TRANSFORMING A BILLION LIVES

The job creation potential from a green power transition in the energy poor world

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Foreword

Nearly two years into the Covid-19 pandemic, the world is experiencing a great divergence. Wealthier countries have spent trillions of dollars to stoke their economies, vaccinate their citizens, and adapt or transition their economies to be more digital and climate friendly, while lower-income countries—and their people—have been left behind. Hundreds of millions of people in the developing world are poorer, less healthy, have fewer opportunities for education and employment, and have less access to electricity.

Across the world, one of the pandemic's many side effects is job losses. In a matter of days, the virus transformed the global economy, leaving behind those whose jobs could not be done remotely and those who lacked the electricity or Internet connectivity required to go online. Unsurprisingly, the job market is not expected to quickly recover in the developing world: the pandemic may keep 200 million people, disproportionately women, unemployed next year.

Growing unemployment is just one way the world is far more vulnerable today. We're already seeing pandemics, extreme weather events, and famines driven by the climate crisis. As a result, this growing divergence risks increasing global instability. When governments struggle to meet the needs of their citizens, democracy will regress, states will fail, and people will migrate to neighboring countries.

Fortunately, humanity has the power to not only end divergence but, if we act quickly, to minimize the greatest risks of climate change.

This new report asks us to imagine what the world would look like if humanity came together behind bold actions to empower people and save the planet. By harnessing the full potential of advances in artificial intelligence, battery storage, and solar power, we could set in motion a green transition across energy-poor countries. By investing $130 billion per annum over the coming decade, the world can create 25 million new jobs in the power sector itself and generate another half a billion jobs in agriculture, health care, education, and diverse small and medium-sized enterprises.

Of course, such a rapid energy transition would have other benefits as well: it would make the world less vulnerable and the risks of climate change far less severe. By empowering some of the 3.8 billion energy-poor people in the world, who live either without any access at all or with limited and unreliable access to electricity, families will stay safe and be healthier, children will be able to study at night, and people everywhere will have access to jobs and economic opportunity. An inclusive energy transition also will lessen the risks of climate change by averting a billions of tons of greenhouse gas emissions – and not a moment too soon.

The world is at a crossroads. Divergence has made the world too vulnerable for the crises we face. Fortunately, technological advances have given humanity the tools for transformative change. For the first time in history, we can address the climate crisis while empowering people with the jobs and electricity they need to care for their families, pursue opportunities, and thrive. We must now find the courage, and the resources, to come together and change how the world works and how people live. Nothing less will do.

IKEA Foundation

IRENA International Renewable Energy Agency

ISA International Solar Alliance

The Rockefeller Foundation

Sustainable Energy for All

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Acknowledgments

This report is an effort of The Rockefeller Foundation. Joseph Curtin drafted the report, with contributions from Robin Bristow, Ashley Chang, John Gans, Eric Gay, Joseph Peralta, Eileen O'Connor, and oversight provided by Ashvin Dayal. Additional input was provided by Flip Dotsch and Tessa van Soest of IKEA Foundation. Catalyst Off-Grid Advisors contributed predictive modelling and case study inputs. Design by AHOY Studios.

Executive Summary

The Covid-19 crisis has had an enormous impact on the global labor market. Millions of workers have lost their jobs in developing countries, with vulnerable groups hardest hit, including young people, women, and low-paid and low-skilled workers. Employment growth is hampered in many cases by low access to vaccines and limited fiscal space to invest in human capital. The potential for long-term unemployment, higher levels of poverty, lives turned upside-down, careers disrupted, and increased social strife looms large.

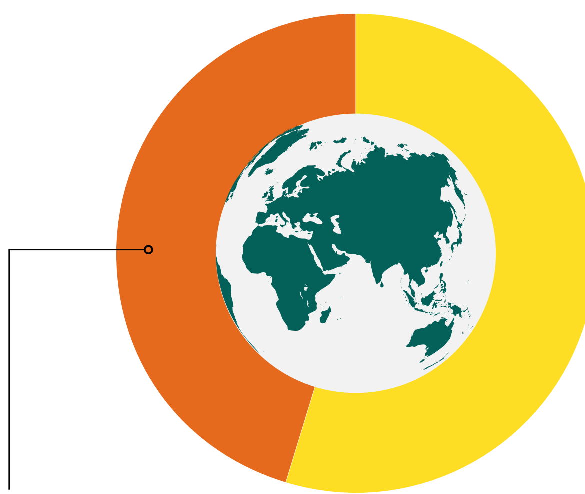
Access to power has become central and indispensable to modern life, yet progress towards achieving universal electrification was also reversed in 2020 for the first time in decades, undermining a key pillar of development progress.

According to the recent report from the UN's climate science body, human-induced climate change is already affecting many weather and climate extremes in every region across the globe. Within this context, the high carbon intensity of the recovery in many geographies is another worrying trend, underlining the urgent need for a global energy transition.

There is nothing inevitable about these developments – they can and must be reversed.

Over the past decade, renewable power generation technologies have rapidly displaced fossil fuels as the most cost-effective building block for economic development. Distributed renewable energy technologies (DREs), in particular, have become a faster, nimbler, and more cost-effective solution for driving inclusive growth and reaching underserved populations.

Yet, we estimate that approximately 3.6 billion people still live in energy poverty today in 63 countries across Asia and Africa. The time is ripe for a global alliance of partners to come together with a plan to greatly expand the climate-friendly use of DREs.



APPROXIMATELY
3.6 BILLION
PEOPLE STILL LIVE IN ENERGY POVERTY TODAY

A uniquely job creating agenda

This report explores a "what if" scenario – what if the world took action to harness the full potential of DREs to end energy poverty, setting in motion a green power transition across the energy poor world? It combines qualitative case studies with predictive economic modelling to explore the job creation potential that would flow from a steep and rapid increase in investment in DREs across 63 energy-poor countries in Asia and Africa. This would require $130 billion per annum of capital investment over the coming decade.

It would result in *25 million new jobs created globally in the power sector itself*, which is more than 30 times the number of jobs that would be created by a comparable investment in fossil fuels.

More remarkably, given the potential to rapidly deploy DREs close to the end-user, we estimate that *491 million additional new jobs* can be created in an array of downstream applications across agriculture, enterprises of various sizes, health, education etc. Furthermore, *hundreds of millions of existing jobs would be improved* by the availability of clean, reliable power.

More than 4 billion tons of CO2 would be saved in the clean energy scenario compared to a fossil fuel dependent development pathway.

Ending energy poverty with a focus on DREs emerges as a uniquely job-creating agenda with transformative potential for more than a billion people.

Direct jobs

19 million permanent jobs and almost 6 million temporary jobs are created in designing, building, operating, and maintaining new DRE power generating facilities. Almost half of these jobs are located in South Asia, the majority in India; a quarter are located in the Sub-Saharan Africa region, and a quarter in the East Asia & Pacific region.

In this case, small really is beautiful. Modest grid-tied systems that could service a medium-sized business or a cluster of small enterprises engaged in activities such as milling, carpentry, or tailoring, represent 46% of these direct jobs. Installing off-grid solar systems for individual households and micro enterprises accounts for another 20% of total direct jobs created.

By comparison, investing in large, centralized fossil fuel assets would create less than half a million jobs, the great majority of which are temporary, focused on the construction of power plants.

Productive use jobs

We find that direct jobs are dwarfed by the unique potential for DREs to grow employment throughout the economy by the utilization of the new electricity generated for so-called "productive uses".

The proximity to the end user, speed of deployment and reliability of DREs compared to traditional fossil assets means that these technologies are potentially transformative for local economies. Based on a detailed assessment of 75 productive uses across 8 key economic sectors, we find that:

- **Almost 500 million new jobs could be created in these downstream applications**
- **Close to 700 million jobs could be improved**

Nearly half of total downstream jobs created or improved are located in South Asia; the Sub-Saharan Africa Region accounts for one third of the total; and East-Asia Pacific the remaining 18%.

Slightly more than half of downstream jobs are created in enterprises of varying sizes, while 35% are in the agricultural sector. As our case studies illustrate, DREs can be used to power ice making factories or solar lanterns used by fishermen in Uganda, irrigation pumps in Ethiopia, or milk chillers in Nigeria.

But it is important to note that the availability of reliable power alone will not spur increased demand for energy services. Significant additional investments will be needed in downstream machinery to ensure that new clean, reliable power from DREs boosts economic growth and improves lives.

