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Sustainable Global Economic Convergence

A framework for advancing prosperity, environmental quality and systemic resilience together



Hunter Hughes
Founder, H Heuristics

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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). This report develops the framework further: five dimensions, a five-stage mechanism, the Sustainable Convergence Measurement Framework (SCMF) and five research propositions. It complements Polycrisis Resilience, also developed by Hunter Hughes.

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Data and methods. All data are public (World Bank, UNDP, WHO, INFORM, Our World in Data). Calculations, SCMF scores, 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

For most of the past two centuries, the question of whether poorer countries are catching up with richer ones has been answered with a single number: income per person. This report argues that the question needs a wider answer. Convergence should be judged by how it happens as well as how fast, and by whether prosperity, environmental quality and resilience advance together.

More than four in five people alive today live in the low- and middle-income economies often called the Global South. On average they earn less than a quarter of the income of people in high-income countries, and they are far more exposed to dirty air, extreme heat, unreliable power, weak health systems and climate disasters. Closing these gaps is the central development task of this century. **Sustainable Convergence**, a concept developed by Hunter Hughes, Founder of H Heuristics, holds that the gaps should be closed through development pathways that simultaneously advance economic productivity, technological capability, institutional capacity, human development and environmental sustainability (Hughes, 2026a).

23%	$45k	78%	72 of 103
Average income in the Global South as a share of the high-income level in 2024, up from 13% in 2000	The absolute income gap per person, which widened from about $36,000 in 2000 even as the ratio improved	of people in developing economies live in countries that caught up between 2000 and 2022 on a carbon-intensive path	developing economies have technology as their weakest of the five Sustainable Convergence dimensions

The core idea

Economic convergence is usually measured by asking whether developing economies are growing richer and approaching the income per person of advanced economies. That matters, but it leaves out most of what people experience as development. A country can raise its income while its air becomes more polluted, its cities more exposed to heat and flooding, and its public institutions no more capable than before. Another country can grow more slowly but build health systems, schools, clean power and digital public services that make every later stage of growth safer and more productive.

Sustainable Convergence asks three questions at once: *Are the gaps closing? Are people's lives actually improving?* And *is the path one that the environment and the country's own institutions can sustain through shocks?* Its central proposition is simple: economic convergence and sustainable development should be pursued as complementary objectives rather than competing priorities. The aim is not to copy the industrial history of today's rich countries, but to reach comparable or better living standards by more technologically advanced, resource-efficient, inclusive and resilient routes.

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).

What the report sets out

- **A formal definition and central proposition** (Section 2), together with the eight academic traditions it integrates, from convergence and endogenous growth theory to ecological economics, diffusion of innovations and resilience theory (Section 3).
- **Five interdependent dimensions**: economic and productive, technological, human-development, institutional, and environmental-and-resilience convergence (Section 4).
- **A five-stage development mechanism** explaining how convergence happens: capability formation, technology diffusion, sustainable structural transformation, multidimensional convergence, and resilient, sustained development (Section 5).
- **New evidence** on the record since 2000, the two development pathways open to emerging economies, and the role of technology diffusion and leapfrogging (Sections 6 to 8).
- **The link with Polycrisis Resilience**: Sustainable Convergence as a proactive strategy for reducing human exposure to interconnected crises in the Global South (Sections 9 and 10).
- **The Sustainable Convergence Measurement Framework (SCMF)**, which tracks the five dimensions separately, in relative and absolute terms, for 151 economies (Section 11), and **five research propositions** that can be tested (Section 12).
- **Regional pathways, barriers, scenarios to 2100, a strategy and a research agenda** (Sections 13 to 17).

Principal findings

- **Catch-up has happened, but it is narrow.** Average income in the Global South rose from 13% to 23% of the high-income level between 2000 and 2024. Without China and India the figure moved only from 18% to 20%, and low-income countries slipped from 4.2% to 3.7% (Section 6).
- **Relative convergence and absolute development are different things.** Of 102 developing economies, 90 became richer since 2000, yet the absolute dollar gap with rich countries widened for 99. Both kinds of progress must be measured (Figure 7).
- **Most catch-up so far has been carbon-intensive.** 78% of people in developing economies live in countries where income converged between 2000 and 2022 but emissions per person rose at least half as fast; only 6% live where convergence came with slow-growing or falling emissions (Section 7).

- **Latecomers can develop more cleanly.** Countries that first reached $10,000 per person after 2000 emitted a median 2.9 tonnes of CO_2 per person at that point, against 4.4 tonnes for those that got there before 1970. Solar modules now cost about 1,101 times less than in 1975 (Section 8).
- **Technology is the binding gap.** On the SCMF, technology is the weakest of the five dimensions for 72 of 103 developing economies, home to 4.0 billion people. Low-income countries score 10 out of 100, against 96 for high-income ones (Section 11).
- **Few countries are converging in a balanced way.** Only 18 of 103 developing economies score 60 or more on all five dimensions, while 59, with 3.3 billion people, score below 40 on at least one (Section 11).
- **Exposure to polycrisis follows the development gap.** 2.1 billion people in the Global South still cook with polluting fuels and 0.69 billion lack electricity. INFORM scores for vulnerability and lack of coping capacity in Sub-Saharan Africa are more than double the high-income level (Section 10).
- **The route to 2100 decides the climate.** If the Global South closes 2% of its income gap each year, it reaches about 74% of the high-income level by 2100. A fossil route would take world emissions to roughly 3,084 billion tonnes of CO_2; a sustainable route with the same income gains keeps the total near 819 billion tonnes, within the 2°C budget (Section 15).

Seven priorities for action

- **Measure convergence in five dimensions, not one.** Adopt the SCMF logic: track economic, technological, human-development, institutional and environmental-and-resilience gaps separately, in relative and absolute terms.
- **Make the cheapest path the cleanest.** Cut the cost of capital for clean energy in developing economies, which is often two to three times higher than in rich ones (IEA, 2024a).
- **Close the technology gap deliberately.** Invest in connectivity, digital public infrastructure, technical skills and the absorptive capacity of firms, so that diffusion turns into productivity.
- **Finish the access agenda.** Universal electricity, clean cooking, safe water, sanitation and affordable cooling remove the everyday exposures that make crises deadly.
- **Invest early in people and institutions.** Health, foundational learning and capable public administration compound over decades.
- **Build resilience in from the start.** Design infrastructure for future climate, extend early warning and adaptive social protection, and pre-arrange disaster finance (Hallegatte et al., 2019; Global Commission on Adaptation, 2019).
- **Reform the international system around convergence.** Debt relief with climate-resilient clauses, local-currency lending, technology partnerships and fair trade rules let latecomers use their advantage.

SECTION 01

Beyond Income Catch-Up

The twenty-first century must close a development gap that took two hundred years to open, and it must do so in a world of tighter environmental limits and more frequent, more interconnected shocks.

IN BRIEF

- Economic convergence has traditionally been judged by income alone. That leaves out health, technology, institutions, environmental quality and resilience.
- The historical route to prosperity 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 widens the definition of catch-up so that prosperity, environmental quality and resilience are pursued together.

1.1 The convergence question

Until about 1800, the gaps 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. Over the next two centuries their incomes multiplied many times over while most of the world grew slowly. 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; Lant Pritchett summarised the pattern as 'divergence, big time' (Pritchett, 1997).

Economic theory predicted something different. In the standard growth model associated with Robert Solow, poorer economies should grow faster than richer ones because each additional unit of capital adds more where capital is scarce (Solow, 1956). Later work found that this 'catchup' happens only when countries share similar conditions, such as education, institutions and openness, which economists call *conditional convergence* (Barro and Sala-i-Martin, 1992; Baumol, 1986). Moses Abramovitz added that a country's 'social capability' to absorb technology decides whether it can exploit the advantage of being behind (Abramovitz, 1986).

Since around 2000 the picture has changed. For the first time in modern history, a majority of developing economies grew faster than the rich world for a sustained period, a shift some economists have called a new era of unconditional convergence (Patel et al., 2021; Kremer et al., 2022). China, India, Vietnam, Bangladesh, Indonesia and others lifted hundreds of millions of people out of poverty. But the boom has faded since the 2010s, low-income countries have fallen further behind, and the absolute distance between rich and poor in dollars has kept widening (Section 6).

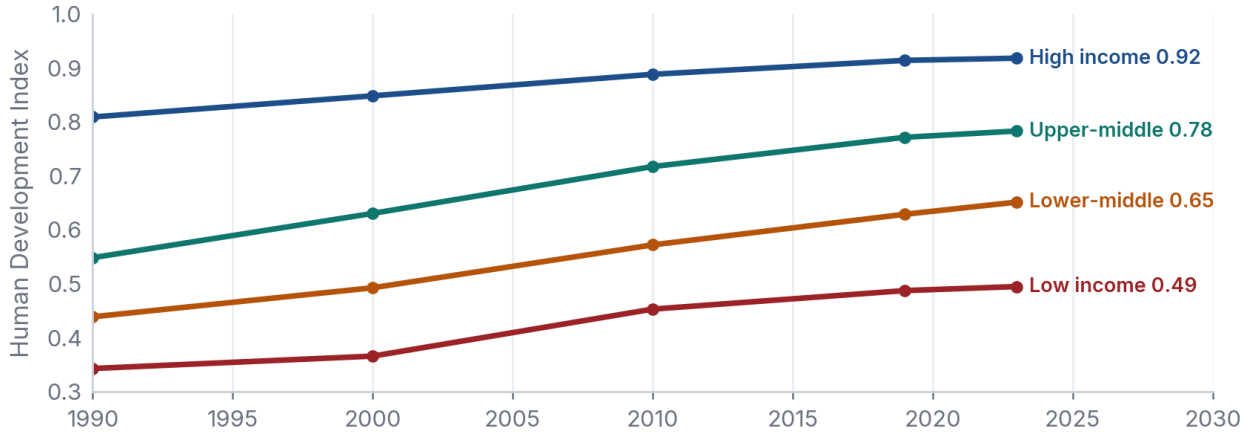
1.2 Why income is not enough

Income per person is the most common yardstick of convergence because it is widely available and easy to compare. Yet it is a poor guide to many of the things that matter most. The Commission on the Measurement of Economic Performance and Social Progress, led by Joseph Stiglitz, Amartya Sen and Jean-Paul Fitoussi, argued that measures of output should be complemented by measures of well-being and sustainability (Stiglitz et al., 2009). Sen's capability approach goes further: development is the expansion of the real freedoms people enjoy, such as being healthy, educated and able to take part in economic and social life (Sen, 1999).

The data bear this out. Across 103 developing economies, the score on the economic dimension of the SCMF is closely related to the human-development and technology scores (correlations of 0.88 and 0.83), less closely to institutions (0.53), and *negatively* to the environmental indicators (-0.48). In other words, higher income tends to come with more emissions and, up to a point, more air pollution. A convergence measure built on income alone would miss exactly the costs that most threaten the durability of development.

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).

1.3 The old route is closing

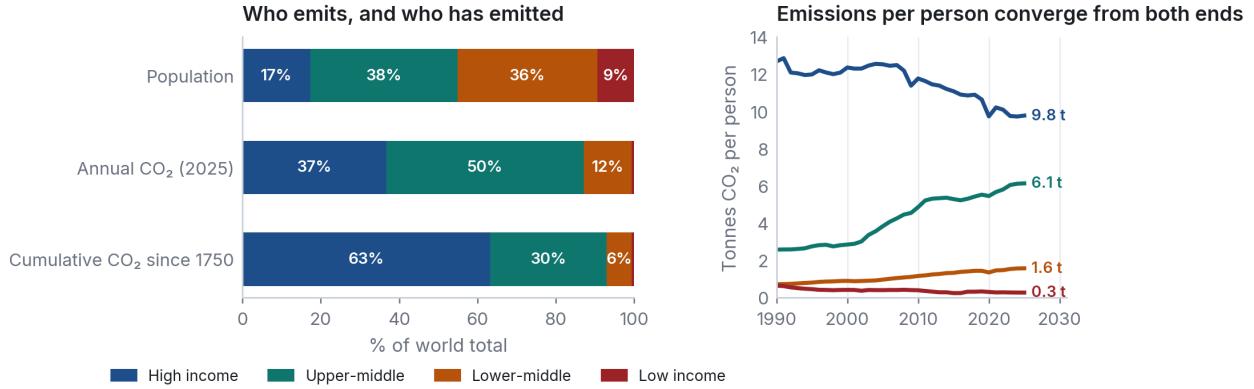
Today's rich countries became rich by burning fossil fuels at scale, and for most of their history they paid little attention to the pollution this caused. High-income countries hold about 17% of the world's population but account for about 63% of all CO_2 emitted from fossil fuels and industry since the Industrial Revolution (Our World in Data, 2025; Friedlingstein et al., 2025). If every developing economy followed the same path, the result would be catastrophic. The remaining carbon budget for a 50% chance of keeping warming below 2°C is roughly 1,050 billion tonnes of CO_2 from 2025, and for 1.5°C it is close to exhausted (Forster et al., 2025). Six of nine planetary boundaries are already estimated to be crossed (Richardson et al., 2023).

This is the core dilemma of twenty-first-century development. The countries that most need growth are also the ones most exposed to the damage that unsustainable growth causes: heat, floods, droughts, crop failures and air pollution fall hardest on the Global South (IPCC, 2023; Hallegatte et al., 2016). Asking them to stop growing would be unjust and unworkable. Asking them

to grow the old way would undermine their own development. Sustainable Convergence starts from this dilemma and argues that it can be resolved.

Figure 2 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.

1.4 A new route has opened

Two things have changed. First, clean technologies have become cheap. Solar modules cost about 1,101 times less than in 1975 and about 21 times less than in 2010; new solar and onshore wind are now the cheapest sources of electricity in most of the world (Our World in Data, 2025b; IRENA, 2025). Second, digital technologies have spread faster than any previous general-purpose technology. Mobile phones, mobile money and digital identity reached billions of people in the Global South within two decades, allowing some countries to skip stages that took rich countries a century (Suri and Jack, 2016; UNDP, 2023).

Together, these changes create a *latecomer advantage*. A country building its energy system, cities and public services today can choose technologies that are cleaner, cheaper and more resilient than those available when rich countries made the same investments. Sustainable Convergence is the framework for turning that possibility into a deliberate strategy.

1.5 Why now: development in an age of polycrisis

Development is also happening in a more dangerous world. Pandemics, climate extremes, debt crises, food-price spikes and conflict increasingly arrive together and amplify one another, a condition described as a *polycrisis* (Lawrence et al., 2024; Tooze, 2022). Shocks can erase years of progress: output losses after major crises are often permanent (Cerra and Saxena, 2008), and large tropical cyclones lower income for more than a decade (Hsiang and Jina, 2014). Within the H Heuristics framework, Sustainable Convergence is therefore a proactive pathway toward Polycrisis Resilience: accelerating development in vulnerable regions while progressively reducing the environmental, infrastructural, technological and socioeconomic conditions that place populations at risk (Hughes, 2026b).

CONTEXT

Why the twenty-first century is different

Four changes make Sustainable Convergence both more necessary and more achievable than at any point in the past.

- **Demography.** The Global South's share of world population is projected to rise from about 83% today to 86% by 2100, with most growth in Sub-Saharan Africa (United Nations, 2024). The development choices of these countries will shape the century.
- **Environmental limits.** The carbon budget for 1.5°C is nearly exhausted and several planetary boundaries are already crossed, so the high-emission route taken by early developers is no longer available at global scale (Forster et al., 2025; Richardson et al., 2023).
- **Technology.** Clean energy and digital systems are now cheaper, faster to deploy and more modular than the technologies they replace, which lowers the cost of a cleaner route.
- **Interconnected risk.** Climate extremes, pandemics, conflict and financial shocks increasingly coincide, so development gains must be built to last (Lawrence et al., 2024).

1.6 How the report is organised

Section 2 defines Sustainable Convergence and its central proposition. Section 3 sets out its academic foundations. Section 4 describes the five dimensions and Section 5 the five-stage mechanism by which convergence happens. Sections 6 to 8 review the evidence: how far convergence has come, the two development pathways open to emerging economies, and the role of technology diffusion. Sections 9 and 10 connect the concept to Polycrisis Resilience and to reducing human exposure in the Global South. Section 11 presents the Sustainable Convergence Measurement Framework and Section 12 five testable propositions. Sections 13 to 17 cover regional pathways, barriers, scenarios to 2100, strategy, and a research agenda.

SECTION 02

Defining Sustainable Convergence

A clear definition is the first requirement of a useful concept. Sustainable Convergence is defined by what is converging, how it converges, and what the convergence is for.

IN BRIEF

- Sustainable Convergence covers economic, technological, institutional and human-development gaps, pursued along sustainable, inclusive and resilient pathways.
- Its central proposition is that convergence and sustainable development are complements, not competing priorities.
- The objective is not to replicate historical industrialisation, but to reach comparable prosperity by better routes.

2.1 The formal definition

This report uses the following definition, developed by Hunter Hughes as part of the H Heuristics research programme on Polycrisis Resilience (Hughes, 2026a; Hughes, 2026h):

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.

Proposed H Heuristics definition. Concept developed by Hunter Hughes, Founder of H Heuristics.

Each part of the definition does specific work. **'Emerging and developing economies'** identifies who is converging: the low- and middle-income economies where more than four in five people live. **'Progressively narrow'** makes clear that convergence is a process over time, measured by direction and speed rather than by arrival at a fixed point. **'Economic, technological, institutional and human-development gaps'** widens the scope beyond income to the capabilities that make income possible and meaningful. **'Environmentally sustainable, socially inclusive and systemically resilient'** sets three conditions on the route: it must stay within environmental limits, share its benefits widely, and hold up under shocks.

The second sentence names what Sustainable Convergence is for: long-term improvement in productivity, living standards, technological capacity, environmental quality and resilience to interconnected global risks. These are the outcomes against which any convergence pathway should be judged.

2.2 The central proposition

> *"Economic convergence and sustainable development should be pursued as complementary objectives rather than competing development priorities."*
>
> Central proposition of Sustainable Convergence, H Heuristics

For much of the past half-century, development and environment were treated as a trade-off. Poor countries were told, explicitly or implicitly, to 'grow first and clean up later', a view supported by the idea of an environmental Kuznets curve in which pollution first rises and then falls as income grows (Grossman and Krueger, 1995). Environmental advocates, in turn, often treated growth in poor countries as a threat to be contained. Sustainable Convergence rejects both positions.

It holds that the two goals reinforce each other when technology, investment and institutions are directed well. Clean power reduces fuel imports and air pollution while supporting industry. Healthier, better-educated workers are more productive. Resilient infrastructure protects the capital stock on which growth depends. Capable institutions both raise productivity and enforce environmental rules. The proposition is not that conflicts never arise (they do, and Section 14 discusses them) but that the best development strategies are those that seek out and exploit the complementarities.

2.3 Not replication, but better routes

A frequent objection to environmental conditions on development is that they 'pull up the ladder': rich countries climbed using fossil fuels and now ask others not to. Sustainable Convergence answers this objection directly. Its objective is not to replicate the historical industrialisation pathways of advanced economies. It is to enable developing economies to achieve comparable or improving standards of prosperity through more technologically advanced, resource-efficient, inclusive and resilient pathways.

This is consistent with the long tradition of thinking about 'the advantages of backwardness'. Alexander Gerschenkron observed that late industrialisers did not repeat the paths of early ones; they used newer technology and different institutions, and often grew faster (Gerschenkron, 1962). Keun Lee's work on catch-up shows that successful latecomers frequently took detours and leapfrogged into new technological fields rather than following incumbents step by step (Lee, 2019). Sustainable Convergence extends this logic to energy, environment and resilience.

2.4 Key terms

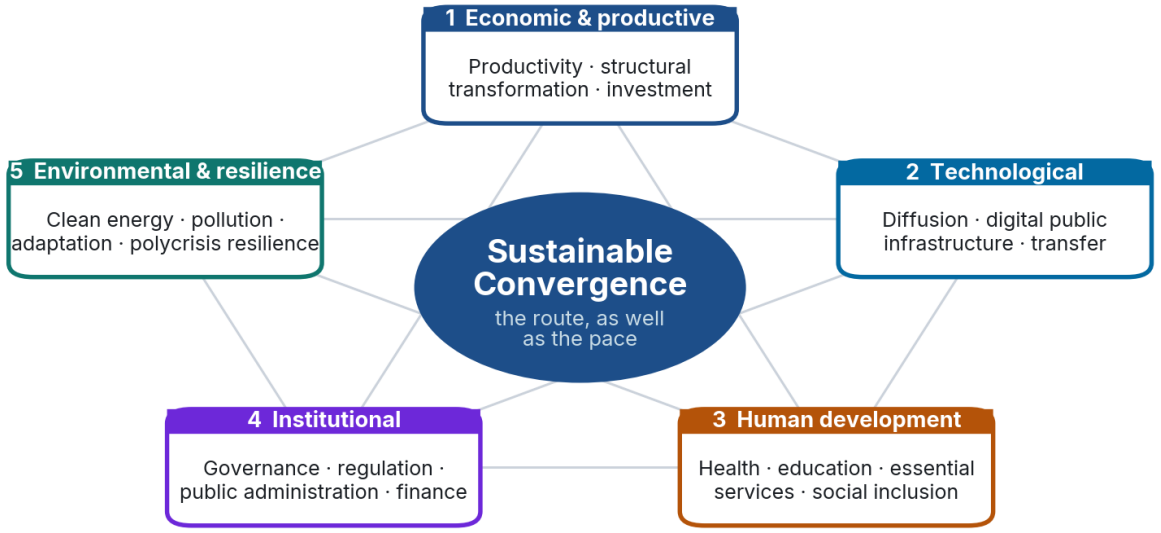
Several terms recur throughout the report. Some, such as convergence and decoupling, have precise meanings in economics that differ from everyday usage, so Table 1 sets out how each is used here.

