Blackout Avoidance through Intelligent Load Shedding in Modern Electrical Power Utility Network

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Abstract

During the last few decades many blackouts have occurred throughout the world. It seems that modern power systems are more vulnerable to major blackouts. Power system in Pakistan is no exception where blackouts affect the economy and hinder the development of the country. Pakistan Electric Power Company (PEPCO) is responsible for generation, transmission, and distribution of electric power in Pakistan. Major blackouts occur due to failure of the protection system of the power transmission network. The remedy for such collapses is disconnection of non-preferred load through Intelligent Load Shedding (ILS) technique. In this paper, the Intelligent Load Shedding is simulated in Electrical Transient Analysis Program (ETAP) software. The technique has been applied on 220kV transmission network of Quetta Electric Supply Company (QESCO), a power distribution company in Balochistan province of Pakistan. This paper focuses on preventing entire QESCO network from cascaded tripping and blackout during N-2 contingency situations. It has been established that implementation of Intelligent Load Shedding is not only helpful for protecting the transmission network of the distribution company, like QESCO, from blackout, but also protects smart grid from blackouts and other power collapses.

Keywords: Power System; Blackout; Cascaded Tripping; Intelligent Load Shedding; N-2 Contingency

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INTRODUCTION

Electrical power nowadays is considered as the life line for any society. Unavailability of uninterrupted electric power results in failure of public transport system, traffics jams, educational institution outages, breakdown of industries and so on. Electrical power outages literally cripple the economy of a country.

The European Network of Transmission System Operators for Electricity defined blackout as “the interruption of electricity generation, transmission, distribution and consumption processes, when operation of the transmission system or a part thereof is terminated”. Power blackout is a complicated phenomenon and occurs due to unusual events in a power network (Adibi, 2015) The initiators of power system blackout have been generalized to atmospheric phenomena, technical causes and human factors (Złotecka and Sroka, 2018). The mechanisms of large scale power blackouts can be analysed through power failure models (Wang et al., 2018). Traditional methods have been used to prevent blackout. Merz and Mc Lellan proposed that in a power blackout situation, power protection system plays a crucial role. Protection system prompts swift isolation of the faulty component, thereby avoiding blackout through a smart protection system (McLellzm, 2010). M. El-werfelli et al. analysed the causes of Libyan blackout and concluded that improper protection of the generating units led to the power network blackout. He also suggested that there should be proper co-ordination between the protection systems of the generating units and power grid. Erica Fong introduced “Alert Management System” to control the energy demand by very large number of consumers that could cause potential blackout. The Alert management system supervises the serious energy intake events for avoiding the system outage. The system could be installed at the supplier's side to prevent energy usage interruption and blackout (Fong et al., 2011). Adeniyi A. Babalola used the technique of an adaptive multi-agent system algorithm to prevent cascading failure (Babalola and Belkacemi, 2018).

The power sector of Pakistan faces frequent blackouts. A lot of work has been done for the blackout avoidance. Younas and Qureshi investigated in 2006 National Grid blackout and suggested the installation

of power system controllers like Power System Stabilizers (PSS) and Flexible AC Transmission Systems (FACTS) (Younas and Qureshi, 2006). For highly stressed grids, Noman Bashir and Zohaib Sherani introduced Ashiyana, an improved and practical form of Direct Load Control (DLC). It was better than manual load-shedding systems as it could decrease the number of customer with no power by 80%. This technique also prevented the utility companies from facing social unrest as well as power security to consumers (Bashir et al., 2015). Blackouts started in Pakistan after 1980. The network of National Grid is connected in an inter-connected system (Kafait-Ullah, 2013).
The main focus of this research work is to avoid blackout in Quetta Electric Supply Company (QESCO) region of Pakistan and to improve the quality of service of the National Grid. In this research work idea of Intelligent Load Shedding (ILS) system has been presented. Through ILS non-preferred load of a power system can be shed at any time. The concept of intelligent load shedding is simulated through Electrical Transient Analysis Program (ETAP).
Table 1 shows various blackouts that occurred in different countries of the world due to transmission lines faults (Scutariu and MacDonald, 2009).

