Investor Roadmap for Inclusive Green Growth

Accelerating clean technology access for emerging consumers

LeapFrog Investments CGAP TEMASEK

Acknowledgements

Research Committee

Phyl Georgiou, Head of Climate Strategy, LeapFrog Investments

Nakul Zaveri, Partner, Co-Head of Climate Investment, LeapFrog Investments

Yalin Karadogan, Partner, Head of Investor Solutions, LeapFrog Investments

James Burton, Senior Manager, Strategy, LeapFrog Investments

Katherine Owens, Associate Director, Impact Measurement and Management, Climate, LeapFrog Investments

Daniel Stacey, Head of External Affairs, LeapFrog Investments

Chio Verastegui, Head of Strategy, LeapFrog Investments

Max Mattern, Senior Financial Sector Specialist, CGAP

Malika Anand, Consultant, CGAP

Bennett Gordon, Consultant, CGAP

Eliza Foo, Director, Impact Investing, Temasek

Di Fu, VP, Impact Investing, Temasek

Data

Phyl Georgiou, Head of Climate Strategy, LeapFrog Investments

Nakul Zaveri, Partner, Co-Head of Climate Investment, LeapFrog Investments

Max Mattern, Senior Financial Sector Specialist, CGAP

Malika Anand, Consultant, CGAP

Bennett Gordon, Consultant, CGAP

Graphic Design

Quirijn Schonewille, Designer, Instance

Andrew McNaughton, Director, Instance

Kees de Klein, Designer

Editorial

Daniel Stacey, Head of External Affairs, LeapFrog Investments

Melissa Yeo, Content Manager, LeapFrog Investments

Keith Lin, Director, Sustainability, Temasek

Amelia Tan, Associate Director, Public Affairs, Temasek

Cover Image by Mikhail Nilov

Printed on recycled paper

"There are now clear pathways for clean development in emerging markets that are cheaper than the carbon-intensive alternatives traditionally used."

1

Five billion reasons to invest for change in Southeast Asia, South Asia, and Africa

Andy Kuper, CEO and Founder of LeapFrog Investments

Sophie Sirtaine, CEO of CGAP

Benoit Valentin, Head of Impact Investing and Private Equity Fund Investments; Deputy Head, Europe, Middle East & Africa, Temasek

This COP28 is a time to reflect on where we have arrived after decades of climate action, and inaction. The last two COP meetings, hosted in Sharm el-Sheikh and now Dubai, have shifted global focus to fast-growing emerging countries. This is a timely pivot, as the consumer power of 5 billion people[1] in the emerging markets of Africa, Southeast Asia, and South Asia, is like a loaded sling shot – either offering a once in a generation chance to build sustainable, green economies of the future, or delivering a wave of carbon-intensive consumption that could upend efforts to lower global emissions.

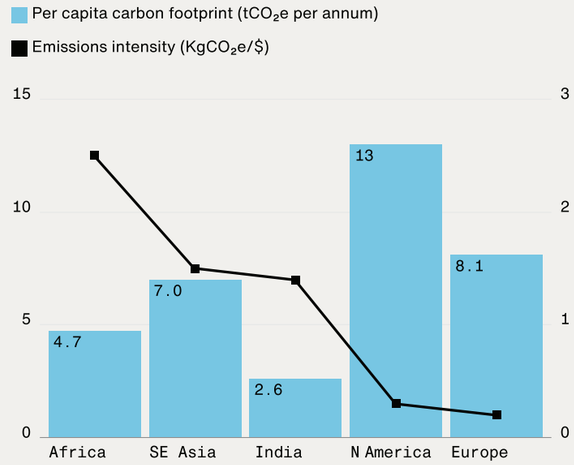
1 International Monetary Fund 2023a

This dynamic – the opportunity and challenge of emerging market growth – is the focus of this report. We have combined the latest data and modelling from the IFC, World Bank, IEA, IPCC's Decarbonisation Scenario Explorer, Oxford Economics, UKAid, McKinsey Transition Finance Model and other sources, with expert insights on the progress of key technologies, to define the investment opportunity, and frame the future as it may manifest under various scenarios of policy action and capital mobilisation.

Key Takeaways from South Asia, Southeast Asia and Africa

6-10x

Emissions intensity despite low per capita carbon footprint



73%

Emerging market share of 2050 global emissions with BAU investment, and if developed markets achieve <2 degree scenarios

$330B

Investment needed each year to 2030

But more importantly, we want to take the discussion further, and offer a pragmatic roadmap for how, right now, we can direct that slingshot, that loaded potential of trillions of dollars of consumer spending, in a direction that is most beneficial to low-income households and the world's shared climate. Emerging markets are the least responsible for the climate crisis of today, and currently deliver only a fraction of global emissions. But the emissions intensity of their consumption is far higher than developed nations. A dollar of GDP in Africa represents over 10 times the emissions of a dollar of output in Europe. This high intensity consumption is not only costly for the environment as incomes rise but shortchanges emerging consumers who pay excessive prices for inefficient technologies.

It is no longer the case that government subsidies, philanthropic grants, and taxes are the only means to accelerate and scale green products and services. Across emerging markets, advances in technology, increasing spending power, and new entrepreneurial approaches to network efficiencies, mean that a tipping point has been reached across multiple sectors, allowing green technologies to outcompete incumbent products. In other words, there are now clear pathways for clean development in emerging markets that are cheaper than traditional carbon intensive alternatives. This is good for households, businesses, countries' development, and the global climate. It can also be a compelling opportunity for investors.

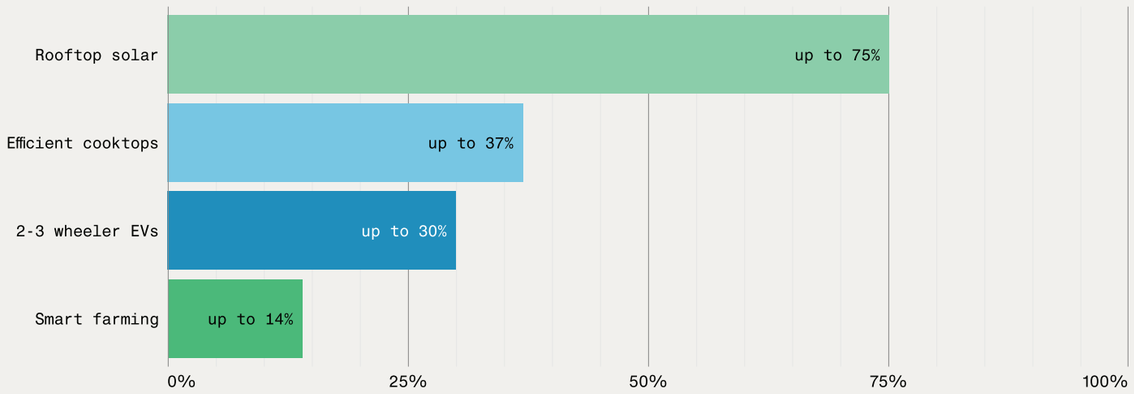
These technologies not only offer a chance to save our planet but are the bedrock of the competitive economies of the future. Emerging markets can leapfrog a generation of polluting, expensive technology and infrastructure, using clean business models to facilitate stronger economic growth, create enormous prosperity, and deliver tens of millions of new jobs. Decentralised models of energy, mobility, and agricultural planning offer households and business owners control over their wealth, stability of income, and even a lower cost of access to credit and insurance. Emerging markets can also build competitive advantage around rich natural endowments of sunlight, critical minerals, and entrepreneurial talent.

This report shares our data on these bright, hopeful, and lucrative opportunities for change, and our aim is to motivate and support a wave of green investment into emerging markets. From electric vehicles in India, to rooftop solar in Kenya, and new cooking and building methods in Indonesia, there is an investible universe of hundreds of billions of dollars awaiting savvy green investors across emerging markets.

Green technologies are already cheaper in many emerging markets

14 - 75%

Green discount versus incumbent alternative



Measures like public sector policy support, reduced fossil fuel subsidies, and voluntary carbon markets also hold out hope for other emerging markets and sectors where the enabling conditions for green investment do not currently exist.

It is not only our duty as good global citizens to fund and scale these opportunities, but for those with the foresight and determination to take the plunge, it is a chance to build world-beating, sustainable businesses of the future, delivering energy, mobility, housing and food to the five billion emerging consumers seeking to rise into prosperity.

2

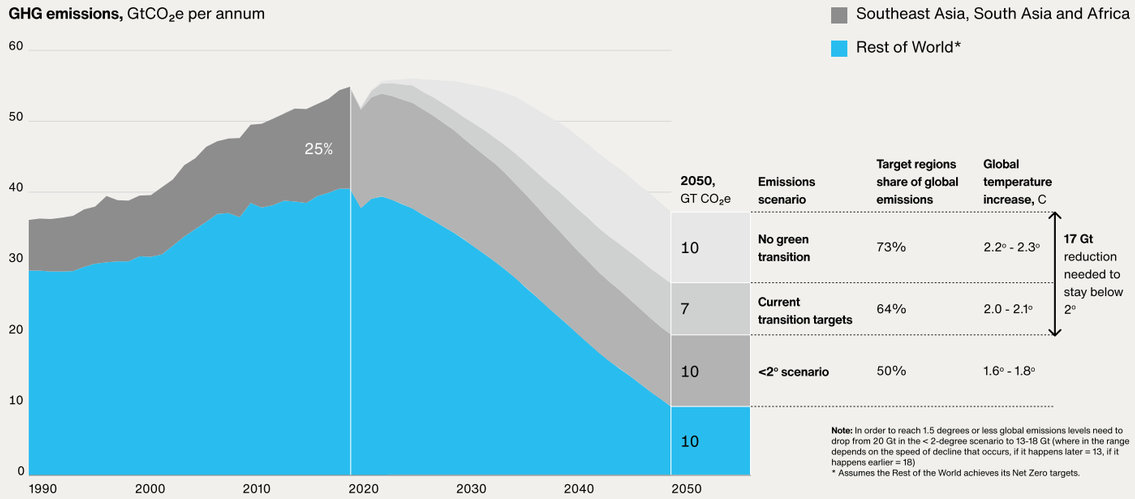
Executive Summary

2.1 The road ahead for emissions

Under the Paris Agreement signed in 2015, the world's major economies agreed to pursue efforts to limit global warming to 1.5 degrees by 2050[2]. Current climate science estimates this target requires emission to be reduced by 45% by 2030, and net zero by 2050[3]. Emerging markets in Southeast Asia, South Asia and Africa have contributed a fraction of historic emissions to date, and currently comprise only 25% of annual global emissions. We cannot expect these markets, which include some of the world's poorest and most vulnerable populations, to shoulder the burden of climate mitigation. Still, their growth in coming decades could shift this balance and challenge efforts to meet the Paris Agreement[4]. In particular, a surge in incomes means that households will be able to afford cars, air-conditioning, larger homes, and higher protein diets. This in of itself is cause for celebration, as hundreds of millions rise into prosperity for the first time.

For the climate, it shouldn't necessarily be cause for alarm. New technologies can deliver these products and services without the enormous greenhouse gas emissions of the past. Still, these technologies require investment, and in many cases an enabling business environment supported by government policies, and public and private sector partnerships. Our goal with this report is to highlight green investments where the economics already support major inflows of private capital, without requiring further government policy support. This could be just the tip of the iceberg. If other countries in these regions also pursue effective enabling policy, further investment could flow. Without this investment, rising incomes across just these three regions will translate into dramatic increases in emissions, with their share of overall global emissions projected to rise to as much as 73% by 2050, assuming the rest of the world achieve their optimistic net zero scenarios[5].

Share of emissions from Southeast Asia, South Asia and Africa could grow to more than ~70% by 2050 without a green transition



Source: McKinsey Global Energy Perspective, Decarbonation Scenario Explorer

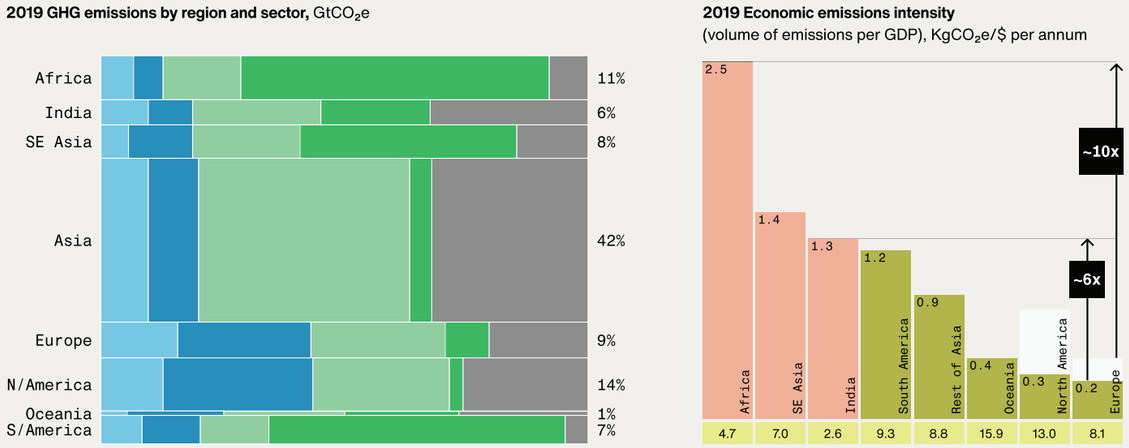
2 United Nations 2015
3 United Nations 2022
4 McKinsey & Co 2023
5 LeapFrog modelling based on McKinsey Global Energy Perspective, Decarbonisation Scenario Explorer, 2023

2.2 Four key sectors define the future

The link between rising incomes and rising emissions exists across multiple sectors, but four key sectors play a dominant role. Energy, mobility, the built environment and agriculture are all slated to boom across emerging markets in coming decades, as consumers reach income thresholds where they are able to connect to electricity grids, buy their first cars, upgrade their homes, and consume more animal protein.

Compared with wealthy markets, emerging markets consume far less across these four sectors, but their consumption is typically more carbon intensive. Instead of grid electricity, for instance, more than 6.5 million diesel generators are in use across Sub-Saharan Africa[6]. Inefficient agricultural practices can lead to the over-use of fertilisers or pesticides, creating not only environmental but health risks[7]. And houses that are poorly insulated create even greater demand for energy, largely from polluting wood stoves[8]. Massive efficiencies can be delivered across these four sectors, as new technologies replace carbon intensive methods.

Africa, India and Southeast Asia contribute ~25% of GHG emissions, however these regions have 6-10X higher economic emissions intensity than developed countries ($KgCO_2e$/$ of annual GDP)



I. Built Environment includes emissions from Buildings and waste management sectors **II.** Includes emissions from LULUCF sector

Source: McKinsey Global Energy Perspective, World Bank

6 International Finance Corporation 2019
7 European Union 2021
8 International Energy Agency 2023

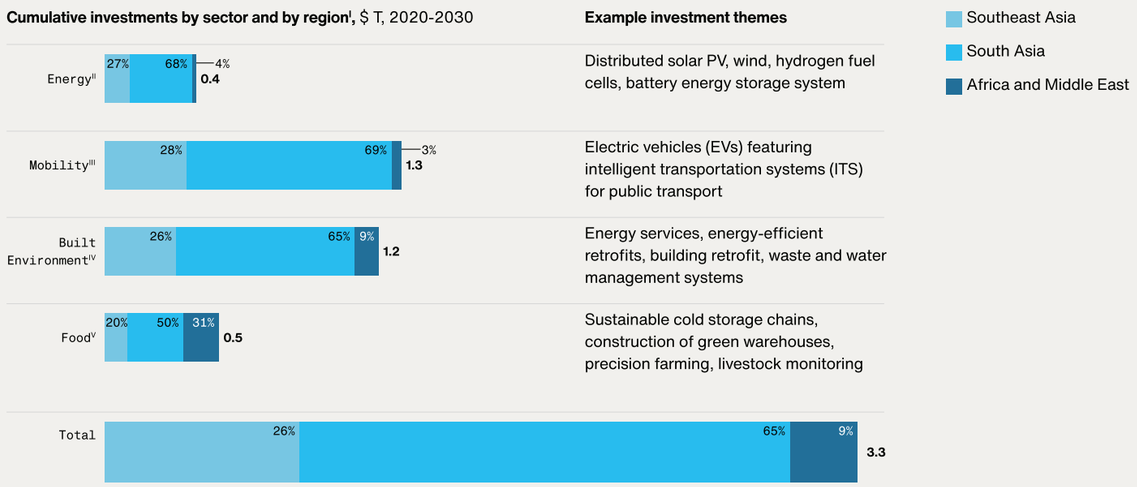
2.3 The opportunity for private capital

Transitioning these four sectors – energy, mobility, the built environment, and agriculture – requires significant investment across both existing and new assets in emerging markets.

Investments in South and Southeast Asia dominate this discussion. Indeed, the investment potential for a green mobility revolution in India alone outstrips green investment opportunities in all these four sectors for Africa.

Around $330B a year, or $3.3 trillion by 2030, is needed to deliver a green transition across all four sectors in South Asia, Southeast Asia and Africa[9]. Current investments account for about 5% of this annual total, leaving a significant funding gap and investment opportunity.

Cumulative investment required to green new and existing assets could reach $3.3T by 2030 or ~$330B per year



I. Southeast: Indonesia, Philippines, Vietnam. (We have excluded estimated investments in China from the IFC's figures by assuming China's investment share equivalent to it's share of the region's projected GDP growth in the period 2020-2030 GDP, or 79%.); South Asia: Bangladesh, India, Africa and Middle East: Egypt, Jordan, Morocco, Cote d'Ivoire, Nigeria, South Africa; **II.** Energy includes: renewable energy and scale up distributed generation and storage; **III.** Mobility includes: low carbon airlines and shipping and green urban transport; **IV.** Built environment includes: low carbon municipal waste and water, buildings for energy efficiency. **V.** Food includes: Scale climate-smart agriculture

Source: International Finance Corporation, 2021

9 International Finance Corporation 2021

2.4 Top four investible green opportunities

Our analysis across these four sectors reveals dozens of investible opportunities. Private capital can be deployed today across many of these opportunities, where the price of green goods and services is out-competing incumbent technologies. There are several reasons for this, for instance enabling infrastructure like electricity grids may not have been constructed meaning electricity costs are actually higher than in developed markets, offering price advantages to rooftop solar systems. In other cases, high gasoline prices make electric vehicles more competitive.

Identifying these opportunities is key to deploying capital responsibly and generating the strong returns to motivate others to enter these markets. From our analysis we have isolated the four most attractive opportunities for green investments in emerging markets:

The top four investible opportunities

Rooftop Solar	**Green discount:** up to 75%	**Key markets:** • Nigeria • Kenya	**Key companies:** • Sun King • M-Kopa • Lumos • SunFi
Efficient Cooktops	**Green discount:** up to 37%	**Key markets:** • Nigeria • India • Kenya	**Key companies:** • URN • M-Gas • Bidhaa Sasa • KOKO Fuel
2-3 Wheeler EVs	**Green discount:** up to 30%	**Key markets:** • India • Kenya	**Key companies:** • Ola Electric • Bajaj Auto • TVS Motors
Smart Farming	**Green discount:** up to 14%	**Key markets:** • Vietnam • India • Indonesia	**Key companies:** • Yara • Nutrien • Agrivi • RIZE

"$330B a year by 2030 is needed to deliver a green transition across energy, mobility, built environment and food in South Asia, Southeast Asia and Africa"

3

Framing the Issue

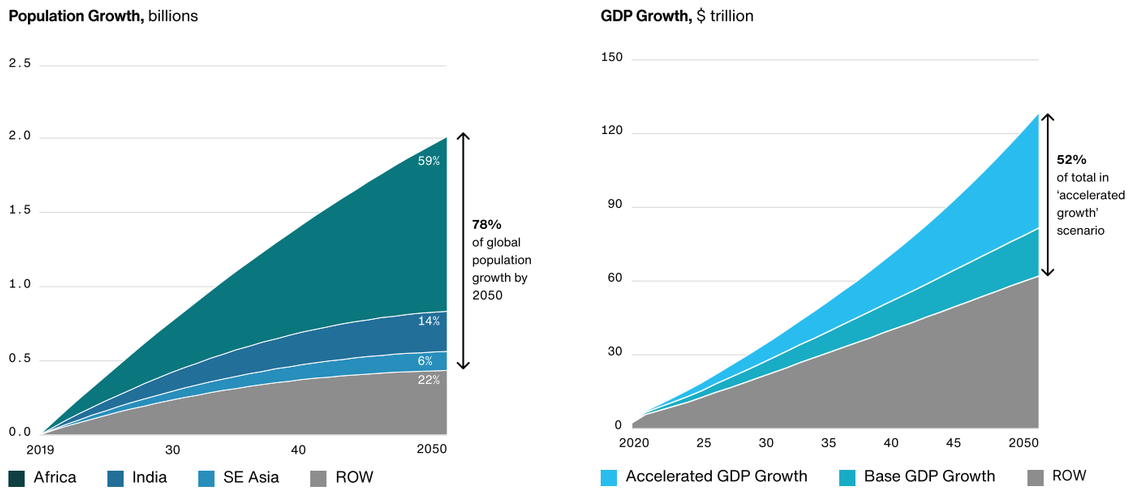
Growing Incomes Don’t Have to Mean Growing Emissions

3.1 Income and consumption trends in emerging markets

Already, growth in emerging markets significantly outpaces the developed world. For 2023, the IMF estimates OECD markets will grow at one third the rate of emerging markets[10]. India is the world’s fastest growing major economy, with IMF growth forecasts of 6.1% and 6.3% in 2023 and 2024[11]. Morgan Stanley now predict India will become the world’s third largest economy by 2027, and the world’s third largest stock market by 2030[12].