2.5 How Sustainable Convergence relates to other ideas

Sustainable Convergence overlaps with several established ideas but is distinct from each. Table 2 compares them by the main question each asks and by what Sustainable Convergence adds.

Figure 3 Sustainable Convergence: five interdependent dimensions, one integrated pathway

The five dimensions of Sustainable Convergence and their main areas of focus



Lines show that each dimension reinforces the others; no single dimension, including income, defines convergence on its own.

Source: H Heuristics, based on Hughes (2026a) (Hughes, 2026a). Conceptual framework.

Table 1 Key terms used in this report

Term	Meaning in this report
Relative convergence	A narrowing of the gap between developing and advanced economies, usually expressed as a ratio (for example, income as a percentage of the high-income level).
Absolute development	An improvement in a country's own conditions over time, whether or not the gap with advanced economies narrows.
Absolute gap	The difference in levels (for example, in dollars per person). It can widen even while the ratio improves.
Decoupling	Growth in income without a matching growth in emissions or resource use. 'Absolute' decoupling means emissions fall while income rises.
Leapfrogging	Adopting a newer technology without passing through the older ones, such as mobile phones without landlines or solar mini-grids without a national grid.
Technology diffusion	The spread of existing technologies across and within countries, including adoption by households, firms and governments.
Polycrisis	A situation in which several crises interact so that their combined harm exceeds the sum of their separate effects.
Polycrisis Resilience	The capacity of people, institutions, economies and systems to anticipate, withstand, adapt to, recover from and reduce vulnerability to multiple interacting crises (Hughes, 2026b).
SCMF	The Sustainable Convergence Measurement Framework: a dashboard of five dimensions, measured separately in relative and absolute terms (Section 11).

Source: H Heuristics.

Table 2 How Sustainable Convergence differs from related ideas

Idea	Main question	What Sustainable Convergence adds
Economic convergence	Are poorer economies growing faster than richer ones?	Judges convergence in five dimensions and by the sustainability of its route
Sustainable development	Does today's progress protect the needs of future generations?	Puts the gap between countries at the centre and asks how it closes
Green growth	Can growth continue while environmental damage falls?	Focuses on catch-up by developing economies rather than growth in general
Degrowth and post-growth	Should rich economies stop pursuing growth?	Accepts that poorer economies need substantial growth in income and capabilities
Doughnut economics	Can everyone meet social needs within planetary limits?	Adds the dynamics of catch-up, technology diffusion and resilience
Polycrisis Resilience	How can people and systems withstand interacting crises?	Supplies the development pathway that builds and protects resilience

Source: H Heuristics, drawing on Barro and Sala-i-Martin (1992), WCED (1987), OECD (2011), Kallis et al. (2018), Raworth (2012) and Hughes (2026b) (Barro and Sala-i-Martin, 1992; WCED, 1987; OECD, 2011; Kallis et al., 2018; Raworth, 2012; Hughes, 2026b).

2.6 Three tests of Sustainable Convergence

The definition implies three practical tests that can be applied to any country, region or policy:

1. **The gap test.** Are the gaps with advanced economies narrowing across the five dimensions, and not only in income?
2. **The improvement test.** Are people's living conditions, environmental quality and resilience improving in absolute terms, whatever is happening to the gaps?
3. **The durability test.** Would the gains survive a severe shock, such as a drought, a pandemic, a financial crisis or a sharp rise in energy prices, and are they being achieved without locking in future environmental damage?

A country that passes all three is on a Sustainable Convergence path. A country that passes only the first, by growing fast on a carbon-intensive and fragile base, is converging in the traditional sense but not sustainably. The rest of this report develops the tools needed to apply these tests systematically.

SECTION 03

Academic Foundations

Sustainable Convergence does not start from a blank page. It draws on eight established research traditions, each of which explains part of how countries catch up and whether that catch-up lasts.

IN BRIEF

- Eight traditions contribute: convergence theory, endogenous growth, sustainable development, development economics, ecological economics, institutional economics, diffusion of innovations and resilience theory.
- Each is well known on its own. They are rarely combined, because they are studied by different disciplines with different questions.
- The originality of Sustainable Convergence lies in integrating, operationalising and applying these traditions, not in claiming that the underlying ideas are new.

A new concept earns its place by organising existing knowledge more usefully, not by pretending that knowledge did not exist. Sustainable Convergence integrates eight research traditions. Table 3 summarises what each contributes and Figure 4 shows how they feed into a single framework. The sections that follow explain each in plain terms.

Table 3 Eight academic foundations of Sustainable Convergence

Academic foundation	Contribution to Sustainable Convergence	Key sources
Economic convergence theory	Narrowing income and productivity gaps	Solow (1956); Barro and Sala-i-Martin (1992)
Endogenous growth theory	Innovation, human capital and technological progress	Romer (1990); Lucas (1988)
Sustainable development	Balancing economic, social and environmental outcomes	WCED (1987); UN (2015)
Development economics	Structural transformation and poverty reduction	Lewis (1954); McMillan et al. (2014)
Ecological economics	Resource efficiency and environmental constraints	Daly (1990); Costanza (1989)
Institutional economics	Governance, institutional capacity and productivity	North (1990); Acemoglu et al. (2001)
Diffusion of innovations	Accelerating adoption of productive technologies	Rogers (2003); Comin and Hobijn (2010)
Resilience theory	Reducing vulnerability to interconnected risks	Holling (1973); Folke (2006)

Source: H Heuristics, based on Hughes (2026a) (Hughes, 2026a; Solow, 1956; Barro and Sala-i-Martin, 1992; Romer, 1990; Lucas, 1988; WCED, 1987; United Nations, 2015; Lewis, 1954; McMillan et al., 2014; Daly, 1990; Costanza, 1989; North, 1990; Acemoglu et al., 2001; Rogers, 2003; Comin and Hobijn, 2010; Holling, 1973; Folke, 2006).

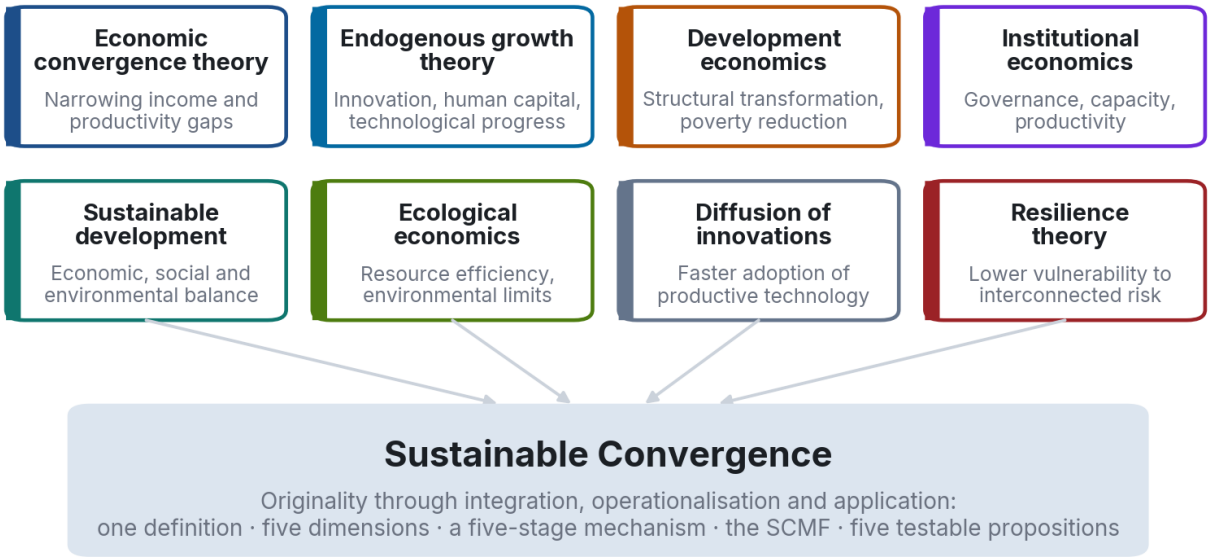
3.1 Convergence and endogenous growth

Economic convergence theory provides the starting question. In Robert Solow's model, an economy with little capital per worker earns high returns on new investment, so it should grow faster than a capital-rich one until the two meet (Solow, 1956). Empirical work by Robert Barro and Xavier Sala-i-Martin showed that this happens among similar economies, such as US states or Japanese prefectures, but not across the world as a whole, because countries differ in the conditions that determine where they end up (Barro and Sala-i-Martin, 1992). Development accounting confirms that most of the income gap between countries reflects differences in productivity, not just in capital (Hall and Jones, 1999; Caselli, 2005).

Endogenous growth theory explains where productivity comes from. Paul Romer modelled ideas as the engine of growth: unlike machines, an idea can be used by everyone at once, so investment in knowledge can keep raising output (Romer, 1990). Robert Lucas emphasised human capital, the skills and knowledge embodied in people, as a source of growth and of spillovers between workers (Lucas, 1988). For Sustainable Convergence, the lesson is that catch-up depends on building the capacity to use and create knowledge, not only on accumulating capital. This is why technological and human-development convergence are separate dimensions.

Figure 4 Eight research traditions feed one integrated framework

Academic foundations of Sustainable Convergence and their contributions



The underlying ideas are not new. What is new is joining them into one framework that can be measured and acted on.

Source: H Heuristics, based on Hughes (2026a) (Hughes, 2026a).

3.2 Development and institutional economics

Development economics adds the insight that growth in poor countries usually comes from moving people and resources out of low-productivity activities, such as subsistence farming, into higher-productivity ones in manufacturing and modern services. Arthur Lewis described this as the core of development (Lewis, 1954). Modern work shows that structural change has been a major source of productivity growth in Asia, while in parts of Africa and Latin America labour has sometimes moved in the wrong direction (McMillan et al., 2014; Gollin et al., 2014). Manufacturing has historically shown strong convergence in productivity (Rodrik, 2013), but many countries are now deindustrialising at lower incomes than early industrialisers did (Rodrik, 2016).

Institutional economics explains why similar opportunities produce very different results. Douglass North defined institutions as the 'rules of the game' that shape incentives (North, 1990). Daron Acemoglu, Simon Johnson and James Robinson argued that differences in institutions are a fundamental cause of long-run income gaps (Acemoglu et al., 2001). Practical experience shows that building state capability is slow and that copying the forms of successful institutions without their function often fails (Andrews et al., 2013). Institutional convergence is therefore its own dimension.

3.3 Sustainable development and ecological economics

Sustainable development entered global policy with the Brundtland Commission's 1987 definition: development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987). It was embedded in the Rio Earth Summit in 1992 and in the 17 Sustainable Development Goals adopted in 2015 (United Nations, 1992; United Nations, 2015). Its central contribution is to insist that economic, social and environmental outcomes be balanced rather than traded off.

Ecological economics provides the harder edge. It treats the economy as part of the biosphere, dependent on flows of energy and materials and on ecosystems that cannot be fully replaced by capital (Costanza, 1989). Herman Daly proposed simple operating rules: harvest renewable resources no faster than they regenerate, and emit wastes no faster than ecosystems can absorb them (Daly, 1990). The planetary boundaries framework turns these ideas into measurable limits at global scale (Rockström et al., 2009; Richardson et al., 2023), and the Dasgupta Review shows how the depletion of natural capital undermines long-term prosperity (Dasgupta, 2021).

3.4 Diffusion of innovations and resilience theory

Diffusion of innovations explains how quickly new technologies spread. Everett Rogers showed that adoption typically follows an S-shaped curve, shaped by the technology's relative advantage, compatibility, complexity, trialability and visibility (Rogers, 2003). Cross-country research finds that new technologies now reach developing economies much faster than in the past, but are used far less intensively once they arrive, and that this gap in intensity explains a large part of income differences (Comin and Hobijn, 2010; Comin and Mestieri, 2018). For Sustainable Convergence, accelerating diffusion is one of the most powerful levers available.

Resilience theory began in ecology, where C. S. Holling distinguished the ability of a system to absorb disturbance and keep functioning from its ability to return to a single equilibrium (Holling, 1973). It has since been applied to social–ecological systems, cities, economies and dis-

aster risk (Folke, 2006; UNDRR, 2017). Its contribution here is the insistence that development gains must be durable: a path that raises income but leaves people exposed to repeated shocks is not sustainable convergence.

3.5 Where the traditions disagree

Integration does not mean pretending that these traditions agree. Convergence and endogenous growth theory treat sustained growth as both possible and desirable; parts of ecological economics question whether growth can continue indefinitely within planetary limits, and the degrowth literature argues that rich economies should stop pursuing it (Kallis et al., 2018). Development economics emphasises industrialisation; ecological economics emphasises the material and energy costs of industry. Resilience theory values redundancy and spare capacity; growth and efficiency thinking tends to remove them.

Sustainable Convergence takes a position on each tension. It accepts that developing economies need substantial growth in income and capabilities, because the gaps in health, energy access and living standards are too large to close any other way. It accepts that this growth must be decoupled from environmental damage, and it treats the evidence that decoupling is possible, and increasingly cheap, as decisive. And it treats resilience not as a cost to be minimised but as a form of insurance that protects the returns on every other investment. These positions are themselves testable, which is why Section 12 sets them out as propositions.

3.6 Originality through integration

None of these ideas is new on its own, and this report does not claim otherwise. What is distinctive about Sustainable Convergence is the way it combines them. Convergence economists rarely measure environmental quality; sustainability researchers rarely ask how quickly poor countries are closing the gap; resilience specialists rarely connect their work to long-run productivity growth. Sustainable Convergence brings these questions into one framework and makes them operational through a definition, five dimensions, a mechanism, a measurement framework and testable propositions. Its originality lies in **integration** (one framework rather than eight separate literatures), **operationalisation** (indicators that can be measured for every country) and **application** (to regional strategy, exposure reduction and Polycrisis Resilience).

SECTION 04

The Five Dimensions

Convergence is multidimensional. Five interdependent dimensions form the core architecture of the concept, and progress in each strengthens the others.

IN BRIEF

- The five dimensions are economic and productive, technological, human-development, institutional, and environmental-and-resilience convergence.
- Each dimension has its own indicators and its own policy levers, but none can advance far without the others.
- The dimensions are mutually reinforcing: clean energy, digital public infrastructure, technology transfer and better health and education all create gains across several dimensions at once.

Sustainable Convergence rests on five interdependent dimensions. They are summarised in Table 4 and described below, with data on where the Global South stands in each. The scores quoted come from the Sustainable Convergence Measurement Framework set out in Section 11, where 100 represents the typical (median) high-income economy.

Table 4 The five dimensions of Sustainable Convergence

Dimension	What converges	Focus areas
1. Economic and productive	Income, productivity, employment, infrastructure and industrial capacity	Productivity growth · structural transformation · trade integration · investment
2. Technological	Access to, adoption of, and capacity to develop productive technologies	Technology diffusion · AI · digital public infrastructure · innovation · technology transfer
3. Human development	Health, education, living standards, opportunity and access to essential services	Human capital · healthcare · education · poverty reduction · social inclusion
4. Institutional	Institutional and governance capacities that support advanced development	Governance · regulatory capacity · public administration · financial systems · rule of law
5. Environmental and resilience	Environmental quality, clean-energy access, climate adaptation and protection against systemic risk	Clean energy · pollution reduction · climate adaptation · resource efficiency · Polycrisis Resilience

Source: H Heuristics, based on Hughes (2026a) (Hughes, 2026a).

4.1 Dimension 1: Economic and productive convergence

The first dimension is the one most people associate with convergence: narrowing gaps in income, productivity, employment, infrastructure and industrial capacity. Output per worker in the Global South rose from about $14,607 in 2000 to $29,876 in the latest year (2021 PPP dollars), lifting it from 16% to 26% of the high-income level. In low-income countries it stalled at around 6% (World Bank, 2026). On the SCMF, the economic score is 30 for low-income countries, 58 for lower-middle-income and 77 for upper-middle-income ones.

The main drivers are investment, structural transformation from low- to high-productivity work, trade integration and the quality of firm management (McMillan et al., 2014; Bloom et al., 2013; Dieppe (ed.), 2021). Under Sustainable Convergence, productive convergence is pursued through cleaner and more efficient capital: renewable power rather than new coal, efficient industrial processes, and compact, well-connected cities.

4.2 Dimension 2: Technological convergence

The second dimension concerns the gap in access to, adoption of, and capacity to develop productive technologies, from electricity and the internet to industrial automation, digital public infrastructure and artificial intelligence. Internet use in the Global South rose from 1% of people in 2000 to 60% in the latest year, but fixed broadband subscriptions remain at 14 per 100 people against 36 in high-income countries, and in low-income countries only 18% of people use the internet (World Bank, 2026; ITU, 2025).

Technology is the weakest dimension for most developing economies: 72 of the 103 covered by the SCMF. Low-income countries score 10 out of 100. This matters because technology is the channel through which latecomers can skip stages. The challenge is not only access but intensity of use: firms in developing economies often have the same tools as rich-country firms but use them less, and lack the managerial and technical skills to exploit them (Comin and Mestieri, 2018; Cirera and Maloney, 2017).

4.3 Dimension 3: Human-development convergence

The third dimension covers health, education, living standards, economic opportunity and access to essential services such as water, sanitation and electricity. Here progress has been substantial. Under-five mortality in the Global South fell from 69 to 31 deaths per 1,000 births, and life expectancy rose from 66 to 72 years. Access to basic sanitation rose from 45% to 77% of people (World Bank, 2026; UNDP, 2025).

Yet large gaps remain. Adults in low-income countries have on average 4.2 years of schooling, against 12.8 in high-income countries, and around seven in ten ten-year-olds in low- and middle-income countries cannot read a simple text (World Bank et al., 2022). Human development is the strongest of the four capability dimensions for most of the Global South (SCMF score 74), but in Sub-Saharan Africa it scores only 44.

4.4 Dimension 4: Institutional convergence

The fourth dimension concerns the capacity of governments and institutions to support advanced development: effective public administration, sound regulation, functioning financial systems and the rule of law. On the World Bank's government-effectiveness indicator, which runs from about −2.5 to +2.5, the Global South improved from -0.7 to -0.1 between 2000 and the latest year, but high-income countries average 1.2 (World Bank, 2025a; Kaufmann et al., 2011).

Institutions are slow to change and hard to measure, but they shape everything else. They determine whether infrastructure is built and maintained, whether environmental rules are enforced, whether investors trust contracts, and whether public money reaches the people it is meant for. Institutional capacity is also central to resilience: governments that can deliver services in nor-

mal times are far better placed to respond in a crisis (COVID-19 National Preparedness Collaborators, 2022).

4.5 Dimension 5: Environmental and resilience convergence

The fifth dimension concerns disparities in environmental quality, clean-energy access, climate adaptation and protection against systemic risks. People in the Global South breathe air with an average fine-particle (PM2.5) concentration of 37 μg/m^3, more than seven times the WHO guideline of 5 μg/m^3 and well above the high-income average of 14 μg/m^3 (World Bank, 2026; WHO, 2021). 2.1 billion people still cook with polluting fuels such as wood, charcoal and kerosene (IEA et al., 2026).

This dimension is unusual because the gap is not simply one of developing economies lagging behind. High-income countries emit far more CO_2 per person (10 tonnes against 3.5), and on the environmental indicators alone they score only 49 out of 100. Sustainable Convergence therefore asks developing economies to converge *upward* on environmental quality, clean energy and resilience, but not on emissions. It is the dimension in which latecomers have the clearest opportunity to do better than the countries they are catching up with.

4.6 Mutually reinforcing dimensions

The five dimensions are designed to be mutually reinforcing. Progress in one creates conditions for progress in others, and weakness in one can hold back the rest. Table 5 gives examples of the most important links.

Table 5 How the five dimensions reinforce one another: examples

Investment or change	Dimensions strengthened	How
Renewable energy	Economic · Environmental · Resilience	Improves energy security, reduces pollution and fuel imports, and supports industrial productivity
Digital public infrastructure	Technological · Institutional · Human development	Improves financial inclusion, public-service delivery and the efficiency of government
Technology transfer	Technological · Economic · Environmental	Accelerates productivity growth while reducing the need to repeat resource-intensive development pathways
Healthcare, education and living conditions	Human development · Economic	Improve labour productivity and long-term economic participation
Clean cooking	Human development · Environmental	Cuts household air pollution, saves time (mostly women's), protects forests
Early warning and adaptive social protection	Resilience · Institutional · Human development	Protects lives and assets in shocks; builds trust and administrative capacity
Capable public administration	Institutional · all others	Delivers infrastructure, enforces environmental rules and lowers the cost of capital

Source: H Heuristics, based on Hughes (2026a) and the evidence reviewed in Sections 6 to 10 (Hughes, 2026a).

The practical implication is that development strategies should look for investments that score well on several dimensions at once, and should avoid strategies that advance one dimension by

sacrificing another, such as cheap but polluting power that raises output today while damaging health and locking in emissions for decades (Unruh, 2000).

ILLUSTRATION

Balanced convergence in practice

Countries whose dimension scores are close together illustrate what balanced convergence looks like. On the SCMF, scored economic, technological, human development, institutional and environmental-and-resilience:

- **Costa Rica** (85, 77, 91, 85, 85) generates almost all of its electricity from renewable sources, has reversed deforestation and has strong health and education systems, while reaching upper-middle income (UNEP, 2019).
- **Uruguay** (89, 98, 93, 96, 88) rapidly shifted its power system to wind and solar in the 2010s alongside strong institutions and near-universal digital access.
- **Vietnam** (66, 74, 84, 66, 69) combined export manufacturing with fast gains in education, electricity access and connectivity, though its reliance on coal power is its main weakness.

By contrast, **India** (61, 34, 74, 77, 62) shows a large technology gap alongside strong institutions and human development, and **Nigeria** (57, 21, 45, 44, 48) lags across all four capability dimensions.

Reinforcement is not automatic, and some interactions are negative in the short run. Rapid industrial growth can raise emissions and air pollution before cleaner technologies are adopted; new dams and roads can damage ecosystems; digital systems can exclude people without identity documents or connectivity. Recognising these trade-offs is part of the framework. The aim is to manage them deliberately, by sequencing investments, setting environmental standards early and designing systems for inclusion, rather than discovering them after the damage is done.

SECTION 05

The Five-Stage Development Mechanism

A useful concept must explain how convergence happens, not only what it means. Sustainable Convergence proposes five analytical stages, from building basic capabilities to sustaining gains through shocks.

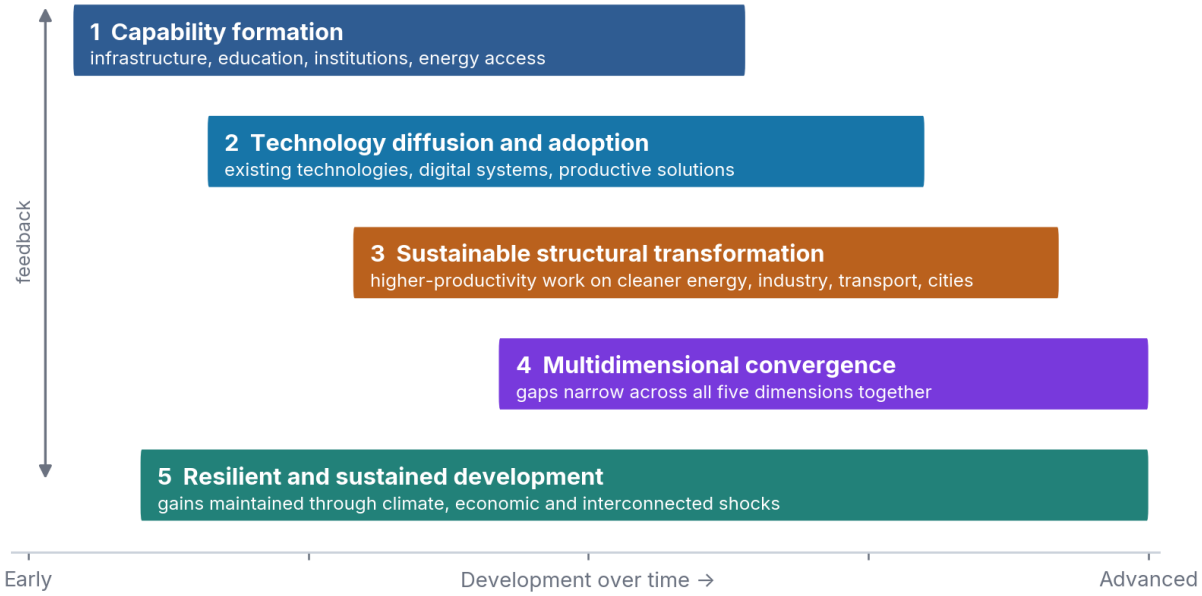
IN BRIEF

- The five stages are capability formation, technology diffusion and adoption, sustainable structural transformation, multidimensional convergence, and resilient and sustained development.
- These are analytical stages, not a rigid sequence. Countries pursue several at once and start from very different conditions.
- Each stage has distinct policy priorities and observable signs of progress, which makes the mechanism useful for diagnosis.

Figure 5 shows the five stages of the development mechanism. They describe the processes through which a developing economy builds the capacity to grow, adopts technology, transforms its economic structure, closes gaps across dimensions and protects its gains. The bands overlap because, in practice, countries work on several stages at the same time, and later stages feed back into earlier ones.

Figure 5 Five analytical stages of Sustainable Convergence, overlapping rather than sequential

The development mechanism of Sustainable Convergence



Source: H Heuristics, based on Hughes (2026a) (Hughes, 2026a). Conceptual diagram; the horizontal axis indicates broad development progress, not calendar time.

5.1 Stage 1: Capability formation

Every later stage depends on foundations: infrastructure, education, institutional capacity, energy access and basic productive capabilities. A factory cannot run without reliable power; a digital service cannot reach people without connectivity and identity; a farmer cannot adopt better seeds without roads to market. In Sub-Saharan Africa, 52% of people have electricity and 36% basic sanitation, so capability formation remains the most urgent stage for much of the region (World Bank, 2026).

Capability formation is also where Sustainable Convergence makes its first choice of route. Power systems, cities and transport networks built now will last for decades. Building them on clean, distributed and resilient technologies avoids locking in high emissions and exposure later. Early investments in nutrition, health and learning have some of the highest long-run returns of any public spending (Hoddinott et al., 2008).

5.2 Stage 2: Technology diffusion and adoption

The second stage is the adoption of existing technologies, innovations, digital systems and productivity-enhancing solutions. Most productivity growth in developing economies comes not from inventing new technology but from adopting and adapting technology that already exists elsewhere (Keller, 2004; Cirera and Maloney, 2017). Diffusion has accelerated: mobile phones reached most of the world's population within about two decades, and the average lag between invention and arrival in a developing economy has fallen sharply over the past century (Comin and Hobijn, 2010).

Evidence from households and firms shows the gains. Mobile money in Kenya helped lift an estimated 2% of households out of poverty, with the largest effects for women-headed households (Suri and Jack, 2016). The arrival of fast internet in Africa raised employment, including in skilled jobs (Hjort and Poulsen, 2019). The policy task is to remove barriers to adoption (cost, skills, regulation, finance) and to raise the intensity with which technologies are used once they arrive.

5.3 Stage 3: Sustainable structural transformation

The third stage is the expansion of higher-productivity economic activity while transitioning toward cleaner energy, industry, transport and urban development. This is where the two trajectories discussed in Section 7 diverge most sharply. Traditional structural transformation moved workers from farms into factories powered by coal and oil, and into cities built around cars. Sustainable structural transformation moves workers into higher-productivity jobs powered by clean electricity, in compact cities with public transport, and in industries designed for resource efficiency.

The opportunities are concrete: green industrial clusters near cheap renewable power, processing of critical minerals, assembly of solar, battery and electric-vehicle components, efficient agriculture and food processing, and modern services enabled by digital technology (IEA, 2025; New Climate Economy, 2016). The risk is premature deindustrialisation, in which countries lose manufacturing jobs before they become rich, cutting off a traditional ladder of productivity growth (Rodrik, 2016).

5.4 Stage 4: Multidimensional convergence

The fourth stage is the progressive narrowing of economic, technological, institutional, human-development and environmental gaps together. It is the outcome that the first three stages are meant to produce, and the one that the Sustainable Convergence Measurement Framework is designed to track. The SCMF shows how uneven this has been so far: across developing economies, the median gap between a country's strongest and weakest dimension is 36 points out of 100 (Section 11).

Multidimensional convergence matters because the dimensions are complements. A country with rising income but weak institutions struggles to turn growth into public services; one with good health and education but little technology struggles to create productive jobs for its educated young people. Balanced progress is more likely to be self-sustaining.

5.5 Stage 5: Resilient and sustained development

The fifth stage is the ability of economies and populations to maintain development gains amid climate change, environmental degradation, economic shocks and interconnected crises. Development history is full of reversals: debt crises in the 1980s, the Asian financial crisis of 1997, the commodity bust of the mid-2010s and the COVID-19 pandemic each wiped out years of progress in many countries (Cerra and Saxena, 2008; Kose and Ohnsorge, 2024). Climate change adds a growing and permanent source of shocks (Hsiang and Jina, 2014; IPCC, 2023).

Resilience is shown in Figure 5 as a band running almost the full length of development, because it is not only a final stage. Resilient infrastructure, social protection and early warning systems need to be built from the start, so that each new gain is protected as it is made. This stage is where Sustainable Convergence connects most directly to Polycrisis Resilience (Section 9).

5.6 Analytical stages, not a rigid sequence

The stages are analytical, not a timetable. Countries can and do pursue several simultaneously, and their starting conditions differ greatly. India built world-class digital public infrastructure (stage 2) while hundreds of millions of its people still lacked clean cooking (stage 1). Vietnam pursued structural transformation (stage 3) through export manufacturing while building out basic services. Small island states must prioritise resilience (stage 5) from the outset because a single cyclone can destroy a large share of their output. Table 6 summarises the priorities and signs of progress at each stage.

The mechanism is most useful as a diagnostic. Three broad archetypes illustrate how the emphasis shifts with a country's starting point:

- **Low-income economies** (average SCMF technology score 10, human development 39) are mainly in stage 1. Their priority is capability formation, but distributed clean energy and mobile systems allow stage 2 to begin at the same time.
- **Lower-middle-income economies** (technology 32, institutions 65) are typically working across stages 1 to 3 at once. The decisive question is whether their structural transformation runs on clean or fossil power.

Table 6 The five stages: priorities and signs of progress

Stage	Policy priorities	Signs of progress
1. Capability formation	Universal electricity, water, sanitation and clean cooking; foundational learning; primary health care; core public administration	Access rates rising; child mortality and learning poverty falling; public revenue rising
2. Technology diffusion and adoption	Connectivity, digital ID and payments, technical skills, extension services, openness to trade and investment	Internet and broadband use; firm adoption of digital tools; productivity growth in existing firms
3. Sustainable structural transformation	Clean power for industry, green industrial clusters, urban planning and public transport, export diversification	Workers moving to higher-productivity jobs; carbon intensity of output falling
4. Multidimensional convergence	Balanced investment across the five dimensions; correcting the weakest dimension	Gaps narrowing on all five SCMF dimensions; smaller spread between strongest and weakest
5. Resilient and sustained development	Climate-proof infrastructure, early warning, adaptive social protection, pre-arranged disaster finance, fiscal buffers	Smaller and shorter losses after shocks; faster recovery; falling disaster mortality

Source: H Heuristics, based on Hughes (2026a) (Hughes, 2026a).

- **Upper-middle-income economies** (economic score 77, environmental indicators 43) are mostly in stages 3 to 5. Their main task is to decarbonise and clean up an existing industrial base while protecting gains against shocks.

In all three archetypes, the stages feed back on one another. Higher productivity (stage 3) raises the tax revenue that funds education and infrastructure (stage 1); resilient systems (stage 5) keep investment flowing after shocks; and the diffusion of digital and clean technologies (stage 2) lowers the cost of every other stage. Sustainable Convergence is therefore best understood as a set of mutually reinforcing loops, which policy can strengthen or weaken, rather than as a ladder that must be climbed one rung at a time.

SECTION 06

The Record: Relative and Absolute Progress

How far has convergence come? The answer depends on what is measured and how. Measured as a ratio, the Global South has caught up substantially since 2000. Measured in dollars, in breadth or in sustainability, the picture is much less encouraging.

IN BRIEF

- Global South income rose from 13% to 23% of the high-income level between 2000 and 2024, but most of the gain came from China and India.
- The absolute gap widened for 99 of 102 developing economies, even though 90 became richer.
- Access to services and connectivity has converged much faster than income, but billions still lack the basics.

6.1 Income: real but concentrated catch-up

Measured in purchasing-power terms, average income per person in the Global South rose from 13% of the high-income level in 2000 to 23% in 2024 (Figure 6). Upper-middle-income countries made the largest relative gains, from 18% to 36%, and lower-middle-income countries rose from 9% to 15%. Low-income countries, by contrast, fell further behind, from 4.2% to 3.7% (World Bank, 2026).

Much of the aggregate progress reflects two very large countries. Excluding China and India, average income in the rest of the Global South went from 18% to just 20% of the high-income level. For most developing economies outside Asia, the period since 2000 has been one of modest relative gains at best.

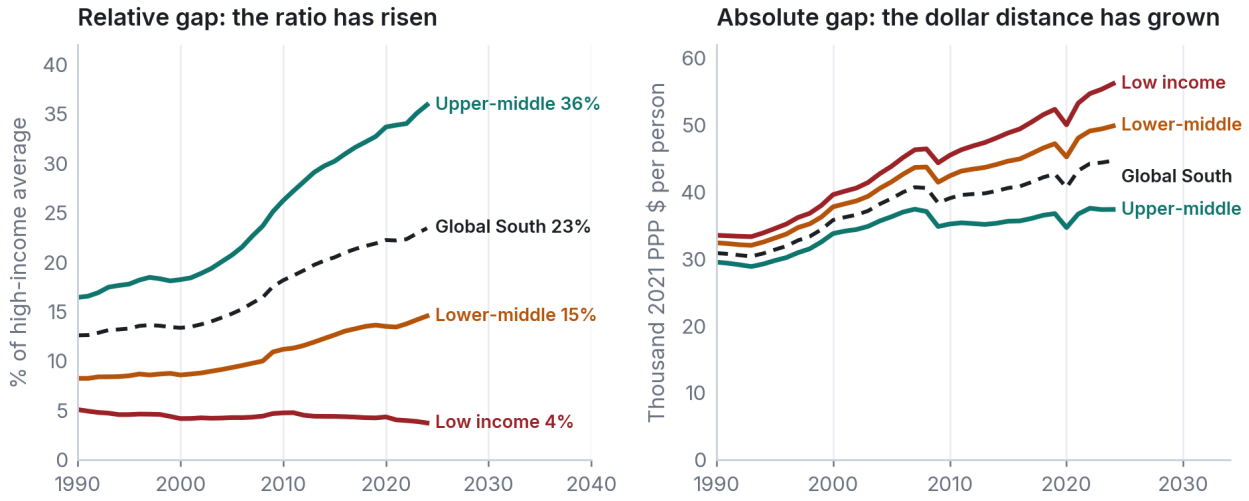
6.2 Relative convergence versus absolute development

The Sustainable Convergence Measurement Framework distinguishes two types of progress. **Relative convergence** asks whether the gap between developing and advanced economies is narrowing. **Absolute development** asks whether people's living conditions, environmental quality and resilience are actually improving. The distinction is essential, because the two can move in different directions.

A country can improve its living standards while falling further behind. Of 102 developing economies with data, 90 had higher income per person in 2024 than in 2000, so they made absolute progress. But 24 of these fell further behind in relative terms, and the absolute dollar gap with the high-income average widened for 99. For the Global South as a whole, the gap grew from about $35,820 to $44,695 per person, because a smaller percentage growth on a large base still adds more dollars than a larger percentage growth on a small one.

Figure 6 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

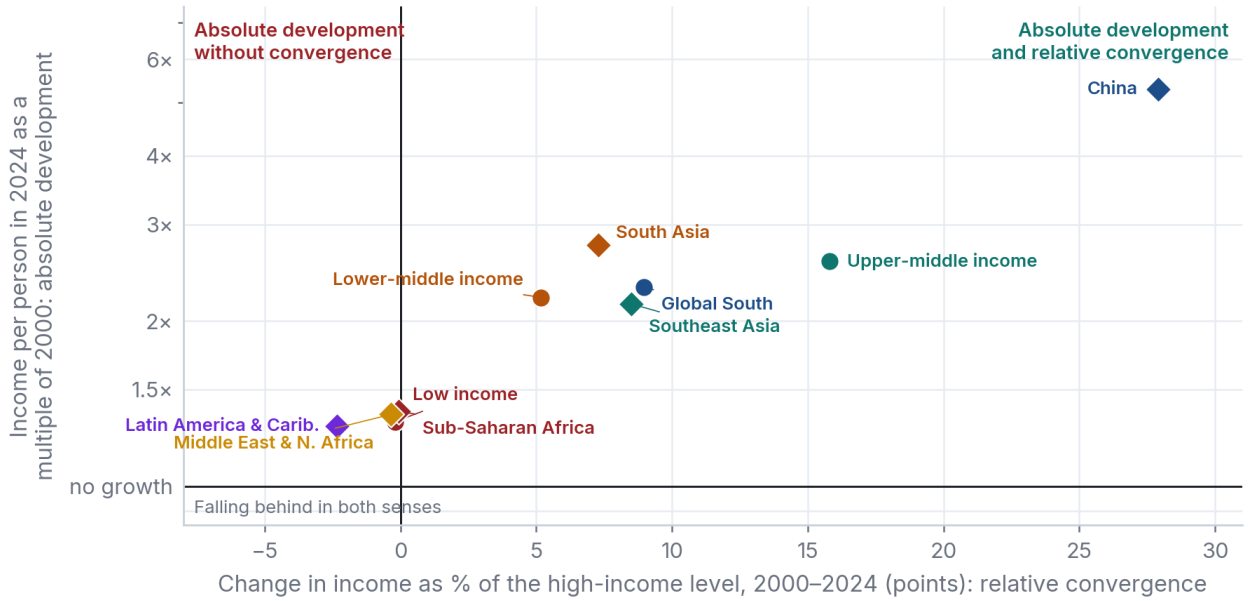


Source: H Heuristics calculations from World Development Indicators, GDP per person in 2021 PPP dollars (World Bank, 2026). Population-weighted group averages; current World Bank income groups.

Conversely, a relative improvement does not mean that absolute conditions are satisfactory. A country's air quality can improve relative to rich countries while remaining many times above safe levels. Figure 7 places income groups and regions on both axes. Latin America, the Middle East and North Africa, and Sub-Saharan Africa grew in absolute terms but did not converge; South and Southeast Asia and, above all, China did both.

Figure 7 Absolute development and relative convergence are different kinds of progress

Income per person in 2024 as a multiple of 2000 (vertical, log scale) against the change in income as a share of the high-income level (horizontal)



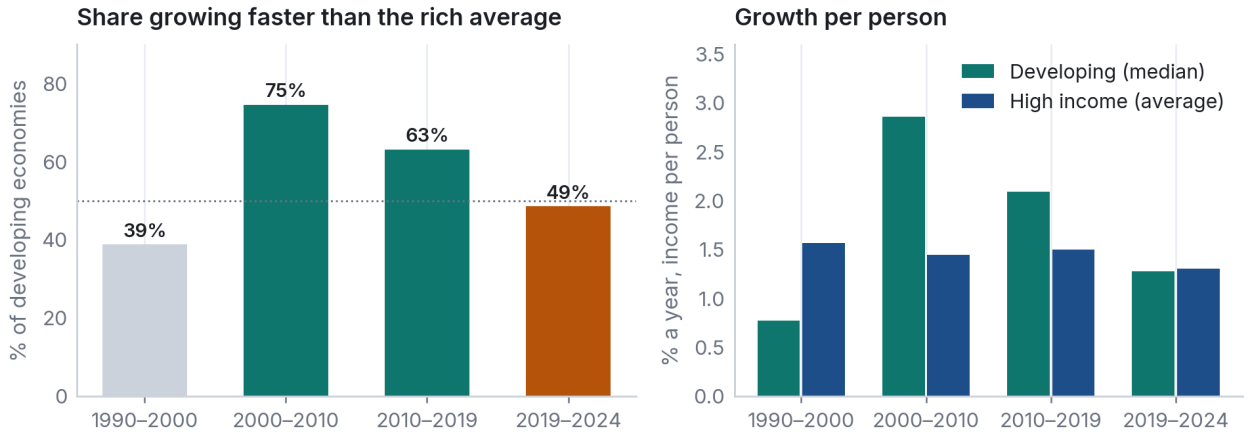
Source: H Heuristics calculations from World Development Indicators, GDP per person in 2021 PPP dollars (World Bank, 2026). Population-weighted averages; circles are World Bank income groups, diamonds are regions of the Global South.

6.3 The convergence boom has faded

Convergence has also slowed. In the 1990s only 39% of developing economies grew faster than the high-income average; in the 2000s 75% did, a historically unprecedented share. That fell to 63% in the 2010s and 49% in 2019–2024, as commodity prices fell, debt rose and the pandemic struck (Figure 8). The World Bank projects that potential growth in developing economies will be lower this decade than in the 2000s and 2010s (Kose and Ohnsorge, 2024).

Figure 8 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).

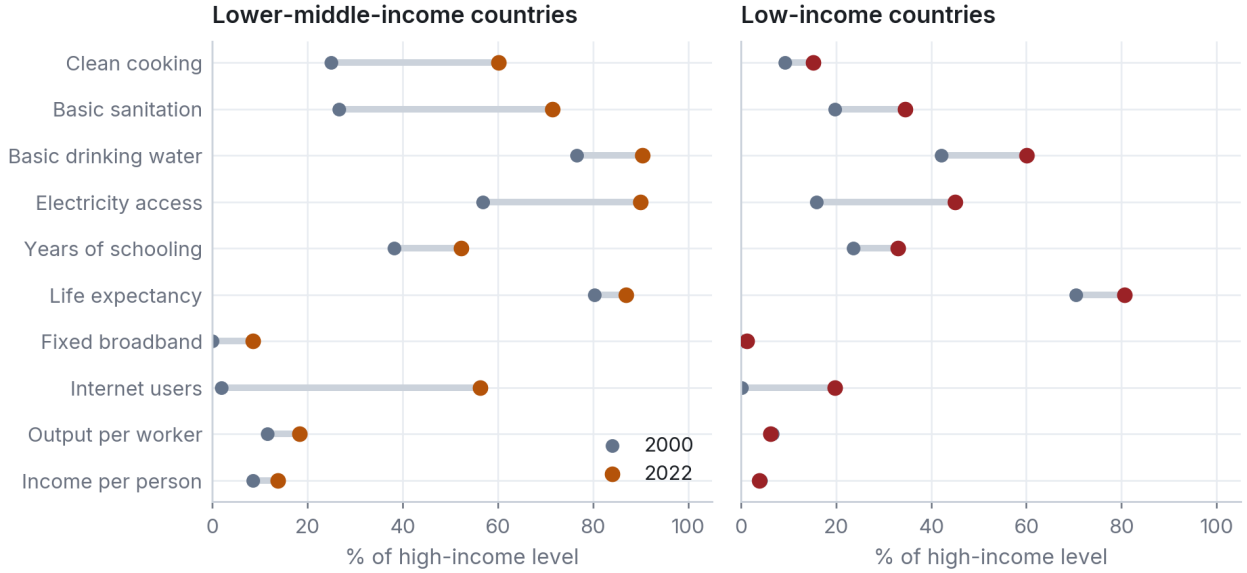
6.4 Access has converged faster than income

Beyond income, the record is more encouraging. Electricity access in the Global South reached 89% of the high-income level, internet use 66%, and life expectancy 90% (Figure 9). Between 2000 and the latest year the number of people without electricity fell from 1.3 billion to 0.69 billion, and those without basic sanitation from 2.7 to 1.5 billion (Figure 10).

This reflects two forces central to Sustainable Convergence: the falling cost of key technologies, and deliberate public effort to extend services. It shows that the capability dimensions can converge faster than income when technology and policy are aligned. But the remaining gaps are large and concentrated. 86% of people without electricity live in Sub-Saharan Africa, and 2.1 billion people still cook with polluting fuels.

Figure 9 Access to services and connectivity has converged far faster than income

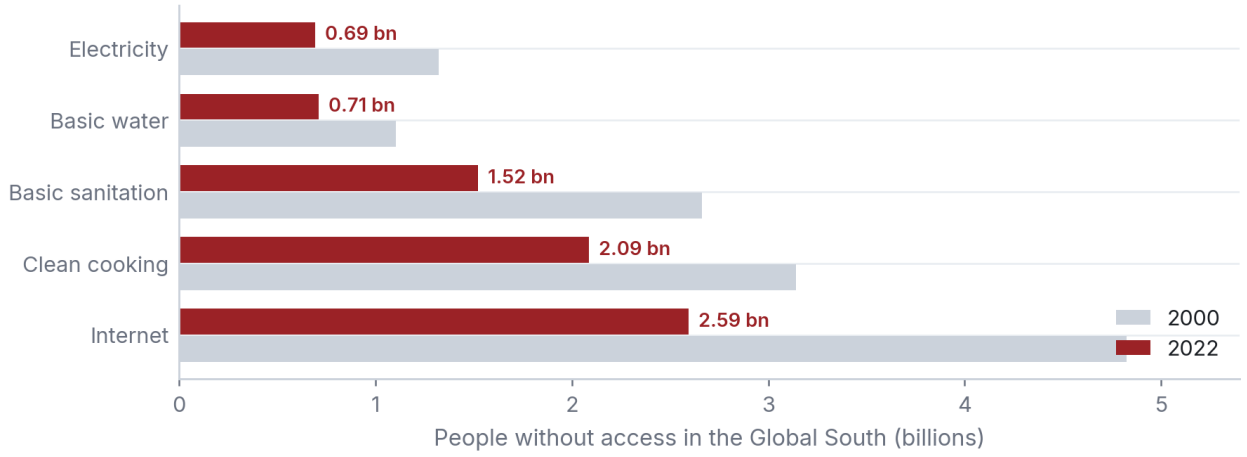
Indicator level as % of the high-income level, 2000 (grey) and 2022 (colour)



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

Figure 10 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).

SECTION 07

Two Development Pathways

Developing economies face a choice of route. One follows the historical pattern of growing first and cleaning up later. The other uses today's technologies to converge sustainably. The evidence shows that most catch-up so far has followed the first route, but that the second is increasingly possible.

IN BRIEF

- 78% of people in developing economies live in countries that converged between 2000 and 2022 while emissions per person grew at least half as fast as income.
- Latecomers emit less on the way up: a median 2.9 tonnes of CO_2 per person at $10,000 of income for those crossing after 2000, against 4.4 for those crossing before 1970.
- Decoupling has so far been a privilege of wealth: 34 of 45 growing high-income economies cut emissions in 2010–2022, against 12 of 91 developing ones.

7.1 Catch up first, clean up later

The traditional development trajectory, followed by Britain, the United States, Japan, South Korea and China, combined rapid growth with steeply rising pollution and emissions. Environmental controls came later, once incomes were higher and citizens demanded cleaner air and water. The environmental Kuznets curve hypothesis formalised this pattern, suggesting that some forms of pollution first rise and then fall as income grows (Grossman and Krueger, 1995).

The hypothesis holds for some local pollutants but not for carbon dioxide, and even where it holds the turning point is neither automatic nor painless (Stern, 2004; Dasgupta et al., 2002). Countries that followed this trajectory paid heavily in health: air pollution still causes millions of premature deaths a year, overwhelmingly in low- and middle-income countries (Fuller et al., 2022; Health Effects Institute, 2025). Figure 11 contrasts this route with a Sustainable Convergence trajectory, in which environmental pressure peaks lower and earlier because clean technologies are adopted during growth rather than after it.

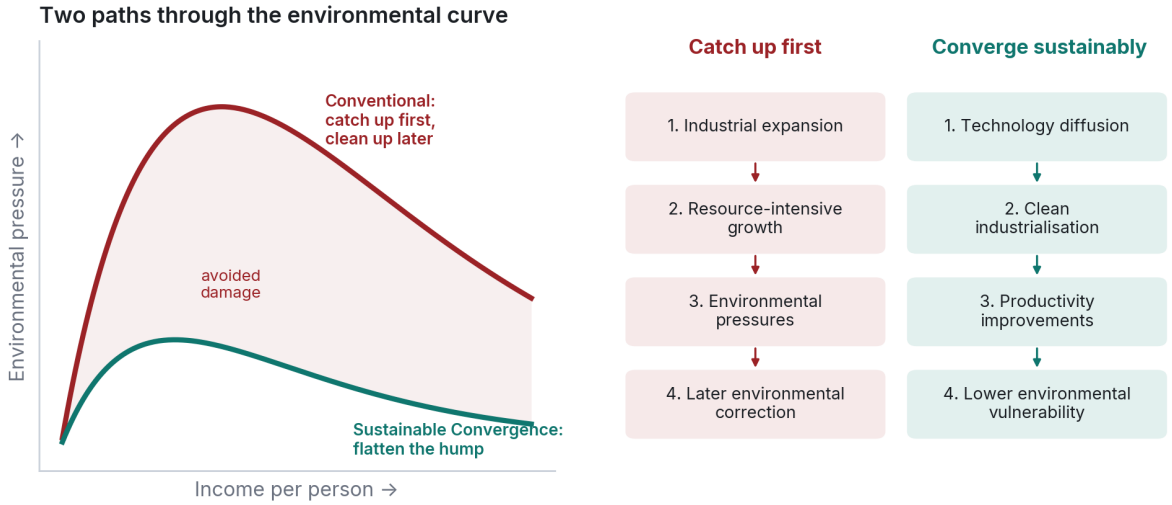
7.2 What the data show

Figure 12 tests the pattern across 150 countries. Air pollution (PM2.5 exposure) does tend to peak at middle incomes and fall in richer countries. CO_2 per person, by contrast, rises almost in proportion to income: a 1% higher income is associated with about 1.1% higher emissions per person, and income alone explains 83% of the variation across countries.

Classifying developing economies by how their income and emissions changed between 2000 and 2022 confirms that most convergence has been carbon-intensive (Table 7 and Figure 13). Countries home to 78% of the population of developing economies, including China, India, Indonesia and Bangladesh, converged on income while emissions per person grew at least half as fast as income. Only 17 economies, with 6% of the population, converged while emissions grew slowly or fell; the remaining 15% lived in countries that did not converge at all.

Figure 11 Two development trajectories: catch up first, or converge sustainably

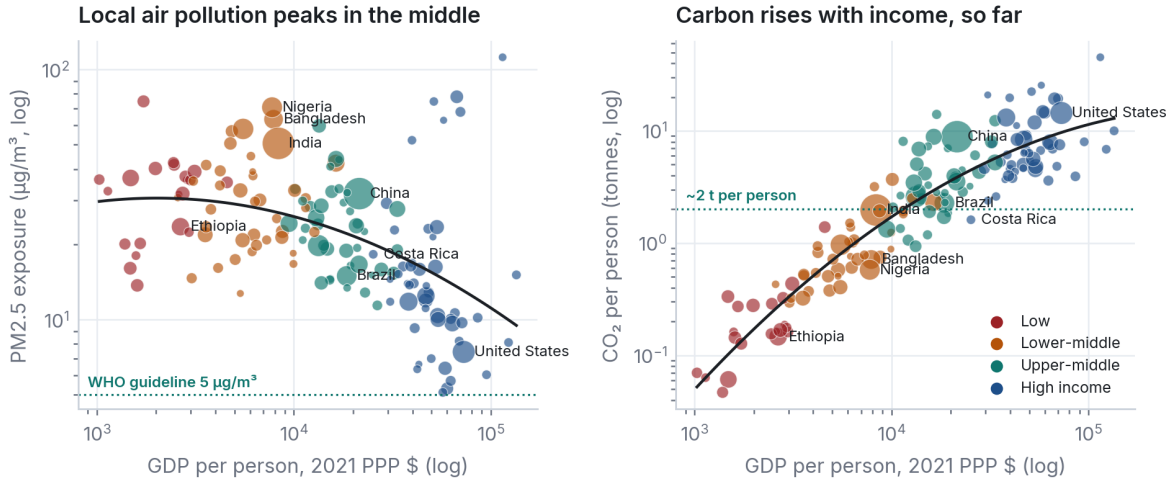
Stylised environmental pressure along the development path (left) and the sequence of each trajectory (right)



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

Figure 12 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.

7.3 The latecomer advantage

Yet there is strong evidence that later developers emit less on the way up. Among countries that first sustained an income of $10,000 per person, those that crossed the threshold before 1970 emitted a median 4.4 tonnes of CO_2 per person in that year; those that crossed after 2000 emitted 2.9 tonnes (Figure 14). At $5,000, the medians were 2.0 and 1.2 tonnes.

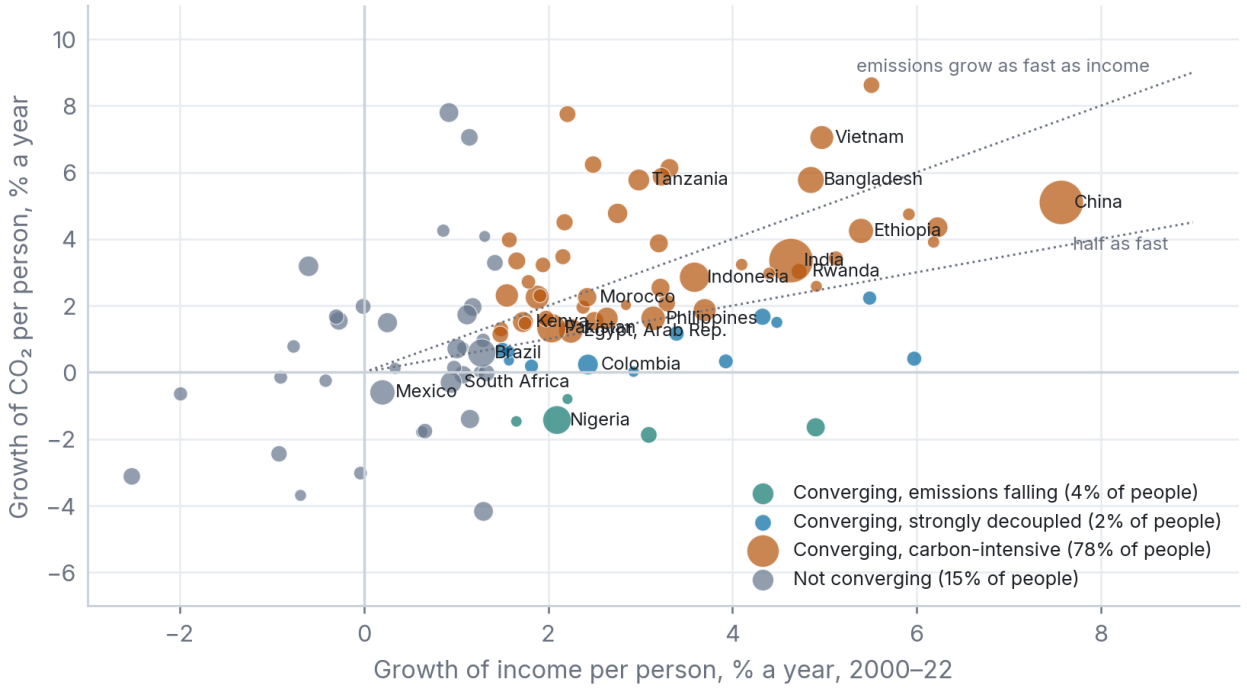
Table 7 Four convergence pathways, 2000–2022

Pathway	Economies	Share of population	Examples
Converging, emissions falling	5	4%	Nigeria, Uzbekistan, Somalia, Fed. Rep., Equatorial Guinea
Converging, strongly decoupled	12	2%	Colombia, Kazakhstan, Tunisia, Dominican Republic
Converging, carbon-intensive	48	78%	India, China, Indonesia, Pakistan
Not converging	35	15%	Brazil, Mexico, South Africa, Sudan

Source: H Heuristics calculations from World Development Indicators (World Bank, 2026). 100 developing economies with more than one million people. 'Converging' means income per person grew faster than the high-income average. 'Strongly decoupled' means CO_2 per person grew less than half as fast as income.

Figure 13 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



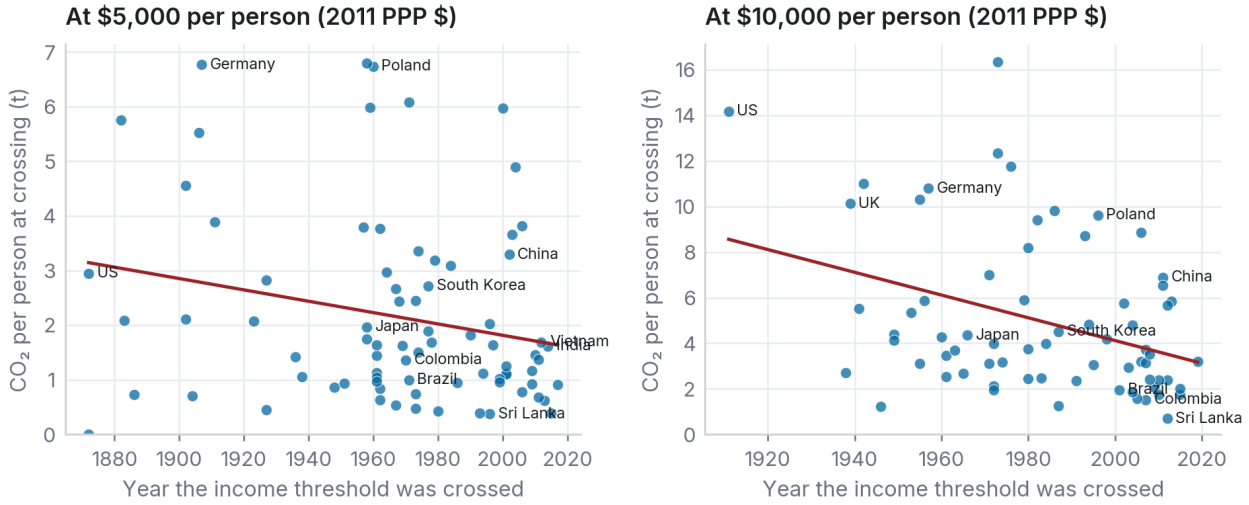
Source: H Heuristics calculations from World Development Indicators (World Bank, 2026). Bubble size reflects population. Dotted lines show emissions growing as fast as, and half as fast as, income.

7.4 Decoupling: so far a privilege of wealth

Decoupling growth from emissions is now common in rich economies. Between 2009–11 to 2020–22, 34 of 45 growing high-income economies reduced their territorial CO_2 emissions; among developing economies the figure was 12 of 91 (Figure 15). Some of the rich-world decline reflects the relocation of heavy industry to developing economies, but consumption-based data confirm that many rich economies have achieved absolute decoupling (Hubacek et al., 2021; Haberl et al., 2020).

Figure 14 Each generation of developers has emitted less on the way up

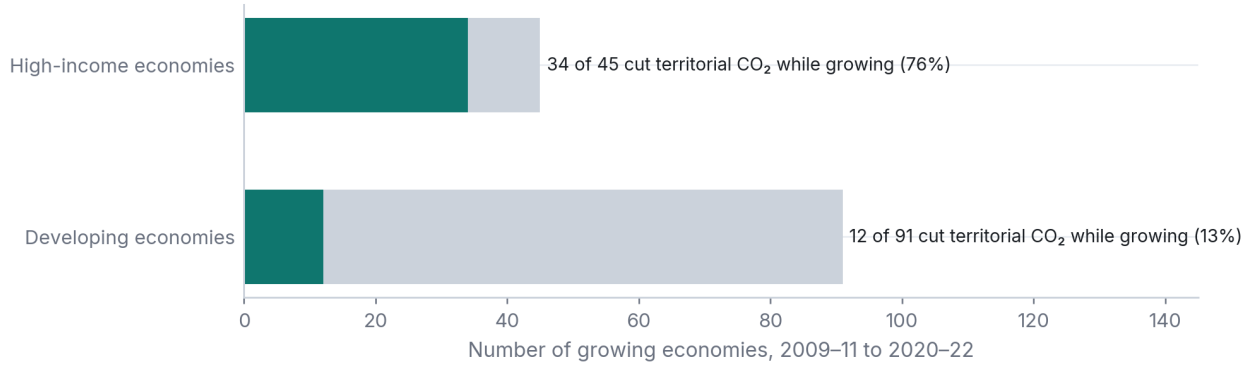
CO_2 emissions per person in the year a country first sustained an income above each threshold (2011 PPP dollars), by year of crossing



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).

Figure 15 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.

The challenge for Sustainable Convergence is to make decoupling available earlier in the development process, so that countries do not need to become rich before they can grow cleanly. This requires access to clean technology at low cost, and to the finance needed to build it. Directed technical change, in which policy steers innovation and investment toward clean technologies, can make the clean path self-reinforcing once it is established (Acemoglu et al., 2012).

SECTION 08

Technology Diffusion and Leapfrogging

Technology is what makes Sustainable Convergence possible. Cheap clean power, mobile and digital systems, and efficient industrial processes allow latecomers to reach high living standards without repeating the resource-intensive pathways of the past.

