Inequality of Opportunity in Asia and the Pacific

Clean Energy

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Economic and Social Commission for Asia and the Pacific

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Country abbreviations

AF	Afghanistan
AM	Armenia
AU	Australia
AZ	Azerbaijan
BD	Bangladesh
BN	Brunei Darussalam
BT	Bhutan
KH	Cambodia
CN	China
FJ	Fiji
PF	French Polynesia
GE	Georgia
GU	Guam
HK	Hong Kong SAR, China
IN	India
ID	Indonesia
IR	Iran, Islamic Republic of
JP	Japan
KZ	Kazakhstan
KI	Kiribati
KP	Korea, Democratic People's Republic
KR	Korea, Republic of
KG	Kyrgyzstan
LA	Lao People's Democratic Republic
MO	Macao SAR, China
MV	Maldives
MY	Malaysia
MH	Marshall Islands
FM	Micronesia, Federated States of
MN	Mongolia
MM	Myanmar
NR	Nauru
NP	Nepal
NC	New Caledonia
NZ	New Zealand
MP	Northern Mariana Islands
PK	Pakistan
PW	Palau
PG	Papua New Guinea
PH	Philippines
RU	Russian Federation
WS	Samoa
SG	Singapore
SB	Solomon Islands
LK	Sri Lanka
TL	Timor-Leste
TH	Thailand
TJ	Tajikistan
TM	Turkmenistan
TO	Tonga
TR	Turkey
TV	Tuvalu
VU	Vanuatu
UZ	Uzbekistan
VN	Viet Nam

About the Inequality of Opportunity papers

The ESCAP *Inequality of Opportunity* papers place men and women at the heart of sustainable and inclusive development. The papers do so by identifying seven areas where inequality jeopardizes person's prospects, namely: education; women's access to health care; children's nutrition; decent employment; basic water and sanitation; access to clean energy; and financial inclusion. Each of these opportunities are covered by specific commitments outlined in the 2030 Agenda for Sustainable Development and addressed in a separate thematic paper covering 21 countries throughout Asia and the Pacific.[i]

ESCAP first discussed inequality of opportunity in its 2015 report *Time for Equality* and established the distinction between inequality of outcome and inequality of opportunity. While the former depicts the consequences of unequally distributed income and wealth, the latter is concerned with access to key dimensions necessary for fulfilling one's potential.

The present papers build on the work of many scholars and the findings from *Time for Equality*.[1] It applies a novel approach to analysing household surveys with the aim of identifying the groups of individuals with the lowest access to the above-referenced opportunities. These groups are defined by common circumstances over which the individual has no direct control.

In addition to identifying the furthest behind, the *Inequality of Opportunity* papers also explore the gaps between in-country groups in accessing the key opportunities, as well as the extent to which these have narrowed or widened over time. These inequalities are then analysed to identify the impact and importance each key circumstance plays.

Ultimately, these findings are of direct use for generating discussion on transformations needed to reach the "furthest behind first" as pledged in the 2030 Agenda.

i All policy papers follow the same methodology, except for decent employment and political participation, where the available datasets did not include adequate questions.

1. Introduction and scope

As part of the 2030 Agenda for Sustainable Development, member States pledge to ensure access to affordable, reliable, sustainable and modern energy for all (SDG 7). As such, for the purposes of this policy paper, clean energy access is defined as: (1) access to electricity; and (2) primary reliance on clean fuels, in line with SDG targets 7.1.1 and 7.1.2. Following the WHO *Guidelines for Indoor Air Quality*, clean fuels include electricity, liquid petroleum gas (LPG), natural gas and biogas,[2] whereas dirty fuels burnt in open fires and leaky stoves include solids such as wood, crop wastes, charcoal, coal and dung.

"...close to half of all people in Asia and the Pacific still rely on traditional and inefficient fuels for cooking and heating, while one in ten still lack access to electricity"

At present, and despite economic progress in recent decades, close to half of all people in Asia and the Pacific still rely on traditional and inefficient fuels for cooking and heating, while one in ten still lacks access to electricity.[3]

Globally, the bottom 40 per cent of the population consume only 10 per cent of all energy, highlighting steep inequalities in both access and use.[4] Inequalities may also exist in the quality of service, for example, how many hours per day electricity is available in different households.

This variability in evaluating energy access is captured by the Multi-tier Framework (MTF) to monitor and evaluate energy access; a framework promoted by the UN Secretary General's Sustainable Energy for All (SE4All) initiative. The MTF moves beyond the traditional binary count (having access or not) and recognizes that having an electricity connection, for example, does not necessarily mean having adequate access to electricity. In other words, reliability and affordability also matter.

Energy access is thus measured with a tiered-spectrum, ranging from 0 to 5.[5] However, complete datasets for exploring gaps and inequalities following the MTF are not yet available. Therefore, the analysis of this policy paper relies on the two SDG indicators that can be derived from Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS).

The provision of clean fuels and electricity to households is complex and relies upon well-functioning markets, well-regulated state or private utilities, as well as household choices. These structural and institutional factors underpinning inequalities in access to clean energy are also beyond the scope of this policy paper.

Overall, the aim of this policy paper is: i) to outline why policymakers need to reduce inequality in access to clean energy; ii) to introduce a new way of analysing survey data by identifying the shared circumstances of those "furthest behind"; and iii) to analyse observed inequality by the relative contribution of each circumstance.

2. Why does inequality in access to clean energy matter?

Inequalities in accessing clean energy are concerning from both a socioeconomic and a resource management perspective. From a socioeconomic perspective, reliable and affordable energy services are fundamental to everyday life. As such, universal access to clean energy increases productivity, reduces health disparities, and bolsters gender equality and the inclusion of marginalized people. From a resource management perspective, eliminating the use of unclean fuels has a visible impact on environmental quality, in both urban and rural settings.

Over the past two decades, the Asia-Pacific region greatly increased electricity connectivity, particularly among rural communities. Still, more than 400 million people live in households without electricity. The progress has been slower for reliance on clean fuels with 50 per cent of the region's population relying on solid, unclean fuels for cooking and heating (Figure 1).[6]

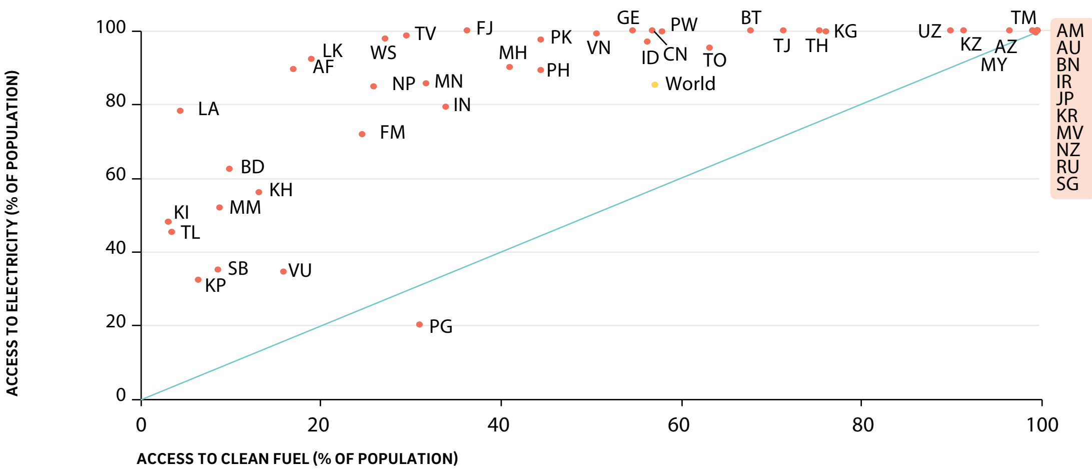
2.1
Productive activities rely on clean energy

Clean energy access benefits all household members by extending studying hours, cooling and heating homes, pumping water, as well as preserving food and medicine. Access also enables individuals to engage in home-based, income-generating activities and use modern technology. Use of clean fuels has additional benefits for women, in particular. For example, collection methods lock women into time consuming, dirty or dangerous fuel-collecting tasks, thereby compromising the productivity of a key household member.

As a result, access disparities advantage some households because they can devote more time to study, work or leisure, leading to overall productivity improvements. Inequality in accessing clean fuels and electricity thereby not only creates, but reinforces inequality gaps in both skills and productivity.

FIGURE 1

Access to electricity and access to clean fuels, 2014



Source: ESCAP calculations based on World Bank, World Development Indicators.

Subsequently, poorer communities with less access to clean energy are more likely to remain poor. This reciprocal relationship between lack of clean energy and chronic poverty elucidates the relevance of clean energy in addressing SDG 1 and ending poverty in all its forms everywhere by 2030.[7]

2.2
Clean energy is critical for health outcomes

Reliance on solid fuels negatively affects air quality in homes and their surrounding communities. As a result, inequality in access to clean energy perpetuates disparities in health outcomes among and within countries. In Asia and the Pacific, every other person relies on solids such as dung or wood to cook and heat their homes. Burning these fuels affects air quality both indoors and in the community.

Differences among countries in using clean fuels are reflected in the geographic clustering of health ramifications resulting from indoor air pollution (Figure 2). In low-and middle-income countries, for example, household air pollution is responsible for almost 10 per cent of total mortality, compared to only 0.2 per cent of all deaths in high-income countries.[8]

Globally, indoor air pollution causes more than 4 million deaths per year and more than half of these deaths occur in India and China alone.[9]

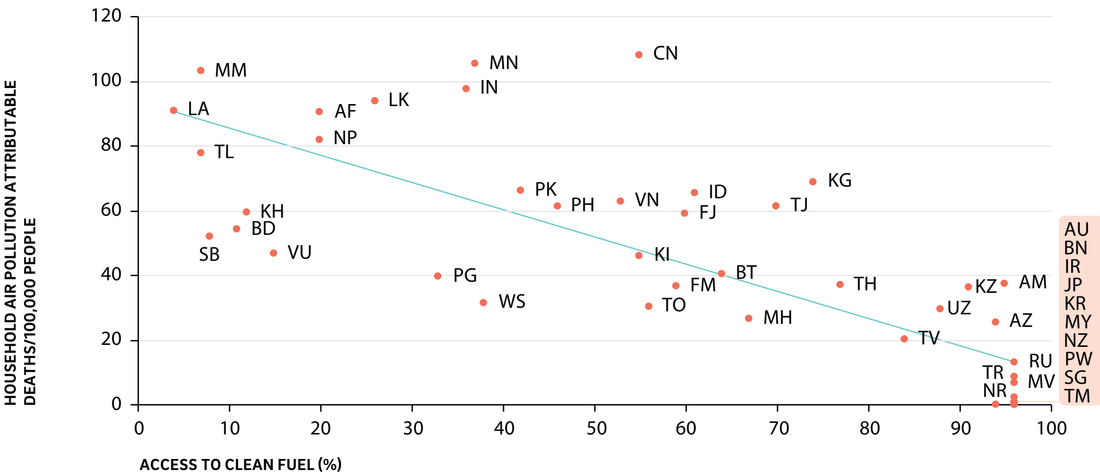
Health risks posed by indoor air pollution disproportionately affect the poorest and most vulnerable subpopulation groups within these countries. Specifically, indoor air pollution severely affects young children the most.

In Afghanistan, 44 per cent of all deaths attributed to household air pollution in 2012 occurred among children between 0 and 4 years of age.[ii] As such, the health consequences from unequal access to clean energy constitute major challenges for member States in ensuring healthy lives and promoting well-being (SDG 3).

Pollution from burning dirty fuels likewise affects everyone. Globally, 84 of the top 100 most polluted cities are in the Asia and the Pacific region. Bangladesh and India, in particular, are the two countries with the highest concentration of particulates in the world, a by-product of unclean household fuel consumption.[10]

FIGURE 2

Total household air pollution attributable deaths per 100,000 population and access to clean fuels, 2013



Source: ESCAP calculations based on World Bank, World Development Indicators.

ii ESCAP calculations based on data from the WHO.