Over the next 30 years, these trends are set to continue and deliver compounding effects that shift the makeup and balance of the global economy. More than half of global GDP growth running up to 2050 is likely to come from Africa, India and Southeast Asia[13]. While the overall quantum of this growth has a certain inevitability due to population dynamics (these markets will also account for 78% of global population growth during that period) the nature of that growth is yet to be determined – whether it will be sustainable or heavily polluting and environmentally destructive.

Over the next 30 years, ~80% of population growth and ~50% of GDP growth could come from Africa, India and Southeast Asia



Note: GDPs in Real 2015 dollars; Growth assumptions are based on favourable demographics, acceleration of digitalisation, consumer spending, business investment, job creation and productivity gains.

Source: Oxford Economics, World Bank, McKinsey Global Institute

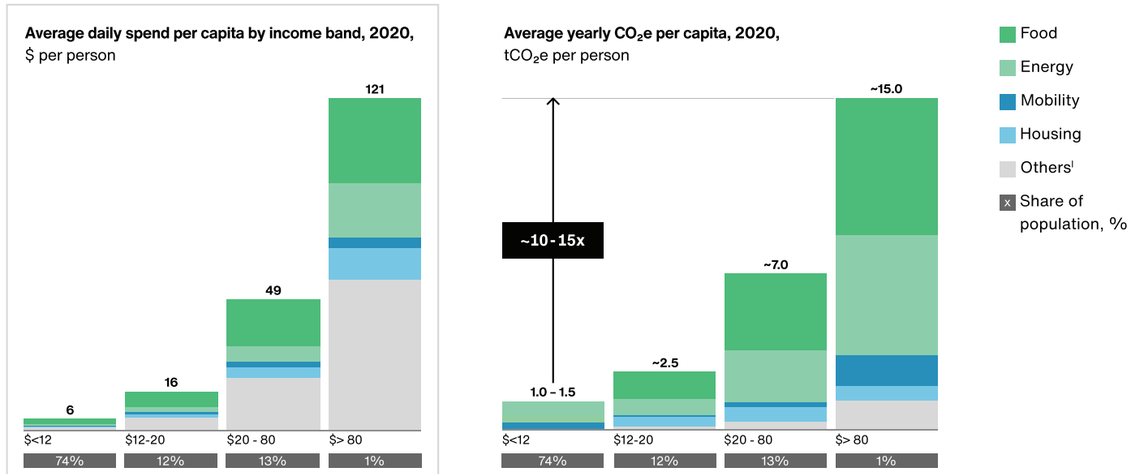
Importantly, and unlike the rest of the world, emerging markets currently have a relatively low percentage of people that earn above $80 a day and can afford large amounts of electricity, meat and fossil fuel transport. This trend will not continue, however, as incomes continue to rise.

10 International Monetary Fund 2023a
11 International Monetary Fund 2023b
12 Morgan Stanley 2022
13 LeapFrog modelling based on Oxford Economics, World Bank and McKinsey Global Institute research

Many people in emerging markets are on the cusp of joining the consuming classes and making their first major purchases in categories like mobility, housing and energy consumption. Low emissions across emerging markets are in this sense deceptive, as many low-income consumers are yet to engage with consumer categories typically associated with high emissions in developed countries.

Within a few decades this will change dramatically, and the higher consuming classes will account for almost half of all emerging market expenditure, rather than around 20% as they do today[14]. This surge in wealth will see billions of people join the consuming classes around the world. Annual expenditure across emerging markets is slated to rise four-fold in this period, or twice the rate of expenditure growth for the rest of the world[15].

As consumers in South Asia, Southeast Asia and Africa earn more, their carbon footprints could rise substantially without a wave of green investment



I. Includes spending on entertainment, leisure, clothing and travel

Source: World Data Pro, Euromonitor, Country consumer surveys, McKinsey Global Institute

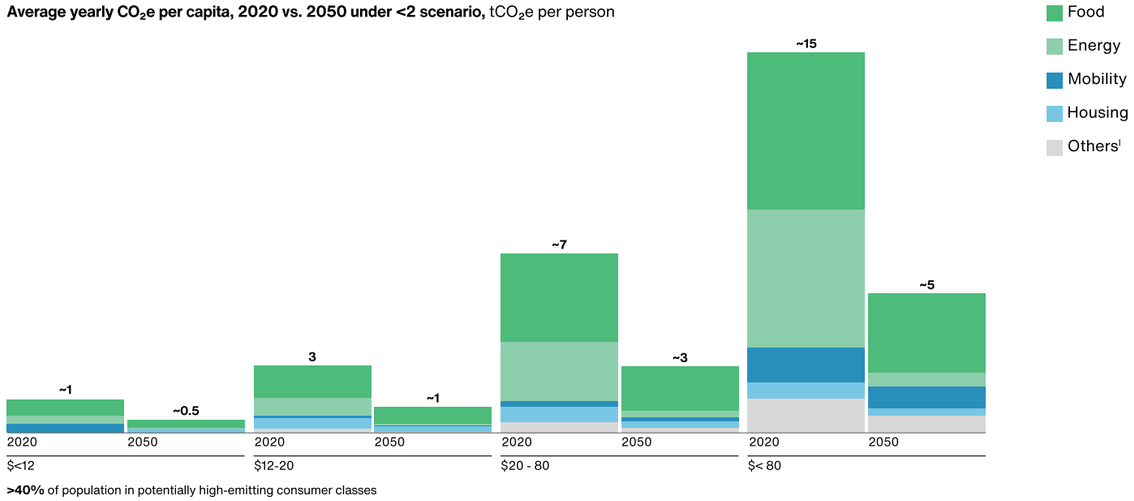
3.2 The future of emerging market climate emissions

As incomes rise and billions more people enter the consuming classes, emerging market carbon emissions could spike dramatically if traditional carbon-intensive methods are used to meet surging demand. A new roadmap for sustainable economic development, and support for green technologies and business methods, are required to avoid the mistakes of previous phases of global growth.

Today, only 1% of the population in emerging markets earns over $80 per day, yet the emissions of this high consuming group have set a worrying precedent[16]. This group spends on average 20x more per day and emits 10-15x more CO_2e per year than those on the bottom of the income pyramid, and on average the emissions intensity of emerging consumers across all income levels is much higher than Europe or North America. The emissions of high-income groups in emerging markets are primarily driven by the consumption of food, energy, housing and mobility, sectors that are experiencing rapid technological progress, suggesting immense opportunities for green investments.

14 LeapFrog modelling based on McKinsey Global Institute, World Data Pro
15 Ibid
16 LeapFrog modelling based on World Data Pro, Euromonitor, Country consumer surveys, McKinsey Global Institute

Per capita emissions across spending groups in Southeast Asia, South Asia and Africa could be reduced by up to ~60% by 2050 if these regions make a “green leap”



I. Includes spending on entertainment, leisure, clothing and travel

Source: McKinsey Global Institute, World Data Pro, Euromonitor, Country consumer surveys

Analysis of various income brackets across emerging markets suggest that significant reductions in carbon emissions are possible, even as incomes, spending power, and consumption rise.

Overall, per capita emissions across spending groups could theoretically be reduced up to 60% by 2050 if these regions are able to make a “green leap” and transition into clean technologies as their economies grow[17]. Indeed, with a successful green transition even high-income consumers earning more than $80 a day could produce lower annual emissions ($5tCO_2e$/person) than lower income groups earning $20-$80 currently produce today ($7tCO_2e$/person). Emissions reductions are particularly apparent in areas like energy, where a switch to renewable alternatives could reduce emissions to almost negligible levels.

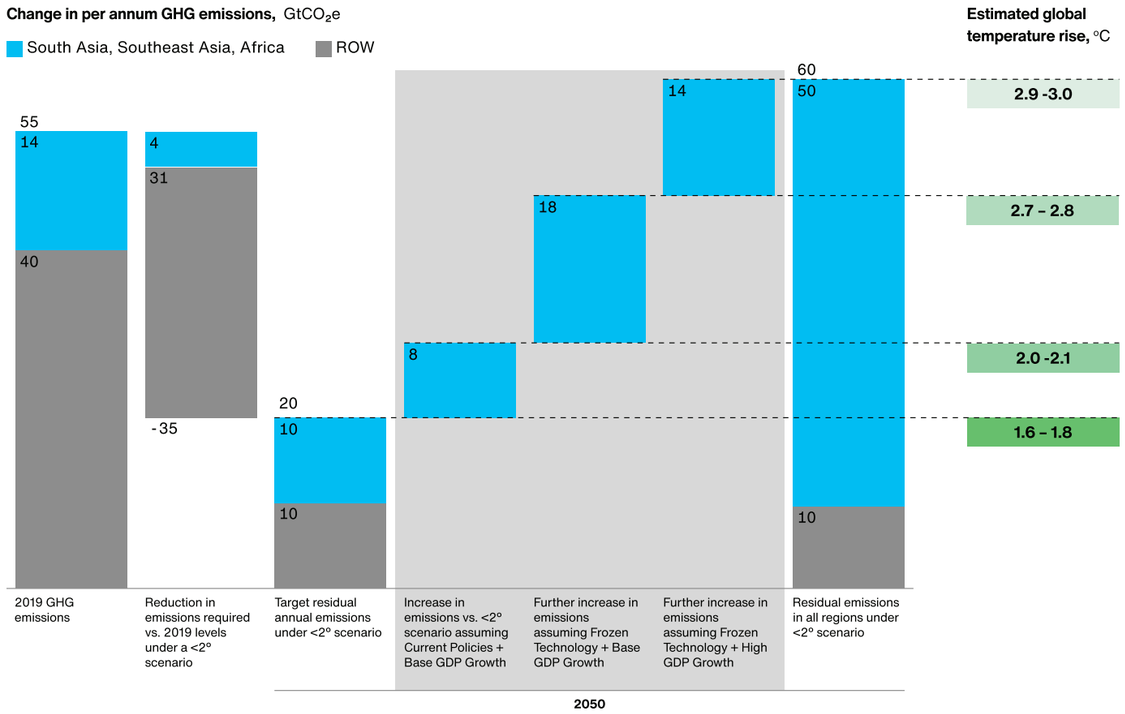
By leapfrogging over older, incumbent industries, these fast-growing economies can both avoid investing in redundant infrastructure and stranded assets, and transcend the tradeoffs between wealth and negative climate outcomes that defined most economic growth and development in the 20th century.

17 Ibid

3.3 The scenarios for action versus inaction

Targeting emerging market emissions is not only important to help build capability, prosperity and resilience in these markets, but also a fundamental priority for global climate efforts.

Without climate action and under a business as usual scenario, emerging market emissions could offset optimistic scenarios for climate progress in developed markets by 2050



Level of climate action and growth

1.6 – 1.8
Assumes target regions achieve commitments set out by Paris agreement to limit global warming to <2 °C (emissions reduced to 10 $GtCO_2e$ p.a.) at baseline GDP growth through 2050.

2.0 -2.1
Assumes some greening of emerging economies with technological progress and business model innovation leveraged largely from developed markets. Current policies support the transition but are not enough to limit warming to below 2 °C at baseline GDP growth.

2.7 – 2.8
Assumes same limited technological and business model innovation as 2.0-2.1 scenario with baseline GDP growth rate.

2.9 -3.0
Assumes technological and business model innovation is extremely limited in target markets. Technology remains constant vs. today and policies do not serve to accelerate emissions reductions as economies grow at a higher-than-expected rate.

Source: McKinsey Global Energy Perspective, Decarbonisation Scenario Explorer

The ability to meet the 2-degree warming scenario targeted under the Paris Agreement could be thwarted by rising incomes and consumption across emerging markets without rapid, decisive action. Indeed, even if developed countries meet all their Paris Commitments, inaction in emerging markets, combined with continued

GDP growth, could see global temperatures surge up to 3 degrees by 2100[18]. The global challenge is to rapidly reduce emissions in developed countries while also enabling low- and middle-income countries to pursue low-carbon growth trajectories.

In certain extreme scenarios of high GDP growth and low technology uptake, South Asia, Southeast Asia and Africa could account for five out of every six tonnes of CO_2e emitted into the atmosphere by 2050, dwarfing the effects of climate action across the OECD, highlighting the critical importance of investing in these markets across the long-term[19]. Even with some greening across emerging markets and enabling regulatory support, emerging markets could feasibly account for close to two thirds of global emissions by 2100, up from around 25% currently, highlighting the critical importance of investing in these markets across the long-term.

18 UN Environment Programme 2019
19 LeapFrog modelling based on McKinsey Global Energy Perspective, Decarbonisation Scenario Explorer

> “The ability to meet the 2-degree warming scenario targeted under the Paris Agreement could be thwarted by rising incomes and consumption across emerging markets without rapid, decisive action.”

4

The Role of Private Capital

Understanding Tipping Points and ‘Green Discounts’

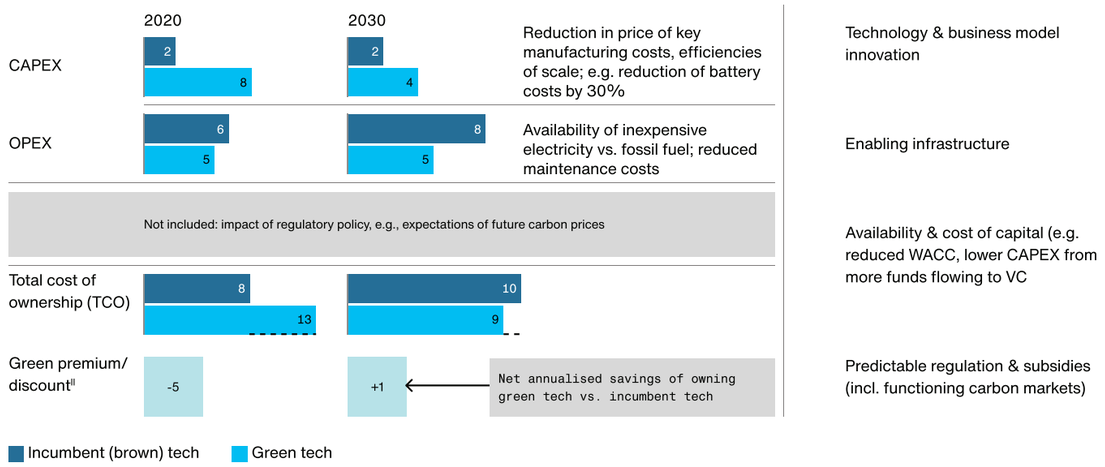
4.1 The components of the green discount

Private capital, unlike government spending and philanthropic grants, can only be deployed where there are clear, investible opportunities to generate market rate returns. Isolating these opportunities is critical to unlocking a wave of green investments into emerging markets.

A green discount analysis can help to identify these investible opportunities, by uncovering areas where the price point for green alternatives is already competitive. Depending on the product or service under consideration, this can involve looking at the total cost of ownership over a reasonable life cycle, to then determine the annualised costs to the customer. In its simplest form, this means analysing capex – usually the upfront cost of purchasing a product or signing on to a service – alongside operating expenditure, which could include fuel costs, service costs, and other rents and fees that are required to maintain the service.

Combined, these two costs can demonstrate the net annualised savings from using a green technology versus incumbent technology. Throughout this report, the concept of a green discount has guided our approach to appraising various commercial opportunities and determining if they are capable of absorbing investment to generate profit.

Calculating green discounts: actions by investors, operators, and policy makers are driving down costs



I. TCO considered before any regulatory interventions (i.e., subsidies or tax rebates), but including expected carbon tax implications; II. Difference in TCO of green technology vs. incumbent technology; in other terms, total savings to owner for switching to green tech

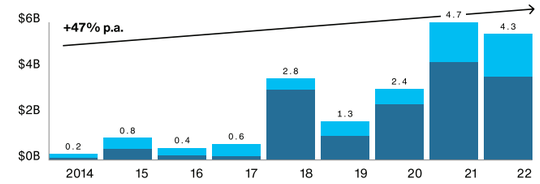
Source: McKinsey Transition Finance Model

Across private capital markets, many investors have already reached the conclusion that a green discount exists, and that green businesses can be brought to scale without waiting for further regulatory or enabling support.

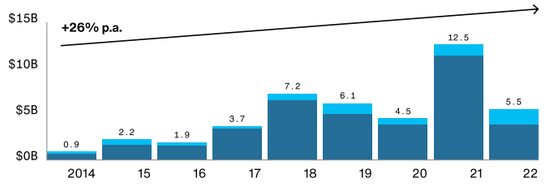
Sustainable investment has accelerated in Southeast Asia, South Asia and Africa over the past 10 years

Food[II]

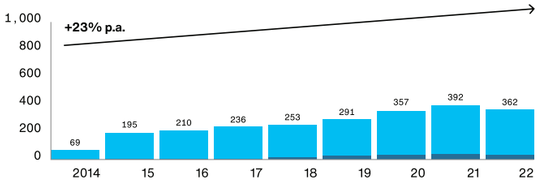
Annual deal funding[V] for sustainable investments[I]

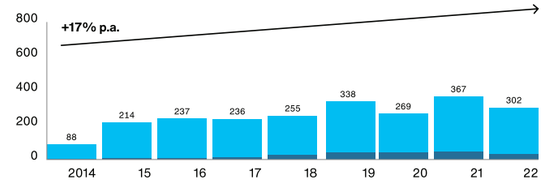


Mobility[III]



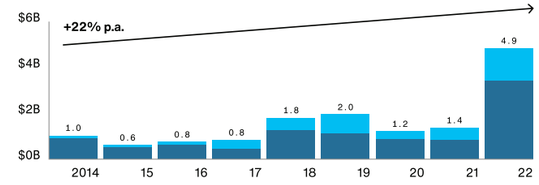
Annual number of sustainable VC and PE deals[I]



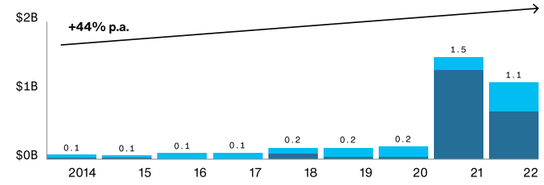


Energy[IV]

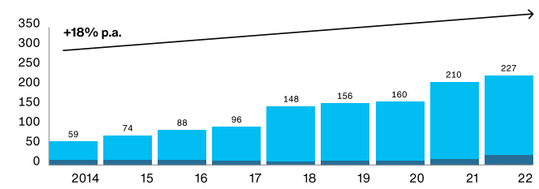
Annual deal funding[IV] for sustainable investments[I]

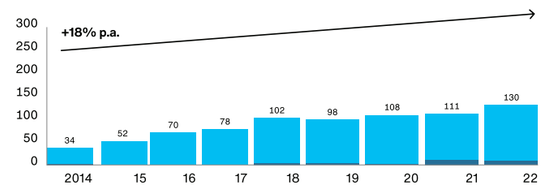


Built environment[V]



Annual number of sustainable VC and PE deals[I]





Venture Capital
Private equity

I. Target markets include Africa, India, and Southeast Asia; **II.** Food includes deals categorised as food tech; AI in agriculture; AI in food; novel foods; organic farming; food logistics; IoT in agriculture; robotics in agriculture; livestock tech; crop tech; aquaculture tech; crop farming; agritech; agriculture biotechnology; food tech India; smart farming; food and agriculture SaaS; agriculture e-commerce; precision farming; sustainable farming; **III.** Mobility includes deals categorised as green transport; electric vehicles; electric vehicles - India; electric vehicles – Asia; electric two wheeler rentals; electric vehicle charging; electric motorcycles; electric scooter manufacturers; electric cars; online trucking; fleet management; warehouse automation; electric aircraft; electric vertical takeoff and landing; smart parking management; AI in supply chain; blockchain in supply chain and logistics; supply chain services; road transport tech; logistics tech; smart public transport; predictive maintenance for automotive; multimodal transport apps; cab ride-hailing; **IV.** Energy includes deals categorised as renewable energy tech; solar energy tech, solar energy; thin film solar cells; smart grid; energy efficiency tech; energy storage tech; wind energy; hydro power; bioenergy; services for energy efficiency; services for energy storage, energy tech-India; microgrid; AI energy; smart water grid; electricity transmission and distribution; geothermal energy; energy storage; energy training and research services ; **V.** Built environment include deals categorised as green Buildings; circular economy; waste and water management; solid waste management tech; water and wastewater management; tech enabled waste haulers; robotic waste sorting; waste heat recovery; waste to energy; smart waste management; commercial waste collection market; smart water grid; smart buildings; construction tech; air pollution management tech; car rentals; household durables; **VI:** "PE deals" includes later stage rounds (from Series C to Series L), Equity crowdfunding, convertible debt, PE; "Venture Capital deals" include seed funded, early-stage rounds (series A and series B)

Source: Tracxn 2023

Private capital allocations to emerging markets are accelerating as green discounts emerge across multiple sectors. This growth trend is uniformly positive, with double digit growth across all key sectors over the last 10 years[20]. So far, venture capital funding has dominated the green investment space in emerging markets, reflecting a moment in time where new technologies are emerging rather than established. Private equity allocations have increased in recent years, particularly in the energy sector.

