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Factors affecting the design and economic operation of distribution networks and its investigation in the 0.4 KV distribution network of Ghazni City

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Abstract
The design of power distribution systems should be such that it can technically respond to the increase in electricity demand properly and economically, optimally designed and high network reliability. In order to respond to the increase in electricity demand, load forecasting must be done so that in addition to providing the electricity needed by customers, expansion of power generation centers, expansion of substations, expansion of transformer stations and selection of their appropriate location can be done optimally. In this article, we first examine the definitions and factors that are technically and economically effective in the economic design of energy distribution systems. And in the next stage, we will see whether these above-mentioned effective factors are considered in the 0.4 kV distribution network of Ghazni city or not.

Keywords: electricity demand, transformer station, distribution systems, design of energy distribution systems, subscribers

Introduction

Ghazni city for the first time in 04/01/2018 benefited from imported electricity. A part of Ghazni city has been supplied with electricity by a diesel generator and private companies since 1977 using a non-standard network. Currently, about 4.5 megawatts of electricity is distributed in Ghazni city and it is planned to increase to 25 megawatts in the coming years. The distribution network of Ghazni city in the fourth period of 1398 had 11.66% of waste and the lowest price of peak voltage was in the last part of Pashtunabad village, which reached 180 volts. Medium voltage networks (20 kV and less), low voltage and distribution systems are occasionally developed to be able to power new consumers.

If this development is not planned according to international standards and standards, and this is accompanied by poor quality equipment, damaged buildings and insufficient maintenance and care, as well as theft of energy, defects in the meter system, electricity transmitted without meters, etc. It will result in an extraordinary loss of electricity and low quality standards and reliability of extremely low consumption in the systems. As a result, the transmission of electrical energy by the power grid system from the source to the consumer will waste the main equipment (line and transformer), will cause a certain amount of electrical energy to be absorbed by the active resistors of the equipment and transferred to the environment. The second compound is passive resistors that convert electrical energy into electromagnetic energy.

Research Methodology

This scientific article is a field research article. The present research method is divided into two main parts:

1- Gathering information

2- Examining the samples and analyzing the obtained knowledge.

Data collection has been done in two ways:

Observation method and documentary method

Factors affecting the network design and economic operation of electrical distribution systems

One of the main tasks of power distribution companies is to provide constant voltage and frequency for subscribers, continuity of power supply and safety of the distribution network.

The selection of electricity distribution network is done according to factors such as route (lane length, route type, transverse route limitation), population density, economic factors and environmental beauty. Unauthorized use of 0.4 kV distribution networks is easier and more common due to the availability of the network, and preventing it, in addition to having a cost, causes local social tensions.
In general, the following points should be considered for the design of the distribution network:

- Full knowledge of the geographical location of the place
- Prepare location maps to standard scales
- Determine the number of subscribers by their energy consumption and their distance from the power transformer.
- Determining the cross section of network wires by considering the power consumption on each circuit and their distance from the power transformer.
- Place the transformers in the center of gravity of the load (in this case the voltage loss is minimized)
- The length of each circuit of the transformer should not exceed the allowable limit (500-600) meters.
- The possibility of future development and increase in consumption should be considered.

The amount of load consumed should not be considered as the maximum total load, but the load synchronization coefficient should be calculated by considering the load factor and the required transformer should be selected. determining the capacity of the transformer using existing international standards.
Considering that the electricity industry is one of the most vital industries in the country, so it requires great attention and investment, this industry needs huge and long-term investment in production, transmission and distribution, which is part of the country's economic potential Focuses on itself.
Current distribution networks have many problems in proper performance. These problems create difficult conditions for operation, especially in periods of maximum demand, and reduce the quality and reliability of the system.

Electric load graph
Load refers to a device or set of devices or consumers that receives electricity from the grid. Electric load graph is a graph of consumption changes in time, which is shown daily, weekly, monthly and annually. Load forecast of a city or region Electric load graph is usually drawn monthly, seasonally and annually. Different consumers do not receive their maximum load simultaneously from the network and depending on the type of consumption, the time to receive the maximum varies. Figure (1) shows the electric charge graph of the Ghazni Breshna distribution network in 24 hours.

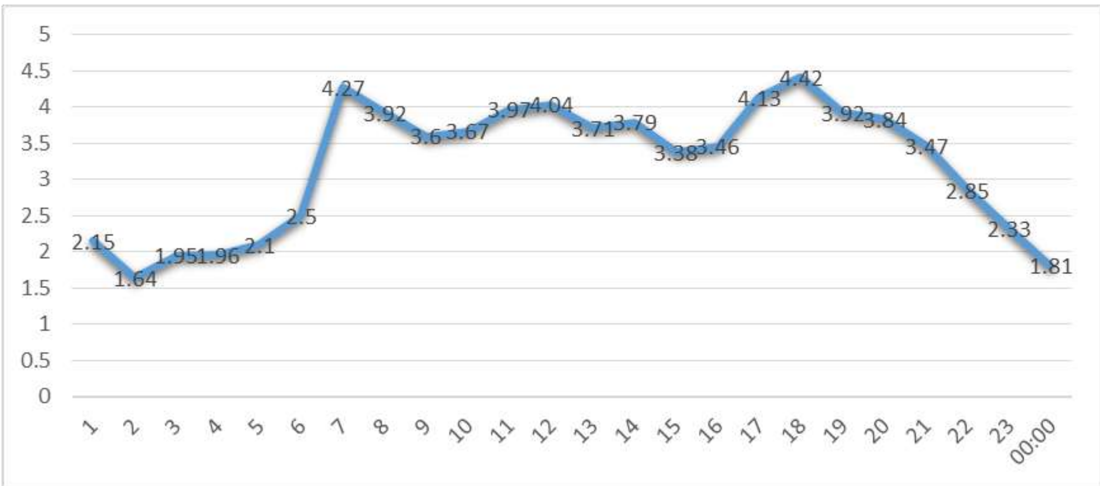

Fig 1. Electric load graph of Ghazni distribution network in 24 hours

With the electric charge graph, we can obtain the average load and the load factor.

$$m = \frac{P_m}{P_{\max}} = \frac{3.203}{4.42} = 0.724$$

The closer the load factor is to one, the optimal use of the networks and the smoother the load graph, ie the average load is closer to the maximum load, which is very low in the distribution network of Ghazni city.

Type of load
In selecting the network, the choice of load type (residential, commercial, industrial, peasant loads) must be specified Factors influencing overload, which are (population, civilization and improving living standards) must be considered. Factors influencing load forecasting are:

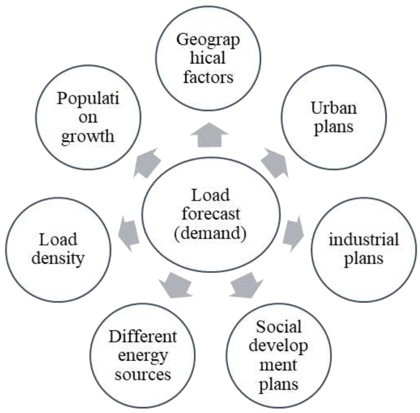

Fig 2. Factors affecting load forecasting

Considering the synchronization coefficient in the electricity distribution network is one of the effective factors.

Considering that the satisfaction of the subscribers is finally tangible in the distribution sector and the smallest defect shows itself more. Therefore, in this regard, serious measures in power distribution networks for the design and optimal use of power systems and compliance with standards is a necessity. Due to the vastness of electricity distribution networks on the one hand and the lack of engineering of these networks due to its high age, it is necessary to review these networks. In the table below, the state of 0.4 kV distribution network in Ghazni city is briefly studied.

