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Estimating the Number of Women Household Biomass Producers, the Largest Segment of the Global Energy Labor Force

By **Philippe Benoit** and **Siyuan Ding**

January 2024

REPORT

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Philippe has managed over 50 publications in the areas of clean energy, development and climate change while at the IEA and the World Bank. He holds a J.D. from Harvard Law School, a B.A. in economics and political science from Yale University, and a masters in trade law from the University of Paris.

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Executive Summary

While tens of millions of people work in formal energy jobs around the world, another group that comprises a massive and key labor segment in this sector is often overlooked: women and girls producing biomass to meet the basic energy needs of millions of poorer households across the developing world. Some 2 billion people rely on biomass for cooking (and some for heating), making those who gather it critical players in the global energy supply system. Women and girls in many developing countries constitute the majority of people collecting fuelwood for household consumption—an often strenuous and time-consuming effort—and estimating their number could elevate the importance attached to improving their working and living conditions. While some initial estimates of this labor force have been made, analyses remain superficial.

This report, part of ongoing research into energy for development and gender dynamics at the Center on Global Energy Policy at Columbia University SIPA, attempts to improve this deficit, providing a systemic albeit rough estimation—given minimal available data—of the number of women household biomass producers. An analysis of clean cooking access rates, population figures, and average household sizes for both rural and urban areas in 92 developing countries estimates that 389 million women and girls undertake this work, which would represent the largest labor segment of today's global energy system.

Additional findings from this report include the following:

- Women household biomass producers outnumber men. While there is parity between men and women in what the authors categorize as Developing Asia, women have higher participation rates in sub-Saharan Africa. The participation rate of men exceeds that of women in Latin America, but that region accounts for only 4 percent of the global population relying on household biomass.
- For every person producing and distributing energy in the world's formal job sector (approximately 40 million), the authors estimate that about nine women are supplying a primary energy source for their households.
- Most women biomass producers—about 75 percent of the total—live in rural areas, often the poorest parts of many developing countries.
- Clean cooking initiatives could obviate the need for much of this labor and are important, in part due to health considerations for people cooking with biomass fuels. While projections

about the dissemination of clean cooking technologies indicate that the number of women producing household biomass should decline this decade, around 200 million, or possibly more, could still be involved in this pursuit in 2030, predominantly in sub-Saharan Africa.

- Household biomass production constitutes the labor of poor and frequently marginalized women. More field research is needed to discover what these producers actually want and how the energy transition can improve their lives and those of their families.

Introduction

Women produce a critical source of energy used in hundreds of millions of homes across the world: biomass.[1] This energy source is relied upon by about 2 billion people for cooking,[2] and is also used by some for heating. Unfortunately, this is an energy source with significant negative impacts, particularly for women. For example, it is estimated that the use of biomass in traditional cook stoves leads to the deaths of millions from indoor air pollution.[3] It also requires women to toil for hours a week, often collecting and transporting heavy loads.[4]

This paper addresses a closely related topic for which attention has been lacking: understanding the size of the women biomass producer labor force. Estimating the number of women and girls who produce biomass for household consumption (such as gathering fuelwood)[5] could elevate the importance attached to improving the working and living conditions of these energy producers.

Various recent analyses have examined the number of energy workers, including in connection with the clean energy transition (e.g., the number of coal miners potentially adversely affected by coal plant closures) and with gender. According to recent analyses by the International Energy Agency (IEA), for example, more than 40 million people work in the formal segments of energy production and distribution.[6] This figure includes almost 8 million in oil supply, about 6 million in coal supply, and 4 million in gas supply. Power generation employs around 11.3 million, while electricity transmission, distribution, and storage combined account for approximately 8.5 million. The end use sectors employ another 25 million, including about 11 million in energy efficiency, bringing the total to 65 million.

Women are underrepresented in these workforces. Women hold less than 25 percent of jobs in the oil and gas industry[7] and less than one-third in the renewables sector.[8] When it comes to managerial and other decision-making positions, the share of women is even lower. In response, various programs have been launched in the formal, professional segments of the industry to increase women's participation[9] by raising awareness about the need for more women in the sector, building support networks of women practitioners,[10] and giving visibility to women already working in energy.

But this focus on addressing underrepresentation in the formal segments of the sector—a very important effort—can generate the misperception that women are not active in producing the world's energy. Instead, millions of women worldwide are producers of biomass, a form of bioenergy.

