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Energy from Wastewater: Solution for power cut up

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Abstract: This paper attempts to analyze the significant sources of fuel used in Nepal and its contribution to GHG emission. It also tries to describe the electricity consumption pattern and the power cut up trends in Nepal. While it is analyzing the energy generation and consumption pattern it also presents the use of biogas in Nepal and data related to decentralizing wastewater treatment plant. There is no enough electricity generation in Nepal as a citizen are facing a power cut up to 17 hours in the dry season. A biogas plant is emerging;as there are around 11000 plants established all over Nepal but they only generate biogas and no other alternative energy. So, to fulfill the electricity demand of the growing population bioelectricity can be generated from the biogas plant,

Key Words: Electricity, Power cut up, Biogas, Wastewater, Bioelectricity

Introduction

Water and energy are coupled in intimate ways. Many of our technical processes of harnessing, extracting, and producing energy utilize water. Similarly, water extraction, treatment, distribution, and disposal processes consume energy. This interdependency often referred to as the 'water-energy nexus,' has been progressivelyemphasized as a significant issue for future planning and strategic policy considerations[1].Wastewater treatment plants represent a portion of the broader nexus between energy and water[2]. Wastewater treatment plants (WWTPs) are widely implemented to reduce harmful emissions in receiving water bodies [3]. However, most WWTPs were designed to meet specific effluent requirements, without sufficient considerations on energy[4]. However, this situation is changing in recent years, as both water and energy are critical elements. The growing scarcity of water has increased the dependency of the urban water system on energy, both for conveyance and treatment [5]. In most WWTPs, water quality is improved at the cost of a large amount of energy input. WWTPs are often ranked as the top individual energy consumers run by municipalities [6]. It was reported that in a conventional WWTP, about 25-40% of operating costs is ascribable to energy consumption [7]. The additional emissions of greenhouse gases in WWTP have also caused broad concern[8]. Thus, it needs to reduce energy input or improve energy independence in WWTPs.

Population growth and Energy Consumption in Nepal:

The population of Nepal in the past few years have grown radically which can be seen in Figure1, it ranged from 75000 in 1960 to around 3 million in 2018 and is estimated to grow further. Energy consumption for 1988 and 2002 by various fuels is shown Table 1. In terms of total consumption, fuelwood is the primary energy source in Nepal. However, in terms of commercial value, petroleum, coal, and electricity carry economic meaning although the use of these sources is less than 15% (in 2002) of the total energy consumption. The share of coal and electricity in total demand was almost equal in 1988. However, the demand for coal hasgone up significantly due to liberal coal imports policy Data shows that energy consumption in the residential sector has declined from about 94% in 1988 to about 88% in 2002. This decline in share is due to increased energy consumption in other economic sectors. The share of energy consumption has grown in the industrial and transport sector from 2.26% and 2.97% in 1988 to 5.70% and 4.43%, respectively, in 2002. In terms of total energy consumption, the average annual growth is about 2.7% [9].

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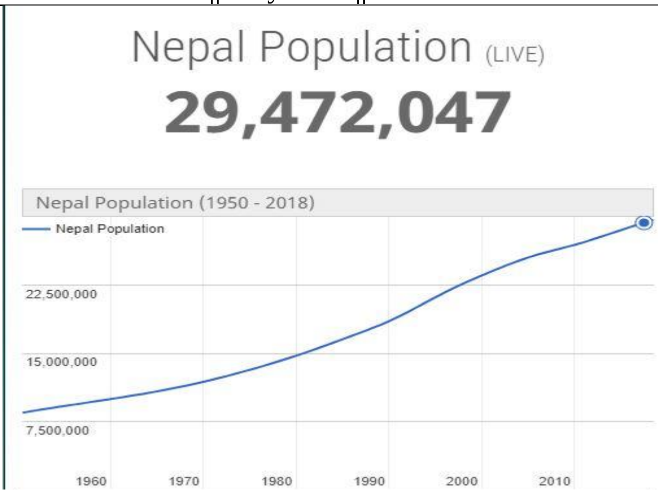

Figure 1: Population Growth Chart

Table 1: The Structure of Energy Consumption

Fuels/Year	1988	%	2002	%
Fuelwood	4754	84.77	6405	76.20
Other tradition	568	10.10	765	9.10
Coal	45	0.80	319	3.80
Petroleum	207	3.70	790	9.40
LPG	5		106	
Kerosean	70		297	
Ms Petrol	16		53	
HSD	80		267	
ATF	19		45	
Others	18		22	
Electricity	40	0.70	126	1.50
Total	5614		8405	
Sector				
Residental	5324	94.83	7432	88.42
Industrial	127	2.26	479	5.70
Transport	116	2.07	372	4.43
Service	41	0.73	103	1.23
Agriculture/Other	13	0.23	97	1.15
Total	5614		8450	

Energy consumption in all sectors and fuel types back casted from the year 2010 to 1996 using the economic parameters, as presented in BAU, where the back cast energy consumption and actual consumption showed in Figure 2. Grid-connected electricity has been the primary means of supply until2000, whereas from 2001 RETs such as Micro/Mini hydro and Solar PV have been promoted.In 2009 the share of renewable energy was 3.37% of the total installed capacity. In 2009, the installed capacity of the connected grid system was 645 MW, whereas Micro/Mini hydro and Solar PV had the capacity of 21.56 MW and 0.93 MW respectively.

In BAU the projected electricity consumption in 2030 is 7.97 TWh, which is 3.47 times higher than that of 2009. The estimated production capacity to cover this consumption is 2235 MW from the grid connected and from off-grid is 82 MW. The total electricity consumption in 2030 is expected to increase by a factor of 5.71 compared to that of in 2009. The total electricity consumption in 2009 was 2.3 TWh, whereas its consumption in 2030 is estimated to be 13.13 TWh. In HGS, it is projected that electricity consumption would increase by 10-fold in 2030 compared to the consumption that took place in 2009. The projected increase in the electricity consumption thus requires the installed capacity of about 6600 MW (the connected grid system), whereas the renewable energy technologies would be in the similar proportion as discussed in BAU and MGS. In all scenarios, it is obvious to claim that additional production capacity of electricity should take place to cope with the future demand of the country. The production capacity and the need to increase electricity can be demonstrated in Figure 3[10].

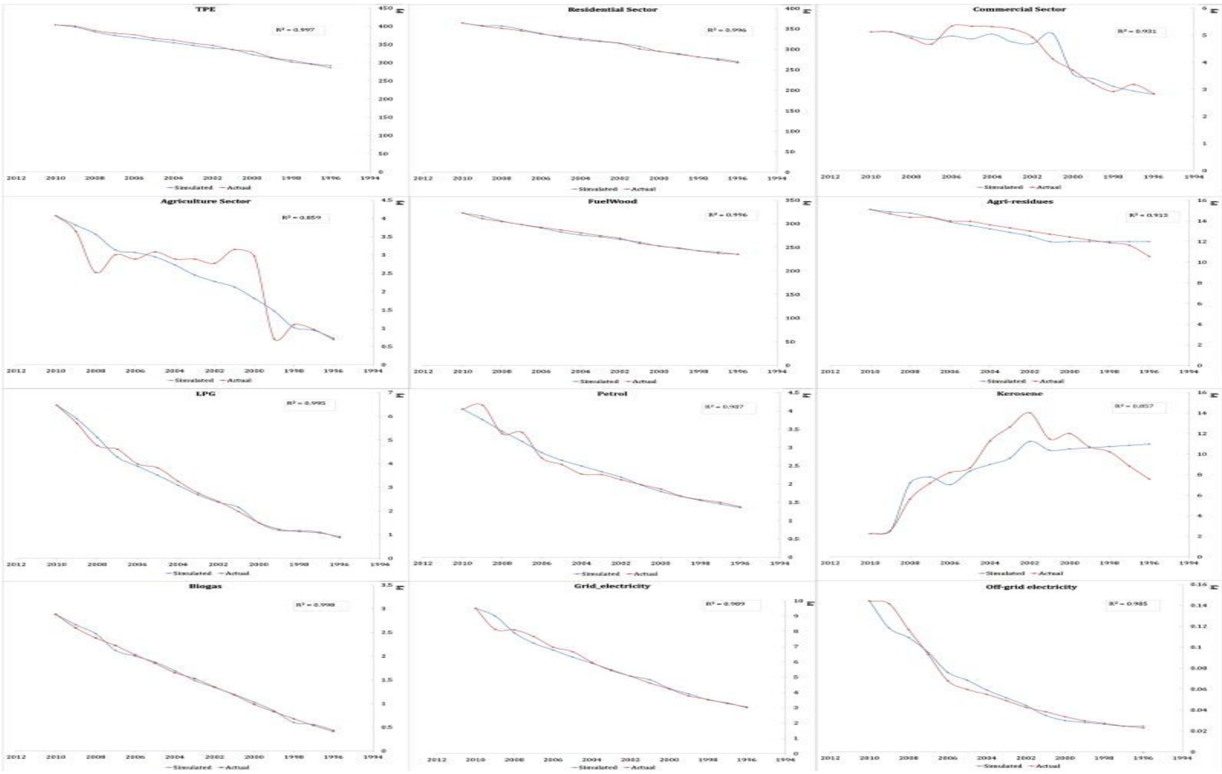

FIGURE 2: Back casted energy consumption and actual consumption

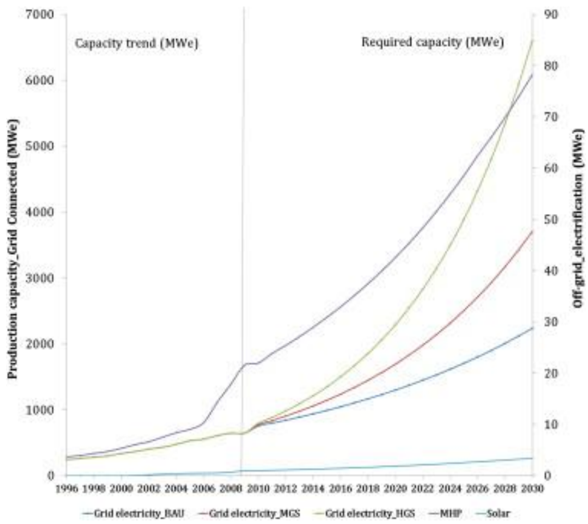

FIGURE 3: The production capacity and the need to increase of electricity

Year	Energy (GWh)	Peak Load (MW)
2008 - 9	3620.4	793.3
2009 - 10	4018.4	878.8
2010 - 11	4430.7	967.1
2011 - 12	4851.3	1056.9
2012 - 13	5349.6	1163.2
2013 - 14	5859.9	1271.7
2014 - 15	6403.8	1387.2
2015 - 16	6984.1	1510.0
2016 - 17	7603.7	1640.8
2017 - 18	8218.8	1770.2
2018 - 19	8870.2	1906.9
2019 - 20	9562.9	2052.0
2020 - 21	10300.1	2206.0
2021 - 22	11053.6	2363.0
2022 - 23	11929.1	2545.4
2023 - 24	12870.2	2741.1
2024 - 25	13882.4	2951.1
2025 - 26	14971.2	3176.7

FIGURE 4: Load Forecast (NEA 2008)

Biogas

Biogas is the combination of gas produced by methane-based bacteria acting upon biodegradable materials in an environment that is lacking air. Biogas is mainly composed of 60–70% methane, 30–40% carbon dioxide and some other gases. Biogas is colorless and burns with a clean blue flame similar to that of liquid petroleum gas (LPG) allowing for virtually smoke-free combustion. Biogas can be used for lightinign and cooking, refrigeration, engine operation, and electricity generation. To date, biogas is used mainly for cooking (80%) and lighting (20%) in Nepal. The technology has been available in Nepal since the mid-1970s, but it was not until the early 1990s that the number of installations was substantially scaled up by the Biogas Support Program (BSP). This program was established in 1992 by the Nepalese, Dutch and German governments[11].