Benefits for vulnerable communities

Low-skilled jobs account for almost half of the downstream job gains and over two thirds of direct jobs, pointing to an opportunity to target those hit hardest by Covid through DRE deployment.

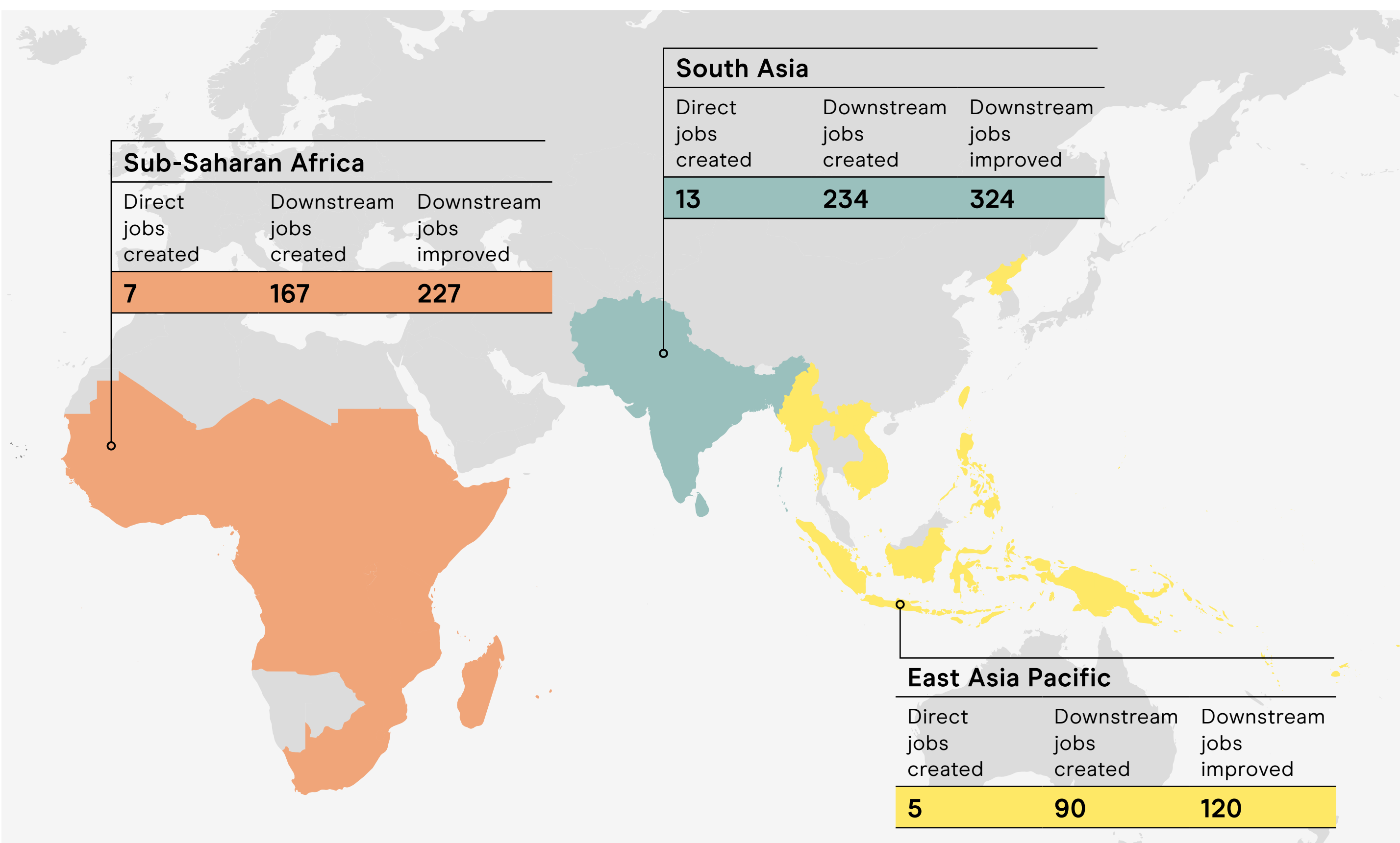
Sectors that have high female representation, such as private enterprises and agriculture and processing, account for many of the new and improved jobs. These findings underscore the potential to advance gender inclusion through DRE deployment. In Nigeria, for example, the benefits of electrifying the milk value chain would flow disproportionately to women.

Conclusion

Achieving the full potential of DREs to end energy poverty is an opportunity that can brighten entire economies – no other global initiative could deliver such a sweeping and lasting impact.

Success necessitates a redoubling of global efforts. No one country or organization, no matter how powerful or well-resourced, can take this on alone. The time is ripe for a global alliance of partners to come together around a comprehensive climate-friendly electrification effort based on clean, reliable power.

Job creation potential by geography (million people)



Introduction

The pandemic is eroding decades of development progress. Beyond its devastating effect on health, morbidity, and mortality, the associated economic downturn pushed more than 120 million people into extreme poverty in 2020.[1]

The scale of labor market disruption in developing countries underlying this statistic has been massive, leaving few firms, workers, and households untouched. The ILO estimates that 255 million full-time equivalent jobs were lost in 2020.[2] The human costs in terms of lives lost will permanently affect global economic growth. This impact will be compounded by elevated levels of poverty, lives turned upside-down, careers disrupted, and increased social strife.[3] Many vulnerable groups and sectors around the globe have been hardest hit, including young people, women, and low-paid and low-skilled workers in developing countries. These same countries are constrained by low access to vaccines and limited fiscal space, and projected employment growth is therefore weak and insufficient to create opportunities for the recently unemployed.

Progress on achieving universal electrification has also been reversed: indeed, **the numbers without basic electricity access rose by 13 million people in 2020.[4] At the same time, global energy-related carbon dioxide emissions are on course to rise by 5% in 2021 alone** – the second-largest increase in history, driven mostly by a resurgence in coal use, and a dire setback in our efforts to combat climate change.[5]

According to the IEA, only 35% of the clean energy investment envisaged under their Sustainable Recovery Plan has thus far been mobilized. The challenge facing emerging and developing economies is even more acute, given that limited resources has been on focused on emergency health and economic measures. For this cohort only 20% of the investments needed for a clean recovery have been mobilized.[6]

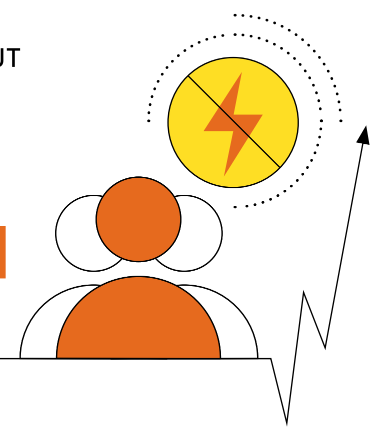
These trends are not inevitable, nor are they irreversible – indeed they can and must be reversed.

A human-centered and equitable recovery to Covid-19 that is protective of the planet is possible. Setting in motion a job-centric recovery that meets the needs of vulnerable citizens will require national and international leaders put to the fore a wide array of macroeconomic, labor market and sector-specific policies and initiatives. These priorities have been detailed elsewhere.[7]

THE NUMBERS WITHOUT BASIC ELECTRICITY ACCESS ROSE BY

13 MILLION

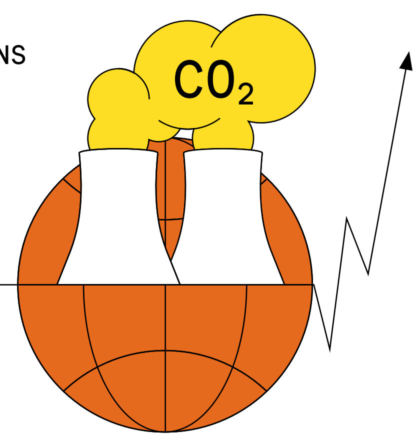
PEOPLE IN 2020



GLOBAL ENERGY-RELATED CARBON DIOXIDE EMISSIONS ARE ON COURSE TO RISE BY

5%

IN 2021 ALONE



In this report, we highlight the enormous job-creating potential associated with ending energy poverty in the green economy, focused on investing in distributed renewables (DREs).8 We consider DREs to be renewable technologies that are either connected to the low and/ or medium voltage distribution network (rather than the high voltage transmission network), or are entirely off-grid, and are generally smaller scale (e.g. <10MW).