Table 1: Blackouts due to line fault

Date	Country	Power Loss (GW)	Population Affected (million)	Blackout Cause
Jan-2007	Croatia	1.30	2	Numerous overloads
Aug2003	USA	6.1	50	High voltage drops
Sep2003	Denmark	6.6	4	Islanded system breakdown
Sep2003	Italy	0.24	57	Loss of synchronism
Nov2006	Poland	1.7	15	Line overloads
Jan-2016	Pakistan	0.12	56	220kV Towers damage

MATERIALS AND METHODS

Implementation of ILS through ETAP

Intelligent Load Shedding (ILS) is the process of optimal and fast disconnection of non-preferred load from a power system to keep the rest of the system operational (Yagami and Ichinohe, 2017). Intelligent Load Shedding is sometimes called automatic load shedding. The purpose of this load reduction is to protect the whole power system or power utility network from large disturbances and power outages.

220 kV Transmission System of QESCO

Quetta Electric Supply Company (QESCO) is responsible for supplying electrical power throughout Balochistan province of Pakistan except district Lasbela which is fed by K-Electric Karachi. QESCO has the power network of three 220kV transmission lines coming from different locations. Following is the detail of 220kV transmission lines of QESCO network:

1. 220kV Daddu (Sindh)-Khuzdar (Balochistan) region
2. 220kV DG-Khan (Punjab)-Loralai (Balochistan) region
3. 220kV Guddu (Sindh) – Sibbi (Balochistan) region

The total 132kV transmission lines and grid stations fed by above 220kV transmission lines are listed in Table-2.
We can convert this load (ampere) into three phase real power (MW) and apparent power (MVA) if we have the voltage and power factor of the load. We have;

$$P = \sqrt{3}\, VIcos\theta$$

Where,
P = Real Power (MW)
V = Voltage across load (v)
I = Load Current (A)
$cos\theta$ = Load Power Factor

The Single Line Diagram (SLD) of all connected loads, transformers and transmission lines are given in Figure-1.