While we have data for energy's formal sector, including on the participation of women, we lack

comparable data for household biomass production. Would collecting such data, revealing the large women biomass workforce, potentially result in greater attention from energy experts and other specialists? While some initial estimates have been made (including by an author of this paper),[11] analyses remain superficial.

This report attempts to provide a more systemic estimation, albeit one that is still preliminary and incomplete given the minimal available data. It begins by reviewing previous efforts to compile numbers around the women biomass workforce before detailing the authors' methodology for arriving at a more granular, though still rough, estimate. The report finds that women household biomass producers represent the largest labor segment of today's global energy system, at just under 400 million, and that their numbers are not likely to diminish soon.

Efforts to Quantify Labor in Household Biomass Production

Recent reports have aggregated and analyzed the amount of labor that goes into producing household biomass. For example, the IEA found in its 2023 report on clean cooking that households without access to clean cooking technologies across sub-Saharan Africa average two hours per day collecting fuel.[12] This estimate varies in different contexts from one to five hours per day on average.

The World Bank reported recently that across most of sub-Saharan Africa women are the primary fuelwood collectors, and the Global Alliance for Clean Cookstoves found a similar situation in parts of South Asia.[13] The work involves gathering and carrying loads of wood that can weigh 50 to 100 pounds,[14] at times for 20 or more hours per week.[15]

As these various figures reflect, collecting firewood and otherwise preparing biomass used for household energy is generally a laborious and time-consuming effort. And, as with any activity, the time spent carries opportunity costs associated with alternative uses of that time, when available, such as paid employment or education, etc.[16] But while gathering and hauling household biomass is frequently done without compensation, it is an important and visible part of the global energy supply chain for the 2 billion people estimated in this report—25 percent of the world's population—who rely on it for the most basic human function: eating.

Methodology

Determining how many women and girls work in collecting biomass energy for household use presents a number of data challenges. Part of the difficulty arguably lies in the fact that women household producers tend to come from the poorest parts of their societies, where robust data collection and surveys are often lacking. A preliminary estimate of this women workforce by one of the authors had put the number at about 300 million.[17] But this estimate was based on global-level figures related to lack of access to clean cooking, household size, and women's participation rates. This report takes a more granular approach, using the most recent country-level data for clean cooking access, in both rural and urban areas, as well as country-specific household size data. Consequently, it provides a more robust, though still very rough, estimate.

This report relies on a top-down approach that draws from available data on the lack of access to clean cooking technologies. Our dataset encompasses the clean cooking access rate, population figures, and average household sizes for both rural and urban areas in 92 countries (see list in Appendix A). The countries are also aggregated into three regions: Developing Asia (which excludes China, given a projected rapid decline in reliance on biomass),[18] Sub-Saharan Africa, and Latin America and the Caribbean.

Population Relying on Biomass

We calculate the number of people who do not have access to clean cooking—a proxy for those who rely on biomass—by subtracting the clean cooking access rate (provided in the IEA's Sustainable Development Goal 7 tracking report[19]) from 100 percent to determine the residual percentage of the population lacking access to clean cooking. Note in Appendix B that levels of access to clean cooking are systematically lower, often severalfold, in rural areas than in urban ones.

This lack-of-access rate by country and rural/urban division is then multiplied by the corresponding population living in the area, as provided by World Bank data.[20] This figure in turn is used as a proxy for those relying on biomass as their primary energy source for cooking (see Table 1).

Table 1: Population reliant on household biomass (millions)

Region	Rural	Urban	Total
Developing Asia	835.17	132.22	967.39
Sub-Saharan Africa	611.47	300.67	912.14
Latin America and the Caribbean	47.11	24.99	72.10
Global total	1,493.75	457.88	1,951.63

Households Relying on Biomass

Data on biomass collection and use is often generated through the use of household surveys, and households remain a foundational unit in organizing the production, procurement, and use of energy.

Accordingly, we determine the number of households relying on biomass by dividing the population by average household figures for the relevant countries' rural and urban areas.[21] This generates the number of households in each country's rural and urban areas that relies on biomass.

