Unit 6

Development of Biogas Energy and its Impact on Users in Rural Nepal

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ABSTRACT

Energy is the key to development. The per capita energy consumption reflects the development situation of a country. In Nepal, feulwood is the primarily used in cooking in the rural area which has adversely affected the health condition of rural women. The potentiality of the development of biogas energy is very high in rural Nepal and it is mainly used for cooking. The smokeless energy in the household consumption has significantly reduced the workload of women and it has brought significant changes in their health condition. Though there is a huge potentiality of biogas energy development, it has to go many steps for its development. This paper highlights the present scenario and its historical development of biogas in Nepal. Moreover, it has deeply analyzed its effects on the rural biogas users mainly on women.

INTRODUCTION

The per capita energy consumption in Nepal is very low (14.6 GJ) and most of the energy is being used for domestic purpose. In Nepal, the sources of energy are primarily conventional. The energy consumption in 2002, by percent is 75.78 percent fuelwood, 9.23 percent petroleum product, 1.47 percent electricity, 5.74 percent animal waste, 3.75 percent agricultural residue, 3.53 percent coal and 0.48 percent renewable energy (WECS, 2003). This indicates that the dependency on forests for energy in Nepal is very high and forests are being used beyond their capacity causing deforestation and environmental degradation. Due to many constraints of technology, finance, politics and many others; the country has failed to create a favourable environment to harness the high potential of water resource and other as well.

Nepal is an agricultural country and important component of Nepalese agricultural system is livestock farming. The number of households with cattle or buffaloes in Nepal is estimated to be 2784583 and the potential biogas households is 1937006 (BSP, 2007).
By the end of 2006, a total number of 157675 plants have been installed which saves 305889 tones of feulwood per year, 4894000 liters of kerosene and produce 260005 tones of bio-compost every year (BSP, 2007).

Biogas is the mixture of gas produced by methanogenic bacteria while acting upon biodegradable materials i.e. cattle dung, human excreta and other organic wastes, in an anaerobic condition within the temperature of 26° to 35° for a certain period. It is mainly composed of 60-70 percent methane, 30-40 percent carbon dioxide and some other gases (BSP, 2003). Biogas is 20 percent lighter than air. It is colourless, odorless and smokeless gas that burns with clear blue flame similar to Liquid Petrolieum Gas (LPG). Its calorific value is about 20 MJ/m^3 and 60 percent efficient in a conventional biogas stove (AEPC, 2000).

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HISTORICAL DEVELOPMENT OF BIOGAS IN NEPAL

The history of biogas in Nepal goes back to 1955, when a Late Father B. R. Saubolle, a Belgian School Teacher at St. Xavier's School, Godavari in Kathmandu, built a demonstration plant of used oil drum. The development of biogas got its momentum after the world energy crisis in 1973, which caused the global interest in this sector. In 1975, as a part of Energy Research and Development Group (ERDG), a Biogas Development Committee (BDC) was formed (Ghimire, 2000).

When the Ministry of Agriculture observed the fiscal year 1975/76 as the 'Agriculture year', biogas was included as a special programme for its effectiveness in controlling deforestation and preventing burning of animal dung which otherwise could be used as fertilizer (IOE,2001). In 1975/76, two hundred and fifty family size biogas plants were installed by private contractors under the supervision of Department of Agriculture. All those plants were floating drum design based on Khadi and Village Industires Commission (KVIC) India (GGTKYS, 2000).

Agriculture Development Bank (ADB) of Nepal played an active role in the promotion of biogas technology. Similarly, Development and Consulting Services (DCS) of United Mission to Nepal (UMN), Balaju Yantra Shala (BYS) and Agricultural Tool Factory (ATF) were the pioneering agencies to make biogas programme success (IOE, 2001).

The Gobar Gas and Agricultural Equipment Development Company Pvt. Ltd. (GGC) were formed in 1977 as a private company for research, development and dissemination of the technology throughout the country. Research on various design of biogas plants such as floating drum, concrete fixed dome, pre-cast tunnel, plastic biodigester, ferro-cement gas holder, brick mortar dome were carried out and experimented. Among the various designs, the fixed dome design (GGC model 1990) has become popular in Nepal (Devkota, 2001).