Over the past decade, distributed and renewable energy technologies have been rapidly replacing fossil fuels as the most cost-effective building block for powering economic development. DREs in particular have become a faster, nimbler, and more cost-effective solution for driving inclusive growth and reaching under-served populations. They have the potential to be at the heart of a global energy transition, which is urgently required.

These technologies are already a major employer in many countries. In India, for example, DRE companies already directly employ as many workers as the traditional utility-scale power sector.[9] But this is just the beginning: according to IRENA, these technologies have "extraordinary growth potential", especially in low-income countries.

In this report, we lay out in detail the job creation potential of ending energy poverty through the maximum deployment and use of these emerging technologies.

Ending energy poverty with DREs is now possible

Access to power has become central and indispensable to modern life: nothing is more predictive of extreme poverty than lack of access to electricity, and nothing does more to alleviate poverty than providing that access. For many of the world's poor, the key impediment to their entry into a modern economy is the inability to plug into a reliable source of power.

For this reason, the U.N. Sustainable Development Goal 7 calls for *"access to affordable, reliable, sustainable and modern energy for all"*. Yet the principal indicator is the residential electrification rate of a minimum of 50 kilowatt-hours (kWh) per capita per year. This level of consumption is in no way sufficient to sustain economic growth. **For a country to reach lower middle-income status requires a *Modern Energy Minimum* of about 1,000 kilowatt hours per person per annum to be achieved.**[10]

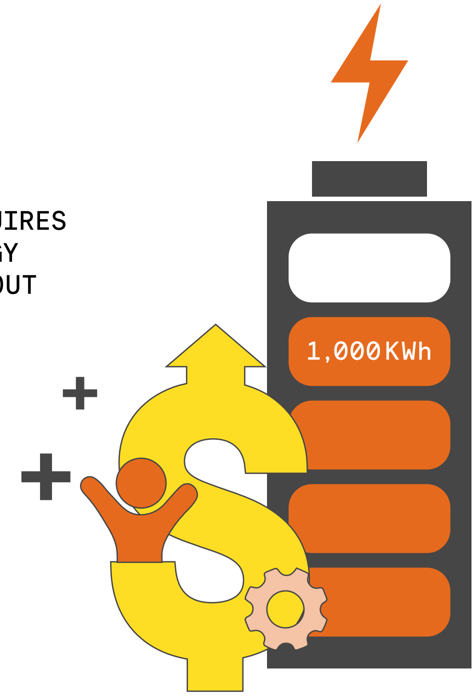
Using this threshold, we estimate that approximately 3.6 billion people still live in energy poverty today. Among them, about 800 million people have no electricity whatsoever, almost 600 million of whom live in sub-Saharan Africa. An additional 1.5 billion people have unreliable or unstable access, while 1.3 billion people have reliable access but are underserved.[11] Achieving the *Modern Energy Minimum* for all countries would transform the lives and livelihoods of billions of people.

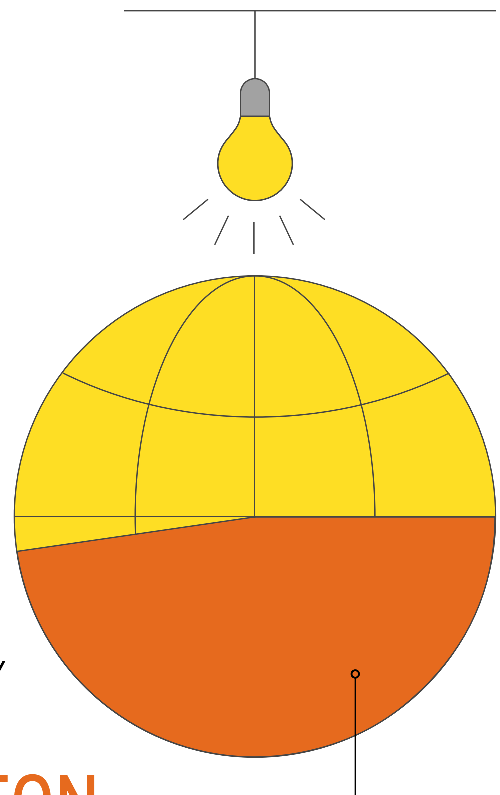
Of the 1.2 billion people who gained access to electricity since 2000, nearly all did so by connections to the main grid. However, 70 percent of the power generated for these new connections came from centralized fossil fuels, adding significantly to regional air pollution and greenhouse gas emissions.[12] While these connections have been transformational for the lives of hundreds of millions, relying on fossil fuels is no longer the most economically viable, technically feasible, or sustainable option to deliver universal and reliable electricity in many places.

A COUNTRY REQUIRES
A MODERN ENERGY
MINIMUM OF ABOUT

1,000 KWh

PER PERSON
PER ANNUM





APPROXIMATELY

3.6 BILLION

PEOPLE STILL LIVE
IN ENERGY POVERTY
TODAY

Countries yet to meet the *Modern Energy Minimum* and/or that have unreliable access

	Meet Modern Energy Minimum but face unreliability issues	Low Modern Energy Minimum Shortfall	High Modern Energy Minimum Shortfall
Sub-Saharan Africa 	Gabon, South Africa	Zambia, Zimbabwe	Angola, Benin, Côte d'Ivoire, Cameroon, Congo (Brazzaville), DRC, Eritrea, Ethiopia, Ghana, Kenya, Mozambique, Niger, Nigeria, Sudan, Senegal, South Sudan, Togo, Tanzania, Burundi, Burkina Faso, CAR, The Comoros, Cabo Verde, Guinea, The Gambia, Guinea-Bissau, Liberia, Lesotho, Madagascar, Mali, Mauritania, Malawi, Rwanda, Sierra Leone, Somalia, Sao Tome and Principe, Eswatini, Chad, Uganda
South Asia 	n/a	India, Sri Lanka, Pakistan	Bangladesh, Nepal, Afghanistan
East Asia Pacific 	n/a	Indonesia, Cambodia, Laos, Philippines, North Korea	Myanmar, Fiji, Micronesia, Kiribati, Marshall Islands, Papua New Guinea, Solomon Islands, Timor-Leste, Tonga, Tuvalu, Vanuatu, Samoa

Fortunately, an inflection point has been reached.

The cost of solar PV panels and battery technologies have both declined by more than 85 percent since 2010. The cost of electricity from bioenergy, hydropower, geothermal, and onshore and offshore wind has also declined rapidly.[13] These breakthroughs have already made renewable energies the cheapest options for new power in more than two-thirds of the world.

By 2030, the cost of renewables will undercut fossil fuels almost everywhere.[14] Renewable and distributed energy technologies that are already mature can supply the overwhelming majority of new power required by 2050, while investments in transmission and distribution systems and system integration technologies can allow for the optimal balancing and deployment of these generation assets.[15] These changing economic fundamentals mean that the goals of ending energy poverty, combating climate change and driving inclusive growth are not just aligned, they have become mutually reinforcing.[16]

Given the billions that will be allocated to power infrastructure over the recovery period, imminent investment decisions will have a decisive impact on whether the world has a chance of meeting the interconnected objectives of human development and climate action.

A Scenario for Ending Energy Poverty with DREs by 2030

Against this backdrop, Catalyst Off-Grid Advisors developed a predictive model for The Rockefeller Foundation to estimate the amount of investment required to set in motion a green power transition consistent with eliminating energy poverty by maximizing the full potential of DREs. The scenario focused on deploying DREs in 63 countries across three regions: Sub-Saharan Africa; South Asia; and East Asia & Pacific.

