H HEURISTICS

H HEURISTICS CENTURY PATHWAYS · RESEARCH REPORT

Optimizing Humanity's Outlook This Century

Sustainable convergence, innovation diffusion and multidimensional development in the Global South



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ABOUT THIS REPORT

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Concepts. Sustainable Convergence, Polycrisis Resilience, Preventive Development Economics, Development Optimization, Human Vulnerability Reduction Economics and the Human Survivability Dividend are concepts developed by Hunter Hughes, Founder of H Heuristics, and brought together in the H Heuristics Macroeconomic Architecture (Hughes, 2026h). They are presented here as proposed frameworks open to testing.

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Data and methods. All data are public (World Bank, UN, WHO, INFORM, Our World in Data). Associations are not causal estimates; projections are scenarios, not forecasts. Calculations 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

This century can become more dangerous while human lives keep improving. Whether that happens depends less on new inventions than on how fast proven ones reach the places where population growth, development needs and climate risk meet.

The question this report asks is practical: **what are the most effective ways to improve humanity's outlook over the rest of this century?** Its answer is that the decisive variable is not the pace of frontier invention, which is already fast, but the pace at which beneficial technologies, institutions and services spread to the low- and middle-income countries where most of the world's people, most of its future population growth and most of its exposure to climate and other shocks are concentrated. The highest-value investments are those that improve several outcomes at once: income, health, learning, clean air, emissions and the capacity to absorb shocks.

96%
of world population growth to 2050 occurs in countries rated at high risk on the INFORM index, home to 49% of people today and 65% by 2100

859→112bn
person-years without five basic services, 2026–2100, if access stays frozen versus if every country moves at the pace its best peers have already achieved

7 of 9
outcomes on which internet use shows a significant favourable association, holding income fixed, across five dimensions of development

6 of 12
illustrative priority interventions that stay in the top six in most simulations, whatever weights are used

The thesis

The report is organised around a four-part thesis. Humanity's long-term outlook depends on accelerating **sustainable global convergence**, diffusing beneficial innovations, strengthening emerging economies and reducing vulnerability to interconnected crises. The greatest opportunities lie in **multidimensional interventions** that improve productivity, human development, environmental conditions and resilience simultaneously. Priority belongs to the **Global South**, where future population growth, development opportunity and climate vulnerability intersect. And the objective is not simply to develop faster, but to develop in ways that make humanity more prosperous, more technologically capable, more environmentally sustainable and more resilient.

This framing deliberately treats the polycrisis, the interaction of climate, health, economic, food and geopolitical shocks (Tooze, 2022), as the reason for urgency rather than the subject. The subject is what can be built: the development loops that cut exposure and vulnerability faster than hazards grow. That is the core idea of the H Heuristics Century Pathways programme (Hughes,

2026a) and of the November 2026 update, which placed adoption, not new frameworks, at the centre of the work (Hughes, 2026i).

Principal findings

- **The century will be decided in a small number of places.** Countries rated at high risk on the INFORM index account for 49% of humanity today, 56% in 2050 and 65% in 2100. They will absorb 96% of population growth to 2050 and are home to 61% of the world's children. Sub-Saharan Africa's share of humanity rises from 16% to 34% (Section 2).
- **Development is the most powerful risk-reduction technology yet found.** Under-five mortality in low-income countries fell from 163 to 64 per 1,000 births between 1995 and 2023, and the global death rate from natural disasters fell from 26.5 per 100,000 in the 1920s to 0.6 in the 2010s, while hazards did not shrink (Section 3).
- **Standing still means going backwards.** Because populations grow fastest where services are thinnest, frozen access rates would leave about 859 billion person-years without electricity, clean cooking, internet, water or sanitation between 2026 and 2100. Today's trend cuts that to 255 billion; matching the pace of the best-performing peers cuts it to 112 billion. The gap between trend and proven pace, about 143 billion person-years, is the century's largest avoidable deprivation (Section 3).
- **Convergence has happened, but narrowly.** Average income in the Global South rose from 13% to 23% of the high-income level between 1990 and 2024, but excluding China and India it stayed near 20%, and low-income countries slipped from 4.4% to 3.7% (Section 4).
- **Diffusion is getting faster.** Mobile phones reached half the population of low-income countries in 2015, 14 years after high-income countries; electricity has still not reached half after more than a century. Technologies that arrive as cheap, modular devices spread in years; those that need networks, institutions or behaviour change take decades (Section 6).
- **Some investments pay several dividends at once, and this can be measured.** Across 131 developing economies, holding income fixed, internet use is favourably associated with 7 of 9 outcomes; electricity, water, sanitation and secondary schooling with 6; immunisation, child nutrition and clean cooking with 5. Account ownership and the renewable share of power show few such links on their own, a reminder that associations are not guarantees (Section 12).
- **The priority list is robust, the exact order is not.** Testing an illustrative twelve-intervention ranking against 20,000 alternative weightings and judgement errors, girls' education, digital public infrastructure, early nutrition and WASH, climate-resilient agriculture, distributed renewables and clean cooking stay in the top six in most runs; trade integration and debt reform almost never do, although they unlock the rest (Section 18).
- **Sub-Saharan Africa is the binding region.** On a six-dimension Century Outlook Dashboard it scores 39 out of 100 against 62 for South Asia and 88 for high-income countries, and it is weakest on economic convergence, human development and demographic resilience (Section 19).

What to do

- **Run two tracks at once.** Deploy now what is proven, tractable and multi-dividend (clean cooking finance, digital public infrastructure, nutrition, water and sanitation, immunisation, early warning, distributed solar for productive use) while fixing the slower structural bottlenecks (cost of capital, debt, trade, urban codes, research and manufacturing capacity) in parallel (Section 18).
- **Invest where demography and risk meet.** Put the largest share of new effort into Sub-Saharan Africa and South Asia, where population growth, service gaps and climate hazards coincide (Section 19).
- **Measure in lives and person-years, not just dollars.** Track progress with the Century Outlook Dashboard and an annual ledger of person-years of deprivation avoided, benchmarked against proven peer pace (Section 21).
- **Treat publication as the start of adoption.** The interventions are known; the constraint is uptake by governments, funders and institutions. Each finding should become a campaign with a named audience, a benchmark and a date (Section 22).

The report in numbers

The table collects the headline quantities used in the report, with the section where each is derived. Ledger figures follow the H Heuristics benchmark adopted in November 2026 (Hughes, 2026i); all projections are scenarios, not forecasts.

Table 1 Headline numbers

Measure	Value	Section
Share of world population growth to 2050 in high-INFORM-risk countries	96%	2
Sub-Saharan Africa's share of humanity, 2025 → 2100	16% → 34%	2
Global death rate from natural disasters, 1920s → 2010s (per 100,000)	26.5 → 0.64	3
Person-years without five services, 2026–2100: frozen / trend / proven pace	859 / 255 / 112 bn	3
Global South income as % of high-income level, 1990 → 2024	13% → 23%	4
Years by which low-income countries trailed high-income ones to 50% mobile adoption	14	6
Significant favourable associations of internet use, of 9 outcomes (holding income)	7	12
Top-six interventions robust in most of 20,000 simulations	6 of 12	18
Century Outlook Dashboard: Sub-Saharan Africa / high-income	39 / 88	19

Source: this report.

PART I · SECTION 01

The Century Objective

Optimizing humanity's outlook means improving expected human outcomes across several dimensions at once, in a century whose hazards are likely to grow. That requires a clear objective, a unit of account and a theory of how progress spreads.

IN BRIEF

- The objective is sustainable global convergence combined with lower human and systemic vulnerability, not growth alone.
- Progress is counted in lives saved, person-years of deprivation avoided and gaps closed, with income as a supporting measure.
- The report connects big concepts (convergence, diffusion, emerging economies, the green transition) with specific interventions (clean cooking, online learning, digital rails).

THESIS

The central thesis of this report

Humanity's long-term outlook depends on accelerating sustainable global convergence, diffusing beneficial innovations, strengthening emerging economies, and reducing vulnerability to interconnected crises.

The greatest opportunities lie in multidimensional interventions that simultaneously improve economic productivity, human development, environmental conditions, and systemic resilience.

Particular priority should be given to the Global South, where substantial future demographic growth, development opportunities, and climate-related vulnerabilities intersect.

The objective is not simply to develop faster, but to develop in ways that make humanity more prosperous, technologically capable, environmentally sustainable, and resilient.

1.1 Why an objective is needed

Most debates about the future ask a forecasting question: will the world be better or worse in 2050 or 2100? This report asks a design question instead: **given what we know, which choices most improve the expected outcome?** Forecasts invite fatalism in both directions. A design question invites action, because it asks what is within reach. It also forces clarity about what counts as a better outcome. A world that is richer on average but where billions remain without electricity, clean air or schooling, and where a single heatwave or harvest failure can erase a decade of gains, is not an optimized outcome, whatever its average income.

The objective proposed here is therefore multidimensional: to **accelerate sustainable global convergence while reducing human and systemic vulnerability to interconnected twenty-first-century risks**. Convergence means that poorer countries close the gaps in income, productivity, technology and living standards with richer ones. *Sustainable* convergence means doing so through pathways that do not repeat the environmental damage of earlier industrialisation, a concept H Heuristics has developed in detail elsewhere (Hughes, 2026g). Reducing vulnerability

means that the same development makes people and systems better able to anticipate, absorb and recover from shocks, the core of Polycrisis Resilience (Hughes, 2026d).

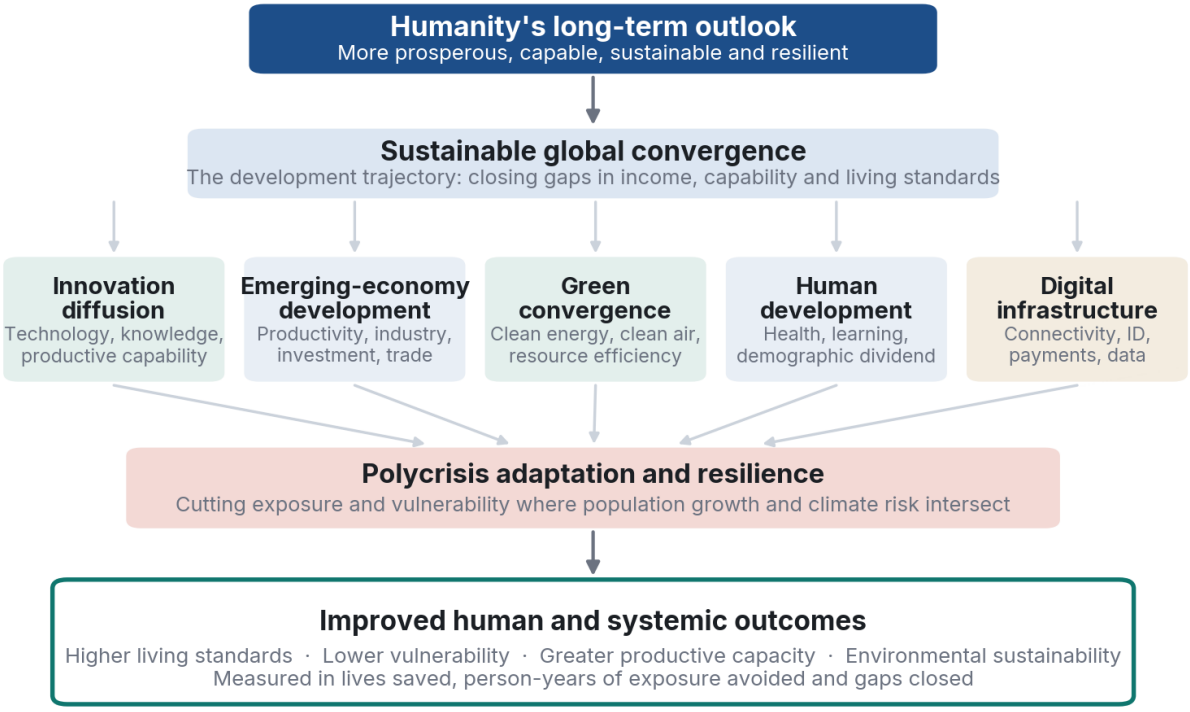
1.2 A century that can get more dangerous while lives improve

The starting point is an apparent paradox. Climate hazards are intensifying: 2024 was the first calendar year above 1.5°C of warming and the decade to 2025 was the warmest on record (WMO, 2026). Heat, drought and flooding will become more frequent across much of the tropics. Yet the historical record shows that human losses depend at least as much on vulnerability as on hazard. Deaths from natural disasters per person have fallen by roughly 98% since the 1920s, and child mortality has fallen in every income group, because societies built warning systems, health services, stronger buildings and the incomes to use them (Section 3).

H Heuristics calls the resulting strategy *Paradoxical Outlook Optimization*: improve expected human outcomes even as the hazard baseline worsens, by investing early in the loops that shrink exposure and vulnerability, where population growth, compounding and lock-in make action worth most (Hughes, 2026a). The paradox is not a forecast that things will turn out well. It is a statement that the outcome is still open, and that the levers which decide it are known and largely affordable.

Figure 1 Sustainable convergence is the trajectory; five forces drive it; resilience is the condition that protects it

The organising framework of the report



Source: H Heuristics. Adapted from the six-concept organising framework set out for this report.

1.3 Counting what matters

An objective needs a unit of account. Following the H Heuristics ledger convention (Hughes, 2026e), this report counts progress in three units: **lives** (deaths avoided), **person-years of deprivation** (years lived without a basic service such as electricity, clean cooking fuel, internet access, safe water or sanitation) and **gaps closed** (the share of the distance to a benchmark that a country covers). Income and GDP remain important supporting measures because they finance everything else, but they are not the objective. Every harm figure in the report is paired, where possible, with the lever that reduces it and an estimate of how much.

Two benchmarks recur throughout. The **current trend** extends each country's recent rate of progress. **Proven pace** is the rate already achieved by the top quarter of comparable countries over the same period, a demanding but demonstrated standard rather than an aspiration (Hughes, 2026e). The difference between the two is the room for improvement that does not depend on any new technology, only on faster adoption of existing ones.

1.4 How the H Heuristics concepts fit together

The report draws on six concepts that H Heuristics has developed and joined into a single macroeconomic architecture, running from diagnosis to valuation (Hughes, 2026h). They are proposed frameworks, open to testing, and the report uses them as lenses rather than as settled results.

Table 2 The six H Heuristics concepts used in this report

Concept	Core question	Where it appears here
Polycrisis Resilience	How can societies withstand and reduce cascading, interconnected crises?	Sections 3, 10, 16
Human Vulnerability Reduction Economics	Who is exposed, and through which arenas of exposure?	Sections 2, 3, 19
Sustainable Convergence	How can poorer countries close gaps without repeating past environmental damage?	Sections 4, 5, 8
Preventive Development Economics	Why does investing before disasters beat paying after them?	Sections 10, 17, 20
Development Optimization	In what order should interventions be sequenced? Risk sets the deadline; development sets the pace.	Sections 11, 18
Human Survivability Dividend	What is the value of lives and capital protected?	Sections 12, 20

Source: H Heuristics Macroeconomic Architecture (Hughes, 2026h). Concepts developed by Hunter Hughes, Founder of H Heuristics.

PART I · SECTION 02

Where the Century Will Be Decided

Almost all of the world's remaining population growth will happen in countries that are both the most exposed to climate and other hazards and the least served by basic infrastructure. That makes them the places where the century's outlook will be won or lost.

IN BRIEF

- Countries at high INFORM risk hold 49% of humanity today and will hold 65% in 2100; they account for 96% of growth to 2050.
- Sub-Saharan Africa grows from 1.3 to 3.5 billion people, rising from one in six to one in three of humanity.
- Demography turns every service gap into a moving target: access must rise faster than population just to stand still.

2.1 The arithmetic of the coming century

The United Nations' medium projection puts the world's population at about 8.2 billion in 2025, 9.6 billion in 2050 and 10.2 billion in 2100, peaking in the 2080s (United Nations, 2024). The total matters less than the distribution. Population is already shrinking in East Asia and much of Europe and will soon peak in Latin America and South Asia. Growth over the rest of the century is concentrated in Sub-Saharan Africa, which rises from 1.3 billion to 2.2 billion in 2050 and 3.5 billion in 2100, and in parts of South Asia and the Middle East.

Using the INFORM risk index, which combines exposure to hazards with vulnerability and lack of coping capacity (European Commission JRC, 2026), the 55 countries rated at high risk (a score of 5 or more) hold 49% of the world's people today. Because they grow fastest, their share rises to 56% by 2050 and 65% by 2100. They will account for 96% of the increase in world population between 2025 and 2050 and already hold 61% of the world's children.

