COSTS OF CONNECTION TO THE DISTRIBUTION NETWORK

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ABSTRACT

New legislation in the energy sector has led to the establishment of new energy subjects, and has caused for existing rules to be redefined and new ones to be developed. Energy Agency of Republic of Serbia is one of the newly formed institutions. One of the tasks of the Energy Agency is development of methodology for calculation of costs of connection (of generators and consumers) to the transmission and distribution network.

This paper gives short overview of existing way of how charges for connection to the distribution network are calculated, as well as the overview of possible solutions that can be implemented for the calculation of connection costs, their strengths and weaknesses. Relevant definitions will be given, cases that attribute to the complexity of the issue, and cost positions that could be included in the calculation. The paper brings out practical problems that the Regulatory Agency had during development of the connection charging methodology. Ways of financing connection itself will, also, be given.

Key words: Connection – Costs of connection – Deep approach – Shallow approach

1 INTRODUCTION

In new organization of energy sector regulatory agencies create or approve methodologies for calculation of cost of connection of generators and consumers to the transmission and distribution grid. There are two main approaches for the solution of this problem, so called: shallow and deep connection. At the first glance the issue of connection charging might not seem too complicated, especially when compared to the complexity of the development of pricing methodologies and tariff systems. However, once the work on the connection charging methodology is on its way, many dilemmas, of a practical nature above all, occur. These dilemmas should be solved with care, since the considerable number of customer complaints in the first years after the establishment of the Regulator come from this field (for example, in Great Britain in the first years, over 90% of all complaints was connected to problems of connection to the networks).

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Here, in Serbia, special attention should be given to the fact that, at the moment, the price of electricity doesn't cover the costs of neither electricity sector as a whole, nor costs of distribution companies. Sadly, this means that the investments and costs of capital maintenance are the first that will be excluded from the plans for the years to come. Nevertheless, the process of connection of new customers to the network is continuous one, and it requires permanent development of distribution network. This requires from the methodology that will be implemented to take in consideration real facts, and not only theoretical assumptions.

The main goal of this paper is to give overview of possible solutions, to mark their good, as well as bad sides, and to present some of the dilemmas that regulators meet when creating this kind of methodologies. Practical difficulties that occurred while drafting methodologies for calculation of costs of connection in front of the people working in the Energy Agency of Republic of Serbia (AERS) will be shown.

2 CONNECTION TO THE NETWORKS IN SERBIA PRIOR TO NEW ENERGY LAW

Since the price of electricity in the last fifteen years was under the cost recovery level, Electric Power Industry of Serbia (EPS), in order to collect enough capital for the development of the network, had to issue a rulebook on calculation of costs of connection to the distribution network. The approach that has been adopted required from the customer to bare all the costs that he incurs in the distribution network from the point of his connection to the highest voltage levels. This actually means that the customer had to pay, besides the costs of his immediate connection, also so called participation expressed in din/kW of the requested capacity, and which was used for the development of the network in deep. The money collected through this participation had been used for the development of the distribution network as a whole.

The customer had an obligation to finance and built so called – inner infrastructure of the connection, meaning – electric power distribution cabinet with meter, supply cables with home electric cable connection if it was the case of underground installation, or supply cable till the point of connection on the pole, in the case of overhead line. Besides, if the situation required, the customer had to finance building, or strengthening of the network up to the point in the grid where the connection was possible. Distribution companies have been engaged in performing necessary works, while the customer had to provide all legal and technical preconditions (permits and approvals). At the end, the customer had to pay different sort of fees to distribution companies – for defining technical conditions, for control of works, for issuance of approval that the connection installation had been built in accordance with the regulation, as well as for the physical connection to the network.

In addition, when obtaining energy permit for connection to the distribution network, the customer had to pay participation whose amount depended on the number of kilowatts for which the energy permit had been issued. This price per kilowatt had been calculated on the basis of analysis that had been done by distribution companies, and approved by EPS. Basically, it had been analyzed which equipment, devices and materials are used for the construction of the low, middle and high voltage network, what are their prices and what is the average number of customers that can be connected to this type of network, having in mind the factor of simultaneousness of their consumption. The result of this analysis was the pricelist according to which the price of one kW approved was higher for the area of the distribution of Belgrade, than in the rest of the Serbia.

The consequence of this solution was that the customer had to provide significant amount of money in order to be connected to the network. Besides, he had to spend lot of time on different administrative procedures. Rather vague criteria on defining necessity for strengthening of the network, and possibility of the people employed in distribution companies to arbitrate on these matters, led to corruption and discrimination of the customers. Discrimination of customers was obvious when one customer should finance the construction of a significant part of the network (usually cables) to which, at the later stage, other customers could connect freely (free riding). This fact had often led to arguments between the customers, in which distribution companies had been involved also.