Table 2: Maximum Connected Load of QESCO Region

S.No.	Name of Grid Station	Transformers Connected	Maximum Load (A)	Maximum Load (MVA)	Maximum Load (MW)	Date
1	132kV G/S Sariab	T-I (40MVA)	1275	25.4	20	20-04-2017
		T-II (40MVA)	1640	32.7	26	20-04-2017
2	132kV G/S Marriabad	T-I (26MVA)	1010	20	16	18-04-2017
		T-II (26MVA)	490	9.8	7.8	18-04-2017
3	132kV G/S Quetta City	T-I (40MVA)	1483	29.5	23.6	27-04-2017
		T-II (40MVA)	1500	30	24	27-04-2017
4	132kV G/S Shiekhmanda	T-I (40MVA)	1460	29	23.3	21-04-2017
		T-II (40MVA)	1490	30	24	21-04-2017
5	132kV G/S Pishin	T-I (40MVA)	1490	30	24	08-04-2017
		T-II (40MVA)	1760	35	28	08-04-2017
		T-III (6.3MVA)	76	1.5	1.2	08-04-2017
		T-IV (40MVA)	1280	25.5	20.4	08-04-2017
6	132kV G/S Q/Abdullah	T-I (40MVA)	1280	25.5	20.4	18-04-2017
		T-II (26MVA)	1280	25.5	20.4	18-04-2017
		T-III (26MVA)	1280	25.5	20.4	18-04-2017
7	132kV G/S Sorrange	T-I (7.5MVA)	246	5	4	12-04-2017
8	132kV G/S Yaru	T-I (26MVA)	1320	26.3	21	10-04-2017
		T-II (26MVA)	1050	21	16.7	10-04-2017
9	132kV G/S Alizai	T-I (26MVA)	940	18.7	15	21-04-2017
		T-II (26MVA)	885	17.6	14	21-04-2017
10	132kV G/S Huramzai	T-I (26MVA)	1280	25.5	20.4	22-04-2017
11	132kV G/S Chaman	T-I (13MVA)	972	19.4	15.5	23-04-2017
		T-II (26MVA)	990	19.7	15.8	23-04-2017
12	132kV G/S Kuchlak	T-I (26MVA)	741	14.76	11.8	21-04-2017
13	132kV G/S Gulistan	T-I (40MVA)	1571	31.3	25	16-04-2017
		T-II (26MVA)	1574	31.4	25	16-04-2017
		T-III (26MVA)	1242	25	20	16-04-2017
14	132kV G/S Sharig	T-I (6.3MVA)	260	5.2	4	08-04-2017
15	132kV G/S Hernai	T-I (6.3MVA)	274	5.5	4.4	13-04-2017
16	132kV G/S Mach	T-I (6.3MVA)	250	5	4	26-04-2017
17	132kV G/S Bagh	T-I (26MVA)	910	18	14.5	19-04-2017
18	132kV G/S Darwaza	T-I (26MVA)	1180	37	30	26-04-2017
19	132kV G/S Khanak	T-I (26MVA)	1180	37	30	15-04-2017
		T-II (26MVA)	800	16	12.8	15-04-2017
20	132kV G/SSibbi	T-I (26MVA)	1150	23	18	16-04-2017
		T-II (26MVA)	1100	22	17.5	16-04-2017
21	132kV G/S Loralai	T-I (26MVA)	1096	21.8	17.5	12-04-2017
		T-II (40MVA)	1885	37.5	30	12-04-2017
		T-III (6.3MVA)	0	0	0	12-04-2017
22	132kV G/S Makhter	T-I (13MVA)	393	7.8	6.2	15-04-2017
23	132kV G/S Kingri	T-I (6.3MVA	266	5.3	4.2	15-04-2017
24	132kV G/S Rakhni	T-I (13MVA)	440	8.8	7	21-04-2017
		T-II (26MVA)	860	17	13.7	21-04-2017
25	132kV G/S Barkhan	T-I (26MVA)	698	14	11	20-04-2017
		T-II (13MVA)	550	11	8.8	20-04-2017
26	132kV G/S Kohlu	T-I (13MVA)	601	12	9.6	27-04-2017
27	132kV G/S Zhob	T-I (13MVA)	475	9.5	7.6	03-04-2017
		T-II (26MVA)	955	19	15.2	03-04-2017
28	132kV G/S Q/Saifullah	T-I (40MVA)	995	19.8	15.8	09-04-2017
		T-II (40MVA)	1030	20.5	16.4	09-04-2017
		T-III (40MVA)	990	19.7	15.8	09-04-2017
29	132kV G/S M. Bagh	T-I (26MVA)	1070	21.3	17	25-04-2017
		T-II (26MVA)	860	17	13.7	25-04-2017
30	132kV G/S G.H Zai	T-I (26MVA)	1100	22	17.5	07-04-2017
		T-II (13MVA)	170	3.4	2.7	07-04-2017
31	132kV G/S M Pur	T-I (6.3MVA)	230	4.6	3.7	03-04-2017
		T-II (26MVA)	430	8.6	6.8	03-04-2017
32	132kV G/S Khanozai	T-I (26MVA)	1163	23	18.5	28-04-2017
		T-II (26MVA)	1194	24	19	28-04-2017
33	132kV G/S Ziarat	T-I (26MVA)	670	13.3	10.7	28-04-2017
34	132kV G/S Dukki	T-I (13MVA)	990	19.7	15.8	12-04-2017
		T-II (13MVA)	370	7.4	6	12-04-2017
35	132kv G/S Mastung	T-I (26 MVA)	1110	22	17.7	08-04-2017
		T-II (26 MVA)	906	18	14.4	08-04-2017
		T-III (26 MVA)	920	18.3	14.7	08-04-2017

