جامعة بيرزيت
BIRZEIT UNIVERSITY

Overview of Electrical Energy in West Bank

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Overview of Electrical Energy in West Bank

- There is no electrical power generation in West Bank.
- 96% of electrical energy consumed was imported from IEC.
- The remaining part was imported from Jordan.

Overview of Electrical Energy in West Bank

- The only main transmission lines constructed in the West Bank by IEC are three main 161 kV overhead lines feeding the three main substations: in Hebron, Qalandia (Atarot) and Salfiet (Ara'el).

Overview of Electrical Energy in West Bank

- These feeders supply West Bank by 800 MVA, 571 MVA which are supplied to the distribution companies and the remaining 229 MVA is supplied to municipalities.
- West Bank is fed from eight feeders by IEC and two feeders from Jordan.

Overview of Electrical Energy in West Bank

- The ranges of voltage of West Bank networks are 400V, 6.6 kV, 11kv, 33 kV.
- In Jerusalem Distribution Electric Company (JDECO), the voltage ranges are 400V, 11 kV and 33 kV.
- Northern Electricity Distribution Company (NEDCO) and Southern Electricity Company (SELCO) use 400V, 6.6 kV and 33 kV ranges.

Overview of Electrical Energy in West Bank

- In Hebron Electric Power Company (HEPCO) the ranges of voltage are 400V, 6.6 kV, 11 kV, 33 kV. Municipalities directly step down the voltage from 33 kV to 400 kV.

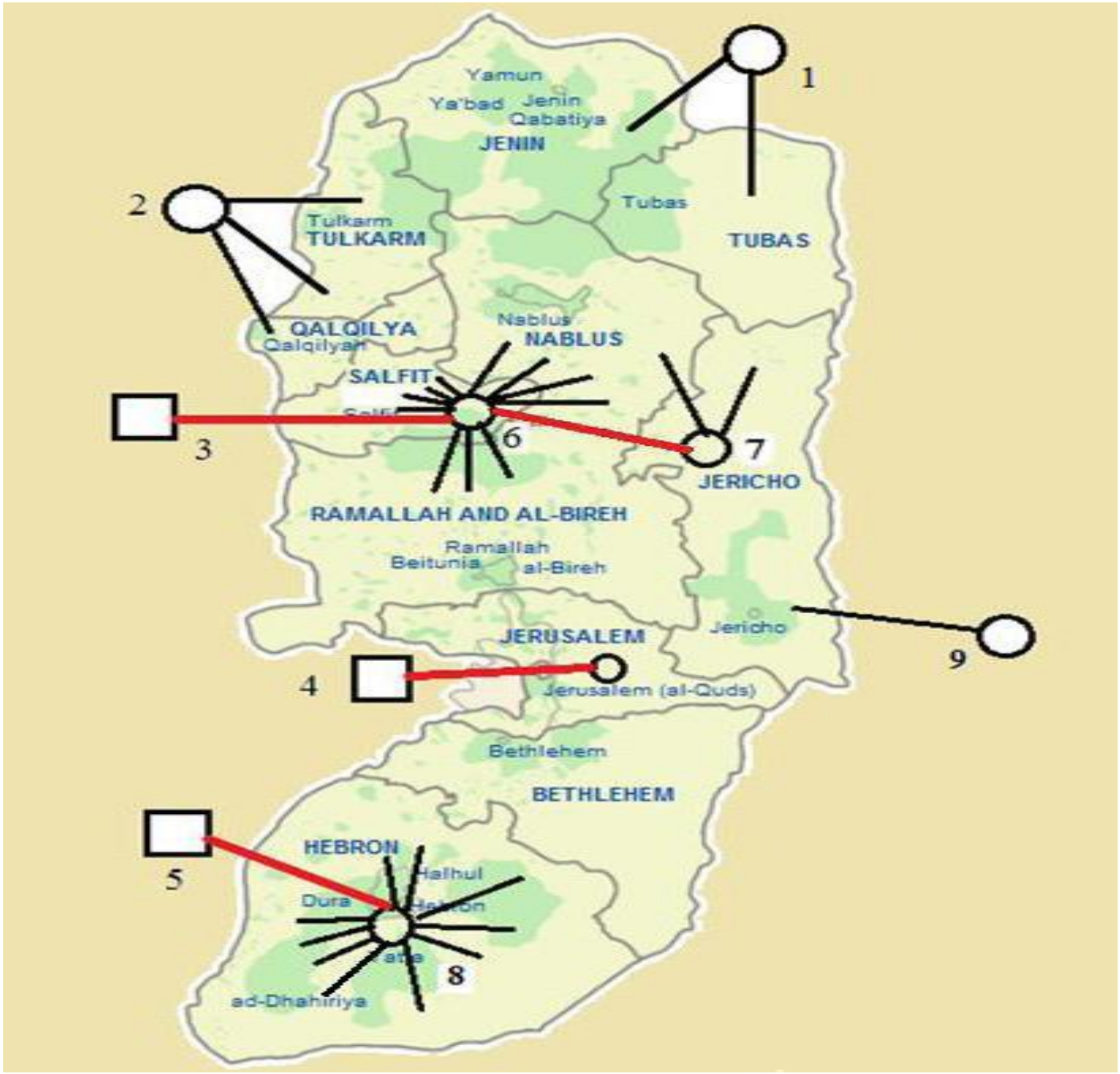
- These networks suffer from high transmission and distribution losses (technical and non technical) that varies from 17-32 %.

Overview of Electrical Energy in West Bank

- The maximum capacity of West Bank is nearly 800 MVA. 70% of the supply from Israel comes indirectly through three 161/33 kV substations; one in the south in area C close to Hebron, a second in the north in the Ariel settlement (area C) close to Nablus, and a third in Atarot industrial area (area C) near Jerusalem.

Overview of Electrical Energy in West Bank

- These feeders feed Hebron, Bethlehem, East Jerusalem, Ramallah, Jericho, Salfeet and Nablus.
- 30% comes directly through two 33 kV feeders from Beisan which feed both Jenin and Tubas. And three 22 kV feeders from Ntanya feed both Tulkarm and Qalqiliya . The supply from Jordan comes through 33 kV (can withstand 132 kV) overhead line (20MW) to supply only Jericho.
- The remaining power is generated by decentralized small diesel generators.