Prior to new Energy law the obligation has been put to consumers – all the assets built as a part of the connection had to be transferred into the ownership of distribution companies free of charge. Distribution companies were responsible for maintenance of the equipment up to the connection point, i.e. up to the pole or cable connection box, depending on the type of the network. Maintenance and replacement of the deteriorated equipment of the inner infrastructure was obligation of the customer, with the exception of the meter and the clock relay or tone freqency control system device. In the new

Energy law, adopted in 2004, article 3, the connection is defined as a “physical connection to the system whereby an energy facility or a customer’s facility is connected to the transmission, transportation, i.e. distribution system “. According to the article 15, which defines the tasks of the Energy Agency, this body “determines criteria and methods for determining costs of connection to the energy transmission, transportation and distribution system“. Articles 51 to 59 also deal with connection of energy objects to the transmission and distribution system. In The General Conditions for Delivery of Electricity, articles 2 to 16 also deal with this issue.

3 COST OF CONNECTION – BASIC PRINCIPLES

When defining the methodology for calculation of costs of connection, it is necessary to take into account the basic principles that are linked, but also often contradict one to another. Methodology should be based on a cost recovery principle, it should promote economic efficiency, it should minimize administrative procedures and administrative costs, it should be clear, simple, and last, but not the least, it should be nondiscriminatory. It is important to stress that this methodology should be regarded as a part of one system, system that has its key-point in tariff system, and that methodology for calculation of connection costs has to be compatible with the solutions implemented in methodologies for calculation of charges for the use of system (both transmission and distribution).

Principles of the shallow and deep connection are regarded as basic principles when defining connection cost methodology. The essential difference between the two is in the structure of costs, defined from the perspective of the point of connection as a frontier between the network and the physical connection.

3.1 Shallow Connection Principle

Under the shallow principle generator, or customer wishing to connect to the transmission or distribution network pays only for the costs of physical connection up to the closest point in the network where the connection is possible. These costs only encompass costs of devices, equipment and material, costs of labor, project and administrative costs that are incurred by the creation of physical connection between the connecting point in the grid and the measuring point where the generator delivers and consumers receives the electricity. It is important to understand that in this case no costs related to strengthening transmission or distribution network beyond the point of connection to the grid, nor costs of possible increase of losses due to new user are taken into consideration for the calculation of connection charge. All these costs, related to the transmission or distribution network should be covered through the use of system charge.

In comparison to other possible solutions result of the application of shallow approach are smaller costs of connection. In that way, new generators and consumers are encouraged to connect to the network. This principle sets the clear border between the costs of network and costs of connection. It clearly defines which equipment is to be used for construction of the connection. This enables the future user to easily calculate the costs of his connection. Clarity and simplicity are main advantage of the shallow connection approach.

On the other hand, main disadvantage of this principle is that it doesn’t give any signal to users where, from the perspective of the network, is the optimal place to connect. Implementing this principle might lead to worsening the situation in the network, which can cause that more investments in it are needed comparing to what would be the case had the connection been created on a different place in the network.

It should be stressed that in the transitional countries, where the price of electricity doesn’t cover the costs of the system, application of the shallow connection deepens the problem of providing the sufficient capital for the development of the network. This has to be taken into account because the process of connection of new generators, and especially customers is an ongoing process, meaning that the system has to be continually developed in order to meet the requests of all users.

3.2 Deep Connection Principle

In order to connect a generator or a customer to the network, it is necessary to install appropriate equipment. This makes the physical connection possible. Besides this, physical connection, the users

cause the need for the strengthening of the network up to the highest voltage level (deep in the system), and they have the impact on the increase of the losses. Deep approach means that the costs of connection will encompass not only the costs of immediate, physical, connection, but also costs of strengthening of the system. Obviously, costs of connection calculated in accordance with the deep approach are higher than those calculated with a shallow one, this would mean that costs of using the network should be lower for all users of the network.

Main advantage of the deep approach is that it gives the signals to the users where they should be connected. In points where significant investments are needed, costs of connection will be larger, which gives a strong signal for the user to consider a different place to be connected. However, this advantage is not that strong when it comes to a real life. Connection and position of consumers depends on different construction conditions, so whatever signals are there, users can't really choose where they want to connect.