Biogas Support Programme (BSP) was initiated in July 1992 to develop and promote the use of biogas in Nepal (BSP, 2003) with the financial support of Netherlands Development Organization (SNV). After the establishment of BSP, the pace of biogas plant installation has increased in an accelerating rate. By the end of the year 2002, the total number of 95,462 biogas plants have been installed under BSP (BSP, 2003). The office of BSP/N has reported that by the end of the third phase of biogas (July, 2003), the number of biogas plants has increased up to 1,10,000.

Though the government interest to support biogas program was noticed first in 1975/76 with the subsidy on biogas as interest free loan, the government plan for construction of biogas plants was first included in the Seventh Five Year Plan (1985-90) with the target to construct 4,000 plants. (IOE, 2001).

During the Eighth Five Year Plan (1992-97), the energy sector received high priority. Government had set a target of commissioning 30,000 plants, and the Ninth Five Year Plan (1998-2002) had fixed target of installing 1,00,000 plants during the period (IOE,2001).

After following the establishment of SNV/BSP in 1992 the government has fixed a flat rate subsidy in Terai, Hill and Remote Hill. The policy of government encouraged many new companies and NGOs to come in to being to participate in the programme. In 1997, The Alternative Energy Promotion Center (AEPC) was set up under the Ministry of Science and Technology which is recognized as a government body and has access to donors and support for the promotion of alternative energy in Nepal. (IOE, 2001). The third phase of BSP has become a joint-venture programme of SNV-Nepal Kreditanstalt for Wiederanfbau (KFW), Agricultural Development Bank Nepal (ADB/N), Rastriya Banijya Bank (RBB), Nepal Bank Limited (NBL) (Dev Part Consult-Nepal1997-98 in BSP, 2002). Other national and international agencies notably UNICEF, Save the Children, Plan International, Consolidated Management Services Nepal (P) Ltd. etc. have also made significant contribution in the growth of biogas technology in Nepal (IOE, 2001). In 1992, BSP was introduced at three different stages for massive dissemination of technology in the country with the long-term objectives of; reducing deforestation and environmental deterioration, improving health and sanitation of rural population especially women; and increasing the agricultural productivity by promoting the use of digested slurry. Hence, the program was divided into three different stages, 1992-1994 first phase, 1994 to 1997 second phase and 1997 to 2002 third phase. The numerical objective of BSP to the end of the third phase was to increase the number of biogas plants up to 100,000.

By the end of 2006, there are 157675 biogas plants, 65 private biogas companies, 16 biogas appliances manufacturing workshops and 130 micro-finance institutions which are supporting for the development of biogas energy. 98 percent of the plants are in operation and 102719 toilets are constructed. Now, it is developed as a Clean Development Mechanism (CDM) project in Nepal for the first time. Two CDM projects of 19396 biogas plants have been constructed under BSP phase IV and it registered with and approved by the CDM Executive Board. The expected outputs of BSP IV phase are to reduce the workload of 135000 households mainly women and girls by 3 hours / day / household. The saved time of the girls and women can be used in income generation, education and other development activities.

RESEARCH ON RAIPUR VDC

Recent study was carried out on biogas energy in Raipur VDC and the general objectives of the program is to find out the impact of biogas energy on users, mainly the rural women. The research methodology had been implied as selecting a small area of survey, however it is good enough topic to discuss as well as arise the development issue of biogas in Nepal. The universe of the study was Raipur VDC of Tanahun district. Using the random sampling, 40 households of biogas users were sampled. The total number of respondents were 40 including both male and female of different age groups. The respondents were chosen by using random sampling method. Both the primary and secondary data were various sources. The primary data collection tools were; the structured questionnaire, semi or unstructured interviews; and observation as well as Focus Group Discussion (FGD) and key informant interview. Simple statistical tools were used while analyzing the data.

Raipur lies in Tanahau district of Gandaki zone in Western Development Region of Nepal. The total area of the VDC is 23.49 sq. km. It is situated between 28°01’15" to 28℃04’00" North Latitude and 83℃56’15" to 84℃02’30" Longitude. This VDC is located at the height of 500m. to 1700m. from the mean sea level. It is 24 km away from the district headquarter to the western part of the district. To the east of this VDC, Bhimad and Bhanumati VDCs of Tanahau district; Kolma, Orastey, Kichanas VDCs of Syangja district to the west; Kolma VDC of Syangja district to the north and Firfire of Tanahun and Magyam VDCs of Syangja to the south are situated near by. The climate of the VDC is sub-tropical. It is neither too hot nor too cold. The temperature ranges from 25℃ to 32.5° C in the summer and 8℃ to 22℃ in the winter season. The monthly average rainfall is 556 mm in summer and in winter the rainfall is very low. The major contributor for energy supply in this VDC is the forest. Fuel wood energy is primarily used for cooking and heating. Kerosene is also being used for lighting purpose.

The trend of using renewable energy like solar, biogas and micro-hydro is increasing. Among the renewable sources; biogas is being used for cooking and solar and micro hydro power are being used for lighting, receiving T.V. and radio communication. At present, there are 135 biogas plants, 237 solar home systems and two micro hydro- power systems in the VDC. The total population of the VDC was 4908. Among them 2248 were male and 2660 were female.The population by the caste type was; Brahmin (39.9 percent), Magar (12.38 percent), Chhetri (7.6 percent), Newar (6.97 percent), Thakuri (6.89 percent), Bhujel (6.96 percent), Gurung (5.36 percent), Karki (0.41 percent) and Dalit (13.5 percent).

POTENTIALITY AND PRODUCTION OF BIOGAS IN NEPAL

Nepal is an agricultural country, and livestock farming is an important component in Nepalese farming system. A survey conducted in 1990/91 had estimated that the total population of cattle and buffalo to be 9.3 million (i.e. 6.3 million cattle and 3.0 million buffalo). Based on the study, technically biogas potential in Nepal is assumed to be around 1.49 million plants (BSP, 2003), and dung availability is assumed to be 23.1 million tons per day for biogas production. However, the potentiality of biogas may rise when we use other biodegradable sources like industrial waste, municipal wastes and other biomass. The geographical region wise production potential and production of biogas is reflected in the following Table 1:

Table 1
Potentiality and Biogas Production

Region	**Total Potential**	**Total Production**
Remote Hill	123962	715
Hill	723599	80992
Terai	1089445	75968
Total	**1937006**	**157675**

Source: BSP, 2007

The mountain region, due to the cold temperature is not feasible for biogas production. Only around 1 percent of biogas plants potential fall in this region, whereas the Hill shares 37 percent and plain 62 shares percent (BSP, 2007).

GOVERNMENT EFFORTS

Though many efforts were practiced, energy sector has received high priority since the Eighth Five Year Plan. For the promotion of biogas, following the establishment of SNV/BSP, the government adopted a subsidy policy and aimed at commissioning 30,000 plants. The Ninth Five Year Plan has formulated the 20 year long term renewable energy plan and it targeted to install 1,00,000 biogas plants. Similarly, the Tenth Five Year Plan has also taken renewable energy as a strong mechanism for poverty alleviation. It has fixed a target of planting 2,00,000 biogas plants (1,95,500 in household level and 500 in community level (NPC, 2002).

FINDINGS OF THE RESEARCH

a) Possessions of Livestock

Livestock rearing constitute important part of farming in the rural agricultural based economy. The entire households surveyed owned sizeable numbers of livestock. The surveyed households owned 104 heads of buffaloes and 95 cattle with an average of 5 heads per biogas user household. Besides, they owned goats, pigs, mules. The possession of livestock is given below in Table 2.

Table 2
Number of Livestock

Kinds of Livestock	Number		
	Big	Small	Total
Buffalo	92	12	104
Cattle	84	12	96
Goat	81	26	107
Pig	8	12	20
Mule/Horse	11	-	11
Chicken	46	81	127

Source: Field Survey, 2006.

b) Plant Size

The plant size of the sampled household was ranging from 4 m^3 to 10 m^3. The plant size and household numbers is presented in following Table 3.

Table 3

Plant Size

Plant Size (m^3)	HH	Percentage
4	1	2.5
6	17	42.5
8	16	40.0
10	6	15.0
Total	40	100

Source: Field Survey, 2006.