Yamun
Ya'bad
Jenin
Qabatiya
JENIN
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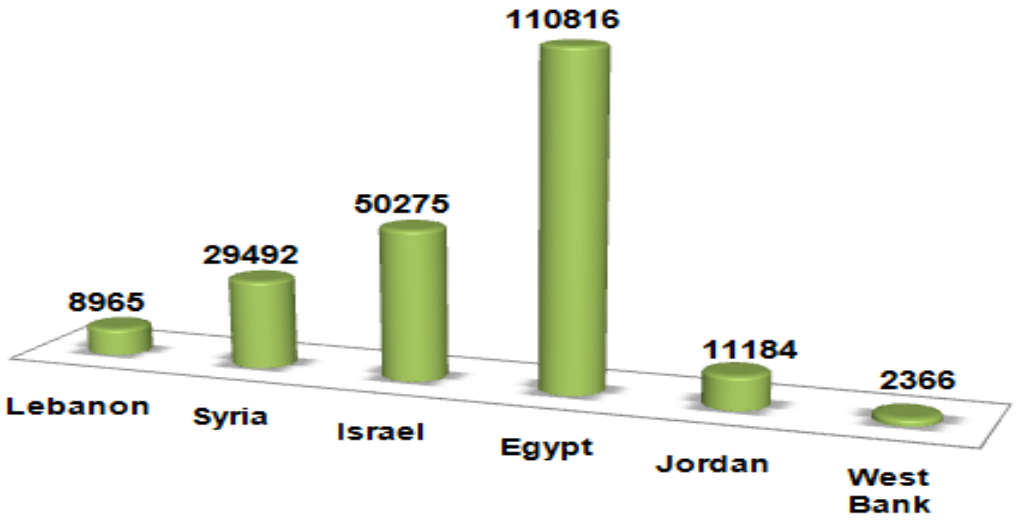
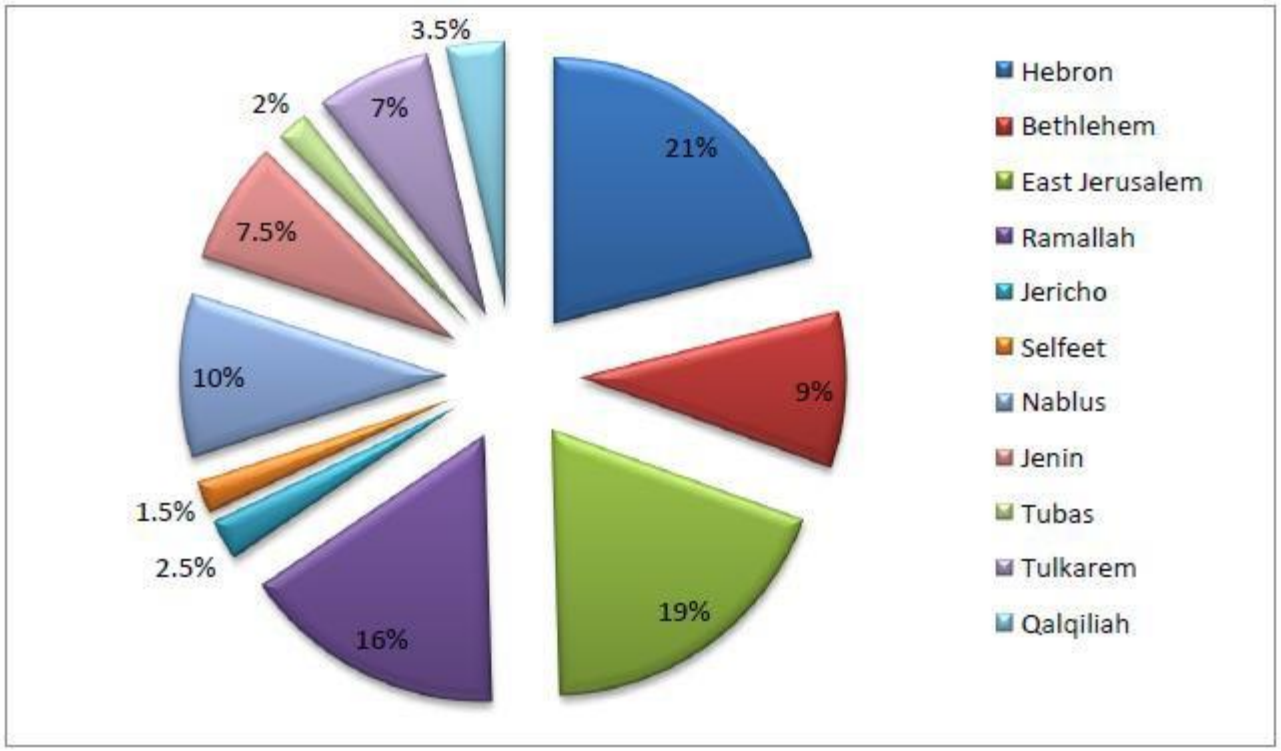
Tubas
TUBAS
2
Tulkarm
TULKARM
QALQILYA
Qalqilyah
Nablus
NABLUS
SALFIT
3
6
7
JERICHO
RAMALLAH AND AL-BIREH
Ramallah
Beitunia
al-Bireh
Jericho
9
JERUSALEM
4
Jerusalem (al-Quds)
Bethlehem
BETHLEHEM
HEBRON
5
Halhul
Dura
8
ad-Dhahiriya

Electrical Energy Consumption

- Total energy consumption in 2009 was 2366 GWh.
- The demand for electricity increases at a rate of 6.4%.

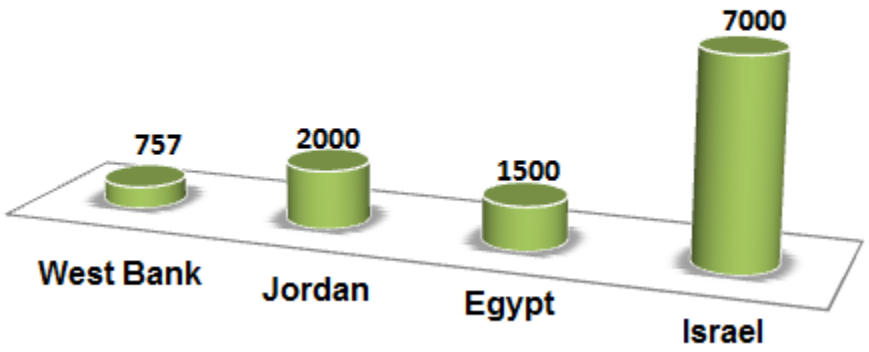


Electrical Energy Consumption



Consumption Per Capita

- Electricity consumption in West Bank is about 757 kWh per capita.
- This consumption is considered very low.



Electric Utilities in West Bank

- The electricity sector in West Bank is fragmented.
- Electricity is distributed by companies and municipalities.
- There are four utilities that distribute electricity in West Bank.

JDECO **NEDCO** **HEPCO** **SELCO**

Electric Utilities in West Bank

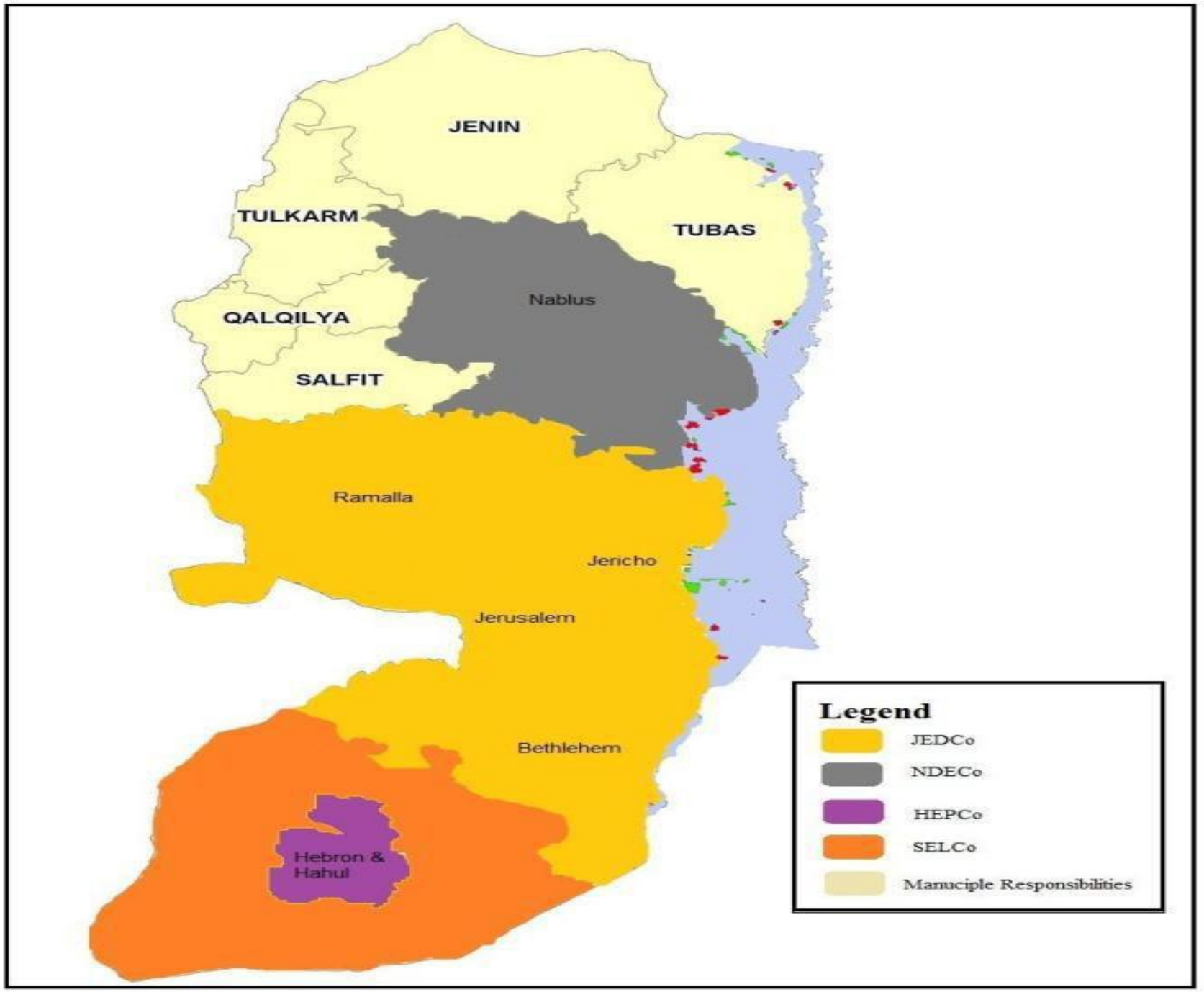
- Jerusalem District Electricity Company (JDECO), established in 1928, it is the largest distribution company in the West Bank covers approximately 25% of it. It serves Bethlehem, East Jerusalem, Ramallah and Jericho and connected to Atarot near Jerusalem and area C near to Hebron.
- Northern Electricity Distribution Company (NEDCO), established in 2008 to serve Nablus, Tulkarem, Jenin and other northern regions of the West Bank. But till now only Nabuls and Jenin city are under its responsibility. Connection point is in Areil settlement, at the north of Nablus

Electric Utilities in West Bank

- Southern Electricity Company (SELCO), established in 2002.It serves Dura, Yatta and Dahariah. Connection point is in area C near to Hebron.

