Cambodia residential energy storage

Cambodia residential energy storage

Cambodia has been on the United Nations list of the least developed countries since 1991. In 2015 Cambodia"s Human Development Index (HDI) was 0.563, which is below the medium HDI of 0.631 and below the East Asia and Pacific average of 0.720 (UNDP 2016). Coupled with a high rate of poverty (18.76% in 2014; Royal Government of Cambodia, 2015), Cambodia is still under the LDC graduation threshold according to UN triennial statistics in 2018 (UN 2018). Most of its land area is classified as rural, approximately 99% in 2010 (World Bank 2017).

The energy ladder concept is often criticized as being a too simplified theory (e.g. Daioglou et al. 2012; Ekholm et al. 2010; Kowsari & Zerriffi, 2011). For example, it assumes that as households get wealthier they abandon the inferior fuels, whereas according to Kowsari and Zerriffi (2011) this contradicts empirical studies (e.g. Heltberg 2004; Hosier et. al. 1987; Masera et al. 2000). Instead of changing energy sources, old ones are complemented with new, thus energy options accumulate in households as they get wealthier; a concept known as the energy stacking model (Fig. 2) (Adamu et al. 2020; Kowsari & Zerriffi, 2011).

The population in Cambodia in 2015 was estimated to be about 15.6 million (UNDESA 2015). The mostly rural Cambodia experienced a rapid urbanization in the 1960"s, but after the Khmer Rouge took power in 1975 the urban population collapsed from 29 to 4% in only one year. Figure 3 illustrates the share of gradually increasing urban population, yet the share of the urban population still has not reached the level of 1974.

Population development in urban and rural areas between 1971 and 2019 (% of the total population). (World Bank 2021)

The World Bank statistics on Cambodian access to electricity show that in 1991 less than 1% of the population had access to electricity, whereas the share was more than half (56%) in 2014, and by 2019 over 90% (World bank 2019, Energypedia, 2021). According to the World Bank, in 2018 nearly all urban Cambodians had access to electricity, while in rural areas the number was almost 90%. Access rates are presented in Fig. 4. The annual fluctuations of statistics may be a result of diverse measurement practices, or based on the definitions of urban or rural areas in different years (World Bank 2021).

Access to electricity in Cambodia in rural and urban areas in 1998-2018 (% of the population). (World Bank 2021)

According to the World Bank (2018), nearly all of Cambodia"s population (97.6%) have access to at least one source of electricity (71.5% on the grid, and 26.1% off the grid electricity), approximately one tenth of the rural population still remains without modern access (World Bank 2021). Energy poverty is around 33% nationwide and persists especially among the rural population (Phoumin & Kimura, 2019). In addition to access to grid quality electricity, the use of batteries still remain very common even in the cities with lower

income groups. Addressing the challenge of rural electrification depends largely on government priorities and the emphasis on equal access to all modern energy sources (e.g. ADB 2018; Phoumin et al. 2020).

The two study provinces, Pursat and Kampong Cham, and study villages marked according to the access to electricity (Map by Adrian Monge Monge, in Kallio et al. 2019)

According to Global Forest Change maps (developed by Hansen et al. 2013) both surveyed provinces have experienced a remarkable forest cover decrease in all canopy categories between 2000 and 2016. This is especially evident in Kampong Cham where forests with dense canopy (> 75%) have diminished fast, over 70% loss since 2000 and even in the sparse forest 42% loss in the same time period. The forests in Pursat are still abundant and multifold in size compared to Kampong Cham, although similar trends are also seen in all canopy categories (Hansen et al. 2013).

Communes were stratified under "Urban and Rural" categories based on the 2008 census (NIS and Ministry of Planning 2008). Furthermore, the electricity distribution map was used to identify communes with/without electricity coverage. Communes and villages were selected at random by Probability Proportional to Size (PPS), forming the elementary sampling units. A quota of 450 households (representative sampling unit) for each province was set according to PPS to district, commune, and village level until reaching saturation of 970 households in total. Systematic random sampling with skip interval proportional to population was used for selecting the households in both urban and rural areas.

All urban areas in the sample are electrified by the grid. In the rural areas, there are communes that use local solutions to produce electricity, for example, solar home systems (Department of Rural Electrification Fund, 2016). Therefore in some non-electrified areas households claim they are connected to the gridFootnote 1 or in some cases parts of the communes have access to the grid (e.g. border regions in the districts).

Household wealth groups were defined by the respondents" type of housing and assets they own, as estimating monetary monthly incomes from multiple income sources was found challenging, especially in rural settings. The housing types were classified according to the building materials. The assets owned by the households included, for example, physical assets such as livestock, or vehicles, among others. Based on the information about the housing standards and the total value of their assets, the wealth status of households was calculated using the following equation: