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# Analysis of the Effectiveness of Renewable Energy Subsidy Policy for Rural Electrification in Nepal

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**Abstract**— This paper attempts to analyze the Renewable Energy Subsidy Policy of Nepal in light of its development and effectiveness to increase access to electricity by easing financing barriers for rural electrification. Based on the selected parameters, the paper discusses the changes in subsidy policies and major outcomes of the policy interventions towards increasing access to electricity in rural areas. Major developments of off-grid electrification in the country have occurred after the formulation of the Renewable Energy Subsidy Policy in 2000 and its subsequent revisions. Till date, more than 16% of the rural population got access to electricity from off-grid renewable energy technology solutions like solar home lighting system, micro and mini-hydro systems where subsidy played an instrumental role. In the study period (2006-2016), it seems that the percentage of subsidy to the total cost for micro-hydro was increased, however, for the solar home system was decreased. The effectiveness of renewable energy subsidy policy is measured by comparing the targets and achievements in the access to electricity in each subsidy period. It is concluded that renewable energy subsidy policy 2009 (2009-2013) was most effective in terms of increasing access to electricity compared to other revisions. From the analysis and stakeholders' interaction meeting, it is concluded that access to electricity by micro-hydro is more subsidy driven than solar home systems.

**Index Terms**— Access to Electricity, Micro-hydro, Off-grid, Policy, Renewable Energy Subsidy, Rural Electrification, Solar Home System,

## 1 Introduction

Nepal has potentially abundant natural energy resources, it is estimated that it could have more than 83GW of hydropower, 3000MW of wind power, and 2100MW of solar power [1], [2]. The potential energy resources of solar, wind, mini and micro hydro could be developed as off-grid solutions to provide electricity access to the people who are far from the national grid [3]. According to the population census conducted by the Central Bureau of Statistics (CBS) in 2011, the proportion of households using electricity as their major source of lighting had increased from 40 to 67% between 2001 and 2012. When disaggregated by area, the increase in usage was from 83 to 94% in urban areas and from 32 to 60% in rural areas [4]. Out of its 29 million people, more than 28% live in rural areas without access to any type of electricity. While those connected to the national electricity grid often have long hours of power cuts [5]. Till 2017, less than 1% of hydropower available potential converted to useful electricity [6].

Different studies have pointed out various kinds of barriers for rural electrification in Nepal. The demand for electricity in a low-income household in rural areas will be small whereas fixed cost to bring electricity is high [7]. The extension of the national electricity grid into rural areas in developing countries is un-economical [8].

Inaccessible geographical terrain of Nepal is the main barrier to harnessing electricity from potential renewable energy resources like hydro and wind power generation [9]. Access to electricity in Nepal has big challenges due to geographical variations, poor transportation infrastructure, fragmented settlements, an elusive electricity development strategy, and a lack of sufficient capital [10]. The location of the village is the most important determinant of a village's electricity connection. Another study reinforces that developing countries face four key barriers: a) information to improve energy supply, b) building awareness of renewable energy, c) an adequate financing mechanism and d) policy support to implement renewable energy projects [11].

To overcome these barriers, proper strategies and action plans need to be prepared carefully [12]. There is a need in addressing the barriers on both demand and supply sides of promotion of renewable energy technologies (RETs) [13]. Domestic factors like good government policies in the regulatory mechanism, smart subsidies and tax incentives, indigenous innovation with required financial support can play a vital role. In order to increase the higher pace of electricity access, Nepal requires integrated and innovative plans and policies from the government to address these barriers [14].

Accordingly, the government of Nepal introduced its Renewable Energy Subsidy Policy in 2000 and revised four times to make it more efficient. Nevertheless, there is a lack of critical reviews of how effective the renewable energy subsidy policies of Nepal are in terms of achieving the target. Thus, the primary objective of this study is to analyze the renewable energy subsidy policies of Nepal and discus their effectiveness in achieving the target set by the government for rural electrifications through off-grid renewable energy technologies. This part was done through the extensive review of subsidy policies, annual reports, and periodic plans. Then, stakeholders' interaction was conducted to present effectiveness of each


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subsidy policies based on findings from the review and discussed to come up with a finite conclusion about which policy was most effective and reasons/factors behind it. Two main renewable energy technologies namely mini/micro hydro (MHP) and solar home system (SHS) are mostly used in rural electrification, this study is limited to the analysis of those two technologies only. This paper also analyzes the proportion of subsidies to the total cost of technologies in subsequent subsidy policy periods.