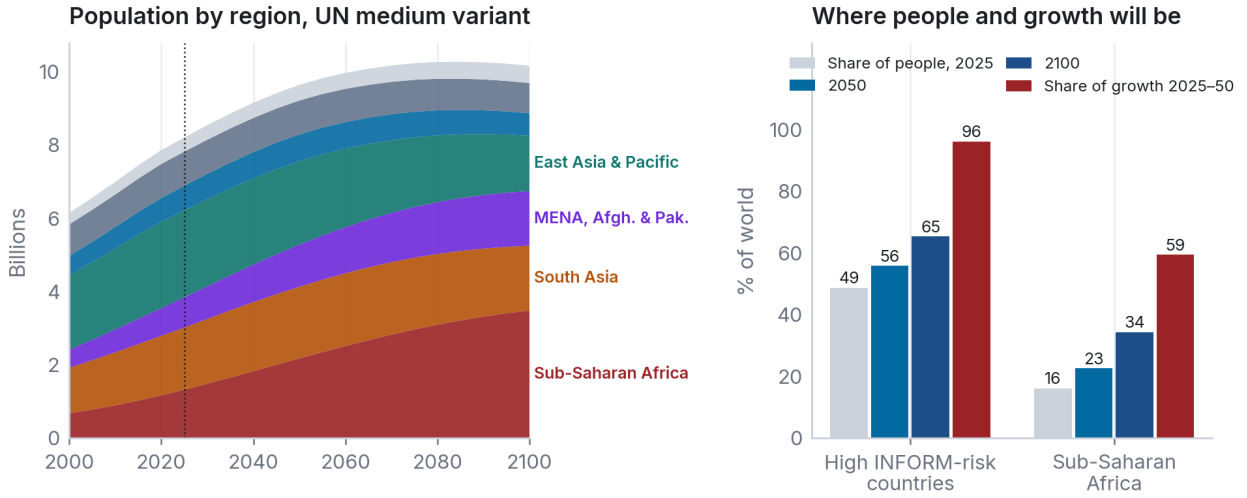
2.2 Survivability-risk regions

Several kinds of risk overlap in the same places. The tropical and subtropical belt that will hold most of the century's population growth also faces the steepest rise in dangerous heat, the greatest dependence on rain-fed agriculture and the thinnest health systems. In the 55 high-risk countries, which hold 4.0 billion people today, high hazard exposure coincides with high vulnerability and weak coping capacity. In the language of Human Vulnerability Reduction Economics, they are where exposure is rising fastest across all four arenas: the body (heat, disease, malnutrition), the household (income, housing, fuel), the community (water, health facilities, local infrastructure) and the system (food prices, debt, energy imports).

The term 'survivability risk' is used here in a precise sense: the risk that combined hazards push conditions beyond what people, with the resources available to them, can safely live through. It is a function of hazard and capacity together. A heatwave that is an inconvenience in a city with reliable electricity and cooling can be lethal in an informal settlement without either. That is

Figure 2 Population growth is concentrated in the highest-risk regions and countries

Left: population by World Bank region, billions. Right: share of world population and of population growth, %



Source: UN World Population Prospects 2024, medium variant (United Nations, 2024); INFORM Risk Index (European Commission JRC, 2026); H Heuristics calculations (Hughes, 2026a).

why development and adaptation cannot be separated. The same investment that raises productivity, such as reliable power, is often the one that makes extreme heat survivable.

Table 3 Population by region, 2000–2100 (billions)

Region	2000	2025	2050	2100	Change 2025–2100 (m)
Sub-Saharan Africa	0.68	1.32	2.17	3.48	+2,160
South Asia	1.24	1.69	1.96	1.77	+74
MENA, Afghanistan and Pakistan	0.49	0.83	1.15	1.49	+666
East Asia and Pacific	2.04	2.38	2.28	1.51	-864
Latin America and Caribbean	0.52	0.67	0.73	0.61	-55
Europe and Central Asia	0.86	0.93	0.92	0.82	-110
North America	0.31	0.39	0.43	0.47	+87

Source: UN World Population Prospects 2024, medium variant (United Nations, 2024); World Bank regions.

2.3 Why demography changes the strategy

Demography has three implications for strategy. First, **standing still means going backwards**. In a country whose population grows by 2.5% a year, an access rate that stays constant leaves more people without the service every year. Second, **early investment compounds**. Children born in the 2020s will be the workforce of the 2050s and the parents of the 2070s; their nutrition, schooling and health set the human capital of the second half of the century. Third, **lock-in is imminent**. Most of the cities, power systems and buildings that Africa and South Asia will use in 2070 have not been built yet. Building them well once is far cheaper than retrofitting them later (Hallegatte et al., 2019).

The demographic transition is also itself a lever. Where girls stay in school longer and families have access to health care and voluntary family planning, fertility falls, the share of working-age adults rises and a 'demographic dividend' becomes possible (Bloom, Canning and Sevilla, 2003). East Asia's rapid growth from the 1960s owed a significant share to this dividend (Bloom and Williamson, 1998). Whether Sub-Saharan Africa captures a similar dividend in the coming decades is one of the most consequential questions of the century, and it depends on investments made now (Section 9).

2.4 A second wave: urban growth

Most of this growth will be urban. The UN projects that about two-thirds of humanity will live in urban areas by 2050, with close to 90% of the increase in Asia and Africa (UN DESA, 2018). Many of the fastest-growing cities are small and medium-sized, with limited planning capacity, and much of their expansion is informal, on floodplains, steep slopes or low-lying coasts. Urbanisation is also the century's greatest development opportunity: cities raise productivity, make services cheaper to deliver and are where fertility falls fastest. Whether they become engines of convergence or concentrations of risk depends on decisions about land, infrastructure and building standards that are being made now.

The coincidence of population growth, urbanisation and rising hazards in the same regions is the defining geographical fact of the century. It means that the places where the outlook can be improved most are also the places where the cost of inaction rises fastest, which is the logic behind the priority this report gives to the Global South.

PART I · SECTION 03

Development Is the Master Variable

Hazards set the stage, but development decides how many people are harmed. The evidence of the past century is that rising incomes, services and institutions cut human losses dramatically, even when hazards do not shrink.

IN BRIEF

- The global death rate from natural disasters fell about 98% between the 1920s and the 2010s.
- Under-five mortality fell by more than half in low- and lower-middle-income countries since 1995.
- Proven-pace access to five basic services would avoid about 143 billion person-years of deprivation beyond the current trend, 2026–2100.

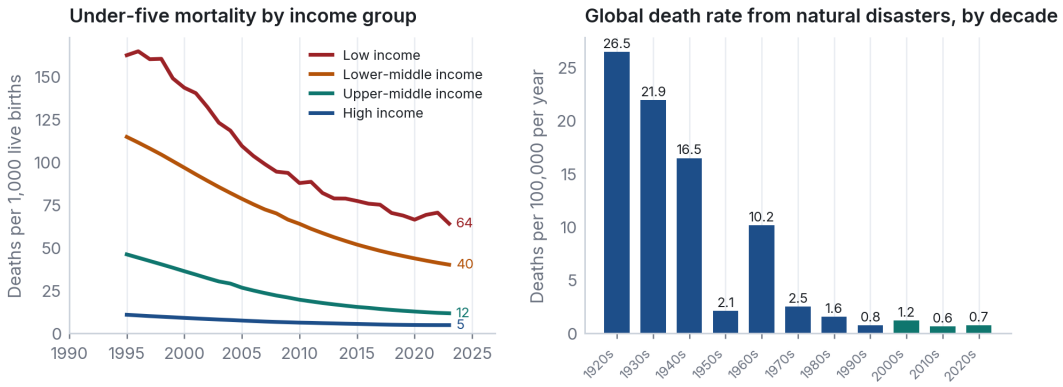
3.1 A century of falling vulnerability

In the 1920s, droughts, floods, storms and earthquakes killed on average about 26 people per 100,000 each year. By the 2010s the figure was 0.64, and in the first half of the 2020s about 0.7 (Ritchie et al., 2025; EM-DAT, 2025). The world did not become less hazardous over that period. What changed was capacity: famine early warning and food aid, cyclone shelters and forecasts, stronger buildings, faster medical response and, above all, higher incomes. Bangladesh is the classic case: cyclone deaths fell from hundreds of thousands in 1970 to a few thousand in recent storms of similar strength, thanks to warnings, shelters and volunteers (Haque et al., 2012).

Child survival tells the same story. Under-five mortality in low-income countries fell from about 163 deaths per 1,000 live births in 1995 to 64 in 2023; in lower-middle-income countries from 115 to 40. Vaccines, oral rehydration, insecticide-treated bed nets, better nutrition, clean water and mothers' schooling all contributed (Jamison et al., 2013). These are the interventions that later sections call human-capital compounders.

Figure 3 Development has cut child deaths and disaster deaths even as hazards persisted

Left: under-five deaths per 1,000 live births. Right: deaths from natural disasters per 100,000 people per year, decade averages



Source: World Bank WDI, SH.DYN.MORT, population-weighted by income group (World Bank, 2026c); EM-DAT via Our World in Data (Ritchie et al., 2025; EM-DAT, 2025). The 2020s cover 2020–2024.

3.2 Hazard is not destiny

Across 183 countries, the INFORM vulnerability score falls steeply with income (correlation -0.77), and the lack-of-coping-capacity score even more so (-0.87). Exposure to natural hazards is far less tied to income (-0.45). Countries in the richest fifth score 2.5 on vulnerability against 6.0 in the poorest fifth, a gap much larger than in hazard exposure (2.4 against 5.3) (European Commission JRC, 2026; Hughes, 2026c). Put simply, poorer countries are not mainly more at risk because nature treats them worse, but because they have less with which to protect themselves. That is the most hopeful finding in risk science, because capacity can be built.

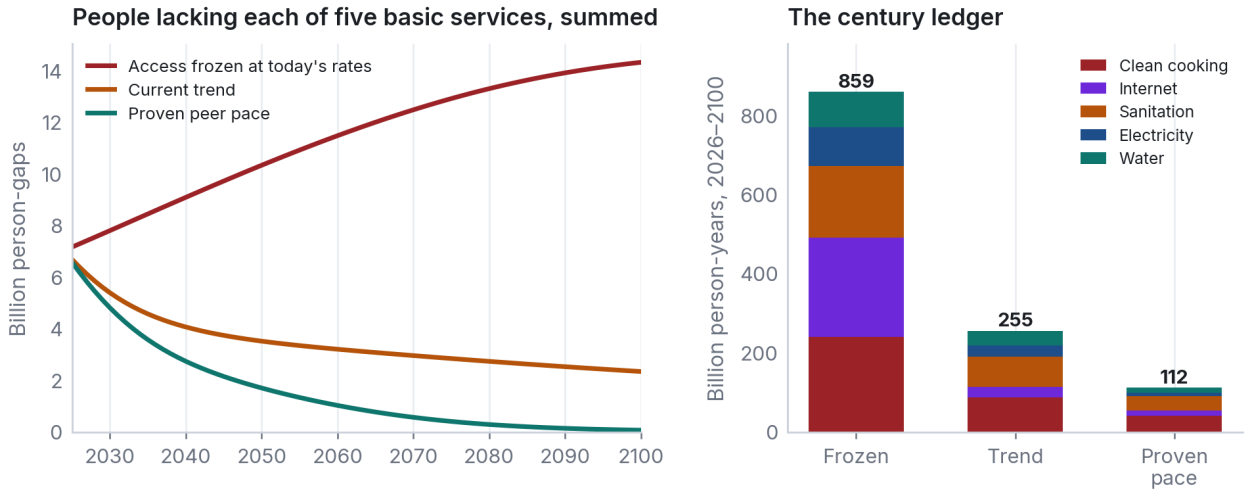
3.3 Exposure momentum: why pace matters more than direction

If development cuts vulnerability, the speed of development becomes the decisive variable. H Heuristics' Century Pathways analysis projects, for every country, the number of people lacking five basic services (electricity, clean cooking, internet use, basic drinking water and basic sanitation) from 2025 to 2100 under three paces of improvement (Hughes, 2026a). In the **frozen** scenario, access rates stay at today's level while populations grow. In the **trend** scenario, each country continues its 2012–2024 rate of progress. In the **proven pace** scenario, every country moves at least as fast as the top quarter of its peers have already managed.

Summed over the five services, the frozen scenario implies about 859 billion person-years of deprivation between 2026 and 2100. The trend scenario cuts this to 255 billion; the proven-pace scenario to 112 billion. The difference between trend and proven pace, about 143 billion person-years, requires no new technology. Clean cooking is the largest single item: at today's trend, 1.26 billion people would still cook with polluting fuels in 2050 and 0.80 billion in 2100; at proven pace, 0.74 billion in 2050 and almost none by 2100.

Figure 4 Proven peer pace cuts the century's deprivation ledger by seven-eighths compared with standing still

Left: people lacking each service, summed across five services, billions. Right: person-years of deprivation 2026–2100 by service, billions



Source: H Heuristics Century Pathways model (Hughes, 2026a), using World Bank WDI access data (World Bank, 2026c) and UN WPP 2024 population projections (United Nations, 2024). Logit-pace projections by country; proven pace is the 75th percentile of peer trends, 2012–2024.

3.4 From the ledger to lives

The November 2026 update adopted these figures as the H Heuristics benchmark (Hughes, 2026i): 859 billion person-years if access is frozen, 255 billion on the current trend and 112 billion at proven peer pace, a gap of about 143 billion between trend and proven pace. Closing even small parts of that gap matters: 0.5% of it is about 0.7 billion person-years, 1% about 1.4 billion and 2% about 2.9 billion. These are illustrative magnitudes, not forecasts of what any single programme will achieve.

Person-years translate into lives. Earlier H Heuristics work estimated that reaching universal clean cooking at proven pace rather than on trend would avoid roughly 2.9 to 6.7 million deaths from household air pollution by 2050, and that each year of delay costs on the order of 292,000 lives (Hughes, 2026e). Across child mortality more broadly, H Heuristics' convergence scenarios put the difference between fragmented and resilience-oriented convergence at roughly 150 million child deaths between 2024 and 2100 (Hughes, 2026c). These magnitudes are why the rest of the report concentrates on the pace of diffusion and on interventions that move several outcomes at once.

Table 4 The century ledger by service

Service	Frozen (bn p-yrs)	Trend (bn p-yrs)	Proven (bn p-yrs)	Without, 2100, trend (m)	Without, 2100, proven (m)
Clean cooking	240	88	42	801	14
Internet use	251	26	13	109	0
Basic sanitation	181	77	36	812	42
Electricity	98	27	8	163	4
Basic drinking water	89	37	13	460	10
Total	859	255	112		

Source: H Heuristics Century Pathways model (Hughes, 2026a). Person-years summed over 2026–2100.

PART II · SECTION 04

Sustainable Global Economic Convergence

Closing the gap between poorer and richer countries is the overarching development task of the century. The record since 1990 shows that convergence is possible, but that it has been narrower, more fragile and more carbon-intensive than headline averages suggest.

IN BRIEF

- Global South income rose from 13% to 23% of the high-income level, 1990–2024, but barely moved outside China and India.
- Poorer countries outgrew richer ones in 2000–2019 (beta -0.53); since 2019 the pattern has reversed.
- 78% of people in developing economies live where catch-up since 2000 was carbon-intensive.

4.1 What convergence means

Economic convergence is the process through which developing economies narrow the gaps in income, productivity and technology with advanced economies. For most of the nineteenth and twentieth centuries the opposite happened. A small group of industrialising countries pulled away from the rest, the 'Great Divergence' (Pomeranz, 2000), and by 1990 income per person in the high-income world was roughly eight times the Global South average. Growth theory predicts that poorer economies should grow faster because they can borrow technology rather than invent it (Solow, 1956; Gerschenkron, 1962). For decades the data did not cooperate: there was convergence among similar economies, but not across the world as a whole (Barro and Sala-i-Martin, 1992; Pritchett, 1997).

Sustainable Convergence, a concept developed by H Heuristics, widens the definition: the gaps should close through pathways that simultaneously advance productivity, technological capability, institutions, human development and environmental quality (Hughes, 2026g). It asks not only *whether* poorer countries are catching up but *how*, and whether the route is one that the planet and the countries' own institutions can sustain through shocks.

4.2 The record since 1990

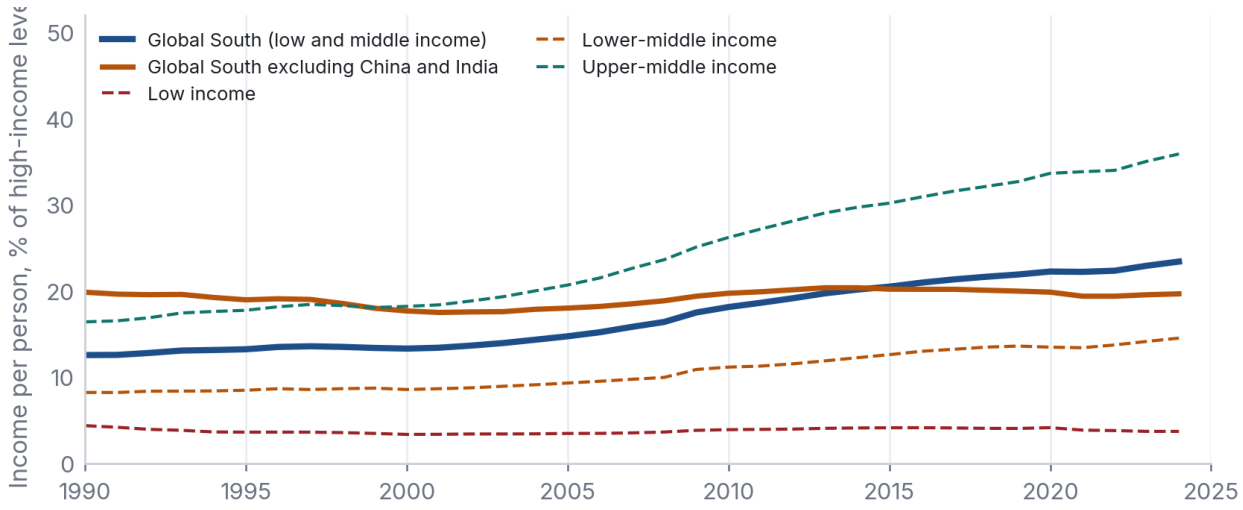
Between 1990 and 2024 average income per person in low- and middle-income economies rose from 12.6% to 23.4% of the high-income level (purchasing-power adjusted). That is real progress, and it lifted more than a billion people out of extreme poverty. But it was concentrated. Excluding China and India, the Global South stood at 20% of the high-income level in 1990 and 20% in 2024. Low-income countries slipped from 4.4% to 3.7%, while upper-middle-income countries doubled their relative position from 16% to 36% (Hughes, 2026c; World Bank, 2026c).

The timing matters. Across about 196 economies, poorer countries grew systematically faster than richer ones between 2000 and 2019 (a 'beta' coefficient of -0.53, meaning each doubling of ini-

tial income was associated with roughly half a percentage point slower growth). In 2000–2010, 85% of developing economies outgrew the United States. Since 2019 the relationship has reversed (beta +0.30), and only 39% of developing economies outgrew the United States in 2019–2024 (Hughes, 2026c; Kremer et al., 2022). Pandemic, inflation, debt and conflict shocks hit poorer economies harder and longer, a pattern the World Bank describes as a lost half-decade for development (World Bank, 2026a).

