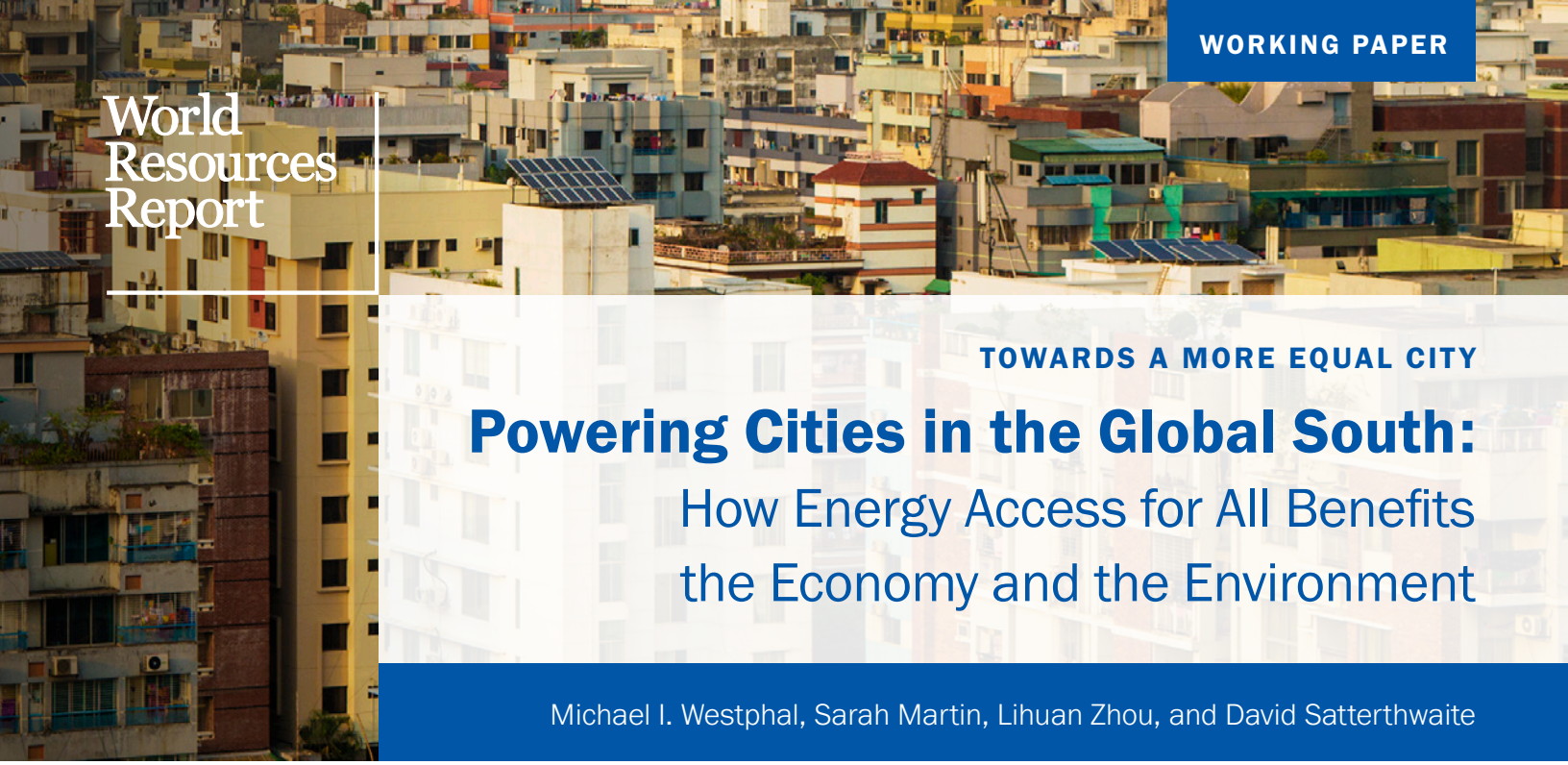

WORKING PAPER

World Resources Report

TOWARDS A MORE EQUAL CITY

Powering Cities in the Global South:

How Energy Access for All Benefits the Economy and the Environment

Michael I. Westphal, Sarah Martin, Lihuan Zhou, and David Satterthwaite

ABOUT THIS WORLD RESOURCES REPORT

This is the third working paper in a series of working papers that comprise the World Resources Report *Towards a More Equal City*. The other working papers cover topics such as housing, transportation, water and urban expansion. To obtain the full version of this paper, other working papers, and to view supporting materials please visit www.citiesforall.org.