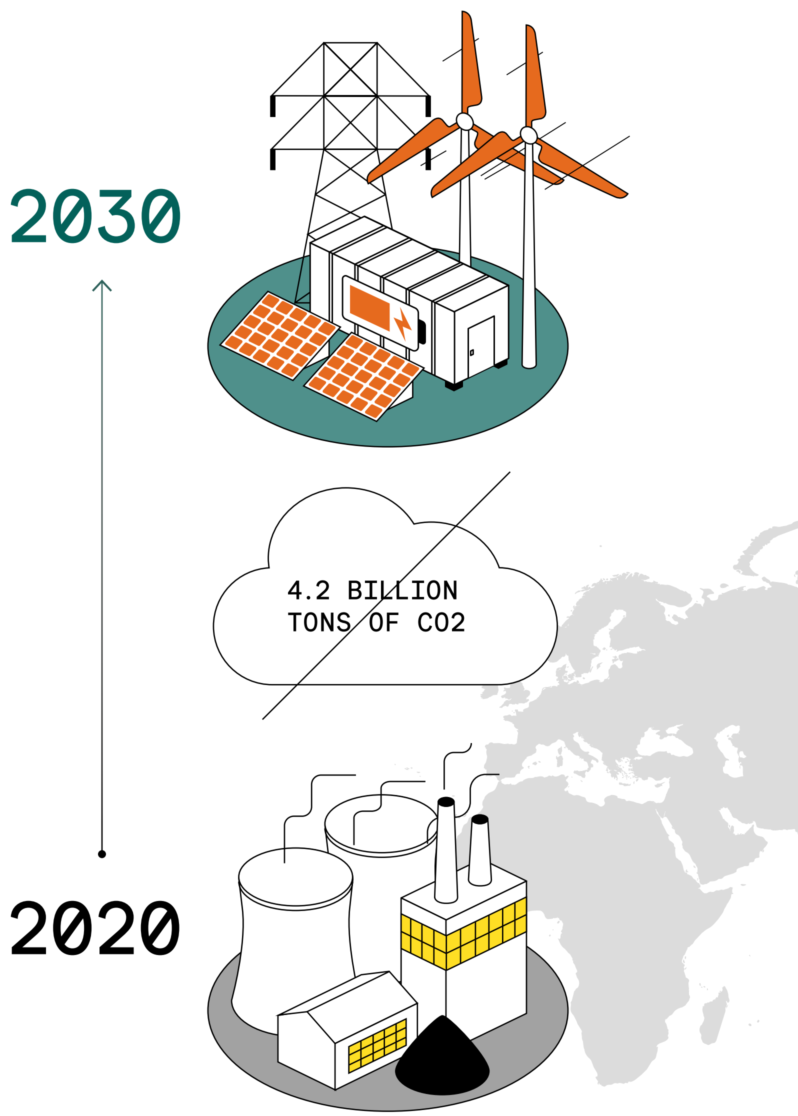
The Ending Energy Poverty scenario will require approximately $130 billion per annum in investments in DREs over the coming decade. Cumulatively this represents the development of **890 GW** of DRE power within a decade, allocated across seven DRE archetypes representing different sizes, configurations and applications of DREs, as described below.

In the Ending Energy Poverty scenario, fully eliminating energy poverty by 2030 in Sub-Saharan Africa remains out of reach, but we illustrate that with some $268 billion in total investment over the coming decade, the continent could be put on a path to meet the Modern Energy Minimum by 2040.

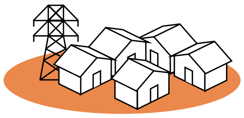
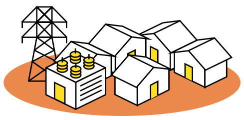
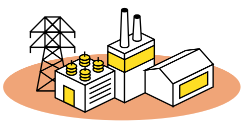
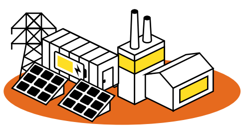
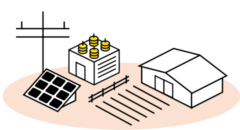
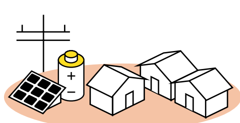
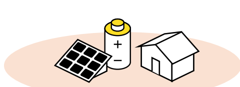
The DRE-led pathway emerges as far more cost-effective when compared to an alternative fossil fuel-led path, when both CAPEX and fuel costs are considered. In the fossil fuel scenario, the investment cost is $491 billion compared to $1.27 trillion in the DRE scenario. However, fossil fuel costs of $1.9 trillion in the fossil scenario compared to close to zero in the DRE scenario, changing the equation completely.[17]

Furthermore, the DRE pathway saves 4.2 billion tons of CO2 by 2030, which is roughly equivalent to total emissions from the EU's 28 Member States in 2020. We will return to considering these climate benefits in a second report in this series, which will be published at COP 26.

It should be noted that there is an enormous investment gap towards meeting this target. For example, today only $4.5 billion annually is invested in DREs to provide electricity access to the 800 million people with no access.[18] This does not capture the full scale of investment targeting energy poverty because it does not include investments that improve reliability or target the underserved (areas for which data is elusive). That said, it does capture the low baseline and illustrates the scale of the transformation envisaged in the scenario we are modeling.



DRE project archetype descriptions and importance in Ending Energy Poverty scenario

DRE ARCHETYPES	DESCRIPTION	TOTAL CAPACITY (GW)	PERCENT OF CAPACITY
 GRID-TIED 5 MW, NO BATTERY BACKUP	Large utility-scale generation serving day-time demand via the grid in primarily urban and peri-urban areas	84	9%
 GRID-TIED 5 MW, 5 MWH OF BATTERY	Large utility-scale generation serving daytime and evening/night demand via the grid in primarily urban and peri-urban areas	419	47%
 GRID-TIED 1 MW, 2 MWH OF BATTERY	Small utility-scale generation serving daily and evening/night demand from large industrial or heavy demand users via the grid and across geographies	168	19%
 GRID-TIED 100 KW, 200 KWH OF BATTERY	Large solar and battery storage serving commercial and industrial customers to improve reliability and autonomy compared to the grid across geographies	84	9%
 GRID-TIED 10 KW, 30 KWH OF BATTERY	Small commercial-scale solar and storage supporting a single enterprise or cluster of enterprises to improve reliability and autonomy compared to the grid service, with particular value in end-of-line, low-reliability contexts	88	10%
 MINI-GRID (SOLAR PV + BATTERY STORAGE, 100 KW/200 KWH)	Community-scale energy access for households, small businesses and productive use applications, generally serving less than 500 connections in rural clusters	17.7	2%
 OFF-GRID SOLAR (AVERAGE SYSTEM SIZE OF 75 WP)	Individual household and micro enterprise electrification powering lighting and small appliances in largely rural areas	30.3	3%
TOTAL		890	100%

CASE STUDY

01

Solar Irrigation in Ethiopia

Agriculture accounts for 40% of Ethiopia's GDP, employing about three-quarters of the country's workforce. Three quarters of farmers are smallholders who work on farms of about 2 acres, earning $707 per year on average.

Less than 5% of Ethiopia's cultivated land is irrigated, while more than 13 million hectares of land (11%) are suitable for solar irrigated agriculture. Solar irrigation could improve yields, enhance crop and water productivity, and reduce the time and physical burden of farming compared to manual irrigation. Solar irrigation pumps are also longer lasting, more efficient, and cheaper to operate than petrol-powered pumps.

A $2.1 billion investment would enable the deployment of 1.4 million 300-400W solar powered irrigation pumps. In total this would bring solar irrigation to 1.2 million smallholder farmers.

Replacing 50% of petrol-powered systems (installing 800,000 solar water pumps) will cumulatively eliminate production of 1.1 million tons of CO2 and save $404 million on petrol costs for farmers by 2030, while 2.2 million smallholder farmers jobs and livelihoods will be improved. This would result in a $7.1 billion increase in cumulative value of crops produced by 2030. Solar irrigation could lift more than 1 million people out of poverty and raise Ethiopia's GDP by $203.5 million. Further, women farmers produce and earn at least 10% less per hectare than male farmers. Solar irrigation can help close this gap.