2.3
Clean energy drives gender equality

Moving forward on achieving gender equality requires addressing the clean energy needs of every household member. Because women bear the brunt of household work and caretaker tasks they are disproportionally affected by lack of electricity and clean cooking fuels.[11] They also spend substantially more time per day cooking, and, as a result, suffer more from the health consequences associated with indoor air pollution.[12]

Women are also often in charge of collecting the resources for solid fuel. In India, for example, some women spend up to three hours per day collecting firewood.[13] Such activities severely restrict the amount of time they then have left to devote to other income-generating, productive or educational opportunities.

Fuel collection responsibilities also place women at a higher risk of physical injury and violence.[14] Availability of lighting at night, as well as access to radio or television, substantially improves women's safety and not only contributes to changes in gender roles, but also reduces levels of domestic violence.[15]

While achieving gender equality and empowering all women (SDG 5) is complex, access to clean energy plays a vital role in improving women's lives and health outcomes, as well as increasing their participation in employment and education.

2.4
Energy inequalities threaten the environment

Estimates show that energy production and consumption are responsible for significant greenhouse gas emissions.[16] Demand for energy is also projected to increase by 60 per cent between 2010 and 2035 because of continuing economic progress and population growth.[17]

In comparison to other energy sources, solid fuels are inefficient and must be used in higher quantities to attain similar energy levels. For example, liquefied petroleum gas (LPG) is between five to ten times more energy efficient than dung.[18] Moreover, black carbon particulates emanating from solid fuels are major pollutants.[19] In countries such as Mongolia, the coal industry is a major contributor of air pollution, especially during the winter.

A lack of access to clean and affordable energy likewise spurs deforestation due to the unsustainable practice of wood collection.[20] Deforestation, in turn, increases the burden on the poor, particularly women, who have to travel longer distances for fuel while also paying a higher price. Without concrete action, the World Bank estimates that the total number of people relying on solid fuels will remain unchanged by 2030.[21]

Ensuring that all households have access to clean energy, particularly those expected to increase their consumption levels, is therefore essential for the realization of the 2030 Agenda. A transition toward clean, reliable and sustainable energy sources is urgently needed to meet the projected increase in energy use and avoid detrimental environmental consequences.[22]

2.5
Energy inequalities distort policy outcomes

Many countries subsidize fossil fuels to protect the poor from rising fuel prices, but fail to achieve their goal.[23] These policies often ignore the fact that the poor consume less energy than the rich. As a result, fossil fuel subsidies disproportionally benefit middle- and higher-income households.

Removal of these subsidies has therefore become a policy focus at the national and international levels. SDG Target 12.c calls on Member States to "rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions". Indeed, the example from Indonesia shows how the gradual removal of the fuel subsidy allows for the reallocation of funds to social protection. As a result, estimates show that Indonesia's fuel subsidy reform in November 2014 accounted for 17.5 per cent of the decline in (income) inequality in 2015–2016.[24]

3. A new approach to identifying the furthest behind

A new methodological approach to ascertain the clean energy gaps is needed to meet the 2030 Agenda. This policy paper analyses household level data from both the *Demographic and Health Surveys* (DHS) and *Multiple Indicator Cluster Surveys* (MICS) for 20 countries in Asia and the Pacific to identify those most excluded from accessing clean energy.[iii]

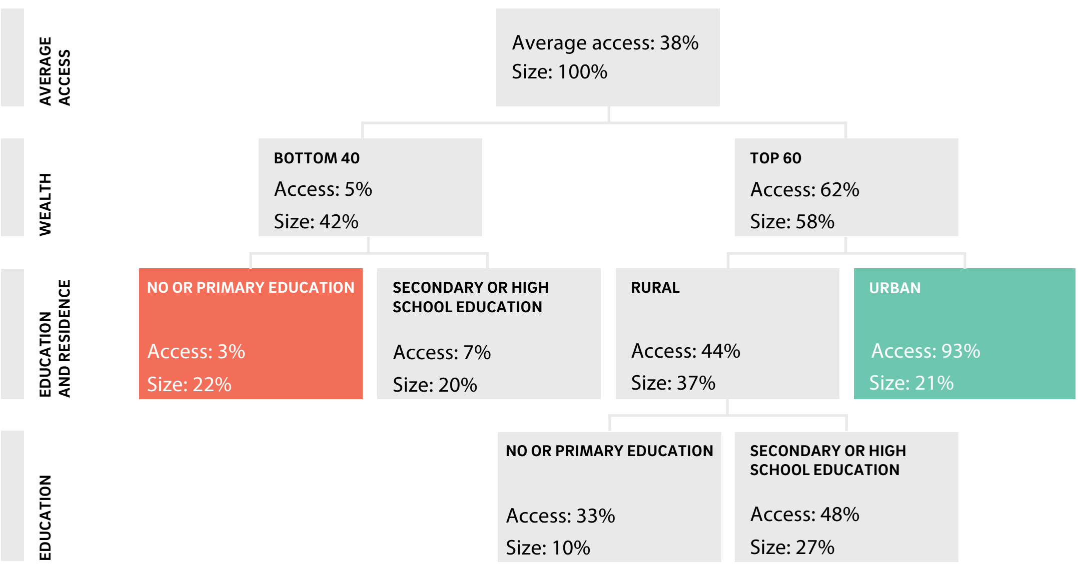
The policy paper uses two indicators to identify the groups with the lowest access to clean energy: access to electricity; and access to clean fuels. Using the classification tree approach, an algorithm splits the value of the target indicators into groups, based on predetermined circumstances, namely: household wealth (split into bottom 40 and top 60); residence (urban and rural); and highest level of educational attainment for any member in the household.[iv]

In each iteration, the classification tree ascertains significantly different groups and identifies those that are most and least advantaged in terms of access to electricity and clean fuels. These groups consist of households sharing common circumstances. Section 6 describes the additional impact of belonging to a minority or culturally marginalized group and repeats the analysis using religion or ethnicity as a shared circumstance for the few countries where these data are available.

Access to clean energy through household surveys requires using the household as the unit of analysis. The analysis therefore does not lend itself to age and sex-disaggregation, nor can it consider differences in household composition.

FIGURE 3

Classification tree highlighting differences in electricity access in Timor-Leste, 2010



iii The policy paper excludes Myanmar from the analysis due to lack of available data.

iv Please see Annex for a more detailed description of the methodology, as well as the selection of indicators and circumstances.

To illustrate how different household circumstances interact to produce a disadvantage (or advantage) in accessing electricity and clean fuels, two examples, from Timor-Leste and Vanuatu, are used.

For Timor-Leste, the first level of separation (split) is wealth (Figure 3). Households belonging to the bottom 40 of the wealth distribution have an access rate of only 5 per cent, compared to a rate of 62 per cent for households belonging to the top 60 of the wealth distribution.[v] The second split comes from education levels (in the bottom 40 group) and from residence (in the top 60 group). The third split comes from education, but is only significant when applied to one group: top 60 rural households.

In green, the tree shows the group that ultimately has the highest access (top 60, urban households) and in red it shows the group that has the lowest access (bottom 40 households, with no or only primary education levels).

Notably, in the group with the lowest access, residence in an urban or rural area does not matter as residence was not identified as a significant factor. Each of these groups with the highest (green box) and lowest (red box) levels of access make up around 20 per cent of all households in Timor-Leste.

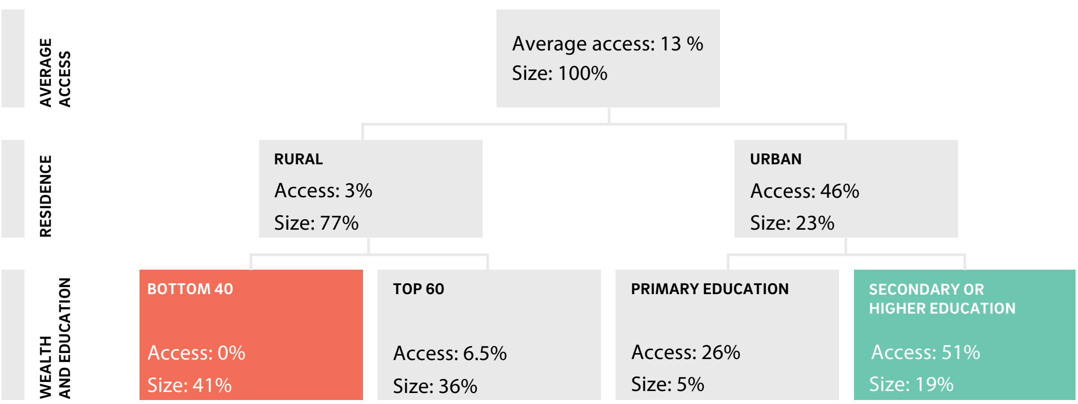
In Vanuatu, the first separation (split) of groups is residence, with 46 per cent of all urban households having primary reliance on clean fuels, compared to 3 per cent of rural households (Figure 4).

The second separator differs for each group. Among rural households, wealth plays the biggest role, while among urban households, having a higher level of education in the household matters.

There is no third separation, because no other factor was significant enough to generate an additional split into further subgroups. Again, the green box depicts how five out of ten urban households with a member completing secondary or higher education have access to clean fuels. Overall, that group represents 19 per cent of the population. The red box depicts how among the bottom 40 rural households, no one uses clean fuels. This group represents as much as 41 per cent of all households in Vanuatu.

FIGURE 4

Classification tree highlighting differences in clean fuels access in Vanuatu, 2007



v Please see Annex regarding the decision to use the bottom-40 top-60 split.

4. Who are those left behind?

Ample evidence demonstrates that many people in Asia and the Pacific are still being left behind. This reality contrasts starkly with the principle of universalism permeating the 2030 Agenda because ignoring or excluding certain groups from opportunities threatens long-term prosperity. In fact, realizing that they are being left behind, marginalized people get discouraged and disillusioned with the promise of progress, which reduces trust in national economic systems and political institutions.

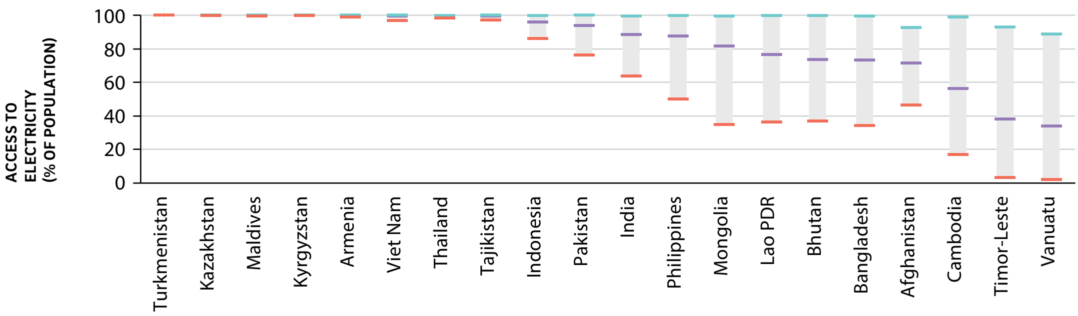
Policymakers therefore need to identify who is being left behind and make those groups, households and individuals the focus of their efforts. Only then can prosperity be shared and future socioeconomic stability protected.

4.1
How large are the gaps?

The tree analysis described in Section 3 allows researchers to compare gaps across countries. This analysis was used for 20 countries and the results are summarized in Figures 5 and 7. The upper lines of each bar represent the access rate of the most advantaged group (those with highest access) for each country. The lower lines represent the access rate of the most disadvantaged group (those with lowest access). The middle line is the average access by which countries are sorted. (The actual composition of the most advantaged or disadvantaged groups is discussed later in this Section).