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EXECUTIVE SUMMARY

Highlights

- Energy is fundamental to economic productivity and livelihoods, and cities have a major role to play in how it is provided and consumed.
- Cities in the global South face three fundamental energy challenges: the urgent need to increase access to clean, affordable, and reliable energy; how to meet increasing electricity demand while addressing inadequate supply and system inefficiencies; and the imperative to chart a new model of development that slows the growth of carbon emissions and is not fossil fuel-intensive.
- Solutions exist that can both address the needs of the urban under-served and provide economic and environmental benefits to the whole city.
- We highlight three solutions in which the city itself can play a key implementing role: accelerating the shift to cleaner cooking; scaling up distributed renewable energy within cities; and increasing energy efficiency of buildings and appliances.
- These solutions require enabling institutions and governance, finance, and policy, as well as decisions by diverse actors in cities.

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Background

The world is entering a new epoch of urbanization. By 2050 it is projected that two-thirds of the world's population will live in urban areas, with a net urban population increase of 2.4 billion people from 2015, mostly in Africa and Asia.[1] Cities that are already struggling to provide clean, affordable, and reliable energy for their residents will likely find it challenging to keep up with the pace and scale of growth. Without much-needed changes in approach, the urban "under-served" population—those who lack access to core services—will expand in cities in rapidly growing parts of the global South. This challenge presents an unprecedented opportunity to create a different kind of city: one that is more equal, where everyone has access to core services, and where all residents can live, work, and thrive.

This paper is concerned with the challenge of expanding access to energy in the growing cities of the global South. More specifically, it asks, *How can cities in the global South provide cleaner, more affordable, and more reliable energy services to the under-served while achieving economic prosperity and safeguarding environmental quality*?

About This Paper

This working paper is part of the larger World Resources Report *Towards a More Equal City*, which views sustainability as composed of three interrelated issues: the economy, the environment, and equity. We use the equitable provision of urban services as the premise for examining whether meeting the needs of the under-served can improve the other two dimensions of sustainability.

To address the question of how to power the city for all, we have conducted extensive literature reviews and consulted with international organizations such as the Global Alliance for Clean Cookstoves, the Collaborative Labeling and Appliance Standards Program, the Global Buildings Performance Network, the Energy Sector Management Assistance Program, and the World LPG Association.

Our goal is to draw attention to the under-appreciated problem of urban energy access. This paper takes a unique approach in that it looks not only at how to improve energy services for the under-served, but also at how various solutions to the access challenge could impact the city's overall economic and environmental well-being. We believe that expanding access to modern energy sources and systems to include the poor and marginalized is not in conflict with action to mitigate climate change. While energy is often considered outside the purview of cities, our paper argues that energy is a fundamental urban issue and that cities have a large and essential role to play in providing clean, affordable, and reliable energy to all their residents.

An equally important goal is to inform urban change agents—a broad suite of actors that include national and regional governments, international financial institutions, civil society, and the private sector—on priority urban energy action areas.

Urban Energy Challenges

We identify three key energy challenges facing cities in the global South (see Figure ES-1). The first is the urgent need to increase energy access, where access comprises not only the basic ability to obtain energy but also the reliability, affordability, and quality of the energy source. The second is that rapidly growing regions in the global South face potentially unsustainable growth in demand for energy that could overwhelm their supply systems and leave millions more people without access. The third challenge is that rapidly growing regions cannot continue to replicate past models of development if they are to avoid locking in dependency on fossil fuels and the associated volatile prices, air pollution, and expensive infrastructure.

Energy access, reliability, and affordability remain vexing and overlooked urban problems in much of the global South

In some countries, particularly those in East Asia and the Pacific, Latin America and the Caribbean, and South Asia, urban electricity access is high, averaging more than 97 percent in 2012.[2] However, in low-income countries, average levels of urban energy access were only 58 percent that same year.[3] In addition, national-level data on access can sometimes mask much worse conditions in individual cities. Even where populations have access to electricity, unreliability and inefficiency can be acute problems. Aging and inefficient infrastructure strains the ability of utilities to supply adequate power, which subjects customers to frequent power outages.