Figure 5 Convergence has been real but narrow: outside China and India the Global South has not gained ground since 1990

Income per person as % of the high-income average, 1990–2024



Source: World Bank WDI, GDP per person PPP (constant 2021 $), population-weighted (World Bank, 2026c); H Heuristics calculations (Hughes, 2026c).

4.3 Relative and absolute gaps

Convergence in ratios can coexist with divergence in dollars. Of 102 developing economies with full data, 90 became richer in absolute terms since 2000, yet the absolute dollar gap with high-income countries widened for 99 of them (Hughes, 2026g). Both measures matter. The ratio tells us whether catch-up is happening; the absolute gap tells us how much of the world's productive capacity, purchasing power and fiscal room remains concentrated in a minority of countries.

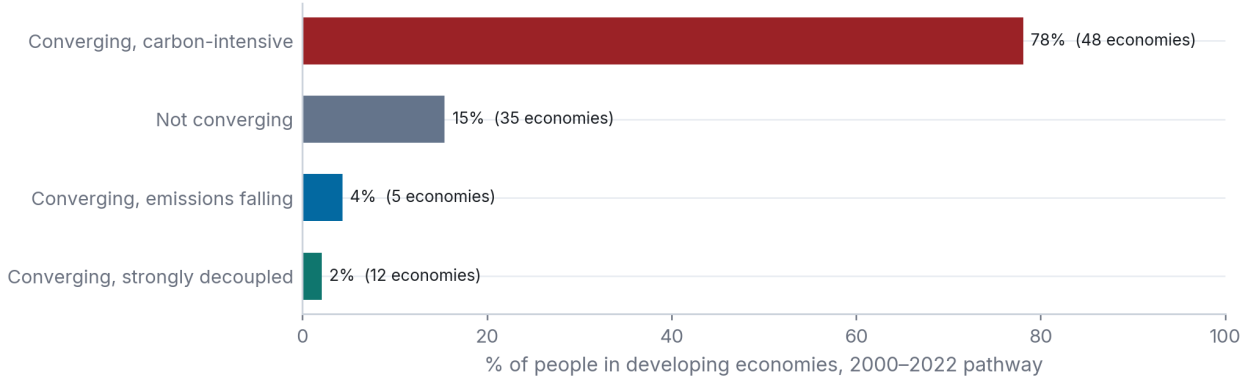
4.4 The pathway problem

How convergence has happened matters as much as how fast. Classifying developing economies by their income and emissions trajectories between 2000 and 2022, H Heuristics found that 78% of their people live in countries that converged on a **carbon-intensive** path, with emissions per person rising at least half as fast as income relative to the frontier. Only about 6% live where convergence came with falling or strongly decoupled emissions, and 15% live in countries that did not converge at all (Hughes, 2026g).

This is the central tension the century must resolve. If the remaining four-fifths of humanity follows the historical route, the climate damage would undermine the very gains it produced. The good news, developed in Section 8, is that the cost of clean alternatives has collapsed, so the cheapest path and the cleanest path are increasingly the same.

Figure 6 Most catch-up since 2000 has been carbon-intensive; very little has been clean

Share of people in developing economies by 2000–2022 pathway, %



Source: H Heuristics Sustainable Convergence typology (Hughes, 2026g), using World Bank WDI and Global Carbon Project data via Our World in Data (World Bank, 2026c; Our World in Data, 2025a).

4.5 Convergence as resilience

Convergence and resilience reinforce each other. Richer countries recover faster from shocks because they have fiscal room, insurance, savings and capable institutions; countries that recover faster lose fewer years of growth to each shock and so converge faster. H Heuristics' earlier analysis found that the reversal of convergence after 2019 was driven largely by the depth and persistence of shocks in the poorest economies rather than by any slowdown in their underlying potential (Hughes, 2026c). A strategy for convergence that ignores resilience will keep being interrupted; a strategy for resilience that ignores convergence will keep running short of the resources it needs. That is why this report treats them as one objective.

PART II · SECTION 05

Emerging Economies as the Engine

The developing world already produces more than half of global output at purchasing-power parity and holds more than four-fifths of humanity. How its economies transform, and whether that transformation can be clean and resilient, will set the trajectory of the whole century.

IN BRIEF

- Structural transformation, from farms to factories and services, has been the main route to prosperity, but manufacturing now peaks earlier and lower.
- Agriculture still employs 56% of workers in low-income countries, against 66% in 2000; manufacturing's share of output has not grown.
- Services, digital trade, green industry and regional integration open new routes, if infrastructure, skills and finance are in place.

5.1 Why emerging economies matter for everyone

Emerging and developing economies account for most global growth, most new energy demand, most new urban construction and most of the coming century's population growth. Their choices about power systems, cities, transport and industry will determine whether global emissions fall fast enough, whether pandemics are caught early, whether food supply keeps pace with demand and whether the world economy remains open. Emerging economies are therefore not just recipients of development; they are the engine through which humanity's outlook is decided (Hughes, 2026g).

5.2 Structural transformation, old and new

Historically, countries grew rich by moving workers from low-productivity farming into higher-productivity manufacturing, then services (Lewis, 1954; McMillan et al., 2014). That route is narrowing. In low-income countries, agriculture's share of employment fell from about 66% in 2000 to 56% in 2024, but manufacturing's share of output stayed at about 8%; most workers who left farms moved into low-productivity services. Across countries, manufacturing's share of output peaks at around $21,000 per person, earlier and lower than in the past, a pattern Rodrik calls premature deindustrialisation (Rodrik, 2016; Hughes, 2026c).

Three newer routes are opening. **Tradable services**, from business process outsourcing to software, design and remote work, let countries sell skills without building factories, if workers are connected and trained (Section 7). **Green industry**, from processing critical minerals to assembling solar systems, batteries and electric two- and three-wheelers, creates demand that did not exist a decade ago (IEA, 2025). **Agricultural transformation**, raising yields, adding storage and processing, and connecting farmers to markets, remains the largest employment opportunity in Africa and South Asia (Section 16).

5.3 The foundations of productive capacity

Whatever the route, the same foundations recur: reliable electricity, transport and connectivity; healthy, educated workers; macroeconomic stability and functioning institutions; and access to finance at a reasonable cost. Firms in developing economies frequently cite power outages, poor roads, skill shortages and the cost of credit as their binding constraints (World Bank, 2026b). The interventions profiled in Part III are, in large part, ways of supplying these foundations in forms that also cut emissions and exposure.

Table 5 Structural change by income group, 2000 → 2024

Income group	Agriculture, % of jobs	Industry, % of jobs	Services, % of jobs	Manufacturing, % of GDP
Low income	66 → 56	11 → 11	23 → 33	8 → 8
Lower-middle income	55 → 40	16 → 22	29 → 38	14 → 13
Upper-middle income	40 → 20	23 → 27	37 → 53	19 → 20
High income	7 → 3	27 → 22	66 → 75	17 → 14

Source: World Bank WDI (ILO modelled employment; national accounts), medians by income group (World Bank, 2026c; Hughes, 2026c).

5.4 Regional integration

Small domestic markets limit specialisation. Regional integration, such as the African Continental Free Trade Area, can let firms reach scale, build regional value chains and keep more processing of minerals and farm products at home. World Bank modelling found that full implementation of the AfCFTA could raise African real incomes by about 7% and lift some 30 million people out of extreme poverty by 2035, mainly through lower non-tariff barriers and trade facilitation (World Bank, 2020). These gains depend on roads, ports, border procedures and payment systems, which is why trade integration is treated in this report as an enabler (Section 17).

PART II · SECTION 06

The Diffusion of Innovations

Humanity already possesses most of the technologies needed to transform living conditions this century. The bottleneck is diffusion: how fast beneficial technologies, knowledge and practices spread from where they are invented to where they are needed most.

IN BRIEF

- Mobile phones reached half of low-income countries' populations 14 years after high-income countries; electricity still has not, after more than a century.
- Device-based technologies diffuse in years; network-, institution- and behaviour-dependent ones take decades.
- Diffusion is conditional on absorptive capacity: power, skills, finance and institutions.

6.1 Invention versus diffusion

An essential distinction runs through this report: between **technological invention** and **technological diffusion**. Vaccines, oral rehydration salts, solar panels, mobile money, drought-tolerant seeds, LPG and electric cooking, early-warning systems and online learning platforms all exist. Their benefits are limited not by whether they have been invented, but by whether they have reached the people who need them. Studies of technology adoption across 166 countries and two centuries find that poorer countries now adopt new technologies much sooner after invention than they used to, but that the intensity of use, how widely and deeply a technology is used once it arrives, still lags far behind, and that these usage gaps account for a large share of income differences (Comin, 2010; Comin and Mestieri, 2018).

The process follows a familiar S-curve: slow early adoption by innovators, rapid spread as imitation and falling costs take hold, and a long tail as the last users join (Rogers, 2003; Bass, 1969). Costs fall predictably with cumulative production, a pattern first documented in aircraft manufacture and since observed for solar modules, batteries and many other technologies (Wright, 1936; Way, 2022). Policy can shift every part of the curve: it can lower costs, reduce risk for early adopters, and reach the last users that markets neglect.

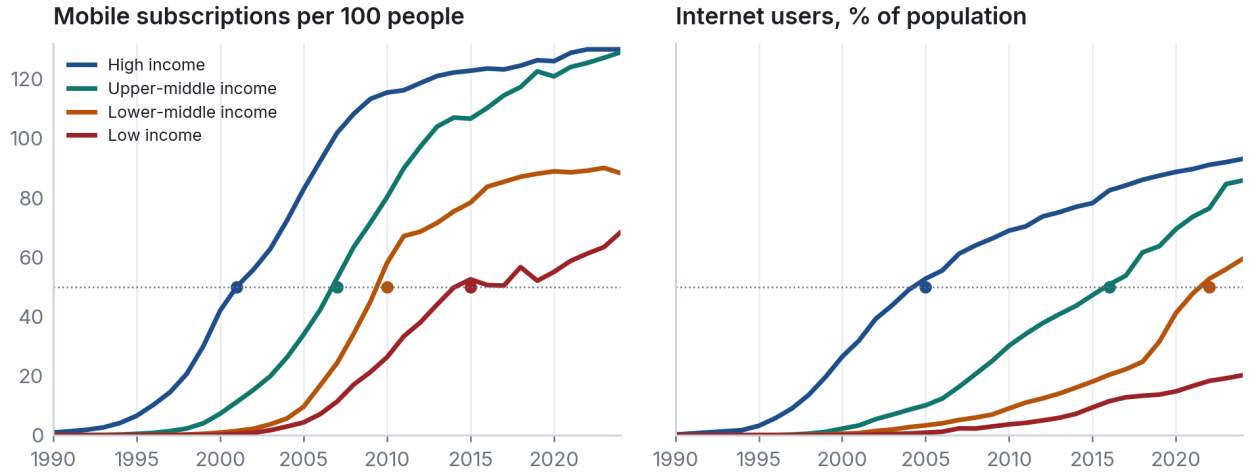
6.2 How fast different technologies spread

The diffusion record of the past three decades shows both how fast technology can spread and how unevenly. Mobile subscriptions passed half the population of high-income countries in 2001, of upper-middle-income countries in 2007, of lower-middle-income countries in 2010 and of low-income countries in 2015. Internet use followed the same order more slowly: low-income countries had reached only about 20% by 2024.

The table shows when each income group first passed half its population for five technologies. Two patterns stand out. Device-based technologies that can be bought and used individually, such as mobile phones, spread to low-income countries within about fifteen years of rich ones.

Figure 7 Mobile phones spread to low-income countries in a decade; the internet is following more slowly

Adoption by income group, 1990–2024



Source: World Bank WDI, IT.CEL.SETS.P2 and IT.NET.USER.ZS, population-weighted by income group (World Bank, 2026c). Dots mark the year each group crossed 50%.

Network technologies that need grids, institutions or changes in daily behaviour, such as electricity and clean cooking, are taking generations.

Table 6 Year in which each income group first reached 50% adoption

Technology	High income	Upper-middle	Lower-middle	Low income	Low income, latest
Mobile subscriptions (per 100)	2001	2007	2010	2015	68%
Internet use	2005	2016	2022	not yet	20%
Financial account (adults)	2011	2011	2017	not yet	45%
Electricity access	before 1991	1995	1997	not yet	49%
Clean cooking	2000	2001	2018	not yet	16%

Source: World Bank WDI, population-weighted group averages (World Bank, 2026c); Findex series begins 2011 (World Bank, 2025); clean cooking series begins 2000.

6.3 What determines the pace

Four conditions explain most of the variation in diffusion speed. **Cost and modularity**: technologies sold in small units, like phones, solar home systems and two-wheelers, spread faster than those needing large up-front investment. **Complementary infrastructure**: the internet needs electricity, and in 179 of 181 countries internet use is no higher than electricity access (Hughes, 2026e). **Capability**: the skills, firms and institutions needed to use, maintain and adapt a technology, sometimes called absorptive capacity. **Finance and risk**: high interest rates and currency risk make capital-intensive clean technologies much more expensive in developing economies than in rich ones (IEA, 2024).

This is why the report emphasises bundles. A solar mini-grid without customers who can afford appliances, an online course without electricity or skills, or a clean stove without a reliable fuel supply each fails for want of a complement. H Heuristics calls the resulting gap between avail-

ability and effective use a diffusion gap, and argues that closing it is the single most important mechanism for accelerating development this century (Hughes, 2026a).

DIFFUSION

Priority areas for accelerated diffusion

- **Agricultural technology**: improved and stress-tolerant seeds, precision irrigation, storage and digital advisory.
- **Medical innovations and vaccines**: routine immunisation, new malaria and tuberculosis vaccines, diagnostics.
- **Renewable energy and storage**: solar, wind, batteries and efficient appliances.
- **Artificial intelligence and automation**: AI tutoring, decision support, translation and productivity tools.
- **Digital financial services**: instant payments, mobile money and digital identification.
- **Educational technologies**: structured, adaptive learning platforms that teach at the right level.
- **Water purification and sanitation**: safe water points, treatment and affordable sanitation.
- **Climate adaptation technologies**: early warning, cooling, flood protection and heat-resilient building.

Accelerated diffusion is therefore measurable. For each technology and country, the relevant questions are how many years separate it from the leaders at the same adoption level, how fast it is moving compared with the best of its peers, and what share of those with access actually use the technology productively. These three measures, the diffusion lag, the pace gap and the conversion rate, are used in Part IV to set targets.

PART II · SECTION 07

Digital Infrastructure and Digital Public Goods

Connectivity, digital identity, instant payments and shared data systems have become the rails on which modern economies and states run. Where they are open and inclusive they cut costs for everyone; where they are missing, people are excluded from markets, services and support in a crisis.

IN BRIEF

- About 3.1 billion people live within range of mobile broadband but do not use it; the usage gap is ten times the coverage gap.
- Account ownership reached 79% of adults worldwide in 2024, and 75% in developing economies.
- Internet use is no higher than electricity access in 99% of countries: digital inclusion is gated by power.

7.1 From access to rails

Digital infrastructure has two layers. The **connectivity layer** is the networks, devices and electricity that let people get online. The **public-infrastructure layer**, increasingly called digital public infrastructure (DPI), is the shared, interoperable systems built on top: foundational digital identity, fast and cheap payments, and secure ways to share data with consent (UNDP, 2023). India's Aadhaar identity and UPI payment system and Brazil's Pix instant payments are the best-known examples; open-source building blocks such as MOSIP let other countries adopt similar systems at lower cost (NPCI, 2025; Banco Central do Brasil, 2025; MOSIP, 2025).

Coverage is no longer the main problem. The GSMA estimates that about 96% of the world's population is covered by mobile broadband, but that some 3.1 billion people, 38% of the world, live under coverage and do not use mobile internet: a 'usage gap' ten times larger than the 300 million people with no coverage at all (GSMA, 2025). The barriers are affordability of devices and data, literacy and digital skills, relevance of content and, for women in many countries, social norms. Financial inclusion has advanced faster: global account ownership reached 79% of adults in 2024, and 75% in low- and middle-income economies, driven largely by mobile money (World Bank, 2025).

7.2 Why digital rails matter for development

The evidence that digital rails can generate several dividends at once is strong. In Kenya, access to M-Pesa mobile money lifted an estimated 2% of households out of extreme poverty, with especially large effects for female-headed households, partly by helping women move from farming into business (Suri, 2016). In India, paying welfare benefits through biometric smartcards cut leakage and delays and made payments faster and more predictable at no extra cost (Muralidharan, 2016). The arrival of fast internet in African countries raised employment, including skilled employment, in connected areas (Hjort, 2019).