Share and Number of Households Relying on Women Biomass Producers

Literature on the extent to which households depend on women and girls for biomass is limited. There are, however, various statements that indicate differing participation rates for different countries and geographical regions. Notably, a 2020 report from the World Bank's Energy Sector Management Assistance Program (ESMAP) and Modern Energy Cooking Services Program, which reviewed other analyses, provides useful indicative information.[22] It found that women are the primary fuelwood collectors across most of sub-Saharan Africa. However, in certain regions of Ethiopia, men primarily fill this role, as they do in parts of Central America (including Guatemala, Honduras, and Nicaragua) and Southeast Asia (including Indonesia and Laos). In other areas, including India, Mongolia, and Papua New Guinea, time engaged in the task is split evenly between men and women.[23]

While there are a number of specific case studies on patterns in the production of cooking fuel,[24] we found little effort to provide an aggregated perspective on the production side, as this report seeks to do. Given the limited gender-specific data regarding biomass production, and building

off these and other reports, we found it necessary to make assumptions regarding the "women's participation ratio," namely the share of households that rely on women's biomass production. In part based on the description used in the ESMAP report and other studies, we use three basic participation rates: (1) 70 percent for countries in which women are the primary fuelwood collectors, (2) 50 percent for countries with near parity, and (3) 30 percent for countries in which men have the main responsibility. We assumed similar participation rates in a country for rural and urban areas. The assumed participation rates by country are provided in Appendix B.

To calculate the number of households relying on women and girls to produce biomass based on these shares, we multiply the total number of households in a country's rural and urban segments by the corresponding participation rate.

Number of Women Biomass Producers

The number of women and girls involved in producing biomass is taken as a function of household size, for which granular information is available, and is based on the proposition that, other than the elderly, infirm, or very young, women can be expected to participate. We estimate that for households of fewer than four people, one woman produces biomass; for households between four and eight, two women; and for households of nine or more, three women. These factors are applied to all households in a country's rural and urban areas based on the average household size for that area (see Appendix B).

We then multiply the number of households in a country's rural and urban areas that rely on women biomass producers by the above household-size-dependent number of women.

In the final phase of our analysis, we broaden our focus from the national level to the regional level. Given that the combined population of the inventoried countries account for virtually 100 percent of the populations lacking access to clean cooking, as well as more than 90 percent of the total population of the developing countries within each region, we use the aggregate results from these country figures to reflect the regional outcomes for Developing Asia, Sub-Saharan Africa, and Latin America and the Caribbean, and the corresponding global total.

Results

The report's methodology, while producing rough estimates, reveals several interesting points regarding the number of women biomass producers, their rural/urban split, and their portion of the larger labor force.

This report estimates that nearly 400 million women globally are household biomass producers, with regional breakdowns provided in Table 2.

Table 2: Women household biomass producers by region and globally (millions)

Region	Women producers
Sub-Saharan Africa	192.78
Developing Asia	188.86
Latin America and the Caribbean	7.38
Global total	389.02

Most of these women producers—about 75 percent of the total—live in rural areas, often the poorest parts of many developing countries. There is a notable difference in the rural/urban breakdowns between Developing Asia, where more than 85 percent of women producers are estimated to live in rural areas, and Sub-Saharan Africa, where a smaller majority, nearly two-thirds, are rural (see Table 3).

Table 3: Rural and urban women household biomass producers by region and globally (millions)

Region	Rural	Urban	Total
Developing Asia	162.40	26.46	188.86
Sub-Saharan Africa	125.23	67.56	192.78
Latin America and the Caribbean	4.89	2.49	7.38
Global total	292.51	96.51	389.02

