Reducing Electricity Aquisition to Cover Internal Energy Consumption of Distribution Operators by using Photovoltaic Panels in 0,4kV Network

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***Abstract*—Distribution operators work at voltage level 0,4-110kV by taking over electricity from National Grid (SEN) and directly from zonal power plants for feeding final customers. In electricity distribution system 0,4-110kV there are technical power losses and also internal energy consumption for relays, electric motors, etc, forming total internal energy consumption (CPT) of distribution operator. The electricity for covering CPT must be bought and paid by distribution operator and complete the financial balances, respectively the monthly profit. An optimal solution to reduce electricity acquisition for covering CPT is to use photovoltaic panels in 0,4kV network of distribution operators.**

Keywords—power losses, photovoltaic panel, 0,4kV network

I. INTRODUCTION

The most important percentages of technical power losses are identified in transformers MV/0,4kV, respectively power loss in Fe and in charge in Cu and also in 0,4kV network, power losses by Joule-Lenz phenomenon. For covering CPT, the electricity is transported from power plants for long distance with other power losses.

In the first step, by mounting photovoltaic panels must cover power losses in transformers MV/0,4kV and in 0,4kV network. Photovoltaic panels work only on the day light and the efficiency is given only by luminosity. So, from a number of 8760 hours in a year, photovoltaic panels produce electricity in about 4380 hours. In our case, CPT will be reduced in light days but not cover the night power losses.

The next step for distribution operators could be in mounting a large number of photovoltaic panels in 0,4kV network for selling electricity to final customers.

Also, being a green energy, distribution operators can have many financial facilities for investments using EU programme and green certificates.

II. 0,4KV NETWORK – CPT LEVEL. EXAMPLE

For relevant results, we consider a transformer point MV/0,4kV - 160KVA with a number of three 0,4kV circuits and the same constant charge of 20kW for each circuit for all 8760 hours of one year.