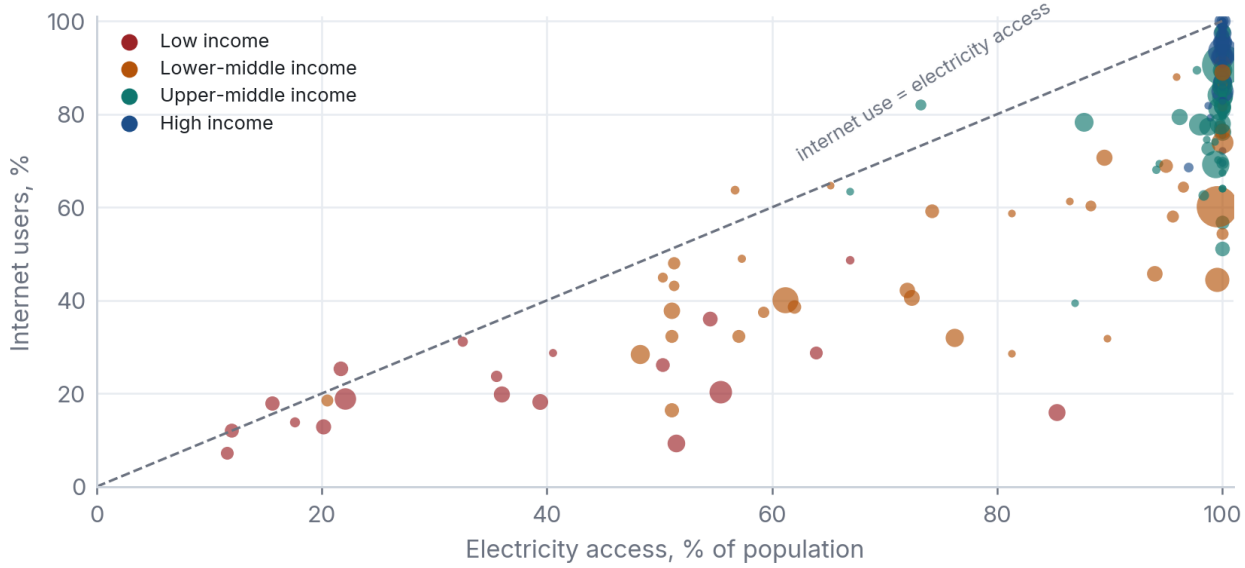
Digital rails also turn out to be resilience infrastructure. During the COVID-19 pandemic, countries with digital identity, payment systems and social registries were able to reach new beneficiaries in days or weeks rather than months. Togo's Novissi programme used mobile phone data and machine learning to target cash transfers to the poorest during lockdown, reducing exclusion errors compared with feasible alternatives (Aiken et al., 2022). The same rails can deliver anticipatory cash ahead of a forecast flood or drought, the bridge between digital infrastructure and Polycrisis Resilience.

7.3 The electricity gate

Connectivity runs on power. The simplest test of this dependency is to compare, country by country, the share of people using the internet with the share who have electricity at home.

Figure 8 Digital inclusion is gated by electricity: almost no country has more internet users than people with power

Internet users against electricity access, % of population, by country



Source: World Bank WDI, EG.ELC.ACCS.ZS and IT.NET.USER.ZS, latest year (World Bank, 2026c); H Heuristics Positive Pathways analysis (Hughes, 2026e). Bubble size proportional to population.

Across 181 countries, internet use is no higher than electricity access in 99% of cases (Hughes, 2026e). Digital strategies that ignore power will stall. The opposite is also true: once a household has electricity, a phone and data, the marginal cost of adding digital services is low. That makes

electricity, connectivity and DPI one of the clearest examples of a joint gate, where several investments must arrive together for any of them to pay off.

7.4 Risks to manage

Digital rails concentrate power. Poorly governed identity systems can exclude people without documents, expose personal data or enable surveillance; payment systems can be captured by a few providers; algorithmic targeting can encode bias. The design principles that distinguish public infrastructure from private platforms, namely openness, interoperability, privacy by design, grievance redress and inclusive enrolment, are therefore not optional extras but conditions for the development dividend (Gelb, 2018; UNDP, 2023).

Table 7 The building blocks of digital public infrastructure

Layer	What it does	Examples	Development use	Safeguard needed
Foundational ID	Proves who someone is, digitally	Aadhaar (India), MOSIP-based systems	Accounts, SIM cards, benefits, school records	Inclusive enrolment; data protection
Instant payments	Moves money cheaply in real time	UPI (India), Pix (Brazil), M-Pesa (Kenya)	Wages, remittances, merchant payments, emergency cash	Interoperability; consumer protection
Data exchange	Shares data with consent between systems	Consent managers, open-banking rails	Credit histories, health records, targeting	Consent, purpose limits, audit
Connectivity and devices	Gets people online	Mobile broadband, $30 smartphones	Learning, services trade, information	Affordability; digital skills

Source: H Heuristics synthesis of (UNDP, 2023; Gelb, 2018; NPCI, 2025; Banco Central do Brasil, 2025; Suri, 2016; GSMA, 2025).

PART II · SECTION 08

The Green Transition and the Latecomer Advantage

Clean energy has become the cheapest source of new electricity in most of the world. That turns the green transition from a cost that developing economies must bear into an opportunity to develop faster, more cleanly and with fewer imported-fuel shocks than earlier industrialisers.

IN BRIEF

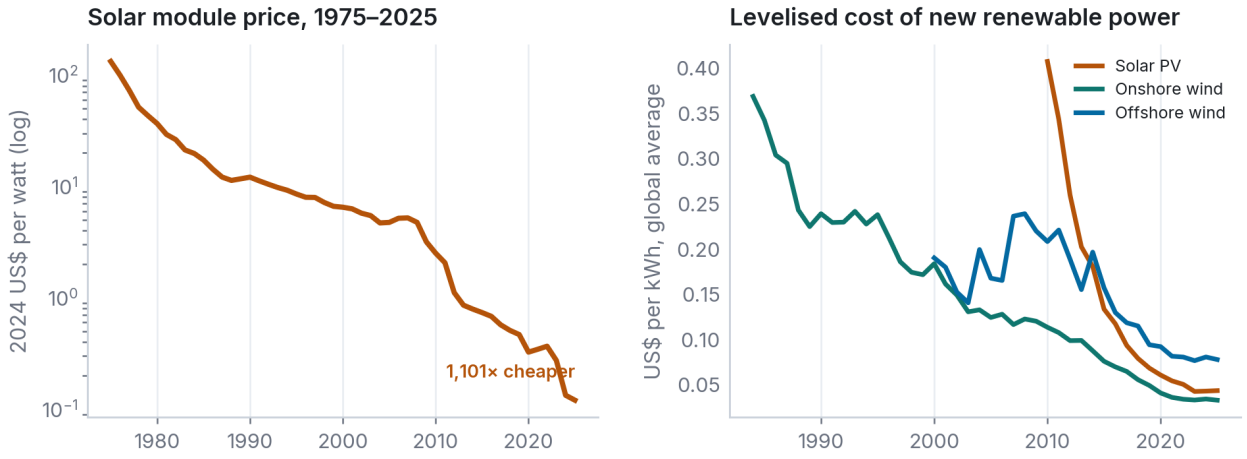
- Solar module prices have fallen roughly 1,101-fold since 1975 and about 21-fold since 2010.
- Countries reaching $10,000 per person after 2000 did so with a median 2.9 t CO_2 per person, against 4.4 t for those that got there before 1970.
- High cost of capital, not technology, is now the main brake on clean investment in developing economies.

8.1 The cost revolution

In 1975 a watt of solar module capacity cost about $132 in today's money; in 2025 it cost about $0.12 (Our World in Data, 2025b). The global average cost of electricity from new utility-scale solar fell from about $0.41 per kilowatt-hour in 2010 to about $0.044 in 2025 (IRENA, 2025). Battery pack prices have followed a similar curve (BloombergNEF, 2025). These are textbook learning curves, and empirically grounded forecasts suggest that a fast transition is likely to save money overall rather than cost it (Way, 2022).

Figure 9 Clean electricity has become the cheapest new power in most of the world

Left: solar module price, 2024 US$ per watt, log scale. Right: global average levelised cost of new renewable power, US$ per kWh



Source: Our World in Data, solar PV module prices (Our World in Data, 2025b); IRENA Renewable Power Generation Costs (IRENA, 2025).

8.2 The latecomer advantage

Latecomers can skip stages. Among countries that first reached $10,000 per person (PPP), those that got there after 2000 did so with a median of 2.9 tonnes of CO_2 per person, against 4.4 tonnes for those that got there before 1970 (Hughes, 2026g). Pakistan's rapid, largely unplanned adoption of rooftop solar, with installed capacity estimated above 27 gigawatts by early 2026, shows how quickly cheap modular technology can spread when grid power is expensive and unreliable (pv magazine, 2026). Bangladesh's solar home systems programme connected millions of off-grid households in a decade (World Bank, 2021).

The advantage is not automatic. Most catch-up since 2000 has still been carbon-intensive (Section 4), and coal capacity continues to be added in parts of Asia. The difference between a clean and a dirty latecomer path is decided by finance, grid planning, industrial policy and the speed at which existing assets are replaced. Once a coal plant, a gas-dependent industrial cluster or a cardependent city is built, it locks in emissions and costs for decades (Unruh, 2000; Arthur, 1989).

8.3 Clean air as a development dividend

The green transition is often discussed as a climate policy, but for most people in developing economies its most immediate benefit is cleaner air. Population-weighted fine-particle pollution (PM2.5) averaged about 48 μg/m^3 in lower-middle-income countries in 2020, against 13 in high-income countries and a WHO guideline of 5 (WHO, 2021; World Bank, 2026c). Burning fossil fuels and biomass is the main source. Every coal plant not built, every household that switches from wood to clean cooking and every bus that runs on electricity reduces both emissions and the burden of respiratory and cardiovascular disease (Romanello, 2025).

8.4 The binding constraint: cost of capital

Clean energy is capital-intensive: most of its lifetime cost is paid up front, while fossil fuel plants spend more on fuel over time. That makes it highly sensitive to interest rates. The International Energy Agency estimates that the cost of capital for clean energy projects in emerging and developing economies is often two to three times higher than in advanced economies, which can make the same solar farm cost far more per unit of electricity (IEA, 2024). Lowering this premium through guarantees, local-currency finance and better project preparation is therefore one of the highest-leverage climate and development policies available (Section 17).

PART II · SECTION 09

Human Development and the Demographic Dividend

People are both the purpose of development and its main engine. Health, nutrition, learning and the timing of the demographic transition determine how much a growing population can produce, how well it can adapt and how quickly the next generation can do better.

IN BRIEF

- Across developing economies, each 10 points of secondary enrolment is associated with 0.39 fewer births per woman (r = -0.78); the link holds after income (-0.40).
- Each extra year of schooling raises earnings by about 9% on average, more for women.
- About 70% of 10-year-olds in low- and middle-income countries could not read a simple text in 2022.

9.1 The compounding asset

Human capital compounds. Healthy, well-nourished children learn more in school; educated adults earn more, adopt new technologies faster and invest more in their own children. The returns to early investment are especially high because they raise the productivity of everything that follows (Heckman, 2006). Across the world, each additional year of schooling raises earnings by about 9% on average, with higher returns for women than for men (Psacharopoulos, 2018). Education also strengthens adaptive capacity: across countries, more educated populations suffer far fewer deaths from comparable natural disasters (Lutz et al., 2014).

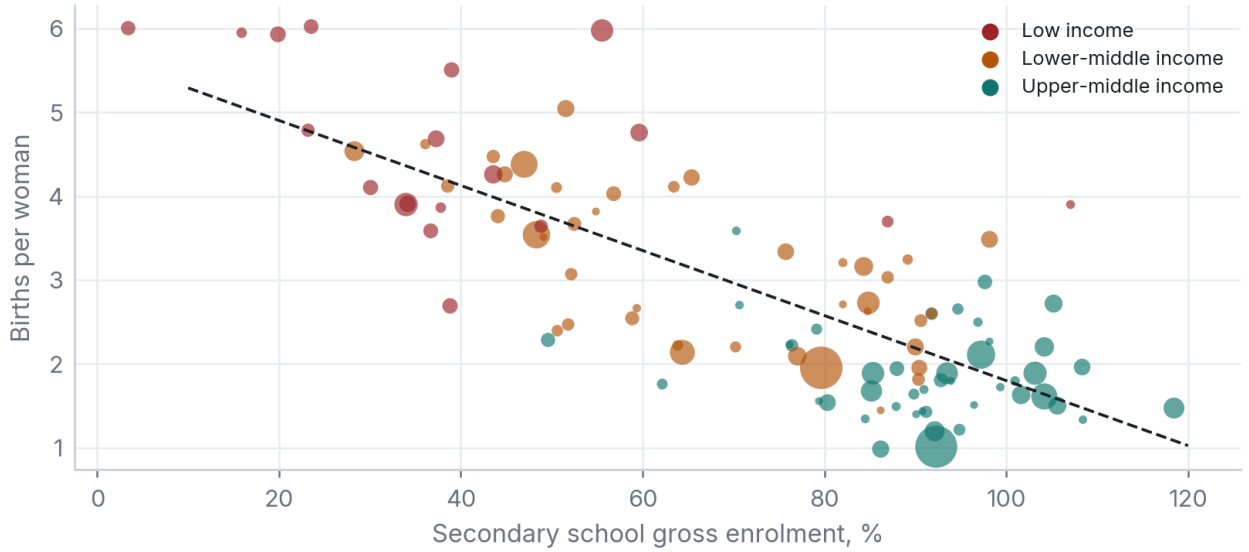
Yet the learning gap is severe. Before the pandemic about 57% of 10-year-olds in low- and middle-income countries could not read and understand a simple text, and school closures pushed the estimate to about 70% (World Bank, 2022). Being in school is not the same as learning. That is why the most cost-effective education interventions are those that change what happens in the classroom, such as structured pedagogy and teaching children at their actual level (GEEAP, 2023; Banerjee et al., 2016).

9.2 Girls' education and the demographic transition

Girls' secondary education sits at the junction of several dividends. It raises women's earnings, improves child health and nutrition, and is one of the strongest correlates of lower fertility. Across 104 developing economies, each 10 percentage points of secondary school enrolment is associated with about 0.39 fewer births per woman (correlation -0.78); holding income fixed, the partial correlation is still -0.40. Experimental evidence supports a causal role: in Ghana, scholarships for free senior secondary school increased educational attainment and reduced the number of children women had by their mid-twenties (Duflo, Dupas and Kremer, 2021), and in India, recruiting young women for business process outsourcing jobs led girls in nearby villages to stay in school longer and delay marriage and childbearing (Jensen, 2012).

Figure 10 Where more young people are in secondary school, families are smaller

Total fertility rate against secondary school gross enrolment, by country



Source: World Bank WDI, SE.SEC.ENRR (gross secondary enrolment, both sexes; female series unavailable at time of writing) and SP.DYN.TFRT.IN, latest year (World Bank, 2026c). Developing economies; bubble size proportional to population.

9.3 The demographic dividend is a choice

When fertility falls, the number of working-age adults grows faster than the number of dependants for several decades. If those adults are healthy, educated and employed, income per person can rise quickly; this demographic dividend accounted for a large share of East Asia's growth miracle (Bloom and Williamson, 1998; Bloom, Canning and Sevilla, 2003). If they are not, a youth bulge becomes a source of unemployment, migration pressure and instability. The dividend is therefore not a demographic fact but a policy outcome, decided by investment in girls' schooling, health, voluntary family planning and job creation.

The same investments are also among the most powerful climate adaptation measures. Educated, healthy populations with smaller families are better able to anticipate, absorb and recover from shocks, and slower population growth eases pressure on water, land and urban infrastructure (Lutz et al., 2014). That is why girls' education and voluntary family planning appear at the top of the illustrative ranking in Section 18.

9.4 Health as infrastructure

Health systems are the human equivalent of resilient infrastructure. Childhood immunisation is among the highest-return investments known: across 94 low- and middle-income countries, every dollar spent on vaccines in 2011–2020 was estimated to return about $16 in avoided illness costs and $44 when the broader value of longer, healthier lives is included (Ozawa et al., 2016). Primary health care, nutrition programmes and safe water and sanitation complete the foundation. The 'Global Health 2035' commission concluded that a 'grand convergence' in health, bringing infectious, maternal and child deaths in poorer countries down to the levels of today's best middle-income performers, is achievable within a generation (Jamison et al., 2013).

PART II · SECTION 10

Polycrisis Adaptation in Survivability-Risk Regions

Adaptation is not a separate agenda from development; it is development designed for the climate and risks of the century ahead. Where population growth meets rising hazards, protecting baseline survivability is a precondition for every other gain.

IN BRIEF

- Investing $1.8 trillion in five adaptation areas could yield $7.1 trillion in net benefits; returns of 2:1 to 10:1 are common.
- Twenty-four hours' warning of a storm or heatwave can cut damage by about 30%.
- Adaptation works best when it is built into development: cities, power, farming, health and finance.

10.1 Why adaptation is unavoidable

Even with rapid emission cuts, warming of around 1.5°C or more is now very likely within the next decade or two, and hazards will intensify accordingly (IPCC, 2023; WMO, 2026). The places where hazards rise most steeply, the tropics and subtropics, are also where population grows fastest (Section 2). Countries at high INFORM risk will hold 65% of humanity by 2100 (Hughes, 2026a). Without adaptation, the same climate shock would harm far more people each decade simply because more people live in harm's way. With it, exposure can be held down even as hazards rise.

Polycrisis adaptation means more than adapting to climate alone. Shocks interact: a drought raises food prices, which strains household budgets and public finances, which cuts health spending just as heat stress and disease rise. The H Heuristics Polycrisis Resilience framework stresses six capacities, among them preventive, absorptive and adaptive capacity, that make societies robust across many kinds of shock rather than to one hazard at a time (Hughes, 2026d).

10.2 The economics of acting early

The Global Commission on Adaptation estimated that investing $1.8 trillion between 2020 and 2030 in five areas (early warning systems, climate-resilient infrastructure, improved dryland agriculture, mangrove protection and resilient water management) could generate $7.1 trillion in net benefits, with benefit-cost ratios commonly between 2:1 and 10:1. It also found that 24 hours' warning of a coming storm or heatwave can cut the ensuing damage by about 30% (Global Commission on Adaptation, 2019). H Heuristics' Preventive Development Economics builds on this evidence: investing before disasters is usually cheaper than paying after them, and the gains are largest where development deficits are greatest (Hughes, 2026f).

The record supports the logic. Early warning systems now cover a growing share of the world, and countries with comprehensive multi-hazard warning have disaster mortality several times

lower than those with limited coverage (UNDRR and WMO, 2023). The UN's Early Warnings for All initiative aims to cover everyone on Earth by 2027 (United Nations, 2022). Heat action plans, from Ahmedabad in India onward, have shown that simple measures such as public warnings, cooling centres and adjusted work hours can reduce heat deaths.