## 2 Background and Literature Review

There is not common defination of energy subsidy. The narrowest and perhaps most common definition is a direct cash payment by a government to an energy producer or consumer to stimulate the production or use of a particular fuel or form of energy [15]. The US Energy Information Administration has defined an energy subsidy as any government action designed to influence energy market outcomes, whether through financial incentives, regulation, research, and development or public enterprises. In a similar way, the International Energy Agency (IEA) defines energy subsidy is that any government's action to reduce cost of energy production or lower price paid by energy consumers (UNEP, 2008).

Many governments provide subsidies for energy, either explicitly or implicitly, to producers and consumers. Today's major modern energy industries have all relied on substantial subsidy support from respective governments [17]. Arriving at a global value of total energy subsidy is not straight forward because different agencies focus on narrower or wider definitions of what exactly constitutes a subsidy and use different methodologies for their calculations [18].

The 1990s saw an explosion of energy policy changes around the globe [19]. Driven by economic, environmental, security, and social concerns, energy regulation has been in great flux. Many of the changes are having a profound influence on renewable energy, both from policies explicitly designed to promote renewable energy and from other policies that indirectly influence incentives and barriers for renewable energy (Beck and Marriot 2004). The need for enacting policies to support renewable energy is often attributed to a variety of conditions that prevent investments from occurring.

In its 5th five-year plan (1975-80), the government of Nepal started to develop the off-grid electrification (micro hydro) sector. As a part of the 6th five-year plan (1980-85), the Agriculture Development Bank Limited launched the "Rural Electrification Project" and started to provide a government subsidy to these micro-hydro schemes. In the 7th five-year plan (1985-90), the government recognized the importance of alternative energy technologies and promoted micro-hydro projects (MHPs) as a tool for developing agriculture and small-scale industries. The 8th five-year plan (1992-97) gave special priority to the energy sector with an emphasis on reducing the gap between urban and rural areas. The Alternative Energy Promotion Centre (AEPC) was established during this period as a body of the government to coordinate and implement rural energy technologies. The 9th (1997-2002) and 10th five-year plan (2002-2007) set clear targets and put emphasis on solar photovoltaic (PV) for rural electrification. In this period the government also started formally the Renewable Energy Subsidy Policy 2000 and promulgated the Rural Energy Policy 2006 [20].

The main objectives stated in Nepal's renewable energy subsidy policies are to; a) improve agro-processing, reducing drudgery b) promote renewable energy for basic rural electrification (RE) and replace imported fossil fuels, c) promote the private sector in the renewable energy sector d) develop the RET market e) increase the standard of rural-electrification services f) support the productive use of electricity for enhancing livelihoods g) promote gender equality and social inclusion in the renewable energy sector and h) turn waste to electricity. To meet the government target of increasing the access of electricity in rural areas and to embrace more renewable energy technologies the subsidy policy was revised four times up to 2016. Initially, there were only a few objectives in the subsidy policy but more objectives were added as the policy was reviewed and refined. The renewable energy subsidy policy 2016 embraces all these objectives.

Due to Nepal's scattered households, decentralized energy systems such as micro-hydro of appropriate size would be optimal energy solution [21]. Considering the diversity of available resources, socioeconomic conditions and geophysical conditions, energy policy should consider hybridization of different energy options to meet both the affordability and acceptability of the local people [22]. Distributed power generation based on renewable energy sources contributes for better livelihood to remote villagers. The results show that the solar photovoltaic system is becoming economically more viable than other options apart from environment benefits [23]. Developing countries are not yet on the proper path to promote renewable energy, it can speed the process up by subsidizing renewable energy technologies (RETs) till the market for it becomes robust and economy of scale is achieved [24]. The issue of electricity affordability is recurrent in the context of rural electrification as the target groups are usually the rural poor. But, not having access to electricity, they often have to spend much of their time and revenue to buying or collecting energy sources for their day-to-day needs. Therefore, rural households are usually willing to pay for access to electricity services [25]. Financing off-grid rural electrification in Nepal remains a major challenge in increasing; however, subsidies have improved affordability and facilitate access of electricity. Financing of off-grid electrification needs a proper mix of subsidy, user's equity, and credit [26]. Only the formulation of policy is not enough but also social barriers such as awareness of the subsidy and proper delivery channel need to be considered [27].