Table 1: Status of low voltage lines of Ghazni distribution networ

NO	The name of the junction	Transformer station name	Transformer number	Transformer Capacity (KVA)		Circuit number	Circuit length (m)	Number of subscribers in the network	Circuit mode (normal / overload)	Circuit Overload%	Status of meter boxes and Fuse (good / very good / replaceable)	Considerations
1	Ghazni Breshna has no Junction	Rowza No. 1	TR001	200		C#1	500	97	Normal		Good	Overload transformers of Ghazni city distribution network are whiten the allowed range
						C#2	540	74	Normal		Good	
						C#3	405	145	Normal		Good	
2		Rowza No. 2	TR002	400		C#1	700	90	Normal		Good	
						C#2	800	150	Normal		Good	
						C#3	750	190	Normal		Good	
3		Rowza No. 3	TR003	200		C#1	855	27	Normal		Good	
						C#2	945	26	Normal		Good	
						C#3	550	28	Normal		Good	
						C#4	450	11	Normal		Good	
4		Rowza No. 4	TR004	160		C#1	650	55	Normal		Good	
						C#2	400	11	Normal		Good	
						C#3	750	32	Normal		Good	
						C#4	700	21	Normal		Good	
5		Khwaja Baqal	TR005	160		C#1	600	135	Normal		Good	
						C#2	500	120	Normal		Good	
6		Shahre Kohna	TR006	400		C#1	730	122	Overload	15%	Replaceable	
						C#2	758	141	Normal		Replaceable	
						C#3	464	156	Normal		Replaceable	
						C#4	435	189	Overload	20%	Replaceable	
7		Bahlool Sahib	TR007	160		C#1	630	108	Normal		Replaceable	
						C#2	350	66	Normal		Good	
						C#3	495	88	Normal		Replaceable	
8		Al-Biruni (Bahlool Saheb Gardens)	TR008	160		C#1	808	102	Normal		Good	
						C#2	612	149	Normal		Good	
						C#3	941	17	Normal		Good	
9		Diesel House No. 1	TR009	800		C#1	1260	173	Overload	20%	Replaceable	
						C#2	900	111	Normal		Replaceable	
						C#3	700	3	Overload	15%	Replaceable	
						C#4	900	156	Normal		Replaceable	
						C#5	900	90	Normal		Replaceable	
						C#6	1150	137	Normal		Replaceable	
10		Hakim Sahib No. 1	TR010	250		C#1	600	42	Normal		Good	
						C#2	500	29	Normal		Good	
						C#3	550	20	Normal		Good	
11		Hakim Saheb No. 2	TR011	200		C#1	228	76	Normal		Good	
						C#2	284	51	Normal		Good	
						C#3	389	47	Normal		Good	
12		Shamir Sahib	TR012	800		C#1	581	90	Normal		Replaceable	
						C#2	730	213	Overload	20%	Replaceable	
						C#3	419	122	Normal		Replaceable	
13		Qala-e-Now sare reg	TR013	200		C#1	250	34	Normal		Good	
						C#2	650	153	Normal		Good	
						C#3	600	66	Normal		Good	

14		Diesel House No. 2	TR014	1000		C#1	1080	138	Normal		Good	
						C#2	990	315	Normal		Good	
						C#3	300	39	Normal		Good	
						C#4	350	11	Normal		Replaceable	
						C#5	855	35	Normal		Good	
15		Qala-e-Now Khajeh Roshnai	TR015	160		C#1	415	75	Normal		Good	
						C#2	743	144	Normal		Good	
						C#3	994	122	Normal		Good	
16		Maihan Abad	TR016	160		C#1	265	24	Normal		Good	
						C#2	300	52	Normal		Good	
						C#3	87	4	Normal		Good	
17		Pashtun Abad No. 1	TR017	400		C#1	491	59	Normal		Good	
						C#2	148	9	Normal		Good	
						C#3	678	158	Normal		Replaceable	
						C#4	495	43	Normal		Good	
18		Pashtun Abad No. 2	TR018	200		C#1	552	99	Normal		Good	
						C#2	414	90	Normal		Good	
						C#3	475	64	Normal		Replaceable	
19		Qala-e-Amir Mohammad Khan No. 1	TR019	160		C#1	484	60	Normal		Good	
						C#2	400	106	Overload	20%	Replaceable	
						C#3	921	132	Normal		Good	
20		Qala-e-Amir Mohammad Khan No. 2	TR020	200		C#1	945	155	Normal		Good	
						C#2	150	17	Normal		Good	
						C#3	498	49	Overload	10%	Replaceable	
21		Fourth Plan	TR021	800		C#1	810	119	Normal		Replaceable	
						C#2	855	149	Normal		Good	
						C#3	585	69	Normal		Good	
						C#4	810	97	Normal		Good	
22		Saqafat center	TR022	250		C#1	400	1	Normal		Good	
23		Faiz Mohammad Katib Road No. 1	TR023	200		C#1	300	119	Normal		Replaceable	
						C#2	450	123	Normal		Good	
						C#3	250	31	Normal		Good	
24		faiz Mohammad Katib Road No. 2	TR024	400		C#1	850	92	Normal		Good	
						C#2	700	107	Normal		Replaceable	
						C#3	550	134	Normal		Good	
						C#4	500	84	Normal		Good	
25		Nawabad Qadam Khan Castle	TR025	250		C#1	550	147	Normal		Good	
						C#2	600	115	Normal		Good	
26		Qadam Khan Castle Hill	TR026	200		C#1	900	104	Normal		Good	
						C#2	450	147	Normal		Good	
27		Qadam Khan Castle	TR027	200		C#1	400	26	Normal		Good	
						C#2	800	92	Normal		Good	
						C#3	500	20	Normal		Good	
						C#4	250	45	Normal		Good	
28		Haider Abad No. 1	TR028	200		C#1	600	122	Normal		Replaceable	
						C#2	450	191	Normal		Replaceable	
						C#3	500	69	Normal		Replaceable	
						C#4	300	54	Normal		Good	
29		Haider Abad No. 2	TR029	200		C#1	300	160	Normal		Replaceable	
						C#2	750	138	Normal		Replaceable	
						C#3	650	40	Normal		Good	
						C#4	350	11	Normal		Good	
30		Sanjetak	TR030	160		C#1	765	44	Normal		Good	
						C#2	500	23	Normal		Good	
						C#3	1200	74	Normal		Good	
31		Khwaja Ali Sahib	TR031	250		C#1	550	205	Normal		Good	
						C#2	850	86	Normal		Good	
32		Third Plan	TR032	800		C#1	990	99	Normal		Good	
						C#2	810	110	Normal		Good	
						C#3	675	61	Normal		Good	
						C#4	250	19	Normal		Good	
33		Said Ahmad Makaee	TR033	800		C#1	550	99	Normal		Good	
						C#2	850	67	Normal		Replaceable	