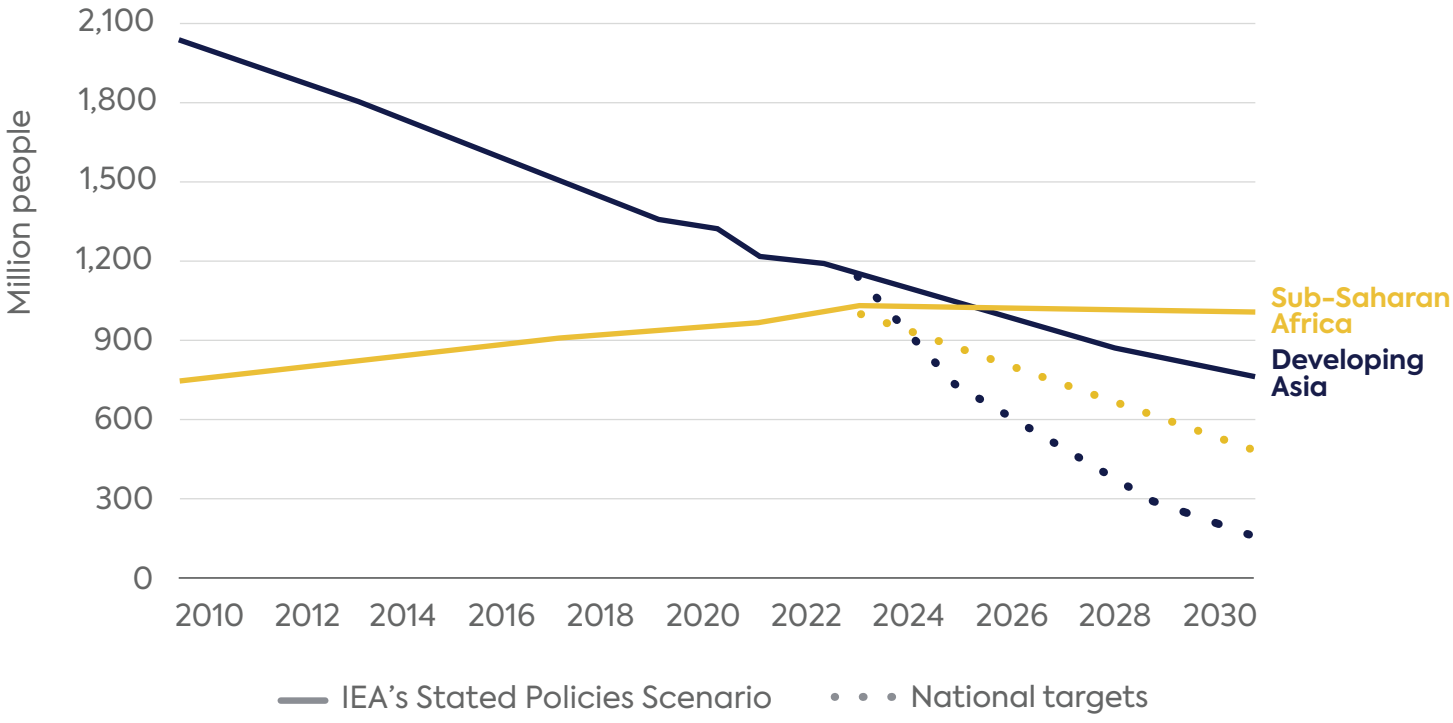
The analysis further indicates that women household biomass producers outnumber men producers. This is because of the higher participation rate of women in Sub-Saharan Africa, a surplus that is not changed by Developing Asia, a region where there is parity. While the participation rate of men exceeds that of women in Latin America, that region accounts for only 4 percent of the global population relying on household biomass, while Developing Asia accounts for 50 percent and Sub-Saharan Africa accounts for 47 percent (as detailed in Table 1). Accordingly, the likely number of men laboring as household biomass producers would fall far below the 389 million estimate for women.

Women biomass producers constitute the largest segment of the world's energy labor force, according to these results. For every person producing or distributing energy in the world's formal energy sector, there are nine women supplying a primary energy source for their households.

Looking Ahead: Impacts of Clean Cooking Trends

Clean cooking initiatives will obviate the need for much of this labor and are extremely important, in part due to the health considerations mentioned earlier in this report. Yet projections regarding the dissemination of clean cooking technologies indicate that women will continue to produce household biomass for years to come. The IEA's 2023 report on clean cooking and 2022 SDG7 tracking report[26] both point to the prospect that this segment of the labor force will exist in 2030 and beyond (see Figure 1). These trends point to a women biomass labor force that has potentially diminished by 2030 but still numbers around 200 million, or possibly more,[27] predominantly in sub-Saharan Africa.

Figure 1: Number of people projected to lack access to clean cooking



Source: International Energy Agency, "A Vision for Clean Cooking Access for All," 2023, 33, figure 2.1.

Conclusions

When people think of the global energy system, what may come most readily to mind are the visible components: oil wells, transmission lines, solar panels and energy efficient HVACs, or perhaps even the concepts of technological innovation and climate finance. But in addition to these facets and the tens of millions who work in the formal sector to deliver energy to consumers around the globe, there's another group, often unrecognized, who may in fact comprise the world's largest energy labor segment: women and girls producing household biomass to meet basic energy needs.

They are crucial producers in the global energy supply system, relied upon by millions of households. Yet they are often overlooked, while facing challenges of poverty and marginalization that frequently mark their lives and those around them. At nearly 400 million people, the largest labor segment of the global energy system deserves more attention to develop appropriate and effective ways to improve their working and living conditions. This effort requires more field research, including on what women biomass producers actually want and how their involvement in the energy transition can be most productive for all involved.