In summary, electricity generation and distribution are costly, total investment depends upon various factors like technology selection, transport access, amount of energy generated and distributed, and operation and management costs. Due to difficult geographical conditions and sparsely distributed population, especially in the mid-hills and High Mountain, it is expensive, difficult and time-consuming to construct costly transmission and distribution lines to provide grid electricity. The economic condition of the people living in remote rural areas is poor, so consequently they have low purchasing power so they cannot afford to consume large amounts of electricity.

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A commercial model of production and consumption of electricity is not financially viable in a rural off-grid situation. Therefore, the first hurdle for the connection of electricity for rural households is the high initial investment. To overcome this barrier, the Government of Nepal (GoN) promoted off-grid electrification through RETs. Subsidy policy aims to reduce the burden of initial investment, and removed taxes and duties on the import of renewable energy equipment, as an indirect subsidy, to keep the cost of the technology as low as possible.

Different policies are designed and implemented to achieve different objectives. Most of the renewable energy policies like feed-in tariff (FIT), renewable portfolio standards (RPS) are aimed to increase the share of renewable energies in the total energy mix. In such cases, many researchers [28], [29], [30] [31], [32], [33], [34], [35] have used regression models to measure the effectiveness of a policy in increasing the proportion of renewable energy in the total energy mix. Others used economic and financial model [36], [37], [38] to determine the effectiveness of FIT using indicators like net present value and internal rate of returns.

## 3 Methodology and Data

### 3.1 Methodology

As discussed in section 2, the renewable energy subsidy policy of Nepal has many of objectives. However, the main objective is promoting renewable energy for basic rural electrification i.e. to increase access to electricity. Therefore, this paper discusses the effectiveness of the policy in increasing access to electricity in rural areas through renewables. Subsidy is investment grant to construct micro-hydro projects (hydroelectricity power plant up to 100kW in capacity generally operating in standalone mode) and to buy solar home system (a solar photovoltaic technology based lighting system with storage battery normally up to 100Wp capacity providing electricity to one house) to individual households in remote areas. Based on the need to achieve the revised national target, the market price of the technologies and responses of the beneficiary, from 2006 to 2016 the government made four revisions in the subsidy policy. This study considered the effectiveness of the policies can be judged from the perspective that how many new households, in rural areas, will use the benefits of the policies to get access to electricity in their homes.

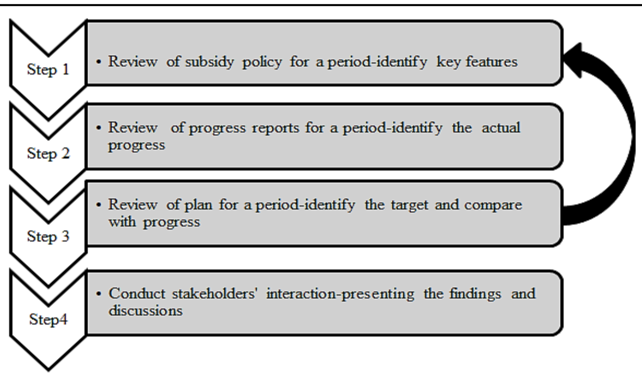


Fig.1. Framework to analyze the effectiveness of Renewable Energy Subsidy Policy.

Figure 1 presents the framework for this study. We applied this framework in five steps and each step are briefly discussed as follows.

**Step 1:** Reviewed the subsidy policies for the different period and analyzed major changes and features of subsidy policies in each period.

**Step 2:** Based on the annual and periodic progress reports, actual progress was identified in each subsidy policy period. As mentioned before, four times subsidy policy revision, therefore, each period of progress was analyzed and able to come with the most effective subsidy policy terms of access to electrification.

**Step 3:** The goal of this study was to analyze the effectiveness of renewable subsidy policies, in this backdrop; we reviewed the plan of Government in terms of the planned target to provide access of electricity. Thus, for each subsidy policy period, government targets were identified. In order to estimate the effectiveness of renewable energy subsidy policy, the paper compares the government targets to increase access to electricity through renewables to the actual achievement made corresponding subsidy policy period. Based on rules used in other sectors and academic papers, the paper sets the criteria as if the achievement is more than 80% of the target then the policy is very effective, if 50% -80% moderately effective and below 50%, not very effective