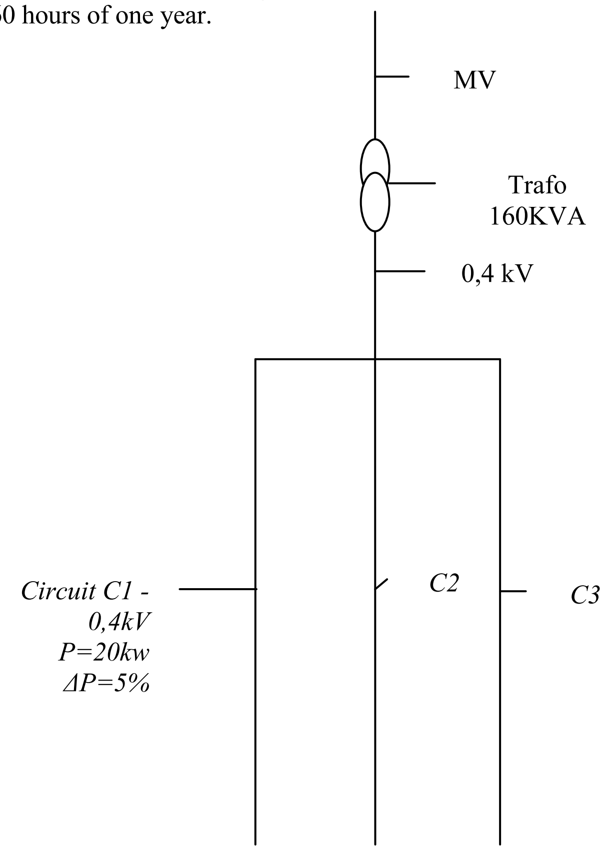

Fig. 1

Transformer 160 KVA

Losses power in Fe = 0,3kW, Losses power in Cu = 0,7 kW

Total losses power = 1,0 kW

Total annual power losses, 1,0kW x 8760 h = 8760 kwh

Circuit 0,4kV – C1

P_{C1}=20kW, losses power Joule-Lentz (5%) = 1,0 kW

Total losses power = 1,0 kW

Total annual power losses

1,0kW x 8760 h = 8760 kwh

Total annual power losses, transformer and three 0,4kV circuits = 35040 kwh

Annual power losses only on days light = 17520kwh

III. 0,4kV Network with Photovoltaic Panels. Example of Reducing Electricity Aquisition

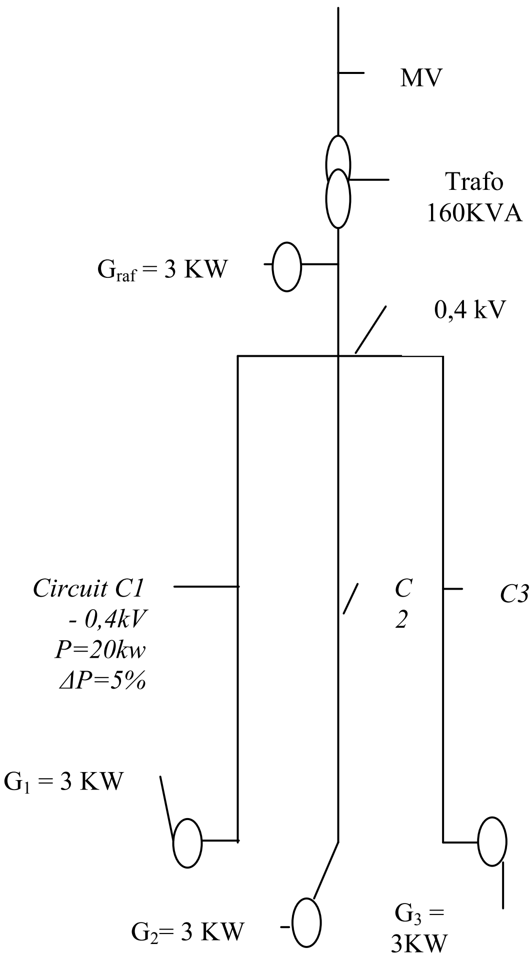

Fig.2

We consider the same transformer point with three 0,4kV circuits and the same annual constant charge of 20kW for each circuit.

Transformer 160 KVA

Losses power in Fe = 0,3kW, Losses power in Cu = 0,7 kW

Total losses power = 1,0 kW

Total annual power losses, 1,0kW x 8760 h = 8760 kwh

Photovoltaic panel - G_{trafo} = 3 KW, with an efficiency about 30%, assure the power losses in transformer for days light.

Reducing electricity acquisition: about 4380 kwh/annum

Circuit 0,4kV – C1

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Photovoltaic panel – G_{C1} = 3 KW, with an efficiency about 30%, assure the power losses in transformer for days light.

Reducing electricity acquisition: about 4380kwh/annum

Using all 4 photovoltaic panels with total power of 12kW, with an efficiency of 30%, it is reducing the electricity acquisition for cover CPT for this transformer point and three 0,4kV circuit about 17520 kwh/annum.

Mounting photovoltaic panels at the end of 0,4kV circuit, it is strongly reducing power losses in circuit.

$$\Delta P=((P^2+Q^2)/U^2) \times R \qquad (1)$$

The places where photovoltaic panels will be mounted will be the decision of design engineers, function of diagram currents, voltage drop, access at poles, etc, specific for each 0,4kV circuit.