- Hebron Electric Power Co. (HEPCO),established in 2000. It serves Hebron and Halhul. Connection point is in area C near to Hebron.

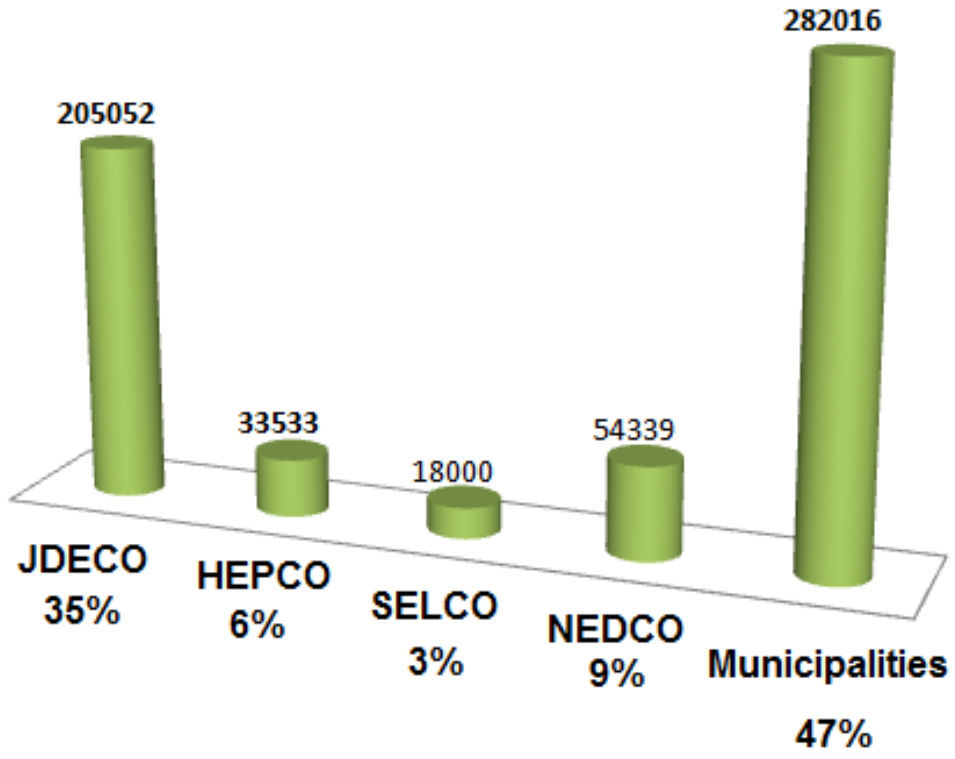
- The remaining areas of the West Bank are under municipal responsibility.


JENIN
TULKARM
TUBAS
Nablus
QALQILYA
SALFIT
Ramalla
Jericho
Jerusalem
Bethlehem
Hebron &
Hahul
Legend
JEDCo
NDECo
HEPCo
SELCo
Manuciple Responsibilities

Electricity Customers

- Number of electricity customers in the West Bank is approximately 592940.
- It increases at a rate of 4%.