						C#3	650	57	Normal		Good	
						C#4	550	135	Overload	25%	Replaceable	
34		Qala-e- Tahwildaran	TR034	250		C#1	850	183	Normal		Good	
						C#2	350	99	Normal		Good	
						C#3	400	25	Normal		Good	
						C#4	1000	130	Normal		Good	
35		Qala-e- Ahengran	TR035	200		C#1	700	57	Normal		Good	
						C#2	500	48	Normal		Good	
						C#3	495	68	Normal		Good	
						C#4	540	35	Normal		Good	
36		Khashik No. 1	TR036	200		C#1	855	156	Normal		Good	
						C#2	400	94	Normal		Good	
						C#3	720	39	Normal		Good	
37		Khashik No. 2	TR037	200		C#1	1260	356	Normal		Good	
						C#2	495	48	Normal		Good	
						C#3	990	61	Normal		Good	
						C#4	350	23	Normal		Good	
38		Khashik No. 3	TR038	250		C#1	495	68	Normal		Good	
						C#2	540	73	Normal		Good	
						C#3	720	76	Normal		Good	
39		Khak Ghariban No. 1	TR039	160		C#1	540	200	Normal		Replaceable	
						C#2	500	125	Normal		Replaceable	
40		Khak Ghariban No. 2	TR040	100		C#1	350	70	Normal		Replaceable	
						C#2	945	82	Normal		Replaceable	
						C#3	855	90	Normal		Replaceable	

Result and Discussion

Providing high quality services, continuity of electricity supply and economical distribution network and its safety is one of the main tasks of electricity distribution companies that non-compliance with standards in the design and economic operation of distribution networks has adverse effects on all of the above in economic design and operation, waste distribution networks increase network uncertainty and waste of capital, which reduces the efficiency of the system. By observing the standards in the economic design and operation of distribution networks and waste reduction, more electricity can be supplied to the subscribers. Based on the results of this study, it is suggested to pay attention to the following:

- Transformers should be placed in the center of gravity of the load as much as possible.
- 5 Transformers in which the voltage conversion takes place in three stages (20/6 / 0.4 KV) should be replaced to transformers in which the voltage conversion takes place in two stages (20 / 0.4 KV).
- The length of each transformer feeder should not exceed 500 to 600 meters.
- To reduce the length of the feeders, multiple low-capacity transformers should be used instead of high-capacity transformers.
- Possibility of future development and increase of consumption according to the overload coefficient and load sharing coefficient.
- Balancing the output loads of transformers should be considered as much as possible.
- If the load of the transformer is high, replace the transformer with a transformer with a higher capacity, otherwise it will be necessary to separate the network and add another transformer to the network.

Conclusion

The studies conducted in this article show that the 0.4 kV distribution network in Ghazni is traditionally designed and unfortunately it is not taken into consideration and is not taken seriously, and this has increased the current costs of the distribution network and in return Has and has adverse effects on consumers. Non-observance of standard distances; The choice of capacity and installation location of the transformer without technical calculations has caused voltage losses and overload of transformers in the network.

- Four transformers in the distribution network of Ghazni city are overloaded, two transformers with a capacity of 160KVA were 20% overloaded and two transformers with a capacity of 200KVA were 15% overloaded, and their overload is within the allowable limit.
- The distance of 57 circuits is in the range of (1260-700) meters, which is not allowed, and also the use of subscribers with shorter cross-section lines has reduced the voltage, which reaches 170 volts in some parts of the network.
- The power of transformers is traditionally chosen so that one kilovolt of amperes is provided for each family.
- The electric charge graph of the Ghazni city distribution network shows that it is not a cost-effective network.

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