10.3 Four arenas of adaptation

Adaptation needs differ by hazard, but four arenas account for most of the risk to human survivability in the fastest-growing regions: heat, water, food and health. Each has a short list of proven, high-value investments, and each investment also pays a development dividend.

Table 8 Polycrisis adaptation: four arenas and their highest-value investments

Arena	Main hazards	Highest-value investments	Co-benefits
Heat	Extreme heat, humid heat, urban heat islands	Heat action plans, passive cooling, shade and canopy, efficient cooling, reliable power	Labour productivity, health, lower energy bills
Water	Drought, floods, salinisation	Water storage and efficiency, 'sponge' urban design, flood buffers, WASH	Health, agriculture, urban productivity
Food	Harvest failure, price spikes	Stress-tolerant seeds, irrigation, storage and cold chains, crop insurance	Rural incomes, nutrition, less food loss
Health and biosecurity	Epidemics, vector-borne disease spread	Surveillance, primary care, regional vaccine manufacturing, immunisation	Child survival, health system strength

Source: H Heuristics synthesis of (Global Commission on Adaptation, 2019; Hallegatte et al., 2019; Romanello, 2025).

10.4 Adaptation as development, not instead of it

The most effective adaptation is often ordinary development done well. Reliable electricity makes cooling and refrigeration possible; piped water and sanitation reduce disease after floods; paved roads keep markets open; savings, insurance and social protection stop a bad harvest from becoming a lifelong poverty trap (Hallegatte et al., 2016). This is why the interventions in Part III are judged both on their development returns and on how much they cut exposure and vulnerability. The goal is a development path whose every step also makes the next shock less damaging.

PART III · SECTION 11

Thinking in Multiple Dividends

The greatest opportunity this century is not to maximise growth, technology or environmental quality separately, but to find the interventions that improve several of them at once and that make the next round of progress easier.

IN BRIEF

- Multidimensional interventions produce reinforcing benefits across economic, health, environmental and resilience outcomes.
- Benefits travel along conversion chains: access → capability → productivity → development → reinvestment.
- The weakest link in a chain, or a missing complement, can cancel the whole dividend.

11.1 The multi-dividend principle

Development agencies usually evaluate an intervention against one objective at a time: an energy project by megawatts, a school programme by enrolment, a health programme by deaths averted. But many of the most valuable interventions pay off in several currencies at once. Clean cooking reduces household air pollution, improves respiratory health, saves the hours women and girls spend collecting fuel and reduces pressure on forests. Digital upskilling increases productivity, opens employment, reduces poverty and connects workers to global markets. Renewable energy diffusion improves energy access, reduces emissions and supports industrial development. Climate-resilient infrastructure protects growing populations while preserving long-term productivity.

H Heuristics calls the preference for such investments the **Multi-Dividend principle**: when resources are scarce, prefer investments that build several kinds of capital at once (Hughes, 2026a). The idea is not new. Economists have long discussed 'double dividends' from environmental taxes, 'co-benefits' of climate policy and the 'triple dividend of resilience' (avoided losses, unlocked investment and development co-benefits) (Tanner, 2015). What this report adds is an attempt to compare interventions across dimensions on a common footing, and to test some of those comparisons with data (Section 12).

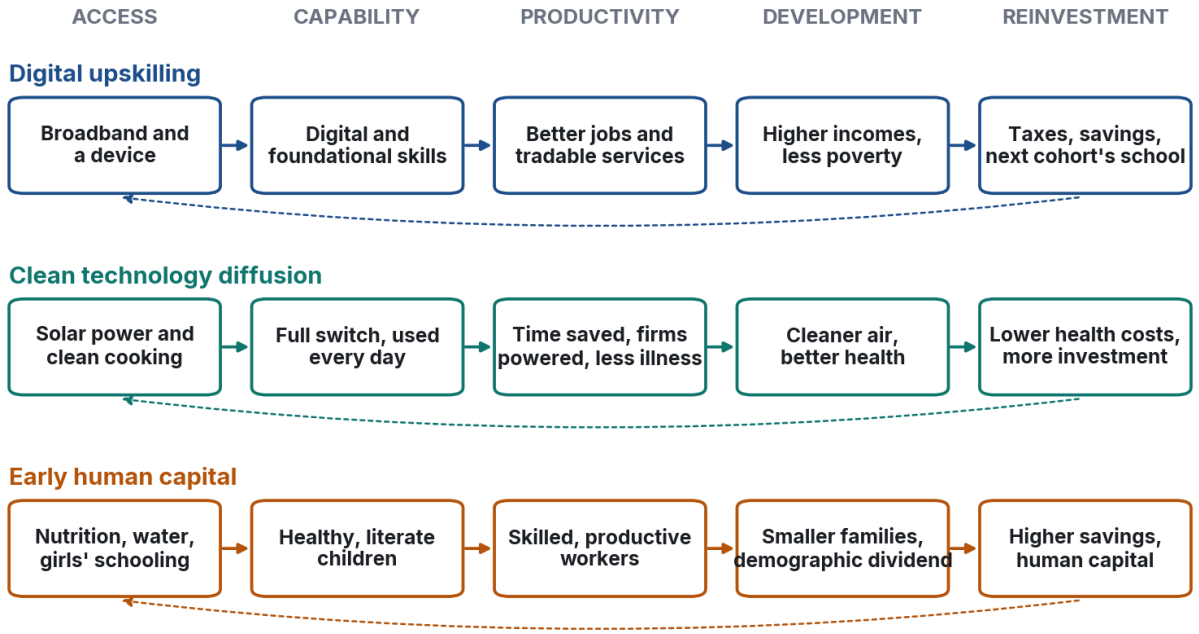
11.2 Conversion chains

A dividend is not automatic. Benefits travel along a chain: **access** to a technology or service must turn into the **capability** to use it well, capability into higher **productivity**, productivity into broader **development** (income, health, learning), and development into **reinvestment** through taxes, savings and the next generation's schooling. Each link can break. A connected household without digital skills gains little; a trained worker without jobs to apply for gains little more.

Earlier H Heuristics work tested one such chain empirically. Across 100 developing economies, schooling and electricity were robustly associated with faster growth between 2010 and 2023, while internet use and its interaction with schooling were not significant once electricity was in-

Figure 11 Benefits travel along conversion chains, and each completed chain finances the next round

Three conversion chains from access to reinvestment



Source: H Heuristics. Illustrative chains for three intervention families; the dashed arrows show reinvestment feeding back into access.

cluded (Hughes, 2026a). The honest reading is that the digital chain is plausible but gated: connectivity pays off where power and foundational skills are already in place. That is a finding about sequencing, not a reason to neglect digital investment.

11.3 Six capitals and intersections

A useful way to see multiple dividends is through six kinds of capital: **human** (health, skills), **infrastructure** (power, water, transport), **digital** (connectivity, identity, payments), **environmental** (clean air, soils, forests, water), **institutional** (effective, trusted public bodies) and **financial** (savings, insurance, fiscal space). Exposure to crises falls most when several capitals rise together, and an intervention's value depends on which capitals it builds and which it needs (Hughes, 2026a).

11.4 Criteria for comparing interventions

To move from a list of good ideas to a portfolio, interventions need to be compared on criteria that reflect the century's objective. This report uses five, following the illustrative multi-criteria screen developed for it: **S**, survivability and health (lives saved and illness avoided); **E**, economic convergence (productivity, incomes, poverty); **R**, resilience (reduced exposure and vulnerability to shocks); **M**, multiplier (how much the intervention raises the return to other investments); and **T**, tractability (how fast it can be deployed at scale with existing technology, institutions and finance). The screen weights resilience at 25%, tractability at 15% and the other three at 20% each. Section 18 reports the resulting ranking and tests how much it depends on those weights.

Table 9 A judgement-based view of multiple dividends

Intervention	Economic	Health	Environmental	Resilience
Clean cooking	Moderate	Very high	High	High
Online learning	High	Indirect	Indirect	High
Distributed solar	High	High	Very high	High
Climate-resilient agriculture	High	High	High	Very high
Digital public infrastructure	Very high	Indirect	Indirect	High
Water infrastructure	High	Very high	High	Very high
Girls' education	Very high	High	Indirect	High
Heat-resilient cities	High	Very high	High	Very high

Source: qualitative strategic assessment prepared for this report. These are judgements, not measured effect sizes; outcomes depend on implementation, local conditions and financing. Section 12 tests them against data.

CONCEPT

Development Optimization: risk sets the deadline, development sets the pace

Development Optimization, one of the six H Heuristics concepts, is about sequencing. The order of investments matters because some interventions raise the return to others (multipliers), some must arrive together (joint gates) and some lose most of their value if they come late (lock-in windows).

The rule of thumb is that rising risk sets the deadline by which protection must be in place, while the pace of development determines how quickly a country can get there. Interventions that cut risk and accelerate development at the same time deserve the earliest place in the queue (Hughes, 2026h).

PART III · SECTION 12

Measuring Multiple Dividends

Judgements about which interventions pay several dividends can be tested. Across developing economies, the services that are most consistently associated with better outcomes on several dimensions, holding income fixed, are the foundational ones: power, water, sanitation, schooling, immunisation and connectivity.

IN BRIEF

- Internet use is significantly and favourably associated with 7 of 9 outcomes; electricity, water, sanitation and secondary schooling with 6 each.
- Clean cooking, child nutrition and immunisation each show five favourable links.
- Account ownership and the renewable share of power show few links on their own: complements and context matter.

12.1 The test

To test multiple dividends, this report takes 131 low- and middle-income economies and asks, for eleven interventions, whether higher coverage is associated with better outcomes on nine measures spanning five dimensions: economic (income growth 2010–2023, lower extreme poverty), health (child survival, life expectancy), human capital (primary completion), demographic (lower fertility), environmental (cleaner outdoor air, lower CO_2 per dollar of GDP) and resilience (a smaller growth shock in 2020 relative to each country's 2015–2019 trend).

Because richer countries tend to have more of everything, the raw correlations would mostly measure income. The test therefore uses **partial correlations holding the logarithm of income per person fixed**. For income growth, coverage and income are measured in 2010; for the 2020 shock, in 2019; for other outcomes, around 2022. A correlation is marked significant when it is at least about twice its standard error. The results are associations across countries, not causal effects: countries that do well on one service often have capable governments that also do well on others.

12.2 What the data show

Three groups emerge. The **broad multipliers**, internet use (7 significant favourable associations), electricity access, basic drinking water, basic sanitation and secondary enrolment (6 each), are associated with faster income growth, less poverty, longer lives, more children completing school and lower fertility, all at the same income level. For example, holding income fixed, electricity access correlates +0.47 with subsequent growth and +0.64 with lower extreme poverty, and sanitation +0.51 with child survival.

The **targeted multipliers**, child immunisation, child nutrition and clean cooking, show five favourable links each, concentrated in health, growth and demographic outcomes. The **conditional interventions**, account ownership (a proxy for digital financial rails), the renewable share of power and cereal yields, show few significant links on their own. Account ownership is even

Figure 12 Foundational services are associated with better outcomes on many dimensions at once, even holding income fixed

Partial correlation between intervention coverage and outcome, holding income fixed

	Income growth	Less poverty	Child survival	Life expectancy	Primary completion	Lower fertility	Cleaner air	Lower CO_2 per $ GDP	Smaller 2020 shock
Electricity access [6]	**+0.47***	**+0.64***	**+0.38***	**+0.42***	**+0.33***	**+0.42***	+0.11	-0.06	+0.01
Basic drinking water [6]	**+0.38***	**+0.62***	**+0.37***	**+0.43***	**+0.28***	**+0.39***	+0.09	-0.15	-0.12
Secondary school enrolment [6]	**+0.35***	**+0.30***	**+0.25***	**+0.28***	–	**+0.39***	**+0.28***	-0.02	+0.08
Internet use [7]	**+0.22***	**+0.46***	**+0.32***	**+0.22***	**+0.28***	**+0.33***	**+0.19***	**-0.33***	-0.15
Basic sanitation [6]	**+0.34***	**+0.40***	**+0.51***	**+0.44***	**+0.26***	**+0.42***	+0.07	**-0.19***	-0.10
Child immunisation (DPT3) [5]	**+0.39***	+0.08	**+0.30***	**+0.36***	**+0.26***	**+0.20***	-0.06	-0.08	-0.06
Child nutrition (less stunting) [5]	**+0.21***	**+0.41***	–	**+0.19***	**+0.22***	+0.14	**+0.26***	-0.13	-0.10
Clean cooking [5]	**+0.21***	**+0.25***	**+0.23***	**+0.21***	+0.06	**+0.25***	+0.07	**-0.20***	-0.16
Cereal yield (ln) [2]	**+0.40***	+0.10	+0.06	+0.08	+0.03	+0.16	-0.08	+0.08	**+0.27***
Account ownership (DPI proxy) [1]	+0.18	**-0.25***	+0.12	-0.16	+0.15	**+0.21***	+0.12	-0.08	-0.02
Renewable share of power [1]	-0.01	**-0.29***	-0.00	-0.10	+0.11	+0.06	-0.00	**+0.19***	-0.06

Source: H Heuristics calculations from World Bank WDI (World Bank, 2026c). Partial correlations across up to 131 low- and middle-income economies, holding ln GDP per person (PPP) fixed. * = $|t| \geq 1.98$. Numbers in brackets count significant favourable associations. Secondary enrolment is the all-sex gross rate; '–' marks pairs omitted because the outcome partly measures the intervention itself.

associated with slightly higher extreme poverty at a given income (-0.25), probably because mobile money spread fastest in poorer African economies, and renewable power share with higher poverty (-0.29) probably because several of the poorest countries draw most of their limited power from hydropower.

Two results deserve emphasis because they cut against easy narratives. First, internet use is associated with *higher* CO_2 per dollar of GDP (-0.33) at a given income: digitalisation tends to come with electrification and industrialisation, which still run partly on fossil fuels. Second, no intervention shows a strong association with a smaller 2020 growth shock except cereal yields (+0.27); the pandemic hit open, service-based and tourism-dependent economies hardest regardless of their infrastructure. Resilience to a global shock of that kind seems to depend more on fiscal and institutional capacity than on any single service.

12.3 Judgement and evidence compared

The table sets the judgement-based assessment from Section 11 beside the measured associations. Broadly they agree that foundational services pay several dividends. They disagree in two places. The data are more favourable than the judgement to internet use, and less favourable to digital financial accounts and to the environmental dividend of energy access, which in today's data shows up in health and growth rather than in cleaner air or lower carbon intensity.

Table 10 Judged versus measured multiple dividends

Intervention (indicator used)	Judged strongest dividends	Significant favourable links	Dimensions where measured
Clean cooking	Health very high; environment high	5 of 9	Demographic, Economic, Health
Internet use (online learning)	Economic high; health indirect	7 of 9	Demographic, Economic, Environmental, Health, Human capital
Electricity (distributed solar)	Environment very high; all high	6 of 9	Demographic, Economic, Health, Human capital
Water infrastructure	Health and resilience very high	6 of 9	Demographic, Economic, Health, Human capital
Secondary enrolment (girls' education)	Economic very high; health high	6 of 8	Demographic, Economic, Environmental, Health
Accounts (DPI)	Economic very high	1 of 9	Demographic
Cereal yield (resilient agriculture)	Resilience very high	2 of 9	Economic, Resilience

Source: Tables and figures in this report; H Heuristics calculations from World Bank WDI (World Bank, 2026c).

12.4 Caveats

Cross-country associations are a screen, not a verdict. They cannot separate an intervention's effect from that of the capable institutions that tend to deliver it, and they say nothing about cost. They are most useful in combination with experimental and quasi-experimental studies, which Section 13 to Section 17 summarise intervention by intervention, including the studies that found smaller effects than expected.

PART III · SECTION 13

Human-Capital Compounders

Three interventions sit upstream of almost everything else: girls' secondary education with maternal health and voluntary family planning; nutrition in the first 1,000 days with safe water and sanitation; and immunisation and primary health care.

IN BRIEF

- They raise the return on every later investment, because stunted, sick or unschooled people cannot capture the full value of jobs, technology or services.
- Benefit-cost ratios are among the highest in development economics, from about 18:1 for nutrition to over 40:1 for immunisation.
- Their main weakness is time: benefits arrive over decades, so they must start now.

13.1 Girls' secondary education, maternal health and voluntary family planning

This bundle ranks first in the illustrative screen because it scores highly on every criterion. Educated girls earn more as women, marry and have children later, have healthier and better-educated children, and are better able to protect their families in a crisis (Psacharopoulos, 2018; Lutz et al., 2014). Maternal and newborn health services, from skilled birth attendance to basic obstetric care, prevent hundreds of thousands of deaths a year; the Copenhagen Consensus team estimated a benefit-cost ratio of 87 for a package of maternal and newborn interventions (Lomborg, 2023). Access to voluntary family planning lets women choose the timing and number of births, which accelerates the demographic transition and the dividend that can follow (Section 9).

What works in practice is reasonably well established: removing fees for secondary school (as in the Ghana experiment), reducing distance through more schools and safe transport, conditional or unconditional cash transfers to families, and visible job opportunities for young women all raise girls' schooling (Duflo, Dupas and Kremer, 2021; Jensen, 2012). The binding constraints are financing secondary places in fast-growing school-age populations and the quality of what is taught.

13.2 Early childhood nutrition and water, sanitation and hygiene

Stunting, low height for age caused by chronic undernutrition and repeated infection, affects about one in five children under five worldwide and is concentrated in South Asia and Sub-Saharan Africa. It reduces cognitive development, schooling and adult earnings. In Guatemala, boys who received a nutritional supplement in early childhood earned substantially higher wages as adults decades later (Hoddinott et al., 2008). Estimated benefit-cost ratios for reducing stunting range from about 4 to 48 across countries, with a median near 18 (Hoddinott et al., 2013). Safe water and sanitation prevent the diarrhoeal disease that drives much stunting and child death; global estimates put the return at several dollars per dollar invested, highest for sanitation (Hutton, 2013; WHO, 2023).