SunCulture, which is operating across Kenya and Ethiopia, is illustrating what is possible in practice. It has pioneered a "Pay-As-You-Grow" business model to make 310 W solar panels and a submersible pump that can support an acre of irrigation and is affordable for smallholder farmers. SunCulture systems can increase income up to ten times and yields up to 5 times for farmers, while saving them 17 hours per week.[19]

The Direct Job Creation Potential

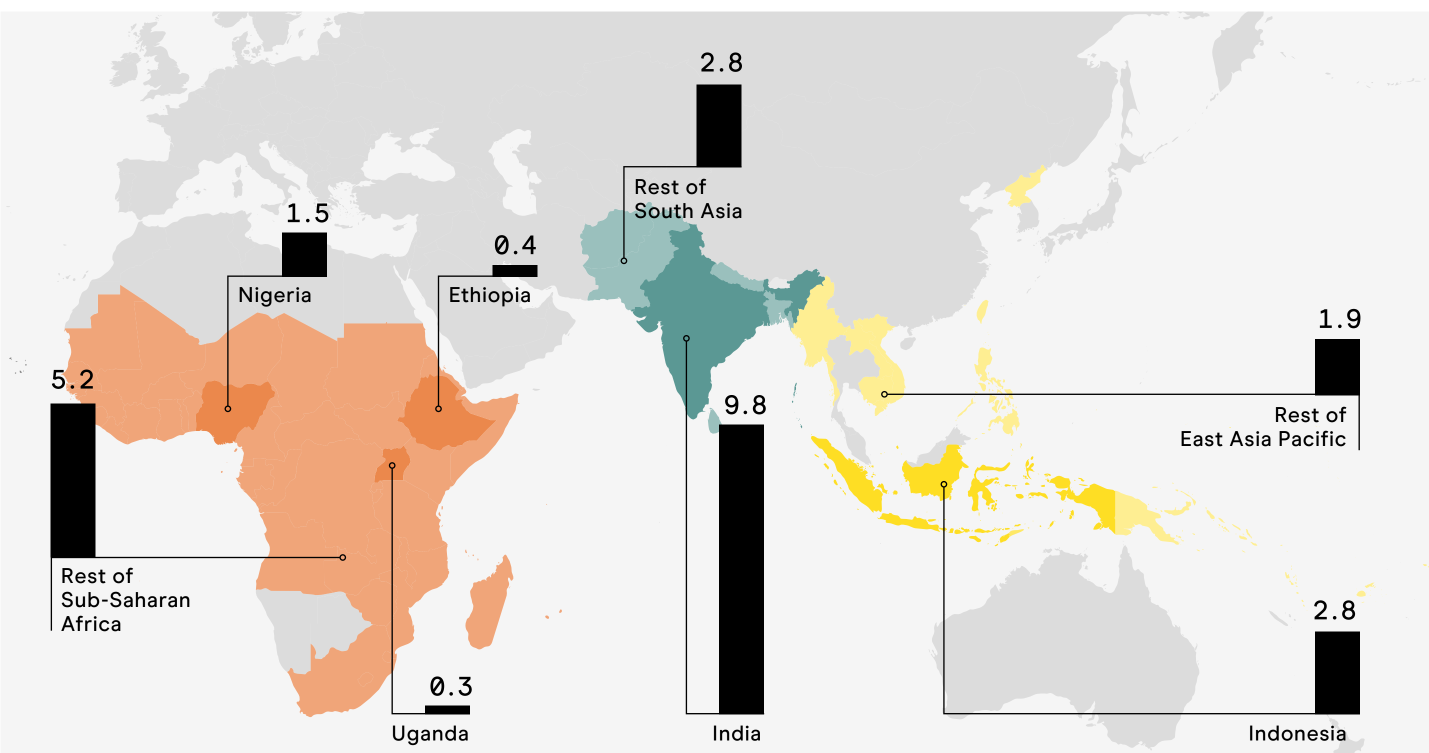
In total, nearly 25 million direct jobs are created, of which 19 million are permanent. These jobs are created in deploying DRE projects, which typically encompasses roles such as design and engineering work, providing financial and legal services, business development, sales and marketing, procurement, constructions and balance of systems. Furthermore, operating and maintaining these systems requires plant managers, guards, maintenance personnel, accountants, administrators and customer service providers.

A simplified fossil-fuel scenario was developed as a benchmark to compare the outputs from the DRE jobs model. The comparable fossil fuel portfolio contains 101 GW of coal generation, 141 GW of natural gas generation, and 39 GW of oil generation. Based on job multipliers for fossil resources from published reports,[20,21] we estimate that this comparable investment in fossil fuels would create 378,000 construction and installation jobs in 2030. Just over 42,100 additional jobs in ongoing plant operations and maintenance would also be supported. Taking account for the lower capital expenditure in the fossil fuel scenario, this means that the DRE pathway creates 41 times more direct jobs.[22]

We estimated the jobs impacts for the DRE scenario across three regions: Sub-Saharan Africa, South Asia, East Asia.[23] In addition, the model includes specific country-level carve-outs for Ethiopia; Nigeria; Uganda; India; and Indonesia.

By geography, the South Asia region, including India, accounts for 54% of all direct jobs created; the Sub-Saharan African region accounts for 27% of the total; while East Asia Pacific accounts for the remaining 19%.

Direct jobs created by region and selected countries (million people)



CASE STUDY

02

Ugandan fish preservation

Uganda has the 7th highest inland fishery production in the world: the sector supports the livelihoods of over 5.3 million Ugandans and provides direct employment to over 1.2 million people. However, there is significant potential to increase the industry's productivity. The sector faces 10-20% post-harvest losses on average, mostly because of inadequate access to cold storage at key points, while up to half of fishing income is spent on kerosene lamps for night fishing.

Men account for about 85% of labor in fisheries, and the role of women and youth in fisheries and aquaculture is often not given the attention it deserves. This has undermined the contribution of the sector to food and nutrition security, poverty eradication, equitable development, and sustainable resource utilization.

There is an opportunity for DREs to raise fish production by providing both cold storage and lighting.

Ice-making enterprises improve access to cold storage and can reduce post-harvest losses and increase net income for fishers. These enterprises represent a clear opportunity for the deployment of either community mini-grids or standalone solar systems.

A capital investment of $10.5 million would be required to deploy 8.9 MW of solar and storage to power these factories, and an additional $6.9 million would be required to construct 173 ice-making factories.

Lanterns are used to attract fish to nets during the evening and morning hours. These lanterns are currently powered by kerosene, which can be both expensive and dangerous. An investment of $1 M would provide 22,000 solar lanterns to fishers and deploy 825 kilowatts of solar and storage capacity supporting 22,000 fishing boats, displacing 88,000 kerosene lanterns. These lanterns could increase income for fishers by savings approximately $80 per month on fuel, while reducing CO2 emissions.

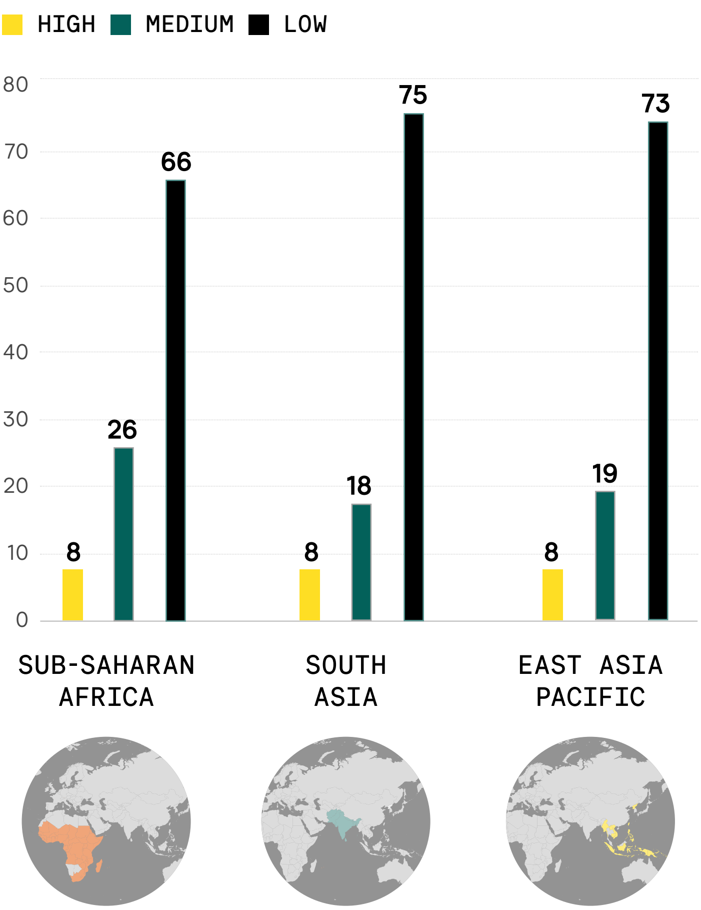
This investment would improve the livelihoods and incomes of 55,000 fishermen, while an additional 865 jobs would be created at ice-making enterprises. At the same time, 447,000 tons of CO2 would be avoided by 2030.