FIGURE 5

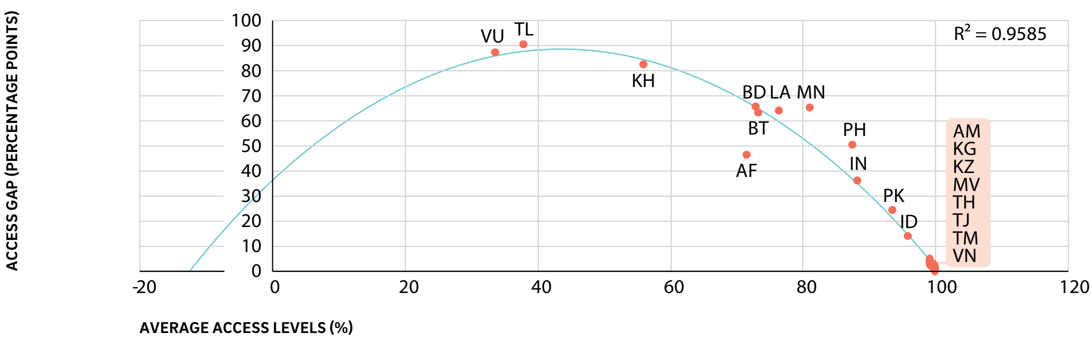
Gaps in accessing electricity within countries, latest year



Source: ESCAP calculations based on latest DHS and MICS surveys for countries in Asia-Pacific.

FIGURE 6

Electricity average access and access gaps, latest year



Source: ESCAP calculations based on latest DHS and MICS surveys for countries in Asia-Pacific.

As an example, in the Maldives, Thailand and Viet Nam, as well as in all countries from North and Central Asia, average electricity access is close to 100 per cent, with no substantial gaps between population groups (Figure 5). In contrast, Cambodia, Timor-Leste not only have the lowest average access rates, but also the highest gaps.

The relationship between average electricity access and the access gap can be further illustrated by using a binomial equation (Figure 6). The inverted U-pattern that is anticipated is not clearly observed because most countries already achieved at least 50 per cent of access to electricity on average and thereafter gaps decrease.

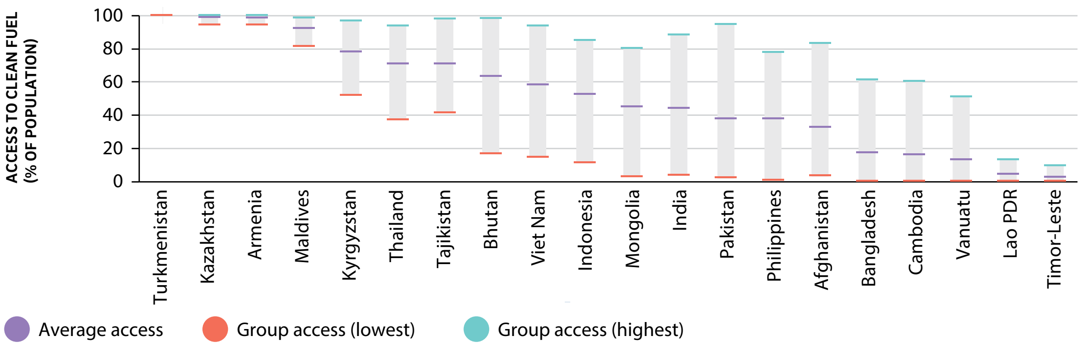
Nevertheless, Afghanistan stands out as a positive outlier in that the gap in accessing electricity is relatively lower compared to several other countries with similar average access (e.g., Bhutan, Bangladesh, and Lao People's Democratic Republic). In fact, those most disadvantaged in Afghanistan are not much worse off than their equivalent group in the Philippines, a country with far higher average access overall.

Average access rates to clean fuels are considerably lower than those found for electricity. The most disadvantaged groups also have significantly lower access. In fact, for half of the countries, less than 3 per cent of the most disadvantaged households rely on clean fuel (Figure 7). In general, the gap in access to clean fuels is lowest in countries with either very high or very low average access rates.

For this indicator, the binomial equation graph captures the relationship clearly (Figure 8). With a wider range of average access levels to clean fuels, the inverted U-shaped graph depicts this relationship (Figure 8). When average access is

FIGURE 7

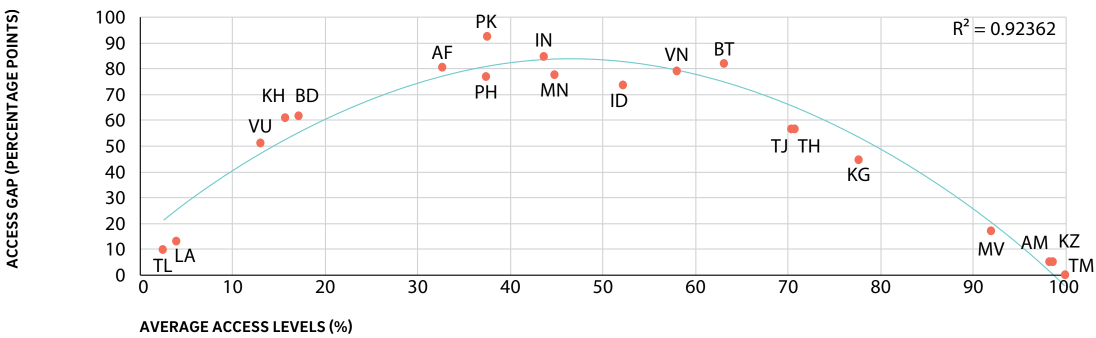
Gaps in accessing clean fuels within countries, latest year



Source: ESCAP calculations based on latest DHS and MICS surveys for countries in Asia-Pacific

FIGURE 8

Clean fuels average access and access gaps, latest year



Source: ESCAP calculations based on latest DHS and MICS surveys for 20 countries in Asia-Pacific low, the gaps are around 10 percentage points to 15 percentage points. When average access increases, gaps increase and can be as high as 90 percentage points. And as countries edge towards universal access, the gaps again move toward zero.

The graph also highlights countries with either higher or lower access gaps than their average rate would imply. Bhutan and Pakistan stand out where gaps are larger than predicted by their average access rates.

4.2 Identifying those left behind

Addressing gaps requires identifying the shared circumstances of those without access to clean energy. This Section narrows the paper's focus onto the most disadvantaged groups in each country to identify the circumstances they share. Although the circumstances of the most disadvantaged groups in each country are not the same across the 20 countries analysed, some commonalities are found.

Tables 1 and 2 list the composition of households (column 1) with lowest access rates (column 2), the size of the population represented (column 3) and the gap between the groups with the highest and lowest access (column 4).[vi] Only countries where the most disadvantaged group has an access rate below 95 per cent are included. This cut-off results in 12 countries for electricity and 17 countries for clean fuels.

In terms of access to electricity, being poorer and living in households with relatively lower levels of education are the main circumstances characterizing disadvantaged groups.[vii]

TABLE 1

The composition of those left behind in access to electricity

CIRCUMSTANCES OF THE MOST DISADVANTAGED GROUPS BY COUNTRY (1)	ACCESS LEVEL OF THE MOST DISADVANTAGED GROUP (2)	SIZE OF THE MOST DISADVANTAGED GROUP (3)	ACCESS GAP FROM MOST ADVANTAGED GROUP (PERCENTAGE POINTS) (4)
BOTTOM 40, RURAL HOUSEHOLDS WITH NO EDUCATION/PRIMARY EDUCATION			
Indonesia	86%	14%	14 pp
BOTTOM 40 HOUSEHOLDS WITH NO EDUCATION/PRIMARY EDUCATION ONLY			
Pakistan	76%	10%	24 pp
India	64%	13%	36 pp
Philippines	50%	11%	50 pp
Lao People's Democratic Republic	36%	24%	64 pp
Bangladesh	34%	19%	65 pp
Cambodia	17%	24%	82 pp
Timor-Leste	3%	22%	90 pp
RURAL HOUSEHOLDS WITH NO EDUCATION			
Afghanistan	46%	17%	46 pp
BOTTOM 40 RURAL HOUSEHOLDS			
Mongolia	35%	26%	65 pp
Vanuatu	2%	41%	87 pp
BOTTOM 40 HOUSEHOLDS			
Bhutan	37%	38%	63 pp

Source: ESCAP estimations based on latest DHS and MICS surveys for countries in Asia-Pacific.
Note: Only countries where access rate for the most disadvantaged population group was less than 95 per cent were included in the table. For a list of circumstances of the groups with highest access, the full classification trees can be made available upon request.

vi These tables do not show the composition of the most advantaged group (with the highest attainment rate) but this information can be made available upon request.

vii Seven out of the 12 countries listed in Table 1.

In Indonesia, a country with high average access to electricity, a compounding factor is rural living. The most disadvantaged group (poor, rural households with no, or only, primary education) still have an access rate of 86 per cent and make up 14 per cent of the population. The access gap is 14 percentage points, implying that the electricity access rate for the most advantaged group in Indonesia is exactly 100 per cent.

Overall, the analysis shows that residing in a rural area significantly lowers the probability of having access to electricity in only four countries: Afghanistan, Indonesia, Mongolia and Vanuatu. And although these countries face geographic challenges in expanding their electricity grids, in Afghanistan and Mongolia wealth also matters once household residence is accounted for. This finding suggests that, aside from availability, electricity access is also a question of affordability.

Access to clean fuels is generally lower and there are 17 countries in total, where the most disadvantaged groups have an access rate lower than 95 per cent (Table 2). Living in a rural household is the most common circumstance in determining the group with the lowest access in 13 of these countries.

"The interplay of geographical location (urban or rural residence) and household wealth illustrates that reliance on clean fuels is a question of both accessibility and affordability"

TABLE 2

The composition of those left behind in access to clean fuels

CIRCUMSTANCES OF THE MOST DISADVANTAGED GROUPS BY COUNTRY (1)	ACCESS LEVEL OF THE MOST DISADVANTAGED GROUP (2)	SIZE OF THE MOST DISADVANTAGED GROUP (3)	ACCESS GAP FROM MOST ADVANTAGED GROUP (PERCENTAGE POINTS) (4)
RURAL, BOTTOM 40 HOUSEHOLDS WITH NO EDUCATION/PRIMARY EDUCATION			
Indonesia	11%	14%	74 pp
Pakistan	2%	22%	93 pp
Timor-Leste	0%	39%	10 pp
RURAL, BOTTOM 40 HOUSEHOLDS WITH PRIMARY/SECONDARY EDUCATION			
Afghanistan	3%	28%	80 pp
Kyrgyzstan	52%	13%	45 pp
BOTTOM 40 HOUSEHOLDS WITH NO EDUCATION			
Maldives	82%	33%	17 pp
BOTTOM 40 HOUSEHOLDS WITH NO EDUCATION/PRIMARY EDUCATION			
Viet Nam	15%	11%	79 pp
India	4%	13%	85 pp
BOTTOM 40 HOUSEHOLDS WITH HIGHER EDUCATION			
Tajikistan	42%	13%	56 pp
RURAL BOTTOM 40 HOUSEHOLDS			
Thailand	38%	30%	56 pp
Mongolia	3%	26%	78 pp
Philippines	1%	29%	77 pp
Bangladesh	0%	37%	62 pp
Cambodia	0%	41%	61 pp
Lao People's Democratic Republic	0%	36%	13 pp
Vanuatu	0%	41%	51 pp
BOTTOM 40 HOUSEHOLDS			
Bhutan	17%	38%	82 pp

Source: ESCAP estimations based on latest DHS and MICS surveys for countries in Asia-Pacific.
Note: Only countries where access rate for the most disadvantaged population group was less than 95 per cent were included in the table. For a list of circumstances of the groups with highest access, the full classification trees can be made available upon request.

