Assessment on the Readiness for Widespread Adoption of Electric Cooking in Nepal

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CLEAN COOKING ALLIANCE

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In Nepal, more than 68% of households still use traditional biomass such as fuelwood, agricultural residue, and animal dung for cooking.[1] The dominant cooking fuel in urban households is liquefied petroleum gas (LPG), which is increasingly being used by peri-urban and rural households. However, increasing imports of LPG simultaneously contribute to Nepal's national trade deficit and with rising LPG prices households increasingly pay more for this fuel.

At the same time, Nepal's national electricity grid is becoming more reliable and may support households in Nepal to switch to electric cooking (e-cooking). Currently, 99% of the urban population and 95% of the rural population have access to electricity, either from the grid or from off-grid solutions like mini/micro-hydro, solar-powered mini-grids, solar/wind-powered hybrid mini-grids, and solar home systems.[2] The Government of Nepal (GoN) has also announced 2018–2028 as the *Decade of Energy and Hydropower* to realize the dream of *Prosperous Nepal, Happy Nepali* and intends to provide electricity access to every household by 2022/23 and promote electric cookstoves in every household by 2028.

Winrock International, in coordination with VRock and Nepal Electricity Authority (NEA) Engineering Company (hereafter, the "study team"), conducted an "Assessment on the Readiness for Widespread Adoption of Electric Cooking in Nepal" for the Clean Cooking Alliance (CCA). The main objective of the assessment was to confirm the extent to which the current and planned hydropower and off-grid electricity generation along with the infrastructure required for its distribution can adequately support the growing demand for electricity to support electric cooking. The study team conducted a comprehensive review of reports, plans, policies, legislation, practices, case studies, and other documents to assess the current status and future plans for grid and off-grid electricity generation, transmission, and distribution infrastructure, including rural electrification plans, within five-year and ten-year time horizons. The study team analyzed the adequacy of current hydropower generation as well as the pipeline of new power plants by 2023 and 2028, respectively, to assess if generation would be sufficient to meet targets and the extent to which importation from India could meet shortfalls. The study team also analyzed how many of the districts in the country had sufficient capacity at the distribution substations to provide sufficient power to meet the GoN's 2023 and 2028 electric cooking targets. The study team conducted key informant interviews (KIIs) via video and telephone, in-person meetings, and field visits at the federal, provincial, and local levels to understand the convenience and affordability of electric cooking as well as the major barriers standing in the way of its adoption and investment and incentives which might overcome them. Additionally, a stakeholder consultation webinar was conducted to present preliminary findings and solicit feedback before finalizing the report.

The study finds that fewer than half of the districts have sufficient capacity at the distribution substation level to meet the 15th Five Year plan target of 15% of households adopting e-cooking by 2023.

The results of the assessment demonstrate the following:

Existing and planned generation, transmission, and distribution infrastructure are insufficient to meet the GoN's target of promoting electric cookstoves in every household by 2028. The current installed capacity of hydropower in Nepal is 1,328 megawatts (MW), and based on signed Power Purchase Agreements (PPA), generation is projected to increase to 4,862 MW by 2023 and 6,755 MW by 2028.[3] While the projection for 2023 comes close to the Ministry of Energy, Water Resources and Irrigation's (MoEWRI) White Paper target of 5,000 MW of generation capacity, the 2028 projection is well short of the 15,000 MW target in the White Paper, 10,000 MW of which is planned for domestic consumption and 5,000 MW for export.[4] There is, however, an additional portfolio of 90 hydropower projects with total capacity of about 16,000 MWs that have not yet signed power purchase agreements (PPA) with NEA but which have received survey licenses from the Department of Electricity Development (DOED).

