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Estimating the Modern Energy Minimum Gap

BLUF: Ensuring everyone on earth achieves the Modern Energy Minimum (MEM) would require less than a 5% increase in global electricity generation. Without more aggressive action, population growth trends mean the 'MEM Gap' could widen by 45% — with sub-Saharan Africa representing 75% of the share — by 2030.

Ambitions for achieving Sustainable Development Goal (SDG) 7 — ensuring "universal access to affordable, reliable and modern energy services" — are high, but the bar for what constitutes modern energy use is far too low.

That is why the Energy for Growth Hub and the Rockefeller Foundation proposed the Modern Energy Minimum (MEM). This metric sets an annual electricity consumption threshold of at least 1,000 kWh per capita (split between 250 kWh at home and 750 kWh in the broader economy), a level that can drive economic growth and meaningful development. For context, an estimated 3.8 billion people currently consume less than that, and the average per capita demand in sub-Saharan Africa is less than one-fifth of the MEM (180 kWh). You can read more on the MEM from some of my colleagues at the Hub here and here.

What might global electricity demand look like if we met the MEM? To answer this question properly would require an integrated assessment of the global energy system, macroeconomy, and physical climate. But some quick back-of-the-envelope math provides useful food for thought.

The short answer is that the amount of additional electricity we'd need is both absolutely big and relatively small when compared to the scale of the global power system. For instance, meeting the MEM in 2000 would have meant generating an additional 32,000 TWh from then to 2022, which is about 1.1x of the world's total electricity generation last year. Closing the gap today would only require the equivalent of a **4.3% increase in global electricity generation**, almost exactly what's expected to happen in 2025. If that new generation were instead concentrated in countries below the MEM, it would represent a step change in prosperity and livelihoods for nearly half the global population.

Method

To estimate the gap between today's global electricity consumption and how much would be needed in a world where everyone achieves the MEM:

1. I compiled a harmonized dataset including World Bank-defined countries and regions and their historical and projected population, historical and projected GDP per-capita growth rate, and historical per-capita electricity generation from Our World in Data.

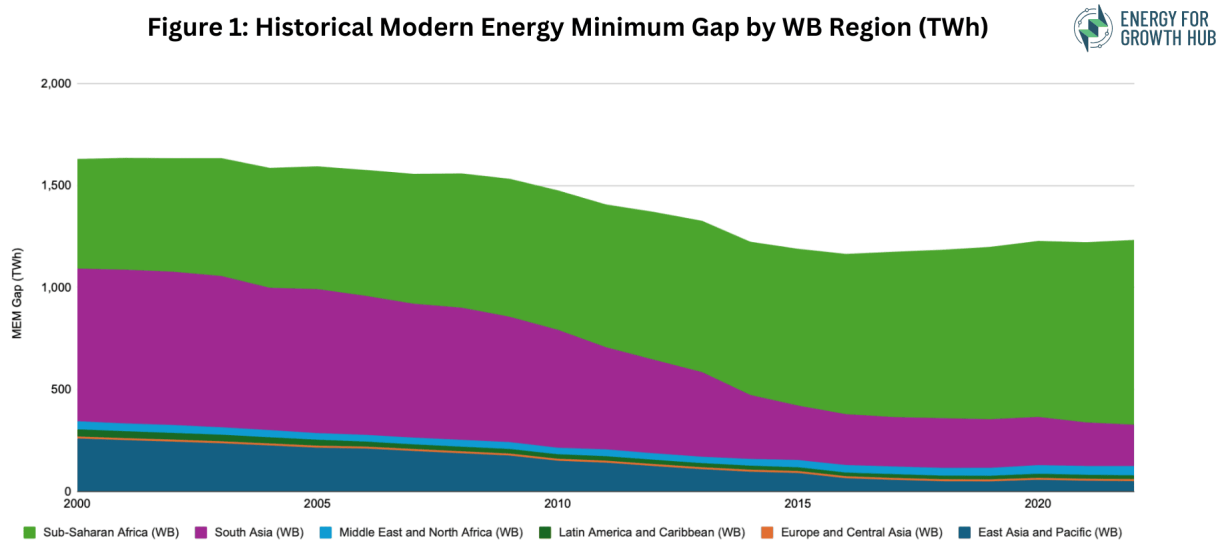
2. For 2000-2022[1] I identified countries below the 1,000 kWh threshold, calculated the difference between actual per capita electricity generation by year and the MEM, and aggregated these differences to find the historical 'MEM Gap'.
3. For 2023-2030 projections, I estimated per capita electricity generation increases indexed against average (2000-2029) historical and projected GDP growth by country and reflective of population projections, up to a cap of 1,000 kWh.[2]

View and download my spreadsheet here.

So, how big is the gap?

