INVESTMENT SCHEDULE MAKING FOR SUBSTATION 110/X kV BUILDING AND RECONSTRUCTING IN THE DISTRIBUTION NETWORK PLANNING PROCESS

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1.Abstract

According energy low in Republic of Serbia, energy policy in Serbia taking into account different activities for reaching strategic goals among of are the decentralization rights and responsibility for planning and realizing energy policy. Planning process is dividing into some different levels so we have subjects with right to distribution network planning in Republic, Province and local region. Duty for making plans document are in Distribution companies (ED) and they have certain importance. If we add recent intensity of making urbanity plans it is clear that ED have to be ready in every moment to respond for different request for information's about distribution network plans.

Distribution network (DM) planning and building TS 110/20 kV in Elektrovojvodina is spending in three tension system 110/20/0,4 kV with step by step abandoning four tension system 110/35/10/0,4 kV. The biggest influence in 110/20/0, 4 kV systems have number of TS 110/20 kV and their locations. Building these substations is financially immense project and it is clear that we have taken special attitude for building schedule.

In this paper is submitted methodology that applying in planning process could be makes decisions for building and reconstructing substations in very simple way. This is the way for simple establishing priority in investment decision making process, so this could be of great profit in hard development problem as is replacing four tension systems with three tension system.

2. Network planning documents

During making planning system documents and criterion for priority establishing, it was in scope that decision makers should have in almost every moment quality and current document (plan) in that base decision maker can make adequate decision in different circumstances (extreme request, unusual request etc).

During making plans it is necessary to have possibilities for weaving proper and quality supplying solutions, for every consumer. In this period supplying has to be correct with minimal expenses. In the other hand, plans have to satisfy technical and economy factors in the future.

For obligation satisfying in proper way, in Elektrovojvodina was established next list of planning documents:

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- long range plans,
- middle range plans,
- conceptual plans and,
- year plans.

Very important planning process segment is data acquisition, preparing data and data analysis. Work on this data files is a continuous process on creating data base, that assume hard treatment of its. Verification of this data is in part confirming during making accurate data base and during plans making. In this paper this part of process is not treated. In follows is submit description of this documents.

2.1 Long range plan

Long range plans are basic document by the routing and accepting of concept DM loops. Network development without long range plans, could easily become no economic.

These plans are made for 15-20 years, but it is recommended to make actualization every 5 years. It is obvious to make new plan when realization step away immensely from proposed plan parameters.

Basically, long range plans are made in couple version (variant) of network plans that satisfy proposed technical constraints. Starting point for all versions is optimal existing network. In this state, all tension regulation tools are exhausted. This state are examine by the proposed technical constraints, and if some of the constrains are ruined, we introduce new investment. Analyzing all states of DM network to the end of analyzing period and introducing new investment if it is necessary, we have different version of DM network plans. Economy compares are made for all version using present worth factor and discount rate [1,2,4]. Economic evaluation is made in area of the unique spatial power forecast. There is to understand that variant is equal.

The best version determine new concept of DM network, that need to give substation 110/20 kV power and location, medium voltage (MV) feeder routes, MV network concept and key MV network solutions (supplying big consumer, industrial zones etc).

Long range plans give us sufficient number of data for next 10 years, but vision for further period. Without long range plans and precise strategic definitions (for example, dynamic of introducing 20 kV instead 10 kV) we are not able to determine priorities, for Elektrovojvodina at a whole and in its parts.

2.2 Middle range plans

Middle range plans are made for 5 year periods and represent work out of long range plans. Middle range plans ending in half or full of decade. In there are solved problems and if it is necessary changing solutions with initialization changing of long range plans. This means concordant realization with new requests. By the middle range plans we perform concordance of investment in network at a whole and plans.

If the amount of financing is unknown the middle range plans have purpose to expose needs for investment in network.

2.3 Global plan

Yearly plans of building network should be in concordance with middle range plans, but the basic problem is bad realization of year plans, at first because pour amount of money. This produce stocking of yearly projects named by middle range plans, so the late of this plans. This is basic reason for introducing new plan document named “global plan” that have all attribute of middle range plans. This plan is middle range plan started in year of consideration overcoming 5 years, but with fewer details than middle range

plan. Is note applied in year of making middle range plans. In this way we have global (shorter middle range plan) 5 years plan in every year except year of making middle range plan.

Global plan base on real and actual situation in network and make dynamism of middle and long range plans. Differently from middle and long range plans, global plan do not contain detail analyzes of DM network concept. Only check long range solutions, and if there is some step away planner initialize changes of long range plans.