36	132kv G/S Panjpai	T-I (26 MVA)	700	14	11	14-04-2017
		T-II (13MVA)	440	8.8	7	15-04-2017
37	132kv G/S Kirdgab	T-I (26 MVA)	1010	20	16	17-04-2017
		T-II (13MVA)	500	10	8	21-04-2017
38	132kv G/S Noshki	T-I (26 MVA)	990	19.7	15	22-04-2017
		T-II (26 MVA)	1282	25.5	20.4	23-04-2017
39	132kv G/S Kharan	T-I (26 MVA)	880	17.5	14	20-04-2017
		T-II (26 MVA)	820	16.3	13	20-04-2017
		T-III (26 MVA)	1160	23	18.5	20-04-2017
40	132kv G/S Khad Kucha	T-I (26 MVA)	1170	23.3	18.6	10-04-2017
		T-II (26 MVA)	1170	23.3	18.6	13-04-2017
41	132kv G/S Mangochar	T-I (40MVA)	1920	38.2	30.6	28-04-2017
		T-II (26 MVA)	1100	22	17.7	28-04-2017
		T-III (26 MVA)	1120	22.3	17.8	28-04-2017
42	132kv G/S Kalat	T-I (26 MVA)	1270	25	20	14-04-2107
		T-II (40 MVA)	980	19.5	15.6	14-04-2107
		T-III (26 MVA)	800	16	12.7	14-04-2107
43	132kv G/S Surab	T-I (26 MVA)	940	18.7	15	07-04-2017
		T-II (13MVA)	650	13	10.4	07-04-2017
44	132kV G/S Gidder	T-I (40 MVA)	1060	21	17	25-04-2017
		T-II (13MVA)	630	12.6	10	25-04-2017
45	132kV G/S Bagh Bana	T-I (40 MVA)	1300	26	20.7	13-04-2017
		T-II (26 MVA)	590	11.8	9.4	13-04-2017
46	132kV G/S Khuzdar	T-I (40 MVA)	1570	31.3	25	07-04-2017
		T-II (18MVA)	700	14	11	07-04-2017
		T-III (26 MVA)	1060	21	17	07-04-2017
47	132kV G/S Nal	T-I (26 MVA)	1150	23	18	03-04-2017
		T-II (26 MVA)	1290	25.7	20.6	03-04-2017
48	132kV G/S Wadh	T-I (26 MVA)	1126	22.4	18	07-04-2017
		T-II (13MVA)	617	12.3	9.8	07-04-2017
		T-III (13MVA)	390	7.8	6.2	07-04-2017
49	132kV G/S Zehri	T-I (26 MVA)	1110	22	17.7	10-04-2017
		T-II (13MVA)	360	7.2	5.7	10-04-2017
50	132kV G/S Dalbandin	T-I (26 MVA)	150	3	2.4	22-04-2017
51	132kV G/S Mall	T-I (26 MVA)	1200	24	19	21-04-2017
52	132kV G/S Chaghi	T-I (13MVA)	40	0.8	0.6	15-04-2017
53	132kV G/S Baseema	T-I (13MVA)	221	4.4	3.5	23-04-2017
TOTAL LOAD CONNECTED			**94592**	**1912**	**1527**	