**Step 4:** Finally, we organized the stakeholders (private sector, users and government official) interaction in order to present findings and to conduct discussions. From this discussion, we were expecting why some period's policy would become more effective and what are the critical success factors. Stakeholders meeting could validate the findings from the review so that the conclusion can be drawn

### 3.2 Data Collection

For the given objectives, this paper analyses secondary data, from renewable energy subsidy policies, annual progress reports and program documents, periodic plans. The amount of subsidy, costs of renewable energy technologies and planned and achieved access to electricity in rural households were used to derive useful statistics on the trajectory of change of subsidy amounts in different technologies, the ratio of subsidy to total cost and increase in access to electricity through renewable technologies. To derive the national target data, the paper re-arranges the government and AEPC programs targets for each subsidy period. The outcomes of increased access to electricity were available in AEPC annual reports

## 4 Helpful Hints Analysis and Discussion

### 4.1 Review of subsidy policies

#### 4.1.1 Policy revisions and subsidy amount for RETs

The Government of Nepal provided subsidies and loans for improved water mills and micro hydro schemes in the early 1970s till 2000. However, as data from this is not available it is not included in this paper. After 2000, AEPC was given the mandate to coordinate the renewable energy subsidy. It started providing investment subsidies to off-grid electricity developers based on the Renewable Energy Subsidy Policy 2000.

Table 1 gives the details of renewable energy technologies and subsidy amounts for them in different revisions of this policy. In the Renewable Energy Subsidy Policy 2000 only a few technologies were subsidized, based on lessons of implementing past policies and demand of the renewable energy market, government included different technologies available in rural areas in the subsidy policy. In the last subsidy policy, ten different types of renewable energy technologies systems for rural electrification were included. The subsidy mainly targeted local developers to provide financial support in the initial investment cost of technologies and equipment. But, due to poor transport infrastructure, the cost of transporting the equipment to the construction site was a barrier. The subsidy policy also started to make provisions for a transportation subsidy to ease the transportation barrier. In some subsidy policy revisions, a transport subsidy was a separate amount and in others, it was combined as a single subsidy amount. The geographical categories A, B, C actually have different subsidy amounts to address the different transportation costs in rural areas. In the first subsidy policy mentioned that the amount of subsidy was made approximately 50% of the total cost of technology. But, in later revisions, it was based on the total project cost providing a larger subsidy to mini and micro-hydro projects.

TABLE 1
PROVISION OF SUBSIDY IN USD FOR RE TECHNOLOGIES IN DIFFERENT REVISIONS OF SUBSIDY POLICY

| RE Policy | | Category | Subsidy amount in USD for RETs[1] subsidy policies[2] — Mini-micro hydro USD/kW: PHP | MHP | Mini HP | IWM -E USD/kW |
|---|---|---|---|---|---|---|
| | | A | 726 | 924+T277 | | 356 |
| 1 | 2000 | B | 726 | 924+T116 | | 356 |
| | | C | 726 | 924 | | 356 |
| | | A | 897 | 1,173+T290 | 1,173+T290 | 552 |
| 2 | 2006 | B | 897 | 1,173+T121 | 1,173+T121 | 552 |
| | | C | 897 | 1,173 | 1,173 | 552 |
| | | A | 1,186 | 1,513+T363 | 1,513+T363 | 726 |
| 3 | 2009 | B | 1,186 | 1,513+T182 | 1,513+T182 | 726 |
| | | C | 1,186 | 1,513 | 1,513 | 726 |
| | | A | 1,584 | 2,448 | 2,112 | 864 |
| 4 | 2013 | B | 1,440 | 2,160 | 1,824 | 768 |
| | | C | 1,296 | 1,872 | 1,632 | 672 |
| | | A | 1,974 | 3,591 | 3,591 | 1,011 |
| 5 | 2016 | B | 1,786 | 2,679 | 2,679 | 776 |
| | | C | 1,645 | 2,444 | 2,444 | 658 |

| RE Policy | | Category | Solar USD/HH: SSHS | SHS | S+W MG | W2E and BMG mini grid USD/kW: BMG | BGG | W2E |
|---|---|---|---|---|---|---|---|---|
| | | A | | 158 | | | | |
| 1 | 2000 | B | | 132 | | | | |
| | | C | | 106 | | | | |
| | | A | 17 | 138 | | | | |
| 2 | 2006 | B | 17 | 110 | | | | |
| | | C | 17 | 83 | | | | |
| | | A | 24 | 121 | | | | |
| 3 | 2009 | B | 24 | 97 | | | | |
| | | C | 24 | 73 | | | | |
| | | A | 48 | 67 | 1,680 | 1,920 | | |
| 4 | 2013 | B | 46 | 60 | 1,440 | 1,920 | | |
| | | C | 43 | 58 | 1,200 | 1,920 | | |
| | | A | 47 | 47 | 4,653 | 4,183 | 611 | 4,009 |
| 5 | 2016 | B | 45 | 45 | 4,371 | 3,854 | 1,739 | 3,760 |
| | | C | 42 | 42 | 4,042 | 3,572 | 1,410 | 3,760 |