Winch Energy is already doing some of this work, having built three mini grid sites which support over 500 homes and business in fishing communities on Bunjako island, Uganda, including an ice-making plant. This ice-making facility has reduced post-harvest loss by up to 50% and increased midday consumption, thereby reducing curtailment and improving the financial viability of their mini grid.[24]

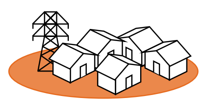
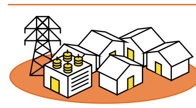
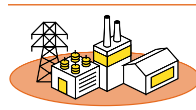
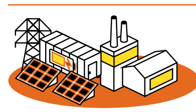
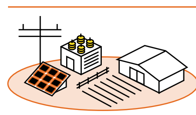
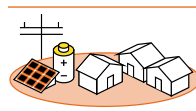
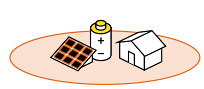
Many of these jobs are ideal for low-skilled workers that have borne the brunt of the Covid crisis. Approximately 16.8 million (68%) are low-skilled jobs, 2.6 million (9.4%) are high-skilled, and 5.6 million (22.8%) are medium-skilled. This split is similar across the three regions, although the proportion of medium skilled jobs is higher in the Sub-Saharan Africa region due to the nature of the enterprises that could be supported across the region.

Smaller scale systems account for the vast majority of jobs created. For example, deployment of 10 kW grid-tied systems with 30 kWh battery, which would typically require 30 or so standard-sized solar panels and three interconnected lithium-ion battery systems, represent nearly half of jobs created (46%). These systems typically support a single medium-sized enterprise in the light manufacturing sector, or a cluster of smaller enterprises engaged in agricultural processing. Together, off-grid systems (mini-grids and off-grid solar), which typically support residential customers and micro- and small enterprises, account for another 26% of direct jobs created.

Skill level of direct jobs created across region (%)



Direct jobs created by DRE archetype

DRE ARCHETYPE	JOBS IN 2030	PERCENT OF TOTAL JOBS
 GRID, 5 MW, NO BATTERY	227,504	1%
 GRID, 5 MW, 5 MWH BATTERY	1,197,863	5%
 GRID, 1 MW, 2 MWH BATTERY	1,243,258	5%
 GRID, 100 KW, 200 KWH BATTERY	4,206,301	17%
 GRID, 10 KW, 30 KWH BATTERY	11,338,347	46%
 MINI-GRID (SOLAR PV + BATTERY)	2,557,204	10%
 OFF-GRID SOLAR	3,942,305	16%

Jobs Created through Productive Use of Energy

When we refer to the productive use of power, we mean electricity that is aimed at enhancing income generation opportunities and productivity in key sectors of the economy that would not have been possible without electricity. Typically, the focus is on power use in SMEs, agriculture, essential services, mobility and industry.

Power generated from DREs can be uniquely transformative for downstream sectors of the economy. This is because DRE projects are generally deployed in closer proximity to the end user, offering unique opportunities for innovative linkages with the local economy. Furthermore, DREs have considerably shorter project development cycles compared to centralized assets. For example, a typical 50 kilowatt solar mini grid serving a single village up to 3 kilometers in radius can now be installed in under two months. With more plug-and-play components, sophisticated procurement systems, and experienced contractors, project timelines are declining every year. Finally, DREs often provide a more reliable service than traditional centralized grids. Distributed renewables therefore quickly boost local economic activity, which is a particularly important characteristic during an economic downturn.

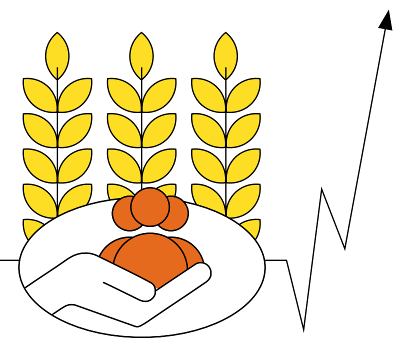
For these reasons, DRE power that is used productively has the potential to create an enormous number of downstream jobs. To model this downstream job-creation potential, we first estimated how much of new electricity generation is consumed for so-called productive uses, compared to other non-productive uses (such as air conditioning or residential appliances), based on an evaluation of current electricity consumption trends in key regions and countries. We then allocated electricity consumption for productive uses across eight key economic sectors (table below), and then to 72 sub-activities within each of these sectors, based on factors including GDP contribution, employment, current electricity consumption, trends and projections. Finally, within each of the 72 individual sub-activities a jobs multiplier was estimated based on a literature review covering reports, journal articles, case studies, company disclosures and engineering manuals.

These jobs multipliers estimate the number of jobs created per additional MWh of electricity consumed for each of the eight key economic sectors. **For example, the Food and Agricultural Processing sector has the highest multiplier at around 8.25 jobs created or improved per MWh of electricity consumed, whereas the Heavy Industry sector had the lowest multiplier at around 0.01 jobs per MWh.**

THE FOOD AND AGRICULTURAL PROCESSING SECTOR HAS THE HIGHEST MULTIPLIER AT AROUND

8.5 JOBS

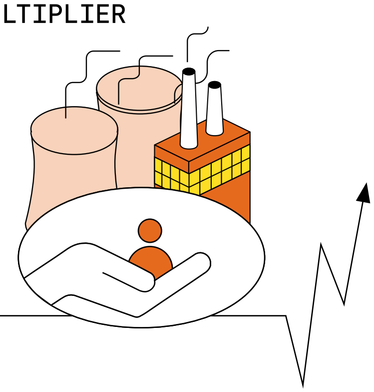
CREATED OR IMPROVED PER MWH



THE HEAVY INDUSTRY SECTOR HAD THE LOWEST MULTIPLIER AT AROUND

0.1 JOBS

PER MWH



Power allocated and jobs multiplier by sector

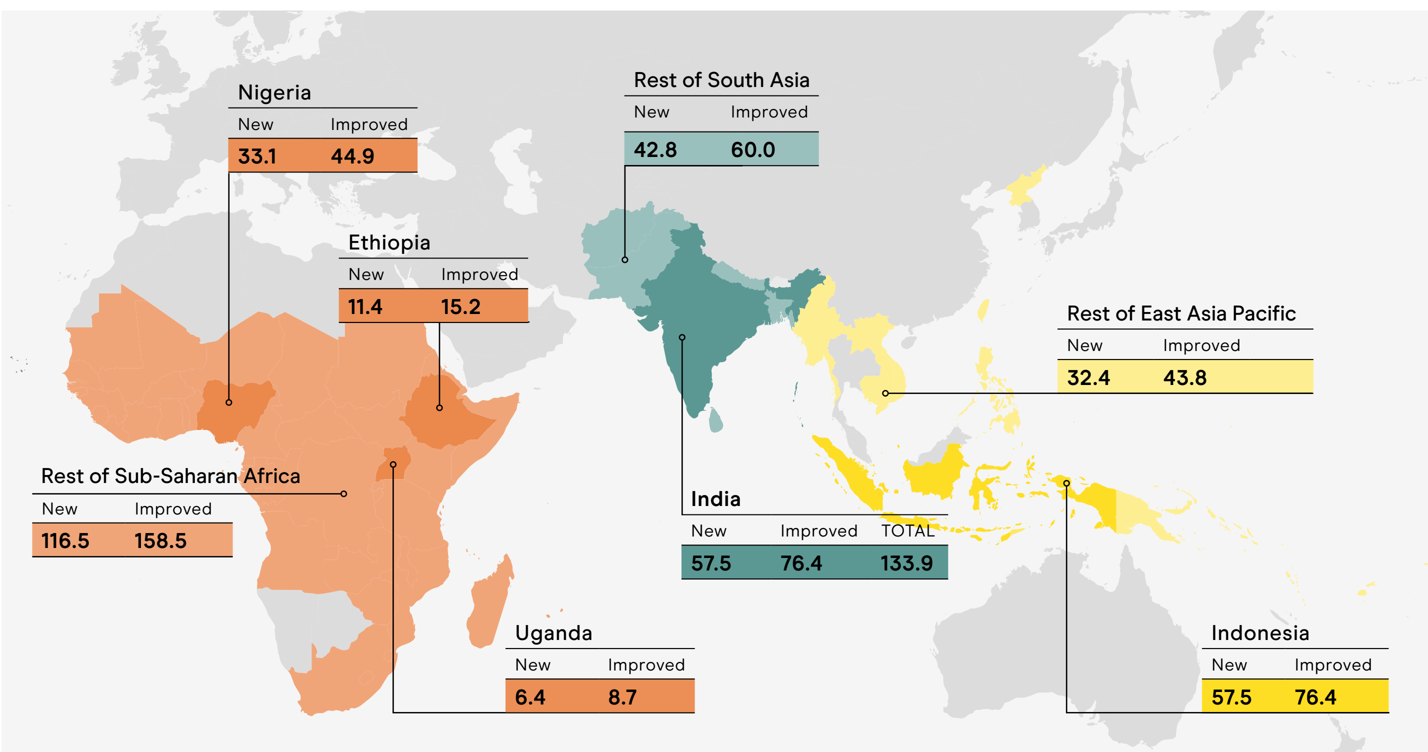
PUE SECTOR	DESCRIPTION	GENERAL PROPORTION OF PUE POWER ALLOCATED TO SECTOR	ESTIMATED JOBS MULTIPLIER (CREATED AND IMPROVED JOBS / MWH)
AGRICULTURAL PRODUCTION	Agricultural crop production including activities like irrigation (small and large), pest management, maize production, rice production, sugarcane production, rubber production, etc.	5% – 10%	2.85
ANIMAL PRODUCTION AND PRESERVATION	Production and preservation of animal products including activities like egg incubation, poultry farming, milk production and preservation, fish farming and aquaculture, cold storage (various scales), slaughterhouses, etc.	1.3% – 3.5%	4.60
FOOD AND AGRICULTURAL PROCESSING	Processing of animal and crop production including activities like milling, grinding, threshing, husking, pressing, drying, etc. for a variety of crops for both small-scale and larger commercial scale applications.	2.5% – 5%	8.25
ESSENTIAL GOODS AND SERVICES PROVISION	Essential goods and services provision including activities like education, healthcare, water and sanitation, streetlighting, etc.	5% – 10%	2.28
MOBILITY	Electrification of transport including electric motorcycles, electric tuk-tuks/3-wheelers, electric boats, electric passenger vehicles, and electric bus rapid transit, as well as associated charging infrastructure	5% – 12.5%	0.71
HEAVY INDUSTRY	Heavy industry including a variety of activities like mining, oil refining, wastewater treatment, data centers, desalination, cement production, chemicals, plastics, vehicle manufacturing, etc.	29% – 56.3%	0.01
LARGE AND MEDIUM ENTERPRISES	Large and medium enterprises including activities like brewing/distilling, gas stations, telecommunications, trade hubs, banks, textiles, light manufacturing, hospitality, etc.	10% – 22.5%	2.62
SMALL AND MICRO ENTERPRISES	Small and micro enterprises including activities like metalworking, carpentry, clothing alteration, vehicle maintenance and repair, visual entertainment, digital services, bakery, general retail, barbershop, nightlife, etc.	10% – 22.5%	4.00