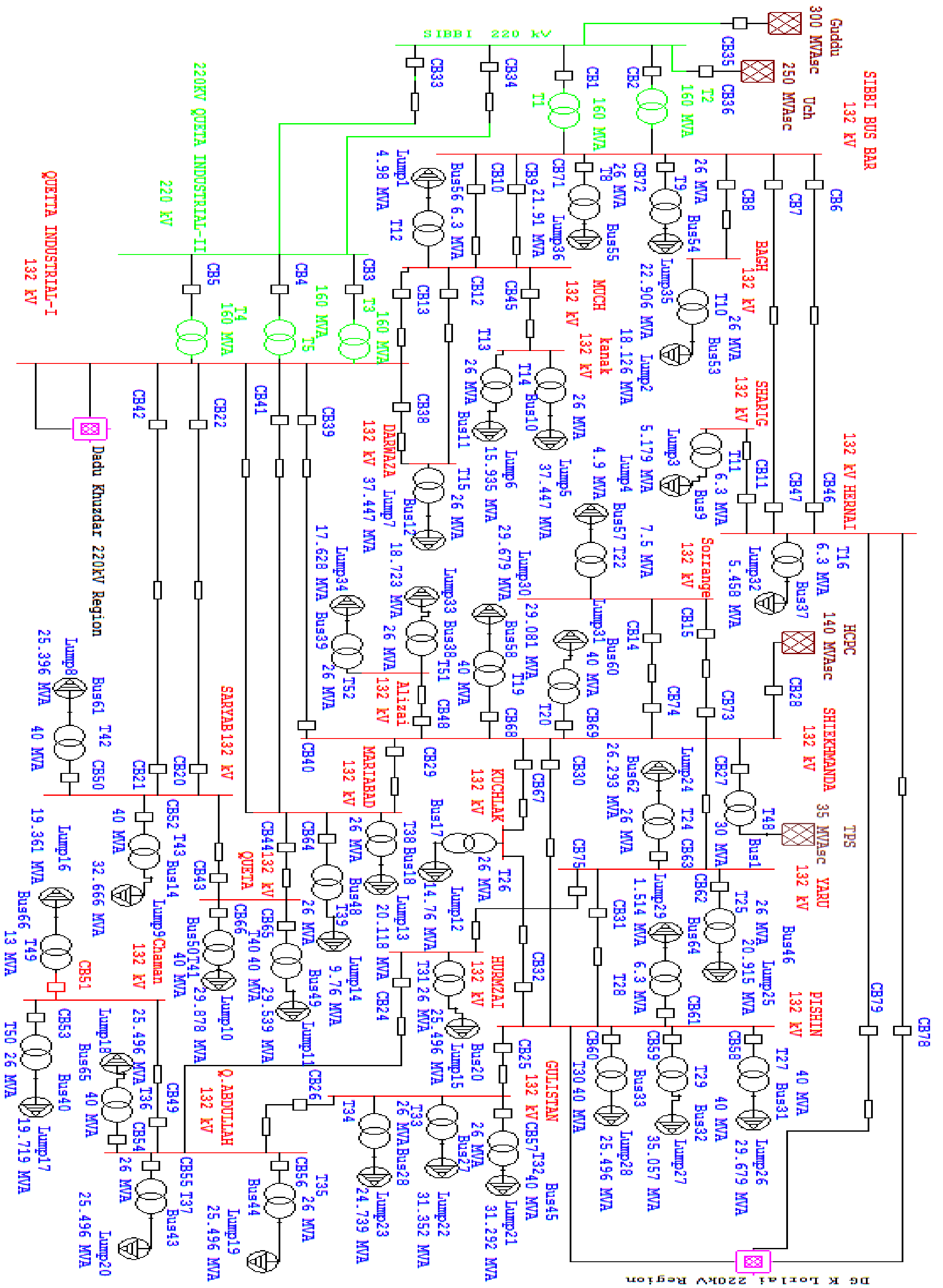

Figure 1: Maximum connected load of QESCO region (Single Line Diagram)

The main objective of this research paper is to shed the non-preferred load of the QESCO network in the event of fault, in order to avoid complete power blackout of the company network. The 220kV transmission lines are connected with the National Grid in an inter-connected manner. To implement intelligent load shedding, Electrical Transient Analysis Program (ETAP) simulation tool is used. Load priority table containing the non- preferred (loads to be shed) is designed in ETAP as shown in Table-3. The load flow analysis is carried out for N-2 contingency situations i.e. when both Daddu-Khuzdar and DG Khan-Loralai 220kV transmission lines are tripped.

Table 3: Load Priority Table

S.No	Name of Grid Station	Transformers Connected	Circuit Breaker Number	Maximum Load (A)	Maximum Load (MVA)	Maximum Load(MW)
1	132kv G/S Panjpai	T-I (26 MVA)	CB138	700	14	11
		T-II (13MVA)	CB138	440	8.8	7
2	132kv G/S Kirdgab	T-I (26 MVA)	CB137	1010	20	16
		T-II (13MVA)	CB137	500	10	8
3	132kv G/S Noshki	T-I (26 MVA)	CB132	990	19.7	15
		T-II (26 MVA)	CB132	1282	25.5	20.4
5	132kv G/S Kharan	T-I (26 MVA)	CB158	880	17.5	14
		T-II (26 MVA)	CB158	820	16.3	13
		T-III (26 VA)	CB158	1160	23	18.5
6	132kv G/S Mangochar	T-I (40MVA)	CB155	1920	38.2	30.6
		T-II (26 MVA)	CB153	1100	22	17.7
		T-III (26 VA)	CB152	1120	22.3	17.8
7	132kv G/S Surab	T-I (26 MVA)	CB128	940	18.7	15
		T-II (13MVA)	CB129	650	13	10.4
8	132kV G/S Gidder	T-I (40 MVA)	CB120	1060	21	17
		T-II (13MVA)	CB120	630	12.6	10
9	132kV G/S Bagh Bana	T-I (40 MVA)	CB121-CB122	1300	26	20.7
		T-II (26 MVA)	CB121-CB122	590	11.8	9.4
10	132kV G/S Nal	T-I (26 MVA)	CB118	1150	23	18
		T-II (26 MVA)	CB118	1290	25.7	20.6
11	132kV G/S Wadh	T-I (26 MVA)	CB119	1126	22.4	18
		T-II (13MVA)	CB119	617	12.3	9.8
		T-III (13MVA)	CB119	390	7.8	6.2
12	132kV G/S Zehri	T-I (26 MVA)	CB154	1110	22	17.7
		T-II (13MVA)	CB154	360	7.2	5.7
13	132kV G/S Dalbandin	T-I (26 MVA)	CB131	150	3	2.4
14	132kV G/S Mall	T-I (26 MVA)	CB131	1200	24	19
15	132kV G/S Chaghi	T-I (13MVA)	CB130	40	0.8	0.6
16	132kV G/S Baseema	T-I (13MVA)	CB160	221	4.4	3.5
17	132kV G/S Makhter	T-I (13MVA)	CB90	393	7.8	6.2
18	132kV G/S Kingri	T-I (6.3MVA	CB89	266	5.3	4.2
19	132kV G/S Rakhni	T-I (13MVA)	CB98-CB99	440	8.8	7
		T-II (26MVA)	CB98-CB99	860	17	13.7
20	132kV G/S Barkhan	T-I (26MVA)	CB100	698	14	11
		T-II (13MVA)	CB100	550	11	8.8
21	132kV G/S Kohlu	T-I (13MVA)	CB101	601	12	9.6