*Statements IWM-E-Improved Water Mills electrification, M-MHEP- Mini hydro (100kW-1000kW) and micro-hydro Projects (5-100kW), PHP-Pico-hydro projects (up to 5kW) projects, W+S-Wind and solar hybrid system, BMG-Biomass and biogas based electrification project, W2E-Waste to energy electrification project. T- Transportation subsidy separate.SSHS small solar home system: less than 10Wp, SHS-above 10 to 50Wp, solar PV system with a storage battery.*

### 4.1.2 Trends in RE subsidy policy revision

The subsidy for MHP was generally given in kilowatt (kW) basis. Since this paper discusses access to electricity at the household level, to make it easy to compare, subsidy per kilowatt (kW) for MHP is converted to a subsidy per household. The reference of numbers of households connected per kW for the first three subsidy policies was eight and five in the last two revisions, accordingly, households were calculated.

Figure 2 shows the change of subsidy per household connected by MHP and SHS. The bar charts show that the subsidy for MHP increased in all revisions of the subsidy policy, whereas that for SHS has continuously decreased. The increase and decrease were more in the last two revisions to the subsidy policies.

The trend of change in the amount of subsidy per household for MHP and SHS is shown in Figure 3. The main argument for changing the subsidy was to address the change in the market price of the technologies, the government target for each technology and affordability of the rural households. The global market price of solar PV based systems declined substantially between 2000 and 2016; accordingly, the market price of SHS declined and the subsidy also decreased. The change to subsidy policies seems to have been guided by the technological choice of both the government and donors. It looks like that the promotion of MHP technology was preferred that it provides better quality acess.

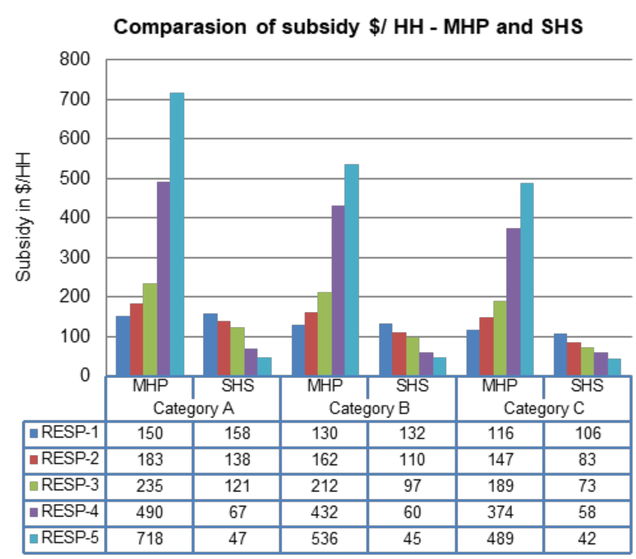


Fig.2. Amount of RE subsidies per HH by MHP and SHS in different subsidy categoriesSource: Renewable Energy Subsidy Policies (2000, 2006, 2009, 2013, 2016), AEPC. Note: HH refers to households in the above figure

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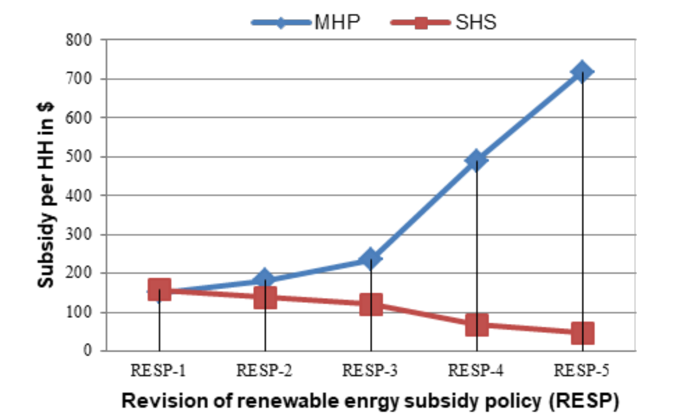