For years of last middle range period global plan are corrector of presumed activities. Corrections are making depending of appearance unpredicted consumers, deviation of predict load growth and deviation of predict investments. For period out of this middle range plan, activities from global plan are concord with activities from long range plan.

Uniform as in middle range plans, in global plans we have to provide concordance of investment in all observed elements of network including elements of superior tension network.

2.4 Yearly plan

Yearly plan of network investment are making based on financial limits. This document is detail work out of plans in first year (middle or longer range plan) and content solution for new consumer connection. Yearly plan content description of works, price of works and explanation for all objects (projects).

3. Role and place of priority investments in substations 110/20 kV in the process of DM network planning

Making priorities for enlarged TS 100/20 kV capacities in Elektrovojvodina, is on charge during making middle range and global plans. In this process we have DM network economy best solution that is establish in long range plan. As the dynamic of long range plan is based on assumptions, now we have investments based on real needs. During work on middle range plans we first have to notice all possible former deviation from long range plan, and if there are no deviations, we start making middle range plan. On the contrary we have to carry out new techno-economy analysis and if it is necessary, make new solution.

For long range solutions it is not necessary to resume all company area, but only is sufficient to work with area that DM network have small number of connection with neighbor areas that are in reserve process of supplying consumer. Company network is clustering into smaller slightly tied network areas for simplifying process. Important is to notice solution with minimal expenses. This is solution toward we move during planning process, while total expenses are not relevant information for long range concept. So we apply present value method. For middle range plans most important information is financing limits. There is born need for comparing different solution in non depending areas of DM network. In Elektrovojvodina are made tool for simple decision priority of building TS 110/x kV. Model is union of technical criterion.

Before definition of union of technical criterion was made analyzes of existing circumstances in DM network, and examine global goals for establishes witch of effects we want to make by extension of DM capacity. In this way it could be making DM network with better performances that means reliable export, bigger reserve in network and bigger flexibility on consumption.

4. Methodology for rulling of building and reconstructing TS 100/x kV priority

Methodology is based on root assumptions and union of technical criterion. In this methodology are adopt principles that provide to establishes priority in investment even without finance limits in the period. Methodology provides correction of priorities in the order to known (expected) finance limits.

Basic rules for addequate making investment priority are:

- maximal concordance beetwen MV network, and TS 110/x kV (with neccesery higher tension connections) building;
- it is supposed that spatial power forecast is in higher level of acceptance;
- network solution choice is made by long range plans, that provide technical and economy correct solution;

Obviously, we tent to make maximally exploited capacities during all life period of network. In the same time we allowe some transitional solutions with good incorporations in system.

4.1 Methodology input data

Methodology input data in all TS 110/x kV and 35/x kV in the area are:

- Tension ratio of transformer;
- Year of work startig TS 110/x kV;
- Transformer rate;
- Cos φ in maximum load;
- Power of possible transfer by MV in maximum load;
- Maximum load in every year of plannig period for TS 110/x kV
- Maximum load in every year of plannig period for TS 35/x kV

4.2 Investment schedule decision

For every investment we have first to make schedule decision. Rate in schedule is No. on the schedule list. First faze is apply technical criterion scheduling in the next way:

CRITERION 1: TS 100/x kV load is biger than limit value;

CRITERION 2: transformer 35/x kV load is biger than limit value;

CRITERION 3: exploitation of TS 110/x kV is longer than 40 years;

CRITERION 4: satisfaction of safe combine criterion;

After this, all projecs (planning activities) that was satisfied some of this criterion submits sceduling under this one criterion. Rate of project that is scheduled by two criterion take “rang” of project.

4.3 CRITERION 1: TS 100/x kV load is biger than limit value

This criterion could be expressed by follow: forecast max load TS 110/x kV in normal state is bigger than nominal power of transformer.

Criterion is applied by follow:

a) In focus are existing TS 110/x kV;

b) Existing capacity would be unchanged without new transformer 110/x kV during all planning period;

c) New expected consumer will be considered;

d) All planed manipulation with transferring among substations will be considered;

e) Substation load in last year will be relevant in scheduling, while all projects (substations) satisfy criterion are on priority list; descendant list with rang by load in last year is made.

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4.4 CRITERION 2: transformer 35/x kV load is biger than limit value

For right evaluation of all parameters of influence on transformer 110/x kV rate it is necessary to estimate all TS 35/x kV in the area. This criterion can be express by: forecast TS 35/x kV load in normal exploitation is bigger than (possible) nominal rate of TS.