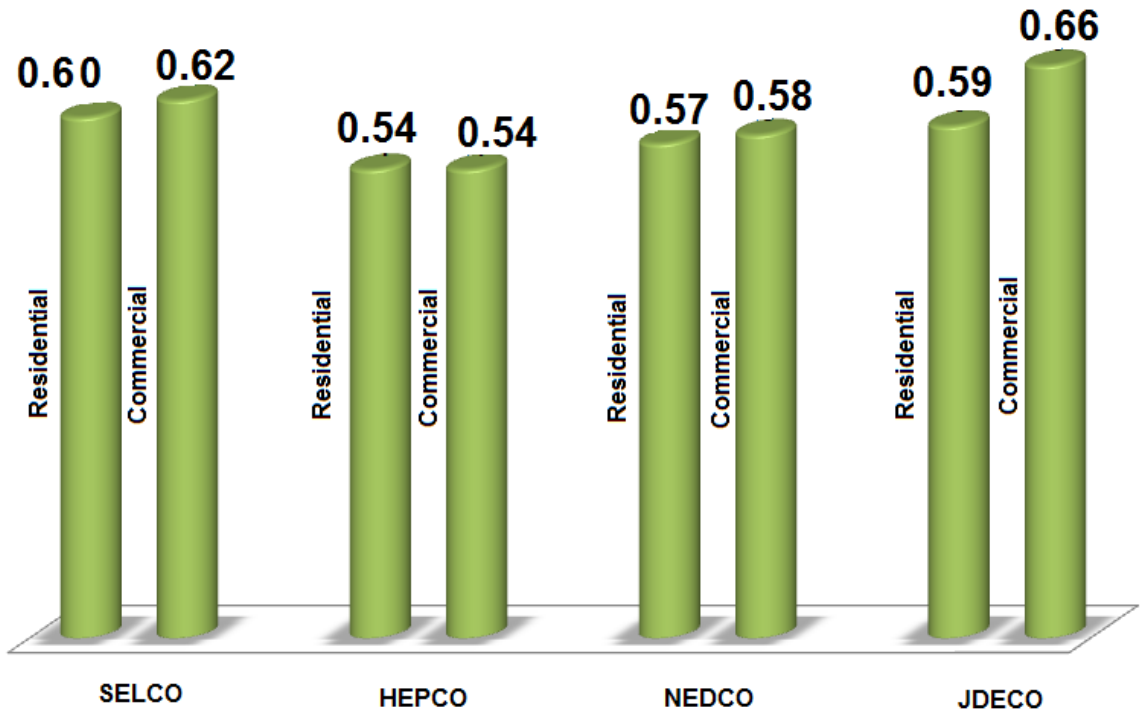
Electricity Customers in West Bank



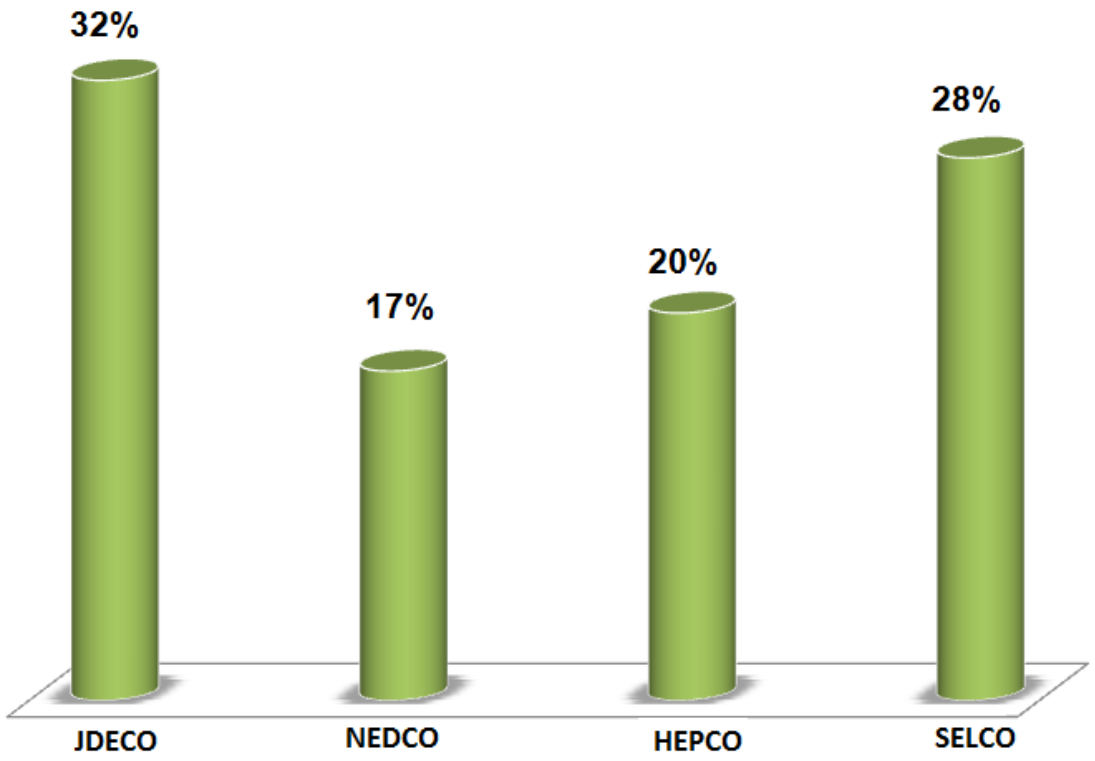
Tariff Structure

- The electricity price paid by consumers is somewhat high.
- Uniform tariff does not exist in West Bank.
- Distribution companies control the prices.
- Prices vary from one company to another.

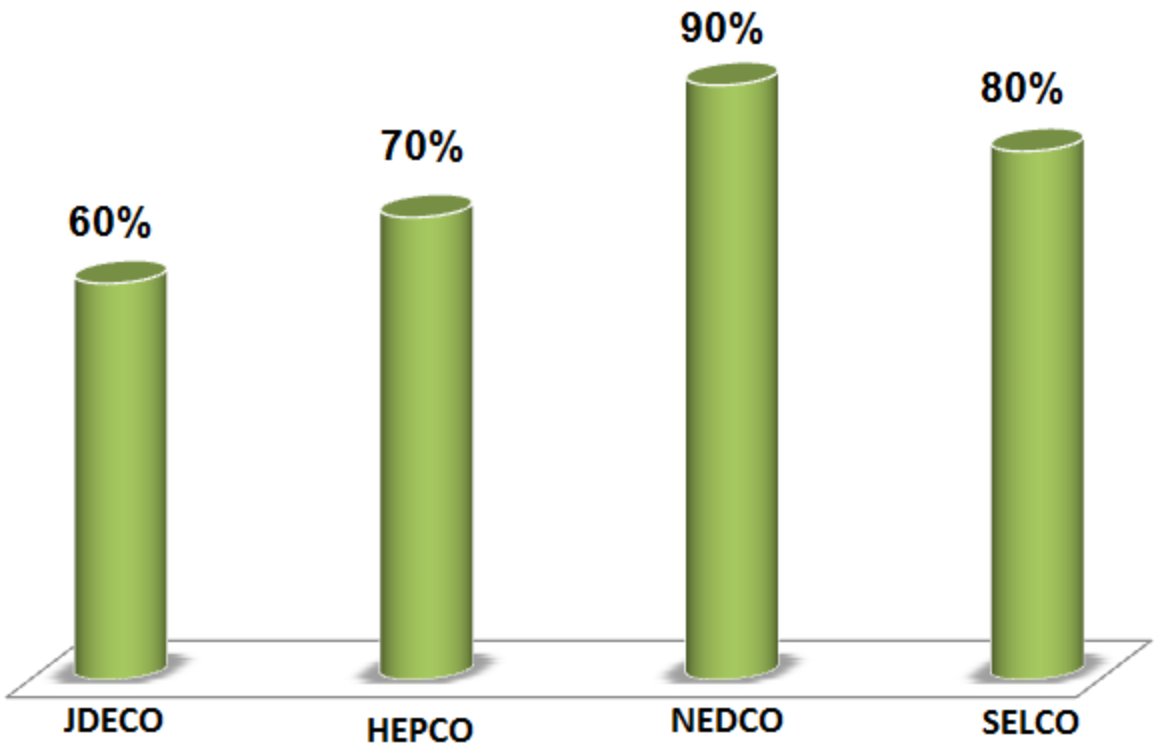
Prepay System



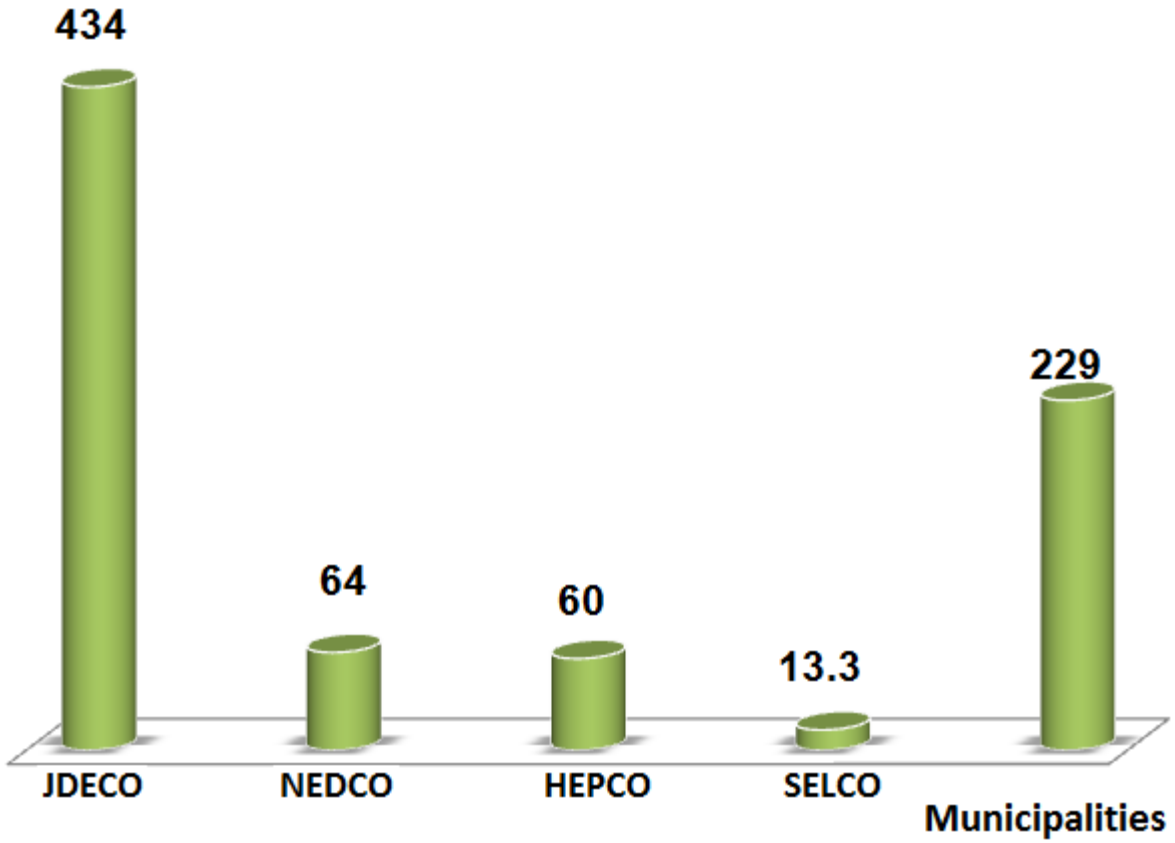
Losses



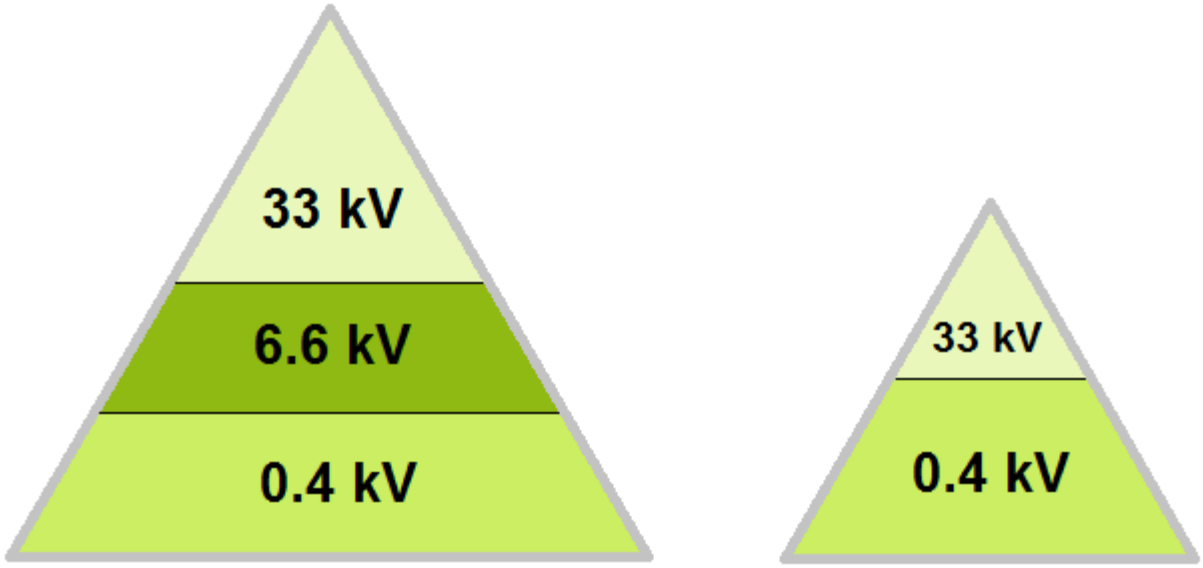
Load Factor



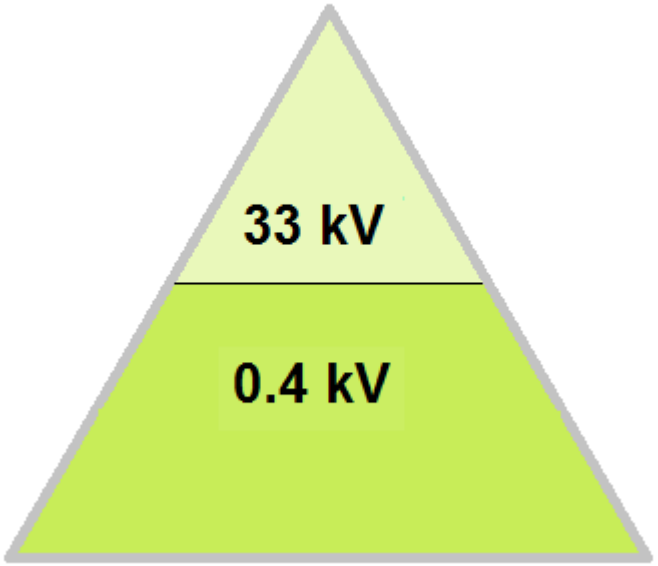
MVA Capacity



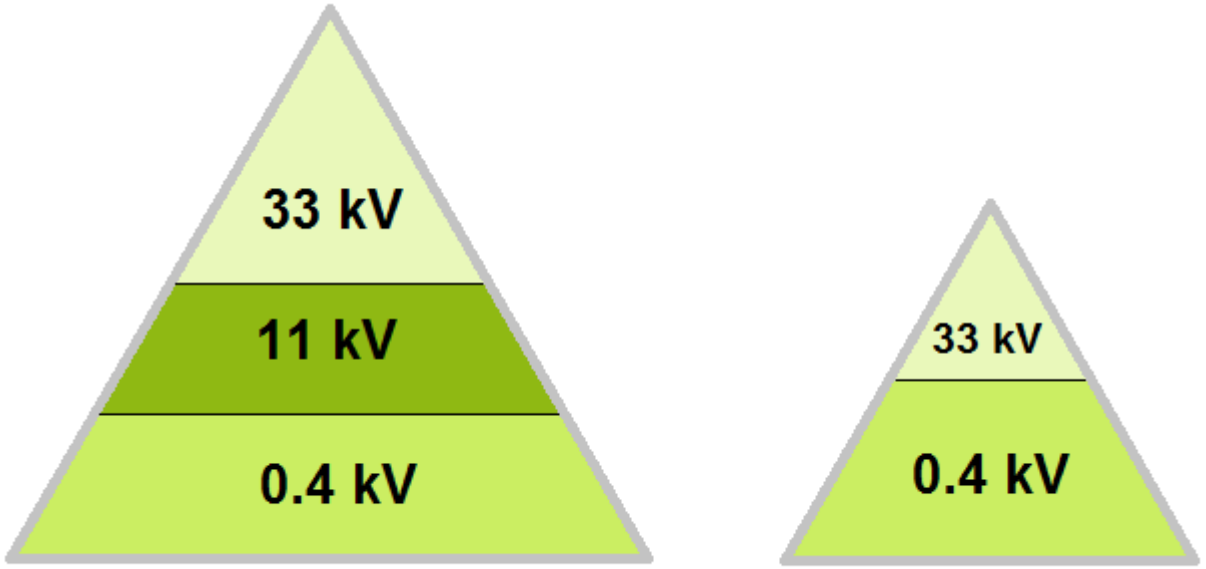
Distribution System in NEDCO & HEPCO



Distribution System in SELCO



Distribution System in JDECO



Transmission Lines

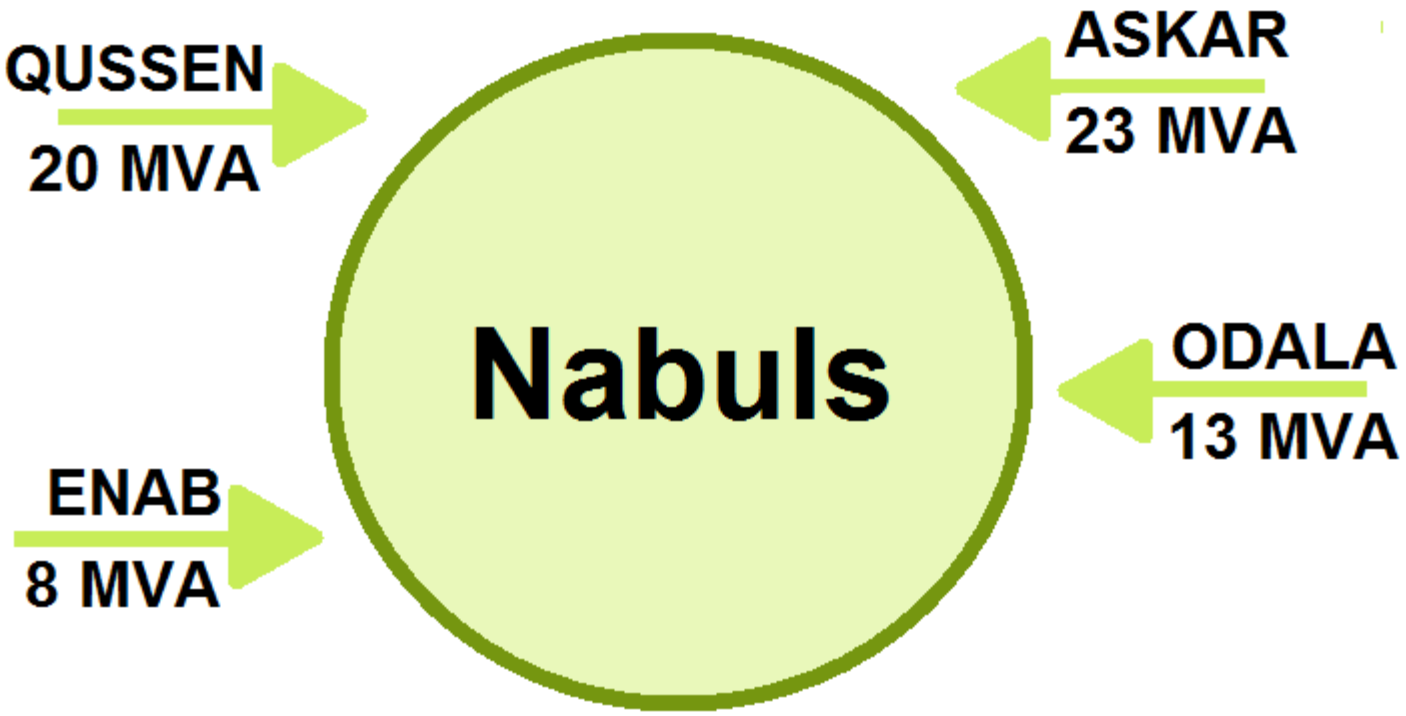
- **ACSR** transmission lines are used for 33kV,11kV and 6.6kV overhead lines.
- **ABC** transmission lines are used for 0.4kV overhead lines.
- **XLPE** transmission lines are use for 33kv,11kV,6.6kV for underground cables.

Transformers

- Dy11 Step down distribution transformers are used.

High Voltage Transformers	Low Voltage Transformers
15 MVA	1000 kVA
10 MVA	630 kVA
7.5 MVA	500 kVA
5 MVA	400 kVA
3 MVA	250 kVA
2.5 MVA	160 kVA &100 kVA

Example: Nablus Distribution System

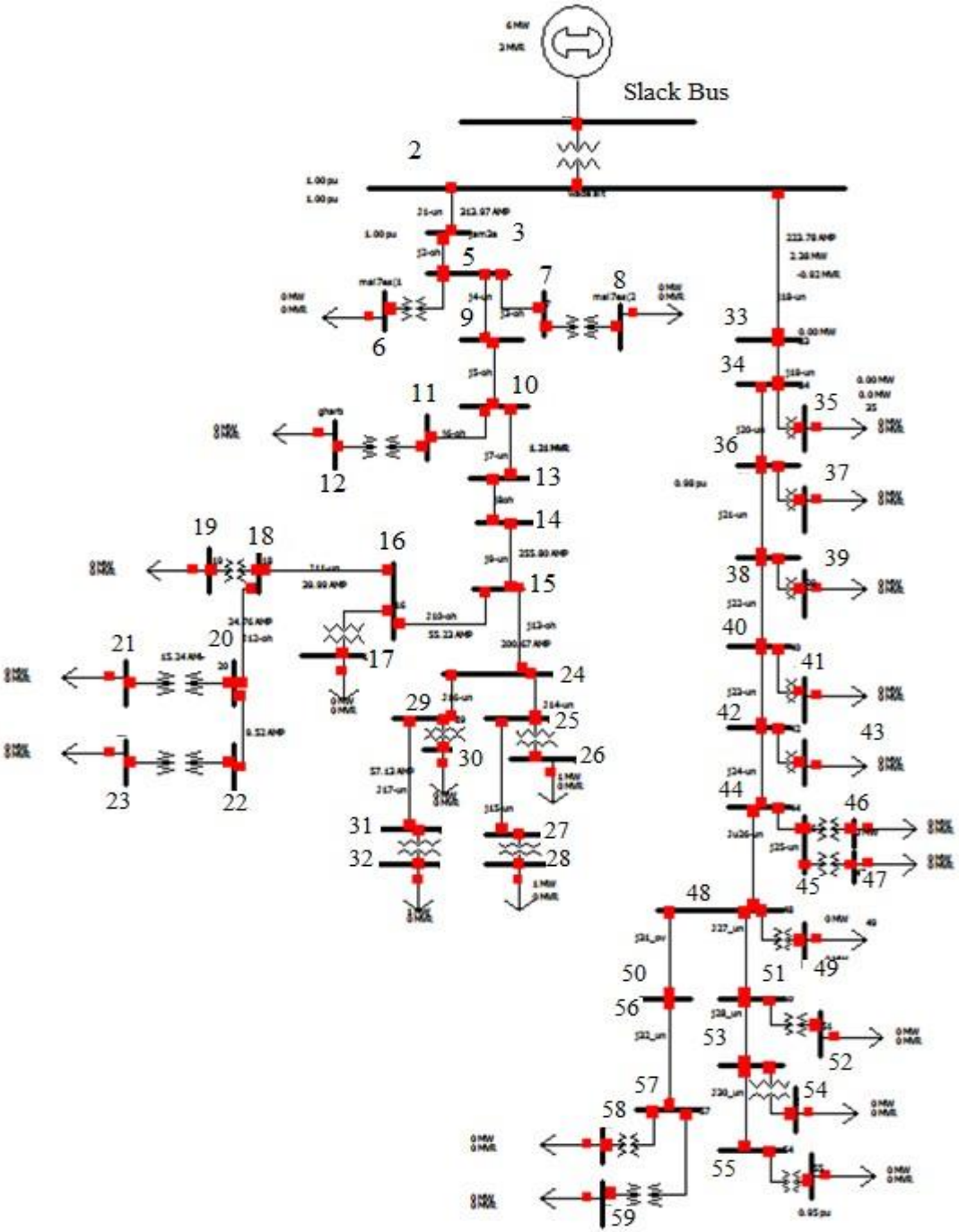


Example: Nablus Distribution System

Substation	Capacity (MVA)	Fed from	No. of Transformers (10MVA)
Askar	13	Odala	1
Central	22	Askar	2
Mujeer Aldeen	17	Qussen	2
Wadi Al-tufah	7	Qussen	1

Example: Wadi Altufah S/S

- Single line diagram consists of 59 buses and 25 transformers.
- Transformers are loaded to 40% of rated capacity and 0.92 power factor.


Slack Bus
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Cont.

- Per unit values for transmission line per phase:

Type	Voltage (kV)	Resistance Pu/ km	Reactance Pu/ km
XLPE(120mm^2)	6.6	0.746	0.285
ACSR(95/15)	6.6	0.85	0.641
ACSR(50/8)	6.6	1.515	0.682

Cont.

- Per unit values for transformer per phase:

Capacity (MVA)	Z_{base}	R(Ω) Per unit	X(Ω) Per unit
0.25	0.4356	1.579798	0.672635
0.4		1.085859	0.46281
0.63		0.654729	0.277778
1		0.579431	0.247934
10	10.89	0.3434	0.135904

Simulation Results

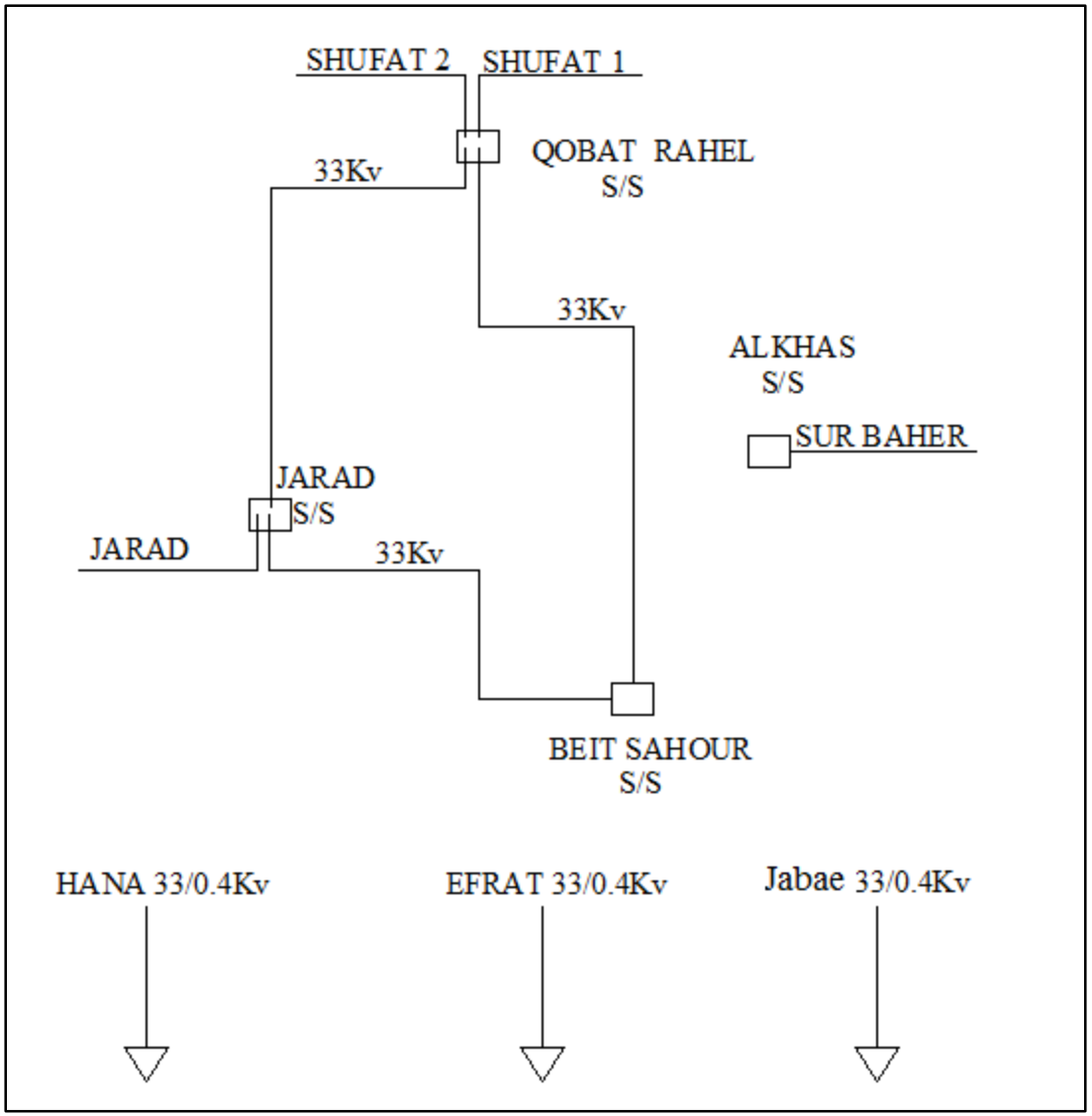
- The capacity of Wadi Altufah substation is **5.7** MW, **2.7** Mvar with **0.90** PF.
- A **5.2** MW, **2.4** Mvar is consumed by the load, with **0.89** PF as an average.
- The losses in the 6.6kV lines is **9%.**
- The maximum voltage drop on 6.6 kV was **10.3%.**