Current status

Different historical records suggest that the first biogas plant in Nepal was established in 1955 in the capital city (Kathmandu). It was an exhibited model that was mainly constructed to determine the potential of biomass to produce energy. A chronology of biogas production events in Nepal is shown in Table 2. Similarly, FIGURE 5 shows the number of biogas plants established in the middle of 1982 and 2003 in Nepal. As shown in this figure, more than 111,000 biogas plants have been established in Nepal[12].

Biogas digester design in Nepal

Many diverse designs of biogas digesters are prepared both in small and large scale works throughout the world [13] In the circumstances of Nepal, fixed dome belowground biogas plants have been used thoroughly. This type of design was first introduced in 1990, which was a change of the Chinese [14] and Indian fixed dome models. A standard model used in Nepal is shown in FIGURE 6. [15]This design is in several sizes ranging from 4 to 20 m3. This type of design can be created almost entirely using locally accessible materials such as clay, brick, cement, bamboo, wooden supports, etc. Some of the health-related advantages achieved from the implementation of biogas plants in Nepal comprise: decreased smoke exposure in the indoor environment, reduced acute respiratory infections on the population of all ages, improved infant mortality rates, reduced eye ailments, reduced concentrations of carbon monoxide, formaldehyde and suspended particles in indoor environments [16].

Table 2: A chronology of biogas development

Year	Biogas related Activity
1955	First Demonstration model
19719774	Department of Agriculture executed a program to build 250 biogas plants; interest-free loan was provided
1980	Gobar Gas and Agricultural Equipment Development Company (GGC) transformed the Chinese fixed dome model
1990	The GGC modified fixed dome model accepted as a suitable model for Nepal
1991	Biogas Support Program (BSP), an independent organization, was established to oversee Nepal's biogas sector
1991-present	BSP continues to play an important role in biogas sector. Approximately, 140,000 biogas plants have been installed all over the country. Numerous private sector businesses have joined the market. Micro credit financing has gained popularity.