IN BRIEF

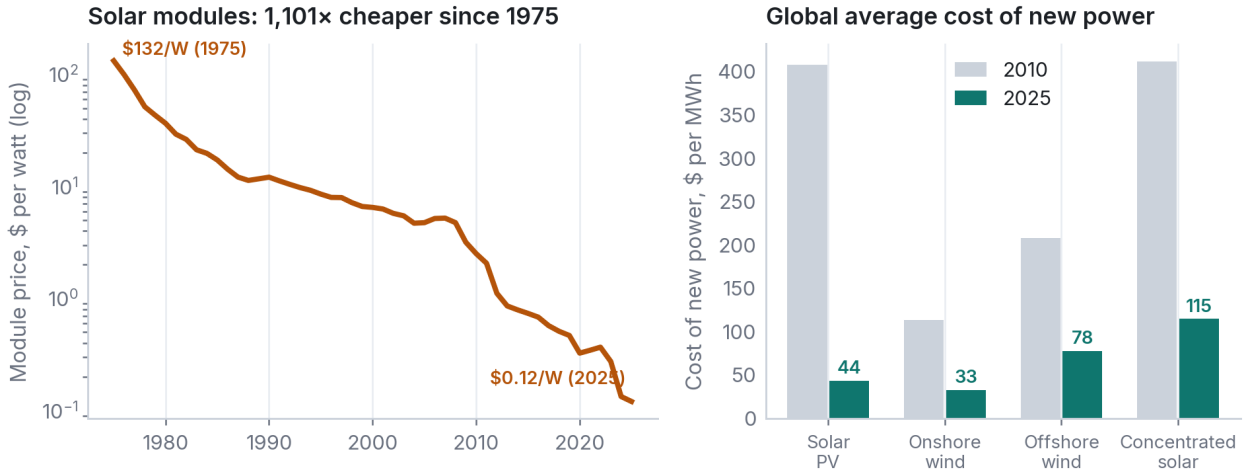
- Solar modules are about 1,101 times cheaper than in 1975; new solar and wind are now the cheapest power in most countries.
- Clean cooking and digital public infrastructure show how targeted technology diffusion can deliver gains across several dimensions at once.
- Leapfrogging has limits: technology does not replace grids, roads, institutions or skills, and the gains depend on intensive use.

8.1 The changing economics of clean energy

The cost of solar photovoltaic modules has fallen by about 1,101 times since 1975 and by about 21 times since 2010 (Figure 16). The global average cost of electricity from new utility-scale solar fell from about $408 per megawatt-hour in 2010 to about $44, and from new onshore wind to about $33 (Our World in Data, 2025c; IRENA, 2025). These are now the cheapest sources of new electricity in most of the world. Forecasts based on historical learning rates suggest that a rapid clean-energy transition is likely to save money overall compared with continued reliance on fossil fuels (Way et al., 2022).

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.

For developing economies the implications are profound. Countries that import oil, gas or coal can replace imports with domestic sunshine and wind, improving their trade balance and energy security. Distributed solar with batteries can bring power to rural areas years before the grid arrives: Bangladesh's solar home system programme reached around 20 million people (World Bank, 2021), and solar imports into Africa have surged (Ember, 2025). The barrier is no longer the cost of the technology but the cost of finance, which in many developing economies is two to three times higher than in rich ones (IEA, 2024a).

8.2 Clean cooking: the forgotten energy gap

Around 2.1 billion people in the Global South still cook with wood, charcoal, dung or kerosene. Household air pollution from these fuels is linked to millions of premature deaths a year, mostly of women and children (WHO, 2024). Collecting fuel takes hours every week, mostly women's time, and charcoal production drives forest loss. Clean cooking is a textbook case of an investment that advances several dimensions at once: health, gender equality, time for work and education, forests and climate (IEA, 2025).

Progress depends on making clean fuels and appliances affordable and reliable. India's LPG programme connected tens of millions of households, and electric pressure cookers powered by solar mini-grids are spreading in East Africa. Trial evidence shows that switching to LPG reduces exposure, although the health benefits depend on near-complete switching rather than partial use (HAPIN Investigators, 2024).

8.3 Digital public infrastructure

Digital public infrastructure (DPI) refers to shared digital systems, such as digital identity, instant payments and data exchange, that governments and businesses can build on (UNDP, 2023). India's Aadhaar identity system and Unified Payments Interface, which processes billions of transactions a month, and Brazil's Pix instant payment system show how DPI can bring hundreds of millions of people into the formal financial system within a few years (NPCI, 2025; Banco Central do Brasil, 2025). Open-source platforms such as MOSIP allow other countries to adopt similar systems at lower cost (MOSIP, 2025).

DPI advances the technological, institutional and human-development dimensions simultaneously. It lowers the cost of delivering social transfers, allows emergency payments to reach people within days of a disaster, and creates the foundations for digital markets. Mobile money in particular has been shown to help households share risk and absorb shocks (Jack and Suri, 2014; Suri and Jack, 2016), and the 2025 Global Findex shows mobile accounts driving rapid gains in saving and digital payments (World Bank, 2025).

8.4 Clean industrialisation

Industrialisation remains important for many developing economies because manufacturing tends to raise productivity, create jobs for less-skilled workers and generate exports (Rodrik, 2013). Sustainable Convergence calls for clean industrialisation: building industrial capacity powered by renewable electricity, using efficient processes and serving growing markets for clean-energy goods. Opportunities include processing critical minerals near where they are mined, producing green iron and fertiliser with cheap renewable power, and assembling solar, battery and electric-vehicle components for regional markets (IEA, 2025; IEA, 2022).

Table 8 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).

Transport offers a further example. Electric two- and three-wheelers and electric buses are spreading quickly in South and Southeast Asia and parts of Africa, because they are cheaper to run than petrol vehicles and cut both urban air pollution and fuel imports. For countries that import most of their oil, electrifying transport with domestic renewable power advances the economic, environmental and resilience dimensions at once.

8.5 Artificial intelligence: opportunity and risk

Artificial intelligence is the newest general-purpose technology, and it could either accelerate or reverse convergence. It could raise the productivity of farmers, nurses, teachers and small firms by putting expert knowledge in their hands, translate services into local languages, and improve weather forecasts and early warnings. But it could also concentrate gains in the countries and firms that own the computing power, data and skills, and automate the kinds of routine manufacturing and service jobs that have been a ladder for developing economies. Under Sustainable Convergence, AI adoption is part of the technological dimension, and the priority is to build the connectivity, data systems, skills and institutions that let developing economies use AI productively rather than merely consume it.

8.6 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). Technology diffusion is therefore a powerful accelerator of convergence, not a substitute for the other four dimensions. This is precisely why Sustainable Convergence insists on a multidimensional approach.

CASE

Kenya: leapfrogging in practice, and its limits

Kenya illustrates both the power and the limits of technology-enabled convergence. It generates around 90% of its electricity from renewable sources, led by geothermal power from the Rift Valley, together with hydropower, wind and solar. Electricity access rose from under a fifth of the population in 2010 to around three-quarters by 2022, helped by grid expansion and pay-as-you-go solar sold through mobile money (World Bank, 2026; IEA et al., 2026).

M-Pesa, launched in 2007, made Kenya a world leader in mobile money, with measurable effects on poverty and risk-sharing (Suri and Jack, 2016; Jack and Suri, 2014).

Yet Kenya's SCMF technology score is only 18, because fixed broadband and intensive digital use by firms remain limited, and its economic score is 50. With a strong environmental-and-resilience score (68), Kenya is a clear example of the 'environment-preserving, capability-lagging' profile described in Section 11: it has the clean base, and now needs the capabilities.

SECTION 09

Sustainable Convergence and Polycrisis Resilience

Sustainable Convergence is a development pathway; Polycrisis Resilience is a strategic resilience objective. Each strengthens the other, and together they describe how the Global South can become both more prosperous and less vulnerable.

IN BRIEF

- Sustainable Convergence narrows multidimensional development gaps; Polycrisis Resilience reduces human and systemic vulnerability to interconnected risks.
- The relationship is reciprocal: convergence builds the capabilities needed to withstand crises, and resilience protects development gains from reversal.
- Sustainable Convergence applies to countries not facing acute crises as well as to those with very high exposure.

9.1 Two concepts, one research architecture

Polycrisis Resilience, also developed by Hunter Hughes, is defined as 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 (Hughes, 2026b; Hughes, 2026c). It responds to a world in which climate extremes, pandemics, conflict, debt and food and energy shocks increasingly arrive together and amplify one another (Lawrence et al., 2024; Lawrence et al., 2022).

Sustainable Convergence sits within this broader research architecture. Table 9 sets out the complementary relationship. Sustainable Convergence is about the *pathway*: how development gaps close. Polycrisis Resilience is about the *objective*: lower vulnerability to interconnected crises. The first is the main way to achieve the second over the long run, and the second is a condition for the first to last.

9.2 A reciprocal relationship

The relationship runs in both directions (Figure 17). **Sustainable Convergence strengthens resilience** by building the productive, technological, institutional and human capabilities needed to withstand interconnected crises. Richer countries suffer far fewer deaths from natural hazards of similar size, mainly because of better housing, infrastructure, health systems and institutions (Kahn, 2005; Toya and Skidmore, 2007). Global vulnerability to climate-related hazards has fallen as incomes have risen, with deaths and losses per person exposed declining sharply since the 1980s (Formetta and Feyen, 2019; Jongman et al., 2015). Education, in particular, is one of the strongest predictors of a population's ability to adapt (Lutz et al., 2014).

Polycrisis Resilience protects convergence by preventing development gains from being reversed by climate shocks, pollution, conflict, poverty and other systemic disruptions. Output

Table 9 Sustainable Convergence and Polycrisis Resilience: complementary concepts

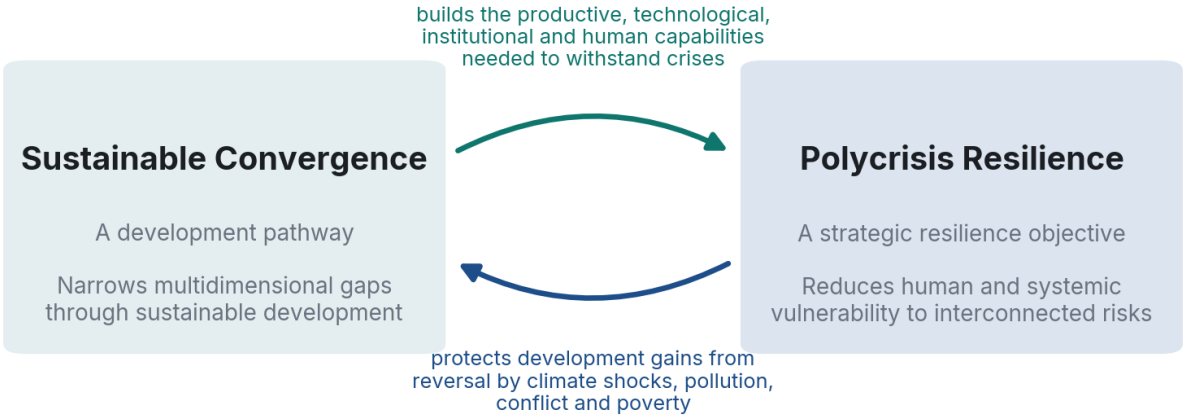
	Sustainable Convergence	Polycrisis Resilience
Primary objective	Narrow multidimensional development gaps through sustainable development	Reduce human and systemic vulnerability to interconnected global risks
Type of concept	A development pathway	A strategic resilience objective
Time horizon	Decades: the long arc of catch-up	From immediate response to long-term risk reduction
Core question	Are the gaps closing, on a sustainable route?	Can people and systems anticipate, withstand and recover from interacting crises?
Main measures	SCMF: five dimensions, relative and absolute	Exposure, vulnerability, coping capacity, recovery
Where it applies	All developing economies, including those not facing acute crises	Everywhere, with priority to the most exposed

Source: H Heuristics, based on Hughes (2026a; 2026b) (Hughes, 2026a; Hughes, 2026b).

losses after banking crises, wars and severe disasters are often permanent rather than temporary (Cerra and Saxena, 2008); large cyclones reduce national income for more than a decade (Hsiang and Jina, 2014). Each shock that is prevented or softened is a step of convergence that does not have to be repeated. Together, the two concepts support development pathways that raise prosperity while reducing vulnerability.

Figure 17 Sustainable Convergence and Polycrisis Resilience reinforce each other

The reciprocal relationship between the development pathway and the resilience objective



Together: development pathways that raise prosperity while reducing vulnerability

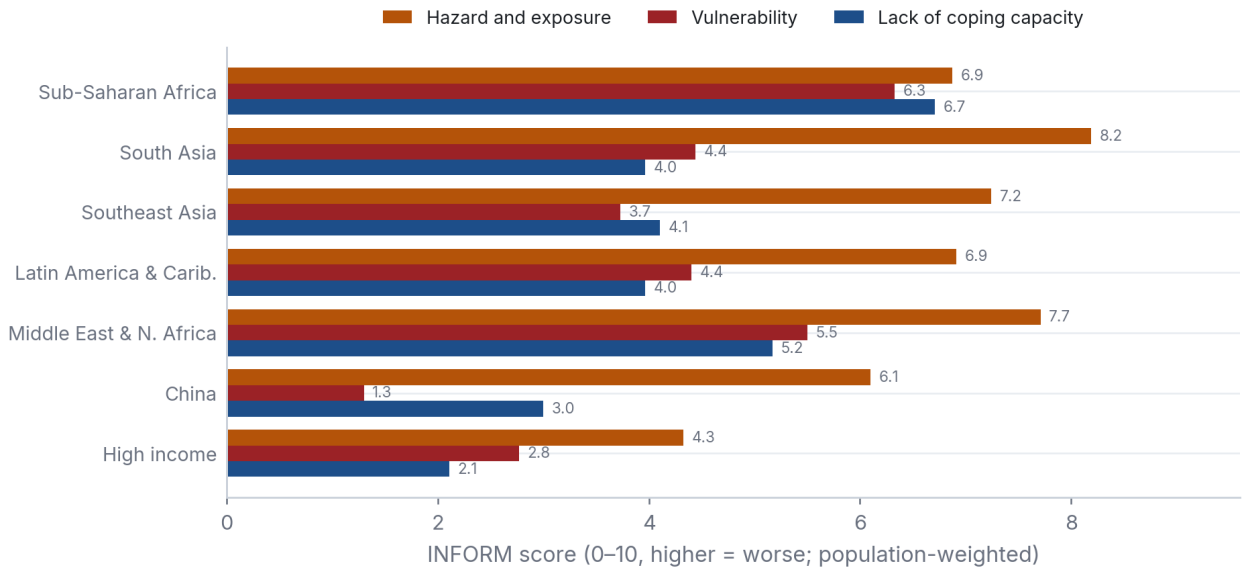
Source: H Heuristics, based on Hughes (2026a; 2026b) (Hughes, 2026a; Hughes, 2026b). Conceptual diagram.

9.3 Exposure follows the development gap

The INFORM Risk Index, published by the European Commission and UN agencies, scores every country on hazard and exposure, vulnerability, and lack of coping capacity (European Commission JRC, 2026). Figure 18 shows how these differ across the Global South. Hazard exposure is high almost everywhere in the tropics, but vulnerability and lack of coping capacity are where the development gap shows most clearly: Sub-Saharan Africa scores 6.3 and 6.7 out of 10, against 2.8 and 2.1 in high-income countries. South Asia combines the highest hazard exposure (8.2) with substantial vulnerability.

Figure 18 Vulnerability and weak coping capacity mirror the development gap

INFORM dimension scores by region of the Global South and for high-income countries (0–10, higher means more risk)



Source: H Heuristics calculations from the INFORM Risk Index 2026 (European Commission JRC, 2026). Population-weighted averages; 'High income' covers all high-income economies.

This pattern is the empirical basis for treating convergence as a resilience strategy. Hazards such as cyclones and heatwaves cannot be prevented, and climate change is making many of them more frequent and severe. But vulnerability and coping capacity are largely products of development: of incomes, housing, health systems, infrastructure, institutions and finance. Narrowing those gaps is the most durable way to reduce risk.

9.4 The resilience dividend of convergence

Bangladesh offers one of the clearest illustrations of how development reduces exposure. A cyclone in 1970 killed several hundred thousand people and the 1991 cyclone around 138,000; Cyclone Sidr in 2007, of comparable strength, killed around 3,400. The difference came from cyclone shelters, early warning, volunteer networks, embankments, better communications and higher incomes and literacy, all products of development (Haque et al., 2012). Similar declines in mortality per person exposed have been documented for floods and storms worldwide as countries have grown richer (Formetta and Feyen, 2019; Jongman et al., 2015).

The lesson for Sustainable Convergence is that resilience is not a separate agenda to be pursued after development, but one of its most valuable products. Every dimension contributes:

- **Economic:** savings, insurance and diversified livelihoods let households absorb losses without selling productive assets.
- **Technological:** forecasts, early warnings and mobile payments speed up both preparation and relief.
- **Human development:** health, education and safe housing reduce deaths and speed recovery.
- **Institutional:** capable governments plan land use, enforce building codes and deliver help quickly.
- **Environmental:** mangroves, forests and clean air reduce hazards and the background burden of disease.

9.5 Not only for countries in crisis

The distinction between the two concepts also creates a useful research boundary. Sustainable Convergence can be applied to countries that are not experiencing acute polycrisis conditions, such as a stable upper-middle-income economy deciding how to decarbonise its industry, while remaining highly relevant to those facing particularly high exposure, such as a low-income Sahel country confronting drought, conflict and food insecurity at once. For the first group, Sustainable Convergence is mainly a question of choosing the right development route. For the second, it is a question of building the capabilities that make any route possible while protecting people from the next shock.

H HEURISTICS FRAMEWORK

Sustainable Convergence as a proactive pathway toward Polycrisis Resilience

Within the H Heuristics framework, Sustainable Convergence functions as a proactive pathway toward Polycrisis Resilience: accelerating development in vulnerable regions while progressively reducing the environmental, infrastructural, technological and socioeconomic conditions that place populations at risk.

Rather than waiting for crises and responding to them, it seeks to change the underlying conditions (poverty, exposure, weak infrastructure, polluted environments and limited institutional capacity) that turn hazards into disasters and disasters into lasting setbacks.

SECTION 10

Reducing Human Exposure to Polycrisis

Sustainable Convergence can serve as a proactive development strategy for reducing human exposure to interconnected environmental, economic and systemic risks. The aim is to make convergence a mechanism for reducing exposure to polycrisis, not simply for increasing national income.

IN BRIEF

- Billions of people in the Global South face everyday exposure to polluted air, extreme heat, unreliable power and water, and weak health systems.
- Seven applications show how convergence can reduce this exposure: air pollution, cooling, climate-resilient infrastructure, clean energy, health, technology diffusion and economic and institutional strengthening.
- Development should be judged not only by GDP growth but by reductions in everyday exposure to harmful conditions.

10.1 From national income to everyday exposure

Sustainable Convergence emphasises the development of interconnected capabilities that improve living conditions and reduce exposure to multiple risks at once, rather than addressing individual crises in isolation. By accelerating economic development while prioritising environmental sustainability, technology diffusion and human development, it can help emerging economies reduce the vulnerabilities that expose their populations to the compounding effects of climate change, air pollution, extreme heat, inadequate infrastructure, poverty and other polycrisis conditions.

The scale of everyday exposure is large. 42% of people in the Global South breathe air with average PM2.5 above 35 μg/m^3, seven times the WHO guideline, and virtually all live above the guideline itself (World Bank, 2026; WHO, 2021). 2.1 billion people cook with polluting fuels, 0.69 billion lack electricity, 0.71 billion lack basic drinking water and 1.5 billion lack basic sanitation (Figure 10 in Section 6). These conditions are harmful in normal times and become deadly when a heatwave, flood, epidemic or price shock arrives.

10.2 Seven applications

Seven applications illustrate how Sustainable Convergence reduces human exposure to polycrisis. Figure 19 maps each to the five dimensions.

1. Air pollution reduction

Accelerating clean cooking adoption, industrial emissions controls, renewable energy deployment and cleaner transport to reduce population exposure to harmful pollutants. Pollution is the largest environmental cause of disease and premature death in the world, responsible for around nine million deaths a year, and more than 90% of these occur in low- and middle-income countries (Fuller et al., 2022). In South Asia average PM2.5 exposure is about 52 $\mu g/m^3$, ten times the WHO guideline. Clean power and clean cooking reduce both local pollution and CO_2, a direct complementarity between human development and environmental convergence.

2. Cooling accessibility

Expanding affordable air conditioning, passive cooling architecture, urban green spaces, heat-resistant housing and reliable electricity access to reduce exposure to extreme temperatures. Heatrelated deaths among older people have risen sharply over the past two decades, and the number of dangerously hot days is increasing fastest in tropical, low-income regions (Romanello et al., 2024). Only a small share of households in the hottest developing countries own air conditioning, and demand for cooling is projected to be one of the largest drivers of global electricity growth (IEA, 2018). Efficient cooling powered by clean electricity is therefore both a health and a climate priority.

3. Climate-resilient infrastructure

Strengthening water systems, sanitation, electricity networks, healthcare facilities, transport and housing against climate-related disruptions. Infrastructure failures cost households and firms in developing economies hundreds of billions of dollars a year, and investing in more resilient infrastructure yields a net benefit of about $4 for every $1 spent (Hallegatte et al., 2019). Because so much infrastructure in the Global South has yet to be built, the cheapest moment to make it resilient is now.