Mostly adopted size of the biogas plant was of 6 m^3 which shared 42.5 percent of the total plants followed by 8 m^3 with 40 percent. Size of 10 m^3 of biogas plants shared 15 percent and size of 4 m^3 was only one sharing 2.5 percent. It was also found that after 2056, the plant size of 6 m^3 had become popular. Before that size of 8 m^3 and 10 m^3 of biogas plants were adopted. The average size of the biogas plant was 7.35 m^3.

c) Capacity Utilization and Plant Feeding

In Nepal, it is the animal dung and human excreta mostly used to produce biogas. Though any biodegradable organic materials can be used for biogas production, people were not found using such materials other than the animal dung and human excreta. The required amount of dung for the different sizes of the biogas plants and production of gas in hilly region is presented in Table 4.

Table 4

Required Amount of Dung in Hilly Region

S.N.	Plant size (m^3)	Amt of dung (kg/day)	Amount of water (liter/day)	Use of a gas stove (hour)
1	4	24	24	2.5
2	6	36	36	3.5
3	8	48	48	5.0
4	10	60	60	6.0

Source: BSP, 2001.

From the above Table 4, it is calculated that the required amount of material per m^3 of biogas plant is 6 kg of dung and 6 liters of water.

It is generally recommended that a biogas plant of 6 m^3, which requires 5 livestock heads with the family (RUSEDA, 2001). In the study area, the average size of the plants was found to be 7.35 m^3 and the average number of livestock, (buffaloes and cows) was 5 heads per household. The number of livestock thus was manageable and the dung availability was sufficient. Theoretically, the required feeding material for 1 m^3 of biogas plants is 6 kg of dung and 6 liters of water. Calculating on this basis, the average amount of dung and water needed to feed regularly is 44.1 kg of dung and 44.1liters of water. The feeding status ofplants in the study area is presented in Table 5 below.

Table 5

Feeding of Plants

Dung (kg/day)	Household	Water (liter/day)	Household
15-20	5	35-40	9
20-25	16	40-45	11
25-30	13	45-50	12
30-35	6	50-55	8

Source: Field Survey, 2006.

From the above, the feeding of plants in an average was 25 kg of dung and 44.87 liters of water per day. Comparing to the theoretical amount, (44.1 kg of dung and 44.1 liters of water) the feeding amount of dung was quite lesser. In spite of the sufficient availability of dung, it was surprising to find out the plant underfed.

d) Production and Use of Gas

The use of the biogas in the study area was found limited to cooking human foods. People were found using firewood for heating purposes in spite of the availability of gas.The average time of using biogas per household for burning one stove was calculated to be 2:45 hours per day. The status of biogas production is presented below in Table 6.

Table 6

Status of Biogas Production

Gas Production in Summer			Gas Production in Winter		
Rank	**HH**	**%**	**Rank**	**HH**	**%**
Sufficient	29	72.5	Sufficient	10	25
Manageable	8	20	Manageable	7	17.5
Less	3	7.5	Less	23	57.5
Total	40	100	Total	40	100

Source: Field Survey, 2006.

In summer 29 (72.5 percent) households responded that gas production is sufficient in summer but in winter 10 (25 percent) households responded that the gas production is sufficient. Only 3 (7.5 percent) households responded that gas production is less in summer but in winter, 23 (57.5 percent) households said that gas production less.

e) Impact of Biogas Energy on Health

The respondents were asked to express their opinion about the status of general health problems of the family members before and after the installation of biogas plants. It is generally accepted that biogas technology helps to reduce various diseases because of improvement of in door as well as outdoor environment after the installation of biogas plants with toilet attachment with plants. A comparison of the status of frequently complained health problems before and after the installation of biogas plants is presented in the following Table 7 and Table 8.

Table 7

Health status of men before and after biogas installation

S.N.	Diseases/Problems	Before		After	
		Yes	No	Improved	Same
1	Cough	23	17	11(47.83)	12(52.57)
2	Eye Infection	15	25	6(40)	9(60)
3	Headache	19	21	10(52.63)	9(47.27)
4	Respiratory	7	33	4(57.14)	3(42.86)

Source: Field Survey, 2006.
Numbers in parenthesis show percent.

Table 8

Health Status of Women Before and After Biogas Installation

S.N.	Diseases/Problems	Before		After	
		Yes	No	Improved	Same
1	Cough	32	8	24(75)	8(25)
2	Eye Infection	28	12	21(78.57)	76(21.43)
3	Headache	29	11	24(82.76)	5(17.24)
4	Respiratory	16	24	2(12.5)	14(8.75)

Source: Field Survey, 2006.
Numbers in parenthesis show percent.