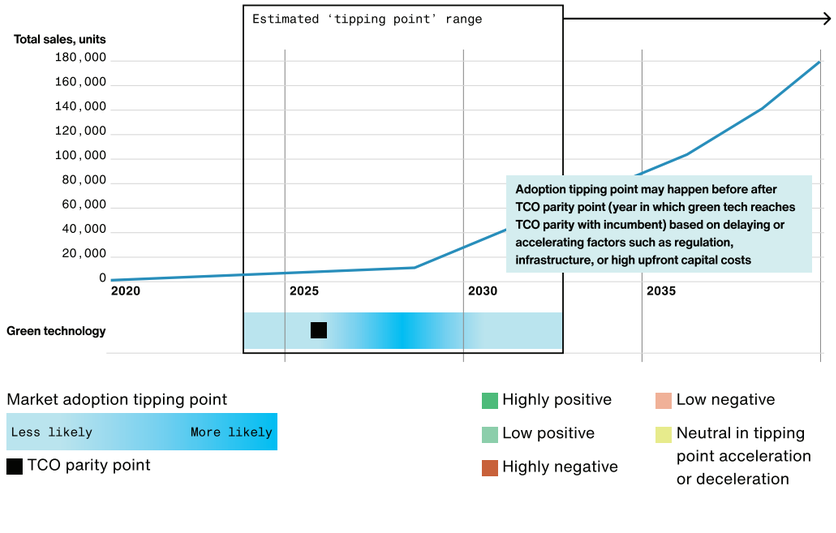
20 Tracxn 2023

4.2 Understanding the difference between green discounts and tipping points in consumer adoption

While a green discount can highlight a potential hotspot of commercial opportunity, there are often barriers other than price that can affect the adoption of new technologies. Throughout this report, a probabilistic approach to tipping points has been utilised to help reflect this complexity and uncertainty.

Identifying green discounts helps to isolate potential 'tipping points' in technology adoption and attractive investible opportunities

Illustrative tipping point analysis



Estimated 'tipping point' range can be before, after, or in-line with the projected TCO-parity year. Relative **certainty is reflected by the width** of the range.

Non-TCO factors pull forward or delay the expected tipping point range.

R I C

Highly positive
Low positive
Highly negative
Low negative
Neutral in tipping point acceleration or deceleration

R Regulatory and policy support
I Infrastructure availability
U High upfront capital requirements
C Consumer preferences
H Health and co-benefits

The range of non-cost related factors that can slow the uptake of a green business model are varied. Across each region and sector we have attempted to identify potential risks and obstacles to a green transition. These can include factors like lagging infrastructure availability where, for instance, there are immature electricity grids to support broad adoption of renewable energy, or a lack of charging stations for EVs. Regardless of the average total cost of ownership, high up-front costs can price out many low-income consumers in the absence of finance and insurance to help lower these initial payments[21]. Regulatory and policy support can change rapidly depending on the government of the day.

All these factors need to be considered to model commercial tipping points and build a reasonable link between a green discount analysis and investment risk.

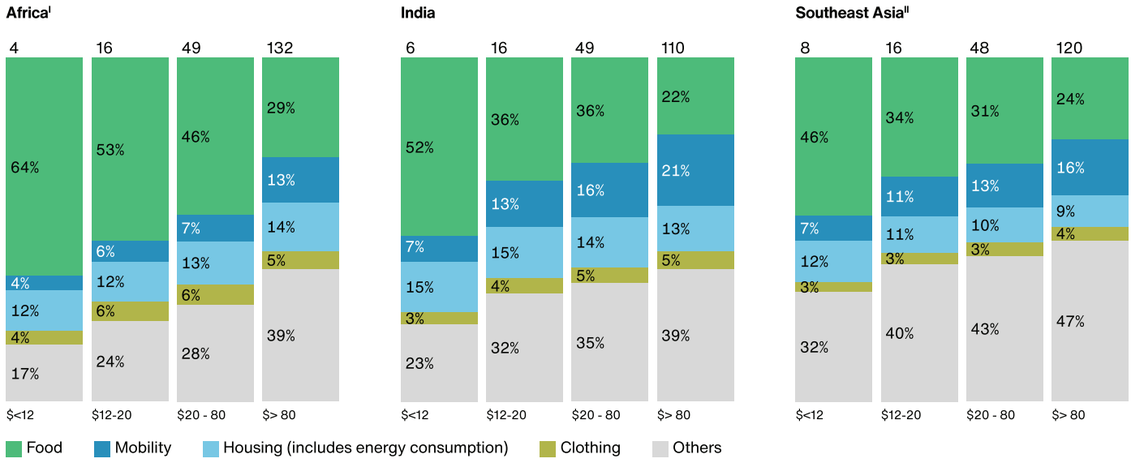
It is also important to understand the consumer tradeoffs of low-income households to model how green technology is adopted across emerging markets. While green discounts may exist in many countries, there also needs to exist sufficient overall demand to power green investments.

21 World Bank 2023b

For instance, many low-income households cannot afford any form of personal mobility – be it a petrol or EV scooter – and so serving those customers a new EV business offering would be unlikely to succeed.

Across Southeast Asia, India and Africa, consumers spend most on food, mobility and housing; share of spend on food reduces as daily spend increases

2020 spending breakdown per income band, 2017 international $, PPP



I. Based on Nigeria, Ghana, Kenya & South Africa data **II.** Based on Philippines, Vietnam, Thailand and Indonesia available data

Source: McKinsey Global Institute, World Data Pro, Euromonitor

As incomes rise, consumer habits will shift dramatically, and understanding these trends can help map the timeline for when commercial tipping points are likely to occur across various sectors, as hundreds of millions of people rise into wealthier income brackets.

For instance, low-income households across India spend 7.5x more on food than on mobility, while in wealthy households, food and mobility account for an equal share of the household budget[22]. Research has also shown that spending on essentials like food and health is relatively inelastic to economic shocks, even in poorer households, while other goods and services like upgrading housing appliances, or eating at restaurants, exhibits greater demand elasticity[23].

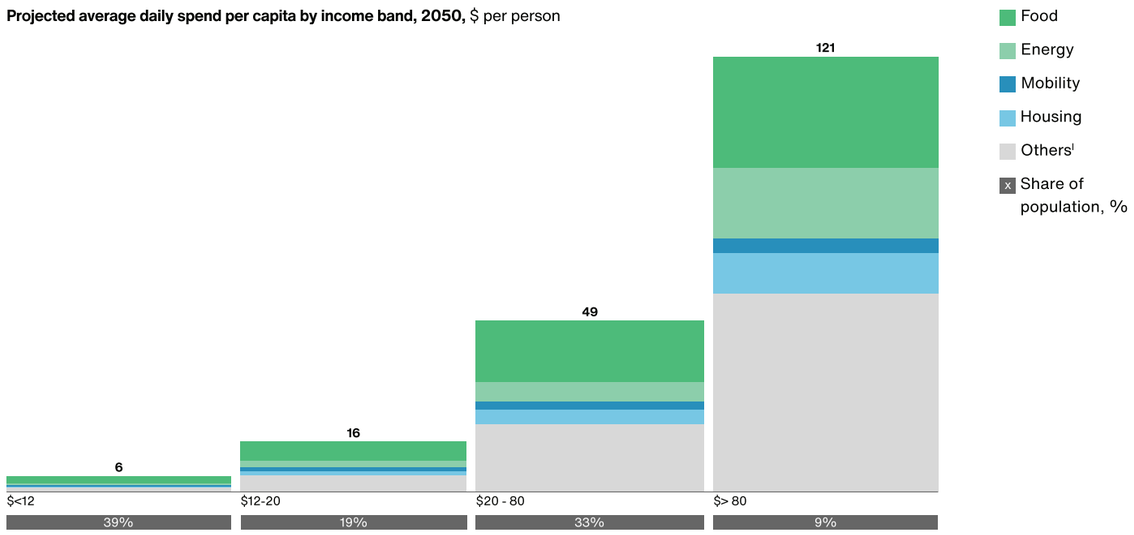
22 LeapFrog modelling based on McKinsey Global Institute, World Data Pro, Euromonitor
23 LeapFrog Investments 2022

4.3 How can a green discount analysis help decarbonisation

There are many factors outside of the consumer's control when it comes to lowering emissions. Industries like steel, cement, and fertilisers produce enormous emissions with no real direct interface with consumers, and no current scaled green alternatives. However, the choices available to emerging consumers in mobility, energy, food and built environment alone still play an enormous role in the overall effort to limit global warming.

High-emitting consumer classes could make up 42% of the population by 2050

Projected average daily spend per capita by income band, 2050, $ per person



I. Includes spending on entertainment, leisure, clothing and travel

Source: McKinsey Global Institute, World Data Pro, Euromonitor, Country consumer surveys

Identifying opportunities in these four sectors where technologies are price competitive is critical to attracting private capital. The overall consumption within these four sectors is on the cusp of a massive acceleration across emerging markets, which would dramatically increase emissions if these consumers are not offered low-carbon options.

Today, only 14% of the population of South Asia, Southeast Asia and Africa are part of the high-emitting consumer classes[24]. By 2050, this is likely to have risen to 42%, part of an irreversible trend in wealth and consumption that will define the future of our planet[25].

To build the green business models of the future and support a green leap across emerging markets, global capital markets will be required to swiftly allocate funds into investments across these four sectors.

24 World Data Pro, Euromonitor, Country consumer surveys, McKinsey Global Institute
25 Ibid

5

Beyond Climate

The Social Impact of a Green Transition in Emerging Markets

5.1 The role of a green transition in promoting job growth and economic opportunity

During the last decade, organisations including CGAP and others have worked to promote green alternatives for households and MSEs across the developing world[26]. This experience has demonstrated that, with the right models and approaches, people living in low- and middle-income countries can successfully adopt green technologies and practices while also improving their incomes and quality of life. From renewable energy to smart agriculture, promoting a green transition can play a critical role in key development outcomes such as reducing poverty, boosting economic opportunity, improving health and food security, and supporting women's empowerment.

There is already strong evidence that carbon-intensive, incumbent technologies can constrain economic opportunities for households and businesses. For example, the World Bank found that African households dedicate a significant portion of their expenditures (7% on average) to lighting and cooking energy. These expenses hit the urban poor hardest. In some urban areas, households spend 15–20% of their monthly incomes on high-cost cooking fuels such as charcoal[27]. By some estimates, more than 40 million work-years are wasted annually on fuelwood gathering and slow biomass cooking, time that could be used to engage in more productive activities[28].

By contrast, green technologies can unlock opportunities for the economically excluded and spur job and income growth. A recent India study, funded by CGAP, found that by using biodigester technology, which transforms farm waste into clean cooking gas, Indian dairy producers can save $85 on average each year on cooking fuel purchases. These savings can be transformative for households living on limited budgets, freeing up income that can be used to pay for their children's education, purchase food, and manage other household expenses.

Income generated by home solar systems

	East Africa	West Africa	South Asia
Share of households generating additional income	28%	14%	11%
Average monthly additional income	$46	$31	$65
Share of national average monthly income per household	14%	8.5%	10%

N(East Africa)=1,419, N(West Africa)=1,678, N(South Asia)=949,

Source: GOGLA, 2020

In East Africa, 28% of rooftop solar customers generate additional household income from their home systems[29], and 34% of customers report that at least one family member undertakes an additional economic activity with this new clean energy. Similar benefits are seen in West Africa (14% and 19%) and South Asia (11% and 12%). Solar customers reported using cheap renewable energy to run phone charging businesses, improve their internet connectivity, extend the trading hours of their stores with improved lighting, provide entertainment to customers and save time previously spent purchasing energy products like wood and kerosene[30].

26 CGAP 2023
27 World Bank 2014
28 Ibid
29 GOGLA 2020
30 Ibid

5.2 How a green transition can contribute to improve health outcomes, food security, and women's empowerment

Low-emission technologies are leading to better health outcomes for customers and societies. Clean cook stoves, for example, promise to improve health outcomes by reducing user exposure to harmful smoke. According to the World Bank and the International Energy Agency, 2.8 billion people — or 66% of the world's population — still burn solid fuels such as wood and animal dung for cooking and heating[31]. Inhaling the smoke from these sources may result in cancer, vascular diseases, cataracts, and low birth weights. It is estimated that biomass cooking contributes to 600,000 deaths and an economic cost of some $58.2 billion annually[32].

By contrast, new clean cookstove technologies can lower blood pressure in pregnant women and increase babies' birth weight. They can also reduce the severity and duration of respiratory diseases in children. On a country-wide level, this could alleviate some of the burden on health systems while improving lives at the same time[33].

For households that depend on kerosene-based lighting products, access to solar energy can help to address health and environmental risks. Kerosene lighting, used by many households excluded from electrical grids in regions such as Sub-Saharan Africa, contribute to indoor air pollution, suppressed visual health, severe burns, and poisoning due to accidental fuel ingestion[34]. In Kenya, a CGAP study found, households that shifted from kerosene lamps to solar home systems noted reduced risks of house fires or children burning themselves with kerosene. Solar systems produce no smoke, odour, or permanent residue left clinging to walls and roofing sheets[35].

In the agriculture sector, green technologies have the potential to mitigate farm emissions, reduce costs, and improve productivity. For example, 81% of Kenyan farmers with a SunCulture solar irrigation system were able to raise their revenue, despite the harsh climatic and economic conditions that worsened the situations of 88% of non-SunCulture farmers[36]. The Sustainable Trade Initiative (IDH) has found that farmers who are able to access cutting-edge agricultural technologies, including sensors, drones, software and other digital tools for collecting and analysing data, can increase their farm-level incomes by 15-40% thanks to reduced input usage and greater farm-level productivity[37]. Research also suggests that regenerative agriculture practices can increase yields for staple crops and protect against yield losses under drought[38]. Reducing costs, improving yields, and protecting against the accelerating effects of climate change are particularly important for smallholder farmers, who by some estimates produce one third of the world's food[39].

Furthermore, green technologies are helping to unlock possibilities for women's empowerment. For example, the International Labor Organization has found that women around the world spend more time on unpaid labor (e.g. household chores and childcare) than men, ranging from 3.4 times in Sub-Saharan Africa to 4.7 times in the

31 Jha and Coll 2021
32 Casteleyn 2017
33 Clean Cooking Alliance 2023
34 Winiecki et al. 2014
35 Zollmann et al. 2017
36 SunFunder 2021
37 IDH 2023
38 Bradford et al. 2021
39 Lowder et al. 2021

Arab world[40]. Gathering fuel and cooking is a particular burden for women and girls, limiting their ability to earn an income or pursue their education.

Time-saving technologies such as clean cookstoves offer a potential solution. In Kenya, research found that women who used improved cookstoves reduced their time spent collecting firewood from 12 to 5 hours per week on average. These women also self-reported that they were able to use their time savings to invest in income-generating activities[41]. Additionally, the Global Alliance for Clean Cookstoves found that women in South Asia saved 1 hour and 10 minutes a day when using a clean cookstove[42], freeing up time to invest in their livelihoods.

Access to solar energy has also been shown to increase women's likelihood of working outside the home[43]. This was the case in East Africa, where a study found that more than half of the extra hours of work made possible after installing a home solar system were contributed by women[44]. In Tanzania, women were 5% more likely to work outside the home if they have PAYG (Pay As You Go) solar lamps[45]. And when women have access to solar energy, they are also better able to choose how they manage their time. Another study in Tanzania found that women who have access to PAYG solar lamps and solar home systems felt that they have more flexibility in how they use their time for different tasks, such as domestic chores, cooking, and childcare[46].

5.3 Enabling inclusive access to the benefits of a green transition

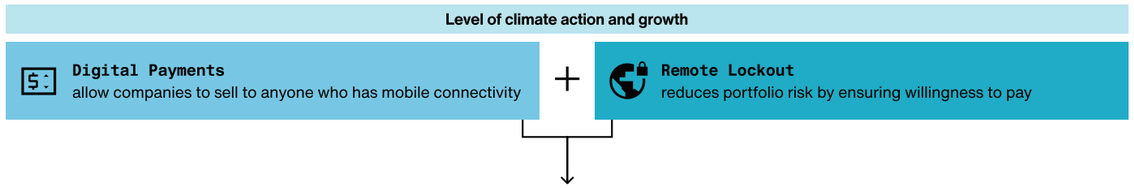
Despite the many social and environmental benefits, companies selling green technologies often struggle to sustainably serve customers in hard-to-reach places, many of whom cannot afford to purchase their products up front. Responsible financial services that reach low-income consumers are critical to promoting adoption of green technologies and practices at scale. Increasingly, successful green businesses are integrating financing into their business models, leveraging digital payments, alternative credit scoring, remote sensing technologies, and agent networks to overcome barriers to serving low-income and rural customers[47].

PAYG solar home system financing is one example of how companies are overcoming barriers to making green technologies available and affordable to low-income customers in difficult-to-reach places. PAYG solar contracts are often structured as lease-to-own arrangements, where customers make a down payment of 10-20% and then use digital payments to purchase "units" of energy to pay for the device as they use it[48]. By allowing customers to pay flexibly over time, PAYG financing helps to defray the high up-front costs that prevent widespread adoption. Solar home system providers are also able to ensure availability at the last mile by keeping costs low. Companies often leverage a network of rural agents to sell and service their products, use digital payments that eliminate the need for cash, and deploy remote sensing technology that allows systems to be locked when customers fail to pay. Between 2015 and 2020, it is estimated that PAYG financing has allowed 25 to 30 million people to purchase solar energy products[49].

40 International Labour Organisation 2018
41 Jagoe et al 2020
42 Bloomfielt et al. 2014
43 Kumaraswamy 2021
44 GOGLA 2020
45 Aevarsdottir et al. 2015
46 Ashden 2023
47 Mattern 2023
48 Sotiriou et al. 2018
49 Power for All 2022

How PAYG solar home system financing expands access to renewable energy

The role of digital finance in universal access



Source: CGAP

Many manufacturers and distributors of green technologies have learned from the success of PAYG solar, and either offer payment plans for their products or partner with financial institutions to provide financing. However, there are significant risks that come with using credit to scale impact, especially for green technology providers lending on balance sheet. The “social impact credit trap” can incentivise irresponsible lending practices that ultimately harm both companies and their customers[50]. Effectively managing credit risk is critical[51], while also ensuring that companies and investors have access to transparent and standardised metrics for measuring portfolio health[52].

Companies must also be accountable to their customers. Building trust is key to convincing customers to make the switch to green technologies and practices. For example, if technologies break down or fail to provide expected benefits, customers may be less likely to use them in the future or repay their loans[53]. However, trust can be strengthened through good communication – for example, by clearly explaining the terms and conditions of credit-backed products – especially when dealing with customers with limited financial literacy[54]. It is critical to avoid pushing households and businesses into unsustainable debt. Failure to protect customers through good quality products, transparent loan terms, and flexible payment schedules can undercut the goal of a green transition. The Global Off-Grid Lighting Association (GOGLA) consumer protection code is one example of how industry is attempting to protect vulnerable customers and prevent the emergence of bad actors[55].

Still, financial services alone cannot ensure that the poorest and most vulnerable can access and afford green technologies and practices. In some cases, there is a need to leverage subsidies, public policy, and innovative approaches such as carbon finance to improve availability and bring down the cost of a green transition. Governments and donors can play a role in bringing down costs through direct subsidies and promoting enabling environments. For example, the Government of Rwanda has helped more than 300,000 people, many of whom live in remote areas not served by the national electric grid, to purchase off-grid solar for the first time using a large-scale subsidisation scheme[56]. In Kenya, the government has partnered with the World Bank and investors

50 Waldron 2021
51 Waldron et al. 2021
52 Borst et al. 2021
53 Waldron 2020
54 Coetzee 2019
55 Waldron et. al. 2021
56 Rwanda Energy Group 2018

to provide critical financing to companies working to increase access to solar energy and clean cookstoves for excluded households through the Kenya Off-Grid Solar Access Project[57]. And revenues from the sale of carbon credits, tied to emissions avoidance and removals produced by the adoption of green practices, can also help to support affordability.

Further research into the impact that green technologies and practices have on the lives and livelihoods of consumers in emerging markets is necessary. There are positive early indications that green technologies and practices can be a win-win for both the climate and emerging consumers, but it is important to recognise that the evidence base supporting this link continues to evolve. Impact data – and the methodologies used for its measurement - often struggle to keep up with the rapid pace of technological and business model innovation, and this is especially true when it comes to green technologies in low- and middle-income countries. Much of the evidence that is available tends to be limited to certain types of technologies and practices (e.g. cookstoves, solar home systems), and studies have sometimes produced mixed results. And as always, the impacts realised in a given context and with a specific market segment may or may not hold true elsewhere.