4. Clean energy convergence

Accelerating access to affordable, reliable, low-emission electricity to reduce dependence on polluting fuels and support healthier living environments. Clean energy convergence connects the access agenda (0.69 billion people still without power) with the mitigation agenda, and with energy security: countries that generate power from domestic sun and wind are less exposed to fossil-fuel price shocks such as those of 2022 (IEA et al., 2026; World Bank, 2024).

5. Healthcare and human development

Expanding healthcare access, disease surveillance, education and essential services to reduce population vulnerability to environmental and socioeconomic shocks. Countries with stronger health systems and higher trust in government fared better in the COVID-19 pandemic (COVID-19 National Preparedness Collaborators, 2022); better-educated populations suffer fewer deaths from natural disasters (Lutz et al., 2014). Human development is resilience in its most basic form.

6. Technology diffusion

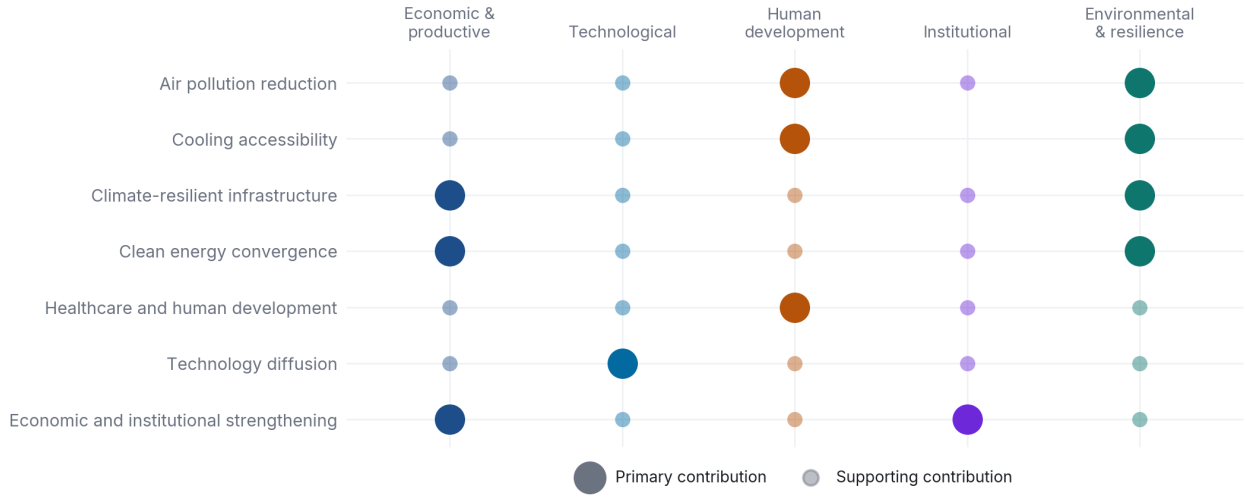
Accelerating the adoption of affordable technologies, including air-quality monitoring, early-warning systems, climate adaptation tools, digital public infrastructure and efficient agricultural systems. Early warning systems are among the most cost-effective adaptation measures: a 24-hour warning of a coming storm or heatwave can cut the resulting damage by around 30% (Global Commission on Adaptation, 2019). Yet only about half of countries report adequate multi-hazard early warning coverage, a gap the UN's Early Warnings for All initiative aims to close (UNDRR and WMO, 2023; WMO, 2025).

7. Economic and institutional strengthening

Improving household economic security, public-sector capacity and infrastructure investment so that populations and governments can better anticipate and withstand interconnected crises. Adaptive social protection systems that scale up automatically after a shock, and pre-arranged disaster finance such as sovereign risk pools, allow help to arrive faster and at lower cost than emergency appeals (Bowen et al., 2020; Clarke and Dercon, 2016; African Risk Capacity, 2025; CCRIF SPC, 2025).

Figure 19 Each application of Sustainable Convergence works across several dimensions

Seven applications for reducing human exposure to polycrisis, mapped to the five dimensions



Source: H Heuristics assessment, based on Hughes (2026a) and the evidence cited in this section (Hughes, 2026a). Large dots mark the dimension each application mainly advances; small dots mark supporting contributions.

10.3 Judging development by reductions in exposure

The broader objective is to make economic convergence a mechanism for reducing human exposure to polycrisis, rather than simply a means of increasing national income. This means evaluating development not only through GDP growth and productivity, but also through improvements in environmental quality, access to essential services, protection from extreme heat, and reductions in everyday exposure to harmful conditions. The measurement framework in the next section is designed with this purpose: its fifth dimension combines environmental quality with resilience, and its human-development dimension includes access to essential services.

SECTION 11

The Sustainable Convergence Measurement Framework

For academic credibility and practical use, Sustainable Convergence needs measurable indicators. The Sustainable Convergence Measurement Framework (SCMF) tracks progress across the five dimensions separately, for 151 economies, in both relative and absolute terms.

IN BRIEF

- The SCMF measures five dimensions separately rather than collapsing them into a single composite score.
- Technology is the weakest dimension for 72 of 103 developing economies; only 18 score 60 or more on all five dimensions.
- Just 37 developing economies, home to 2.9 billion people, are above the median on both capabilities and environment-and-resilience.

11.1 Why a dashboard, not a single score

Rather than immediately creating one composite score, the SCMF measures progress across the five dimensions separately. A single index is easy to communicate but hides the trade-offs that matter most. A country that raises its income rapidly while its environmental quality deteriorates could end up with the same composite score as one that improves slowly but evenly. Methodological guidance on composite indicators warns that aggregation choices (weights, and whether weaknesses in one area can be offset by strengths in another) can drive the results (OECD and JRC, 2008). The earlier H Heuristics Sustainable Convergence Index combined dimensions using a geometric mean to limit such offsetting (Hughes, 2026f); the SCMF goes a step further and keeps them apart.

Keeping the dimensions separate has three advantages. It shows which dimension is holding a country back. It allows the relationships between dimensions to be studied, which is necessary to test the propositions in Section 12. And it reflects the central claim of the concept: convergence is multidimensional, and no single dimension, income included, defines it on its own.

11.2 Indicators

Table 10 lists the indicators used for each dimension. All come from public sources and are available for most countries. Each indicator is scored from 0 to 100, where 100 equals the median high-income economy (for capability indicators) or a health-based threshold such as the WHO airquality guideline (for environmental indicators). Dimension scores are simple averages of their indicators.

Table 10 SCMF dimensions and indicators

Dimension	Suggested indicators (framework)	Indicators scored in this report
Economic	GDP per capita, labour productivity, TFP, employment, industrial value added	GDP per person (PPP); output per worker (PPP)
Technological	Internet access, digital adoption, R&D, AI adoption, technology exports	Internet users; fixed broadband subscriptions
Human development	HDI, life expectancy, education, poverty, access to essential services	Life expectancy; under-five mortality; mean years of schooling; electricity, water, sanitation and clean-cooking access
Institutional	Government effectiveness, regulatory quality, institutional capacity	WGI government effectiveness; WGI regulatory quality
Environmental and resilience	CO_2 intensity, PM2.5 exposure, renewable energy, climate vulnerability, disaster preparedness	PM2.5 exposure; CO_2 per person and per unit of GDP; renewable electricity; INFORM vulnerability and lack of coping capacity

Source: H Heuristics. Data from World Development Indicators, Worldwide Governance Indicators, UNDP and INFORM (World Bank, 2026; World Bank, 2025a; UNDP, 2025; European Commission JRC, 2026). Latest available year, mostly 2022–2024. TFP, R&D, AI adoption and technology exports are priorities for a future edition.

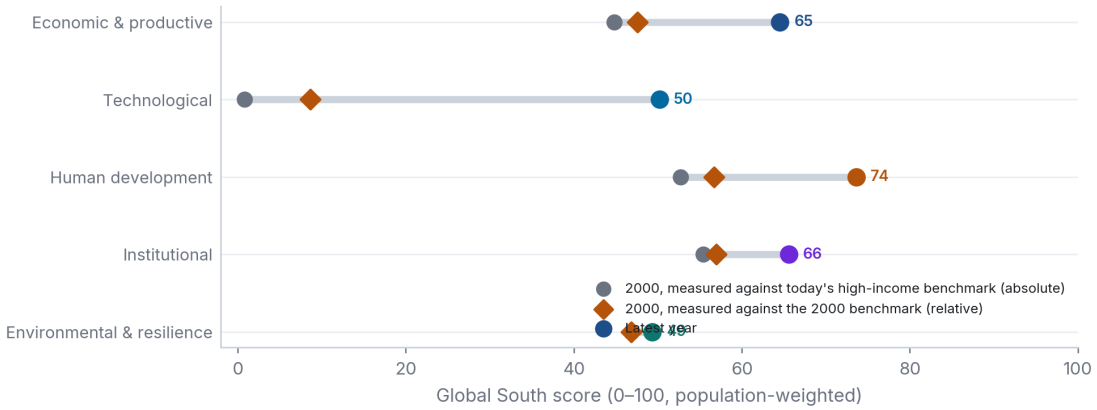
11.3 Relative convergence and absolute development

The SCMF compares developing economies against advanced-economy benchmarks while also tracking absolute improvement. It does this by scoring each country twice for a past year: once against the high-income benchmark *of that year* (relative position) and once against *today's* benchmark (absolute level). The difference reveals whether a country has improved because it moved, or only appeared to fall behind because the benchmark moved.

Figure 20 applies this to the Global South. On the technological dimension, its score in 2000 was 1 against today's benchmark and 9 against the 2000 benchmark; it is now 50: huge absolute progress and substantial relative convergence. Human development rose from 53 to 74. The environmental indicators barely moved, from 47 to 49: capabilities converged while environmental quality stood still.

Figure 20 Capabilities improved fast; environmental quality barely moved

Global South score on each SCMF dimension: 2000 measured against today's benchmark, 2000 against the 2000 benchmark, and latest year



Source: H Heuristics calculations; see Table 10 for data sources. Population-weighted Global South averages. Resilience indicators are not available for 2000, so the change in the fifth dimension uses the environmental indicators only.

11.4 Three measurement principles

1. **Multidimensional convergence.** Progress must be assessed across all five dimensions, not GDP alone.
2. **Environmental compatibility.** Economic growth should not depend on indefinitely increasing environmental degradation.
3. **Resilience-adjusted development.** Development gains should be evaluated in terms of their durability under economic, environmental and geopolitical shocks.

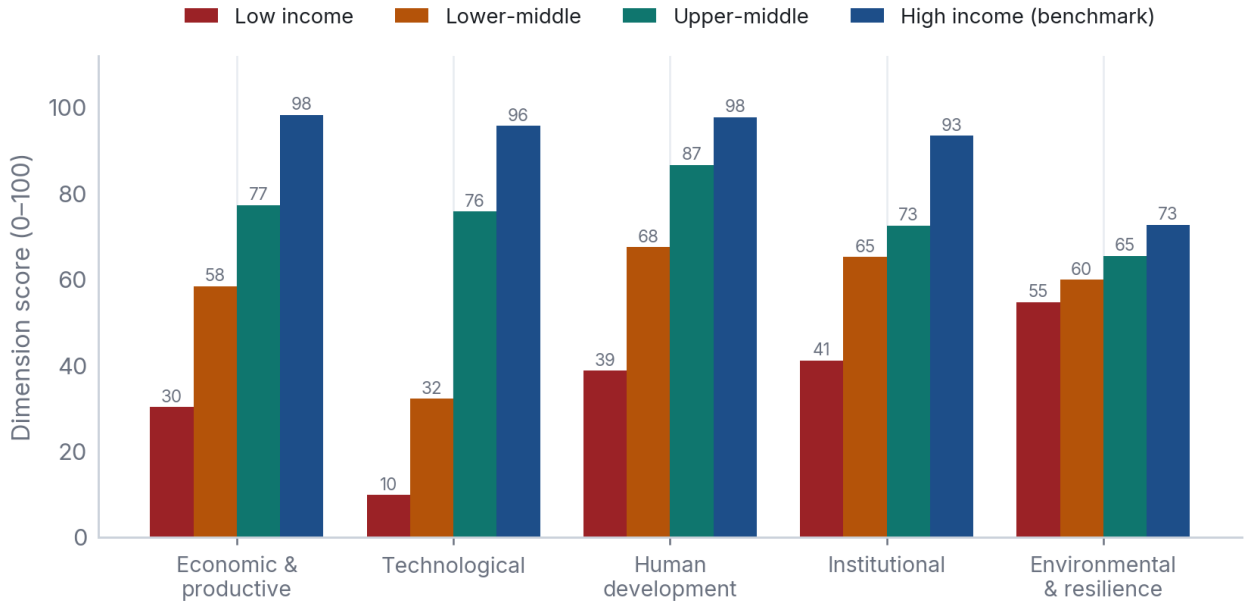
The first principle is applied through the five-dimension dashboard. The second is applied by scoring environmental indicators against health and climate thresholds rather than against rich-country levels, so that converging toward high-income emissions does not count as progress. The third is applied by including INFORM vulnerability and coping capacity in the fifth dimension; a fuller version would track how much each country's indicators fall after shocks and how quickly they recover.

11.5 Results by income group and region

Figure 21 shows the five dimension scores by income group. High-income economies score above 90 on the four capability dimensions but only 73 on environment and resilience, because their emissions remain high. Low-income countries score 30 on the economic dimension and just 10 on technology, but 55 on environment and resilience, reflecting low emissions offset by high vulnerability. Within the fifth dimension the two halves pull in opposite directions: the environmental score falls from 71 in low-income to 51 in lower-middle-income and 43 in upper-middle-income countries, while resilience rises from 38 to 69 and 88. Traditional convergence buys resilience at the cost of the environment; Sustainable Convergence seeks both.

Figure 21 Every group lags on environment and resilience; the poorest lag on everything else

SCMF dimension scores by income group, latest year (0–100; 100 = high-income median or health-based threshold)

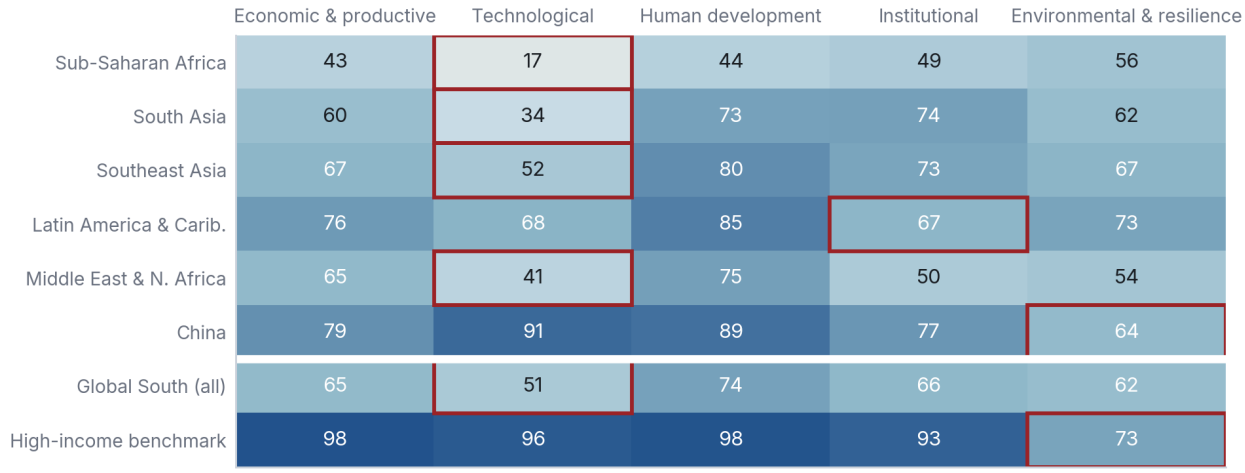


Source: H Heuristics calculations; see Table 10 for data sources. Population-weighted averages by current World Bank income group.

Across regions (Figure 22), the weakest dimension (outlined) is technology for Sub-Saharan Africa (17), South Asia (34) and the Middle East and North Africa (41). China scores 91 on technology, close to the high-income level, but its environmental-and-resilience score (64) is its weakest. Latin America has relatively strong human development (85) and the best environmental-and-resilience score of any region (73), helped by hydropower, but its economic convergence has stalled.

Figure 22 Each region has a distinct profile, and a distinct weakest dimension

SCMF dimension scores by region of the Global South and high-income benchmark, latest year (0–100)



Source: H Heuristics calculations; see Table 10 for data sources. Population-weighted averages; China shown separately from East Asia. The outlined cell is each region's weakest dimension.

11.6 Country profiles

Figure 23 shows SCMF profiles for twenty developing economies. The spread between a country's strongest and weakest dimension is often larger than the differences between countries. Rwanda scores well on institutions relative to its income but poorly on technology; South Africa has relatively strong capabilities but a weak environmental-and-resilience score; Costa Rica and Uruguay show unusually balanced profiles. Such profiles help each country identify the dimension where additional effort would do most for balanced convergence.

11.7 The weakest dimension

Across all 103 developing economies, technology is the weakest dimension for 72, institutions for 16, and environment and resilience for 14 (Figure 24). Measured by population, technology is the binding constraint for 4.0 billion people and environment and resilience for 1.8 billion, a group that includes China and India. The median spread between strongest and weakest dimension is 36 points. Only 18 developing economies score 60 or more on every dimension, among them Türkiye, Kazakhstan, Malaysia, Argentina, Mauritius, Serbia.

Figure 23 Country profiles reveal the dimension holding each economy back

SCMF dimension scores for selected developing economies, latest year (0–100)

	Economic & productive	Technological	Human development	Institutional	Environmental & resilience	
China (UMC)	79	91	89	77	64	spread 27
India (LMC)	61	34	74	77	62	spread 44
Indonesia (UMC)	69	43	80	81	70	spread 38
Vietnam (UMC)	66	74	84	66	69	spread 19
Bangladesh (LMC)	58	33	68	53	57	spread 35
Pakistan (LMC)	53	23	61	53	53	spread 39
Philippines (UMC)	62	52	77	73	67	spread 25
Brazil (UMC)	77	74	86	67	79	spread 19
Mexico (UMC)	81	73	86	70	68	spread 18
Costa Rica (HIC)	85	77	91	85	85	spread 14
Uruguay (HIC)	89	98	93	96	88	spread 10
South Africa (UMC)	77	47	77	73	51	spread 30
Nigeria (LMC)	57	21	45	44	48	spread 35
Kenya (LMC)	50	18	55	63	68	spread 50
Ethiopia (LIC)	33	10	35	51	64	spread 53
Rwanda (LIC)	39	16	50	78	68	spread 62
Ghana (LMC)	56	39	57	70	66	spread 31
Egypt (LMC)	80	55	85	61	63	spread 31
Morocco (LMC)	65	58	81	71	67	spread 22
Mauritius (UMC)	85	79	88	98	79	spread 19

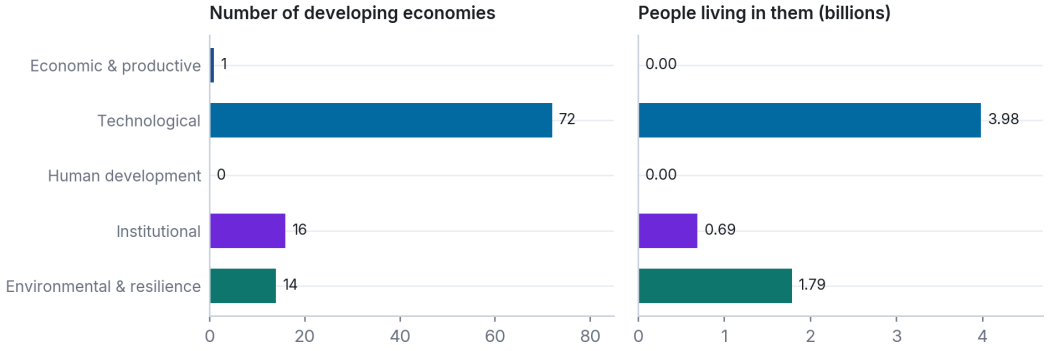
Source: H Heuristics calculations; see Table 10 for data sources. The outlined cell is each country's weakest dimension; 'spread' is the gap between strongest and weakest.

11.8 Four convergence profiles

Combining the four capability dimensions into one axis and plotting them against the environmental-and-resilience dimension reveals four profiles (Figure 25). Across developing economies the two axes are positively correlated (0.51), mainly because resilience rises with capability; the environmental indicators alone move the other way. **Balanced convergers** (37 economies, 2.9 billion people, including China, Indonesia, Brazil, Mexico) are above the median on both. **Capability-led, environment-lagging** economies (15, 1.8 billion, led by India and South Africa) have built capabilities on a polluting, exposed base. **Environment-preserving, capability-lagging** economies (15, including Ethiopia and Kenya) have low emissions and relatively clean power but weak capabilities. **Broadly behind** economies (36, 1.4 billion people, including Pakistan, Nigeria and Bangladesh) lag on both.