Appendix A

1. List of Inventoried Countries

In this study, we have included 92 countries.

Regional figures are generated using the IEA's nomenclature in its "Tracking SDG7: Energy Progress Report, 2022." Various countries are excluded for different reasons, including ongoing wars and insufficient data availability.

Sub-Saharan Africa

Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Côte d'Ivoire, Democratic Republic of Congo, Djibouti, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, São Tomé and Príncipe, Senegal, Sierra Leone, Somalia, South Africa, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

Developing Asia

Afghanistan, Bangladesh, Cambodia, India, Indonesia, Iran, Iraq, Jordan, Kazakhstan, Kyrgyzstan, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Syria, Tajikistan, Thailand, Turkmenistan, Uzbekistan, Vietnam, Yemen.

Latin America and the Caribbean

Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad and Tobago, Uruguay, and Venezuela.

2. Data Sources

The data sources are the same for all countries.

- Access rates for urban/rural areas for each country are taken from "Tracking SDG7: The Energy Progress Report, 2022," which provides data for year 2020.

- Population data for urban/rural areas for each country is from the World Bank Data Center (accessed August 2023) for the year 2020.
- Household sizes for urban/rural areas for each country is taken from the most recent year reported by Global Data (https://globaldatalab.org/areadata/table/hhsize/?levels=1+2, accessed October 2023). The last reported year varies by country, with many falling within the 2016 to 2019 range, but some stretching as far back as 1999.

Appendix B

Table B-1: Data by country

Region/country		Clean cooking access rate	Women participation rate in biomass	Household size
Sub-Saharan Africa				
Angola	Rural	0.08	0.7	5.94
	Urban	0.78	0.7	6.65
Benin	Rural	0.01	0.7	8.02
	Urban	0.07	0.7	6.88
Botswana	Rural	0.25	0.7	5.63
	Urban	0.86	0.7	6.00
Burkina Faso	Rural	0.01	0.7	7.95
	Urban	0.35	0.7	7.36
Burundi	Rural	0.00	0.7	5.92
	Urban	0.00	0.7	6.36
Cabo Verde	Rural	0.50	0.7	4.88
	Urban	0.94	0.7	5.02
Cameroon	Rural	0.02	0.7	8.50
	Urban	0.38	0.7	6.94
Central African Republic	Rural	0.00	0.7	5.29
	Urban	0.02	0.7	6.22
Chad	Rural	0.00	0.7	5.98
	Urban	0.29	0.7	5.96
Comoros	Rural	0.03	0.7	7.04
	Urban	0.17	0.7	6.58
Côte d'Ivoire	Rural	0.01	0.7	6.85
	Urban	0.62	0.7	5.86

Region/country		Clean cooking access rate	Women participation rate in biomass	Household size
Democratic Republic of Congo	Rural	0.00	0.7	4.93
	Urban	0.08	0.7	5.49
Djibouti	Rural	0.00	0.7	5.08
	Urban	0.12	0.7	5.93
Equatorial Guinea	Rural	0.04	0.7	5.68
	Urban	0.33	0.7	5.53
Eritrea	Rural	0.10	0.7	6.15
	Urban	0.20	0.7	6.16
Eswatini	Rural	0.41	0.7	4.71
	Urban	0.89	0.7	2.89
Ethiopia	Rural	0.00	0.3	6.02
	Urban	0.29	0.3	4.81
Gabon	Rural	0.46	0.7	6.56
	Urban	0.94	0.7	6.55
Gambia	Rural	0.00	0.7	10.70
	Urban	0.02	0.7	7.53
Ghana	Rural	0.09	0.7	5.14
	Urban	0.34	0.7	4.28
Guinea	Rural	0.00	0.7	7.96
	Urban	0.04	0.7	8.47
Guinea-Bissau	Rural	0.00	0.7	7.11
	Urban	0.02	0.7	6.32
Kenya	Rural	0.05	0.7	5.91
	Urban	0.44	0.7	4.63
Lesotho	Rural	0.20	0.7	4.17
	Urban	0.79	0.7	3.12
Liberia	Rural	0.00	0.7	4.63
	Urban	0.00	0.7	4.65