On this basis, we estimate that 1.16 billion jobs could potentially be created or improved in the Ending Energy Poverty scenario, through the productive use of energy in energy-poor countries.

Of this total, 491 million new jobs are created and 671 million jobs are improved. When we refer to new jobs, these are entirely new positions that would not exist without DRE power. "Improved" jobs refers to existing formal and informal jobs that are made easier, more efficient, more cost-effective and less burdensome. For example, in unelectrified areas, agricultural processing is often undertaken manually, which is both time- and labor-intensive. By providing access to mechanized processing powered by DREs, this informal and mostly unpaid work is improved.

Slightly less than half of new and improved jobs are located in South Asia, while the Sub-Saharan Africa Region accounts for one third of the total, and East-Asia Pacific the remaining 18%.

Jobs created and improved by geography (million people)



Of this total, slightly more than half are created in enterprises of varying sizes, while 35% of are in the three agricultural sectors. These are sectors of the economy dominated by women. For example, the time and physical burden for agricultural processing overwhelmingly and disproportionately falls on the shoulders of women and young girls. By empowering new productive use applications in value chains like milling, threshing, grinding, water pumping, etc., DREs can drive new job creation for women and significantly improve livelihoods. Furthermore, SMEs have consistently proven to be a key pathway for supporting economic opportunity, equity, and inclusion for women.

Jobs created or improved by sector (million people)

By creating the space for women's economic inclusion, scaling investment in distributed renewables can therefore yield a "gender dividend" by enabling economies to tap into the latent economic potential of women, which in turn drives faster and more inclusive economic development.[23] Nearly half (48%) of all new jobs created are low-skilled, pointing to the opportunity to target the jobs hardest hit by Covid with DRE deployment programs. This includes vulnerable groups and sectors around the globe, most notably low-paid and low-skilled workers in developing countries. The opportunity is apparent in agricultural production and processing, with the possibility of creating almost 100 million low-skill downstream jobs, and in micro, small, medium and large enterprises, where another 124 million low-skilled jobs could be created. New jobs in essential services, mobility and heavy industry tend to be weighted towards medium and high skilled roles.

Jobs created by skill level

SECTOR	HIGH AND MEDIUM SKILL	LOW SKILL
AGRICULTURAL PRODUCTION	4	34.6
ANIMAL PRODUCTION AND PRESERVATION	12.2	24.8
FOOD AND AGRI-CULTURAL PROCESSING	18.4	37.4
ESSENTIAL GOODS AND SERVICES PROVISION	23.4	13.2
MOBILITY	13.5	1.2
HEAVY INDUSTRY	2.2	0.5
LARGE AND MEDIUM ENTERPRISES	75.3	70.4
SMALL AND MICRO ENTERPRISES	106.1	54
TOTALS	255.2	236

CASE STUDY

03
Milk Preservation in Nigeria

Nigeria has Africa's 5th largest cattle herd, yet the country imports most of the milk it consumes – $1.3 billion worth per year. Small scale pastoralists account for 95% of all milk produced in Nigeria, earning two-thirds of their income from livestock and milk production on average. However, low productivity and cheap imports have suppressed domestic market and local value chains.

About 62% of dairy farmers are women. Milk sales are more likely to make up the bulk of women farmers' total income than it is those of men farmers. However, male dairy farmers still earn 64% more in total than females, while large disparities exist in asset ownership and control, including cow ownership (72% of women dairy farmers do not own cattle), access to land, access to credit and capital, access to transportation, and participation in the formal dairy sector.

Nigeria anticipates a staggering 577% increase in domestic demand for milk by 2050. However, inconsistent access to refrigeration along the value chain holds back productivity for pastoralists. Low production is largely due to high rates of post-production losses of up to 40%. Another 10% is rejected for not meeting quality standards.

Investing $22.4 million into DREs could bring more reliable refrigeration to two critical points: collection points and large collection centers.

Collection points have less access to electricity and are more vulnerable to power supply irregularities since they are typically located in remote areas. Small milk chillers (300-liter capacity) powered by solar mini-grids or standalone solar would provide more reliable cooling infrastructure and serve as anchor loads for mini-grids. $15.5 million is needed to power 3,000 milk collection points. Milk chillers powered by 5.8MW of new solar generation and storage capacity are required at large collection centers, with an investment cost of $6.9 million.

With investment in DREs and milk collection centers, post-production losses would fall to 8%, yielding 84% average income increase per milking day. This would directly create 18,000 jobs and improve the lives of 146,000 dairy farming households. If cooling infrastructure were powered by DREs instead of diesel or the Nigerian grid, that would eliminate the production of 32-40 MT of C02.

Given the prominence of women in the dairy industry and milk processing specifically, women stand to benefit more from DREs for chilling capacity, especially if investments are strategically directed to them. The income benefits of DRE investments are also more profoundly felt by women dairy farmers, raising their incomes by 17% compared to 10% for men.[25]

Conclusion

The world faces a once-in-a-generation crisis caused by the Covid-19 pandemic. Vulnerable groups are hardest hit, including young people, women, and low-paid and low-skilled workers in low-income countries. Already there are warning signs that development gains made in certain areas over previous decades are in reverse, and the prospects for recovery are diverging dangerously across countries and regions. Strong and targeted action from the international community and national policy makers is necessary to avoid lasting damage to lives and livelihoods.