Example: Bethlehm Distribution System

- Bethlehm is fed from seven 33kV feeders.
- Four main substations.
- The rated capacity is 94.6 MVA.
- Consumed power about 211 GWh.

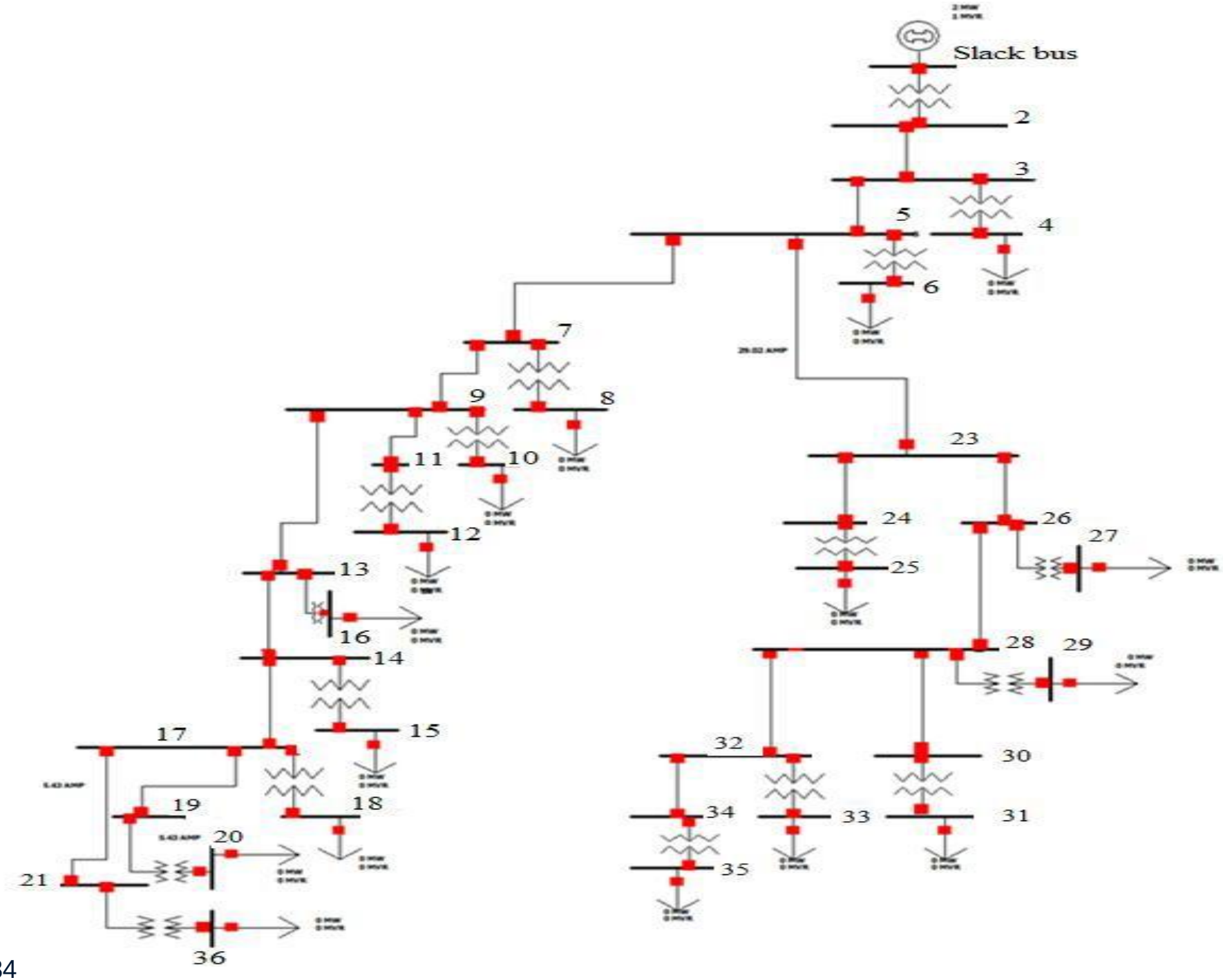
Substation	Transformers (33/11) kV
Qobat Rahel	2X15 MVA
Beit Sahour	10 MVA 7.5 MVA
Jarad	2X10MVA
Alkhas	5 MVA

Shufat1	20 MVA
Shufat2	20 MVA
Hana	20 MVA
Efrat	6 MVA
Jarad	20 MVA
Sur Baher	8.1 MVA
Jabae	0.5 MVA
Total	94.6 MVA



Example: Alkhas S/S

- Single line diagram consists of 36 buses and 16 transformers.
- Transformers are loaded to 40% of rated capacity and 0.92 power factor.


Slack bus
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Simulation Results

- The capacity of Alkhas substation is **1.7** MW, **0.73** Mvar with **0.92** PF.
- A **1.65** MW, **0.7** Mvar is consumed by the load, with **0.91** PF as an average.
- The losses in the 11kV lines is **3.5%.**
- The maximum voltage drop on 11 kV was **4%.**

Electrical Energy Problems

- Absence in generating in West Bank.
- Absence of integrated electrical network.
- Lack of supply capacity of electrical energy to meet present and future needs.

Cont.

- Energy prices are very high.
- High transmission and distribution losses.