IV. Technical Solution for a 3kW Photovoltaic Panel Mounted in 0,4kV Network

In practice, in case of 0,4kV network , must use some opportunities:

- We do not need land for mounting photovoltaic panels, we can use the place of existent poles. It means avoiding to buy land and paying local taxes for land
- We must only replace a 0,4kV existent pole with a MV(20kV) pole
- We can use the existent ground socket

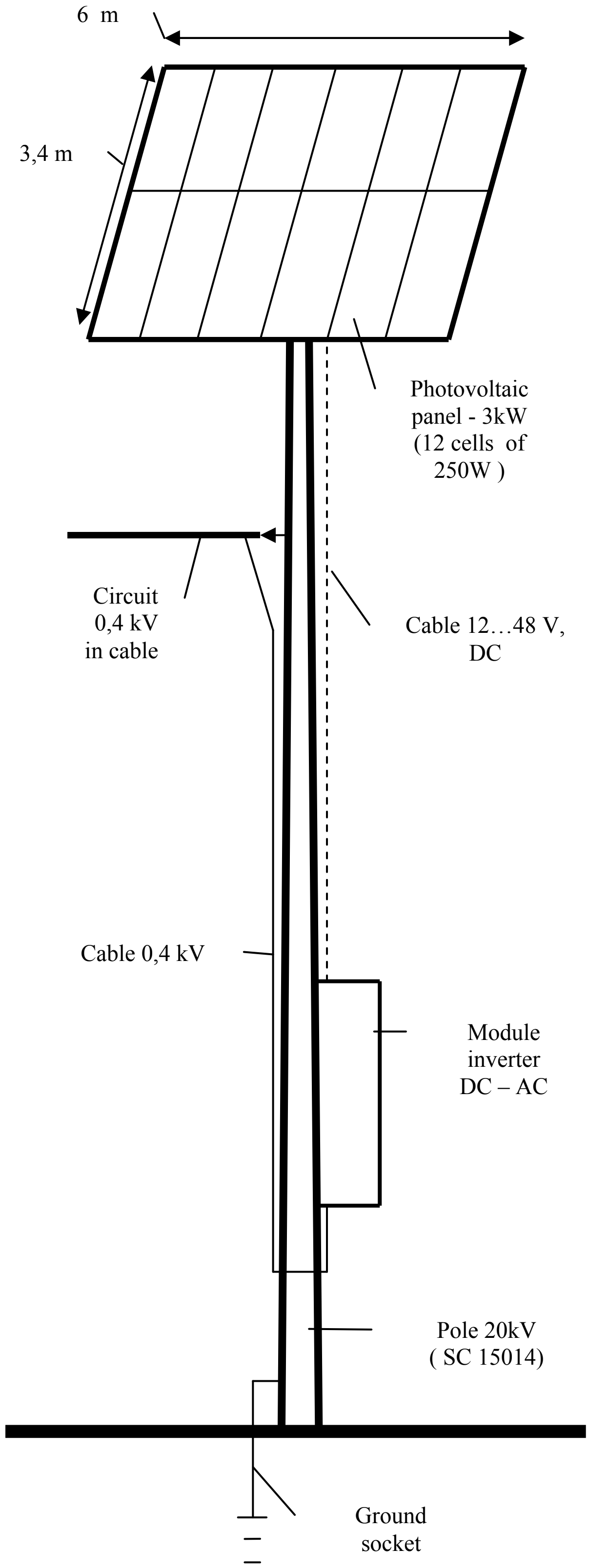

Fig.3

Pole verification – SC 15014 – at all mechanical conditions:

TABLE 1

Pole	Length [cm]	Dimension on end [cm]	Dimension on ground [cm]	Weight [kg]
1	*2*	*3*	*4*	*5*
SC 15014	***1200***	***32***	***50***	***2600***

Bending limit [daNm]	Torsion limit [daNm]	Compression limit [daN]
6	*7*	*8*
16693	***455***	***> 20 000***

SC 15014 – length outside – 10 meters

Compression verification

Weight mounted on pole:

- 12 photovoltaic cells – 250 Kg
- Metallic support for panel – 600 Kg
- Ice – maximum 350 Kg
- Snow – maximum 3000 Kg
- Other equipment, workers – maximum 1000 Kg

Total weight (with snow) = maximum 4000 Kg

Pole is design at weight > 20000 daN (Kg)

Pole is charge at weight about 25% from limit construction.