The interplay of geographical location (urban or rural residence) and household wealth illustrates that reliance on clean fuels is a question of both accessibility and affordability in most countries. Levels of education also matter for differentiating advantaged households. Education not only provides access to better jobs with higher incomes, it informs individuals about the significant health risks posed by the consumption of solid fuels.

In the cases of Indonesia, Pakistan and Timor-Leste, accessibility (living in rural areas), affordability (being in a poorer household) and knowledge (lack of education), intersect to severely restrict the adoption of clean fuels amongst disadvantaged households. In Pakistan, for instance, only 2 per cent of rural households belonging to the poorest 40 per cent, and with low education, rely on clean fuels for cooking and heating, compared to 95 per cent of the most advantaged group. In Bangladesh, Cambodia, Lao People's Democratic Republic, and Vanuatu, the rural poor have zero access to clean fuels.

4.3
Are the gaps in access to clean energy falling over time?

Access gaps have not reduced in all countries despite sustained growth. In general, economic growth and prosperity increases the average numbers of households with access to clean energy. This Section reviews whether progress made over time in countries for which the two different surveys were available also translated into progress for the most disadvantaged.

Notably, progress across countries is not fully comparable because the time lag between the two surveys spans from 7 years (in Thailand) to 22 years (in Pakistan). Therefore, the results need to be viewed under that light. Furthermore, the composition of the most disadvantaged group may vary between the two surveys.[viii]

That being said, if the claim that growth benefits everyone is correct, two achievements should be expected: that average access increases over time; and that the distance of the most marginalized group from the average will fall.[ix]

For electricity, this occurs in Indonesia, Pakistan and the Philippines; all of whom edged towards universal access in the period between the two surveys (Figure 9). In all three countries, the most disadvantaged groups moved closer to the mean, as shown by the falling percentage point difference from the mean between the later and earlier surveys.

Several countries in North and Central Asia, as well as Thailand, had already achieved almost universal access compared to earlier surveys. The two notable exceptions to this trend are Bangladesh and Cambodia, where the differences in access between the furthest-behind group and the average increased, and which more than doubled in Cambodia, from 16 to 39 percentage points.

With respect to clean fuels, average access also increased over time, albeit at a slower pace than electricity (Figure 10). Still, certain groups were left behind, with the percentage point distance of the most marginalized groups from the average increasing in Indonesia, Afghanistan and Cambodia.

Improvements in clean fuels reliance were greatest in Armenia and Kazakhstan, where huge strides were taken in providing clean fuels access for the entire populations. In Thailand, despite comparably lower progress in the shorter period between the two surveys, improvements in clean fuels access were also shared by disadvantaged and advantaged population groups alike.

viii A full list of the classification trees that reveals the composition of all groups is available upon request and will be posted on the ESCAP website soon.

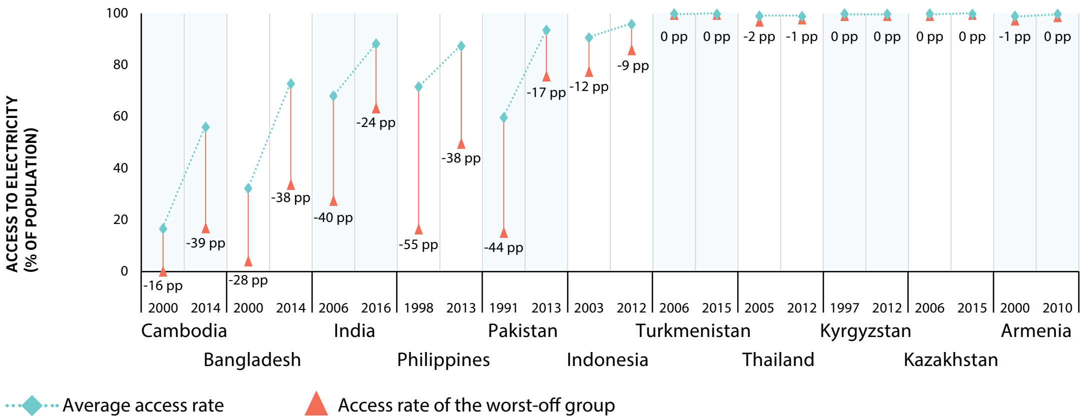
ix It is important to note that the most disadvantaged group, which has the lowest access, always represents at least 10 per cent of the sample population since this is a requirement set in the classification tree analysis (see Annex).

Neither the reasons behind these improvements nor the contributions to delays in progress are the subject of this policy paper. Noting the trend of marginalization in a few countries, however, proves that policy and institutions matter and that development alone does not suffice to benefit everyone.

Countries such as Armenia and Kazakhstan started with higher overall levels of development and a culture of universalism in the provision of services. Consequently, when household incomes rose and markets developed, all households were able to switch to cleaner fuels because the structures and institutions supported this transition. In other countries, like Indonesia, strong average progress still left portions of the population behind.

FIGURE 9

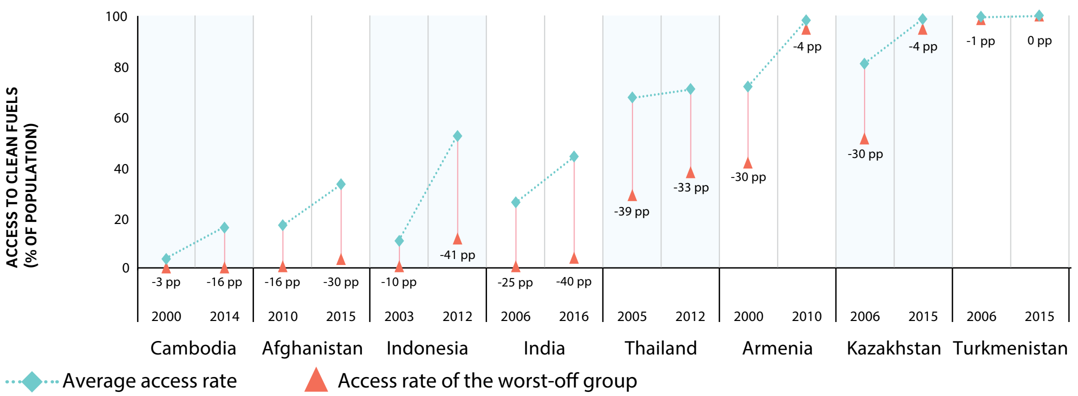
Distance of the worst-off group from the average in access to electricity, earliest and 2010s



Source: ESCAP calculations based on latest DHS and MICS surveys for countries in Asia-Pacific.
Note: "Average" is the average rate of access in respective year. Access rate of the most disadvantaged group is the access rate of the least advantaged group in the respective year – and the size and composition of that group may vary from year to year. "pp" stands for percentage points.

FIGURE 10

Distance of the worst-off group from the average in access to clean fuels, earliest and 2010s



Source: ESCAP calculations based on latest DHS and MICS surveys for countries in Asia-Pacific.
Note: "Average" is the average rate of access in respective year. "Access rate of the most disadvantaged group is the access rate of the least advantaged group in the respective year; the size and composition of which may vary from year to year. "pp" stands for percentage points.

5. Understanding overall inequality in access to clean energy

Beyond identifying the most disadvantaged groups, this Section calculates overall levels of inequality in accessing clean energy as experienced by all population groups in a given country. The calculated inequality can then be decomposed by circumstances, thereby capturing the individual impact on inequality of opportunity for every country. Policymakers can likewise follow this analysis in identifying factors aggravating inequality in their country.

BOX 1

Calculating the Dissimilarity Index

The dissimilarity index, or D-index, measures how all different population groups fare in terms of accessing clean energy. For example, two countries with identical average access rates may have a very different D-index if the distribution of access in one country excludes certain groups (such as poorer groups, or ethnic minorities). To obtain the D-index, inequalities in access among all possible population groups are calculated using the following equation:

$$D = \frac{1}{2\bar{p}} \sum_{i=1}^{n} \beta_i \left| p_i - \bar{p} \right|$$

where β_i is the weighted sampling proportion of group i, (sum of β_i equals 1), $\bar{p}$ is the average access rate in the country and p_i is the level of access of population group i, and takes values from 0 to 1. There are n number of groups defined by using the interactions of the circumstances selected for the analysis.

Three circumstances are used to determine the number and composition of the population groups: wealth (2 groups); residence (2 groups); and education (4 groups). This produces n=16 groups (2x2x4), covering the entire sample population.

5.1 Calculating overall inequality

The first step to measuring overall inequality is identifying all possible population groups and their access levels. The Dissimilarity Index (D-index) is then determined by taking the access distances for each of these groups and comparing them to the average access level for each country (see Box 1). The calculated D-index represents the overall inequality in access to clean energy.

> "...two countries with identical average access rates may have a very different D-index if the distribution of access in one country excludes certain groups"

5.2 Where is overall inequality highest?

Research shows that overall inequality in access to electricity is highest in countries with low, average access. For example, Vanuatu and Timor-Leste have the highest inequality in access to electricity, as shown by a high D-index (Figure 11). Armenia, Kyrgyzstan, Tajikistan, Turkmenistan, as well as Maldives, Thailand and Viet Nam all have a D-index close to zero. Indonesia and Pakistan also have low D-indexes, below 0.05 (5 per cent), however low D-indexes say little about the quality of electricity service. For instance, it is common knowledge that access to electricity in both Indonesia and Pakistan is intermittent and unreliable in both rural and urban settings.[25]

Inequality in access to clean fuels is substantially higher than access to electricity, with D-indexes reaching 0.7 in Timor-Leste, 0.6 in Lao People's Democratic Republic and Vanuatu and 0.5 for Bangladesh (Figure 12). Notably, these results stand in contrast with Timor-Leste and Lao People's Democratic Republic where research finds the smallest gaps between the most disadvantaged and advantaged groups (Figure 7).[x]

"Wealth determines more than half of the inequality for electricity in most countries"

5.3
What circumstances matter more in accessing clean energy?

Building on the calculation of the D-index, the contribution of each of the circumstances to inequality is estimated. This analysis follows a methodology called the Shapley decomposition (Box 2). From a policymaking perspective, understanding these patterns is useful for informing energy priorities, particularly if the goal is to "leave no one behind".

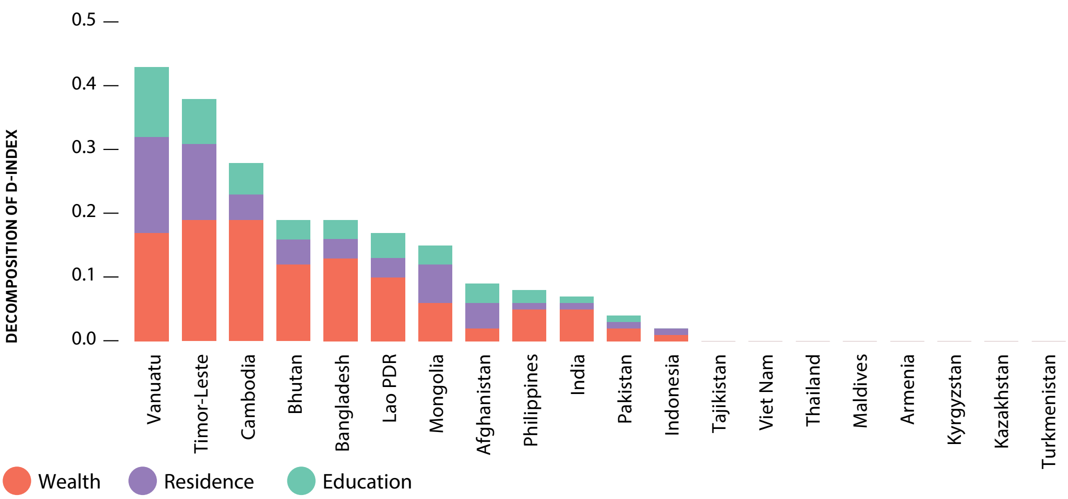
As measured by the D-index, the relative contribution that specific circumstances make to overall inequality in access to electricity does not vary much across the region. Wealth (belonging to the bottom 40 and as shown by the dark red portion in Figure 11) determines more than half of the inequality for electricity in most countries. The only exception is Vanuatu, where rural living plays an equally significant role along with the highest level of education in the households.