22	132kV G/S Zhob	T-I (13MVA)	CB85	475	9.5	7.6
		T-II (26MVA)	CB85	955	19	15.2
23	132kV G/S M. Bagh	T-I (26MVA)	CB81	1070	21.3	17
		T-II (26MVA)	CB81	860	17	13.7
24	132kV G/S G.H Zai	T-I (26MVA)	CB83	1100	22	17.5
		T-II (13MVA)	CB83	170	3.4	2.7
25	132kV G/S M Pur	T-I (6.3MVA)	CB84	230	4.6	3.7
		T-II (26MVA)	CB84	430	8.6	6.8
26	132kV G/S Khanozai	T-I (26MVA)	CB102	1163	23	18.5
		T-II (26MVA)	CB103	1194	24	19
27	132kV G/S Ziarat	T-I (26MVA)	CB86	670	13.3	10.7
28	132kV G/S Dukki	T-I (13MVA)	CB77-CB79	990	19.7	15.8
		T-II (13MVA)	CB77-CB79	370	7.4	6
29	132kV G/S Q/Abdullah	T-I (40MVA)	CB24-CB26	1280	25.5	20.4
		T-II (26MVA)	CB24-CB26	1280	25.5	20.4
		T-III (26MVA)	CB24-CB26	1280	25.5	20.4
30	132kV G/SSorrange	T-I (7.5MVA)	CB14-CB15	246	5	4
31	132kV G/SAlizai	T-I (26MVA)	CB48	940	18.7	15
		T-II (26MVA)	CB48	885	17.6	14
32	132kV G/SHuramzai	T-I (26MVA)	CB75	1280	25.5	20.4
33	132kV G/SChaman	T-I (13MVA)	CB49	972	19.4	15.5
		T-II (26MVA)	CB49	990	19.7	15.8
34	132kV G/SKuchlak	T-I (26MVA)	CB67-CB32	741	15	12
35	132kV G/SGulistan	T-I (40MVA)	CB25-CB26	1571	31.3	25
		T-II (26MVA)	CB25-CB26	1574	31.4	25
		T-III (26MVA)	CB25-CB26	1242	25	20
36	132kV G/S Sharig	T-I (6.3MVA)	CB11	260	5.2	4
37	132kV G/S Hernai	T-I (6.3MVA)	CB168	274	5.5	4.4
38	132kV G/S Bagh	T-I (26MVA)	CB8	910	18	14.5
39	132kV G/S Darwaza	T-I (26MVA)	CB12-CB38	1180	37	30
40	132kV G/S Khanak	T-I (26MVA)	CB45	1180	37	30
		T-II (26MVA)	CB45	800	16	12.8
41	132kV G/SMastung	T-I (26 MVA)	CB144	1110	22	17.7
		T-II (26 MVA)	CB143	906	18	14.4
		T-III (26 VA)	CB144	920	18.3	14.7
42	132kV G/SQ.Saifullah	T-I (40MVA)	CB 183	995	19.8	15.8
		T-II (40MVA)	CB 186	1030	20.5	16.4
		T-III (40MVA)	CB 193	990	19.7	15.8
43	132kV G/SKalat	T-I (40 MVA)	CB150	1060	21	20
		T-II (26MVA)	CB126	630	12.6	15
44	132kV /SKhadKucha	T-I (26 MVA)	CB 136	1170	23.3	18.6
		T-II (26 MVA)	CB 145	1170	23.3	18.6
TOTAL LOAD SHED				**67097**	**1364**	**1091**

RESULTS AND DISCUSSION

The projected load demand and capacity of the three 220kV transmission lines of QESCO grid network is summarized in Table-4 (Marwat, 2017). It is clear from Table-4 that even in normal situation there is a shortage of 155 MW in the network.