Bending verification

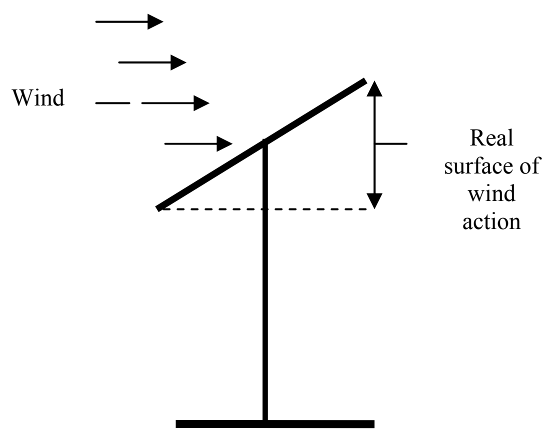

Fig.4

For verification, it is using PE 106/2003, respectively, Technical book for design 0,4 kV aerian electric lines.

F = Yn x Cts x Bv x Pvmax x A (2)

Where:

F – wind force in daN

Yn – security coefficient = 1,3

Cts - aerodinamic coefficient (0,7 for round surface and 1,4 for vertical surface)

Bv – correction coefficient at wind speed at wind gust (1,5 in open area, 1,0 in cities, 0,4 in centre of cities with buildings higher than > 30 meters)

Pvmax – dynamic pressure at maximum wind (42 daN/mp for zone meteo B)

A – wind surface

Bending formula

M=F x l (3)

Where:
F - force
l – length of force action

Photovoltaic panel – 3kW

Is mounted at 10 meters over the ground on pole and at 30^0 from horizontal surface. According with Fig. 4, wind exposure surface at horizontal wind is 10,5 meters square (mp)

Using Formula (2) , wind force push on panel is:

Fop = 1,3 x 1,4 x 1,0 x 42 x 10,5 =803 daN (4)

Bending of pole generated by photovoltaic panel is:

Mp = 1204 x 10 = 8030 daNm (5)

Pole SC 15014

Pole surface = 3,4 meters square (mp)

Using Formula (2) , wind force push on pole is:

Fs = 1,3 x 0,7 x 1,0 x 42 x 3,4 = 130 daN (6)

Bending of pole generated by the wind on pole is:

Ms = 130 x 5 = 650 daNm (7)

Cable 0,4kV mounted on pole:

Bending on pole generated by 0,4kV cable is calculated using instruction 1.Lj-Ip8-76.

Ft=750 daN (8)

Bending of pole generated by 0,4kV cable is:

Mt = 750 Dan x 8m = 6000 daNm (9)

Bending of pole (total) in most unfavorable conditions is:

Mtotal = Mp+Ms+Mt = 8030+650+6000 = 14680 daNm (10)

Compare results of verification with the minim value from TABLE 1 – pct. 6, results :

M total (14680 daNm) < M st limit (16693 daNm) (11)

It is easy to observe that in most unfavorable conditions, the pole is charged at maximum 88% of bending pole limit.

Torsion verification

The torsion limit of pole about 455daNm it is too high that this pole could be force by wind on photovoltaic panel. The wind acts uniformly on surface and there are no other torsion force that could act on pole.

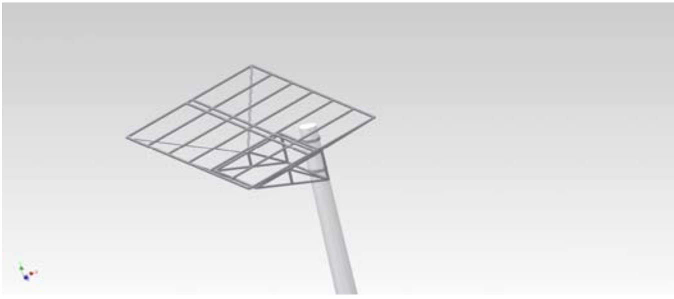

Fig.5

V. TECHNICAL SOLUTION FOR FOTOVOLTAIC PANEL MOUNTED ON METALIC POLE SMZ-12-2800

Picture 1

Advantage:

- In this case, in most unfavorable conditions, the pole is charged at maximum 52% of bending pole limit (calculated bending - Formula 10 = 14680daNm compare with 28000daNm – pole limit at bending)
- Long life use of metallic pole SMZ-12-2800 compare with concrete pole SC 15014

VI. TECHNICAL SOLUTION FOR USING THREE PHOTOVOLTAIC PANELS – 3KW - AND ONLY ONE DC-AC INVERTER

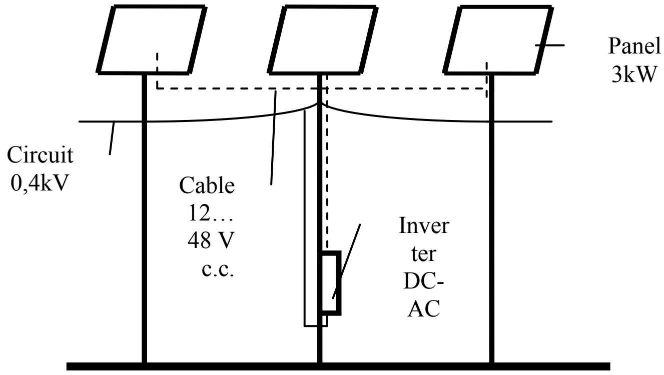

Fig. 6

VII. TECHNICAL SOLUTION FOR USING PHOTOVOLTAIC PANELS ON ROOF OF TRANSFORMER POINTS BUILDINGS

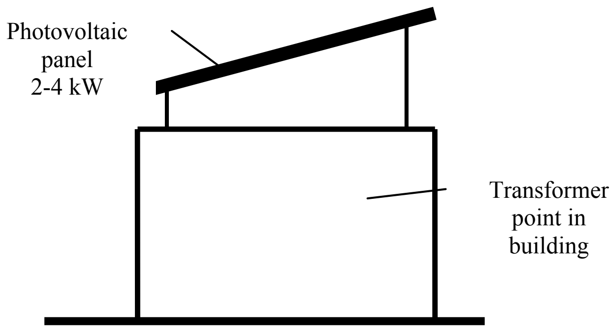

Fig. 7

VIII. COSTS AND OPORTUNITIES FOR DISTRIBUTION OPERATORS IN INVESTMENTS IN PHOTOVOLTAIC PANELS MOUNTED IN 0,4KV NETWORK

Technical facilities:

- Use the place of existent poles
- Avoid buying land and paying local taxes for land
- Only replace a 0,4kV existent pole with a MV(20kV) pole
- Use the existent ground socket

Costs:

- Replace existent 0,4kV pole with a 20kV pole – difference costs - about 800 euro for SC 15014 pole and about 2000 euro for metallic pole SMZ-12-2800
- 12 photovoltaic cells – about 2000 euro
- Support photovoltaic cells on pole – about 500 euro
- Inverter – about – 1000 euro
- Cables, etc… - about 200 euro
- TOTAL – about 4500 euro for SC 15014 pole and 5700 euro for metallic pole SMZ-12-2800

Investment recovery:

- 4-6 years, normal recovery
- 3-5 years if distribution operators are using EU financial aid programmed and green certificates

Opportunity:

Distribution operators can mount photovoltaic panels also in any design projects for modernizing and repairing the existent 0,4kV network.

IX. CONCLUSION

Distribution operators can reduce the electricity acquisition to cover energy losses (CPT) using photovoltaic panels in 0,4kV network.

The investment in photovoltaic panels is very efficient and is recovered in short time using EU funds and green certificates.

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[2] SC ELECTRICA SA, "1.Lj-Ip8-76, Indreptar de proiectare pentru retele electrice de joasa tensiune cu conductoare izolate" Bucharest, 1976