Future Plans in West Bank

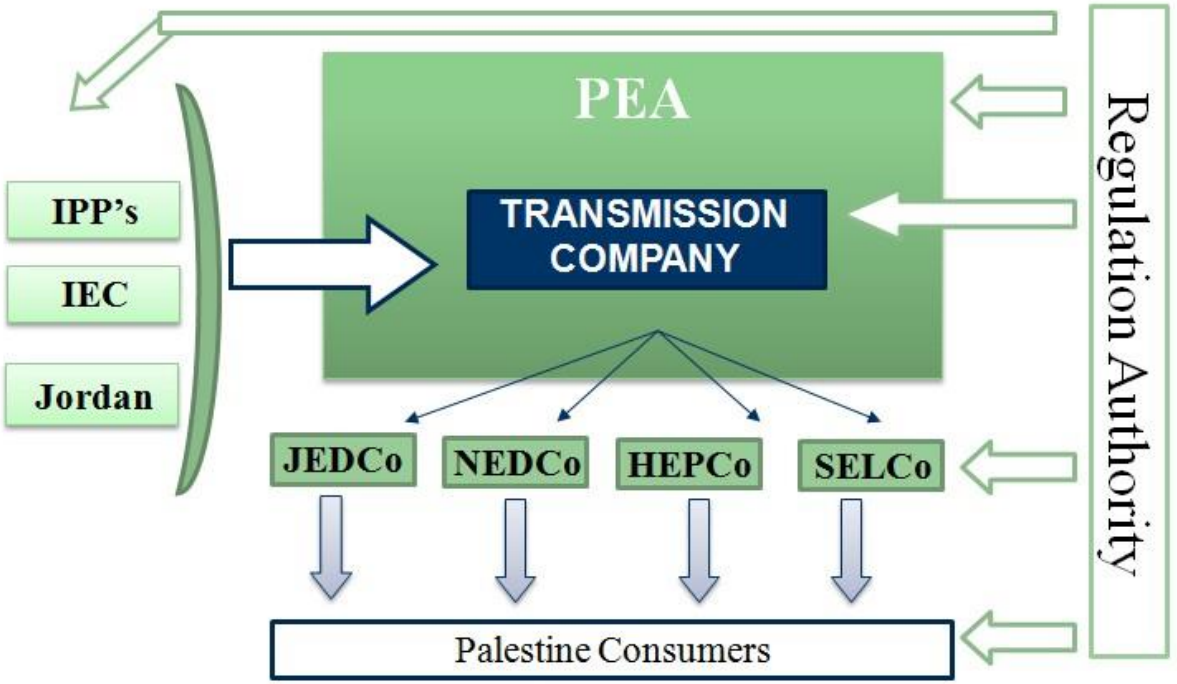
- A project is in its way to be implemented to install four new 161/33 kV transmission substations across West Bank.
- Palestine Energy Transmission Company Ltd. (PETL).
- Connection to seven Arab country grid.

Cont.

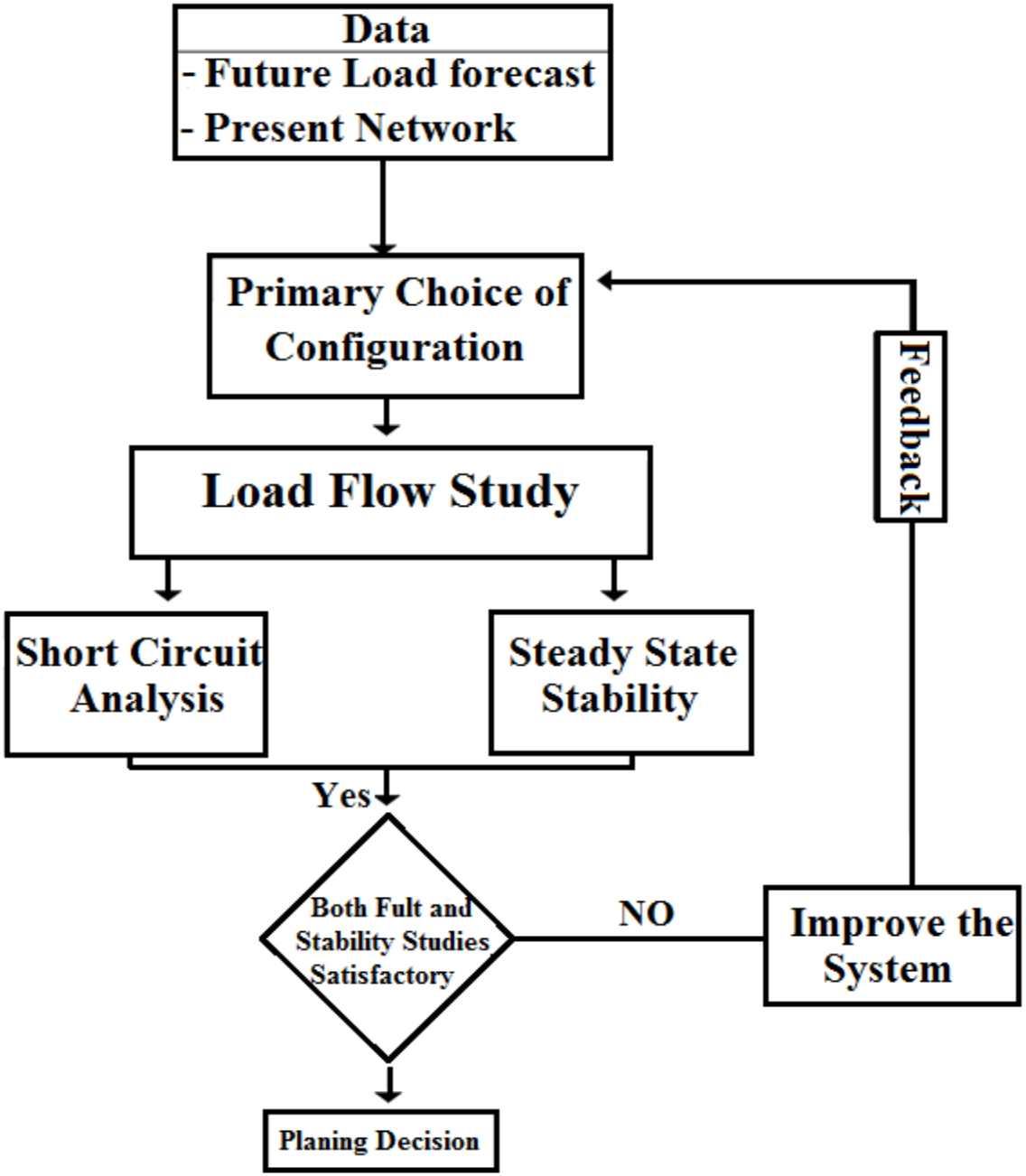
- Two new power plants in West Bank will be constructed, which are:

1) Jayyus Power Plant in the north, near Qalqiliya.
2) Turqumia Power Plant in the south, west of Hebron.

Future Organization of the Power Sector



PEA	Palestinian Energy Authority
IEC	Israeli Electric Corporation
IPP	Independent Power Producers


Data
- Future Load forecast
- Present Network
Primary Choice of Configuration
Load Flow Study
Short Circuit Analysis
Steady State Stability
Yes
Both Fult and Stability Studies Satisfactory
NO
Improve the System
Feedback
Planing Decision

Economic Voltage

INCREASING IN VOLTAGE

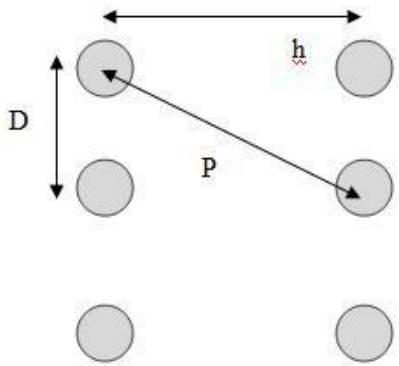
Cost of conductor material ↓

Cost of insulators ↑

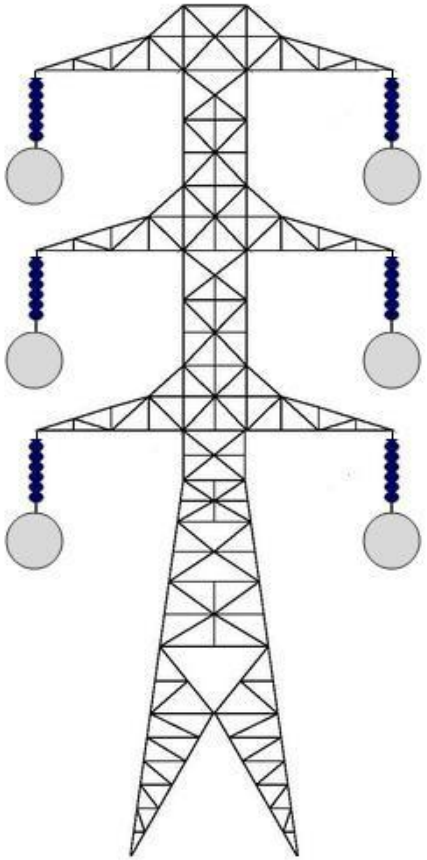
Cost of Switchgears ↑

Cost of transformers ↑

Selection of Transmission Lines, Tower Example



Type of tower	Vertical spacing [m]	Horizontal spacing [m]
132 kV: Double circuit	3.96	7.32
230 kV: Double circuit	6.70	12.6



$$X_L = 4\pi f * 10^{-7} * \ln\frac{Deq}{r}$$

$$B = 2\pi f\left(\frac{2\pi\varepsilon}{\ln\frac{Deq}{D/2}}\right)$$