Region/country		Clean cooking access rate	Women participation rate in biomass	Household size
Madagascar	Rural	0.00	0.3	4.61
	Urban	0.02	0.3	4.16
Malawi	Rural	0.00	0.7	4.31
	Urban	0.04	0.7	4.16
Mali	Rural	0.00	0.7	7.37
	Urban	0.02	0.7	8.90
Mauritania	Rural	0.18	0.7	6.44
	Urban	0.64	0.7	6.13
Mauritius	Rural	0.96	0.7	5.44
	Urban	0.98	0.7	5.29
Mozambique	Rural	0.00	0.7	5.63
	Urban	0.14	0.7	6.05
Namibia	Rural	0.13	0.7	7.04
	Urban	0.72	0.7	5.64
Niger	Rural	0.00	0.7	7.66
	Urban	0.12	0.7	8.13
Nigeria	Rural	0.04	0.7	7.19
	Urban	0.30	0.7	6.32
Rwanda	Rural	0.00	0.7	4.39
	Urban	0.10	0.7	4.07
São Tomé and Príncipe	Rural	0.01	0.7	3.96
	Urban	0.04	0.7	4.11
Senegal	Rural	0.04	0.7	13.20
	Urban	0.46	0.7	11.50
Sierra Leone	Rural	0.00	0.7	6.85
	Urban	0.01	0.7	7.06
Somalia	Rural	0.00	0.7	5.68
	Urban	0.05	0.7	6.55

Region/country		Clean cooking access rate	Women participation rate in biomass	Household size
South Africa	Rural	0.66	0.7	5.81
	Urban	0.95	0.7	4.60
Tanzania	Rural	0.01	0.7	7.15
	Urban	0.11	0.7	6.16
Togo	Rural	0.01	0.7	4.62
	Urban	0.21	0.7	4.00
Uganda	Rural	0.00	0.7	6.45
	Urban	0.01	0.7	5.53
Zambia	Rural	0.02	0.7	6.67
	Urban	0.20	0.7	6.20
Zimbabwe	Rural	0.07	0.7	4.20
	Urban	0.79	0.7	3.67
Developing Asia				
Afghanistan	Rural	0.16	0.5	9.93
	Urban	0.83	0.5	9.45
Bangladesh	Rural	0.08	0.5	4.28
	Urban	0.58	0.5	4.18
Cambodia	Rural	0.25	0.5	5.41
	Urban	0.70	0.5	6.22
India	Rural	0.54	0.5	4.55
	Urban	0.91	0.5	4.25
Indonesia	Rural	0.75	0.3	4.69
	Urban	0.93	0.3	4.82
Iran	Rural	0.92	0.5	4.43
	Urban	0.99	0.5	4.01
Iraq	Rural	0.98	0.5	6.86
	Urban	0.99	0.5	6.14

Region/country		Clean cooking access rate	Women participation rate in biomass	Household size
Jordan	Rural	0.99	0.5	6.20
	Urban	1.00	0.5	5.68
Kazakhstan	Rural	0.87	0.5	4.07
	Urban	0.98	0.5	3.03
Kyrgyzstan	Rural	0.66	0.5	4.65
	Urban	0.94	0.5	3.29
Malaysia	Rural	0.92	0.5	5.99
	Urban	0.98	0.5	5.16
Mongolia	Rural	0.15	0.5	3.57
	Urban	0.69	0.5	3.66
Myanmar	Rural	0.11	0.5	5.21
	Urban	0.76	0.5	5.62
Nepal	Rural	0.20	0.5	4.33
	Urban	0.63	0.5	4.22
Pakistan	Rural	0.26	0.5	8.64
	Urban	0.86	0.5	8.13
Philippines	Rural	0.28	0.5	5.44
	Urban	0.69	0.5	5.29
Syria	Rural	0.97	0.5	6.08
	Urban	0.99	0.5	5.31
Tajikistan	Rural	0.77	0.5	7.95
	Urban	0.97	0.5	6.28
Thailand	Rural	0.77	0.5	2.99
	Urban	0.90	0.5	2.67
Turkmenistan	Rural	1.00	0.5	5.81
	Urban	1.00	0.5	4.62
Uzbekistan	Rural	0.73	0.5	5.76
	Urban	0.98	0.5	4.31