Equipping both public and private sector stakeholders with robust impact data will not only support the effective allocation of global resources, but also ensure that a green transition truly benefits those who are most at risk from the accelerating climate crisis.

57 SNV Netherlands Development Organisation 2019

6

Harnessing Carbon Markets

How Offsets Can Support a Wave of Green Investments

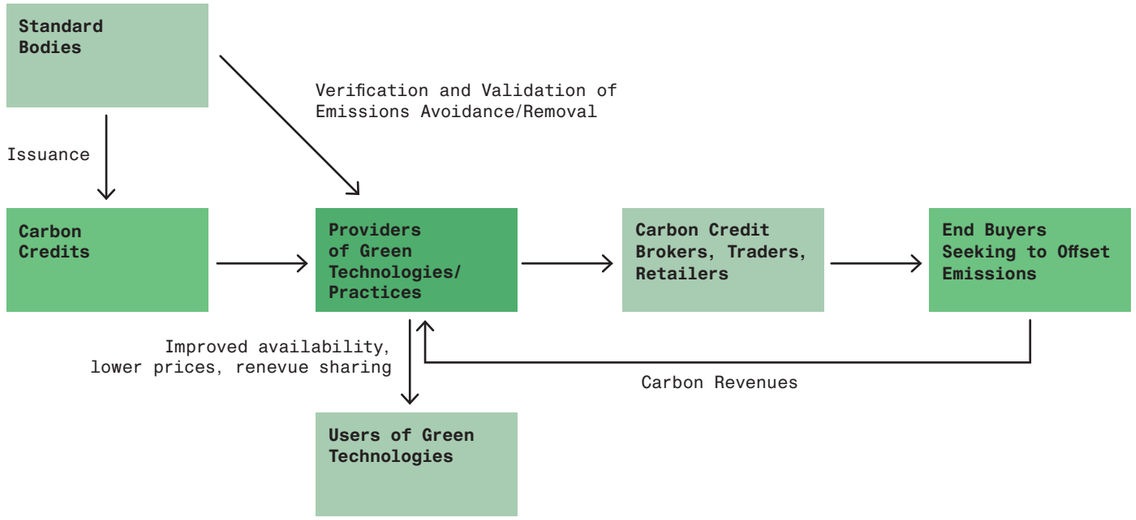
6.1 The global demand for carbon offsets presents an opportunity

Technologies and approaches that mitigate greenhouse gas emissions in emerging markets are becoming increasingly competitive with carbon-intensive alternatives. However, they remain out of reach for many households and businesses. In some cases, the upfront costs of investing in green technologies and practices can be prohibitively high when compared to incumbent alternatives, even if their lifetime costs are lower in the long run.

To ensure a just transition for those who have contributed the least to the current climate crisis, there is a need to ensure that green technologies and practices are both affordable and readily available for low income consumers. And as global demand for carbon credits increases amid efforts to offset emissions and achieve net zero pledges, voluntary carbon markets (VCMs)[58] present an opportunity to subsidise the provision and adoption of green technologies across the developing world. VCMs can facilitate flows of capital from developed to developing countries where revenues from the sale of carbon credits can be used to lower the upfront cost of technology, subsidise operations, or even provide additional income to users.

However, realising the potential of VCMs to spur adoption will first require investors, project developers and other global stakeholders to address barriers that prevent users of green technologies and practices from benefiting from global demand for carbon credits. Inclusive financial services can play a critical role in addressing these challenges, CGAP has found, by enabling households and businesses to participate in, and benefit fairly from, VCMs, supporting a truly just transition.

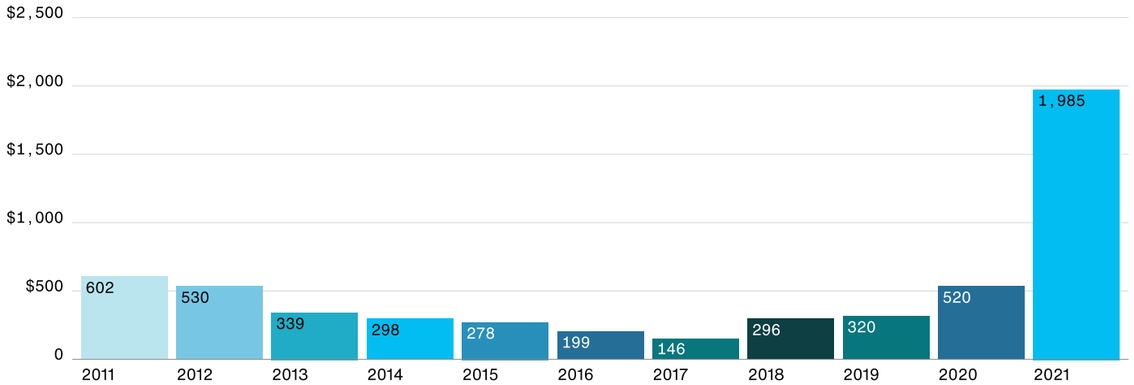
How voluntary carbon markets support the adoption and use of green technologies and practices



58 Voluntary carbon markets provide high-emitting organisations with the option to offset emissions through the voluntary purchase of credits derived from emissions avoidance or removal projects and issued by non-governmental standard bodies. VCMs are distinct from compliance markets, in which governments set emissions allowances for companies and sectors, while requiring organisations to purchase government-issued credits if their emissions exceed these limits.

Voluntary carbon markets allow high-emitting organisations to offset their greenhouse gas emissions by purchasing carbon credits. These credits are generated by carbon offset projects, which use green technologies and practices to either avoid emissions that would otherwise occur (e.g. renewable energy) or remove carbon from the atmosphere (e.g. agroforestry). Projects work with carbon standard bodies to certify emissions reductions or removals, after which credits can be sold to buyers, with each credit representing one tonne of carbon dioxide (tCO_2). Carbon offsets will, at least initially, be important for achieving global pledges to achieve net zero emissions, with demand for carbon skyrocketing in recent years. The value of carbon credits traded on VCMs reached $2 billion in 2021 and is on track to reach between $10 billion and $40 billion by 2030[59].

Annual value of voluntary carbon credit issuance (millions)



Source: Ecosystem Marketplace 2022

6.2 Using carbon markets to support low-carbon growth in emerging economies

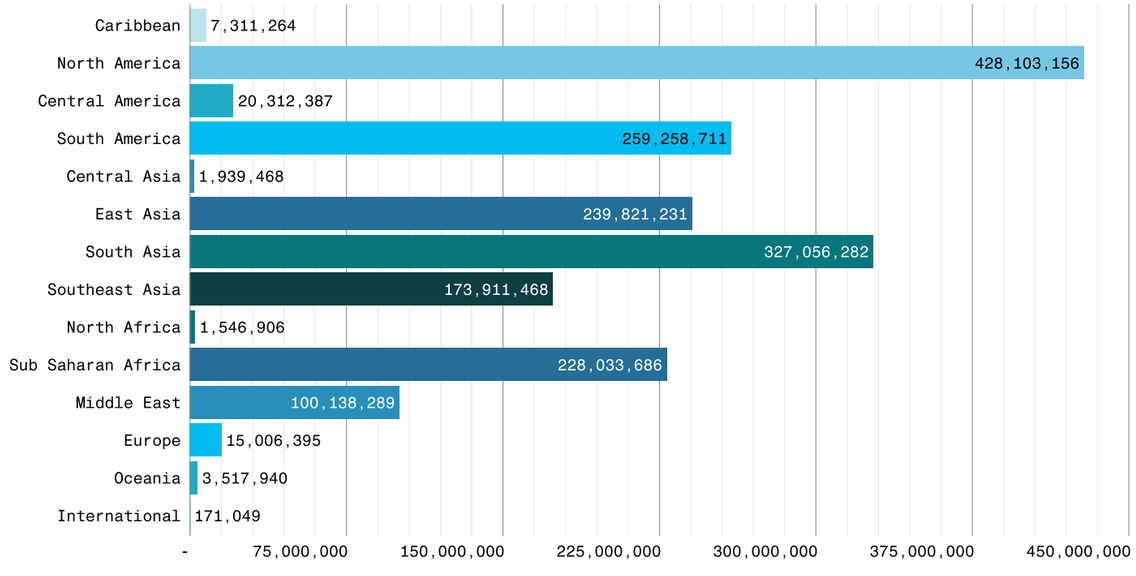
As growth in global demand for carbon offsets places upward pressure on prices, there is an increasing opportunity to leverage revenue from the sale of carbon credits to improve the affordability of green technologies and practices. Indeed, a significant share of the projects that generate carbon credits are already located in low- and middle-income countries. The Task Force on Scaling Voluntary Carbon Markets (TSVCM) notes that increasing demand for carbon represents a once-in-a-generation opportunity to encourage flows of public and private capital to developing economies[60].

A range of innovative emerging market green companies have already begun using carbon revenues to bring down the cost of their products. Kenyan startup Koko Networks, which sells bioethanol cookstoves designed to replace charcoal use, has raised more than $100 million from the sale of carbon credits. These revenues allow the company to subsidise the cost of its stoves by 85%[61], and make its fuel 40% cheaper than charcoal[62]. And Koko Networks, alongside other clean cookstove providers like ATEC, are able to secure higher prices on voluntary carbon markets

59 BCG 2023
60 Taskforce on Scaling Voluntary Carbon Markets 2021
61 Financial Times 2023
62 fDi Intelligence 2022

thanks to the co-benefits they provide. For example, cookstove credits sell for $8-10[63], nearly double the average price of re/afforestation credits, which sold for $4.70 in 2021[64]. The higher price of cookstove credits reflect demand among buyers for interventions that produce impact beyond emissions mitigation, in areas like health, women's empowerment, and biodiversity[65].

Carbon credit issuance by region ($)



Source: So, Haya, Elias 2023

For other companies, VCMs have provided the capital they need to scale and serve customers at the last mile. The cost of serving customers in low-income countries can often outstrip the ability of customers to pay for critical services such as off-grid energy[66], and carbon finance can in some cases fill this gap. Some solar home system distributors, such as d.light and EasySolar, monetise their customers' emissions avoidance to make their businesses more sustainable. The result is improved access to reliable solar energy for households who would otherwise rely on polluting energy sources like kerosene lamps[67].

In some cases, emerging consumers are also receiving direct payments for the emissions they remove or avoid, further incentivising the adoption of green technologies and practices. Rabobank's ACORN initiative provides seedlings on credit to smallholder farmers in Sub-Saharan Africa, with the trees planted helping to capture carbon from the atmosphere. Rabobank works with carbon standards to certify carbon removal and sells the credits to buyers, with 80% of revenues going to farmers. Part of that revenue is used to pay off farmers' loans, with any additional proceeds shared directly with farmers[68]. Boomitra, a company that helps farmers

63 Quantum Commodity Intelligence 2022
64 Golub et al. 2023
65 Co-benefits are additional benefits that go beyond greenhouse gas emissions (GHGs) avoidance and removal, such as positively impacting communities and biodiversity. Sylvera 2022
66 Acumen 2022
67 Waldron 2023
68 ACORN 2023

and ranchers to adopt regenerative agriculture practices, works with standards to generate credits that are sold to international buyers, and shares the majority of the proceeds directly with farmers and ranchers[69].

Early findings from recent CGAP research suggest that VCM benefits will increasingly be passed through to emerging consumers as green businesses better integrate financial services into carbon offset projects. This integration can help households and businesses to finance upfront investments in green technologies and practices, and enable project developers to more efficiently, securely, and transparently share carbon revenues directly with users, amongst other potential positives. For example, digital payments can provide an efficient, secure, and transparent way for carbon offset projects to distribute revenues directly to households and businesses, with 57% of adults in LMICs having made or received a digital payment in the last year as of 2021[70]. Companies like ATEC have begun paying customers for using their clean fuels using live data connections on their cookstoves, and remitting payments via mobile money services[71]. Rabobank's ACORN initiative likewise sends payments digitally to farmer bank accounts or mobile wallets[72].

6.3 The opportunity and challenge of scaling carbon markets

Although the potential for VCMs to accelerate adoption of green technologies and practices is exciting, most of the approaches highlighted in this chapter have yet to achieve scale. Recent controversies surrounding the actual contribution of carbon offset projects to emissions removal and avoidance could undermine the potential for carbon revenues to support a green transition in emerging markets unless they are resolved effectively. For example, research accusing cookstove projects of over-crediting is raising concerns amongst buyers and investors[73].

Carbon prices also continue to be extremely volatile and unpredictable, and certification often complicated and costly. Governments, investors, and donors, have an important role to play in providing access to blended finance and patient capital, along with technical assistance and funding, to solve these problems.

The high cost of monitoring, reporting and verification (MRV) required by carbon standards, in addition to the fees charged by intermediaries who help broker the sale of credits, can also limit the amount of revenue available to companies seeking to expand adoption and use of green technologies and practices. When costs to generate, verify, and sell carbon credits are high and prices are low, there is little left to share with emerging consumers.

For companies to truly leverage VCMs to help scale the emerging market green transition, it will first be necessary to address integrity concerns, while also pushing down the cost of MRV and intermediation[74]. The rise of digital technologies for MRV offers one potential solution, allowing for lower-cost and more accurate measurement of emissions avoidance and removal[75].

New approaches to intermediation that link projects directly to buyers can also bring down costs and expand smaller projects' access to VCMs. For example,

69 Boomitra 2023
70 World Bank 2021
71 Batchelor 2022
72 Rabobank 2021
73 Wiehl et al. 2023
74 Ferdinand and del Ser 2022
75 World Bank 2022

distributed ledger technology and web3 approaches are increasingly being tested by organisations like Open Forest Protocol[76][77]. Others, like 4R Digital's CAVex digital platform, are using technology to link small projects with international buyers and reduce the cost of MRV[78].

The global community has an unprecedented opportunity to leverage global demand for carbon credits to make green technologies more affordable and accessible, while also incentivising adoption and use. With the right tools and support, VCMs can potentially help further accelerate the accessibility, affordability and accountability of a just transition for consumers in emerging markets.

76 World Economic Forum 2023
77 Mercy Corps Ventures 2022
78 GSMA 2021

7

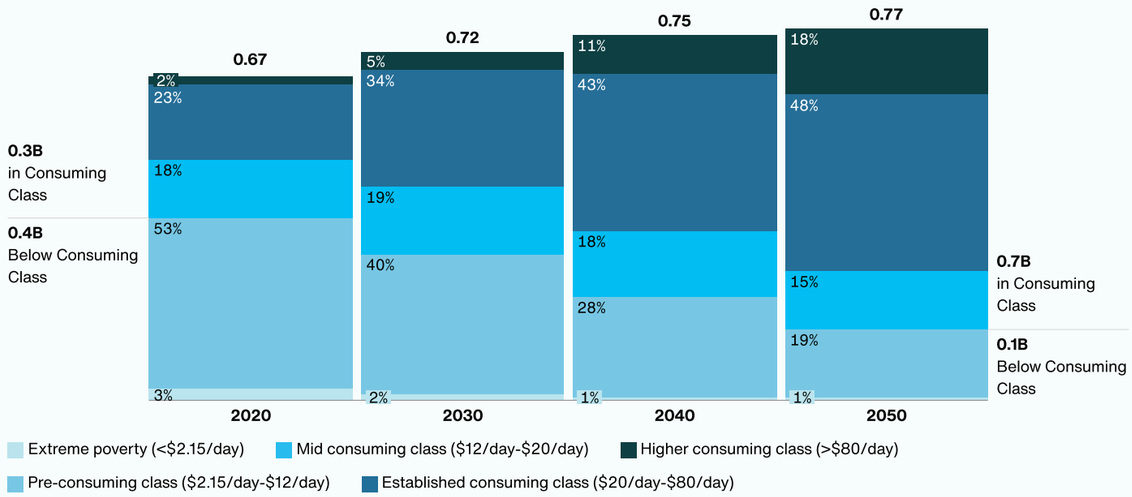
Southeast Asia

7.1 Demographic and emissions trends

Southeast Asia comprises many of the world's fastest growing large economies, from Vietnam to Thailand and Indonesia[79] [80]. Digital commerce and business models have high levels of penetration across the region, and this trend will continue, with Southeast Asia's digital economy growing at 15% a year and forecast to outpace GDP growth by a significant margin up until 2030 in all the region's major economies[81]. This is driven by significant uptake of mobile phone technology and related services like mobile banking, mobility apps, and digital insurance[82]. Over the next 30 years the consuming class in Southeast Asia is predicted to more than double from around 300 million to 700 million, driven partly by a 15% increase in population, but also by rising wealth[83]. Currently, less than half of the Southeast Asian population earn more than $12 a day. By 2050, more than 80% will have joined this group[84].

Southeast Asia[I]

Share of population by daily consumption spending[II], Billions of people, % of total



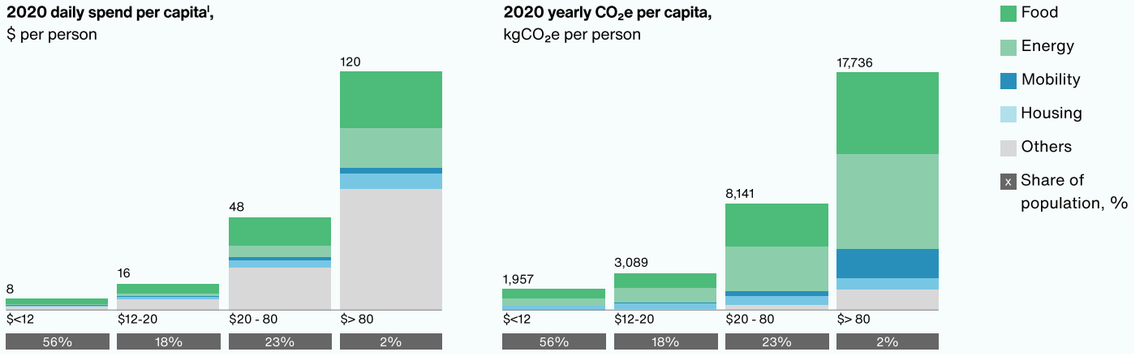
I. Includes 11 South-East Asian countries: Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam, Cambodia, Laos, Myanmar, Brunei and Timor-Leste **II.** Daily spending, 2017 international $, PPP

Source: McKinsey Global Institute, World Data Pro

While many Southeast Asian consumers currently generate comparatively low emissions per capita compared to consumers in wealthier nations, those at the top of the consumption pyramid in Southeast Asia already account for significant carbon emissions through purchases of food and energy, with mobility also a high-polluting category. Today, a high-income earner in Southeast Asia living of more than $80 a day generates 9x the emissions of a low-income consumer earning less than $12 per day[85].

79 In this study Southeast Asia data includes Indonesia, Philippines, Thailand and Vietnam
80 IMF 2023
81 Google, Temasek, Bain & Company 2023
82 Atora et al. 2022
83 LeapFrog modelling based on McKinsey Global Institute, World Data Pro
84 Ibid
85 LeapFrog modelling based on McKinsey Global Institute, World Data Pro, Euromonitor

Southeast Asia: Per-capita spend and emissions



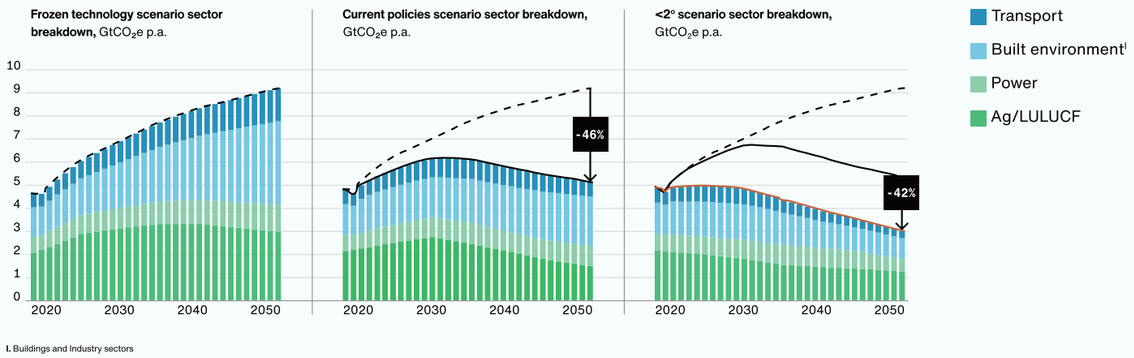
I. Based on Philippines, Vietnam, Thailand and Indonesia available data

Source: McKinsey Global Institute, World Data Pro, Euromonitor

The food and energy sectors in particular offer exciting opportunities for new technologies, combined with investment and an enabling business environment, to support low-carbon growth. With current technologies, Southeast Asia is forecast to double its emissions, driven in particular by a short-term surge in carbon emissions related to food production, and in the long term by a huge rise in emissions from the built environment as hundreds of millions of people move to urban centres or upgrade their homes[86].

With improved technology rolled out across these markets, supported by a wave of private investment, and supporting policies, these forecast emissions would drop by two thirds[87]. Current policies across the region already support reductions in this forecast, with all sectors seeing declines from their emissions footprint today.