Figure 24 Technology is the most common binding constraint on balanced convergence

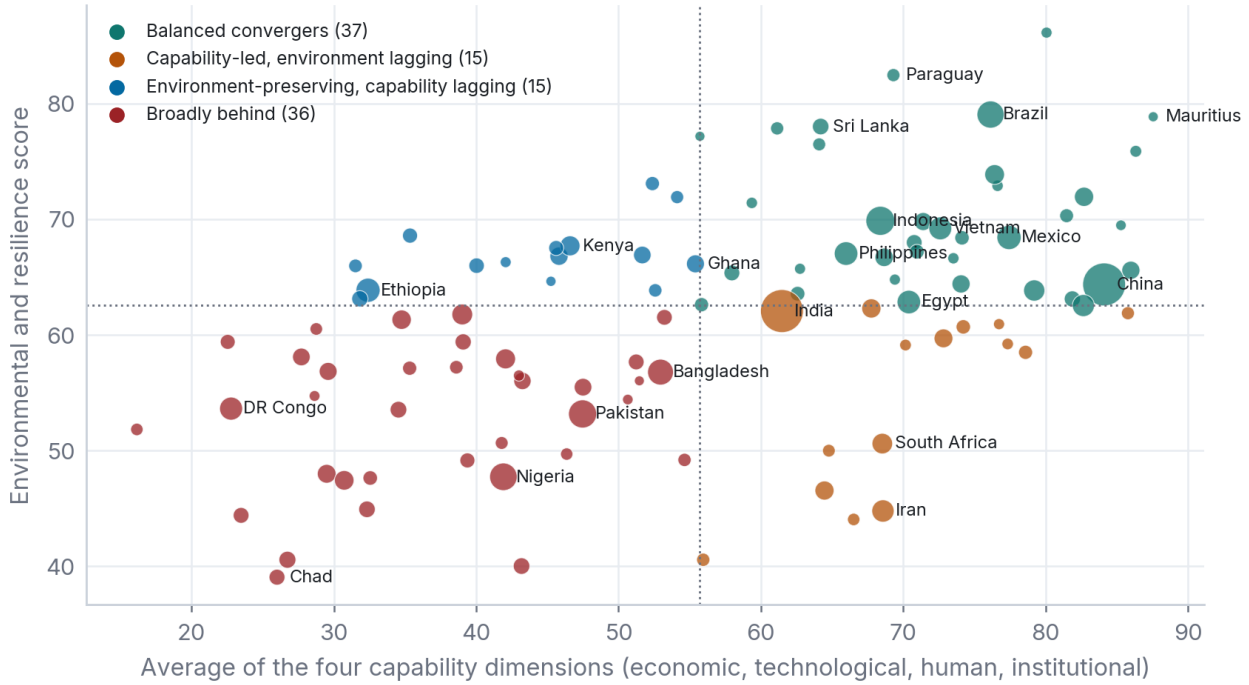
Developing economies by their weakest SCMF dimension, and their population (n = 103)



Source: H Heuristics calculations; see Table 10 for data sources.

Figure 25 Four profiles of convergence across the developing world

Average of the four capability dimensions against the environmental-and-resilience dimension, developing economies, latest year



Source: H Heuristics calculations; see Table 10 for data sources. Bubble size reflects population; dotted lines are medians across developing economies.

Each profile calls for a different emphasis. Balanced convergers need to keep their environmental performance as incomes rise. Capability-led economies need to clean up power, industry and cities quickly. Environment-preserving economies need to build capabilities without abandoning their clean base, which is exactly the leapfrogging opportunity described in Section 8. Broadly behind economies need all five dimensions, starting with capability formation.

11.9 Leaders in each dimension

Leaders differ markedly from one dimension to the next, which is another way of seeing that convergence is multidimensional. Table 11 lists the three highest-scoring developing economies with at least five million people on each dimension, and the three lowest.

11.10 Using and developing the SCMF

The SCMF is designed to be used at several levels: by governments to diagnose their weakest dimension and set balanced targets; by development partners to direct finance where it complements national strengths; and by researchers to test the propositions in the next section. It is a first version. Priorities for development include adding total factor productivity, R&D, AI adoption and technology exports to the technological and economic dimensions; poverty and learning outcomes to human development; climate-adaptation and disaster-preparedness indicators to the fifth dimension; and sub-national data, since national averages hide large gaps within countries. A composite score can be considered once the dimensions and their relationships are well understood.

Table 11 Leaders and laggards on each SCMF dimension, developing economies

Dimension	Highest scores	Lowest scores
Economic	Türkiye (94), Kazakhstan (91), Malaysia (89)	Burundi (10), Central African Rep. (15), Madagascar (19)
Technological	Belarus (98), China (91), Serbia (88)	Sudan (0), Burundi (4), Uganda (5)
Human development	Belarus (97), Serbia (93), Argentina (93)	Central African Rep. (14), Chad (23), Niger (25)
Institutional	Malaysia (94), Indonesia (81), Rwanda (78)	Somalia (17), Libya (20), Syria (20)
Environmental & resilience	Paraguay (82), Brazil (79), Sri Lanka (78)	Chad (39), Syria (40), Libya (41)

Source: H Heuristics calculations; see Table 10 for data sources. Developing economies with at least five million people.

Two patterns in the leaders table deserve emphasis. First, no developing economy leads on every dimension: Malaysia tops institutions and ranks highly on the economic dimension but not on environment and resilience, while Paraguay and Brazil lead on environment and resilience largely because of hydropower and lower industrial emissions. Second, the laggards are concentrated among fragile and conflict-affected states, where weak capabilities and high exposure reinforce each other. This is where the link between Sustainable Convergence and Polycrisis Resilience is most direct: in these countries, building capabilities is itself the main form of risk reduction.

For governments, the practical value of the SCMF lies less in league tables than in the profile: knowing which dimension is weakest, how far each dimension has moved in absolute terms, and whether progress in one is being bought at the expense of another. For development partners, it offers a common language for aligning finance with national priorities across the five dimensions.

SECTION 12

Five Propositions for Research

A concept becomes a research programme when it makes claims that can be tested. Sustainable Convergence rests on five propositions, each of which can be examined with data and could, in principle, be shown to be wrong.

IN BRIEF

- The five propositions concern complementarity, technology-enabled convergence, multidimensional convergence, resilience preservation, and development pathway differentiation.
- Early evidence from the SCMF and the wider literature is broadly consistent with all five, but in several cases the support is partial.
- Each proposition is paired here with a testable hypothesis and the evidence that would count against it.

The propositions below could form the foundation of an academic concept paper. For each, the report states the proposition, summarises the current evidence, and sets out how it could be tested. Table 12 at the end of the section brings them together.

12.1 Proposition 1: Complementarity

COMPLEMENTARITY

Proposition 1

Economic convergence and sustainable development can reinforce one another when technological progress, productive investment and institutional development are directed toward environmentally sustainable outcomes.

Evidence so far. The record is mixed, which is what the conditional wording of the proposition anticipates. Across developing economies, gains in capability dimensions between 2000 and 2022 were not associated with environmental deterioration; if anything the reverse (correlation +0.17 across 101 economies). Progress in different dimensions tends to travel together, though weakly: the average correlation between changes in pairs of dimensions is +0.13, and 14% of economies beat the developing-country median on five or six dimensions, against about 11% expected by chance. On the other hand, in levels, the economic score is negatively correlated with the environmental indicators (-0.48): richer developing economies pollute and emit more. Complementarity is possible, but it is not yet the norm.

How to test it. Compare countries and periods in which investment and policy were directed toward clean outcomes (for example, large renewable programmes or clean-cooking drives) with those in which they were not, and examine whether capability and environmental indicators improved together. **What would count against it:** evidence that even well-directed clean investment systematically slows capability growth.

12.2 Proposition 2: Technology-enabled convergence

TECHNOLOGY-ENABLED CONVERGENCE

Proposition 2

Technology diffusion and adoption can accelerate convergence by allowing emerging economies to improve productivity and expand productive capabilities without reproducing every stage of historical industrial development.

Evidence so far. Strong. Technologies now reach developing economies far faster than in the past (Comin and Hobijn, 2010). Access-based indicators such as electricity and internet use have converged much faster than income since 2000 (Figure 9). Later developers reached $10,000 of income with lower emissions (2.9 against 4.4 tonnes per person), and mobile money, digital identity and distributed solar have delivered measurable gains in poverty, employment and access (Suri and Jack, 2016; Hjort and Poulsen, 2019; World Bank, 2021). The caveat is intensity: technology is still the weakest SCMF dimension for 72 developing economies, and differences in how intensively technology is used explain much of the income gap (Comin and Mestieri, 2018).

How to test it. Use adoption lags and intensity of use (as in the Cross-country Historical Adoption of Technology dataset) to estimate whether faster diffusion predicts faster productivity convergence, controlling for investment and education. **What would count against it:** evidence that technology adoption without traditional industrialisation produces no lasting productivity gains.

12.3 Proposition 3: Multidimensional convergence

MULTIDIMENSIONAL CONVERGENCE

Proposition 3

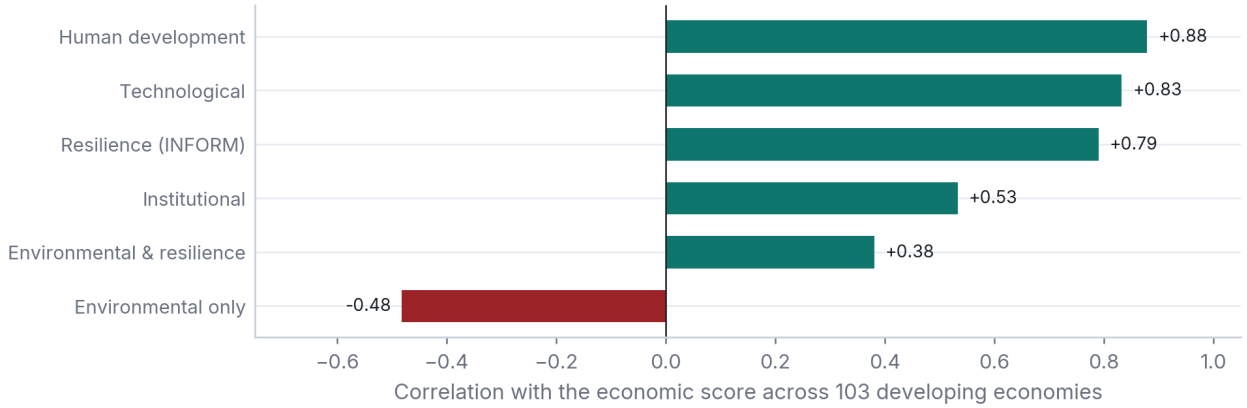
Income convergence alone is insufficient to establish sustainable development convergence. Technological, institutional, human-development and environmental improvements must also be considered.

Evidence so far. Strong. Income is closely related to some dimensions but not others (Figure 26). Across 103 developing economies its correlation is +0.88 with human development and +0.83 with technology, but only +0.53 with institutions and -0.48 with the environmental indicators. Ranking countries by income alone places only 54 of 103 in the same fifth of the distribution as their average on the other four dimensions, and 14 are two or more fifths apart. A convergence assessment based on income would misjudge many countries and would miss the environmental cost of growth entirely.

How to test it. Examine whether multidimensional measures predict later outcomes, such as resilience to shocks, health or growth itself, better than income alone. **What would count against it:** evidence that income captures almost all the variation that matters for long-run well-being and resilience.

Figure 26 Income tracks human development and technology, but not institutions or the environment

Correlation between the SCMF economic score and other dimension scores, developing economies, latest year



Source: H Heuristics calculations from the SCMF; see Table 10 for data sources.

12.4 Proposition 4: Resilience preservation

RESILIENCE PRESERVATION

Proposition 4

Economic convergence is more sustainable when countries strengthen their capacity to withstand shocks that could reverse development gains.

Evidence so far. Substantial. Output losses from crises are often permanent (Cerra and Saxena, 2008), and repeated shocks are a major reason why many developing economies have failed to sustain growth spurts (Commission on Growth and Development, 2008). Countries with stronger early warning, social protection and disaster finance suffer smaller losses and recover faster (Hallegatte et al., 2017; Clarke and Dercon, 2016). INFORM data show that lack of coping capacity falls steeply with development, from 7.1 out of 10 in low-income to 3.5 in upper-middle-income countries (Section 9).

How to test it. Compare growth spells in countries with and without strong resilience capacity, measuring whether gains were sustained through subsequent shocks. **What would count against it:** evidence that resilience investment slows growth by more than it reduces losses.

12.5 Proposition 5: Development pathway differentiation

PATHWAY DIFFERENTIATION

Proposition 5

Countries do not need to replicate the historical development trajectories of advanced economies. Alternative pathways based on clean technologies, digital infrastructure, innovation and institutional modernisation can support convergence.

Evidence so far. Promising but incomplete. The latecomer advantage in emissions (Figure 14), the spread of digital public infrastructure and the cost of clean power all suggest that new pathways exist. But so far only 6% of people in developing economies live in countries that converged

with slow-growing or falling emissions (Table 7), and no large economy has yet reached high income through a predominantly clean pathway. Vietnam, Morocco, Costa Rica and Uruguay offer partial models; the coming decades will provide the real test.

How to test it. Track the SCMF profiles of countries pursuing explicitly clean development strategies over the next decade and compare them with those of countries following traditional routes. **What would count against it:** a persistent pattern in which only carbon-intensive growth delivers sustained convergence.

Table 12 The five propositions: hypotheses, evidence and tests

Proposition	Testable hypothesis	Current evidence	Data and methods
1. Complementarity	Directed clean investment improves capability and environmental indicators together	Mixed: possible, not yet the norm	SCMF panel; event studies of clean-energy and clean-cooking programmes
2. Technology-enabled	Faster diffusion predicts faster productivity convergence	Strong for access; weaker for intensity of use	Technology adoption datasets; firm surveys; productivity data
3. Multidimensional	Multidimensional measures predict later outcomes better than income	Strong: income misranks many countries	SCMF dimensions; growth, health and resilience outcomes
4. Resilience preservation	Growth spells last longer where resilience capacity is high	Substantial	Growth-spell analysis; disaster and crisis loss data
5. Pathway differentiation	Clean-pathway countries converge as fast as carbon-intensive ones	Promising but incomplete	Long-run SCMF tracking; country case studies

Source: H Heuristics.

Taken together, the propositions turn Sustainable Convergence from a normative aspiration into a research programme. Two of them (technology-enabled and multidimensional convergence) already have strong support; two (complementarity and pathway differentiation) are plausible but unproven at scale; and resilience preservation is well supported by evidence on shocks but rarely tested alongside the other dimensions. A regularly updated SCMF panel would allow all five to be examined with the same data.

SECTION 13

Regional Pathways in the Global South

Sustainable Convergence looks different in each region. Starting points, endowments, demographic trends and exposure to risk differ, and so do the most promising routes.

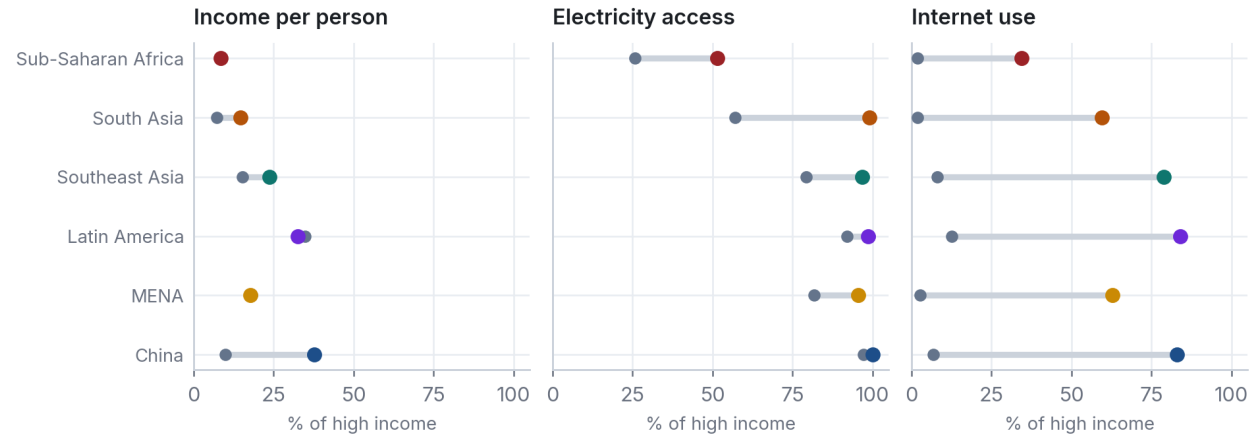
IN BRIEF

- Sub-Saharan Africa's priority is capability formation, with clean energy and digital systems as the foundation for its growing workforce.
- South Asia must resolve its combined heat, air pollution and water challenges while sustaining fast growth.
- Southeast Asia, Latin America, China and the Middle East and North Africa each face distinct challenges, from industrial upgrading to stalled productivity and fossil-fuel dependence.

Figure 27 compares regions on three indicators of convergence, and Figure 22 in Section 11 shows their SCMF profiles. Together they show that the Global South is not one place. The paragraphs below sketch a Sustainable Convergence pathway for each major region.

Figure 27 Regions have converged far more on access and connectivity than on income

Income per person, electricity access and internet use as % of the high-income level, 2000 (grey) and latest year (colour)



Source: H Heuristics calculations from World Development Indicators (World Bank, 2026). Population-weighted averages; China shown separately.

13.1 Sub-Saharan Africa: building the foundations

Sub-Saharan Africa is where the convergence challenge is largest and most urgent. Its income per person is about 8% of the high-income level, unchanged since 2000; only 52% of people have electricity and 21% cook cleanly. It scores lowest of all regions on four of the five SCMF dimensions, with technology at 17. By 2100, about a third of the world's people may live there (United Nations, 2024).

Its strengths are equally significant: the world's best solar resource, large critical-mineral reserves, very low per-person emissions, and a young population. A Sustainable Convergence path-

way would prioritise capability formation through distributed and grid-connected renewable power, clean cooking, digital public infrastructure and foundational learning, and use cheap clean power to build processing industries near mineral and agricultural resources. Initiatives such as Mission 300, which aims to connect 300 million Africans to electricity by 2030, show the scale required (World Bank, 2024).

13.2 South Asia: heat, air and water

South Asia has converged quickly: income rose from 7% to 15% of the high-income level, and electricity access is near universal. But it faces the most severe combination of environmental exposures of any region: average PM2.5 exposure of 52 μg/m^3, the highest INFORM hazard score (8.2), extreme heat and water stress. Its environmental-and-resilience score is 62.

The Sustainable Convergence priorities are clean power to replace coal as demand grows, clean cooking, cleaner transport, affordable and efficient cooling, and resilient water systems. India's digital public infrastructure offers a model for technological convergence; the challenge is to extend that success to air quality and heat protection.

13.3 Southeast Asia: industrial upgrading on clean power

Southeast Asia has followed a classic export-led manufacturing path and reached about 24% of the high-income income level. Vietnam stands out, with one of the most balanced SCMF profiles in the developing world. The region's challenge is to keep upgrading into higher-value manufacturing and services while switching the power that drives it from coal to renewables, as global buyers increasingly demand low-carbon supply chains and border carbon measures such as the EU's CBAM take effect (European Commission, 2025). Exposure to typhoons, floods and sea-level rise makes resilient infrastructure a priority for coastal cities.

13.4 Latin America: productivity and institutions

Latin America has one of the cleanest power mixes of any developing region, strong human development and the best environmental-and-resilience score (73). But its economic convergence has stalled: income has slipped from 35% to 33% of the high-income level since 2000. The binding constraints are productivity and institutions rather than energy. A Sustainable Convergence pathway would use the region's clean power and mineral wealth (lithium, copper) to attract green industry, while protecting the Amazon and other ecosystems whose loss would undermine both climate and development (Dasgupta, 2021).

13.5 China, the Middle East and North Africa

China is the largest convergence success in history, rising from 10% to 38% of the high-income income level since 2000, and it now leads the world in manufacturing clean-energy technologies. But it did so on a carbon-intensive path, and its environmental indicators remain weak (environmental score 33). Its next stage of convergence depends on decarbonising heavy industry and power. The Middle East and North Africa faces a different challenge: heavy dependence on fossil-fuel revenues, stalled income convergence (about 18% of the high-income level), institutional weakness and extreme heat and water scarcity. Its world-class solar resource offers a route to diversification.

13.6 Small island states and fragile states

Two groups cut across regions. Small island developing states face extreme exposure to cyclones and sea-level rise relative to the size of their economies, and depend heavily on imported fuel; for them, resilience (stage 5) and clean energy are immediate priorities, not later ones, and parametric insurance such as the Caribbean facility shows how risk can be pooled (CCRIF SPC, 2025). Fragile and conflict-affected states, concentrated in the Sahel, the Horn of Africa and parts of the Middle East, face the deepest gaps on every dimension. In these settings Sustainable Convergence starts with basic services, livelihoods and institutions that can deliver them, using distributed technologies that do not depend on large, vulnerable infrastructure.