Fig. 3. Trend of change in subsidy on per household by MHP and SHS.Source: AEPC- Renewable Energy Subsidy Policies (RESP) (2000, 2006, 2009, 2013, 2016)

Its possibility in productive use of electricity to improve beneficiary livelihoods also seems to be promoted. On the other hand, the flow of remittance in rural areas of Nepal increased the purchasing power of the people, enabling them to afford an SHS on their own or even with a minimum government subsidy. Recently, the subsidy for SHS is considered just as a market and quality assurance discount to technology providers.

### 4.2 Subsidy and RETs Cost

In general, the cost of generating electricity from renewable energy technologies is high. In rural and remote areas, the cost is greater due to high transportation and construction costs. On the other hand, the paying capacity of rural people is also low. Therefore, to increase rates of access to electricity in rural areas, the Government of Nepal provides a subsidy to renewable technology based electricity generation. The renewable energy subsidy policies have been calculated based on the costs of technologies, the national target to increase access from each technology and the willingness of local people to pay for electricity.

For the comparison subsidy costs, the highest subsidy category A - very remote geographical area is taken as the reference. For ease of comparison between technologies (MHP and SHS), it is done on households basis i.e. subsidy and cost of technology per household. Table 2 compares the average cost of technology to the corresponding subsidy in each subsidy period. The percentage of subsidy to cost per household for MHP was always more than 60% and is increasing. Especially in the recent subsidy policy, the subsidy for MHP is up to 87% of total cost. Whereas, in the case of SHS, the subsidy was always less than 50% of the total cost and is decreasing. SHS received a maximum of 49% subsidy in its first subsidy policy and only 37% in the 2016 subsidy policy.

### 4.3 Footnotes Access to Electricity

The promotion of renewable energy technologies in Nepal was consolidated after the establishment of AEPC in 1996. The AEPC was given mandate by the Government of Nepal and support from external development partners. In 1999, the Danish government designed a twenty-year long Energy Sector

TABLE 2
RETs in Category A

| olicy | | | 1<br>2000 | 2<br>2006 | 3<br>2009 | 4<br>2013 | 5<br>2016 |
|---|---|---|---|---|---|---|---|
| Duration | | | 2000-2006 | 2006-2009 | 2009-2013 | 2013-2016 | 2016-now |
| Average Cost and subsidy for MHP kW-HHs | Cost in USD | kW | 1933 | 2354 | 3380 | 3580 | 4143 |
| | | HHs | 242 | 294 | 422 | 670 | 828 |
| | Sub-sidy in USD | kW | 1201 | 1463 | 1876 | 2448 | 3591 |
| | | HHs | 150 | 183 | 235 | 490 | 718 |
| | % age-HHs | | 62% | 62% | 56% | 73% | 87% |
| Average Cost and subsidy for SHS - HHs | Cost in USD | | 322 | 301 | 260 | 148 | 126 |
| | Subsidy in USD | | 158 | 138 | 121 | 67 | 47 |
| | % age HHs | | 49% | 46% | 47% | 45% | 37% |

Assistance Program (ESAP) to promote renewable energy technologies, which was joined by the government of Norway in 2003. During the same, period United Nations Development Program (UNDP) was implementing a Rural Energy Development Program (REDP). Both of these programs supported Nepal's renewable energy sector until 2017 in different phases and names of the programs. In this period, Nepal has achieved quite encouraging results in the promotion of renewable energy technologies for rural electrificatio

By 2016, more than 16% of the total population accessed electricity from RETs. The credit goes to the funding support of external development partners and the policy and institutional arrangement the Government of Nepal made. The Rural Energy Policy 2006 and Renewable Energy Subsidy Policy (2000-2016) are the main policies instruments behind it.

#### 4.3.1 Access to Electricity in Each Subsidy Policy

The RE subsidy revisions took place during different time intervals. The first revision in 2006 was after six years, while all other revisions were in the interval of around three to four years. In the first subsidy period, the RE market was under development and there were only a few RETs providers. Figure 4 shows the number of households that gained access to electricity in each subsidy policy period. In the period, 2000-2006 and 2006-2009 the household's access to electricity increased but was not as high as in the in period 2009-2013 and 2013- 2016. In the period 2009-13 and 2013-16 more than half a million households adopted SHS. Households with MHP electricity access were also highest in the period 2009-13. In the period 2009-2013 only, around four hundred thousand households gained access to electricity from SHS and MHPs. The higher rate of increment in access in recent years might be from increased subsidy in mini and micro-hydro, fall in the price of solar PV system), many technology providers increased awareness and increased purchasing power due to remittance flow in rural areas.