Success in recent years in mobilizing investment for hydropower projects, from both the private and public sectors, is a positive sign that megawatt (MW) shortfalls are possible to overcome (particularly since there is also the option of importing power from India during the dry season). The

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major infrastructure shortfalls that stand in the way of universal e-cooking are, however, megavolt ampere (MVA) capacity of distribution substations, kilovolt ampere (kVA) capacity of service transformers, and cable sizes of last-mile distribution networks. Based on available data, the study was limited to analyzing the adequacy of distribution substations (where transformers bring the voltage down to 11 kV from higher transmission voltages), supplying districts in each of the seven provinces to analyze whether these substations had sufficient capacity to distribute the needed power to achieve e-cooking as per GoN targets or not. While there was plenty of reporting and anecdotal evidence that the capacity of downstream service transformers and distribution cables would present major and widespread bottlenecks, there was insufficient data available to analyze how many transformers and kilometers of cable would need to be upgraded in every district to meet the government's electric cooking targets.

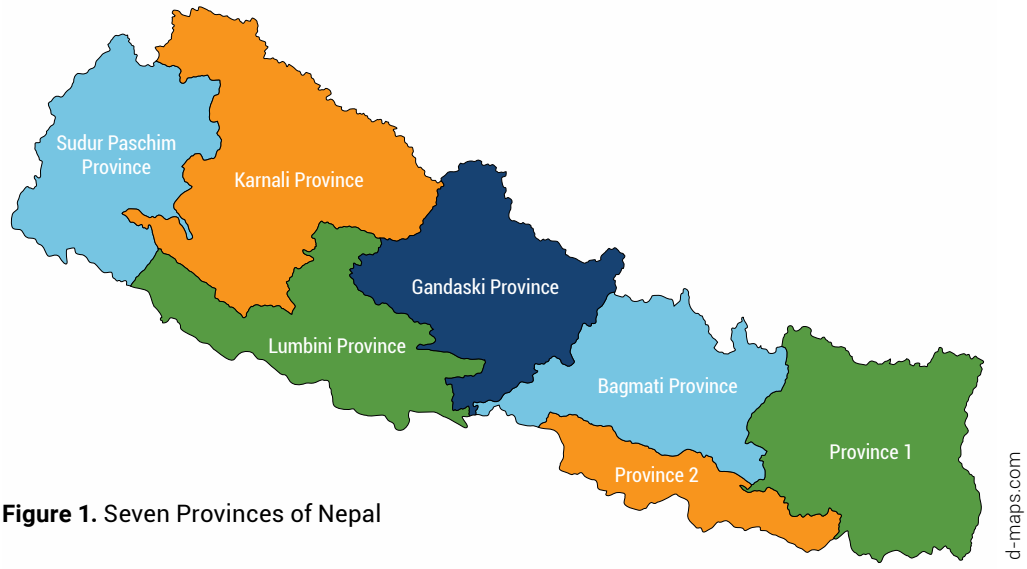

Figure 1. Seven Provinces of Nepal

The study finds that fewer than half of the districts have sufficient capacity at the distribution substation level to meet the 15th Five Year plan target of 15% of households adopting e-cooking by 2023.[5] The study further finds that distribution substation capacity would need to be increased by between 3 and 4.5 times above the planned 2023 capacity to achieve the 100% electric cooking targets by 2028, as spelled out in the 2018 MoEWRI White Paper.

The study calculates that the projected peak load to accommodate 15% of households cooking on electricity by 2023, when added to the demand forecast by NEA's Distribution System Rural Electrification Master Plan (DSREMP), would add up to 4,383 MW. This demand can be met by domestic hydropower projects under construction, supplemented by imports from India during the dry season. The peak load would more than triple to 13,101 MW in 2028 if 100% households adopted electric cooking and would significantly exceed the White Paper's 10,000 MW power generation target for domestic consumption. Peak power production from projects with signed PPAs would be substantially exceeded, meeting only around half the power generation requirements. Only 66% of the required peak load would be met in the dry season even after importing the maximum amount of power possible from India. **It is imperative for NEA to develop new-generation projects and sign new PPAs with developers to enable them to begin construction of hydropower projects (currently undergoing survey and design) for there to be sufficient generation to meet the MoEWRI White Paper 2028 electric cooking targets.**

Transmission infrastructure has been expanding in the country, both through upgrading to 132 kV, 220kV, and 400kV voltage levels, and additional kilometers of high-tension lines to convey expected new power generation to load centers throughout the country. Extension of transmission lines will result in nearly doubling the coverage of transmission lines from 3,806 circuit kilometers to about 7,161 circuit kilometers by 2023, with an additional 5,709 circuit kilometers in the planning phase.