Access to modern, non-solid fuels is also lacking in many urban areas in the global South. Nearly half a billion urban residents worldwide still use solid cooking fuels.[4] Cooking with such fuels on traditional stoves and open fires is highly polluting and linked to premature mortality and morbidity.

The cost of electricity and fuels can represent a major burden. Poor households in the global South often spend as much as 14 percent to 22 percent of their income on energy, although households are typically considered energy poor if they spend 10 percent or more of their income on fuel and electricity.[5] Moreover, even if the poorest residents can meet the cost of monthly bills, they may not be able to afford high connection charges and are thus denied access altogether.

Rapidly growing regions in the global South face potentially unsustainable growth in energy demand

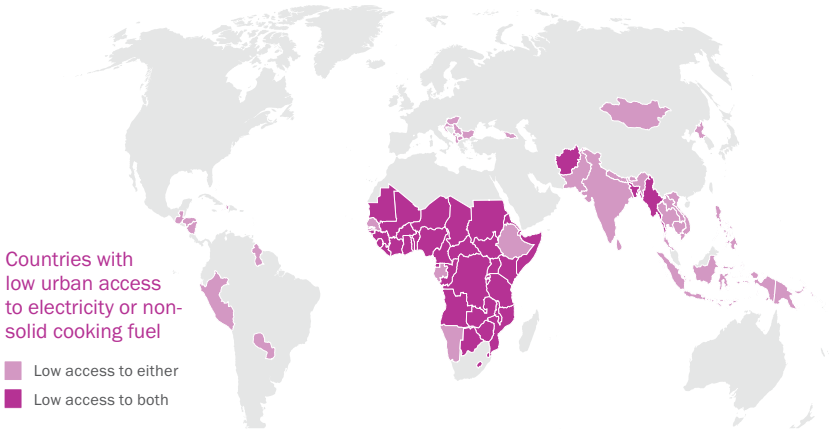
Increasing electricity access in the global South is a development imperative, but emerging cities face the dual challenge of rising demand and inadequate supply, made worse by system inefficiencies and line losses. More than 15 percent of electricity in much of the global South is lost during transmission and distribution; in some cities the percentage is higher.[6] In many cities in the global South, growth rates of electricity consumption are much greater than rates of population growth. Going forward, cities in the global South will need to expand their sources of energy supply and provide better-quality services per unit of energy.

Rapidly growing regions cannot continue to replicate past models of development

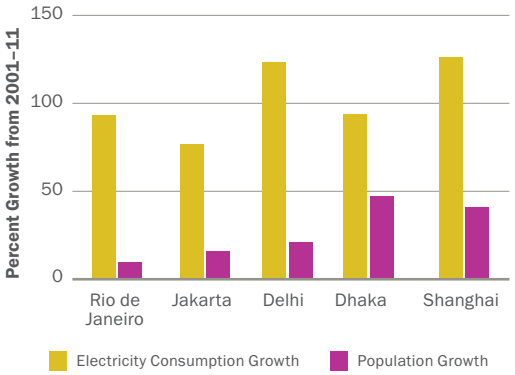
The old fossil fuel-intensive model of development that was undertaken in the global North is not tenable, given a greater awareness of the health impacts of air pollution in cities. The majority of cities in Africa and Southeast Asia monitored by the World Health Organization have experienced increases in particulate matter (PM_{10}) concentrations in recent years. Among the megacities, those in South Asia, for example, have at least double the $PM_{2.5}$ concentrations of cities in the global North, such as New York, Paris, or London.[7] Furthermore, fossil fuel-intensive electricity generation entails energy security risks and import dependence for a number of countries in the global South. For example, in 2014, the Philippines, Senegal, and Sri

Figure ES-1 | **Urban energy challenges in the global South**

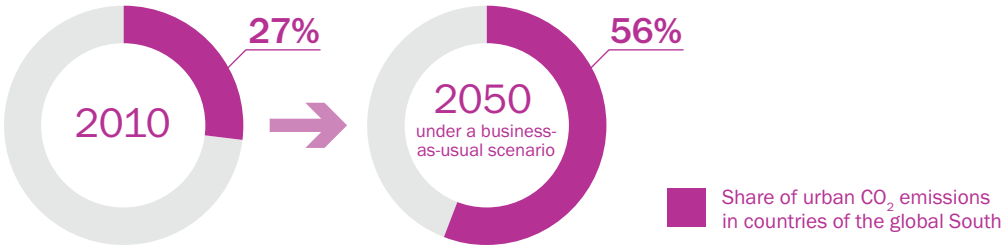
1. Existing problems with poor energy access, reliability, and affordability



2. Unprecedented growth in energy demand from rapid urbanization



3. Continued carbon-intensive development driving pollution, energy insecurity, and climate risks



Source: World Bank, 2016; IEA, 2015; Kennedy et al., 2015; Erickson and Tempest, 2014.

