Hunter Hughes, Founder of H Heuristics (Hughes, 2026a).

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About H Heuristics. H Heuristics is an independent research practice founded by Hunter Hughes, publishing research on development, resilience, the clean transition and interconnected global risks at researchreports.hheuristics.com.

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