The measured associations in Section 12 support the bundle: basic sanitation is the service most strongly associated with child survival holding income fixed (+0.51), and less stunting is associated with faster growth, lower poverty and higher primary completion.

13.3 Immunisation and primary health care

Immunisation is the most proven multiplier in global health. Returns of about 16 to 44 dollars per dollar invested (Ozawa et al., 2016) reflect not only deaths averted but also the schooling and productivity that healthy children go on to achieve. Primary health care, community health workers and essential medicines extend the same logic to the broader burden of disease. The challenge is reaching 'zero-dose' children who receive no routine vaccines at all, concentrated in fragile and conflict-affected areas and in urban slums.

Table 11 Human-capital compounders: evidence at a glance

Intervention	Key evidence	Returns or effect	Main gate
Girls' secondary education	Ghana free secondary school RCT; global returns to schooling	~9% earnings per year of schooling, higher for women; lower fertility	School places and quality
Maternal and newborn health	Copenhagen Consensus SDG analysis	Benefit-cost ratio about 87	Skilled staff, facilities
Early nutrition (first 1,000 days)	Guatemala long-run follow-up; stunting cost-benefit	Benefit-cost ratio about 4–48 (median ~18)	Delivery to the poorest
Water and sanitation	Global cost-benefit estimates; WHO burden of disease	Several dollars per dollar; large child-health gains	Operation and maintenance
Immunisation	94-country return on investment study	$16 (illness costs) to $44 (full value) per $1	Reaching zero-dose children

Source: (Duflo, Dupas and Kremer, 2021; Psacharopoulos, 2018; Lomborg, 2023; Hoddinott et al., 2008; Hoddinott et al., 2013; Hutton, 2013; Ozawa et al., 2016).

PART III · SECTION 14

Digital Rails, Online Learning and Upskilling

Digital public infrastructure and digital learning can bypass institutional bottlenecks at low marginal cost. The evidence is strong for payments and identity, promising but uneven for technology in education, and clear that results depend on design and complements.

IN BRIEF

- Open DPI formalises economies, cuts transaction costs and enables instant cash transfers in a crisis.
- Adaptive learning software and AI tutoring have produced large gains in some trials; generic hardware distribution has not.
- AI tools can widen gaps as well as close them: design for the lowest performers, not just the best.

14.1 Open digital public infrastructure

Digital identity, instant payments and consented data sharing are general-purpose rails. Once built, they lower the cost of opening a bank account, paying a supplier, receiving a pension, registering a business or getting emergency support. Global account ownership reached 79% in 2024 (World Bank, 2025), yet about 1.4 billion adults still have none, and many who do rarely use their accounts. Brazil's Pix, launched in 2020, became the country's most-used payment method within a few years (Banco Central do Brasil, 2025); India's UPI processes billions of transactions a month (NPCI, 2025). The development case rests on lower transaction costs, formalisation of small firms, fewer leakages in public spending and the ability to reach people quickly in a crisis (Muralidharan, 2016; Aiken et al., 2022).

The measured evidence is more cautious about accounts on their own (Section 12): ownership without usage, merchant acceptance and trust does little. The lesson is to treat DPI as a platform for services, such as government-to-person payments, credit histories for small firms and anticipatory cash, rather than as an end in itself.

14.2 Online learning, AI tutoring and digital upskilling

Education technology has a mixed record. Programmes that simply distributed laptops or tablets generally did not raise learning. Programmes that used technology to *personalise instruction* often did. In Delhi, after-school access to the Mindspark adaptive learning software raised mathematics and Hindi test scores substantially within months, with the largest gains for students who started furthest behind (Muralidharan, 2019). In Nigeria, a six-week after-school programme in which secondary students used a GPT-4-based assistant for English, guided by teachers, raised test scores by about 0.31 standard deviations, equivalent to well over a year of typical learning, at low cost (De Simone et al., 2025). Low-tech approaches built on the same principle, such as Teaching at the Right Level, have been scaled to millions of children (Banerjee et al., 2016; GEEAP, 2023).

Results are not uniformly positive. In a field experiment with Kenyan entrepreneurs, access to an AI business mentor produced no average effect: high performers improved, but low performers did worse, apparently because they followed generic advice poorly suited to their situation (Otis, 2024). The implication for policy is to pair AI tools with human guidance, design them for the lowest performers and measure who benefits.

14.3 From learning to earning

Digital upskilling matters for convergence because it opens a route to tradable services. A young person in Lagos, Nairobi or Dhaka with reliable power, a laptop, broadband and strong skills can sell software, design, customer support or data work to the world. That route is currently open to a minority: internet use in low-income countries averages about 20%, and the GSMA estimates that a $30 smartphone could bring up to 1.6 billion people within reach of mobile internet (GSMA, 2025). Countries that combine connectivity, foundational literacy and numeracy, digital skills and certification can turn their young populations into a services export base, but only if all links of the conversion chain are present (Section 11).

DESIGN

What good digital investment looks like

- **Power first**: plan electricity and connectivity together; most unconnected people also lack reliable power (Section 7).
- **Open and interoperable**: build identity, payments and data exchange as public infrastructure with privacy safeguards.
- **Teach at the right level**: use adaptive software and AI tutoring to personalise, with teachers in the loop.
- **Affordable devices and data**: target the usage gap, not just coverage.
- **Measure the bottom**: track outcomes for the lowest performers and for women and girls.

PART III · SECTION 15

Clean Energy, Clean Cooking and Cold Chains

Distributed renewables can power rural industry, irrigation and cold storage without waiting for legacy grids, and a full switch to clean cooking would remove one of the largest health burdens on the planet. Both are proven technologies held back by finance and delivery.

IN BRIEF

- About 655 million people lack electricity, 86% of them in Sub-Saharan Africa; about 2 billion lack clean cooking.
- About 1.38 billion people have electricity but still cook with polluting fuels.
- Proven-pace clean cooking would avoid roughly 2.9–6.7 million deaths by 2050.

15.1 Productive-use distributed renewables

Off-grid solar, mini-grids and batteries can now supply electricity to many rural communities faster and more cheaply than grid extension. The Tracking SDG7 2026 report counts about 655 million people without electricity, 86% of them in Sub-Saharan Africa, and notes that population growth absorbed most recent gains (IEA et al., 2026). The World Bank and African Development Bank's Mission 300 aims to connect 300 million Africans by 2030, through both grid and off-grid solutions (World Bank, 2024).

The development dividend depends on **productive use**. In South Africa, rural electrification raised women's employment by freeing time from fuel collection and home production (Dinkelman, 2011). But in Kenya, a randomised trial that subsidised grid connections found little effect on incomes, health or education after several years, largely because households could not afford appliances or did not have businesses to power (Lee, 2020). The lesson is not that electricity does not matter, but that connections must come with appliances, credit, markets and productive activities: irrigation pumps, milling, refrigeration, welding and digital services.

15.2 Cold chains

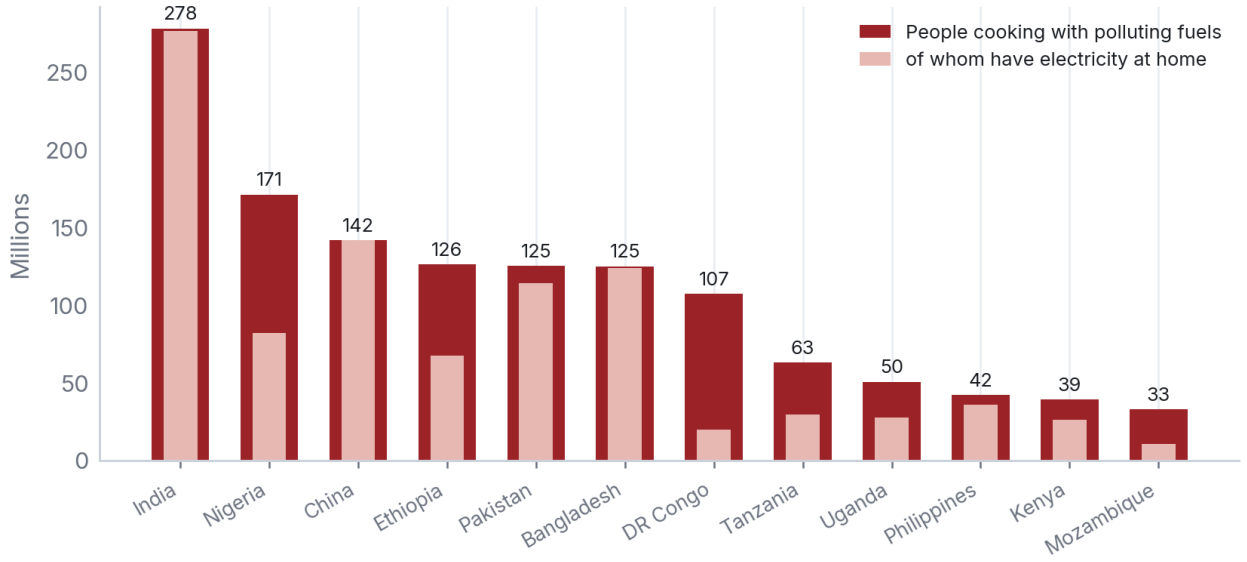
Between harvest and market a large share of food, especially fruit, vegetables, fish and milk, is lost for lack of cooling, storage and transport. Solar-powered cold rooms and refrigerated transport can raise farm incomes, improve nutrition and cut the methane emitted by rotting food, while also keeping vaccines and medicines safe. Because cooling demand will rise sharply with heat and incomes, efficient, climate-friendly cooling is both an adaptation and a mitigation priority (UNEP, 2025; IEA, 2018).

15.3 The clean cooking transition

About 2 billion people still cook with wood, charcoal, dung, crop waste or kerosene (IEA et al., 2026). The smoke causes millions of premature deaths each year from pneumonia, heart disease, stroke and lung disease, falls hardest on women and young children, and contributes to forest degradation and black carbon emissions (WHO, 2024; Romanello, 2025). Twelve countries account for 64% of people cooking with polluting fuels. Strikingly, about 1.38 billion people already have electricity at home but still cook with polluting fuels, including almost all of the 278 million in India (Hughes, 2026e).

Figure 13 Clean cooking: a dozen countries hold two-thirds of the challenge, and many users already have electricity

People cooking with polluting fuels, and those among them who have electricity, millions, top 12 countries



Source: H Heuristics Century Pathways country cards (Hughes, 2026a), from World Bank WDI EG.CFT.ACCS.ZS and EG.ELC.ACCS.ZS and UN population (World Bank, 2026c; United Nations, 2024).

The evidence on solutions is instructive. Improved biomass stoves have often disappointed because households used them alongside traditional fires. A large multi-country trial of free LPG stoves and fuel (HAPIN) cut exposure substantially but did not significantly change birth weight or childhood pneumonia, probably because exposure stayed above the WHO guideline (Clasen, 2022). That points to the need for a *full switch* to genuinely clean fuels such as LPG, biogas, ethanol and electric induction, sustained by affordable fuel supply. Indonesia's kerosene-to-LPG conversion moved tens of millions of households within a few years (Budya, 2011). Where households already have reliable electricity, induction cooking is increasingly the cheapest option.

H Heuristics estimates that reaching universal clean cooking at proven peer pace rather than on trend would avoid roughly 2.9–6.7 million deaths by 2050, with each year of delay costing on the order of 292,000 lives (Hughes, 2026e). The November 2026 update made clean cooking the subject of the first 12-month adoption sprint (Hughes, 2026i).

PART III · SECTION 16

Adaptation Interventions: Crops, Cities, Biosecurity and Warnings

Four adaptation interventions protect baseline survivability where population growth meets rising hazards: climate-resilient agriculture, heat-resilient and flood-ready cities, distributed biosecurity and vaccine capacity, and early warning linked to early action.

IN BRIEF

- Flood-tolerant rice raised yields in flooded fields and encouraged farmers to invest more.
- Cities are being built now; designing for heat and floods at the outset is far cheaper than retrofitting.
- Regional vaccine manufacturing and surveillance cut the time from outbreak to response.

16.1 Climate-resilient crops and precision water

Agriculture employs a majority of workers in many low-income countries and is the sector most directly exposed to heat and drought. Stress-tolerant varieties, better water management and storage protect both incomes and food supply. In India, a flood-tolerant rice variety (Swarna-Sub1) increased yields in flood-prone fields and, by reducing downside risk, led farmers to invest more in fertiliser and planting methods, an example of resilience unlocking productivity (Emerick et al., 2016). Agricultural research is among the highest-return investments in the Copenhagen Consensus set, whose twelve priority interventions have benefit-cost ratios between 18 and 125 (Lomborg, 2023). Precision irrigation powered by solar pumps, digital weather and price advisories, and insurance complete the package, though solar pumps must be managed to avoid groundwater depletion.

16.2 Heat-resilient and 'sponge' cities

Africa's and South Asia's cities will add hundreds of millions of residents by mid-century, much of it in informal settlements exposed to heat and flooding. Urban design decided now will determine exposure for generations. Passive cooling in buildings (orientation, shading, insulation, reflective roofs), tree canopy and green space, and 'sponge' design that lets cities absorb and store rainwater rather than channel it into floods can cut both heat and flood risk at modest cost if built in from the start (Hallegatte et al., 2019). Heat is a growing killer: the Lancet Countdown attributes hundreds of thousands of deaths a year to heat, rising with both warming and ageing (Romanello, 2025). Efficient cooling for those who need it, powered by clean electricity, is the complement.

16.3 Distributed biosecurity and regional vaccine manufacturing

The COVID-19 pandemic showed how unequal access to vaccines, diagnostics and medical supplies can be. Africa imports almost all of its vaccines; the African Union and Africa CDC aim for the continent to manufacture 60% of the vaccines it uses by 2040 (Africa CDC, 2022). CEPI's 100 Days Mission aims to make safe, effective vaccines available within 100 days of a new pandemic threat being identified (CEPI, 2024), and the World Health Assembly adopted a Pandemic Agreement in May 2025 (WHO, 2025). Community-based disease surveillance, laboratory networks and strong primary care are the first line of defence, and also the services that control endemic diseases whose range is expanding with warming.

16.4 Early warning and anticipatory action

Early warning is the clearest case of a cheap intervention with a large resilience dividend: forecasts, communication and pre-agreed actions such as evacuation, livestock sales or anticipatory cash transfers before a flood or drought peaks (Global Commission on Adaptation, 2019; United Nations, 2022). Linking warnings to digital payments (Section 14) and to pre-arranged finance (Section 17) turns information into protection. Coverage gaps remain largest in least developed countries and small island states (UNDRR and WMO, 2023).

Table 12 Adaptation interventions: evidence at a glance

Intervention	Key evidence	Returns or effect	Main gate
Climate-resilient crops	Swarna-Sub1 rice trial, India; Copenhagen Consensus agricultural R&D	Higher yields in flood years and more investment; high benefit-cost ratios	Seed systems, extension
Heat-resilient cities	Lancet Countdown heat mortality; infrastructure resilience studies	Avoided heat deaths, flood losses and lost labour	Urban codes before build-out
Biosecurity and vaccines	COVID-19 vaccine inequity; Africa CDC and CEPI targets	Faster response; 60% local vaccine supply goal by 2040	Finance, regulation, demand
Early warning and action	Global Commission on Adaptation; MHEWS status reports	24 hours' warning cuts damage ~30%; much lower mortality	Last-mile reach, pre-agreed action

Source: (Emerick et al., 2016; Lomborg, 2023; Romanello, 2025; Hallegatte et al., 2019; Africa CDC, 2022; CEPI, 2024; Global Commission on Adaptation, 2019; UNDRR and WMO, 2023).

PART III · SECTION 17

The Enablers: Finance, Trade and Debt

Some interventions do little directly for lives or incomes but decide whether everything else can be financed and scaled. The cost of capital, the burden of debt and access to markets are the main ones.

IN BRIEF

- Interest payments take a median 11% of government revenue in low-income countries, against 3% in high-income ones.
- Clean energy capital can cost two to three times more in developing economies than in advanced ones.
- Climate-resilient debt clauses and parametric insurance stop a disaster from becoming a fiscal crisis.

17.1 Blended finance and the cost of capital

Most of the interventions in this report require up-front investment that pays back over many years, so their cost depends heavily on interest rates. Investors demand a large premium to lend in developing economies because of currency, political and project risks, which can double or triple the cost of capital for clean energy compared with advanced economies (IEA, 2024). Blended finance uses public or philanthropic money to absorb part of that risk, through guarantees, first-loss capital or currency hedging, so that private capital can follow. Its record so far is modest in scale, which is why reform of multilateral development banks to lend more, in local currencies and with more risk appetite, is central to proposals such as the Bridgetown Initiative (Bridgetown Initiative, 2024).

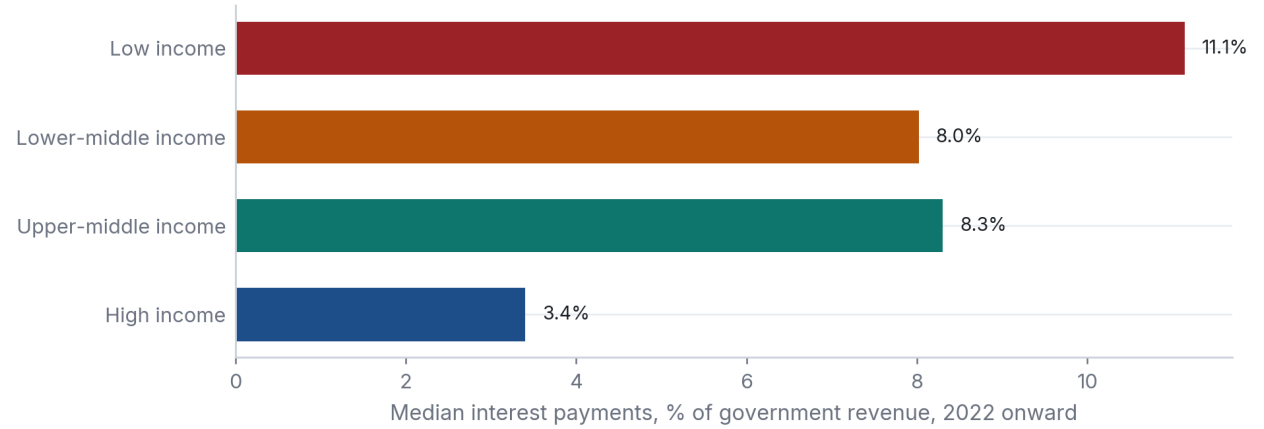
17.2 The fiscal squeeze

Public budgets are the other half of the finance problem. Governments pay for most of the human-capital, water and adaptation investments in this report, and in many developing economies a growing share of revenue now goes to creditors.