With the completion of the 400 kV Dhalkebar substation in March 2021, Nepal marks the establishment of this new higher voltage transmission standard as the backbone of the transmission network. Similarly, the capacity of grid substations is expected to increase almost three-fold from 5,244 MVA at present to 14,165 MVA by 2023, with plans to expand to an additional 8,797 MVA. Despite these planned investments, the infrastructure is well short of what will be needed to transmit the 13,100 MW to supply the peak load required for universal electric cooking. A detailed load flow analysis must be carried out to determine which transmission lines will need to be upgraded.

Distribution is expected to present the most immediate bottleneck to achieving widespread adoption of electric cooking across provinces. The study analyzes how much electric cooking the planned MVA capacity of distribution substations, at each of the 77 districts, can support and at what point substation capacity becomes a limitation for further expansion of electric cooking. We find that aggregate substation capacity would be sufficient to meet the 15% e-cooking target by 2023 of the government's 15th Five-Year Plan in only 33 of the 77 districts. These are mostly districts starting with low levels of electrification with available capacity to accommodate additional electrical loads. Districts with high urban populations and high levels of electrification do not have spare capacity for additional cooking loads required for e-cooking. Only Sudurpaschim and Karnali, the two westernmost provinces with the lowest rates of electrification, at 65% and 34% respectively, have spare substation capacity to meet the 15% cooking targets in 2023. All districts in Sudurpaschim province except Achham and Kailali can meet the 2023 targets. Similarly, in Karnali Province, all districts except Rukum West, Surkhet, and Dailekh have the spare capacity to meet the 2023 e-cooking targets. By comparison, in Province 2, which has an electrification rate of 99%, three districts—Saptari, Siraha, and Rautahat—have sufficient capacity to meet the 2023 e-cooking targets while the other five do not.

Distribution infrastructure is being revamped to increase capacity by an additional 53,000 circuit kilometers of 11 kV low-voltage transmission lines and more than 8,500 distribution transformers. The objective of the distribution infrastructure expansion is to increase the rate of basic electrification. However, this revamping would not necessarily make the distribution system supportive of e-cooking. Detailed load flow analysis would need to be carried out to determine which distribution networks need to be upgraded for expansion of electric cooking.

There is a need to upgrade household wiring. In addition to the generation, transmission, and distribution infrastructures, household meter capacity and wiring are needed to support electric cooking. Household connections under 15 amps (A) will only support limited e-cooking and are recommended for upgrading. However, recently NEA has started the upgrading process from 5 amp watts to 15 amp watts for free if formally requested by customers. The study found out that more than 75% of the household customers of NEA have 5A meter capacity installed. The cost of upgrading for household wiring to ensure safe electric cooktop usage is expected to range from NRs. 3,000 to NRs. 6,000 and up, with costs depending on the materials used and the quality, and the current status of earthing arrangement for safety.

In addition to the generation, transmission, and distribution infrastructures, household meter capacity and wiring are needed to support electric cooking.

Off-grid generation, transmission, and distribution currently are not adequate for electric cooking. Although there are several well-known examples, such as the town of Barpak in Gorkha District and the communities at the base of Mt. Everest served by the mini-utility, Khumbu Bijuli Company (KBC), where over 50% of the households meet at least some of their cooking needs using power from hydropower mini-grids, the majority of off-grid systems in Nepal are designed to provide basic access to electricity for lighting, television and charging phones and to power rural enterprises in the daytime, rather than for cooking. Designing micro-hydro projects to support substantial levels of e-cooking would require increasing the average power subscription per household from current levels of 200W to 250W and providing incentives to cook during off-peak hours when power is not needed for lighting. The example from KBC demonstrates how technical solutions such as load scheduling and smart meters can be used to incentivize e-cooking by providing lower tariffs during off-peak hours. Further, energy from solar mini-grids are also considered too expensive for cooking until the price of storage batteries comes down significantly. There is also demand for electric cooking in off-grid areas with trekking tourism and areas with a high level of remittance income.