Table 4: Analysis of QESCO Network

Network Topology	Maximum Demand (MW)	Load (MW)	Losses (MW)	Remarks
Daddu- Khuzdar is tripped	1961	1329	77	555 MW needs to be shed
Guddu-Sibbi is tripped	1961	1244	176	541 MW needs to be shed
DG-khan Loralai is tripped	1961	1292	133	536 MW needs to be shed
All 220 kV lines connected	1961	1698	108	155 MW needs to be shed

The load flow analysis after implementation of ILS in ETAP is shown in Table-5 while the Single Line Diagram highlighting the active loads is given in Figure-2. The results of load flow analysis and SLD shows that with implementation of ILS the blackout of QESCO network could be avoided. The preferred load is still energized while the non-preferred load is shed as defined in load priority table.

Table 5: Load Flow of Energized Load of QESCO

S. NO.	Name of grid station	Transformers Connected	Bus ID	Maximum Load (A)	Maximum Load (MVAR)	Maximum Load(MW)
1	132kV G/S Sariab	T-I (40MVA)	61	1275	-15	-20
		T-II (40MVA)	14	1640	-19.6	-26
2	132kV G/S Marriabad	T-I (26MVA)	18	1010	-12	-16
		T-II (26MVA)	48	490	-5.8	-7.8
3	132kV G/S Quetta City	T-I (40MVA)	49	1483	-17.7	-23.6
		T-II (40MVA)	50	1500	-18	-24
4	132kV G/S Shiekhmanda	T-I (40MVA)	60	1460	-17.4	-23.3
		T-II (40MVA)	58	1490	-17.8	-24
5	132kV G/S Pishin	T-I (40MVA)	31	1490	-17.8	-24
		T-II (40MVA)	32	1760	-21	-28
		T-III (6.3MVA)	64	76	-0.9	-1.2
		T-IV (40MVA)	33	1280	-15.3	-20.4
6	132kV G/S Yaru	T-I (26MVA)	62	1320	-15.8	-21
		T-II (26MVA)	46	1050	-12.5	-16.7
7	132kV G/S Hernai	T-I (6.3MVA)	37	274	-3.3	-4.4
8	132kV G/SSibbi	T-I (26MVA)	54	1150	-13.4	-18
		T-II (26MVA)	55	1100	-13.2	-17.5
9	132kV G/SKhuzdar	T-I (40 MVA)	67	1570	-18.8	-25
		T-II (18MVA)	68	700	-8.4	-11
		T-III (26 MVA)	71	1060	-12.7	-17
10	132kV G/SKalat	T-II (40 MVA)	125	980	-11.7	-15.6
11	132kV G/SLoralai	T-I (26MVA)	157	1096	-13.1	-17.5
		T-II (40MVA)	156	1885	-22.5	-30
12	132kV G/SQ/Saifullah	T-I (40MVA)	165	995	-11.9	-15.8
		T-II (40MVA)	166	1030	-12.3	-16.4
		T-III (40MVA)	164	990	-11.8	-15.8
13	132kV G/S M. Bagh	T-I (26MVA)	167	1070	-12.8	-17
		T-II (26MVA)	168	860	-10.3	-13.7
TOTAL LOAD ENERGIZED				**32084**	**-382.8**	**-510.7**