Under a "current tech" scenario, Southeast Asia could double its annual emissions by 2050; its annual emissions could reduce by ~30% if it pursues a green leap



I. Buildings and Industry sectors

Source: McKinsey Global Energy Perspective, Decarbonisation Scenario Explorer

86 UNESCAP 2019
87 LeapFrog modelling based on McKinsey Global Energy Perspective, Decarbonisation Scenario Explorer

7.2 Mobility sector in Southeast Asia

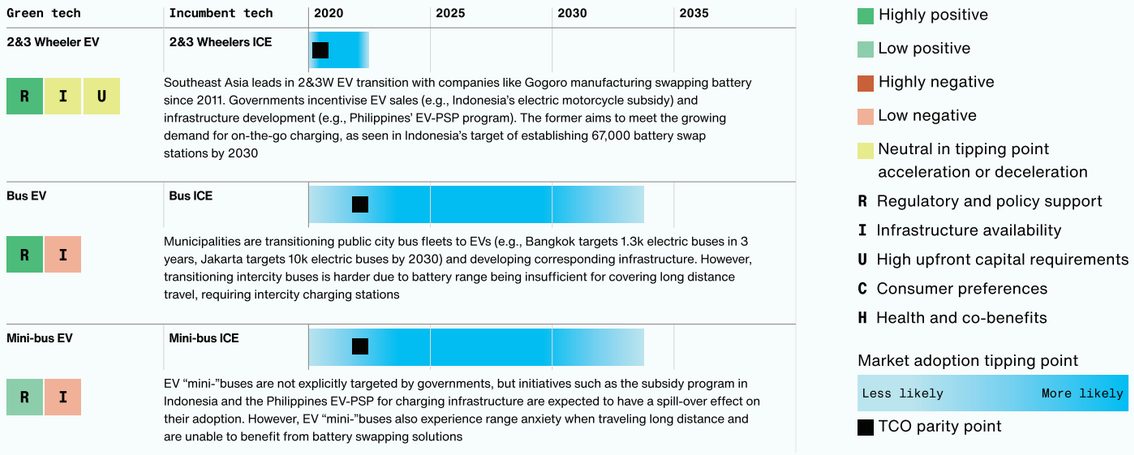
The mobility sector in Southeast Asia is currently at the very beginning of its green transition. While in markets like India electric scooters have begun to gain traction, they still represent a very small share of the market in Southeast Asia. New government programs to support enabling infrastructure like battery swapping stations are rapidly shifting this balance. In market leader Vietnam, the uptake of two-wheeler EVs is leading the way, accounting for 8% of all vehicle sales in 2020[88]. Enabling regulation is moving in neighbouring Thailand, where the government has approved a package of incentives including tax cuts and subsidies to promote EVs, while Indonesia is exploring changes to its value-added tax on electric car sales.

By 2050, between 40-95% of two and three-wheeler vehicles in the region are likely to be fully electric, and indeed the tipping point for cost has already been reached[89]. Electric commercial road vehicles like buses and mini buses are also close to price parity, but challenges with battery range nd a shortage of battery charging/swapping stations mean these segments are likely to take longer to mature.

Transitions by 2050

Sector	Subsector	2020	2050 Current Policy Scenario	2050 <2 Scenario
Transport	Road – Passenger	~0% of 2W/3W are electric ~0% of cars are electric	~40% of 2W/3W are electric ~75% of cars are electric	~95% of 2W/3W are electric ~95% of cars are electric
	Road – Commercial	~1% of buses are electric	~30% of buses are electric	~80% of buses are electric

Tipping point analysis: mobility



88 Taylor 2023
89 LeapFrog modelling based on McKinsey Transition Finance Model, McKinsey Catalyst Zero, expert calls, press research

7.3 Energy sector in SoutheastAsia

Across Southeast Asia, grid connectivity and reliability remain major problems. More than 350 million people in the region have only limited access to electricity and 130 million people still have no access at all[90,91]. As a consequence, many homes and businesses rely on gasoline and diesel generators across the region.

Southeast Asia is one of the fastest growing in terms of electricity demand, driven by the increasing ownership of household appliances and air conditioners[92]. By 2030, energy demand is forecast to grow a further 42%, requiring $1.1 trillion in cumulative clean energy investments to meet UN Nationally Determined Contribution climate targets[93].

Still, across the region today there is already 15% of renewable energy in the overall power generation mix, driven by strong renewable energy targets set by ASEAN, supported at national levels with feed in tariffs and other support for rooftop solar systems[94]. High up-front costs for solar systems mean that although these options are already price competitive, there is some uncertainty as to when consumers across these regions will more wholeheartedly switch to solar from fossil fuel generators. With strong investment and policy support, up to two thirds of power generation could come from renewable sources by 2050[95].

Transitions by 2050

Sector	Subsector	2020	2050 Current Policy Scenario	2050 <2 Scenario
Power	Centralised	~15% renewable in power generation mix	~40% renewable in power generation mix	~65% renewable in power generation mix

Tipping point analysis: energy

Green tech	Incumbent tech	2020	2025	2030	2035
Solar home systems	Gasoline generators	■			
R U	The Association of Southeast Asian Nations (ASEAN) targets 23% renewable energy by 2025 (Indonesia: 52% share of renewables in electricity capacity additions from 2021 to 2030, Philippines: 15 GW renewables installed capacity by 2030.). Governments use feed-in-tariffs and promote solar home systems (Indonesia, Vietnam) yet higher upfront capital costs vs. gasoline generators remain a challenge. Vietnam and Malaysia are the world's second and third largest manufacturers of solar PV modules				
Solar & CGI systems	Diesel Generators	■			
R U	Businesses take advantage of feed-in-tariffs (Indonesia and Vietnam) as well as incentives for small-scale solar production (Thailand) in addition to leveraging private loans to finance upfront capital costs				

90 Asian Development Bank 2023
91 UNESCAP 2022
92 International Energy Agency 2020
93 Bain & Company, Temasek, AWS, GenZero 2023
94 International Energy Agency 2022
95 LeapFrog modelling based on McKinsey Global Institute, Oxford Economics, World Bank research

7.4 Built environment sector in Southeast Asia

The built environment is slated to be one of the fastest growing sectors across Southeast Asia in coming decades, as migration to urban centres continues and millions of families upgrade from informal to formal housing[96]. These changes have positive and negative climate impacts, with new housing construction potentially spiking demand for carbon intensive materials like cement, while also shifting families from traditional heating and cooking sources like wood fires to gas and electric cooktops. LPG cookstoves present a short-term investment opportunity in this space, with a high probability of market adoption in the coming 3-5 years[97]. Green building supplies like cross-laminated timber are less commercially viable, although are already proving effective in major urban construction projects where speed and scale add to their competitiveness.

Transitions by 2050

Sector	Subsector	2020	2050 Current Policy Scenario	2050 <2 Scenario
Built Environment	Residential Buildings	~40% of energy demand is electricity	~80% of energy demand is electricity	~85% of energy demand is electricity
	Commercial Buildings	~65% of energy demand is electricity	~70% of energy demand is electricity	~80% of energy demand is electricity
	Industry	~20% of energy demand is electricity	~25% of energy demand is electricity	~60% of energy demand is electricity

Tipping point analysis: built environment

Green tech	Incumbent tech	2020	2025	2030	2035
LPG Cookstove	Fire/coal cookstove	■			
R H C U	Most households use LPG for cooking (58% in Philippines (2018), 69% in Indonesia (2020)). Governments promote LPG cooking through initiatives such as the Vietnam's National Target Program on new Rural Development which promotes clean energy and Indonesia's Energy Subsidy Reform, ensuring availability and affordability of LPG. This improves cooking efficiency, reduces health risks from indoor pollution and smoke exposure. However, higher upfront capital costs vs. firewood, charcoal, remain a challenge				
Cross-Laminated Timber (CLT)	Cement	■			
U C	Large format and upfront costs of CLT pose challenges for emerging consumers with limited capital (who prefer to purchase building materials in smaller quantities). CLT format and economics favor urban use cases that value speed of construction and reduced labor costs (e.g., high-rise apartment buildings); no current policy support in place. However, the region's existing use of wood (bamboo) for home construction could encourage adoption				

96 ASEAN 2022
97 LeapFrog modelling based on McKinsey Global Institute, Oxford Economics, World Bank research

7.5 Agriculture and food sector in Southeast Asia

Agriculture and food are the major contributor to climate emissions from Southeast Asia's high consuming classes. Luxury food products like red meat and fish generate large greenhouse gas emissions, with little climate policy or regulation currently targeting these products[98]. With incomes continuing to rise across the region, stabilising and reducing emissions from meat consumption poses major challenges, however some protein-rich plant-based substitutes like soy products could play a role[99].

The greatest emissions reductions are likely to come behind the farm gate, with smarter and greener farming practices, like data-driven fertiliser applications (see case study 7.6) and insect-based animal feed, offering the opportunity to reduce farm emissions from their current state, even as meat consumption continues to rise[100].

Transitions by 2050

Sector	Subsector	2020	2050 Current Policy Scenario	2050 <2 Scenario
Agriculture	Agriculture	Lack of climate policy and regulation does not curtail on-farm emissions from livestock and fertilisers	Curtailed demand for conventional meat stabilises on-farm emissions but lack of strong climate action leads to minimal agriculture abatement	Curtailed demand for conventional meat and climate policy reduces on-farm emissions and frees up land, but some growth in meat consumption continues due to rising incomes
	Land use, land-use change and forestry (LULUCF)			

Tipping point analysis: Agriculture and food

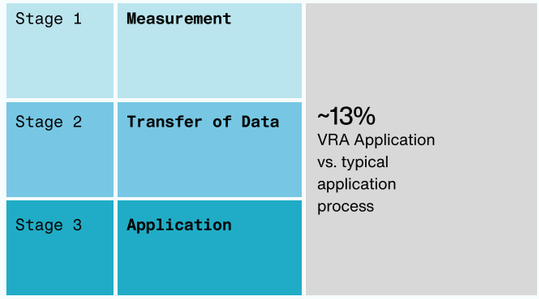
Green tech	Incumbent tech	2020	2025	2030	2035
Poultry	Red meat				
R C	Except Thailand, (4th in poultry production and 5th in poultry egg production), other countries rely on poultry imports (e.g., Vietnam 14th world poultry importer). Governments now support domestic industry growth through initiatives such as National Livestock Development Master Plan in Indonesia and the National Livestock Program in the Philippines				
Soy	Poultry				
R C	Southeast Asian countries primarily rely on soybean imports, with Indonesia as world's largest importer. Governments have shown support for the agriculture industry through various initiatives (e.g., Crop Insurance Program in Thailand, National Target Program on New Rural Development in Vietnam). However specific soybean programs are limited with the exception of the National Soybean Development Program in Indonesia				
Black Soldier fly feed	Fish meal				
R	Fish stocks are currently exploited at their maximum (90-100%), making feed options not sustainable. Insect-based protein is expected to have a penetration rate of around 20% globally by 2030, indicating a significant growth opportunity. No dedicated policy framework for the industry, but the emergence of new startups such as Insectta in the Philippines could promote on the industry's development				

98 Ivanovich et al.2023
99 Ibid
100 LeapFrog modelling based on McKinsey Global Institute, Oxford Economics, World Bank research

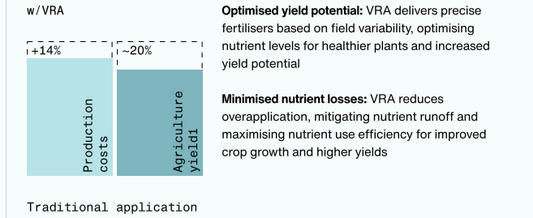
7.6 Case Study: Vietnamese data-driven farming

1. VRA of fertilisers impact on production

While Variable Rate Appliation (VRA) systems are accompanied by additional costs, yield improvements can more than offset the excess expenditure and significantly reduce environmental impacts from pollutants



Key drivers of value for farmers & agricultural yield



Optimised yield potential: VRA delivers precise fertilisers based on field variability, optimising nutrient levels for healthier plants and increased yield potential

Minimised nutrient losses: VRA reduces overapplication, mitigating nutrient runoff and maximising nutrient use efficiency for improved crop growth and higher yields

Potential nutrient impact by 2023

~1.8M tonnes
Nitrogen impact

~0.5M tonnes
Phosphate impact

~0.2M tonnes
Potassium impact

2. Devices and mobile apps enabling VRA

The growing ecosystem of tech-enabled precision agriculture solutions creates yield improvement opportunities for farmers with access to mobile data

GPS Satellite Navigation	GPS apps	GPS allows farmers to work during low visibility field conditions, boosts productivity, offers a considerable reduction in wasting valuable resources, such as fertilisers and herbicides
Satellite Remote Sensing System	Agricultural mapping and field mapping	Drones equipped with cameras can create high-resolution maps of fields. This data can identify problem areas, track crops and assess yield potential
Weather station	Weather monitoring	Hyperlocal weather data can help users decide when to plant, how much water to give crops and when to harvest
Autosteering kit for tractor	Soil sampling and analysis	Mobile apps can collect data about soil type, fertility, moisture content, and more. This information can decide about irrigation, fertilisation and other aspects of crop management

3. Consumer insights

Small-scale farming dominates the agricultural landscape in Vietnam; mobile phones are the preferred technology vector among Vietnamese farmers

Note: Vietnamese agriculture is highly labor-intensive; much plowing is still done by water buffalo leaving unique opportunities for labor-saving technologies, particularly those that leverage mobile devices and cellular networks

10M
Smallholder farmers in Vietnam

68%
Of mobile phone owners have a smartphone in rural Vietnam

Innovative business models accelerating adoption

	Reduce upfront CAPEX	Reduce OPEX
Equipment sharing platforms: facilitate the sharing or rental of VRA equipment among farmers	✓	
Usage-based model: provide VRA equipment and services on a pay-per-use or pay-per-acre basis	✓	
Annual subscription: Pay an annual fee for access to VRA equipment or services	✓	
Mobile technology and apps: provide simplified and user-friendly interfaces for VRA prescription generation and field mapping	✓	✓

Source: USDA, McKinsey analysis, Yara website, Mobile Marketing Association, press research

8

India

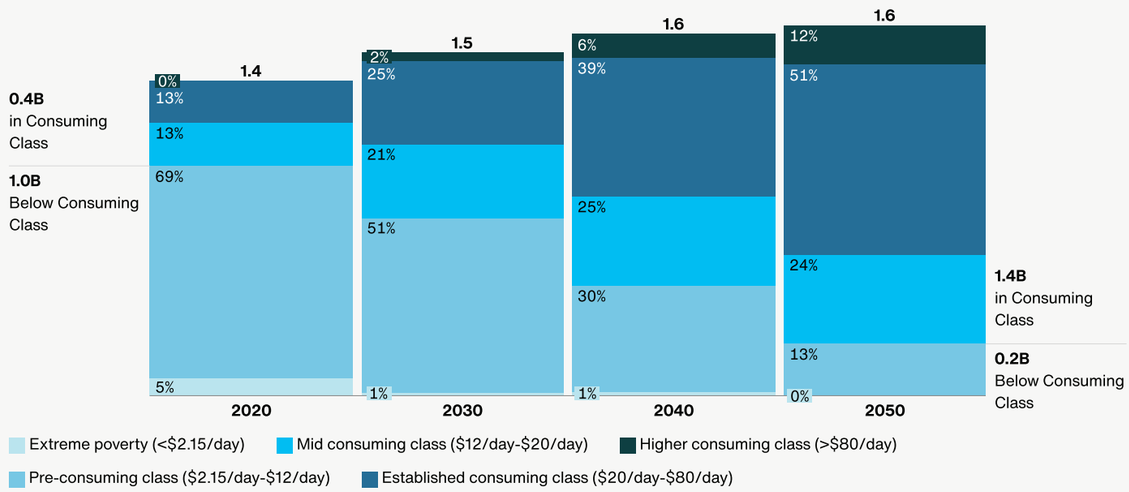
8.1 Demographic and emissions trends

India is undergoing some of the most remarkable demographic shifts across all emerging markets. Last year, it overtook the United Kingdom as the world's fifth largest economy[101], and continues to outpace China's growth to claim the mantle of the world's fastest growing major economy[102]. Yet there are still 1 billion people in India earning less than $12 a day. This massive cohort of low-income people are rising rapidly into the middle classes, and by 2050 it's likely an additional 1.2 billion people will earn over $12 a day on adjusted terms and join the consuming classes[103].

This has huge implications for India's climate emissions, which are already the third largest of any country in the world[104]. A person earning over $80 a day in India currently produces 11x the emissions of a person earning less than $12 a day. Food, energy, and mobility are the critical sectors that contribute to higher emissions for wealthier consumers in India. Indeed, people earning over $20 a day in India produce a higher carbon footprint through food consumption alone than the total emissions produced by those earning less than $20 a day.

India

Share of population by daily consumption spending[1], Billions of people, % of total



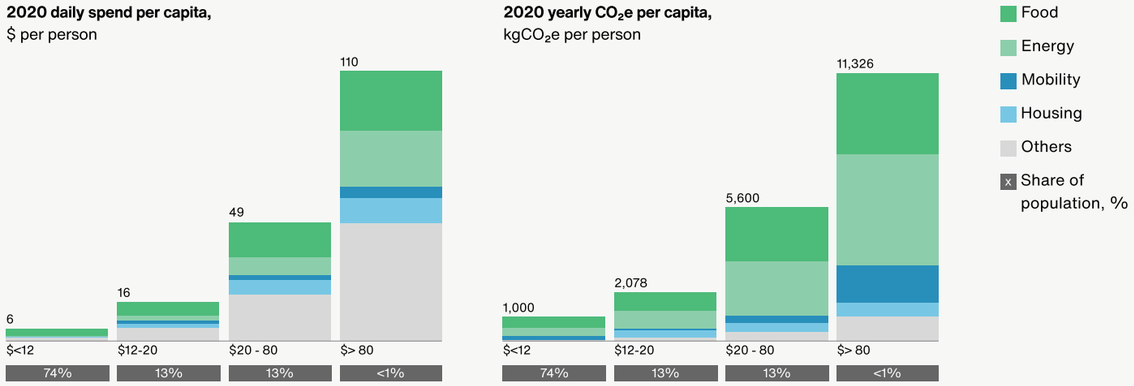
1. Daily spending, 2017 international $, PPP

Source: McKinsey Global Institute, World Data Pro

In the coming decades, emissions from the built environment are slated to rise dramatically as urbanisation continues across the country. While current agricultural emissions may be challenging to reduce, they could be effectively capped with a shift in diets and food production methods. The greatest decarbonisation efforts are likely to be in energy and mobility, where green shoots are already developing. India's ratio of renewables within its overall energy generation mix is currently twice that of Southeast Asia, with renewable electricity supply growing faster than in any other major economy[105].

101 Armstrong 2022
102 Lasarte 2023
103 LeapFrog modelling based on McKinsey Global Institute, World Data Pro
104 Gupta et al. 2022
105 Birol et al. 2022

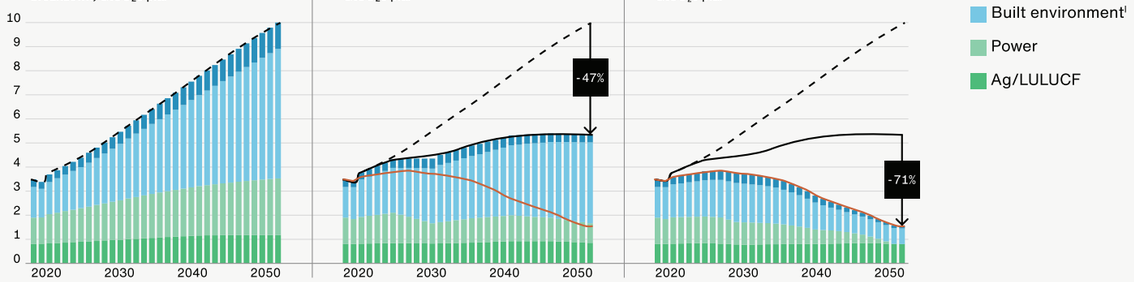
India: Per-capita spend and emissions



Source: McKinsey Global Institute, World Data Pro, Euromonitor

The electric vehicle revolution also has been taking off in recent years, with electric scooters now comprising 15% of new vehicle sales[106]. Continued strong investment and effective enabling policy could reduce transport and power emissions to almost zero by 2050, more than halving current national emissions.