Region/country		Clean cooking access rate	Women participation rate in biomass	Household size
Vietnam	Rural	0.56	0.5	3.82
	Urban	0.82	0.5	3.95
Yemen	Rural	0.42	0.5	8.69
	Urban	0.93	0.5	8.41
Latin America and the Caribbean				
Belize	Rural	0.73	0.3	4.33
	Urban	0.95	0.3	3.47
Bolivia	Rural	0.59	0.3	5.29
	Urban	0.99	0.3	4.98
Brazil	Rural	0.79	0.3	4.65
	Urban	0.99	0.3	4.06
Chile	Rural	1.00	0.3	2.91
	Urban	1.00	0.3	2.91
Colombia	Rural	0.66	0.3	4.82
	Urban	0.99	0.3	4.44
Costa Rica	Rural	0.88	0.3	3.21
	Urban	0.98	0.3	3.21
Cuba	Rural	0.87	0.3	2.63
	Urban	0.97	0.3	2.76
Dominican Republic	Rural	0.76	0.3	3.14
	Urban	0.96	0.3	3.08
Ecuador	Rural	0.85	0.3	3.19
	Urban	0.99	0.3	3.03
El Salvador	Rural	0.81	0.3	4.10
	Urban	0.97	0.3	3.82
Guatemala	Rural	0.14	0.3	6.43
	Urban	0.75	0.3	5.58

Region/country		Clean cooking access rate	Women participation rate in biomass	Household size
Guyana	Rural	0.80	0.3	3.58
	Urban	0.84	0.3	3.28
Haiti	Rural	0.01	0.3	5.70
	Urban	0.07	0.3	5.50
Honduras	Rural	0.23	0.3	4.01
	Urban	0.73	0.3	3.72
Jamaica	Rural	0.78	0.3	3.24
	Urban	0.90	0.3	3.13
Mexico	Rural	0.59	0.3	3.98
	Urban	0.91	0.3	3.69
Nicaragua	Rural	0.09	0.3	3.90
	Urban	0.85	0.3	3.30
Panama	Rural	0.69	0.3	3.93
	Urban	0.98	0.3	3.51
Paraguay	Rural	0.41	0.3	3.67
	Urban	0.86	0.3	3.03
Peru	Rural	0.42	0.3	4.92
	Urban	0.96	0.3	4.88
Suriname	Rural	0.90	0.3	4.08
	Urban	0.97	0.3	3.78
Trinidad and Tobago	Rural	1.00	0.3	3.31
	Urban	1.00	0.3	3.14
Uruguay	Rural	1.00	0.3	3.09
	Urban	1.00	0.3	3.01
Venezuela	Rural	0.88	0.3	4.80
	Urban	0.99	0.3	4.93

Notes

1. World Health Organization, "WHO Publishes New Global Data on the Use of Clean and Polluting Fuels for Cooking by Fuel Type," press release, January 20, 2022, https://www.who.int/news/item/20-01-2022-who-publishes-new-global-data-on-the-use-of-clean-and-polluting-fuels-for-cooking-by-fuel-type.

2. International Energy Agency, "Tracking SDG7: The Energy Progress Report, 2022" June 2022, https://www.iea.org/reports/tracking-sdg7-the-energy-progress-report-2022. Published jointly with the International Renewable Energy Agency, United Nations Statistics Division, the World Bank, and the World Health Organization.

3. See, e.g., World Health Organization, "Household Air Pollution," November 22, 2022, https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health.

4. International Energy Agency, *World Energy Outlook 2019*, November 2019, 37, https://www.iea.org/reports/world-energy-outlook-2019. See also IEA, "Tracking SDG7: The Energy Progress Report, 2022."

5. Biomass for household cooking and heating use comes in different forms, notably fuelwood, charcoal, agricultural waste, and animal dung (see, e.g., description by the International Fund for Agricultural Development at https://www.ifad.org/en/renewable-energy.)

6. See, for example, International Energy Agency, "World Energy Employment: Overview," September 2022, https://www.iea.org/reports/world-energy-employment/overview. (See also underlying report: https://www.iea.org/reports/world-energy-employment.)

7. See, for example, Nick Johnstone and Marta Silva, "Gender Diversity in Energy: What We Know and What We Don't Know," International Energy Agency, March 6, 2020, https://www.iea.org/commentaries/gender-diversity-in-energy-what-we-know-and-what-we-dont-know.

8. International Renewable Energy Agency, "Renewable Energy: A Gender Perspective," 2019, https://www.irena.org/publications/2019/Jan/Renewable-Energy-A-Gender-Perspective.

9. See, e.g., Sustainable Energy for All, "Women and Youth at the Forefront," https://www.seforall.org/women-at-the-forefront; South Asian Women in Energy, https://sawie.org/; International Energy Agency, "Energy and Gender," https://www.iea.org/topics/energy-and-gender; and the Association of Women in Energy, https://www.awenergy.net/.