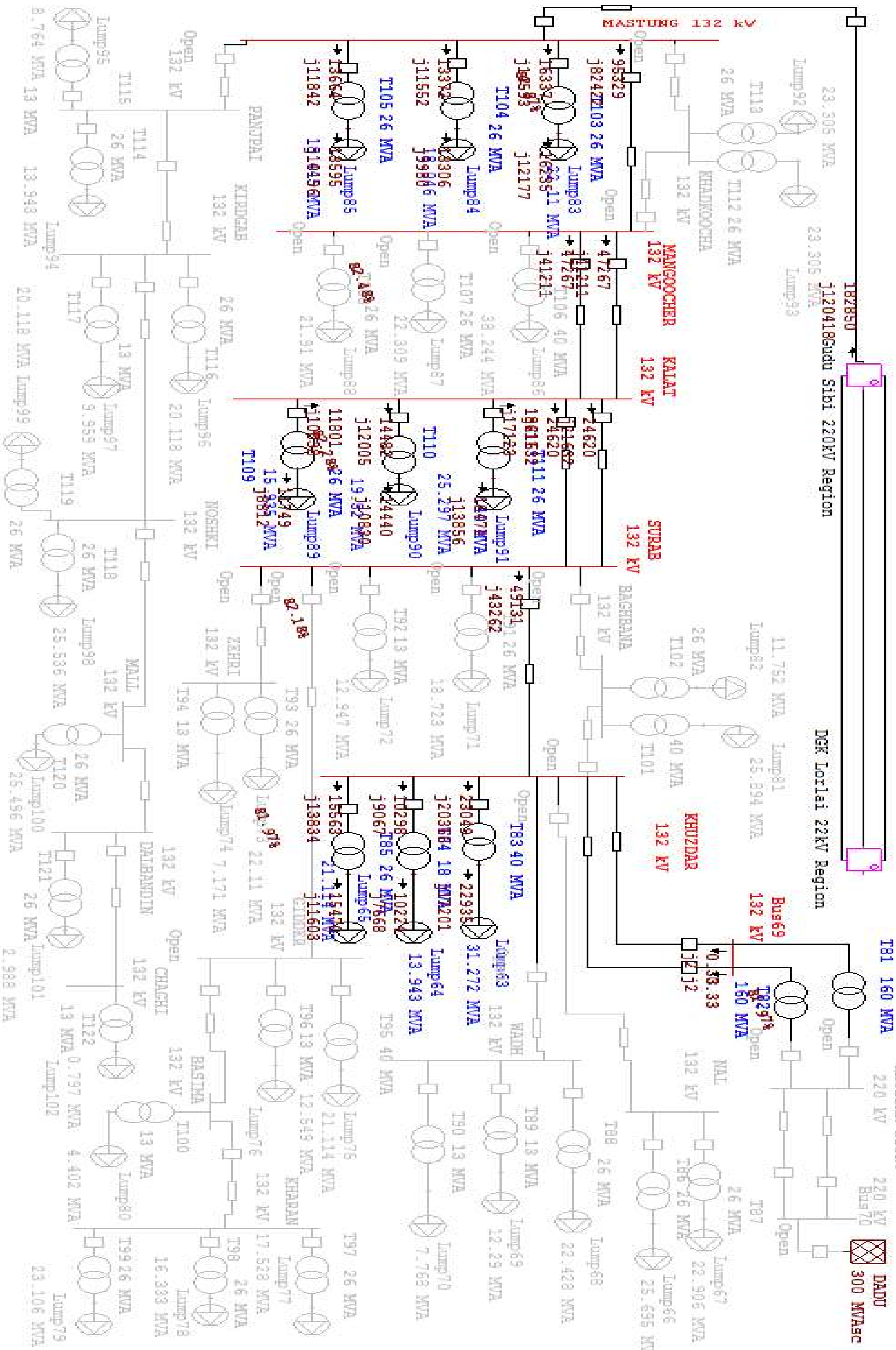

Figure 2: Load Flow of Energized Load of QESCO

As, we were deficient of combined input power of both Daddu-Khuzdar and D.G Khan-Loralai (220kV lines), we disconnected 1091 MW of load through Load Priority Table in Table-3.

CONCLUSION

The maintenance and sustained operation of electrical power system is complex and cumbersome job. In Pakistan, it is more challenging to prevent the National Grid from blackouts and maintain the electrical power system stability. To avoid power system blackout, in this research work an idea of Automatic Node-Switching or Intelligent Load Shedding (ILS) system is introduced. Through ILS non-preferred load of a power system has been disconnected to avoid the tripping of whole power utility network. For simulating ILS, Electrical Transient Analysis Program (ETAP) software was used. The Automatic Node-Switching operation of ETAP Real-Time is based on maintaining system stability with minimum load shed. The Automatic Node-Switching has been applied at the 220kV transmission network of QESCO through different scenarios. The technique of ILS, if applied, is helpful in maintaining the stability and power security of National Grid or any one of the Distribution Companies (DISCOS). Major breakdowns and calamities of the power system can be easily handled without collapsing the entire electrical power system of the utility company. This will lessen the losses and damage of the expensive power equipment from power collapses.

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