Lanka all imported about 50 percent of their energy.[8] Urban areas globally are responsible for the majority of global final energy use and the associated greenhouse gas (GHG) emissions. On average, per capita GHG emissions in urban areas in the global South are still far lower than in the global North, but in terms of absolute emissions, the picture is changing rapidly. In 2010, China, developing Asia, India, Africa, and Latin America[9] comprised about one-quarter of total urban GHG emissions from the core sectors of buildings, transport, and waste disposal.[10] In a business-as-usual scenario, those regions are projected to be responsible for about 56 percent of total urban emissions in 2050.[11] With future electricity demand projected to increase, national and local governments must make decisions now about their future energy infrastructure.

Solutions to the Urban Energy Challenges

This paper focuses on three urban energy solutions in which the city itself can play a major role in implementation (see Figure ES-2). Despite the breadth of the challenge, our solutions are deliberately focused more narrowly, to make them easier to implement. The focus of the World Resources Report *Towards a More Equal City* is on the urban under-served, so our first concern is to ask how a solution enhances services for the under-served in terms of access, reliability, cost, health impacts, and livelihoods, and whether a solution is practical and scalable. Our second concern is how these solutions improve life in the city as a whole, by enhancing economic productivity, improving air quality, and avoiding the long-term lock-in of inefficient energy consumption and rising GHG emissions.

Based on our framing, we argue that urban change agents should focus on the following solutions:

- Accelerate the shift to cleaner cooking
- Scale up distributed renewable energy within cities, especially using solar photovoltaic (PV) systems
- Increase energy efficiency via measures that include building codes for new construction and energy-efficient appliance standards

This paper focuses on three urban energy solutions in which the city itself can play a major role in implementation.

While these solutions may not be new, we hope to provide a new perspective by evaluating their benefits across the three dimensions of equitable access for the under-served, the economy, and the environment of the overall city.

Accelerating the shift to cleaner cooking

The use of modern cooking fuels—such as liquefied petroleum gas (LPG), electricity, biogas, and ethanol—would result in dramatic reductions in indoor air pollution and improved health benefits for the urban poor. Because of the premature mortality associated with solid cooking fuels, no urban energy intervention would have a greater public health impact. Globally, indoor air pollution from household cooking with solid fuels accounted for 3.5 million deaths and 4.5 percent of disability adjusted-life years in 2010.[12] If we assume exposure is the same for rural and urban populations, and given the fact that about 16 percent of all people using solid cooking fuels in 2010 were in urban areas, then close to 550,000 premature deaths might have occurred in urban areas in that year due to indoor air pollution from solid cooking fuel.[13] In many cases, modern fuels can also result in significant cost and time savings to households, compared to biomass or kerosene.

Scaling up distributed renewable energy

Distributed renewable energy (such as solar PV) addresses the urgent need to provide electricity access and offers additional benefits when compared to traditional grid connection. While we recognize that other distributed renewable energy solutions exist, solar PV systems have greater overall potential in urban areas than technologies such as wind power. Solar PV is still an option even where individuals do not have adequate rooftop space, and community-owned, community-shared solar systems are a promising model in such cases. Solar PV (both on-grid and off-grid) can offer affordability, reliability, and productivity benefits to the under-served. Grid electricity can be expensive, and the cost of solar PV systems and storage batteries is declining.

The average levelized cost of electricity (LCOE) for residential rooftop solar PV in India and China is now within the cost range for natural gas–fired generation in both countries. With greater access to more reliable and affordable supplies, the urban under-served will rely less on dirty diesel and kerosene, which are used extensively in the global South and are often expensive. In addition, home-based enterprises undertaken by the under-served are often energy-intensive and require a reliable supply of power. In some cases rooftop solar PV systems may allow owners to sell power back to the grid, although such arrangements are in nascent stages in the global South.