10. For example, the Women in Energy initiative at the Center on Global Energy Policy, Columbia University, https://www.energypolicy.columbia.edu/initiatives/women-in-energy/.

11. See, e.g., Alexandra Peek and Philippe Benoit, "Invisible Women in Energy: Millions of Household Biomass Producers," Energy Explained, Center on Global Energy Policy, Columbia University, July 6, 2023, https://www.energypolicy.columbia.edu/invisible-women-in-energy-millions-of-household-biomass-producers/; and Philippe Benoit, "Women Are the Forgotten Energy Providers in the Climate Conversation," World Economic Forum, January 13, 2022, https://www.weforum.org/agenda/2022/01/women-biofuel-climate/.

12. International Energy Agency, "A Vision for Clean Cooking Access for All," July 2023, 22 and figure 1.2, https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all.

13. Energy Sector Management Assistance Program et al., "The State of Access to Modern Cooking Energy Services," World Bank, 2020, 21, https://documents.worldbank.org/en/publication/documents-reports/documentdetail/937141600195758792/the-state-of-access-to-modern-energy-cooking-services; Global Alliance for Clean Cookstoves, "Gender and Livelihoods Impacts of Clean Cookstoves in South Asia," 2014, https://www.cleancookingalliance.org/binary-data/RESOURCE/file/000/000/363-1.pdf.

14. IEA, *World Energy Outlook 2019*, 37.

15. Global Alliance for Clean Cookstoves, "Gender and Livelihoods Impacts of Clean Cookstoves in South Asia."

16. Some analysts have estimated $800 billion annually in lost productivity for women from the various activities required to produce meals. See Clean Cooking Alliance, "Gender and Clean Cooking Fact Sheet," 2021, https://cleancooking.org/wp-content/uploads/2023/07/Gender-and-Clean-Cooking.pdf.

17. Benoit, "Women Are the Forgotten Energy Providers in the Climate Conversation."

18. Given the recent significant downward revision to the number of households relying on biomass in China (which was cut in half, to 200 million, in the IEA's *World Energy Outlook 2022*), and the projection that the country will achieve universal access to clean cooking by 2030, we have not included China in these calculations. International Energy Agency, *World Energy Outlook 2022*, October 2022, 264, footnote 12, https://www.iea.org/reports/world-energy-outlook-2022.

19. IEA, "Tracking SDG7: The Energy Progress Report, 2022."

20. World Bank population data for rural areas in individual countries is available at https://data.

worldbank.org/indicator/SP.RUR.TOTL, and data for the corresponding urban areas is provided at https://data.worldbank.org/indicator/SP.URB.TOTL.

21. The relevant household data from the Global Lab is available at https://globaldatalab.org/areadata/table/hhsize/?levels=2.

22. ESMAP et al., "The State of Access to Modern Energy Cooking Services."

23. Ibid., 21 and footnote 4.

24. See, for example, Priscilla Cooke, Gunnar Köhlin, and William F. Hyde, "Fuelwood, Forests and Community Management – Evidence from Household Studies," *Environment and Development Economics* 13, no. 1 (February 2008): 103–135, https://www.jstor.org/stable/44378986; Gunnar Köhlin, Erin O. Sills, Subhrendu K. Pattanayak, and Christopher Wilfong, "Energy, Gender and Development," background paper to the 2012 World Development Report, World Bank, September 2011, https://elibrary.worldbank.org/doi/abs/10.1596/1813-9450-5800; Ewan Bloomfield, "Gender and Livelihoods Impacts of Clean Cookstoves in South Asia," Global Alliance for Clean Cookstoves, 2014, https://cleancooking.org/binary-data/RESOURCE/file/000/000/363-1.pdf; and Tal Lee Anderman et al., "Biogas Cook Stoves for Healthy and Sustainable Diets? A Case Study in Southern India," *Frontiers in Nutrition* 2 (2015), https://www.frontiersin.org/articles/10.3389/fnut.2015.00028/full.

25. IEA, "A Vision for Clean Cooking Access for All."

26. IEA, "Tracking SDG7: The Energy Progress Report, 2022."

27. To generate this estimate, the ratio of (1) women household biomass producers (set out in Table 2) to (2) the population reliant on household biomass (set out in Table 1) is applied to the number of people projected to lack access to clean cooking technologies in 2030, as presented in Figure 1.

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