Criterion is applied by:

a) Every TS 35/x kV is analyzed by yourself;

b) Mark every TS that in base or planed year have nominal load;

c) Mark every solution with enlarged capacity in 110/x kV, and have to be concords with long range plan in the area.

d) If we take assumption that we have enough finance sources for all plans, than we have formal priorities, according year of work starting objects.

e) If we take fact that we have no enough finance sources for all plans by this criterion, we than take into account TS 35/x kV load in last year of a plans period. Diference between planing load and possible installed transformer load makes priority. In this way we consider possibility of changing transformer in TS with transformer with bigger rate. All TS with positive difference are including on list. Na taj način se uvažava mogućnost zamene postojećeg ET u TS transformatorom veće snage. Sve of priority

4.5 CRITERION 3: exploitation of TS 110/x kV is longer than 40 years

For taking into account expliotation life over 40 years and reconstruction needs, we take simple criterion. In Elektrovojvodina is on road transfering from four tension (voltage) to three tension system, and this takes as an oportunity for reconstracting TS 110/35 kV with investments on MV network.

If we adopt assumption that we have enough finance sources for all objects that satisfied this criterion, than we have formal priority in accordance with date in plan. This is base of methodology use, as we consider that in moment of making middle plan finance sources are unknown.

If we have knowledge about finance limits and if we don't have enough sources than we for treating take schedule according by equipment condition, for allowed normal network functioning. For objects with satisfying equipment condition, we don't have to postpone investment.

4.6 CRITERION 4: satisfaction of safe combine criterion

When we use this criterion we start with (n-1) criterion for suplly transfering in case of outage one of transformer 110/20 kV in maximum load, taking into consideration existing and planning MV network state.

Criterion is defined as:

$$S_i = k \cdot S_P - \frac{P_{vr\{} - P_r}{\cos\varphi}$$

S_i – coverage of transformer outage,

k – overload transformer factor in winter, adopted value 1,25, and for transformer over 40 year is 1,0 ,

S_P - rest of installed transformer power in TS after outage one of transformer,

$P_{vrš}$ – maximum load of substation

P_r – possible load reservation thru MV network,

cos φ - cos φ in maximum load,

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Power difference ($P_{vrš}$-P_r) is substation power value in maximum load if all existing and planed MV connection with neighbor substation is used for transferring. By this value, we calculate coverage of transformer outage (S_i), by incrementing rest of power in transformer with factor "k". After that we decrease consume power that we can transfer on neighbor substations. Negative value of coverage of transformer outage leads to conclusion that we can't have reserve supplying when one transformer 110/x kV is out.

Meaning of factor "k" is that in outage work in winter we allowed overload of 110/x kV transformer of 25%. Allowed 110/x kV transformer overloading [3] is in winter 130% on nominal power. In our practice for making network plans [4] and in foreign practice to, it is normal to take value 1,25, so we take it here.

Criterion is apllying in this way:

a) We take into account all planed load transfering in way that we confirm all MV netvork supllying limits (don't consider new network or substation).

b) All objects with negative value of coverage of transformer outage are into consideration, and sceduled by this paramethar.

c) For define schedule list by all parameters and in this way define level of investments, we define boundary value of coverage of transformer outage as a goal in further period. After analyzes in Elektrovojvodina it was conclude that in next 10 years all substations need to have coverage of transformer outage less than 10 MW. All substations that overload this value are in the priority list.

5. Final list of priorities

Strictly technical constraint list obeying give investment schedule in plans period. Exceptions of schedule are suggestions for replacing big equipment because of its ruining. Such substations are on list of priority without scheduling, but it is possible to move it throw list only by time coordinate, for coordinate with other activities.

Activities are in priority bad smaller number in schedule, or "rang". Year in with are confirmed constrains (1-4) rule the year of object work starting, and year of starting with investment activities. In the case of unknown finance limits, schedule is made by simple examination of list, year by year, starting with first year.

In the case of unknown finance limits, priority takes criterion 1, after that criterion 2 and so on. In the bad case (minimal amount of money) situations in criterion 2 are solving by some transit solution. Than criterion 3 has to be solved in the frame of maintenance, while constraint 4 is not in consider.

6. Conclusion

In the paper is submitting system of planning documents in Elektrovojvodina, used for development plans definition, but for augmented network capacities. It is point out to relationship between this documents and their solitude role. It is outstand importance of economic development provide, that is reached by applying present worth value method. For providing rational spending of money it is necessary to provide concordance in MV network and substations plans, with influence of superior tension network. For substation building schedule is developed method that consists of ruled union of technical criterion. This model is applied in Elektrovojvodina for making middle range plans. Suitable choice of technical limits influence on goal score in MV network strategies. Union of objects that satisfy some of criterion directly influences on amount of investments, and that influence is on financial limits for some of goals. Submitted method provide scheduled in investment for taking financial limit in middle range period.

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7. Literature

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