India could more than halve its current annual emissions by 2050, with only residual emissions from agriculture and industry by 2050



I. Buildings and Industry sectors

Source: McKinsey Global Energy Perspective, Decarbonisation Scenario Explorer

106 Hebbalulu and Talwani 2023

8.2 Mobility sector in India

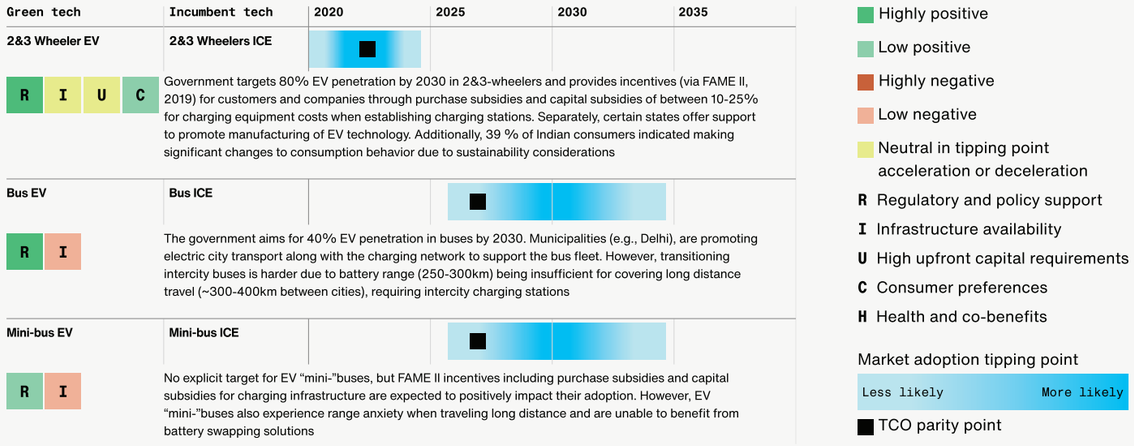
India's transition to electric vehicles, while lagging China, has in recent years accelerated rapidly. Companies like Ola Electric have invested billions into manufacturing affordable electric scooters that now rival the cost of petrol scooters, and represent ~15% of new scooter sales. The Indian government has supported these efforts with subsidies for electric buses, cars, and scooters[107], and by 2030 is targeting EV 2/3 wheelers to represent 80% of new vehicle sales[108].

Government support for charging infrastructure is also helping underpin a shift to EVs, especially in cities, although outside of urban centres a lack of infrastructure has limited the uptake of EVs[109]. A lack of rural infrastructure also makes it difficult to transition inter-city bus services to clean alternatives. A government target to install a charging station every 25km on major highways[110], if fulfilled, could rapidly improve regional and rural EV adoption.

Transitions by 2050

Sector	Subsector	2020	2050 Current Policy Scenario	2050 <2 Scenario
Transport	Road – Passenger	~0% of 2W/3W are electric ~0% of cars are electric	~99% of 2W/3W are electric ~40% of cars are electric	~99% of 2W/3W are electric ~99% of cars are electric
	Road – Commercial	~1% of buses are electric	~40% of buses are electric	~99% of buses are electric

Tipping point analysis: mobility



107 Ministry of Heavy Industries 2023
108 NITI Aayog and Rocky Mountain Institute 2019
109 Bolt Earth 2023
110 Ministry of Power, India 2022

8.3 Energy sector in India

India has a high proportion of renewables in its energy mix, and one of the fastest growing renewable energy sectors in the world. A commitment over recent years to support large-scale solar installations has driven down the costs of solar energy infrastructure, and India now has the lowest renewable energy costs in Asia[111]. An abundance of large storage hydropower plants, combined with new energy trading routes with hydropower rich neighbours like Nepal[112], has also in some areas allowed for a stable supply of renewable energy around the clock[113].

Still, India suffers from relative energy poverty, and has the lowest per capita consumption of energy among the world's top 10 economies[114]. As incomes rise, energy usage is predicted to surge. In the absence of reliable energy grids, and with continued high energy costs in many areas of India, this could support a boom in residential, commercial, and industrial use of solar. Government subsidies, combined with new private pay-as-you-go models to defray the high upfront costs of solar infrastructure, have in recent years seen dramatic growth in these smaller solar systems throughout India[115].

Transitions by 2050

Sector	Subsector	2020	2050 Current Policy Scenario	2050 <2 Scenario
Power	Centralised	~30% renewable in power generation mix	~80% renewable in power generation mix	~99% renewable in power generation mix

Tipping point analysis: energy

Green tech	Incumbent tech	2020	2025	2030	2035
Solar home systems	Gasoline generators	■			

R U

Government target to achieve 500 GW of renewable energy by 2030, including 280 GW of solar power: government provides tax breaks and net metering incentives while private companies offer pay-as-you-go and leasing options to support these efforts. India is expected to represent ~30% of the global PV market size in 2040, yet higher upfront capital costs vs. gasoline generators remain a challenge

Green tech	Incumbent tech	2020	2025	2030	2035
Solar & CGI systems	Diesel Generators	■			

R U

Businesses are contributing to the national renewable energy transition and have similar opportunities as residential customers to adopt solar systems ; they can access loans up to Rs 10 lakhs from nationalised banks for rooftop PV systems; their larger scale enables to negotiate better tax breaks, enhancing the benefits of solar adoption

111 Wood Mackenzie 2019
112 Shrestha 2023
113 Powell et al. 2023
114 Pandit et al. 2023
115 Koundal 2023

8.4 Built environment sector in India

India has one of the most acute shortages of formal housing in the world, with 160 million people estimated to live in slums[116]. These types of homes often remain disconnected from key utilities like power, gas and water, as well as lacking appropriate insulation for heating and cooling[117]. As a consequence, Indian residential buildings currently utilise low rates of electricity and gas in their overall energy consumption, with around 20% of their energy consumption provided by biomass (firewood, charcoal) and kerosene lamps[118].

Significant government backed efforts have been underway now for decades to help shift slum-dwellers into modern homes, including recent schemes to subsidise interest rates for home loans[119]. These measures are seeing significant construction of new homes, and an overall construction boom that is estimated to see the sector employ 100 million people by 2030[120]. This will generate its own climate effects through increased use of materials like cement and steel, but also deliver a pipeline of larger scale construction projects where next generation materials like cross-laminated timber have a greater chance of becoming cost competitive.

Transitions by 2050

Sector	Subsector	2020	2050 Current Policy Scenario	2050 <2 Scenario
Built Environment	Residential Buildings	~35% of energy demand is electricity	~75% of energy demand is electricity	>95% of energy demand is electricity
	Commercial Buildings	~70% of energy demand is electricity	~96% of energy demand is electricity	~99% of energy demand is electricity
	Industry	~30% of energy demand is electricity	~50% of energy demand is electricity	~55% of energy demand is electricity

Tipping point analysis: built environment

Green tech	Incumbent tech	2020	2025	2030	2035
LPG Cookstove	Fire/coal cookstove	■			

R H U

The Pradhan Mantri Ujjwala Yojana (PMUY) scheme, 2016 provides incentives for LPG adoption among impoverished households, resulting in various benefits such as reducing exposure to smoke and indoor air pollution (traditional cooking causes ~360k premature deaths each year in India) . About 14% of rural households in India completely rely on biomass, while another 66% collect biomass to supplement clean fuels. However, higher upfront capital costs vs. firewood, charcoal, remain a challenge

Green tech	Incumbent tech	2020	2025	2030	2035
Cross-Laminated Timber (CLT)	Cement	■			

R U C

Large format and upfront costs of CLT pose challenges for emerging consumers with limited capital (who prefer to purchase building materials in smaller quantities). CLT format and economics favor urban use cases that value speed of construction and reduced labor costs (e.g., high-rise apartment buildings); no current policy support in place

116 World Bank 2021
117 Burger et al. 2014
118 Navinya et al. 2023
119 Ministry of Housing and Urban Affairs 2023
120 RICS, Knight Frank 2023

8.5 Agriculture and food sector in India

India is one of the world's largest agricultural producers, however its farming sector is highly disaggregated, with many small-scale landholders. This can present roadblocks to the rollout of new agricultural technologies at scale, however various government programs are seeking to overcome this and modernise India's food production, encouraging entrepreneurship and increased production.

In the poultry sector, for instance, the Indian government is supporting technology upgrades in farming, meat processing, and animal feed plants, in the form of concessionary loans and subsidies. Similarly in soybean production, the government continues to support and subsidise an industry that delivers high protein foods with lower emissions. There is nascent interest in insect farming to deliver feedstock and insect-based protein products for human consumption. Loopworm, an Indian startup using food waste to farm insects for the animal feed industry, recently raised a seed funding round, targeting production of 300,000 tonnes of sustainable insect protein per annum[121].

Transitions by 2050

Sector	Subsector	2020	2050 Current Policy Scenario	2050 <2 Scenario
Agriculture	Agriculture	Lack of climate policy and regulation does not curtail on-farm emissions from livestock and fertilisers	Curtailed demand for conventional meat stabilises on-farm emissions but lack of strong climate action leads to minimal agriculture abatement	Curtailed demand for conventional meat and climate policy reduces on-farm emissions and frees up land, but some growth in meat consumption continues due to rising incomes
	LULUCF			

Tipping point analysis: Agriculture and food

Green tech	Incumbent tech	2020	2025	2030	2035
Poultry	Red meat				
R U	India (5th largest poultry producer) has implemented various government schemes to support entrepreneurship in poultry farming including technology assisted poultry farms, meat processing & value addition infrastructure, and animal feed plants. Eligible beneficiaries can receive up to 90% loans on capital costs at 3% interest or alternatively a 50% subsidy when establishing parent farms or rural hatcheries				
Soy	Poultry				
R C	Indian government supports soybean production through minimum support prices and subsidies on inputs to reduce production costs. With global soybean demand projected to reach 400 million metric tonnes by 2025, India is expected to continue its support of soybean production; ~30% of Indians are vegan or vegetarian requiring plant-based proteins				
Black Soldier fly feed	Fish meal				
R	Fish stocks are currently exploited at their maximum (90-100%), making feed options not sustainable. Insect-based protein is expected to have a penetration rate of around 20% globally by 2030, indicating a significant growth opportunity. No dedicated policy framework for the industry, but the emergence of new startups such as Loopworm, (India's first insect farming startup, which secured $3.4m in seed round funding in 2022), could promote on the industry's development				

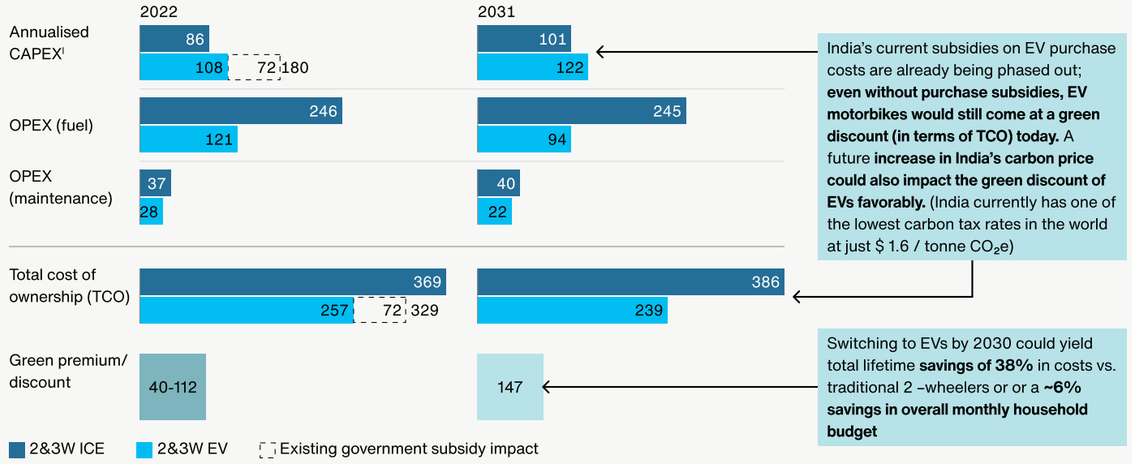
121 Ngige 2022

8.6 Case study: the 2-wheeler EV revolution in India

Green discount decomposition 2022 vs. 2031

2&3-wheel EVs achieved a discount in 2022. The shift is mostly driven by government support

Annualised costs, $



India's current subsidies on EV purchase costs are already being phased out; **even without purchase subsidies, EV motorbikes would still come at a green discount (in terms of TCO) today.** A future **increase in India's carbon price could also impact the green discount of EVs favorably.** (India currently has one of the lowest carbon tax rates in the world at just $ 1.6 / tonne CO_2e)

Switching to EVs by 2030 could yield total lifetime **savings of 38%** in costs vs. traditional 2 –wheelers or or a **~6% savings in overall monthly household budget**

Key drivers of TCO

Upfront capital costs have been reduced by FAME II subsidy of INR 15,000/ KW (capped at 40% of vehicle cost) from 2019 to 2022. Subsidy will be reduced to 15% of after-factory vehicle purchase. **This second phase of subsidy program will run until the end of 2024**

Fossil fuel prices continue to increase driven largely by rising import taxes while electricity costs remain stable

EV maintenance costs tend to be lower than those of ICE counterparts as there are no mechanical engines to maintain

I. Assumes 10-year vehicle lifetime

Source: McKinsey Transition Finance Model, McKinsey Center for Future Mobility, 2022, McKinsey India Mobility Consumer Survey (n=1,199), press research

9

Africa

9.1 Demographic and emissions trends

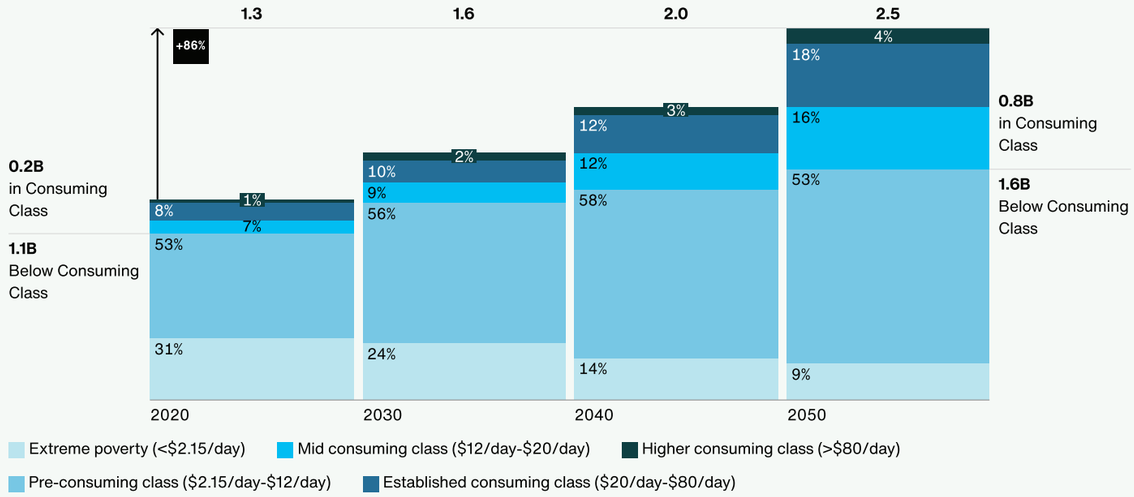
Like India, Africa currently has a large population of 1.1 billion earning less than $12 a day, although incomes are predicted to rise more slowly by 2050. On aggregate, Africa has experienced decades of relatively stagnant growth, with real GDP growing at only 1.1% a year since 1990[122] , and average GDP growth at 4.2% from 2000 - 2019. However, on a country-by-country basis, the growth picture can be startlingly different, with some nations like Ethiopia, Ghana, Tanzania and Kenya consistently outperforming Africa's growth average.

The significant majority of Africans earn less than $12 a day, spending on average only $4 a day. As a consequence, they contribute very little to climate emissions. The emissions they do contribute are quite stubborn, as many come from livestock raised by small agricultural landholders. As a result, by 2050, Africa is slated to reduce emissions by only 14% under an aggressive reductions scenario, with agricultural emissions trending up rather than down during that period.

Africa's energy sector, much like its agricultural sector, is disaggregated and operating inefficiently. In Nigeria, for instance, 80 million people lack access to electricity[123], and almost $14 billion annually is spent on small diesel generators to supplement grid power[124]. In Sub-Saharan Africa, 568 million people remain off-grid, with the rate of electrification outpaced by population growth. This has led to the emergence of innovative PAYG rooftop solar and clean cookstove businesses across the continent, serving customers with clean and safe energy.

Africa[I]

Share of population by daily consumption spending[II], Billions of people, % of total

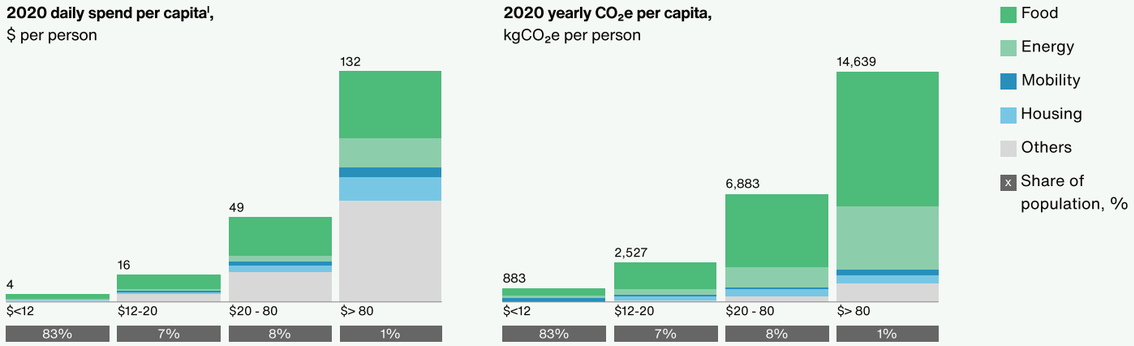


I. includes all 54 African countries II. Daily spending, 2017 international $, PPP

Source: McKinsey Global Institute, World Data Pro

122 Kuyoro et al. 2023
123 World Bank 2023a
124 Rural Electrification Agency 2017

Africa: Per-capita spend and emissions



I. Based on Nigeria, Ghana, Kenya & South Africa available data

Source: McKinsey Global Institute, World Data Pro, Euromonitor

Africa's significant agriculture emissions means it could reduce annual emissions by only ~14% by 2050, however ~80% of these agricultural emissions are non-CO_2 gases

I. Buildings and Industry sectors

Source: McKinsey Global Energy Perspective, Decarbonisation Scenario Explorer

9.2 Mobility sector in Africa

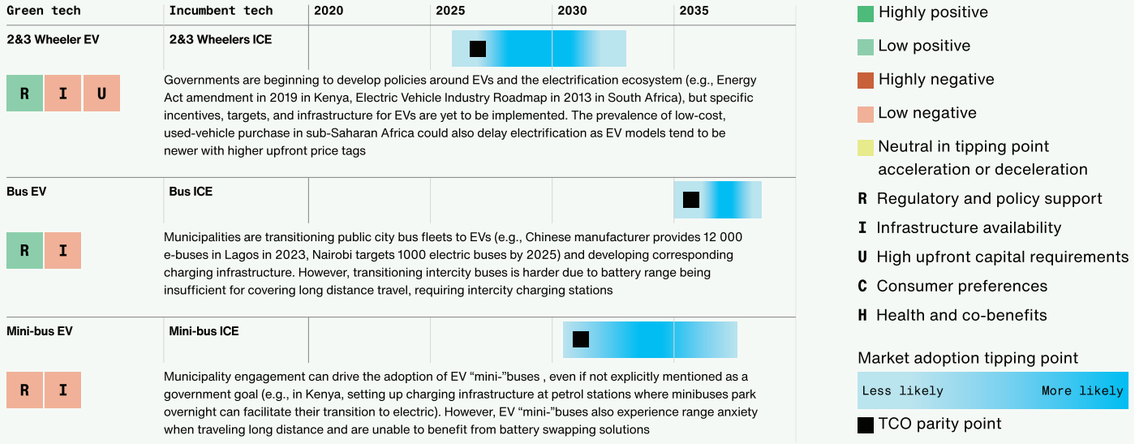
Africa currently has almost no penetration of electric vehicles, although favourable government policies are beginning to accelerate their adoption in some countries. In Kenya, for example, a strict policy on imported vehicles has sparked a flurry of local startups, including Mobius Motors and Opibus, manufacturing and retro-fitting EVs for the domestic market. Still, the wide use of older used vehicles across Africa could slow the uptake of EVs, due to apprehension at their high upfront costs.

In urban centres, a number of progressive municipalities are beginning to upgrade bus fleets to electric vehicles, and in 2022, Lagos in Nigeria announced a plan to commission 12000 electric buses from Chinese manufacturer OEM Yutong with charging infrastructure supplied by a subsidiary of the national oil company Oando[125]. Transitioning intercity bus services to electric power remains a long term challenge, with sparse infrastructure to support recharging and servicing outside cities.

Transitions by 2050

Sector	Subsector	2020	2050 Current Policy Scenario	2050 <2 Scenario
Transport	Road – Passenger	~0% of 2W/3W are electric ~0% of cars are electric	~40% of 2W/3W are electric ~30% of cars are electric	~95% of 2W/3W are electric ~95% of cars are electric
	Road – Commercial	~1% of buses are electric	~15% of buses are electric	<95% of buses are electric

Tipping point analysis: mobility



125 Morris 2023

9.3 Energy sector in Africa

Africa has the world's lowest energy connectivity, with 80% of the global population that lacks access to electricity living in Sub-Saharan Africa[126]. As a consequence consumers rely on a range of formal and informal energy sources in their homes and businesses including diesel generators, kerosene stoves, biomass like wood and charcoal, as well as grid-connected power and renewables. Abundant and consistent sunlight has led to a boom in both commercial and home-use solar installations, and innovative new models to defray upfront costs to allow low-income customers to afford otherwise costly private generating equipment.