Increasing energy efficiency of buildings and appliances

Over time, the development and enforcement of energy-efficiency building codes and energy-efficient appliance standards can bring both direct and indirect benefits to the under-served. More energy-efficient structures and appliances will provide benefits in terms of reduced energy bills, improved economic productivity, comfort, health (reduced illnesses), and climate-change resilience (e.g., to heat waves). Potential savings in energy consumption (and hence cost) realized by switching to the best available household appliances and equipment are on the order of 40 percent to 50 percent.[14]

Figure ES-2 | **Recommended approaches to the urban energy challenges in the global South**

	ACCELERATE SHIFT TO CLEANER COOKING	SCALE UP RENEWABLE ENERGY	INCREASE ENERGY EFFICIENCY OF BUILDINGS AND APPLIANCES
Benefits to the Under-served	• ***Health:*** Modern fuels result in dramatic reductions in particulate matter and associated mortality • ***Economic:*** Significant cost and time savings, productivity improvements for enterprises in the informal sector	• ***Access:*** Addresses the urgent need to provide electricity access, particularly in informal settlements • ***Reliability:*** More reliable supply of electricity • ***Economic:*** Costs of solar PV are declining rapidly; higher cost savings compared to diesel, productivity improvements, potential revenue source if owners can sell back to the grid (as "prosumers")	• ***Economic:*** Significant cost savings from reduction in household energy consumption, increased productivity • ***Health, Safety, and Comfort:*** Safer, more comfortable, and higher quality spaces to live and work with lower respiratory and heat-related illnesses
Benefits to the Overall Economy and Environment of the City	• Cleaner cooking cuts outdoor air pollution from solid fuels • Reduced GHG emissions • Cost savings where kerosene subsidies are high	• Avoided costs of new transmission infrastructure • Reduced electricity demand • Reduced GHG emissions • Energy security and climate resilience • Local business development	• Increased energy productivity • Reduced need for new installed capacity • Significant energy cost savings • Air pollution benefits where cities rely on "dirty" electricity grids • Greatest potential for cities to reduce GHG emissions and build climate resilience

Environmental and economic benefits for the whole city

In addition to benefiting the urban under-served, the solutions described above will enhance wider environmental quality and economic productivity. Household heating and cooking is a significant source of ambient (outdoor) air pollution, in addition to indoor pollution. In 2010, outdoor air pollution from the use of solid fuels for household cooking was estimated to have resulted in 370,000 deaths and 9.9 million disability-adjusted life years, globally.[15] Given that in 2010 about 16 percent of the total population using solid fuels for cooking resided in urban areas, then at least 58,000 premature deaths and 1.5 million disability-adjusted life years were likely attributable to outdoor air pollution from solid fuels for cooking in urban areas.[16] The decrease in premature mortality among all urban residents—not only those using solid cooking fuel—from air pollution reductions (both household and ambient) would result in increased economic productivity for cities in the global South. In countries where kerosene subsidies are high, shifting to modern fuels can result in cost savings, given the increases in energy efficiency.

Switching to modern fuels and the cleanest-burning biomass stoves would also result in lower GHG emissions compared to traditional biomass stoves. While this benefit transcends the city's environmental quality, climate change action is an important entry point for local and national leaders who have made climate change commitments, and is an important consideration for programs led by international development finance institutions. Increased use of distributed renewables can help reduce pressures on grid electricity. At scale, rooftop solar PV can offer savings due to the avoided costs of new transmission infrastructure, which translate into savings for electricity customers. That being said, the impact of rooftop solar PV on utilities' overall financial viability needs to be carefully examined, particularly in terms of technical concerns (e.g., intermittency), load forecasting and balancing, and planning. Rooftop solar PV can also contribute to energy security, climate change resilience, and economic development opportunities for cities through the creation of local businesses and employment opportunities.

Scaling up distributed renewable energy could result in GHG emissions reductions and decreased associated air pollution. This is especially the case where countries' electricity grids are carbon-intensive, as they are in South Africa, China, India, and Indonesia. We calculate that the power generated by tripling the current installed capacity of solar PV across 60 countries (assuming constant demand) would reduce GHG emissions by 108 $MtCO_2e$, an amount equivalent to the total annual emissions of Belgium in 2012.[17]

On average, residential and commercial buildings are the largest energy consumers in urban areas globally. Because they can exist for decades, buildings represent the biggest lock-in for cities in terms of energy use. The economic case for energy efficiency is well understood. Building energy-efficiency measures can generally reduce energy use by up to 50 percent to 90 percent in new buildings and 50 percent to 75 percent in existing buildings.[18] Energy cost savings in municipal buildings translate into more money for other public services. Furthermore, every kilowatt-hour (kWh) saved where cities depend on "dirty" electricity grids also means reduced air pollution associated with fossil fuel-fired electricity generation.