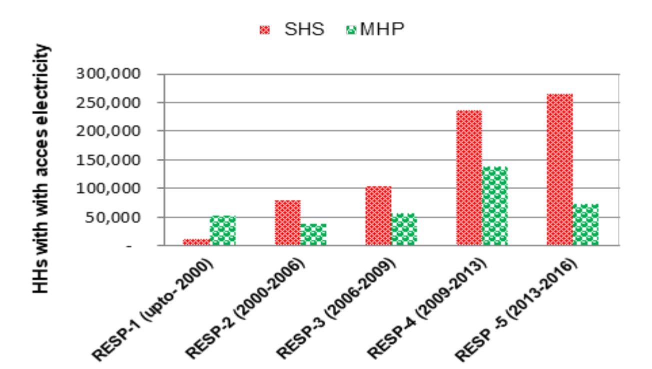


Fig.4. Access to electricity in a rural household in each renewable energy subsidy policy (RESP) period. Source: AEPC

### 4.3.2 Access to Electricityin the Entire Period

The subsidy of mini and micro hydro has increased in every revision of subsidy policy and the MHP curve shows an upward rise after every revision of subsidy. We found that MHP beneficiaries waited till a new subsidy was effective to get more subsidies. Whereas in the case of SHS, even though the amount of subsidy per household has decreased in each subsidy policy revision, access to this technology has increased. In general, the total and individual technology access to electricity is increasing.

In some previous years the curves were somehow flat indicating the shortage of subsidy funds. During such periods, AEPC even stopped accepting subsidy applications for some technologies. This occurred when one donor program had finished and another has not started.

### 4.3.3 Ratio of Change in Subsidy and Access

Figure 6 compares the percentage change in subsidy per household in different revisions of the subsidy policy to the percentage change in increased access to electricity in the same period. In the case of MHP, with an increase in subsidy per household, there was increasing trend but not uniform. In the case of SHS, irrespective of the decreased percentage of the subsidy per household the increase in access was always high.

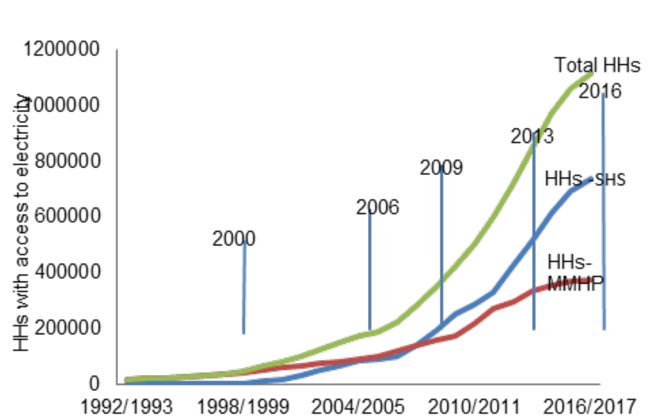


Fig. 5.Cumulative increases in access to electricity all renewable energy subsidy policy (RESP) Source: AEPC

Therefore, it looks like that the access to electricity by MHP is more subsidy driven than that by SHS. Though, SHS access was not dependent on the subsidy but having a government subsidy was always good for SHS suppliers to have better marketing and quality assurance strategies, as AEPC has made it mandatory to have tested products in the subsidy scheme. The ratio of subsidy change in 2009 was highest for the case of micro-hydro; however, it was the opposite direction for the SHS.

### 4.4 Target vs Achievement in acess to Electricity

The National Planning Commission (NPC) sets general targets to increase access to electricity for each five-year plan. From its 10th five-year plan NPC started to put the percentage of households or population to get access to electricity from RETs. The NPC plans were then translated into detail periodic and annual targets by AEPC. AEPC prepares a detailed plan and targets to access to electricity from different renewable energy technologies in a given period. In order to meet the government target AEPC also recommends the government of Nepal to review and revise the renewable energy subsidy policy to meet targets. Table 3 provides the targets and achievements of each subsidy policy period. It shows that the average achievement is more than 80% except in subsidy policy (2006-2009) for MHP.