"...residence matters most for having access to clean fuels"

The picture is more varied in terms of accessing clean fuels (Figure 12). In 8 out of 20 countries, residence matters most for having access to clean fuels. These also happen to be the countries with the lowest average access, where clean fuels may not only be unavailable in some rural areas, but household technology/appliances may not yet support the use of clean fuels.

In 7 out of 20 countries, on the other hand, wealth mattered the most. In these countries, average access levels were higher so it is affordability, not distance from an urban centre that is the determining factor. The contribution of education to inequality in clean fuels is generally

FIGURE 11
Inequality in access to electricity and its decomposition, latest year

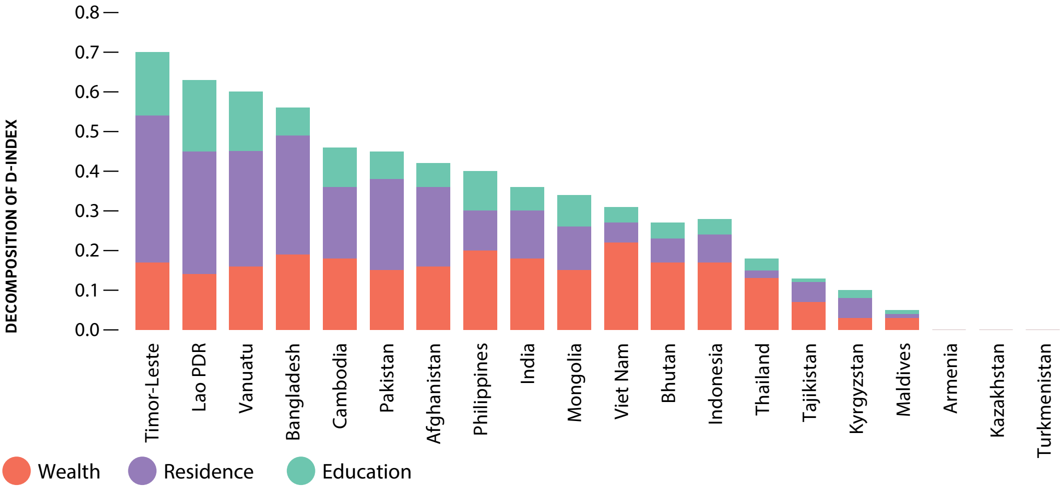


Source: ESCAP calculations using data from the latest DHS and MICS surveys for countries in Asia-Pacific.

x This discrepancy is present because the calculation formula of the D-index "penalizes" countries with lower average access. See Box 1.

FIGURE 12

Inequality in access to clean fuels and its decomposition, latest year



Source: ESCAP calculations using data from the latest DHS and MICS surveys for countries in Asia-Pacific.

less important. Knowing which circumstance contributes more toward inequality can guide policymakers toward the most effective areas of intervention.

5.4
How does each circumstance contribute to determining access?

In order to bolster the analytical findings, logistic regressions were conducted to observe the effects of circumstance variables (household wealth, residence and education) on a household's access to clean energy.

The logistic regression model for each country is given by:

$$logit(p_i) = \log\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_{2+} \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5$$

Where p_i stands for $P(y=1)$ and y is a binary response variable which assumes two values:

$$y = \begin{cases} 1, & if\ a\ household\ has\ access\ to\ electricity\ (clean\ fuel) \\ 0, & if\ a\ household\ has\ no\ access\ to\ electricity\ (clean\ fuel) \end{cases}$$

and

where $\beta_0..n$ are logit model coefficients and $X_1..n$ are circumstance variables, i.e. X_1 is household wealth, X_2 is household residence, and X_3–X_5 is the highest education level in the household, and can represent primary, secondary or higher education.

The base references used in the model are households belonging to the bottom 40 per cent in terms of wealth, rural households and households with no education.[xi]

The results show that households coming from the top 60 of the population have a higher chance of having access to clean energy. For instance, in the case of Bangladesh, the odds of having access to electricity for a top 60 household are 27 times the odds for a bottom 40 household.

For residence, results indicate that the odds of having access to electricity or clean fuels are higher for urban households compared to their rural counterparts. In the case of Bangladesh, the odds for an urban household of having access to electricity is two times the odds of a rural household.

xi A total of 40 logistic regressions (20 for access to electricity and 20 for clean fuels reliance) are summarized in Table A3 and Table A4.

BOX 2

Shapley decomposition

The Shapley decomposition method estimates the marginal contribution of each circumstance to inequality in accessing clean energy. The basic idea behind this decomposition, taken from cooperative game theory, is measuring how much the estimated D-index would change when a circumstance was added to the pre-existing set of circumstances. The change in inequality caused by the addition of a new circumstance would be a reasonable indicator of its contribution to inequality.[xii]

The impact of adding a circumstance A (e.g. wealth) is given by the following formula:

$$D_A = \sum_{S \subseteq N\{A\}} \frac{|S|!(n-|S|-1)!}{n!} [D(S \cup \{A\}) - D(S)]$$

Where N is the set of all n circumstances; and S is the subset of N circumstances obtained after omitting the circumstance A. D(S) is the D-index estimated with the sub set of circumstances S. D(SU{A}) is the D-index calculated with set of circumstances S and the circumstance A.

The contribution of characteristic A to the D-index is then formula:

$$M_A = \frac{D_A}{D(N)}$$

The critical property satisfied by the Shapley decomposition is that the sum of contributions of all characteristics adds up to 1 (100 per cent).

Finally, households whose heads had completed primary, secondary or higher education were found more likely to have access to clean energy, as compared to households with no education. In the example of Bangladesh, once more, the calculated odds ratios are 1.21, 1.75 and 2.39, respectively, hence, increasing steeply with the level of education. This indicates that the odds of having access to electricity are 21 per cent, 75 per cent and 139 per cent higher for households with primary, secondary and higher education, as compared to the odds of households with no education. For the full list of estimates, please see the Annex.

xii Shorrocks, Anthony F. Decomposition procedures for distributional analysis: a unified framework based on the Shapley value. *Journal of Economic Inequality*, Vol. 11, Issue 1 (Dec. 2013).

6. Does ethnicity matter for determining the furthest behind?

In many countries marginalized groups are also defined by a non-dominant, common ethnic or religious identity. However, there is a general lack of survey data detailing how ethnicity and religious characteristics shape inequality and create marginalized pockets within countries.

Nine countries covered in this policy paper included questions on ethnicity, language, or religion in their MICS, thereby opening a small, but unique window to understanding these interactions. Repeating the classification tree analysis to include ethnicity, religion and language as circumstance variables alters the composition of the furthest behind groups in four countries (Tables 3 and 4). These results are also confirmed in the regression analysis results provided in the Annex.

In Viet Nam, ethnicity does not play a role in determining access to electricity. For clean energy however, ethnic minorities are disadvantaged and only 5 per cent of poorer (bottom 40) minority households having access, as compared to poorer households from the majority Kinh ethnicity with 20 per cent average access.

In Kazakhstan, the 2006 survey revealed that poorer (bottom 40) Kazakhs had lower access to clean fuels than poorer households from Russian or from other minority ethnicities (Table 4). This gap disappeared however, from the latest survey (2015). The most marginalized group now consists of poorer, rural households with low education. And even among those households, only 4 per cent do not have access to clean fuels (96 per cent have access).[xiii]

In Lao People's Democratic Republic, access to electricity rates for poorer animist households (believing in ghosts) is 20 percentage points lower than for poorer Buddhist or "other minor religion" households.

TABLE 3
Access to electricity for different groups

	CIRCUMSTANCES AND ACCESS RATE OF THE MOST MARGINALIZED LINGUISTIC/ETHNIC/RELIGIOUS MINORITY (1)	CIRCUMSTANCES AND ACCESS RATE OF A LESS MARGINALIZED LINGUISTIC/ETHNIC/RELIGIOUS MINORITY (2)	CIRCUMSTANCES AND ACCESS RATE OF A LESS MARGINALIZED LINGUISTIC/ETHNIC/RELIGIOUS MINORITY (ADDITIONAL) (3)
Afghanistan (2010)	Poorer Pashto-speaking: 6.3%	Poorer Uzbek/Turkmen-speaking: 12%	Poorer Dari-speaking: 27%
Lao People's Democratic Republic (2011)	Poorer Animist: 34%	Poorer Buddhist or other minor religion: 54%	n/a

Note: pink colour if the most marginalized group and the most marginalized ethnic/religious minorities are identical.

TABLE 4
Access to clean fuels for different groups

	CIRCUMSTANCES AND ACCESS RATE OF THE MOST MARGINALIZED LINGUISTIC/ETHNIC/ RELIGIOUS MINORITY (1)	CIRCUMSTANCES AND ACCESS RATE OF THE LESS MARGINALIZED LINGUISTIC/ETHNIC/ RELIGIOUS MINORITY (2)
Afghanistan (2010)	Rural non-poor Pashto, Uzbek and Turkmen-speaking: 4.7%	Rural non-poor Dari-speaking: 15%
Kazakhstan (2006)	Poorer Kazakh with low education: 42%	Poorer Russian or other minor ethnicity: 64%
Viet Nam (2013)	Poorer minor ethnicity: 4.9%	Poorer Kinh: 20%

Note: Ibid.

xiii The full list of classification trees depicting all the changes is available upon request.

Finally, for all four countries where ethnicity or religion matter, coming from a poor household remains a common, significant circumstance for determining access to electricity and clean fuels, even when factoring in additional variables. Notably though, the impact of ethnicity or religion disappears among the advantaged groups.

6.1
So what's the impact on overall inequality?

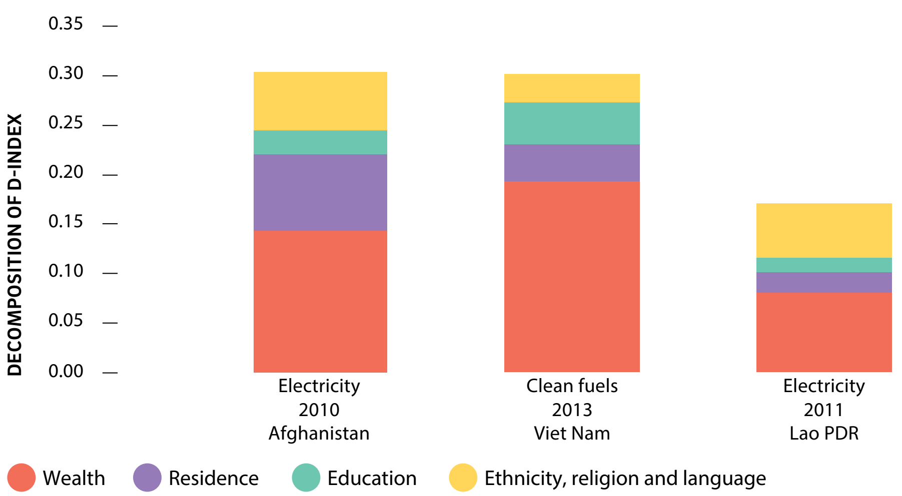
The analysis in this Section shows that ethnic marginalization can be both partly concealed and partly compounded by economic, social or geographical circumstances. Recalculating the decomposition of inequality, including the circumstances of ethnicity, religion and language, confirms these findings. Household wealth still matters most in shaping inequality (Figure 13). However, ethnicity is the second most importance circumstance in the Lao People's Democratic Republic and third in Afghanistan.