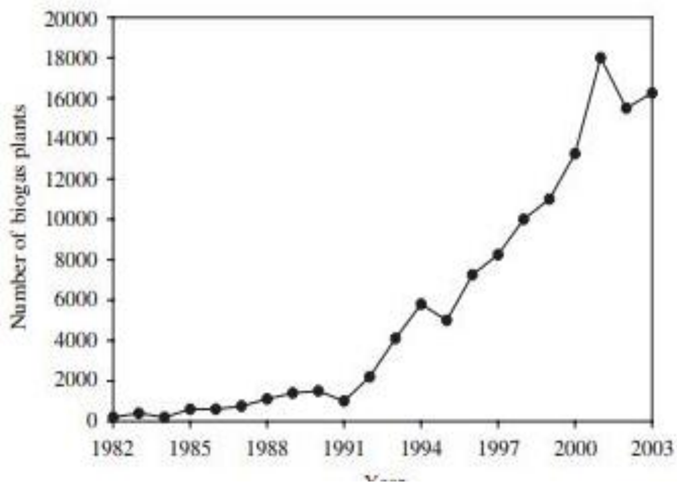

FIGURE 5: The number of biogas plants installed

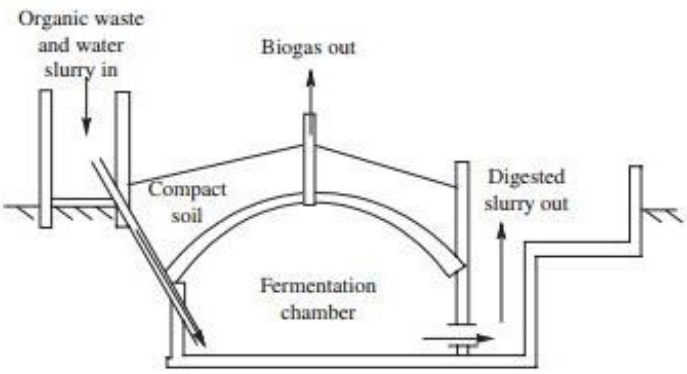

FIGURE 6: Biogas Design in Nepal

Bioelectricity

Anaerobic digestion (AD) utilizes biomass under anaerobic conditions to produce biogas, a mixture containing between 50 and 75% of methane with the rest being carbon dioxide [17]. The biogas can be used to generate heat and electricity. As a source of renewable energy, AD has the potential to improve the security of energy supply and help reduce greenhouse gas (GHG) emissions. It is also useful as an energy source that can be accessed on demand, unlike some other renewables such as wind and solar, which are more intermittent. Currently, 29 European countries have incentives that promote electricity generation from biogas. An example is Germany with around 7000 AD plants in 2010 [18] many of which are small (<75 kWe and farm-based. The AD operators receive between 12 and 25 Events for each kWh of electricity generated. Italy is another country where AD benefits from financial incentives with payments of 8.5e23 Vents/ kWh, depending on capacity; to date, there are around 1000 AD installations nationally. In the UK, the growth in AD installations was kick-started by the introduction of the feed-in tariffs (FITs) in 2010 and the Renewable Heat Incentive (RHI) in 2011 which pay for electricity and heat generation, respectively[18].

Conclusion

It is rather tragicomic to have a country like Nepal, richly endowed with water resources, suffer from the problem of load shedding. Almost a case of scarcity in the midst of plenty (actually not exactas only production potential is there, but the lack is due to no generation) which is parallel to another cliché: water, water everywhere, but not a drop to drink (a little closer to the truth). The primary source of fuel is still the biomass, which has contributed tothe emission of greenhouse gas. Biogas Plant has an old history with a promising future in Nepal with the increasing establishment in different parts of Nepal. This project is one of the successful projects of Nepal but is limited to only biogas generation, and use of the material is limited to farm waste only. All the biogas generation plants are manual and do not need electricity. The amount of domestic waste is higher than the industrial waste in Nepal, which is directly discharged in rivers. Wastewater treatment in Nepal is not in good condition because of the lack of proper functional wastewater treatment plant. In the total wastewater treatment plant, only some are working partially with the effluent level that does not meet the standard of Nepal. The alternative decentralized wastewater treatment plant has been established in various community level of which is currently functioning good but are manual so the sustainability of the treatment plants cannot be assured. The sludge generated from the wetland is not used in any energy generation process instead are dried for six months and are used as fertilizers. Throughout Nepal,no paper documents the generation of bioelectricity through biogas.

Recommendation

The problem is not too difficult to solve if only the hydrocrack starts to think 'outside the box.' The problem is rooted in a tunnel vision; Load shedding does not happen because the decision makers are unable to figure out what the demand will be for the years to come or because such data are not available to them. If the DEWATS system can be combined with the biogas generation as they both are working efficiently but separately, and bioelectricity can be generated then two problems could be solved with one solution. Most of the community would get at least a certain percentage of electricity, and the problem of wastewater would also be solved.

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