The major health problems of the people; headache, coughing, respiratory and eye infection were found reduced after the installation of the biogas plants. The above tables show that though the health status of both man and woman had improved, woman were found more benefited then men comparatively.

The respondents who stated improvement in their health condition explained that they used to cook food on firewood. The smoke and other noxious gases caused health problems. After biogas installation, because of the smoke free and clean environment, their health status improved.

f) Workload of Men and Women

The impact of biogas on the workload of different activities undertaken by men and women is shown in Table 9 and Table 10.

Table 9

Time saving of men

S.N.	Works	Time in Minutes		Time Saved (Minutes)
		Before biogas	After biogas	
1	Water fetching	-	-	-
2	Firewood Collection	40	10	30
3	Dung Collection	-	10	-10
4	Mixing Slurry	-	10	-10
	Total	**40**	**30**	**10**

Source: Field Survey, 2006.

Table 10

Time Saving of Women

S.N.	Works	Time in Minutes		Time Saved (Minutes)
		Before biogas	After biogas	
1	Fuelwood Collection	50	20	30
2	Cooking	190	135	55
3	Cleaning Vessels	50	25	25
4	Water Fetching	15	30	-15
5	Dung Collection	-	10	-10
6	Mixing Slurry	-	10	-10
	Total	**305**	**230**	**75**

Source: Field Survey, 2006.

The time presented on the above tables was the average value of the biogas user households. On an average of 10 minutes of time of male per day was saved due to the installation of the biogas plants. The women were found definitely benefited as compare to men from the biogas technology. In total women were found to save 75 minutes (1:15 hours) of time per day. They had saved time significantly in collecting fuelwood, cooking and washing vessels.

g) Fuelwood Consumption

Still, in rural areas, fuelwood is the most commonly used energy source for household consumption. The development of biogas energy can be an alternative to it. The saving of fuelwood consumption after installation of biogas plants is presented in following Table 11.

Table 11

Saving of Fuelwood after Biogas Installation

Amount (Bhari)/year	Households
40-50	4
50-60	14
60-70	12
70-80	10

Source: Field Survey, 2006.
1 Bhari = 30 kg (approximately)

From the above table, the mean value of saving of fuelwood of each household per year was 62 bhari (approximately equivalent to 1.8 metric tone). In rural areas trees are cut down from the forest regularly to meet fuelwood requirements. Therefore, introduction of biogas contributed significantly to preserve the forest eco-system, environment and bio-diversity.

h) Women's Participation in Decision Making

Specific information were collected form the sampled households about decision making on plant installation, toilet attachment and site and company selection. Though the matter of biogas installation, site selection, toilet attachment were found discussed between male and female before commissioning the biogas plants, males had played the leading role. The data presented in following Table 12 shows women's sub-ordination and their passive role in decision making process of plant installation, company selection, and other pre plant installation activities.

Table 12
Gender Participation in Decision Making

S.N.	Kinds of decision	Male	Female	Both	Total
1	Plant installation	28(70)	2(5)	10(25)	40(100)
2	Site selection	18(45)	16(40)	6(15)	40(100)
3	Company Selection	35(87.5)	1(2.5)	4(10)	40(100)
4	Toilet attachment	21(87.5)	17(42.5)	2(5)	40(100)
5	Cattle shed management	29(72.5)	6(15)	5(12.5)	40(100)
6	Financial management	37(92.5)	1(2.5)	2(5)	40(100)

Source: Field Survey, 2006
Number in parenthesis show the percent.

Very few women had access to the activities like marketing and decision making for the installation of biogas plants. The decisions made on biogas plant installation were male dominated. Female participation and their role was higher in site selection (40 percent), and toilet attachment (42.5 percent), in comparison to other activities.

i) Women's Participation in Plant Management

Women's role in different phases of management of biogas plants including planning, resourcemobilization, implementation and supervision is shown.

Table 13
Women's Participation in Management

S.N.	Management Aspects	Rating		
		Active	General	Passive
1	Planning	9(22.5)	3(7.5)	28(70)
2	Resource Mobilization	4(10)	5(12.5)	31(77.5)
3	Implementation	7(17.5)	4(10)	29(72.5)
4	Supervision	3(7.5)	5(12.5)	32(80)

Source: Field Survey, 2006.
Number in parenthesis show the percent.