What this analysis does not show is that geographic isolation and historical dispossession of ancestral lands makes energy access among indigenous groups particularly difficult, thereby forcing the use of unsustainable and highly-polluting biomass and biofuels.[26] But even these forms of energy are often under threat. Where deforestation is rampant, firewood becomes scarce. In addition to lacking access to clean energy, indigenous groups and ethnic minorities are often negatively impacted by large electricity production projects, from which they don't always benefit.

> "...indigenous groups and ethnic minorities are often negatively impacted by large electricity production"

This brief assessment indicates the additional negative impact belonging to a minority may have on access to opportunities across Asia-Pacific, in this case clean energy. It also reveals the general lack of comparable, reliable and consistently collected data on these population groups and the need to include them to a much larger degree into future data collection efforts. This is, however, also the case for migrants, slum dwellers and other difficult to reach groups.

FIGURE 13
The role of ethnicity, religion or language in shaping inequality in clean energy, latest year



Source: ESCAP calculations using data from the latest DHS and MICS surveys for countries in Asia-Pacific.

7. Recommendations for closing the gaps

Countries in the region face a range of challenges in providing universal access to clean energy. While some countries are drastically improving the distribution of clean energy, others are struggling with little to no change.

> "With 2 billion people in Asia and the Pacific deprived of access to clean fuels, and hundreds of millions lacking electricity...policymakers need to take resolute, prompt action to close existing access gaps"

With 2 billion people in Asia and the Pacific deprived of access to clean fuels, and hundreds of millions lacking electricity, people's health and wellbeing, as well as their opportunities for education and productive work, are negatively impacted. Importantly, improvements for gender equality and the environment are likewise restrained. Therefore, policymakers need to take resolute, prompt action to close existing access gaps.

This policy paper demonstrates that those at the bottom end of the spectrum, i.e., poor and rural households with low levels of education, still lack access to electricity and primarily rely on solid fuels for heating and cooking. To meet SDG 7.1, countries should seek to extend access to clean and affordable energy in an equitable manner by prioritizing disadvantaged groups.

Energy demand in Asia and the Pacific is growing at a fast pace and is projected to surpass that of any other region.[27] Efforts to transition towards universal access to clean and affordable energy must then surmount this additional challenge. Policies to increase access should be understood within this context.

The following are key considerations for policymakers when designing regulatory and other applicable policies to clean energy access initiatives:

1. **Identify the shared common circumstances shaping household choices to accessing clean energy.** Unequal access to clean energy is strongly linked to unequal outcomes in other development objectives (e.g. lower education). Understanding the key circumstances shaping household choices is therefore paramount to addressing not only energy inequalities, but others as well.

2. **Explore the social, economic and cultural reasons for localized disparities in clean energy access.** In communities with minimal access to clean energy, multi-stakeholder consultations are necessary for understanding household motivations and decisions. Research demonstrates that one household may keep burning dirty fuels, while a neighbouring family, perhaps with slightly higher education or from a different ethnic group, instead invests in cleaner fuels. Hence, it is important to understand the nuances restricting some households from making "better" choices.

3. **Prioritize collaboration among government ministries and agencies to strengthen household incentives for choosing clean energy sources.** Given the diversity of circumstances impacting household decisions, cross-sectoral and inter-ministerial coordination is imperative to creating opportunities for households to invest in clean energy.

4. **Strengthen data collection efforts to understand how energy deficits impact individual household members.** Existing data do not allow for a full understanding of household choices, behaviours or subsequent inequalities arising among and within households. Granular data are therefore necessary for dissecting how different members of a particular household cover their clean energy needs, as well as the consequences for failing to do so.

5 **Provide public regulatory structures and monitoring bodies with the resources and skills necessary for assessing household access gaps and determining why they exist.** Reliable electricity access depends on quality infrastructure and investment decisions usually made by power producers and distributors. Understanding why some households have access and others do not could generate valuable information for a profit-maximizing company. The State and its regulatory authorities could therefore monitor which households are excluded from access and partner with private companies to understand and address the reasons.

6 **Incentivize private service providers to target the specific energy needs of women.** Despite women being primarily responsible for ensuring the availability of fuels for cleaning, cooking and other purposes, existing data conceal the gender dimensions of energy inequality within household units. Although progress in women's empowerment exposed many of these inequalities, Asia-Pacific, along with the global community, still has a long way to go before reaching true gender equality. Information campaigns and targeted marketing strategies could help influence men's and women's attitudes toward reversing gender stereotypes.

7 **Improve national energy policies to avoid aggravating inequalities.** Fossil fuel subsidies are enacted in many countries in the region with the aim of protecting the poor. However, these subsidies are regressive because they often ignore the actual energy consumption patterns of the poorest households. Policy will be more effective if subsidies are removed and the resources are redirected to empowering the least advantaged households.

8 **Encourage initiatives undertaken by civil society, local and indigenous communities to move toward clean energy.** Local and indigenous communities are increasingly turning toward renewable energy sources, often with the help of civil society. Such movements are addressing energy poverty while maintaining indigenous independence and environmental values. Governments therefore need to understand community motivations and encourage these initiatives.

Annex: Methodology for identifying gaps in access to opportunities

Inequality of Opportunity

To measure inequality of opportunity, this policy paper series on *Inequality of Opportunity* identify a set of opportunities and measures the gaps among different population groups in access to these opportunities. To do so, a set of circumstances is selected from available variables in the DHS and MICS datasets to define the groups. The circumstances are conditions over which the individuals or households have no control.

In this policy paper, those circumstances are used in the classification tree analysis to identify the groups that are most disadvantaged in each country; in this case, meaning those who have the least access to clean energy. The composition of those groups varies from country to country, as does the size of the sample population they represent.

This approach differs from the use of "inequality of opportunity" in other recent literature, which instead uses regression analysis to explain the share of inequality of outcome (income inequality or consumption inequality) that can be attributed to circumstances over which individuals have no control, such as race and sex.

Given that the DHS and MICS datasets do not include information on income or consumption (both classified as outcomes), these policy papers do not include such regressions. However, future analysis might use the wealth index of the DHS and MICS as a proxy "outcome" and regress it against the set of circumstances used in this analysis.

The data sources

This analysis in this series uses the *Demographic and Health Surveys* (DHS) and the *Multiple Indicator Cluster Surveys* (MICS). DHS and MICS are publicly available for 21 Asian and Pacific countries as shown in Table 1.[xiv] The DHS and MICS datasets are selected because of: a) the comparability across countries; b) the accessibility of the data; and c) the extensive questions on health, demographic and basic socioeconomic data referencing both the household (e.g., water and sanitation, financial inclusion, electricity and clean fuels, ownership of mobile phones) and individuals (e.g., level of education, nutrition status).

The countries

Based on available surveys, 20 out of 21 countries are included in this policy paper on clean energy. The policy paper does not include Myanmar due to lack of data. Ten countries have surveys representing two different points in time, all of which include questions on electricity and seven of which include questions relating to clean fuels. Table A1 provides the full list of 21 countries and their survey years (latest and earliest).

The indicators and circumstances

The indicators depicting inequality in access to clean energy are access to electricity and clean fuels reliance. As reported by the Interagency Group on SDG Indicators (IAEG-SDGs), their connection to the Sustainable Development Goals (SDGs) were the main criterion for selecting these indicators.[xv] The circumstances used are residence (rural or urban), wealth (belonging to the bottom 40 or top 60) and highest education level in the household (no education, primary, secondary and higher education) (Table A2).

The classification tree analysis

The primary goal of the household survey analysis is identifying the groups with the lowest and highest access to clean energy by using the two selected indicators. The indicators can be seen as "response variables", while the factors characterizing the groups are defined as "circumstances".

xiv Access to the DHS datasets for three additional Pacific countries has been requested and the requests are still under consideration.

xv The latest indicators to be used for monitoring the SDGs can be found at: https://unstats.un.org/sdgs/iaeg-sdgs/.

TABLE A1
List of countries and survey years

COUNTRY	EARLIEST YEAR	EARLIEST SURVEY	LATEST YEAR	LATEST SURVEY
Afghanistan	2010	MICS	2015	DHS
Armenia	2000	DHS	2010	DHS
Bangladesh	2000	DHS	2014	DHS
Cambodia	2000	DHS	2014	DHS
India	2006	DHS	2016	DHS
Indonesia	2003	DHS	2012	DHS
Kazakhstan	2006	MICS	2015	MICS
Kyrgyzstan	1997	DHS	2012	DHS
Lao PDR	2000	MICS	2011	MICS
Mongolia	2000	MICS	2013	MICS
Pakistan	1991	DHS	2013	DHS
Philippines	1998	DHS	2013	DHS
Thailand	2005	MICS	2012	MICS
Turkmenistan	2006	MICS	2015	MICS
Viet Nam	2000	MICS	2013	MICS
Bhutan	n/a	n/a	2010	MICS
Maldives	n/a	n/a	2009	DHS
Myanmar	n/a	n/a	2000	MICS
Tajikistan	n/a	n/a	2012	DHS
Timor-Leste	n/a	n/a	2010	DHS
Vanuatu	n/a	n/a	2007	MICS

The analysis then uses a classification tree model to identify the groups with highest or lowest access. A classification tree is an analytical structure representing groups of the sample population with different response values, or different levels of access to a certain opportunity.

Consider the following example:

Opportunity: Clean Energy
Indicator ("response variable"): "Access to electricity".
Factors ("circumstances"): The circumstances being considered are the following:
1. Residence (urban vs. rural);
2. Household wealth (Bottom 40 or Top 60);
3. Highest education level in the household (No Education, Primary, Secondary, Higher).

To identify the groups with the highest or lowest access to clean energy, a classification tree is constructed for each country, using R, an open source statistical software. The root node of the tree is the entire population sample. The tree method algorithm starts by searching for the first split (or branch) of the tree. It does so by looking at each circumstance and separating the sample in two groups, so that it achieves the most "information reduction". This information metric can be defined in a few ways, while the most common one – and the one used in this analysis is the "entropy".[28]

The tree representation

A tree method is an algorithm that estimates the accessibility of clean energy by partitioning the household into different groups based on the household circumstances chosen:

$$p(Y_i = 1 \| X_{1i}, X_{2i}, ..., X_{li}) = \sum_{j=1}^{m} p_j \times I((X_{1i}, X_{i2}, ...X_{li}) \in A_j)$$

Where Y_i is the observed opportunity for the i-th household in the sample, X_{1i}, ..., X_{li} are the circumstances for the household. In the example of clean energy, Y is the access to clean energy, X_1, X_2, X_3 (where l = 3) are residence, household wealth level and highest education level of household members, three circumstances of the household from the survey. A_1, A_2, ... A_m are the different partitions of the sample, also called end nodes, where:

$A_i \cap A_j = \emptyset$ and $\cup_{i=1}^{m} A_i = \Omega.$

This means the end nodes are mutually exclusive and complementary, and every household belongs to one and only one of the end nodes. I () only takes value 1 when the i-th household belongs to j-th end node, otherwise, I () takes value 0. The tree algorithm generates the end nodes, according to metrics that measure the effectiveness of the partition that gives to different levels of access to clean energy.

Information theory and entropy is a very common choice for the metrics. Entropy for j-th end node can be calculated according to the definition:

$$I_E(p_j) = -(p_j \times log_2 p_j + (1 - p_j) \times log_2(1 - p_j))$$

The aggregated entropy for the tree is calculated by:

$$H(T) = \sum_{j=1}^{m} q_j \times I_E(p_j)$$

Where q_j is the sample proportion of A_j. The actual algorithm that generates the end-nodes works step-by-step, starting from the entire sample. Each time the sample is partitioned, new end-nodes are generated and the entropy is calculated and compared to the entropy before the new partition. Each partition (and hence the new end nodes) is kept when the increment of entropy is bigger than a pre-set threshold. The algorithm stops when no more increment of entropy can be made through a new partition, or a set of present conditions can't be satisfied.