In low-income countries, interest payments now take a median of about 11% of government revenue, compared with about 3% in high-income countries (World Bank, 2026c). UNCTAD reports that billions of people live in countries that spend more on interest than on health or education (UNCTAD, 2025). Every dollar of interest is a dollar not spent on schools, clinics, water systems or adaptation. That is why debt is not a separate issue from development but a constraint on all of it.

Figure 14 Debt service crowds out the spending that builds resilience in the poorest countries

Median interest payments as % of government revenue



Source: World Bank WDI, GC.XPN.INTP.RV.ZS, medians by income group, 2022 onward (World Bank, 2026c; Hughes, 2026c).

17.3 Shock-absorbing debt and parametric insurance

Climate-resilient debt clauses let a country pause debt service after a qualifying disaster, so that it can spend on relief and reconstruction rather than on creditors. Parametric insurance pays out quickly when a measured trigger, such as rainfall or wind speed, is reached, without waiting for loss assessments. Regional risk pools such as the Caribbean Catastrophe Risk Insurance Facility and African Risk Capacity have paid out within weeks of disasters (CCRIF SPC, 2025; African Risk Capacity, 2025), and the Global Shield against Climate Risks aims to extend pre-arranged finance to the most vulnerable countries (Global Shield against Climate Risks, 2025). The IMF's Resilience and Sustainability Trust provides longer-term financing for climate and pandemic preparedness reforms (IMF, 2025).

17.4 Trade integration and local value chains

Regional trade agreements and the infrastructure that makes them work (roads, ports, customs systems and payment links) let firms in small economies reach larger markets and specialise. Keeping more processing of minerals, farm products and green-industry components local builds durable tax bases and skilled jobs, provided it is competitive rather than protected (World Bank, 2020; Hausmann et al., 2007). These gains accrue over decades and depend on coordination among many governments, which is why trade integration ranks low on tractability even though it raises the ceiling for everything else.

SEQUENCING

Why enablers rank low but matter most

In the illustrative screen in Section 18, blended finance, trade integration and debt reform score lowest, mainly because of low tractability: they require political and multilateral coordination that moves slowly.

But they function as **unlockers**. Without a lower cost of capital and room in public budgets, poorer countries cannot scale clean cooking, distributed power, nutrition, water and urban adaptation at the speed demographic growth demands. A sound strategy therefore runs them in parallel with the interventions that can be deployed immediately, rather than after them.

PART IV · SECTION 18

Ranking and Sequencing the Interventions

A ranking turns a list of good ideas into a portfolio. This section presents an illustrative multi-criteria ranking of twelve interventions, tests how much it depends on its assumptions, and proposes a two-track sequence.

IN BRIEF

- The top six (girls' education, DPI, nutrition and WASH, resilient agriculture, distributed renewables, clean cooking) are robust to weights and judgement errors.
- Enablers rank last on the screen but unlock the rest; they must run in parallel, not afterwards.
- Track 1 deploys proven multi-dividend interventions now; Track 2 fixes structural bottlenecks before lock-in windows close.

18.1 An illustrative multi-criteria ranking

The table presents a ranking prepared for this report using the five criteria introduced in Section 11: survivability and health (S, 20%), economic convergence (E, 20%), resilience (R, 25%), multiplier (M, 20%) and tractability (T, 15%). Each intervention is scored from 1 to 10 on each criterion and the weighted sum is scaled to 100. The scores are structured expert judgements informed by the evidence in Part III, not measured quantities, and they should be read as a starting point for debate.

18.2 Why the top three dominate

Girls' education with family planning, digital public infrastructure and early nutrition with WASH win because they sit *upstream* of almost every other investment. Stunted children, or unbanked and unconnected adults, cannot capture the full value of online learning, green jobs or climate advisories. Improving the foundation raises the multiplier on everything downstream. Climate-resilient agriculture, distributed renewables and clean cooking form a second cluster that scores highly because the technologies already exist and directly protect health, food security and household time. Clean cooking earns the highest tractability score: once financing and fuel supply are solved, household switching can be fast, as Indonesia showed (Budya, 2011).

18.3 How robust is the ranking?

Any ranking built on judgement is only as good as its assumptions. To test this one, the analysis ran 20,000 simulations in which both the weights and the scores were perturbed: weights were drawn at random around the stated ones, and every individual score was allowed to be one point higher or lower than stated. A third test allowed any weights at all. The figure shows each intervention's stated rank, its average simulated rank and the range within which it falls 90% of the time.

Table 13 Illustrative multi-criteria ranking of twelve century interventions

#	Intervention	S	E	R	M	T	Score	Primary catalytic mechanism
1	Girls' education & family planning	9	9	9	10	8	90.5	Accelerates the demographic dividend, women's earnings, child health and long-term resource resilience
2	Digital public infrastructure	9	9	8	10	8	88.0	Formalises economies, cuts transaction costs, enables instant disaster cash transfers
3	Early nutrition & WASH	9	8	9	9	8	86.5	Prevents stunting and waterborne disease; raises the return on all later schooling and skills
4	Climate-resilient agriculture	9	8	10	8	7	85.5	Protects smallholder incomes; stops heat and drought shocks spiralling into hunger and migration
5	Distributed renewables & cold chains	8	9	9	9	7	85.0	Powers rural industry, irrigation and cold storage without waiting for legacy grids
6	Clean cooking	8	7	9	9	9	84.0	Cuts household air pollution, black carbon, deforestation and women's unpaid labour
7	Blended finance & de-risking	8	9	8	9	5	79.5	Breaks the interest-rate trap that blocks clean-energy and grid investment
8	Online learning & upskilling	8	9	6	9	8	79.0	Bypasses teacher shortages; lets young people export tradable digital services
9	Heat-resilient cities	8	7	10	7	6	78.0	Prevents heat deaths, flood damage and lost urban labour in fast-growing cities
10	Biosecurity & vaccines	9	6	10	7	6	78.0	Reduces pandemic tail risk and the spread of vector-borne disease
11	Trade & value chains	8	9	6	7	5	70.5	Keeps mineral and green-industry processing local; builds durable tax bases
12	Debt reform & insurance	7	7	8	7	5	69.5	Pauses debt service after disasters so shocks do not force health and education cuts

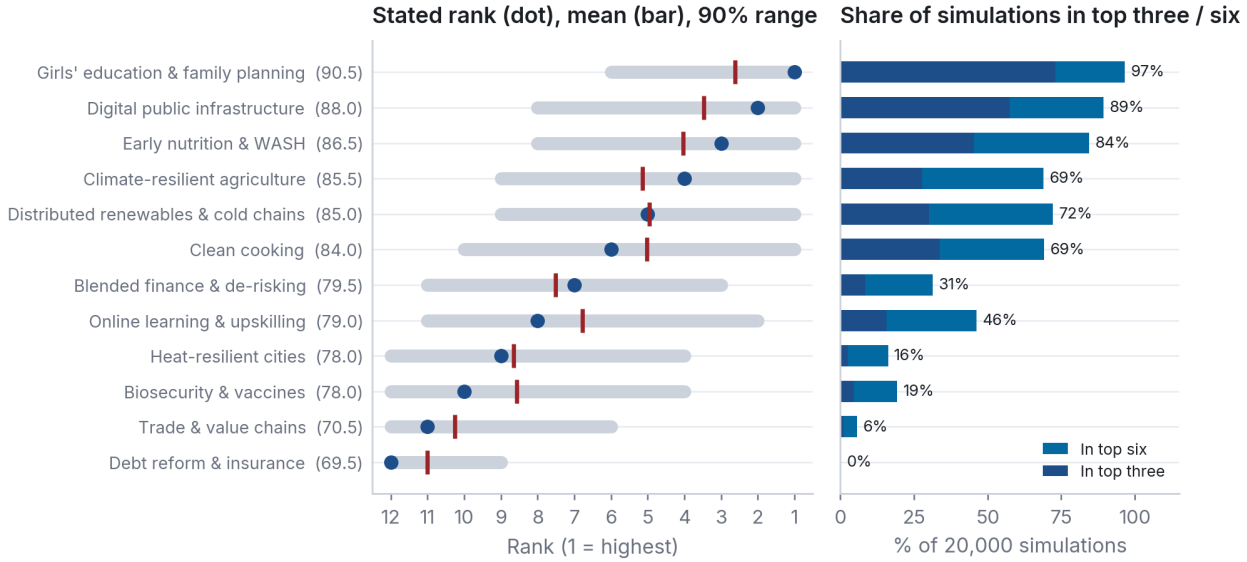
Source: illustrative multi-criteria screen prepared for this report. S survivability and health (20%), E economic convergence (20%), R resilience (25%), M multiplier (20%), T tractability (15%). Judgements, not measurements.

The results are reassuring at the top and bottom and humbling in the middle. Girls' education stays in the top six in 97% of simulations and DPI in 89%; nutrition and WASH in 84%. Resilient agriculture, distributed renewables and clean cooking stay in the top six in 69–72% of runs, but their order among themselves is essentially a coin toss: the spread of scores between ranks 3 and 6 is only 2.5 points out of 100. Debt reform and trade integration never reach the top three and rarely the top six. The middle of the list, blended finance, online learning, heat-resilient cities and biosecurity, is genuinely uncertain: each can rank anywhere from about sixth to eleventh.

The measured evidence in Section 12 suggests two adjustments. It supports a higher place for connectivity and online learning, since internet use shows the most favourable associations of any service (7 of 9), provided electricity and foundational skills are in place. And it cautions against treating account ownership alone as a top-tier multiplier (1 of 9): DPI earns its high place when it is used as a platform for payments, services and crisis response, not when it is counted as accounts opened.

Figure 15 **The top six are robust to the weights and to errors of judgement; the exact order within them is not**

Left: stated rank (dot), mean simulated rank (bar) and 90% range. Right: share of simulations in the top three and top six



Source: H Heuristics calculations. 20,000 Monte Carlo draws with Dirichlet-distributed weights and integer score errors of ±1; top-three and top-six shares use fully random weights with score errors.

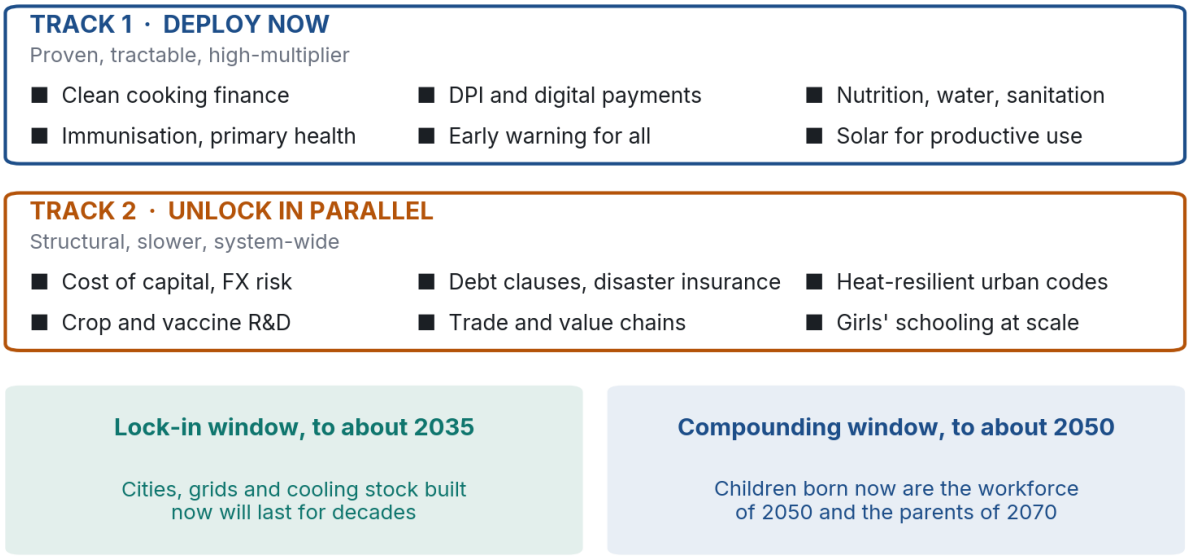
18.4 A two-track portfolio

The ranking implies a sequence, not a queue. **Track 1** deploys immediately the interventions that combine high tractability with high multipliers: clean cooking finance, open DPI and digital payments, early nutrition and WASH, immunisation and primary health, early warning for all, distributed solar for productive use and localised online learning. **Track 2** fixes the structural bottlenecks in parallel: cost-of-capital and currency de-risking, climate-resilient debt clauses and disaster insurance, heat-resilient urban codes before cities lock in, crop and vaccine research and regional manufacturing, trade integration, and the financing of girls' secondary schooling at scale.

Two windows set the timing. The **lock-in window**, roughly to 2035, is the period in which the cities, power systems and cooling stock of the fastest-growing regions are being built; choices made then last for decades. The **compounding window**, roughly to 2050, is the period in which children born now become the workforce; investments in their nutrition, health and schooling compound for the rest of the century. Development Optimization's rule, that rising risk sets the deadline and development sets the pace, says that both windows argue for acting early rather than waiting for more evidence on the interventions that are already proven.

Figure 16 **Deploy proven multipliers now while unlocking the structural constraints in parallel**

The two-track portfolio and the two windows that set its timing



Source: H Heuristics, applying Development Optimization (risk sets the deadline; development sets the pace) (Hughes, 2026h).

18.5 What would change the ranking

The ranking should be revised as evidence accumulates. Three kinds of finding would move it most. Rigorous evidence that AI tutoring keeps producing large gains at scale would lift online learning into the top tier. Evidence that full-switch clean cooking programmes deliver the health gains that partial switching did not would raise clean cooking's survivability score. And progress on multilateral reform that cuts the cost of capital quickly would raise the tractability of blended finance, which would then rank among the leaders because its multiplier is so large. The ranking is a tool for argument, not a verdict.

PART IV · SECTION 19

Regional Pathways

The same interventions matter everywhere, but their priority differs by region. A six-dimension Century Outlook Dashboard shows where each region stands and which gap binds hardest.

IN BRIEF

- Sub-Saharan Africa scores 39/100 overall, against 88 for high-income countries; it is the binding region of the century.
- 49 of 112 developing economies, with 1.7 billion people, score below 40 on at least one dimension.
- Several countries outperform their income level by wide margins, proving that policy, not just income, sets the outlook.

19.1 The Century Outlook Dashboard

The dashboard turns the six measurement dimensions proposed for this report into scores from 0 to 100 using public indicators with fixed goalposts. **Economic convergence** is income per person relative to the high-income average (log scale). **Human development** combines life expectancy, under-five survival and primary completion. **Technological diffusion** combines internet use, account ownership and mobile subscriptions. **Environmental improvement** combines clean air (PM2.5), clean cooking and the renewable share of power. **Adaptive capacity** combines government effectiveness, the INFORM risk score (inverted) and electricity access. **Demographic resilience** combines secondary enrolment, fertility and the share of children in the population, as measures of the capacity to support a growing population. Regional scores are population-weighted averages of country scores.

Figure 17 Sub-Saharan Africa trails on every dimension; South Asia's weakest link is the environment

Scores out of 100 by dimension and region, latest data

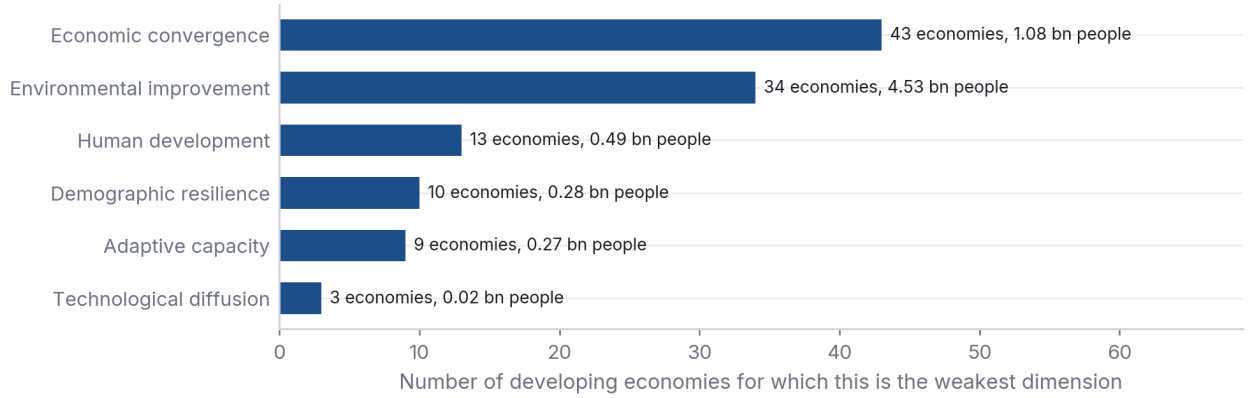
	Economic convergence	Human development	Technological diffusion	Environmental improvement	Adaptive capacity	Demographic resilience	Overall
Sub-Saharan Africa (1.32 bn)	31	33	50	45	39	34	**39**
South Asia (1.69 bn)	53	64	72	41	69	75	**62**
East Asia & Pacific* (2.14 bn)	72	76	87	58	76	88	**76**
Latin America & Caribbean (0.63 bn)	70	70	78	76	65	84	**74**
MENA, Afghanistan & Pakistan* (0.75 bn)	51	58	57	47	55	56	**54**
Europe & Central Asia* (0.25 bn)	74	75	83	65	68	83	**75**
High-income (1.40 bn)	97	89	94	72	85	94	**88**

Source: H Heuristics Century Outlook Dashboard, from World Bank WDI, WGI and INFORM (World Bank, 2026c; World Bank, 2025a; European Commission JRC, 2026). Scores 0–100 with fixed goalposts; population-weighted regional averages. *Developing economies only.