The affordability of electric cooking is a barrier. Households that already cook with LPG find that cooking with electricity can be less expensive as long as they use high efficiency appliances such as induction cookers, electric pressure cookers, and high-quality rice cookers. This only applies, however, if they use less than 400kWh per month. NEA's increasing

block pricing means that the price advantage switches to LPG for higher usage levels. Though the GoN has reduced the electricity tariff rate by an average of 1.04 percent, which came into an effect from November 2021. Nonetheless, the tariff need not necessarily be a barrier for low-income households, since cooking for a family of five generally consumes around 150 kWh per month. The main barrier for adoption of electric cooking for these families is the purchase cost of high-efficiency cookers and the special pots and pans, which are sometimes required for their use. Experience from other countries, such as Ecuador, suggests that fiscal incentives can be used to lower the price of high efficiency e-cooking appliances and that consumer financing can make it easier for customers to pay for their cooking appliances in installments.

For households that do not use commercial fuels for cooking but cook mostly with agricultural residue or collected firewood in the baseline, paying the monthly tariff to cook with electricity would be a major burden. The study assumes that most of these households will take a step-by-step approach to e-cooking, starting with popular appliances such as rice cookers and then slowly moving to cooking a higher percentage of their meals with electricity.

Nepal's ambitious plans to have 15% of all households cooking with electricity by 2023 and adoption of universal electric cooking by 2028 are currently impractical to achieve, due to infrastructure constraints. Significant investment in hydropower projects by both the private and the public sectors in recent years means that power generation will not present the most immediate bottleneck to expanding electric cooking. Distribution networks, however, present an immediate constraint to widespread adoption of e-cooking. The study shows that when capacity is examined at the level of distribution substations, fewer than half of the country's 77 districts have adequate transformer capacity to meet even the modest 2023 electric cooking target of 15%. Although there was not sufficient data to carry out a detailed analysis, anecdotal evidence suggests that even more serious constraints exist downstream of the distribution substations at the level of service transformers and last-mile distribution cables, which will further limit the uptake of electric cooking.

Substantial infrastructure investment is required to upgrade transmission and distribution networks throughout the country. This investment will largely need to come from the national utility, NEA, federal and provincial governments, and development partners. Alongside this public investment, households will need to invest in upgrading their house wiring to cook safely with electricity and to purchase efficient cookers for electric cooking to be cost competitive with alternatives such as LPG. There is a potential role for local governments to subsidize the cost of these investments for poor households to receive the benefits of electric cooking. The federal government can incentivize the purchase of high-efficiency electric cookers through fiscal incentives such as reducing customs and value-added taxes on their importation and sales.

The assessment demonstrates that there are several barriers including gaps in the electricity generation, transmission and distribution infrastructure, and the affordability of electric cooking. Nonetheless, the assessment also highlights areas where progress is being made towards the widespread adoption of electric cooking including the national electricity grid becoming more reliable; the transmission infrastructure expanding; household wiring upgrading options being provided, and; and consumer financing mechanisms lowering the price of electric cooking appliances.

Notes

1. Economic Survey 2018/19, Ministry of Finance, Government of Nepal
2. International Energy Agency; International Renewable Energy Agency; United Nations Statistic Division; World Bank Group; World Health Organization. 2019 Tracking SDG7: The Energy Progress Report.
3. Calculated by the Winrock team based on NEA's Generation Database.
4. The White Paper published by MoEWRI in May 2018, Page 24
5. The Fifteenth Plan (Fiscal Year 2019/20–2023/24), Government of Nepal, National Planning Commission

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