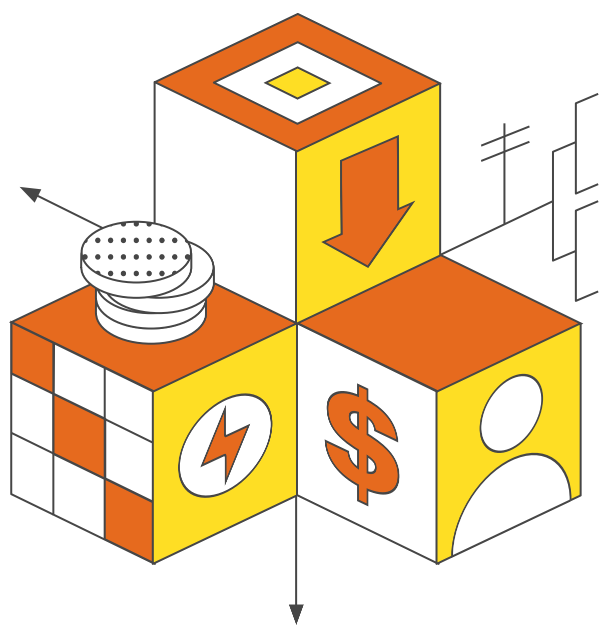
These developments have occurred against a backdrop of an increasingly undeniable climate crisis, which will erode the basis for human wellbeing in the decades ahead if it cannot urgently be addressed.

In this report, we identify a key opportunity to invest in the green economy to drive recovery. It is widely recognized that DREs are becoming increasingly cost effective, while technological innovations are every day presenting new use cases and highlighting sectors of the traditional economy that could be transformed.

Within this context, we identify the job creation opportunity from investing in DREs across the developing world, in a scenario compatible with ending energy poverty by 2030 and achieving SDG 7. This necessitates a rapid increase in investment in DREs across 63 energy-poor countries in Asia and Africa, reaching $130 billion per annum over the coming decade.

In this scenario some 25 million direct jobs are created, which is more than 30 times the number of jobs that would be created from a comparable investment in centralized fossil fuel assets. More significantly, these direct jobs are dwarfed by new and improved down-stream productive use jobs that are created in the DRE pathway. Around 500 million new jobs would be created and almost 700 million jobs would be improved.

More than 4 billion tons of CO_2 would be saved in this scenario compared to a fossil fuel dependent development pathway.



Ending energy poverty with a focus on DREs emerges as a uniquely job-creating agenda with transformative potential for billions of people. Smaller-scale DRE projects are the most labor intensive and give rise to the greatest numbers of new jobs. Low-skilled jobs account for over two thirds of the direct jobs created and almost half of downstream jobs, pointing to an opportunity to target those hardest hit by the pandemic and the associated economic slowdown.

The potential to advance gender inclusion and create enterprise opportunities for women also emerges from this study. DRE-powered job creation is heavily weighted in favor of sectors dominated by women. In Nigeria, for example, the benefits of electrifying the milk value chain using DREs would flow disproportionately to females.

From these findings, it is clear that new electricity generated for productive use applications is a critically important part of enhancing the economic and social development impacts of DRE deployment and rural electrification programs.

But electricity demand will not grow automatically when energy services arrive. Rather, as our case studies illustrate, significant additional investments are required to capture these benefits, be it targeted at milk chillers in Nigeria, water pumps in Nigeria or solar lanterns and ice-making machines in Uganda. Specific interventions that develop community skills, build access to financing, connect value chains and increase market access are necessary to ensure that communities use electricity effectively.

Energy then becomes an enabler of sustainable development in other sectors rather than an end goal in itself.

In a second report in this series, which will be published at COP 26, we will return to evaluating the full CO2 mitigaiton potential from deploying clean energy technologies in energy poor countries.

No one country or organization, no matter how powerful or well-resourced, can take on an agenda of this magnitude and importance alone. The time is ripe for a global alliance of partners to come together to support a comprehensive electrification effort based on clean, reliable power. Done right, this could transform a billion lives and brighten entire economies. No other global initiative could deliver such a sweeping and lasting impact.

Footnotes

1 https://unstats.un.org/sdgs/files/report/2021/secretary-general-sdg-report-2021--EN.pdf

2 https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/briefingnote/wcms_767028.pdf

3 https://fas.org/sgp/crs/row/R46270.pdf

4 https://www.iea.org/articles/the-covid-19-crisis-is-reversing-progress-on-energy-access-in-africa

5 https://www.iea.org/news/global-carbon-dioxide-emissions-are-set-for-their-second-biggest-increase-in-history

6 https://www.iea.org/reports/sustainable-recovery-tracker/key-findings

7 See, for example, https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/briefingnote/wcms_767028.pdf and https://blogs.worldbank.org/jobs/developing-countries-introduced-unprecedented-social-protection-and-jobs-policy-response

8 In a second report in this series, which we will publish at COP 26, we will outline in full the CO2 mitigation potential associated with this recovery pathway.

9 https://www.powerforall.org/news-media/press-releases/first-annual-powering-jobs-census-released-showing-large-employment-opportunity

10 This is inclusive of both 300 kWh of household and 700 kWh of non-household electricity consumption: See: https://www.energyforgrowth.org/wp-content/uploads/2021/01/SHORT-Modern-Energy-Minimum-Final-Jan2021.pdf

11 Estimate provided by Catalyst Off Grid Advisors, November 2020

12 https://www.iea.org/reports/energy-access-outlook-2017

13 https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/May/IRENA_Renewable-Power-Generations-Costs-in-2018.pdf

14 https://about.bnef.com/new-energy-outlook/

15 IPCC (2018) estimate that renewables could account for to 85 percent of electricity by 2050 in climate-safe scenario. Some studies have concluded that an electrical system powered 100% by renewable energy is technically and economically feasible, https://web.stanford.edu/group/efmh/jacobson/Articles/I/USStatesWWS.pdf but this finding has been contested https://blogs.scientificamerican.com/plugged-in/landmark-100-percent-renewable-energy-study-flawed-say-21-leading-experts/

16 https://newclimateeconomy.report/2018

17 Catalyst Off-Grid Advisors

18 IEA (2020) WEO

19 In addition to modeling undertaken by Catalyst Off-Grid Advisors, this case study was informed by the following references:
http://www.practica.org/wp-content/uploads/2021/04/Solar-irrigation-market-Analysis-in-Ethiopia_GIZ-NIRAS-IP-Consult-PRACTICA.pdf
https://rmi.org/wp-content/uploads/2020/04/capturing_productive_use_dividend.pdf
http://www.fao.org/3/i9047en/I9047EN.pdf
https://www.sciencedirect.com/science/article/pii/S0143622817310457
http://www.iwmi.cgiar.org/Publications/IWMI_Research_Reports/PDF/pub172/rr172.pdf

19 UC Berkeley RAEL Lab "Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?; Available at: http://rael.berkeley.edu/old_drupal/sites/default/files/very-old-site/renewables.jobs.2006.pdf

20 Other literature reviews highlight similar ranges for renewable energy vs. fossil fuels:: "on average, $1 million of demand for RE generates 7.49 FTE jobs (4.50 direct plus 2.99 indirect). That same level of demand generates 7.72 FTE jobs in EE (4.59 direct, 3.13 indirect). These averages are nearly three times the level of job creation in FF, which averages a total of 2.65 FTE jobs per $1 million demand (0.94 direct, 1.71 indirect)."

21 It is important to note, however, that these estimates do not include distribution and transmission jobs which will likely be higher with a centralized fossil fuel systems.

22 **Medium-High** – Consumption of 1,000 kWh or higher per capita but with an unreliable electricity grid, defined by outages of at least 12 hours per month on average;
Medium-Low – Consumption of between 500 and 1,000 kWh per capita;
Low – Consumption below 500 kWh per capita

23 Investing in Women and Girls for a Gender Dividend, Population Reference Bureau, Kate Belohlav, June 6, 2016

24 In addition to modeling undertaken by Catalyst Off-Grid Advisors, this case study was informed by the following references:
https://lvfo.org/sites/default/files/field/Nile%20Perch%20-Value%20Chain%20Analysis%20%282%29.pdf
http://www.fao.org/documents/card/en/c/ca9742en
https://eepafrica.org/bfd_download/mini-grid-study/
https://www.nrel.gov/docs/fy18osti/71663.pdf
https://ir.library.oregonstate.edu/concern/conference_proceedings_or_journals/8336h321k

25 In addition to modeling undertaken by Catalyst Off-Grid Advisors, this case study was informed by the following references:
https://sahelconsult.com/the-nigerian-dairy-sector/
https://sahelconsult.com/nddp-oyo-baseline-report/
https://sahelcp.com/wp-content/uploads/2018/10/NDDP-Gender-Study-Report.pdf
https://pdf.usaid.gov/pdf_docs/PA00WQX4.pdf
http://www.fao.org/3/ca5464en/ca5464en.pdf
http://www.fao.org/3/i5791e/i5791e.pdf
https://www.pwc.com/ng/en/publications/transforming-nigeria-s-agricultural-value-chain.html