In addition to finding groups that have **significant differences** in their access to electricity, the classification tree algorithm also operates under the limitation that each group should have **enough group members**. To avoid a too small sub-sample size, the analysis has set the tree nodes to have a minimum size of at least 10 per cent of the total population and the split of tree is only made when an "information reduction" criterion is satisfied.

In Section 6, which introduces ethnicity and religion as a circumstance, the minimum size of the population group criterion is reduced to 5 per cent of the population to fully capture minority religions and ethnicities.

Choice of circumstances

Out of the many variables available in the DHS and MICS surveys, several determinant factors are considered to help identify the most excluded groups. The selection of variables is consistent across all surveys to maintain comparability across countries.

The classification tree includes these factors in the tree as branches only if they are found to reduce entropy. Ultimately, these circumstances (determinant factors) define the composition of the groups. However, circumstances should not be interpreted as "causes" of inequality. The association found does not imply causality. Furthermore, there are many other factors that these models cannot consider, because of the limitations of the datasets.

Ideally, it would have been preferred to include only circumstances over which a household member has very little control, such as the dominant religion in a household, ethnicity, existence of a disability, or the education of the mother or father of the respondent. The majority of the DHS did not ask these questions. Some MICS, however, did ask questions related to ethnicity, language and religion and the results are presented in Section 6.

Additional factors of interest for study are geographical variables, such as province or city in a given country, but inclusion would have affected comparability across countries. Geographic variables can be analysed in future work focusing on one country only.

Gaps and limitations

The available datasets limit the scope of this analysis somewhat. First, several relevant circumstances cannot be captured. For example, distance from a source of clean fuel is an important circumstance that might shape a household's use of the clean source.

Furthermore, and consistent with similar studies on inequalities among groups, this analysis does not consider inequality within groups.[29] Even within homogenous groups, additional unobserved circumstances, or different levels of effort, may affect outcomes. This analysis only calculates observable average access to opportunity for each group, and thus draws conclusions on gaps and inequality based on these average observations.

Because data on access to clean energy is collected at the household level, the analysis also does not reflect inequality experienced within households. Importantly, the gender dimensions of energy inequality are currently concealed and sex-disaggregated data cannot be produced for household-related questions.

Finally, recent literature on inequality of opportunity also links inequality of outcome with inequality of opportunity, by calculating the share of income inequality (inequality of outcome) that can be explained by the circumstances of each group.[30] The analysis in this series of policy papers does not follow the same approach because the datasets do not include an income proxy besides the wealth index.

The wealth index and the bottom 40–top 60 wealth split

Wealth, as used in this policy paper, is a composite index reflecting a household's cumulative living standard that is developed by the DHS and MICS researchers and combines a range of household circumstances including: a) ownership of household assets, such as TVs, radios and bicycles; b) materials used for housing; and c) type of water and sanitation facilities.

The wealth index is calculated using the Principal Component Analysis and thus allows a relative ranking of households based on their assets.[xvi] The wealth index is not comparable across countries, however, as it consists of different assets in each country. Cross-country comparison of household access based on "wealth" should be understood with that caveat.

In this series, the wealth index is employed as a circumstance to distinguish between different types of households. Although technically not a circumstance over which households have no control, wealth is still a proxy for many hidden conditions that may limit access to a certain opportunity, especially considering the lack of other determinant factors to explore, such as education of mother or father, ethnicity, prevalence of a disability or migrant status.

In this policy paper, households can belong to one of two possible groups based on the wealth index: the bottom 40 (sometimes labelled as "poorer") and the top 60.

Several other possible cuts of the wealth index were considered, including by quintile, top 40–bottom 40, and top 10–bottom 40. These options were not selected however, because generally they produce more homogenous groups, thus overshadowing other circumstances (e.g. education levels, rural/urban distinctions). The top 40–bottom 40 approach (and its variation of top 10–bottom 40) were also rejected because they eliminate 20 to 50 per cent of the sample population from the analysis, with a risk of missing some "middle class" groups with common characteristics (e.g. secondary education).

Narrowing the sample population to only half (top 10–bottom 40) also runs the risk of not allowing for making statistically significant inferences. Moreover, neither the top node, or root, of the tree, nor the size of the groups of the rest of the nodes would be representative of the population.

Finally, the wealth index in the DHS and MICS produces a distribution of households by wealth, without any monetary values assigned to the distribution. Therefore, the comparisons of top 10–top 40 per cent do not have the same explanatory value as they would if the wealth index had taken continuous monetary values.

TABLE A2

Selected indicators and factors

OPPORTUNITY STUDIED				FACTORS USED TO DETERMINE EXCLUDED GROUPS			SDG REFERENCE	SURVEY REFERENCE		
	OPPORTUNITY COMPONENT	INDICATOR	REFERENCE (TARGET) GROUP IN SURVEY	FACTOR 1	FACTOR 2	FACTOR 3	RELATED SDG INDICATOR	SURVEY QUESTION IN DHS/MICS	DESCRIPTION	SURVEY RECODE
1	Energy	Electricity	All households	Wealth (Bottom 40 - Top 60)	Residence (Urban/ Rural)	Highest Education	7.1.1 Proportion of population with access to electricity	Does your household have electricity?		HH*
2	Energy	Clean fuels	All households	Wealth	Residence	Highest Education	7.1.2 Proportion of population with primary reliance on clean fuels and technology	What type of fuel/energy does your household mainly use for cooking?	Clean fuel includes natural fuel (e.g. compressed natural gas or liquefied petroleum gas) or a blend (e.g. gasohol) used as substitutes for fossil fuels and which produces less pollution than the alternatives	HH*

Note: *household

xvi For more information see Demographic and Health Surveys (DHS) http://www.dhsprogram.com/programming/wealth%20index/DHS_Wealth_Index_Files.pdf

TABLE A3

Logit model results: Access to clean fuels

DHS	AFGHANISTAN			ARMENIA			BANGLADESH			CAMBODIA			INDIA			KYRGYZSTAN		
	(1)			(2)			(3)			(4)			(5)			(6)		
	Coeff.	SE	OR	Coeff.	SE	OR	Coeff.	SE	OR	Coeff.	SE	OR	Coeff.	SE	OR	Coeff.	SE	OR
(Intercept)	-3.74***	0.07		14.58	395.6		-9.12***	0.73		-8.95***	0.76		-3.72***	0.02		-0.1	0.75	
RicherHousehold	2.03***	0.05	7.646	3.4***	0.73	30.097	6.23***	0.71	508.3	6.3***	0.71	543.909	3.31***	0.01	27.299	0.54***	0.06	1.708
ResidenceUrban	2.21***	0.04	9.156	1.77***	0.3	5.855	2.47***	0.06	11.809	1.66***	0.05	5.243	1.87***	0.01	6.464	1.96***	0.09	7.084
HighestEduPrimary	0.33***	0.06	1.40	-12.00	395.60		-0.01	0.21		0.51*	0.28	1.68	-0.21***	0.03	0.813	0.58	0.89	
HighestEduSecondary	0.60***	0.06	1.83	-11.93	395.60		-0.01	0.20		0.97***	0.28	2.64	0.06***	0.02	1.062	0.13	0.75	
HighestEduHigher	0.99***	0.07	2.71	-11.59	395.60		0.60***	0.20	1.83	1.75***	0.28	5.77	0.77***	0.02	2.168	0.63	0.75	

DHS	INDONESIA			MALDIVES			PAKISTAN			PHILIPPINES			TAJIKISTAN			TIMOR-LESTE		
	(7)			(8)			(9)			(10)			(11)			(12)		
	Coeff.	SE	OR	Coeff.	SE	OR	Coeff.	SE	OR	Coeff.	SE	OR	Coeff.	SE	OR	Coeff.	SE	OR
(Intercept)	-2.88***	0.12		0.67***	0.12		-4.04***	0.12		-5.18***	1.12		1.02	0.82		-37.41	821.54	
RicherHousehold	2.18***	0.03	8.848	3.01***	0.24	20.344	3.07***	0.08	21.48	3.56***	0.10	34.992	1.57***	0.07	4.803	16.43	382.03	
ResidenceUrban	0.79***	0.02	2.205	-0.67**	0.33	0.512	2.34***	0.05	10.334	1.27***	0.05	3.552	2.42***	0.12	11.24	2.14***	0.22	8.461
HighestEduPrimary	0.68***	0.12	1.97	1.37***	0.16	3.94	0.07	0.14		0.43	1.12		-1.08	0.98		14.80	727.31	
HighestEduSecondary	0.97***	0.12	2.64	1.21***	0.13	3.37	0.13	0.12		0.60	1.12		-1.35*	0.82	0.26	15.84	727.31	
HighestEduHigher	0.86***	0.12	2.37	1.38***	0.31	4.01	0.60***	0.12	1.83	1.50	1.12		-1.38*	0.82	0.25	17.20	727.31	

MICS	BHUTAN			KAZAKHSTAN			LAO PDR			TURKMENISTAN			VIET NAM		
	(1)			(2)			(3)			(4)			(5)		
	Coeff.	SE	OR	Coeff.	SE	OR	Coeff.	SE	OR	Coeff.	SE	OR	Coeff.	SE	OR
(Intercept)	-1.51***	0.35		3.37***	0.27		-35.98	701		37.16	7837.04		-1.76***	0.11	
RicherHousehold	3.55***	0.05	34.824	2.26***	0.31	9.586	16.98	310.06		-15.13	5924.40		3.56***	0.07	35.097
ResidenceUrban	1.86***	0.12	6.44	0.91***	0.26	2.479	17.06	628.7		-16.71	5130.44		0.35***	0.07	1.418
HighestEduPrimary	-0.16	0.35		-0.1	0.38		-0.91***	0.15	0.401	20.24	17438.49		0.00	0.12	
HighestEduSecondary	0.38	0.37		0.08	0.29		-0.32 **	0.16	0.728	19.94	6459.86		0.04	0.13	
HighestEduHigher	0.52	0.37		0.51	0.33		0.53***	0.14	1.695	20.71	6347.74		0.1	0.13	

MICS	MONGOLIA			THAILAND			VANUATU		
	(6)			(7)			(8)		
	Coeff.	SE	OR	Coeff.	SE	OR	Coeff.	SE	OR
(Intercept)	-3.07***	0.1		-0.01	0.06		-19.43	360.91	
RicherHousehold	2.32***	0.05	10.14	2.78***	0.04	16.189	16.63	360.91	
ResidenceUrban	1.7***	0.05	5.482	-0.02	0.04		2.33***	0.18	10.269
HighestEduPrimary	-0.67***	0.11	0.512	-0.21***	0.06	0.808	-0.83***	0.19	0.436
HighestEduSecondary	-0.23 **	0.11	0.798	-0.06	0.08		0.25	0.15	
HighestEduHigher	0.2 **	0.09	1.219	0.00	0.07		1.42 ***	0.19	4.152

Source: UNESCAP elaboration based on DHS and MICS household surveys.
Notes: 1. Latest year available for each country. 2. Base references are poorer household, rural household, and no education.
Coeff. = Coefficient, SE = Standard Error, OR = Odds Ratio.
*** 1% level of significance
** 5% level of significance
* 10% level of significance