From the above Table 13, it is revealed that female had played passive role in management of all phases of biogas including planning, resource mobilization, implementation and supervision. Among the sampled households, only in 9 households, women had played the active role in planning while the figures for resource mobilization, implementation and supervision are 10 percent, 17.5 percent and 7.5 percent respectively. This shows that women had played more supportive role rather than the active or lead role.

j) Women's Participation in Plant Construction

Both male and female were found actively participating in the construction phase of the biogas plants. The skilled labours for the plant construction were sent by the biogas company. So, the participation of local people (both male and female) while constructing the plants was limited to unskilled labour contribution; such as collecting sand and stone, making concrete, etc. Though both male and female were found actively participating, the wage rate was different.

Table 14
Labour contribution and wage rate

		Skilled		Unskilled	
S.N.	Description	Day	Wage/Day(Rs)	Day	Wage/Day(Rs)
1	Male	10	250	17	100
2	Female	-	-	13	80

Source: Field Survey, 2006.

Both skilled and unskilled labours were used for plant construction. The use of labour and the wage rate presented in Table 14 shows that female were not used for the skilled labour. Only male were used for skilled labour at a rate of Rs. 250 per day. Similarly they were used at a rate of Rs. 100 per day for unskilled labour contribution while female were used at a rate of Rs. 80 per day for the same task. This reveals that women need to be provided trainings so that they can participate in the skilled job during the construction phase of biogas plants.

REASONS FOR INSTALLING BIOGAS

The followings are the reasons to install biogas plants in rural parts of Nepal:

- To build toilet and keep households environment clean and healthy,
- To make cooking easier and faster,
- To make smokeless kitchen,
- To make easier to clean cooking pots,
- To avoid difficulties of cooking on firewood,
- To reduce firewood consumption, and
- To build up a social prestige.

PERCEPTION OF PEOPLE ABOUT BENEFITS FROM BIOGAS

Focus group discussion of biogas users revealed the following benefits they have achieved from biogas plants:

- Saving of firewood,
- Easy for cooking and smokeless indoor environment,
- Reduction of workload mainly of women and school girls,
- Saving of time,
- Extra time availability for school children,
- Clean and healthy environment,
- Proper management of toilet,
- Raising living standard,
- Forest protection, and
- Easier for cleaning utensils.

CONCLUSION

Energy is undoubtedly a fundamental means for meeting the needs of life support system and developmental efforts. Nepal's energy supply is primarily based on three sectors; traditional, commercial and renewable. Traditional energy sources are the primary sources of energy in the rural area. Rural Nepal has better options and resource potential for the development of renewable energy. It can be developed without destroying the environmental condition. Biogas energy is emerging as the major contributor in the current renewable energy resources development.

The sampled households were found using biogas energy except for cooking domestic foods. Even below optimum amount of production of biogas was found sufficient for them. If people feed biogas plants properly and use biogas energy for other activities along with cooking domestic food, the quantity of saving of fuelwood consumption would increase considerably.

The development of biogas technology would be a milestone in the overall development of rural areas. It can be produced from locally available biodegradable materials. It can cut down the use of both imported and traditional energy sources. Therefore, government, I/NGOs, social organizations and private sector should join hands and come up with better plans, policies and pragmantic strategies for extending biogas energy to the poorer section of people in rural areas.

RECOMMENDATIONS

The following recommendations have been proposed for the further development of biogas technology in the rural area in particular and throughout the country in general.

* Local peoples should be provided trainings on the operation, management, repairing, maintenance and supervision of the biogas plants.
* Effective awareness programmes should be launched for the capacity utilization of biogas plants. Such as slurry management, utilization and marketing system of biogas.

* Trainings should be given to people on the techniques and methods of slurry management of compost preparation.
* Biogas companies should provide regular supervision and monitoring of the biogas plants.
* People should be made aware that not only animal dung but also any other biodegradable materials can be identified and used for the production of biogas energy.
* A policy of clean development mechanism and carbon trading in international market. It will be beneficial to sustain the technology in rural area and gradual poverty reduction.

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