Unlike in the mobility sector, a number of African governments including Kenya, Nigeria and Ghana have set national renewables targets or provided subsidies for solar systems and components. By 2050, this could see renewable energy's share of the generation mix in Africa triple, as homes and businesses move enmasse to install reliable and cheap solar systems. Already, both residential and commercial solar systems have reached a price tipping point, due to the high ongoing running costs of the gasoline and diesel generators used by millions of people across the continent to supplement unreliable or unavailable grid-connected power.

Transitions by 2050

Sector	Subsector	2020	2050 Current Policy Scenario	2050 <2 Scenario
Power	Centralised	~20% renewable in power generation mix	~45% renewable in power generation mix	~60% renewable in power generation mix

Tipping point analysis: energy

Green tech	Incumbent tech	2020	2025	2030	2035
Solar home systems	Gasoline generators	■			

R U

Several African governments have set specific targets for renewable power (e.g., the Ministry of Energy in Kenya targets 100 gigawatts (GW) of installed renewable power capacity by 2040, Nigeria targets 3,500 MW installed solar PV by 2025). In Ghana, off-grid solar system components are VAT exempt. High upfront capex of solar systems remains a challenge for adoption (e.g., the upfront cost of a solar system can be up to 5 times higher than that of a gasoline generator). Interest in solar is still nascent as many are unaware of the benefits

Solar C&I Systems	Diesel generators	■			

R U

African governments set renewable power targets (e.g., South Africa aims for 41% renewables by 2030) and businesses are actively contributing to the national renewable energy transition, similar to home systems. Interest in solar is still nascent as people (incl. business owners) are unaware of the benefits of solar (e.g., some people consider solar unreliable)

126 International Energy Agency et al. 2023

9.4 Built environment sector in Africa

African residential buildings have an extraordinarily low percentage of their energy demand supplied by electricity, with the average less than 5% compared to India at 35% and Southeast Asia at 40%. These low rates of electricity utilisation also translate to commercial and even industrial buildings. As more Africans transition into formal housing, electricity usage in residential buildings could increase six fold by 2050, although it is still predicted to be below the electricity utilisation rates of a country like India today.

Similarly, the use of clean cookstoves in family homes is low, and in Sub-Saharan Africa only 20% of the population has access to clean cooking. Like the PAYG revolution in rooftop solar, similar models have been applied to the cookstove market to allow low income families to defray the high upfront costs of new clean cookstoves.

Countries like Kenya and Nigeria also have flourishing timber industries that can provide species relevant for cross-laminated timber (CLT) building materials, although there is no policy support currently in place to support CLT adoption within local building industries.

Transitions by 2050

Sector	Subsector	2020	2050 Current Policy Scenario	2050 <2 Scenario
Built Environment	Residential Buildings	<5% of energy demand is electricity	~25% of energy demand is electricity	~30% of energy demand is electricity
	Commercial Buildings	~10% of energy demand is electricity	~30% of energy demand is electricity	~50% of energy demand is electricity
	Industry	~20% of energy demand is electricity	~25% of energy demand is electricity	~50% of energy demand is electricity

Tipping point analysis: built environment

Green tech	Incumbent tech	2020	2025	2030	2035
LPG Cookstove	Fire/coal cookstove	■			

R H U

20% of the Sub-Saharan Africa population has access to clean fuels and technologies for cooking. Main challenge is in reducing upfront costs associated with adopting LPG as a cleaner alternative to traditional cookstoves. Moreover, the air pollution concern of "dirty" cooking practice is more and more emphasised by Health Authorities (e.g., in Kenya 22K deaths attributed to Household Air Pollution annually). However, higher upfront capital costs vs. firewood, charcoal, remain a challenge

Cross-Laminated Timber (CLT)	Cement	■			

U C

Large format and upfront costs of CLT pose challenges for emerging consumers with limited capital (who prefer to purchase building materials in smaller quantities). CLT format and economics favor urban use cases that value speed of construction and reduced labor costs (e.g., high-rise apartment buildings); no current policy support in place. However, Kenya and Nigeria provide timber species for CLT production

9.5 Agriculture and food sector in Africa

Many African countries are self-sufficient in agriculture, although like India, most farms are of a small size. Government support exists across critical sectors like poultry and soy, focused on training, technical assistance and boosting production. However, a lack of climate policy and regulation focused on agricultural emissions means there is limited pressure for farmers to adopt new clean farming practices, and its likely agricultural emissions will remain consistent, and most likely rise slightly, by 2050.

Changing consumer tastes could potentially reduce appetites for meat protein over coming decades, although current consumption evidence suggests a large spike in food-based emissions for consumers rising into higher income brackets. Like India, new insect protein startups are emerging across the region, like Entomo Farms in Kenya. These startups use sustainable insect farming as a source of animal feed.

Transitions by 2050

Sector	Subsector	2020	2050 Current Policy Scenario	2050 <2 Scenario
Agriculture	Agriculture	Lack of climate policy and regulation does not curtail on-farm emissions from livestock and fertilisers	Curtailed demand for conventional meat stabilises on-farm emissions but lack of strong climate action leads to minimal agriculture abatement	Curtailed demand for conventional meat and climate policy reduces on-farm emissions and frees up land, but some growth in meat consumption continues due to rising incomes
	LULUCF			

Tipping point analysis: Agriculture and food

Green tech	Incumbent tech	2020	2025	2030	2035
Poultry	Red meat				
R C	African countries are mainly self-sufficient in poultry production, and their governments support growth in the industry through initiatives such as Kenya's National Poultry Development Plan providing training and technical assistance, and South Africa's Poultry Sector Master Plan serving as a strategic roadmap to address challenges and enhance competitiveness				
Soy	Poultry				
R C	Governments support the agriculture sector through initiatives (e.g., Planting for Food and Jobs in Ghana), though limited specific programs exist for soybeans (except the Soybean Value Chain Development Initiative in South Africa providing technical assistance, market linkages, and policy advocacy). Boosting local production could allow capture of growing consumer demand (e.g., soybean meets only 10% of the market demand due to agricultural challenges and pests in Kenya)				
Black Soldier fly feed	Fish meal				
R C	Fish stocks are currently exploited at their maximum (90-100%), making feed options not sustainable. Insect-based protein is expected to have a penetration rate of around 20% globally by 2030, indicating a significant growth opportunity. No dedicated policy framework for the industry, but the emergence of new startups such as Entomo Farms in Kenya could promote on the industry's development. Furthermore, 90% of farmers and 85% of feed producers in Kenya are ready to use insect-based feed				

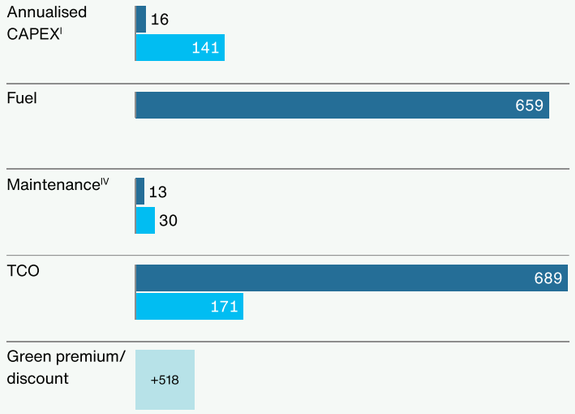
9.6 Case study: rooftop solar adoption in Nigeria

1. Green discount decomposition 2023

Home solar systems are cost-effective compared to diesel generators, but ~5x higher upfront capital costs remain a barrier despite significant lower OPEX

Gasoline generator · Solar home system

Annualised cost, $



Key drivers of TCO

The upfront capex to acquire a home PV solar system can be ~5 times higher than that of a diesel generator

PV solar systems have low operating costs (mostly maintenance, repair, battery replacement) compared to gasoline generators, which are driven by volatile fuel prices (e.g., avg. retail price of diesel increased by 55.90% on a year-on-year basis[V])

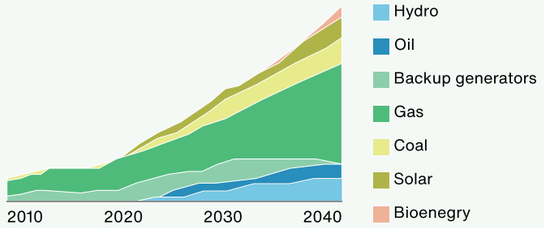
Gasoline generator cost: ~$ 240[I]

Solar home system cost: ~$ 1 170[III]

A switch to solar could yield more than $500 savings p.a. for Nigerian households over the lifetime of the system (20 years) or a total savings of ~ $10,000

2. Projected adoption rate of solar in Nigeria

Nigeria electricity generation by technology[VI] 2010-2040, in TWh



Factors driving adoption

Solar PV systems remain unaffordable to many due to high upfront costs. Purchase and installation of solar can be prohibitive for many households. The Naira's devaluation impacts importation of solar equipment, leading to a rise in effective prices. High interest rates and short repayment terms of microfinance loans deter many households with fluctuating and low incomes

Regulatory and policy support begins to favor renewable energy sources. Nigeria set a 2050 Renewable Energy roadmap including solar. The Solar Power Naija Project was launched in 2020 to roll-out 5 million solar-based connections to communities that are off-grid. The Rural Electrification Agency commissioned several solar projects in rural communities. The government also plans to eliminate fuel subsidies though this has been delayed in recent years

3. Consumer insights

Without reliable access to grid-based electricity, a significant portion of Nigerian households depend on generators

The frequent power outages and unreliability of grid electricity drive the need for households to install gasoline generators for a consistent power supply. Interest in solar systems is still in its early stages, and many people are unaware of the numerous benefits that solar systems can provide

7 hours
Without electricity per day in avg. Nigerian household[VII]

40%
Of Nigerian households own generators[VII]

Innovative business models accelerating adoption

	Reduce upfront CAPEX	Reduce OPEX
Pay-as-you-go: small down payment and pay as you go system (for $0.22 per day)	✓	✓
Subscription: subscription plan providing access solar home system equipment for a fee	✓	✓
Connecting platform: platform that connects people who want solar energy, to access to payment plans that match their needs	✓	✓

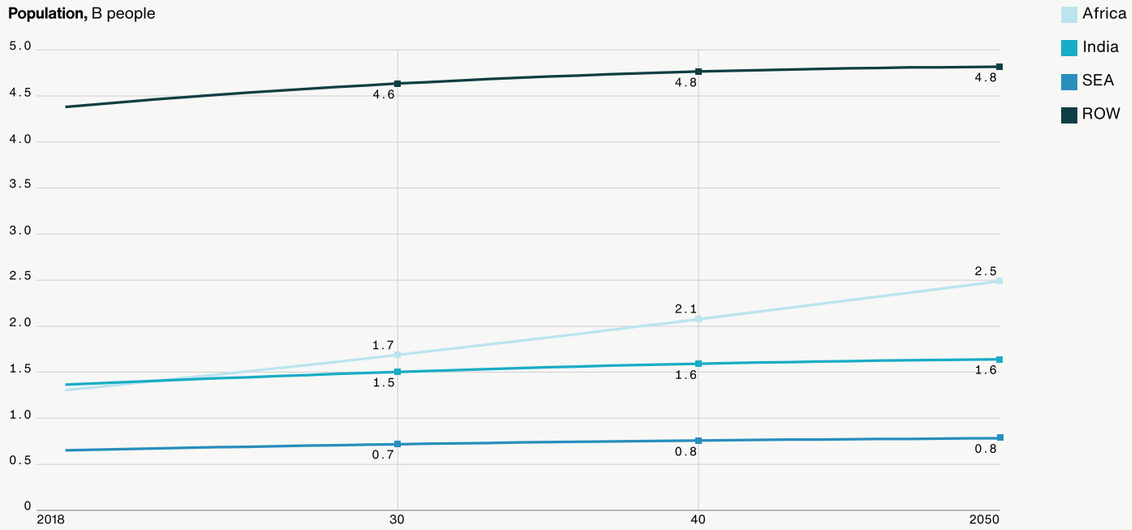
I. Estimated lifetime : gasoline generator 15 y; solar PV 20y; battery 3-6y; inverters 10-15y; **II.** May 2023 price, Jumia; **III.** May 2023 prices : 2 PV units ~USD 434, higher price, Jumia, ~Battery ~USD 425, higher price, Jumia ; Inverters ~USD 309, AliExpress; **IV.** Fuel ~660 USD/year for 6hours per day, 0.8 consumption (L/h), ~USD 0.4 per L of gasoline; **V.** National Bureau of Statistics (NBS); **VI.** Africa Energy Outlook ("Africa Case") – IEA projection, 2019; **VII.** The levelized cost of energy (LCOE) is a measure of the average net present cost of electricity generation for a generating plant over its lifetime - Report: Nigeria's State of Power: Electrifying the Nation's Economy

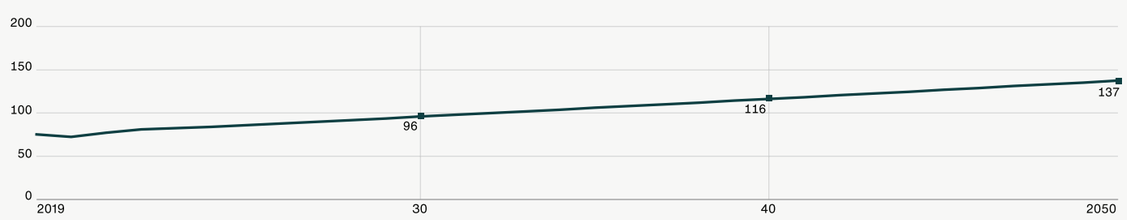
10

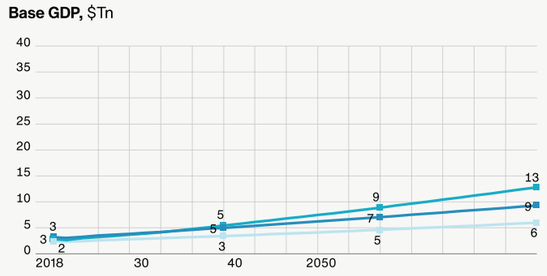
Appendix & Methodology

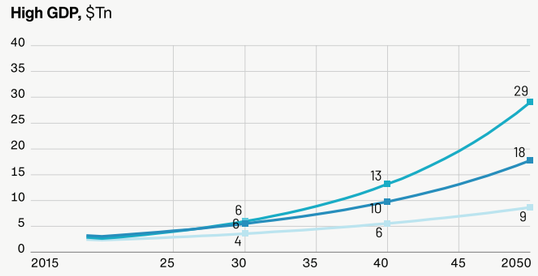
10.1 Key assumptions

Emissions scenarios: Population and GDP assumptions underlying the scenarios









Note: GDPs in Real 2015 dollars

Source: McKinsey Transition Finance Model

10.2 Methodology: decarbonisation pathways

To shape our decarbonisation pathways, we used the Decarbonisation Scenario Explorer (DSE), McKinsey's proprietary tool that helps to model scenarios built on underlying activity levels (e.g. vehicles, tonnes of cement, steel, etc.) that drive the regions' emissions throughout the projected time horizon. The tool contains over 300 technologies and abatement levers across all sectors of the economy that allow to build our tailored abatement scenarios.

Each scenario assumes demand in line with projected sectoral growth rates as well as GDP.

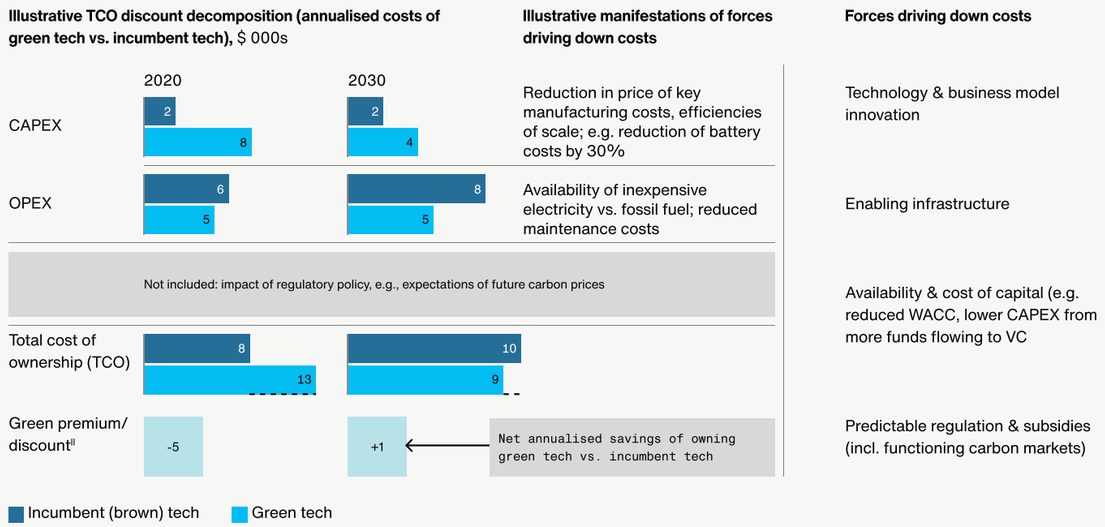
The DSE also defines various technologies and fuel types for each segment – differing uptake levers in line with sectoral growths are input in the DSE for the lever library technologies and fuel types for each sector and segment. These range from conventional technologies, such as ICE long-haul trucks and coal blast furnaces for industrial heating, to technologies still under development, such as hydrogen trucks and electric furnaces. For new technologies, uptake rates were estimated based on products reaching the market and reasonable ramp-ups based on their technology development pace. The resulting pathway provides a lever-by-lever outlook of how the regions could decarbonise

Cross-cutting themes such as CCUS, material circularity, NCS and Green hydrogen were modelled bottom-up based on inputs from the sector-wise models and integrated into the DSE.

To express volumes of different greenhouse gases using a common metric, we used metric tonnes of CO_2 equivalent (CO_2e). Different greenhouse gases have different impacts on global warming. CO_2 can remain in the atmosphere for decades, while methane has a much stronger warming effect but a half-life of only 12 years. It is not obvious how much methane abatement is equal to abating a gram of CO_2, since the average global warming potential of methane is much higher over a 20-year period than over a 100-year period. To translate methane and other GHG emissions to CO_2, therefore, requires setting a common timescale. We adopted the 100-year global warming potential for all greenhouse gases to aid comparability and conforming to current mainstream practices.

10.3 Methodology: green discount

Calculating green discounts: actions by investors, operators, and policy makers are driving down costs



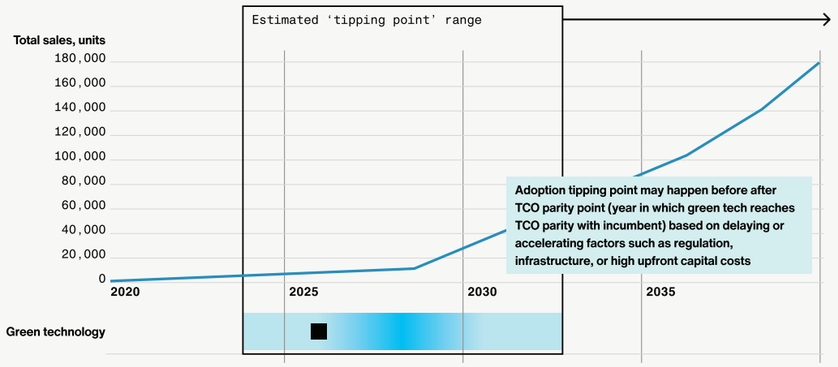
I. TCO considered before any regulatory interventions (i.e., subsidies or tax rebates), but including expected carbon tax implications; II. Difference in TCO of green technology vs. incumbent technology; in other terms, total savings to owner for switching to green tech

Source: McKinsey Transition Finance Model

10.4 Methodology: tipping points

Identifying green discounts helps to isolate potential ‘tipping points’ in technology adoption and attractive investible opportunities

Illustrative tipping point analysis



Estimated ‘tipping point’ range can be before, after, or in-line with the projected TCO-parity year. Relative **certainty is reflected by the width** of the range.

Non-TCO factors pull forward or delay the expected tipping point range.

R **I** **C**

Market adoption tipping point

Less likely — More likely

TCO parity point

- Highly positive
- Low positive
- Highly negative
- Low negative
- Neutral in tipping point acceleration or deceleration

- **R** Regulatory and policy support
- **I** Infrastructure availability
- **U** High upfront capital requirements
- **C** Consumer preferences
- **H** Health and co-benefits

“To ensure a just transition for those who have contributed the least to the current climate crisis, there is a need to ensure that green technologies and practices are both affordable and readily available for low income consumers.”

Bibliography

Acorn. “Plant a better future”. 2023. Accessed July 18, 2023. https://acorn.rabobank.com/en/

Acumen. “Optimism and Urgency at the 2022 Global Off-Grid Solar Forum & Expo”. October 2022. Accessed July 18, 2023. https://acumen.org/blog/optimism-and-urgency-at-the-2022-global-off-grid-solar-forum-expo/.

Aevarsdottir et al. “Rural electrification: The potential and limitations of solar power.” May 2015. Accessed August 1, 2023. https://www.theigc.org/collections/rural-electrification-potential-and-limitations-solar-power.