13.7 Regional priorities at a glance

Table 13 summarises each region's weakest SCMF dimension, its main assets and the priorities that follow.

Table 13 Starting points and Sustainable Convergence priorities by region

Region	Weakest SCMF dimension	Main assets	Priorities
Sub-Saharan Africa	Technology (17)	Solar, minerals, young population, low emissions	Capability formation: power, clean cooking, DPI, learning
South Asia	Technology (34)	Fast growth, digital public infrastructure	Clean power, air quality, cooling, water resilience
Southeast Asia	Technology (52)	Manufacturing base, trade integration	Clean industrial upgrading, coastal resilience
Latin America	Institutional (67)	Clean power, minerals, human development	Productivity, institutions, ecosystem protection
Middle East & N. Africa	Technology (41)	Solar resource, capital, location	Diversification, water and heat resilience, governance
China	Environment & resilience (64)	Clean-tech manufacturing, technology, infrastructure	Decarbonising power and heavy industry, air quality

Source: H Heuristics calculations from the SCMF; see Table 10.

SECTION 14

Barriers and Risks

Sustainable Convergence is possible, but it is not easy. Finance, debt, deindustrialisation, technology concentration, politics and climate damage all stand in the way, and some trade-offs are real.

IN BRIEF

- The cost of capital is the single largest barrier: clean energy is capital-intensive, and capital is expensive in developing economies.
- Debt burdens, premature deindustrialisation and the concentration of technology in a few countries limit the latecomer advantage.
- Political economy, a just transition and growing climate damage determine whether the pathway is feasible in practice.

14.1 The cost of capital

Clean energy is cheap to run but expensive to build: most of its lifetime cost is paid upfront. That makes its competitiveness highly sensitive to the cost of finance. In many developing economies, the cost of capital for clean-energy projects is two to three times that in advanced economies, which can make a solar farm more expensive than a gas plant even when the technology is cheaper (IEA, 2024a; IEA, 2023). Clean-energy investment in emerging and developing economies outside China needs to rise several-fold to meet development and climate goals (Songwe et al., 2022).

Reducing the cost of capital is therefore one of the highest-impact policies for Sustainable Convergence. Tools include guarantees and first-loss capital from development banks, local-currency lending to remove currency risk, better project preparation, and stronger domestic financial systems, which also advance the institutional dimension.

14.2 Debt and fiscal space

Many developing economies face heavy debt burdens. More than three billion people live in countries that spend more on interest payments than on health or education (UNCTAD, 2025). High debt service crowds out the public investment that Sustainable Convergence requires, and leaves governments with little room to respond to shocks. Official development assistance fell sharply in 2025 (OECD, 2026). Proposals such as the Bridgetown Initiative call for climate-resilient debt clauses, expanded lending by multilateral banks and new sources of concessional finance (Government of Barbados, 2023).

Table 14 Barriers to Sustainable Convergence and possible responses

Barrier	Why it matters	Possible responses
High cost of capital	Makes capital-intensive clean energy expensive	Guarantees, local-currency lending, project preparation, domestic financial reform
Debt and fiscal constraints	Crowd out public investment and shock response	Debt relief, climate-resilient debt clauses, concessional finance
Premature deindustrialisation	Weakens the traditional route to productive jobs	Green industry, agro-processing, digitally tradable services, skills
Technology concentration	Limits industrial opportunities and creates supply risk	Technology partnerships, regional manufacturing, fair trade rules
Political economy	Incumbents and subsidies resist change	Just-transition support, subsidy reform with compensation, visible co-benefits
Climate damage and fragility	Reverse gains and divert resources	Adaptation finance, resilient infrastructure, early warning, conflict prevention

Source: H Heuristics, drawing on the sources cited in this section.

14.3 Premature deindustrialisation

Manufacturing has historically been the main escalator of convergence, but many developing economies are now reaching peak manufacturing employment at much lower incomes than early industrialisers did (Rodrik, 2016). Automation and the concentration of global manufacturing in East Asia make the traditional route harder. Sustainable Convergence must therefore find new sources of productive employment: clean-energy construction and maintenance, green industry, modern agriculture and food processing, and tradable services enabled by digital technology.

14.4 Technology concentration and trade rules

Clean-energy manufacturing is highly concentrated: China produces most of the world's solar modules, battery cells and many processed critical minerals (IEA, 2022; IEA, 2025). Concentration has driven costs down, but it also creates supply risks and limits the industrial opportunities for other latecomers. Border carbon measures could penalise exporters in developing economies that lack the finance to decarbonise quickly (European Commission, 2025). Fair trade rules and technology partnerships are needed to ensure that the clean transition supports convergence rather than widening gaps.

14.5 Resource wealth and critical minerals

The clean transition is raising demand for copper, lithium, cobalt, nickel, graphite and rare earths, many of which are mined in developing economies such as the Democratic Republic of Congo, Chile, Peru, Indonesia, Zimbabwe and Guinea (IEA, 2025). This is an opportunity: mineral wealth could finance infrastructure and human development, and processing near the mine could create industrial jobs. But history warns of the 'resource curse', in which mineral booms bring volatility, corruption, conflict and environmental damage while leaving other sectors weak.

Whether critical minerals support Sustainable Convergence depends on the institutional dimension: transparent contracts, fair taxation, sovereign wealth management, environmental and labour standards, and partnerships that move processing and manufacturing closer to the source. Without these, the minerals that power the clean transition elsewhere could deepen gaps where they are mined.

Most of these barriers are not technical but financial, institutional and political. That is encouraging, because they can be changed by policy, and many of the responses, such as cheaper finance, debt reform and stronger institutions, would advance several dimensions of Sustainable Convergence at once.

14.6 Political economy and a just transition

Changing development pathways creates winners and losers. Coal regions, fossil-fuel exporters, state-owned utilities and workers in polluting industries may resist change. Fuel subsidies are popular even when they mainly benefit the better off. A just transition, with support for affected workers and communities, transparent use of revenues and visible benefits such as cleaner air and cheaper power, is essential to sustain political support.

14.7 Climate damage, conflict and fragility

Finally, the climate is already changing. Rising heat, shifting rainfall and stronger storms reduce agricultural yields, labour productivity and the value of infrastructure, and the costs fall heaviest on the poorest countries (IPCC, 2023). Adaptation finance remains far below needs (UNEP, 2025). Conflict and fragility, concentrated in parts of the Sahel, the Horn of Africa and the Middle East, can reverse decades of progress. These risks are the reason Sustainable Convergence is linked so closely to Polycrisis Resilience.

SECTION 15

Pathways to 2100

How much difference does the route make? Three illustrative scenarios show that the speed of convergence decides how prosperous the Global South becomes, while the route decides whether the world stays within its carbon budget.

IN BRIEF

- With steady convergence, Global South income could reach about 43% of the high-income level by 2050 and 74% by 2100.
- On a fossil route, cumulative world emissions to 2100 would be about 3,084 billion tonnes of CO_2, nearly three times the 2°C budget.
- On a Sustainable Convergence route, with the same income gains, the total would be about 819 billion tonnes, within the budget.

15.1 Three scenarios

The scenarios are deliberately simple. They treat the Global South as a single economy, starting from its current average income and emissions, and vary two things: the speed of income convergence and the rate at which the carbon intensity of output falls. High-income emissions are assumed to fall linearly to zero by 2050 in all three, so that differences come only from the Global South's route. The scenarios are illustrations of orders of magnitude, not forecasts.

- **Stalled convergence.** The Global South grows only as fast as high-income economies, so its income stays at about 23% of the high-income level. Carbon intensity falls 2% a year.
- **Fossil catch-up.** The Global South closes 2% of the remaining (log) income gap each year, reaching 43% of the high-income level by 2050 and 74% by 2100, while carbon intensity falls slowly, as in the past.
- **Sustainable Convergence.** Income converges exactly as in fossil catch-up, but carbon intensity falls rapidly as clean power, electrified transport and clean industry spread.

15.2 Results

The results are stark (Figure 28). Stalled convergence would leave billions of people far behind and still emit about 1,834 billion tonnes of CO_2 to 2100, well above the 2°C budget. Fossil catch-up would deliver the income gains but push cumulative world emissions to about 3,084 billion tonnes, nearly three times the 2°C budget of about 1,050 billion tonnes. Sustainable Convergence delivers exactly the same income gains with cumulative emissions of about 819 billion tonnes, within the 2°C budget, although still well above the budget for 1.5°C.

The results are sensitive to the speed of convergence, but the conclusion is not. If the Global South closes only 1% of its gap a year, it reaches about 51% of the high-income level by 2100, and the Sustainable Convergence route emits about 718 billion tonnes. If it closes 3% a year, it reaches 88%, and the sustainable route emits about 916 billion tonnes. In every case, the sustainable route allows faster convergence within the 2°C budget than the fossil route allows at any speed.

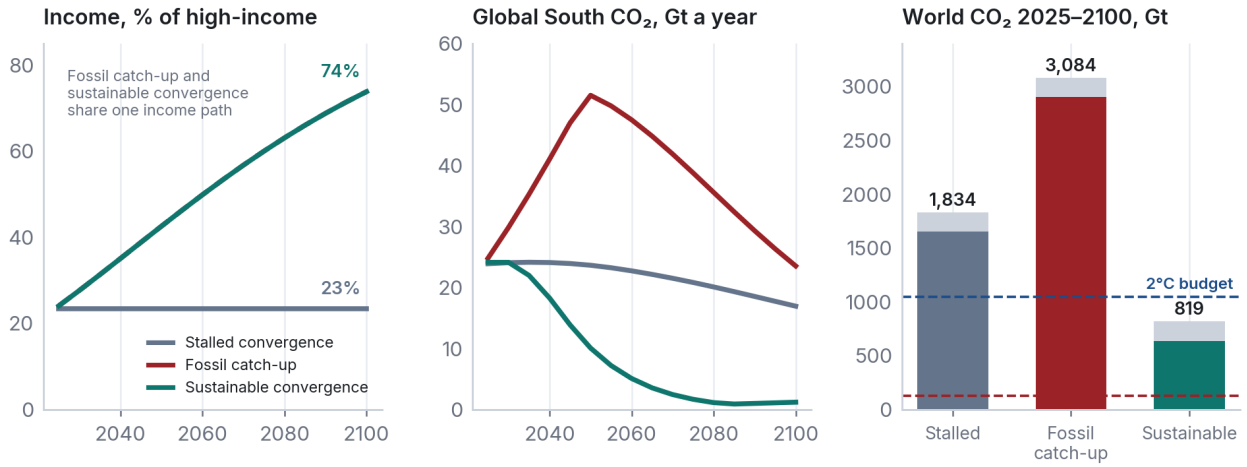
Table 15 Three illustrative pathways for the Global South, 2025–2100

	Stalled convergence	Fossil catch-up	Sustainable Convergence
Income convergence	None: 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).

Figure 28 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 15 notes). Carbon budgets from Forster et al. (2025) (Forster et al., 2025). In the right panel, the grey segment is high-income emissions.

15.3 What the scenarios imply

Three implications follow. First, there is no climate case for slowing convergence: stalled convergence is both poorer and, because it leaves carbon intensity falling slowly, not much cleaner. Second, the climate outcome depends overwhelmingly on the route the Global South takes, which in turn depends on access to clean technology and affordable finance in the next two decades, when most of its energy system, cities and industry will be built. Third, the scenarios understate the benefits of the sustainable route, because they ignore the gains in health from cleaner air, in energy security from domestic power, and in resilience from avoided climate damage.

15.4 What the scenarios leave out

The scenarios are intentionally stylised, and several simplifications should be kept in mind:

- **One Global South.** Treating developing economies as a single unit hides large differences: some will converge faster and some may not converge at all.
- **Only CO_2 from fossil fuels and industry.** Methane, land-use change and other greenhouse gases are excluded, as are climate feedbacks.
- **No damage from climate change.** The scenarios do not reduce growth for climate damage, which would hit the fossil route hardest.
- **No co-benefits.** Health gains from cleaner air, savings on fuel imports and avoided disaster losses are not counted.
- **Population held to UN projections.** Faster human development would likely lower fertility and population, reducing emissions on every route (United Nations, 2024).

The scenarios also make clear the responsibility of high-income economies. Even in the sustainable scenario, the world uses most of its 2°C budget. Rapid decarbonisation in rich countries, and the transfer of finance and technology to developing ones, are preconditions for Sustainable Convergence, not optional extras.

SECTION 16

A Strategy for Sustainable Convergence

Turning Sustainable Convergence from a concept into practice requires action by national governments, the international system, investors and businesses, guided by a small set of principles and by better measurement.

IN BRIEF

- Five principles guide strategy: aim for balance, choose the clean route early, close the weakest dimension, build resilience in, and measure what matters.
- National governments set the direction; the international system determines the cost of capital and access to technology.
- Investors and businesses can make Sustainable Convergence a commercial opportunity rather than a cost.

16.1 Five principles

1. **Aim for balance.** Pursue the five dimensions together, and prefer investments that advance several at once.
2. **Choose the clean route early.** The infrastructure built in the next two decades will lock in emissions and exposure for half a century. Clean, efficient and resilient choices are cheapest when made at the outset.
3. **Close the weakest dimension.** Use SCMF profiles to identify the dimension holding a country back, and direct additional effort there.
4. **Build resilience in.** Treat resilience not as a final stage but as a condition of every investment.
5. **Measure what matters.** Track relative convergence and absolute development across all five dimensions, and report them alongside GDP.

16.2 What national governments can do

National governments set the direction of development. For Sustainable Convergence, the most important tasks are to make clean energy the default for new power and industry, to finish universal access to electricity, clean cooking, water and sanitation, to build digital public infrastructure, to invest in health and foundational learning, and to strengthen the public administration that delivers all of these. Fuel-subsidy reform, carbon pricing where feasible, and stable, transparent regulation can shift investment toward clean options (World Bank, 2012; Hallegatte et al., 2012).

Table 16 A national action agenda across the five dimensions

Dimension	Priority actions	Example measures of progress
Economic and productive	Clean industrial clusters; trade integration; management and skills programmes; productive public investment	Output per worker; manufacturing and services value added; investment rate
Technological	Universal broadband; digital ID, payments and data exchange; technical and vocational training; technology extension for firms; responsible AI adoption	Internet and broadband use; firm digital adoption; R&D
Human development	Primary health care; early-childhood nutrition; foundational learning; universal water, sanitation, power and clean cooking	Child mortality; learning poverty; access rates
Institutional	Public financial management; regulatory quality; tax capacity; local government; anti-corruption	WGI indicators; tax revenue; public investment efficiency
Environmental and resilience	Renewable power; clean transport and cooking; air-quality management; climate-proof infrastructure; early warning; adaptive social protection; disaster finance	PM2.5; CO_2 intensity; renewable share; INFORM vulnerability and coping capacity

Source: H Heuristics.

16.3 What the international system can do

The international system determines two of the most important inputs to Sustainable Convergence: the cost of capital and access to technology. Multilateral development banks can expand lending, take more risk, and lend in local currencies. Debt restructuring frameworks can include climate-resilient debt clauses that pause repayments after a disaster. Rich countries can meet and exceed their climate-finance commitments, with a larger share for adaptation (Songwe et al., 2022; Government of Barbados, 2023; UNEP, 2025).

Technology partnerships, open standards for digital public infrastructure, support for regional manufacturing of clean-energy components, and trade rules that recognise the needs of latecomers can help ensure that the clean transition supports convergence. Sovereign risk pools such as the African Risk Capacity and the Caribbean Catastrophe Risk Insurance Facility show how international cooperation can provide fast, predictable disaster finance (African Risk Capacity, 2025; CCRIF SPC, 2025).

16.4 What investors and businesses can do

For investors and businesses, Sustainable Convergence describes one of the largest economic opportunities of the century: building the energy systems, cities, industries and digital infrastructure for six to eight billion people. Firms can invest in clean manufacturing and services in developing economies, partner with local firms to transfer technology and skills, and use blended finance to manage risk. Investors can price the long-run risks of carbon-intensive and climate-exposed assets, and the opportunities of resilient and clean ones.

16.5 Sequencing by convergence profile

The four SCMF profiles identified in Section 11 suggest different starting priorities:

- **Broadly behind** economies: capability formation first, with distributed clean power, clean cooking, primary health care, foundational learning and digital identity and payments as the backbone; protect gains through adaptive social protection.
- **Environment-preserving, capability-lagging** economies: build productive capabilities on the existing clean base; use cheap renewable power to attract industry; invest in skills and connectivity.
- **Capability-led, environment-lagging** economies: clean up power, industry, transport and cities quickly; tackle air pollution; avoid locking in new coal; protect populations from heat.
- **Balanced convergers**: keep environmental performance as incomes rise; move into innovation and higher-value activities; strengthen resilience to protect accumulated gains.

16.6 Measure, monitor and learn

Finally, Sustainable Convergence requires better measurement. Governments and international organisations should report convergence across the five dimensions alongside GDP, using the SCMF or similar frameworks, and should track both relative and absolute progress. Sub-national data, data on intensity of technology use, and data on how indicators respond to shocks are particular gaps. Better measurement makes it possible to learn which strategies work, and to hold decision-makers accountable for balanced progress.

None of these actions is new on its own. What Sustainable Convergence adds is a way of choosing among them: favouring those that advance several dimensions at once, correcting the weakest dimension first, and judging every investment by whether it leaves people both better off and less exposed.

SECTION 17

Research Agenda and Conclusion

Sustainable Convergence is a framework for one of the defining questions of the century: how the majority of humanity can reach high living standards on a planet under strain. This final section sets out the research needed to develop it and summarises the argument.

IN BRIEF

- The research agenda includes testing the five propositions, extending the SCMF, studying the mechanism at country level, and integrating Sustainable Convergence with Polycrisis Resilience.
- Sustainable Convergence widens the definition of catch-up to include technology, institutions, human development, environmental quality and resilience.
- The route, not only the pace, will decide whether convergence delivers lasting prosperity.

17.1 A research agenda

Sustainable Convergence is a framework in development. Table 17 lists the research priorities that would strengthen it, the questions each would answer, and the data and methods required.

Table 17 Research priorities for Sustainable Convergence

Priority	Key questions	Data and methods
Testing the propositions	Are the five propositions supported across countries and over time?	SCMF panel data; growth-spell and event-study methods
Extending the SCMF	How can TFP, R&D, AI adoption, poverty, learning and adaptation indicators be added?	New data sources; sensitivity analysis; sub-national data
The mechanism in practice	How do the five stages interact in specific countries? What sequences work best?	Country case studies; comparative historical analysis
Complementarities	Which investments deliver gains across the most dimensions at once?	Programme evaluations; cost–benefit analysis
Finance	How can the cost of capital in developing economies be reduced most effectively?	Project-level finance data; policy experiments
Resilience	How much do resilience investments protect convergence gains after shocks?	Disaster and crisis loss data; recovery trajectories
Integration with Polycrisis Resilience	How can exposure reduction be built into development measurement and planning?	Joint SCMF and Polycrisis Resilience indicators

Source: H Heuristics.

Three questions stand out. First, can the propositions be tested rigorously, so that Sustainable Convergence becomes an evidence-based framework rather than an aspiration? Second, can the SCMF be developed into a standard tool, with richer indicators and annual updates? Third, can the complementarities between dimensions be identified precisely enough to guide investment?

Answering them will require collaboration between economists, environmental scientists, resilience researchers and practitioners in developing economies.

17.2 Conclusion

For two centuries, convergence has been measured mainly by income. That yardstick captured something real, but it left out much of what development means and most of what determines whether it lasts. Sustainable Convergence widens the yardstick. It defines convergence as the narrowing of economic, technological, institutional and human-development gaps along environmentally sustainable, socially inclusive and systemically resilient pathways, and it sets out five dimensions, a five-stage mechanism, a measurement framework and five testable propositions.

The evidence assembled in this report shows why the wider view matters. The Global South has caught up substantially on access and connectivity and, in Asia, on income; but most of that catch-up has been carbon-intensive, low-income countries have fallen further behind, the technology gap remains the most common binding constraint, and only 18 developing economies are converging in a balanced way across all five dimensions. At the same time, the falling cost of clean technology, the spread of digital systems and the latecomer advantage mean that a better route is now open.

Within the H Heuristics framework, Sustainable Convergence is a proactive pathway toward Polycrisis Resilience: accelerating development in vulnerable regions while progressively reducing the environmental, infrastructural, technological and socioeconomic conditions that place populations at risk. The long-term convergence of developing and advanced economies should be pursued through development pathways that simultaneously advance economic productivity, technological capabilities, institutional capacity, human development and environmental sustainability. In a century of tightening environmental limits and interconnected crises, the route will matter as much as the pace.

> *“Sustainable convergence requires moving beyond traditional income-based measures of economic catch-up toward a multidimensional understanding of development in which prosperity, environmental quality, and systemic resilience advance together.”*
>
> Hunter Hughes, Founder of H Heuristics

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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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