TABLE A4

Logit model results: Access to electricity

DHS	AFGHANISTAN			ARMENIA			BANGLADESH			CAMBODIA			INDIA			MALDIVES		
	(1)			(2)			(3)			(4)			(5)			(6)		
	Coeff	SE	OR	Coeff	SE	OR	Coeff	SE	OR	Coeff	SE	OR	Coeff	SE	OR	Coeff	SE	OR
(Intercept)	1.30***	0.05		20.90	3041.52		-0.98***	0.09		-1.98***	0.13		0.46***	0.01		4.09***	0.44	
RicherHousehold	0.03***	0.03		1.8 **	0.74	6.04	3.32***	0.06	27.797	2.7***	0.05	14.916	3.58***	0.02	35.821	20.12	1960.53	
ResidenceUrban	1.23***	0.04	3.43	-0.98	0.72		0.71***	0.06	2.029	2.05***	0.07	7.788	0.7***	0.02	2.004	-2.45 **	1.15	0.086
HighestEduPrimary	0.51***	0.04	1.66	-0.22	3314.96		0.19*	0.10	1.21	0.02	0.14		0.18***	0.01	1.196	19.97	3565.00	
HighestEduSecondary	0.85***	0.04	2.34	-13.83	3041.52		0.56***	0.10	1.75	0.47***	0.13	1.61	0.71***	0.01	2.036	2.52***	0.72	12.44
HighestEduHigher	1.32***	0.06	3.76	-13.66	3041.52		0.87***	0.11	2.39	0.87***	0.16	2.39	0.86***	0.02	2.36	0.43	1.09	

DHS	KYRGYZSTAN			INDONESIA			PAKISTAN			PHILIPPINES			TIMOR-LESTE			TAJIKISTAN		
	(7)			(8)			(9)			(10)			(11)			(12)		
	Coeff	SE	OR	Coeff	SE	OR	Coeff	SE	OR	Coeff	SE	OR	Coeff	SE	OR	Coeff	SE	OR
(Intercept)	17.97	2025.02		0.63***	0.07		1.06***	0.07		-0.85***	0.27		-3.81***	0.12		15.13	440.51	
RicherHousehold	1.16**	0.56	3.182	3.3***	0.13	27.151	3.22***	0.27	24.954	3.98***	0.16	53.493	3.06***	0.07	21.351	3.35***	0.56	28.481
ResidenceUrban	-0.23	0.62		1.41***	0.07	4.078	1.69***	0.2	5.411	0.21***	0.07	1.236	1.73***	0.06	5.65	0.54	0.56	
HighestEduPrimary	-0.25	2352.70		0.66***	0.08	1.94	0.79***	0.11	2.21	0.75**	0.28	2.12	0.00	0.12		-12.64	440.51	
HighestEduSecondary	-12.52	2025.02		1.26***	0.08	3.51	1.10***	0.11	3.01	1.78***	0.28	5.95	0.76***	0.11	2.13	-12.09	440.51	
HighestEduHigher	-12.37	2025.02		1.38***	0.12	3.99	1.71***	0.20	5.54	2.31***	0.28	10.10	1.59***	0.15	4.91	-11.46	440.51	

MICS	BHUTAN			KAZAKHSTAN			TURKMENISTAN			VIET NAM			LAO PDR		
	(1)			(2)			(3)			(4)			(5)		
	Coeff	SE	OR	Coeff	SE	OR	Coeff	SE	OR	Coeff	SE	OR	Coeff	SE	OR
(Intercept)	-0.18	0.35		24.69	5763.75		56.29	12550.64		3.06***	0.29		-1.13***	0.12	
RicherHousehold	3.13***	0.06	22.83	18.64	1824.54		-14.71	3895.04		2.6***	0.52	13.522	3.45***	0.07	31.571
ResidenceUrban	2.65***	0.2	14.146	-1	0.77		-16.56	3419.28		1.56***	0.52	4.751	2.85***	0.12	17.286
HighestEduPrimary	-0.48	0.35		-19.71	5763.75		-0.45	15559.13		0.49	0.31		-0.48***	0.1	0.617
HighestEduSecondary	-0.83**	0.37	0.437	-17.38	5763.75		-0.76	12080.34		2.43***	0.76	11.4	-0.23 *	0.14	0.791
HighestEduHigher	-0.72 *	0.37	0.488	-0.78	6172.62		-18.19	11430.49		2.18***	0.77	8.808	0.04	0.21	

MICS	MONGOLIA			THAILAND			VANUATU		
	(6)			(7)			(8)		
	Coeff	SE	OR	Coeff	SE	OR	Coeff	SE	OR
(Intercept)	-0.14	0.13		4.01***	0.22		-3.96***	0.3	
RicherHousehold	3.87***	0.13	47.729	1.34***	0.17	3.807	3.6***	0.3	36.629
ResidenceUrban	2.66***	0.08	14.31	0.25 *	0.15	1.289	2.19***	0.12	8.956
HighestEduPrimary	-0.64***	0.13	0.528	-0.08	0.23		-1***	0.15	0.368
HighestEduSecondary	-0.52***	0.14	0.595	0.23	0.32		0.12	0.15	
HighestEduHigher	-0.25 *	0.13	0.781	-0.01	0.27		0.77***	0.23	2.168

Source: UNESCAP elaboration based on DHS and MICS household surveys.
Notes: 1. Latest year available for each country. 2. Base references are poorer household, rural household, and no education.
Coeff. = Coefficient, SE = Standard Error, OR = Odds Ratio.
*** 1% level of significance
** 5% level of significance
* 10% level of significance

References

1 Roemer, John and Trannoy, Alan. Equality of Opportunity: Theory and Measurement. *Journal of Economic Literature*, Vol. 54, No. 4 (December 2016). Atkinson, Anthony B. and Bourguignon, Francois, eds. *Handbook of Income Distribution*, Vol. 2., North Holland, 2016. Ferreira, Francisco H.G. and Gignoux, Jeremie (2011). The Measurement of Inequality of Opportunity: Theory and an Application to Latin America. *Review of Income and Wealth*, Vol. 57, No. 4 (December 2011). Ooghe, Erwin, Schokkaert, Erik and Van de gaer, Dirk. Equality of Opportunity Versus Equality of Opportunity Sets. *Social Choice and Welfare*, Vol. 28, No. 2 (February 2007).

2 World Health Organization. *WHO Indoor Air Quality Guidelines: Household Fuel Combustion – Review 5: Population levels of household air pollution and exposures*. Geneva, 2014.

3 United Nations, Economic and Social Commission for Asia and the Pacific. *Regional Cooperation For Sustainable Energy in Asia and the Pacific*. Sales No. E.17.II.F.10. Asian Development Bank. *Access to Energy and ADB Energy Issues*. Available from https://www.adb.org/sectors/energy/issues/access-energy.

4 International Institute for Applied Systems Analysis. Energy Inequality, 24 July 2014. Available from http://www.iiasa.ac.at/web/home/research/alg/energy-inequality.html.

5 Energy Sector Management Assistance Programme. *Multi-tier Framework for Measuring Energy Access*. Available from https://www.esmap.org/node/55526.

6 United Nations, Economic and Social Commission for Asia and the Pacific (2017). Statistical Database. Available from http://data.unescap.org/escap_stat/.

7 World Health Organization. Ambient Air Pollution: a global assessment of exposure and burden of disease. Geneva, 2016.

8 World Health Organization. Ambient Air Pollution: a global assessment of exposure and burden of disease. Geneva, 2016.

9 United Nations, Economic and Social Commission for Asia and the Pacific. *Regional Cooperation For Sustainable Energy in Asia and the Pacific*. Sales No. E.17.II.F.10.

10 Health Effects Institute. *State of Global Air 2017: A Special Report on Global Exposure to Air Pollution and Its Disease Burden*. Boston, 2017.

11 Sanay Habtezion. United Nations Development Programme. Gender and Energy. Gender and Climate Change: Asia and the Pacific, Policy Brief, Vol. 4, 2013.

12 Sovacool, Benjamin. Energy Access and Energy Security in Asia and the Pacific. ADB Economics Working Paper Series, Vol. 383 (December 2013).

13 United Nations Development Programme. *Human Development Report 2007/08 – Fighting climate change: Human solidarity in a divided world*. New York, 2007.

14 World Health Organization. *Fuel for Life: Household Energy and Health*. Geneva, 2006.

15 Haves, Emily. Does energy access help women? Beyond anecdotes: a review of the evidence, May 2012. Available from https://www.ashden.org/downloads/files/Ashden_Gender_Report.pdf.

16 United Nations. SDG 7: Affordable and Clean Energy: Why it matters, 7 Aug 2016. Available from http://www.un.org/sustainabledevelopment/wp-content/uploads/2016/08/7_Why-it-Matters_Goal-7_CleanEnergy_2p.pdf.

17 Asian Development Bank. *Energy Outlook for Asia and the Pacific 2013*. Manila, 2013.

18 Barnes, Douglas F. and Floor, Willem M. Rural Energy in Developing Countries: A challenge for economic development. *Annual Review of Energy and the Environment*, Vol. 21 (Nov. 1996).

19 World Health Organization. Household air pollution and health, Feb. 2016. Available from http://www.who.int/mediacentre/factsheets/fs292/en/.

20 Velumail, T. Regional Context for Improving Access to Energy: Energy for Creating and Sustaining Livelihoods. Presentation to the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) and International Fund for Agricultural Development (IFAD) inception workshop Leveraging Pro-Poor Public-Private-Partnerships for Rural Development. Bangkok, 2012.

21 World Health Organization. Household air pollution and health, Feb. 2016. Available from http://www.who.int/mediacentre/factsheets/fs292/en/.

22 United Nations, Economic and Social Commission for Asia and the Pacific. *Regional Cooperation For Sustainable Energy in Asia and the Pacific*. Sales No. E.17.II.F.10.

23 United Nations, Economic and Social Commission for Asia and the Pacific. Enhancing regional cooperation for sustainable energy in Asia and the Pacific, 73rd Commission Session. 5 April 2017. E/ESCAP/73/7.

24 United Nations, Economic and Social Commission for Asia and the Pacific. Report of the Strategic Dialogue on Poverty and Inequality, 5–6 October 2017. Bangkok, 2017 (Forthcoming).

25 Kiran Stacey and Henny Sender. Glimmer of Light in Pakistan's blackout crisis. *Financial Times*, 30 April 2017. Apriadi Guawan. Indonesia putting an end to power crises one province at a time. *The Jakarta Post*, 6 June 2017.

26 Guruswamy, Lakshman, ed. *International Energy and Poverty: The Emerging Contours*, New York, 2016.

27 United Nations, Economic and Social Commission for Asia and the Pacific. Enhancing regional cooperation for sustainable energy in Asia and the Pacific. 5 April 2017. E/ESCAP/73/7 (https://www.unescap.org/commission/73/document/E73_7E.pdf)

28 Kelleher, John D., Brian Mac Namee, Aoife D'Arcy. *Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies*. The MIT Press Cambridge, Massachusetts.

29 Ferreira, F and Gignoux, J. (2011). The Measurement of Inequality of Opportunity: Theory and Application to Latin America. *Review of Income and Wealth*. International Association for Research in Income and Wealth.

30 European Bank for Reconstruction and Development. *Transition Report 2016-17: Transition for All: Equal Opportunities in an Unequal World*. London, 2017.

Inequality of Opportunity in Asia and the Pacific: Clean Energy

Reducing inequality in all its forms is at the heart of the 2030 Agenda for Sustainable Development. It is emphasized in the stand-alone Goal 10 "Reduce inequality within and among countries" and in other Goals that call for universality and for "leaving no one behind". Reducing inequality advances human rights and social justice and is fundamental for all three dimensions of sustainable development.

The ESCAP *Inequality of Opportunity* policy papers identify seven basic opportunities where inequality jeopardizes a person's life prospects, namely: education; women's access to health care; children's nutrition; decent work; basic water and sanitation; access to clean energy; financial inclusion. Each of these opportunities are covered by specific commitments outlined in the 2030 Agenda for Sustainable Development and addressed in a separate thematic paper covering some 22 countries throughout Asia and the Pacific.

This paper on Inequality of Opportunity in Clean Energy explores gaps between in-country groups in electricity access and use of clean fuels, as well as the extent to which these gaps have narrowed or widened over time. In addition to identifying the furthest behind, inequalities are also analysed to identify the relative contribution of each underlying circumstance. Ultimately, these findings are of direct use for generating discussion on transformations needed to reach the "furthest behind first" as pledged in the 2030 Agenda.

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