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Moving Forward: Barriers to and Enablers of Change

The three solution areas we recommend in this paper—accelerating the shift to cleaner cooking, scaling up distributed renewable energy within cities, and increasing energy efficiency of buildings and appliances—all require the critical enablers of institutions and governance, finance, and policy.

Institutions and governance

Government leadership at all levels, effective and well-coordinated institutions, modern regulatory frameworks, and engagement with the under-served are fundamental to success. Issues related to property tenure need to be addressed. Institutions must be adequately staffed to set standards; promote energy efficiency and renewable energy targets; develop local plans; enforce and monitor compliance with regulations on modern fuels, building codes, and appliance standards; provide training to project developers, regulators, and utilities; and raise awareness. Often, national- and subnational-level agencies or specialized departments need to be developed to coordinate efforts. Participatory process and civil society organization (CSO) engagement are vital to make sure equity concerns are incorporated in planning processes and implementation.

Policy

There are numerous complementary policies that can help catalyze these solutions. Pretax fossil-fuel consumption subsidies totaled about US$330 billion in 2015,and subsidy reforms, such as replacement of these subsidies with targeted cash transfers for the poor, could remove some "headwinds" for clean cooking, energy efficiency, and renewable energy.[19] Import policies on modern fuels and cookstoves can be made less restrictive so as to foster uptake. Renewable energy policies adopted at either the national or city level—such as feed-in tariffs, net or gross metering, and reverse auctions, or special tariffs for renewable energy customers such as green tariffs, quotas, and renewable portfolio standards—can help accelerate distributed renewable energy.

Finance

The proliferation of new finance models, such as pay-as-you-go consumer payment schemes, bode well for distributed solar energy, energy-efficient appliances, and clean cooking. It is likely that affordability will continue to increase for distributed renewables. The costs of solar PV technology have declined in a steep, nonlinear fashion, and the cost of battery storage is projected to decline significantly in the future. Other financing models include innovative blended finance, social impact and green bonds, and revolving funds. However, more needs to be done to address up-front costs and willingness-to-pay issues. One important role for international public finance is to address externalities, such as the climate change and local air pollution costs of energy, through carbon finance and results-based payments. When combined with consumer finance models, these have the potential to make the economics of clean cooking, energy efficiency, and distributed solar even more favorable.

The solutions we have identified necessitate involvement by diverse change agents in the urban space—municipal leaders, utilities, national and state leaders, international aid organizations and development agencies, the private sector, and CSOs. It is only through the coordinated actions of these actors that the energy needs of the urban under-served and the long-term environmental and economic interests of the city as a whole will be met.

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ENDNOTES

1. United Nations Department of Economic and Social Affairs, 2014.
2. World Bank, 2016.
3. World Bank, 2016.
4. World Bank, 2016.
5. Parikh et al., 2012.
6. World Bank, 2016.
7. World Health Organization, 2014.
8. World Bank, 2017.
9. These are the regional groupings of the Organisation for Economic Co-operation and Development (OECD).
10. Authors' analysis of the data from Erickson and Tempest, 2014.
11. Authors' analysis of the data from Erickson and Tempest, 2014.
12. Lim et al., 2013.
13. World Bank, 2016; Authors' calculations based on expert opinion of Kirk Smith, UC Berkeley School of Public Health, and Lim et al., 2013.
14. Sarkar and Singh, 2010; Lucon et al., 2014.
15. Chafe et al., 2014.
16. Authors' calculations based on analysis of World Bank, 2016, and Chafe et al., 2014.
17. Authors' calculations based on International Energy Agency (IEA), 2015, and Whiteman et al., 2016. Assuming a capacity factor of 0.21 and a derate factor (system loss) of 0.77. The numbers for the carbon intensity of the electric grids are for 2013, while the installed capacity data for solar PV are from 2015.
18. Lucon et al., 2014.
19. Coady et al., 2015.

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