Subsidy policy 2000 was very effective as it achieved more than 130% of its target, but the duration of the subsidy was also long. The individual subsidy policy period, subsidy policy 2009 (2009-2013) was the most effective as it achieved high access results for both MHP and SHS. While subsidy policy 2006 (2006-2009) was moderately effective with the lowest results. Therefore, as mentions in the methodology of this paper and from the analysis presented in Table 3, it can be concluded the renewable energy subsidy policies of Nepal were very effective in increasing the access of electricity in rural and remote Nepal.

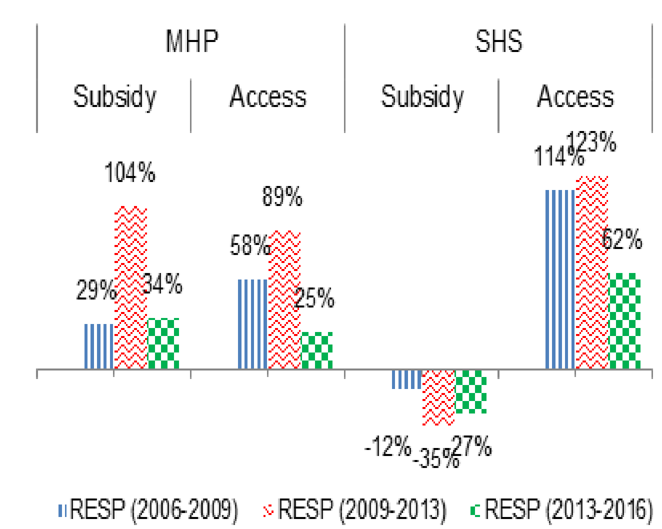


Fig.6. Ratio of change in subsidy and access to electricity in the household level. Source: AEPC- Renewable Energy Subsidy Policies (RESP) (2000, 2006, 2009, 2013, 2016).

TABLE 3
TARGET VS ACHIEVEMENT OF ACCESS TO ELECTRICITY

| Policy | | | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| | | | 2002 | 2006 | 2009 | 2013 |
| **Duration** | | | 2000-2006 | 2006-2009 | 2009-2013 | 2013-2016 |
| **MHP kW/HHs** | **Target** | **kW** | 2,850 | 7,500 | 12,500 | 15,000 |
| | | **HHs** | 28,500 | 75,000 | 100,000 | 75,000 |
| | **Results** | **kW** | 4,729 | 5,697 | 13,695 | 9,165 |
| | | **HHs** | 37,560 | 56,970 | 138,096 | 72,860 |
| | **% age-HHs** | | 132% | 76% | 138% | 97% |
| **SHS HHs** | **Target** | | 45,000 | 125,000 | 245,000 | 360,000 |
| | **Result** | | 66,000 | 114,843 | 236,353 | 296,670 |
| | **% age HHs** | | 147% | 92% | 96% | 82% |

## 5 CONCLUSION

Rural electrification in Nepal is marred by many barriers, the financial barrier is one the key barriers. Due to difficult terrain generation, transmission and distribution of electricity are expensive and time-consuming. The high initial investment is the main barrier for the remote area where the paying capacity of people is also low. Therefore, the Government of Nepal provides subsidies to promote off-grid renewable energy technologies for rural electrification. Accordingly, the Alternative Energy Promotion Center was established and the government created its first Renewable Energy Subsidy Policy in 2000. The policy was revised and refined four times up to 2016 to make it effective in achieving its objectives and targets. In all the revisions, the subsidy for MHP has increased and that for SHS decreased. The ratio of subsidy to cost per house for MHP is from 62-87% in increasing trend and that for SHS it is 37-49% in decreasing trend.

Each subsidy revision has achieved more than 80% government target for the periods. In the subsidy period 2009-2013 only, 400,000 rural households gained access to electricity, the highest number so far. Thus, subsidy policy 2009 (2009-2013) was the most effective as it achieved high access results for both MHP and SHS than another period. During this period, change in subsidy was also highest (104%) for the case of micro hydro. From the analysis and stakeholders' interaction meeting, it is concluded that access to electricity by micro-hydro is more subsidy driven than solar home systems. Therefore, this paper concludes that by far, the renewable energy subsidy policy of Nepal was effective in meeting its objectives in overcoming financial and geographical barriers to rural electrification.

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