Unfortunately, reductions in the gap have been flat or worsening for the last decade, similar to progress towards SDG 7. See Figure 1. This problem is not going to solve itself. It has also become an increasingly African story. Due to rapid electrification progress in India, sub-Saharan Africa's share of the gap has risen from about 50% to nearly 75%, a share that is likely to hold steady through the decade without more aggressive action — more on that below.

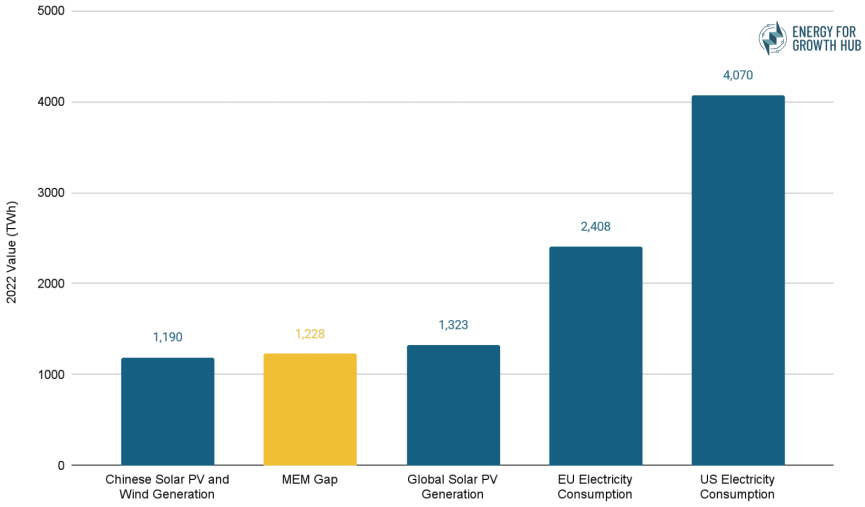
Figure 1: Historical Modern Energy Minimum Gap by WB Region (TWh)



In aggregate, to meet the MEM for every person on earth in 2022, countries with per capita consumption below the threshold would have collectively needed to generate an additional 1,228 TWh. That's about the same amount of electricity generated by every solar panel on earth or by every solar panel and wind turbine in China, or about half of Europe's annual electricity consumption, or about 30% of the United States' in that year. See Figure 2.

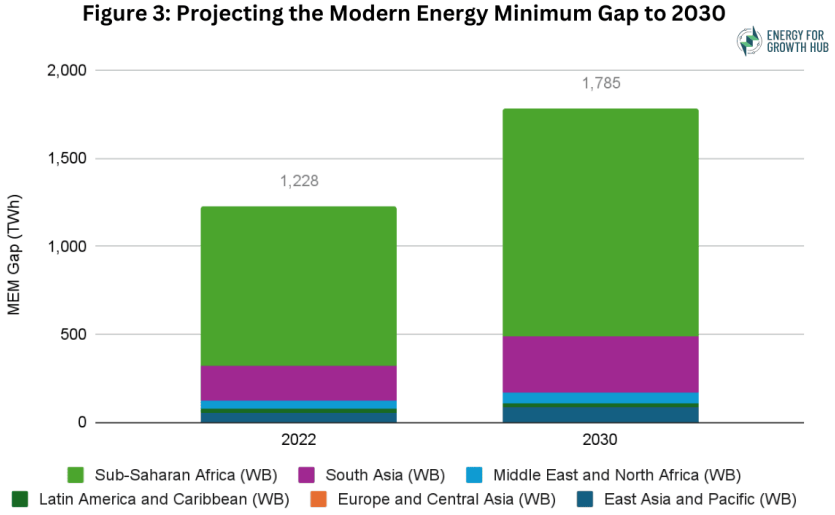
[1] 2022 is the most recent common year across the relevant datasets, and is thus considered the base year for this analysis.
[2] To err conservative on these indicative estimates, once a country hits the 1000 kWh cap, no further increase in electricity consumption per capita is assumed.

Figure 2: The MEM Gap is both Relatively Small and Absolutely Big



Looking ahead based on the strong historical correlation between electricity use and GDP growth, the MEM gap could grow by 45% through the rest of the decade, largely due to booming demographics in low-energy use countries. See Figure 3. The MEM gap could grow most in markets including Pakistan, Mozambique, Syria, Cambodia, Angola, and Botswana.

Figure 3: Projecting the Modern Energy Minimum Gap to 2030



Implications

The upshot: Raising electricity consumption ambitions in low-energy economies is necessary for a high-energy, high-growth, low-emission future for all.

Interventions targeted at consumers with extremely low energy consumption should be focused primarily on economic development and adaptation. National governments, utilities, and electrification agencies should be planning to meet higher levels of electricity demand sufficient to power broad economic growth, not just subsistence. The first step is sizing the prize.