The dimensions are related but not identical: across 112 developing economies their average pairwise correlation is 0.72, and the overall score correlates 0.92 with log income. Only 28 developing economies score 60 or more on all six. Their weakest dimension varies, as the second figure shows: for most it is economic convergence itself, but for many it is environmental improvement or human development.

Figure 18 Each country's binding gap differs, so a single global priority list must be adapted locally

Number of developing economies, and their population, by weakest dimension



Source: H Heuristics Century Outlook Dashboard (World Bank, 2026c; World Bank, 2025a; European Commission JRC, 2026).

19.2 Regional priorities

The dashboard and the evidence in Part III together suggest a different emphasis for each region. The table lists each region's weakest dimensions and the interventions most likely to move them; the global two-track portfolio applies everywhere, but the order of Track 1 should follow the binding gap.

Table 14 Regional priorities for optimizing the century outlook

Region	Score	Weakest dimensions	Highest-priority interventions
Sub-Saharan Africa	39	Economic convergence, human development, demographic resilience	Electricity and clean cooking at proven pace; girls' secondary schooling and family planning; nutrition and WASH; climate-resilient agriculture; cost of capital
South Asia	62	Environmental improvement (air, cooking)	Full switch to clean cooking for electrified households; clean power and air quality; heat action and urban cooling; digital upskilling for services export
MENA, Afghanistan and Pakistan	54	Environment, technology, water	Water efficiency and storage; distributed solar; girls' education in lagging states; heat resilience
East Asia and Pacific	76	Environment (coal, air)	Coal-to-clean transition; coastal flood and typhoon resilience; ageing-related heat risk
Latin America and Caribbean	74	Adaptive capacity, productivity	Productivity and institutional capacity; disaster insurance and debt clauses for small islands; urban resilience
Small island developing states	–	Exposure, finance	Parametric insurance and risk pools; climate-resilient debt; early warning; coastal adaptation

Source: H Heuristics Century Outlook Dashboard and synthesis of Part III. Small island states are not scored as a group.

19.3 Sub-Saharan Africa: the binding region

Sub-Saharan Africa is where the century's outlook will be most decided. It holds about 16% of humanity today, will hold about 34% in 2100 and accounts for 59% of world population growth to 2050 (Section 2). It is home to between 560 and 580 million of the roughly 655 million people without electricity, depending on the source, and about half of those without clean cooking (Hughes, 2026e; IEA et al., 2026). The lowest dashboard scores are concentrated there: Niger, Central African Republic, Chad, Somalia, Burundi, DR Congo. These are also among the countries where fragility and conflict make delivery hardest, which argues for approaches that work through local actors, digital payments and modular technologies that do not depend on a strong central grid.

19.4 Countries that beat their income

The dashboard also identifies countries that score well above what their income alone would predict: the Kyrgyz Republic, Cabo Verde, Tajikistan, Lesotho, Morocco, Nepal. Their routes differ, but common threads include early investment in schooling and health, near-universal electricity, and in several cases strong remittance and digital links. Such positive deviants are the most persuasive evidence that the outlook is a matter of policy as well as income, and they are natural partners for peer learning.

Table 15 Highest and lowest Century Outlook scores among developing economies

Lowest ten	Score	Highest ten	Score
Niger	16	Montenegro	84
Central African Republic	17	Georgia	82
Chad	18	Belarus	82
Somalia	19	North Macedonia	81
Burundi	21	Albania	81
DR Congo	27	Malaysia	81
Liberia	31	Argentina	81
Madagascar	31	Serbia	81
Sudan	32	Mauritius	80
Burkina Faso	32	China	80

Source: H Heuristics Century Outlook Dashboard (World Bank, 2026c; World Bank, 2025a; European Commission JRC, 2026). Developing economies with population above 0.5 million.

PART IV · SECTION 20

The Century Ledger: Scenarios to 2100

What is at stake can be expressed in people, years and lives. Three paces of development produce very different centuries, and the differences are largest for the countries that grow fastest.

IN BRIEF

- Five-service deprivation, 2026–2100: about 859 billion person-years frozen, 255 billion on trend, 112 billion at proven pace.
- Resilience-oriented convergence would mean about 147 million fewer child deaths than fragmented convergence, 2024–2100.
- A sustainable route to the same income gains would keep cumulative emissions to a fraction of a fossil route.

20.1 Three centuries

Scenarios are not forecasts. They show what follows from stated assumptions, and their value lies in the comparison. This section brings together three sets of H Heuristics scenarios that share a common logic: the difference between stalled, trend and accelerated development. **Fragmented**: access and convergence stall, and shocks keep pushing the poorest countries back. **Trend**: countries continue at their recent pace. **Optimized**: countries move at proven peer pace on basic services, convergence resumes at the pace of 2000–2019, and the remaining gaps close faster through resilience-oriented investment.

Table 16 Three centuries compared

Outcome	Fragmented / frozen	Trend / accelerated	Optimized
Person-years without five basic services, 2026–2100 (bn)	859	255	112
People cooking with polluting fuels, 2050 (bn)	2.90	1.26	0.74
People without electricity, 2050 (m)	1111	434	79
Global South income, % of high-income level, 2100	14	35	35
Africa's income, % of high-income level, 2100	7	26	26
Global South life expectancy, 2100 (years)	73.7	79.2	79.4
Cumulative child deaths, 2024–2100 (m)	314	181	167

Source: H Heuristics Century Pathways model (rows 1–3) (Hughes, 2026a); convergence scenarios (rows 4–7: fragmented, accelerated and resilience-oriented convergence) (Hughes, 2026c). Scenario sets use different assumptions and are shown side by side, not combined.

Three messages stand out. First, the deprivation ledger is overwhelmingly a story of pace: at proven peer pace, the number of people without electricity falls to about 79 million by 2050, against 434 million on trend. Second, convergence and child survival move together: resuming

the convergence of 2000–2019 lifts Global South income from 14% to about 35% of the high-income level by 2100 and avoids more than 130 million child deaths. Third, the route matters for the climate: reaching the same income gains through a fossil-heavy route would take cumulative emissions to about 3,084 billion tonnes of CO_2, against about 819 billion on a sustainable route (Hughes, 2026g).

20.2 Milestones for 2030 and 2050

Long horizons need near-term milestones. The table gives, for six services, the number of people projected to lack access in 2030 and 2050 on the current trend and if every lagging country moved at proven peer pace from 2026. The last column shows how much of the possible gain to 2050 would be forfeited by waiting ten years before accelerating.

Table 17 People without access on trend and at proven pace, 2030 and 2050 (millions)

Service	2030 trend	2030 proven	2050 trend	2050 proven	Lost by 10-year delay
Electricity	592	489	434	84	57%
Clean cooking	1,678	1,587	1,257	758	61%
Internet use	1,232	1,082	254	32	62%
Financial account	982	839	415	105	62%
Basic drinking water	617	555	495	219	59%
Basic sanitation	1,277	1,209	1,080	660	61%

Source: H Heuristics Positive Pathways ledger (Hughes, 2026e), from World Bank WDI and UN WPP 2024 (World Bank, 2026c; United Nations, 2024). Proven pace = 75th percentile of peer logit trends, 2012–2024.

20.3 The value of the dividend

The Human Survivability Dividend values these differences in lives and capital protected. On the conventions adopted in the November 2026 update, closing just 0.5%, 1% or 2% of the 143 billion person-year gap between trend and proven pace would avoid about 0.7, 1.4 or 2.9 billion person-years of deprivation (Hughes, 2026i). Valued with the statistical-life methods used in public policy, even the lower figures would justify large public investments. The point of such numbers is not precision but proportion: they show that accelerating proven interventions is among the most valuable things humanity can do this century.

PART IV · SECTION 21

Measuring Progress and Developing the Concepts

What gets measured gets managed. A useful contribution is to evaluate development by its combined benefits rather than one outcome at a time, and to keep the concepts that guide this work few, defined and testable.

IN BRIEF

- Six measurement dimensions: economic convergence, human development, technological diffusion, environmental improvement, adaptive capacity and demographic resilience.
- An annual ledger should report person-years of deprivation avoided against proven peer pace.
- Twelve candidate concepts map onto the six H Heuristics concepts; most are better treated as dimensions or measures than as new labels.

21.1 A measurement framework

The framework proposed for this report measures six dimensions, each with a small set of public indicators so that it can be updated every year for every country. The Century Outlook Dashboard in Section 19 is a first implementation. Three principles guide it. Measure **outcomes for people** (survival, learning, access) rather than inputs. Measure **relative and absolute** progress, since catching up and getting better are different things. And benchmark every country against **proven peer pace**, so that targets are demanding but demonstrably achievable.

Table 18 Six dimensions for measuring progress toward an optimized century outlook

Dimension	What it captures	Core indicators used	Candidate additions
Economic convergence	Productivity and income gaps	GDP per person relative to the high-income average (PPP, log)	Output per worker; extreme poverty; absolute gap
Human development	Education, health and living standards	Life expectancy; under-five survival; primary completion	Learning-adjusted schooling; stunting; maternal mortality
Technological diffusion	Adoption and accessibility	Internet use; account ownership; mobile subscriptions	Meaningful connectivity; DPI usage; device affordability
Environmental improvement	Emissions, pollution, resource efficiency	PM2.5 exposure; clean cooking; renewable share of power	CO_2 per dollar; forest loss; water efficiency
Adaptive capacity	Preparedness and ability to withstand shocks	Government effectiveness; INFORM risk; electricity access	Early-warning coverage; social protection; pre-arranged finance
Demographic resilience	Capacity to support changing, growing populations	Secondary enrolment; fertility; share of children	Girls' secondary completion; jobs per new worker; urban services growth

Source: H Heuristics. Dimensions adapted from the measurement framework proposed for this report; indicators from World Bank WDI, WGI and INFORM.

21.2 An annual ledger

Alongside the dashboard, H Heuristics proposes an annual ledger in the units that matter most: lives saved, person-years of deprivation avoided and people reached, benchmarked against proven peer pace. The baseline is the November 2026 benchmark: 859 billion person-years if access is frozen, 255 billion on trend and 112 billion at proven pace for 2026–2100 (Hughes, 2026i). The first annual adoption audit, planned for November 2027, will report how the trend has moved and how H Heuristics' own outreach has contributed, counting only independent citations and claiming contribution rather than attribution (Hughes, 2026b).

21.3 Which concepts to develop

Many candidate concepts were proposed during the preparation of this report. Concept discipline matters: a new label is only useful if it has a clear definition, a measure and a claim that could turn out to be false. Several candidates are already well established in the literature and should be cited rather than claimed. The table maps twelve candidates onto the six concepts of the H Heuristics Macroeconomic Architecture (Hughes, 2026h) and recommends how each should be used.

Table 19 Twelve candidate concepts and how they relate to the H Heuristics architecture

Candidate concept	Short definition	Maps to	Recommendation
Sustainable Convergence	Narrowing development gaps while strengthening sustainability and resilience	Sustainable Convergence	Core concept; already developed
Adaptive Convergence	Narrowing gaps while strengthening capacity to adapt	Sustainable Convergence; Polycrisis Resilience	Treat as a dimension, not a new label
Polycrisis-Adjusted Development	Judging progress alongside exposure to systemic risk	Human Vulnerability Reduction Economics	Use as a measurement principle
Sustainable Diffusion	Spreading technologies that support sustainable development	Sustainable Convergence	Use descriptively; cite diffusion literature
Developmental Resilience	Sustaining progress despite shocks	Polycrisis Resilience	Fold into Polycrisis Resilience
Anticipatory Development	Building capacity ahead of foreseeable pressures	Preventive Development Economics	Fold in; cite anticipatory action
Multidimensional Development Optimization	Coordinating interventions for simultaneous gains	Development Optimization	Use as the full name of the concept
Resilience-Oriented Urbanization	Urban growth that reduces exposure	Polycrisis Resilience; HVRE	Pathway-level term with a metric
Convergent Technology Diffusion	Diffusion that accelerates productivity catch-up	Sustainable Convergence	Merge with the diffusion gap measure
Preventive Development Economics	Early investment to prevent future vulnerability	Preventive Development Economics	Core concept; already developed
Demographic Resilience	Capacity to manage demographic change	HVRE; Development Optimization	Keep as a measurement dimension
Productive Sustainability	Environmental gains with expanding productive capacity	Sustainable Convergence	Fold in; overlaps green growth

Source: H Heuristics. Candidate definitions as proposed during preparation of this report; mappings and recommendations by the author.

21.4 A research agenda

- **Causal multiple dividends.** Move from cross-country associations to quasi-experimental estimates of how each intervention affects several outcomes at once, starting with clean cooking, connectivity and girls' schooling.
- **Conversion rates.** Measure how often access turns into use, use into productivity and productivity into income, by intervention and country.
- **Joint gates.** Identify which combinations of investments (power and connectivity, water and nutrition, finance and appliances) must arrive together for any of them to pay off.
- **Proven pace by intervention.** Publish country-by-country benchmarks of what peers have achieved, as the basis for demanding but feasible targets.
- **The resilience of shocks.** Explain why no single service predicted resilience to the 2020 shock, and which fiscal and institutional capacities did.
- **Valuing the dividend.** Develop transparent methods to value lives and capital protected, consistent with the Human Survivability Dividend.
- **Diffusion lags.** Track, technology by technology, how many years separate lagging countries from leaders and whether the lag is shrinking.
- **Adoption of the concepts themselves.** Measure whether the frameworks in this report are taken up by researchers, educators and institutions, counting only independent citations (Hughes, 2026b).

Each item on this agenda is designed to produce a number that could prove the report wrong: a dividend that does not appear, a chain that does not convert, a pace that cannot be matched. That is the standard H Heuristics applies to its own concepts, and the one it invites others to apply.

PART IV · SECTION 22

Conclusion: Ten Propositions for the Century

The century's trajectory is maximised by closing the gap between frontier innovation and Global South deployment, turning clean technology, digital infrastructure and early human capital into self-reinforcing engines of health, growth and climate survival.

IN BRIEF

- The tools largely exist; the binding constraint is the speed of their diffusion to where people and risks are growing.
- Invest in interventions that pay several dividends, in the places where demography and risk meet, and measure the results in lives and person-years.
- Every finding should become an adoption campaign with an audience, a benchmark and a date.

22.1 Ten propositions

1. **The century will be decided where demography and risk meet.** High-risk countries will hold 65% of humanity by 2100 and absorb 96% of growth to 2050.
2. **Development is the most powerful risk-reduction technology.** Vulnerability, not hazard, explains most of the difference in human losses between countries.
3. **Pace matters more than direction.** Proven peer pace would cut the century's five-service deprivation ledger from 255 to 112 billion person-years.
4. **Convergence must be broad, clean and resilient.** Catch-up that bypasses the poorest countries, depends on fossil fuels or collapses at the first shock does not optimize the outlook.
5. **Diffusion, not invention, is the bottleneck.** Device-based technologies spread in years; network- and institution-based ones need deliberate policy.
6. **Foundations pay the most dividends.** Power, water, sanitation, schooling and connectivity are associated with better outcomes across five dimensions, holding income fixed.
7. **Human capital compounds.** Girls' education, early nutrition and immunisation raise the return on everything that follows.
8. **Complements decide returns.** Connections without appliances, devices without skills and stoves without fuel fail; invest in conversion chains, not single links.
9. **Enablers unlock scale.** The cost of capital, debt and market access rank low on any single criterion but determine whether everything else can grow.
10. **Measure in lives and person-years, and act on the measure.** A shared benchmark, proven peer pace, turns aspirations into accountable targets.

22.2 From report to adoption

H Heuristics does not implement programmes. Its role is to develop concepts, publish open-access research and use it to influence what decision-makers measure, target and fund (Hughes, 2026i). In that spirit, this report is the start of a campaign rather than an end product. Its findings point to three immediate uses: the two-track portfolio as a frame for national development and climate plans; proven peer pace as a benchmark for targets; and the Century Outlook Dashboard and annual ledger as a way to track progress. The first campaign, the 12-month Clean Cooking Sprint, applies exactly this logic to the intervention with the clearest combination of lives at stake, proven technology and tractable delivery (Hughes, 2026b).

The idea that this century can become more dangerous while human lives keep improving is not a prediction. It is a description of what becomes possible if the knowledge and technology humanity already has reaches the places where most of humanity will live. The objective is not simply to develop faster, but to develop in ways that make humanity more prosperous, more technologically capable, more environmentally sustainable and more resilient. The rest of the century is the time available to do it, and the first decade matters most.

MILESTONES

What success would look like by 2035

- Every lagging country moving at or above proven peer pace on electricity, clean cooking, water, sanitation and connectivity.
- Electrified households cooking with clean fuels as the norm, beginning with the dozen countries that hold two-thirds of the challenge.
- Early warning reaching everyone, linked to digital payments and pre-arranged finance.
- A visibly lower cost of capital for clean energy and resilient infrastructure in developing economies.
- Girls' secondary completion rising fastest where population growth is highest.
- An annual ledger, published every November, showing person-years of deprivation avoided against the 2026 benchmark.

> *"The century's trajectory is maximised by closing the gap between frontier innovation and Global South deployment."*
>
> Central conclusion of this report

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