Armstrong. “This chart shows the growth of India’s economy”. World Economic Forum: September 26, 2022. https://www.weforum.org/agenda/2022/09/india-uk-fifth-largest-economy-world

Arora et al. “E-commerce is entering a new phase in Southeast Asia”. McKinsey & Co, December 2022. Accessed July 28, 2023. https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/e-commerce-is-entering-a-new-phase-in-southeast-asia-are-logistics-players-prepared.

ASEAN Secretariat. “ASEAN Sustainable Urbanisation Report”. December 2022. Accessed August 21, 2023. https://unhabitat.org/sites/default/files/2022/12/asean_sustainable_urbanisation_report_final_dec_2022.pdf

Ashden. “Gender and intra-household dynamics of of-grid electricity access; insights from rural Tanzania”. Accessed August 1, 2023. https://ashden.org/storage/2021/08/Ashden-gender-and-solar-access-study-Tanzania.pdf.

Asian Development Bank. “Energy”. 2023. Accessed July 30, 2023. https://www.adb.org/what-we-do/topics/energy/overview

Bain & Company, Temasek, GenZero and Amazon Web Services. “Southeast Asia’s Green Economy 2023 Report”. 2023. Accessed August 12, 2023. https://www.bain.com/globalassets/noindex/2023/bain-temasek-southeast-asia-green-economy-2023-report.pdf

Batchelor. “ATEC & MECS to pilot digitised ‘cook to earn’”. November 2022. Accessed July 26, 2023. https://mecs.org.uk/blog/atec-mecs-to-pilot-digitised-cook-to-earn/.

BCG. “The Voluntary Carbon Market is Thriving”. January 2023. Accessed August 12, 2023. https://www.bcg.com/publications/2023/why-the-voluntary-carbon-market-is-thriving.

Birol et al. “India’s clean energy transition is rapidly underway, benefiting the entire world”. IEA: January 2022. https://www.iea.org/commentaries/india-s-clean-energy-transition-is-rapidly-underway-benefiting-the-entire-world

Bloomfield et al. “Gender and Livelihoods: Impact of Clean Cookstoves in South Asia”. Global Alliance for Clean Cookstoves, November 2014. https://cleancooking.org/binary-data/RESOURCE/file/000/000/363-1.pdf.

Bolt Earth. “The Impact of EV Charging Infrastructure on Mobility in India”. LinkedIn: July 4, 2023. https://www.linkedin.com/pulse/impact-ev-charging-infrastructure-mobility-india-boltearth/.

Boomitra. “Our Mission”. 2023. Accessed July 18, 2023. https://boomitra.com/about/

Borst et al. “How a new set of metrics is poised to transform PAYGo solar.” June 2021. Accessed August 1, 2023. https://www.cgap.org/blog/how-new-set-of-metrics-is-poised-to-transform-paygo-solar.

Bradford et al. “Understanding soil carbon science to identify strategies for climate mitigation and adaptation.” Aspen Global Change Institute (March, 2021). https://www.agci.org/research-reviews/understanding-soil-carbon-science-to-identify-strategies-for-climate-mitigation-and-adaptation.

Burger et al. “The Socioeconomic Effects of the Working Poor Moving to Permanent Dwellings”. CA: RAND Corporation, 2014. https://www.rand.org/pubs/research_reports/RR714.html.

Casteleyn. 2017. “Clean cooking in sub-Saharan Africa: modeling the cooking fuel mix to 2050”. M.Sc thesis, KTH Industrial Engineering and Management. http://www.diva-portal.org/smash/get/diva2:1155748/FULLTEXT01.pdf

CGAP. “Climate Change”. 2023. Accessed October 23, 2023. https://www.cgap.org/climate.

Clean Cooking Alliance. “The Value of Clean Cooking”. 2023. Accessed October 23, 2023. https://cleancooking.org/the-value-of-clean-cooking/.

Coetzee. “It’s time to change the equation on consumer protection.” June 2019. Accessed August 14, 2023. https://www.cgap.org/blog/its-time-to-change-equation-on-consumer-protection

Duflos and Coetzee. “Rethinking Consumer Protection: A Responsible Digital Finance Ecosystem”. August 2022. Accessed August 14, 2023. https://www.cgap.org/blog/rethinking-consumer-protection-responsible-digital-finance-ecosystem.

European Union. “The Use of Pesticides in Developing Countries and Their Impact on Health and the Right to Food”. 2021. Accessed August 2, 2023. https://www.europarl.europa.eu/cmsdata/219887/Pesticides%20health%20and%20food.pdf.

fDi Intelligence, “The fDi 2022 Report”. 2022. Accessed August 2, 2023. https://www.fdiintelligence.com/.

Ferdinand and del Ser. “Inclusive and Nature-based Carbon Markets: A Path to Resilient Livelihoods in Sub-Saharan Africa”. October 2022. Accessed August 21, 2023. https://c7f1c266-da8e-48a8-9c8f-aaed0b192849.usrfiles.com/ugd/3c15e9_2773ee0b9de24278a8c73c9280e7273e.pdf

GOGLA. “Powering Opportunity.” May 2020. Accessed August 12, 2023. https://www.gogla.org/wp-content/uploads/2023/04/powering_opportunity_global_report.pdf.

Golub et al. “Pricing Forest Carbon”. UN Environmental Programme, 2023. Accessed August 6, 2023. https://www.un-redd.org/sites/default/files/2023-02/ForestCarbonPricing_Report_16Feb_FINAL.pdf.

Google, Temasek, Bain & Company. “e-Conomy SEA 2023”. November 2023. Accessed November 18, 2023. https://economysea.withgoogle.com/report/.

GSMA. “CaVEx: Unlocking access to climate finance”. November 2021. Accessed October 18, 2023. https://www.gsma.com/mobilefordevelopment/uncategorized/case-study-4r-digital/.

Gupta et al. “Decarbonising India: Charting a pathway for sustainable growth”. October 27, 2022. Accessed September 20, 2023. https://www.mckinsey.com/capabilities/sustainability/our-insights/decarbonising-india-charting-a-pathway-for-sustainable-growth.

Hebbalalu and Talwani. “India’s Ola Electric launches its most affordable e-scooter”. Reuters: August 15, 2023. https://www.reuters.com/article/ola-electric-india-idAFL4N39W1QJ.

IDH. “Net Zero in Agriculture, Role of Technologies.” 2023. Accessed June 1, 2023. https://www.idhsustainabletrade.com/uploaded/2023/07/Net-Zero-In-Agriculture_Role-of-technologies.pdf.

IEA. “2020 Regional focus: Southeast Asia”. December 2020. Accessed August 6, 2023. https://www.iea.org/reports/electricity-market-report-december-2020/2020-regional-focus-southeast-asia.

IEA. “Total primary energy supply by fuel in Southeast Asia, 2000-2020”. May 2022. Accessed August 6, 2023. https://www.iea.org/data-and-statistics/charts/total-primary-energy-supply-by-fuel-in-southeast-asia-2000-2020.

IEA. “Heating”. 2023. Accessed August 12, 2023. https://www.iea.org/energy-system/buildings/heating.

International Finance Corporation. “A Green Reboot for Emerging Markets”. 2021. Accessed August 25, 2023. https://documents1.worldbank.org/curated/en/560761621495404959/pdf/Ctrl-Alt-Delete-A-Green-Reboot-for-Emerging-Markets-Key-Sectors-for-Post-COVID-Sustainable-Growth.pdf.

International Finance Corporation. “The Dirty Footprint of the Broken Grid”. 2019. Accessed August 12, 2023. https://www.ifc.org/en/insights-reports/2010/dirty-footprint-of-broken-grid.

International Monetary Fund. “World Economic Outlook: A Rocky Recovery”. April 2023. Accessed October 10, 2023. https://www.imf.org/en/Publications/WEO/Issues/2023/04/11/world-economic-outlook-april-2023.

International Monetary Fund, “ World Economic Outlook Growth Projections.” July 2023b. Accessed July 31. https://www.imf.org/en/Publications/WEO/Issues/2023/07/10/world-economic-outlook-update-july-2023#Projections.

International Monetary Fund. “World Economic Outlook.” April 2023. Accessed August 17, 2023. https://www.imf.org/external/datamapper/datasets/WEO.

Ivanovich et al. “Future warming from global food consumption”. March 2023. Nat. Clim. Chang. 13, 297–302 (2023). https://doi.org/10.1038/s41558-023-01605-8.

Jha and Coll. “No time to waste: Financing biodigesters to save time for rural women”. November 2021. Accessed July 24, 2023. https://www.cgap.org/blog/no-time-to-waste-financing-biodigesters-to-save-time-for-rural-women.

Kumaraswamy. “Does PAYGo Solar Improve Women’s Lives? A Look at the Evidence”. April, 2021. Accessed July 30, 2023. https://www.cgap.org/blog/does-paygo-solar-improve-womens-lives-look-evidence.

Kumari et al. “Green energy provides a triple win for women dairy farmers in India”. February 2023. Accessed August 4, 2023. https://www.accion.org/green-energy-provides-a-triple-win-for-women-dairy-farmers-in-india.

Kuyoro et al. “Reimagining economic growth in Africa: Turning diversity into opportunity”. McKinsey Global Institute: June 5, 2023. https://www.mckinsey.com/mgi/our-research/reimagining-economic-growth-in-africa-turning-diversity-into-opportunity.

Lasarte. “India’s GDP growth outpaced China last quarter”. World Economic Forum: March 3, 2023. https://www.weforum.org/agenda/2023/03/indias-gdp-growth-outpaced-china-economy/.

“Emerging Health and Wealth Index 2022”. October 2022. Accessed August 12, 2023. https://leapfroginvest.com/leapfrog-emerging-wealth-and-health-index-2022/

Lowder et al. “Which farms feed the world and has farmland become more concentrated?”. World Development Journal, Volume 142 (2021). Accessed June 15, 2023. https://www.sciencedirect.com/science/article/pii/S0305750X2100067X?via%3Dihub.

Mattern. “Innovations in Asset Finance”. May 2020. Accessed August 2, 2023. https://www.cgap.org/sites/default/files/publications/slidedeck/2020_05_Slidedeck_Innovations_Asset_Finance_0.pdf.

McKinsey & Co. “Global Energy Perspective 2022”. April 2022. Accessed June 30, 2023. https://www.mckinsey.com/industries/oil-and-gas/our-insights/global-energy-perspective-2022

Mercy Corps Ventures. “Reforestation, Emerging Markets, and the Voluntary Carbon Market Opportunity”. August 2022. Accessed August 14, 2023. https://medium.com/mercy-corps-social-venture-fund/reforestation-emerging-markets-and-the-voluntary-carbon-market-opportunity-e02652fc02fb.

Ministry of Heavy Industries. “About FAME II”. 2023. Accessed October 12, 2023. https://fame2.heavyindustries.gov.in/

Ministry of Housing and Urban Affairs. “PMAY (Urban)”. 2023. Accessed October 17, 2023. https://pmay-urban.gov.in/

Ministry of Power, India. “Charging Infrastructure for Electric Vehicles – the revised consolidated Guidelines and Standards”. January 14, 2022. https://powermin.gov.in/sites/default/files/webform/notices/Final_Consolidated_EVCI_Guidelines_January_2022_with_ANNEXURES.pdf

Morgan Stanley. “India Economic Boom: 2031 Growth Outlook”. November 2022. Accessed 18 July, 2023. URL: https://www.morganstanley.com/ideas/investment-opportunities-in-india.

Morris. “Yutong to deliver 12,000 electric buses to Lagos, Nigeria”. Charged EV Fleet and Infrastructure News: May 11, 2023. https://chargedevs.com/newswire/yutong-to-deliver-12000-electric-buses-to-lagos-nigeria/.

Navinya et al. “Heating and lighting: understanding overlook energy-consumption activities in the Indian residential sector”. Environmental Research Communications 2023: Volume 5, Number 4. https://iopscience.iop.org/article/10.1088/2515-7620/acca6f

Ngige. “India’s first insect farming startup Loopworm secures $3.4m seed round led by Omnivore, WaterBridge. AgFunder: August 25, 2022. https://agfundernews.com/indias-first-insect-farming-startup-loopworm-secures-3-4m-seed-round-led-by-omnivore-waterbridge.

NITI Aayog, Rocky Mountain Institute. “India’s Electric Mobility Transformation”. April 2019. Accessed October 28, 2023. https://rmi.org/wp-content/uploads/2019/04/rmi-niti-ev-report.pdf.

Pandit et al. “Hydropower: A low-hanging sour-sweet energy option for India”. Heliyon 2023: Volume 9, Issue 6. https://www.sciencedirect.com/science/article/pii/S2405844023043591.

Powell et al. “Sustaining grid stability: Role of hydropower in India”. May 6, 2023. Accessed October 12, 2023. https://www.orfonline.org/expert-speak/sustaining-grid-stability/.

Power for All. “Off-grid PayGo: Unlocking affordable energy access and financial inclusion in SSA”. April 2022. Accessed August 2, 2023. https://www.powerforall.org/application/files/6316/4986/8168/Fact_Sheet_Off-grid_PayGo_Unlocking_Affordable_Energy_Access_and_Financial_Inclusion_in_SSA.pdf

Quantum Commodity Intelligence. “Cookstove carbon credits come of age with expected supply boom”. July 2022. Accessed August 6, 2023. https://www.qcintel.com/carbon/article/cookstove-carbon-credits-come-of-age-with-expected-supply-boom-7077.html.

Rabobank. “The Acorn Framework for Voluntary, Ex-Post, Agroforestry Carbon Removal Units”. September 2021. Accessed July 15, 2023. https://assets.ctfassets.net/9vhdnop8eg9t/5HTRPAA8U0geZofq8qPhtx/aff50c099d45a2666006d2643f81913a/The_Acorn_Framework_v1.0_-_Sept_2021.pdf

Rwanda Energy Group. “REF Window 5”. 2018. Accessed July 28, 2023. https://www.reg.rw/what-we-do/rbf-programs/rbf-window-5.

RICS, Knight Frank. “Skilled Employment in Construction Sector in India”. 2023. Accessed October 8, 2023. https://content.knightfrank.com/research/2729/documents/en/skilled-employment-in-construction-sector-in-india-2023-10450.pdf.

Rural Electrification Agency. “Nigeria Minigrid Investment Brief”. December 2017. Accessed July 26, 2023. https://rea.gov.ng/Nigeria_MinigridInvestmentBrief_171202-V2.pdf.

Shrestha. “Nepal, India reach ‘milestone’ deal on trade, transmission of electricity”. Kathmandu Post: February 19, 2023. https://kathmandupost.com/national/2023/02/19/nepal-and-india-agree-to-increase-power-trade-build-more-cross-border-power-lines.

SNV Netherlands Development Organisation. “SNV and Sunfunder partner to manage new solar and cookstoves project on behalf of Kenya Government.” June 2019. Accessed July 28, 2023. https://www.snv.org/update/snv-and-sunfunder-partner-manage-new-solar-and-cookstoves-project-behalf-kenya-government.

Sotiriou et al. “Strange Beasts: Making Sense of PayGo Solar Business Models.” January 2018. Accessed August 2, 2023. https://www.cgap.org/research/publication/strange-beasts-making-sense-of-paygo-solar-business-models.

SunFunder. “Groundbreaking $11m Syndication for SunCulture to Expand Solar Irrigation.” 2021. Accessed October 1, 2023. https://www.sunfunder.com/post/groundbreaking-11m-syndication-for-sunculture-to-expand-solar-irrigation.

Sylvera. “Co-benefits of carbon offsets”. June, 2022. Accessed July 28, 2023. https://www.sylvera.com/blog/carbon-offsets-co-benefits.
Taskforce on Scaling Voluntary Carbon Markets. “Final Report.” January 2021. Accessed August 2, 2023. https://www.iif.com/Portals/1/Files/TSVCM_Report.pdf.

Taylor. “Southeast Asia lags in electric vehicles. Can it catch up?”. Reuters: February 23, 2023. https://www.reuters.com/article/sea-climate-electric-idINL8N3512HR.

“Tracxn. “Private Equity” and Venture Capital Database”. Accessed July 30, 2023.

UN Environment Programme. “Emissions Gap Report 2019”. November 2019. Accessed August 2, 2023. https://www.unep.org/resources/emissions-gap-report-2019.

UNESCAP. “Slow Advancements in Sustainable Energy”. 2022. Accessed July 30, 2023. https://www.unescap.org/sites/default/d8files/knowledge-products/Policy%20Brief_SDG7_to%20CKMS_Final_0.pdf.

UNESCAP. “The future of Asian and Pacific cities”. October 2019. Accessed October 8, 2023. https://www.unescap.org/publications/future-asian-and-pacific-cities-2019-transformative-pathways-towards-sustainable-urban.

United Nations. “Adoption of the Paris Agreement, 2015”. Accessed October 16, 2023. https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf.

United Nations. “Sixth Assessment Report, 2022”. Intergovernmental Panel on Climate Change. Accessed October 26, 2023. https://www.ipcc.ch/assessment-report/ar6/.

Waldron et al. “Getting repaid in asset finance: A guide to managing credit risk.” June 2021a. Accessed August 1, 2023. https://www.cgap.org/research/publication/getting-repaid-in-asset-finance-guide-to-managing-credit-risk.

Waldron et al. “Two Sides, One Coin: Credit Risk Management and Consumer Protection”. June 2021b. Accessed October 2, 2023. https://www.cgap.org/blog/two-sides-one-coin-credit-risk-management-and-consumer-protection.

Waldron. “How carbon credits are driving down the cost of climate-friendly goods in Africa”. Impact Alpha: May 10, 2023. https://impactalpha.com/how-carbon-credits-are-driving-down-the-costs-of-climate-friendly-goods-in-africa/

Waldron. “The Breaking Point: How Warranties Support Sustainable Asset Finance”. September 2020. Accessed August 1, 2023. https://www.cgap.org/blog/breaking-point-how-warranties-support-sustainable-asset-finance.

Waldron. “The social impact credit trap in asset finance”. May 2021. Accessed August 1, 2023. https://www.cgap.org/blog/social-impact-credit-trap-in-asset-finance

Wiehl et al. “Cooking the books: Pervasive over-crediting from cookstoves offset methodologies”. February 2023. Accessed August 12, 2023. https://www.researchgate.net/publication/368760959_Cooking_the_books_Pervasive_over-crediting_from_cookstoves_offset_methodologies

Wilson. 2023. “Start-up taps carbon markets to boost clean cooking in Africa.” Financial Times: August 15, 2023. https://www.ft.com/content/5ab93324-685d-43c8-b30d-b5332b1a378d

Winiecki et al. “Access to Energy via Digital Finance.” 2014. Accessed August 22, 2023. https://www.cgap.org/sites/default/files/researches/documents/DigitallyFinancedEnergy-_FINAL.pdf.

Wood Mackenzie. “India leads with lowest renewable cost in Asia Pacific”. July 27, 2019. Accessed July 26, 2023. https://www.woodmac.com/press-releases/india-leads-with-lowest-renewable-cost-in-asia-pacific/.

World Bank. “Sustainable Energy for All”. January, 2023a. Accessed October 2, 2023. https://datacatalog.worldbank.org/search/dataset/0041706/Sustainable-Energy-for-All.

World Bank. “Breaking Down Barriers to Clean Energy Transition.” May 2023. Accessed July 17, 2023b. https://www.worldbank.org/en/news/feature/2023/05/16/breaking-down-barriers-to-clean-energy-transition.

World Bank. “Clean and Improved Cooking in Sub-Saharan Africa”. 2014. Accessed July 30, 2023. https://openknowledge.worldbank.org/server/api/core/bitstreams/0a15c030-2442-554c-93ff-876141abc28a/content

World Bank. “Population living in slums (% of urban population)”. 2021a. Accessed August 23, 2023.

World Bank. “The Global Findex Database 2021: Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19”. 2021b. Accessed August 6, 2023. https://www.worldbank.org/en/publication/globalfindex.

World Bank. “What you need to know about the measurement, reporting and verification of Carbon Credits”. July 2022. Accessed August 21, 2023. https://www.worldbank.org/en/news/feature/2022/07/27/what-you-need-to-know-about-the-measurement-reporting-and-verification-mrv-of-carbon-credits.

World Economic Forum. “Recommendation for the Digital Voluntary and Regulated Carbon Markets”. Briefing Paper: March 2023. Accessed August 18, 2023. https://www3.weforum.org/docs/Recommendations_for_the_Digital_Voluntary_and_Regulated_Carbon_Markets.pdf.

Zollmann et al. “Escaping Darkness”. 2017. Accessed October 23, 2023. https://www.cgap.org/sites/default/files/researches/documents/Forum-Escaping-Darkness-Dec-2017.pdf.


GRAND HYATT
ELECTRIC BUS
#INTEGRASI
metroTrans
SMART Mobility for Smart City
MYS-22036
1500-102
B 7009 SGX

“With the right models and approaches, people living in emerging economies can successfully adopt green technologies and practices while also improving their incomes and quality of life.”

LeapFrog Investments

Profit with Purpose

www.leapfroginvest.com, www.cgap.org, www.temasek.com.sg