This approach doesn't explicitly define how deep cost calculation should go. It is a subject of different assumptions. Strengthening of the network elements is possible in discrete steps which depend on the capacity of network elements. This capacity is significantly larger than the capacity required by a single small consumer, household for example. This additionally complicates the case of how to decide what would be the justified cost of strengthening of the network for this kind of consumer. Customers can be discriminated if one group of consumers invest in strengthening, or even the complete construction of a new network, while the users that connect at a later stage use this, already built network without any additional costs. This makes the costs of connection significantly lower for the latter group. Main disadvantages of the deep approach are its complexity, non-transparency and discrimination of the consumers. However, in a transitional phase, when the price of electricity doesn't cover the costs, deep approach allow distribution companies to collect money needed for the development of the network.

3.3 Standard Connection

Costs of connection have to be calculated for each user since each connection is a separate case (usual term for this type of connection is "individual connection" meaning that the costs have to be calculated for each user on individual basis). Different understanding of the costs of connection between the users and the companies often leads to numerous complaints of the users, and unavoidable arbitrage by the regulator. This makes creation of groups of similar connections very useful. This is especially the case with the largest category of consumers – the households and commercial sector. For these groups of consumers regulator can create a method of calculation of the costs of connection, which leads to simplicity and transparency of the calculation and diminishes administrative burden on the consumers.

Small connections on a low voltage network, being the simplest and predominant, could be separated in groups inside which there are no differences in costs between different users, or the differences are negligible. This type of connection is called "standard connection", and the costs of this kind of connections is based on averaged costs for each group (or a type) of connections. Standardizing of connections makes sense if the same devices and materials can be used for the construction of the connection, if the needed labor is identical, and if the same administrative procedure is needed.

3.4 Embedded Generation

Embedded generation consists usually of small generators. It can have a special treatment when connecting to the network. This is even more the case when the renewable sources are used for electricity production. These generators (for example, small hydro or wind farms) are usually far from the existing network. This makes the connection rather expensive. What more, this type of generation usually causes significant need for the strengthening of the existing distribution system, and having in mind the unpredictability of their production they cause additional costs of distribution system operation. However, due to promotion of energy from renewable sources the costs of these generators should be calculated using the shallow approach. Even calculated in accordance with this approach, the costs of connection can be high, therefore the European directives give the possibility for the

distribution companies to cover part of the costs of connection of distributed generators, the main reason being promotion of this electricity source.

4 FINANCING OF THE CONNECTION

One of the key questions regarding the connection to the network is who will finance its construction. There are two opposite answers and a third in the middle.

Construction of the connection can be financed from the sources of the energy subject to whose network the connection is being made. This would mean that customer or producer interested in connection submits an application, and distribution (or transmission) company has to perform the connection to the system requiring no fee. Costs incurred due to connection would be covered in full from the use of system charge. Described approach is very convenient for the users of the network since it doesn't require any financial effort from them. Though it might sound unusual, this approach could be defended by the fact that the development of the system, which assumes connection of new users, is one of the main roles of distribution (and transmission) companies. Besides, the physical connection belongs to these companies, which makes it reasonable for them to finance its construction. On the other hand, it is clear that this approach puts significant financial burden on companies since the expense is made in one moment, while the return of these assets happens through time. Transitional countries have one more obstacle to this approach – electricity price below level of costs.

In case when energy subjects don't have enough capital to provide uniform development of the network and construction of connections, users might accept to pay for connection, while during usage of the network they would only pay for the use of system. Regulator, then, gives the methodology for calculation of one-off payment for the connection, while the distribution company gives the conditions for the connection and organizes its construction. User pays for the connection in accordance to the pricelist. It is clear that this solution puts certain financial burden to the users, while it leaves possibility for the companies to obtain certain assets free of charge. It must be stressed that the assets acquired in this way mustn't be treated as a part of the regulatory asset base, i.e. companies must not earn return on these assets. So, what might seem as an attractive solution, for companies, in the short term might not be that in the longer term.

The third solution would be the one where one part of the connection is financed by the users of the system, and another part by distribution company. This compromise suffers from following weaknesses: it is arbitrary, nontransparent and discriminatory. The decision on the ratio in which each of the players (user and company) will participate in construction of the connection is arbitrary, and depends on the one who makes it. The fact that one part of the connection is financed by the user and another by the company points out to the non-transparency. In such a case it is unclear who is the owner of the connection, who has the obligation of the replacement and maintenance of the equipment, and who can receive profit from this investment. The praxis according to which user transfers the part of the connection financed by him to the distribution company free of charge is definitely not in line with market oriented way of thinking and acting. Finally, if said ratio would change with time it would lead to the discrimination of users since for the same connection some would pay more, some less. Discrimination is even more visible when one understands that company finds its sources for financing of the connection in the use of system charge, paid by all users. This means that if one user had financed, for example, 70% of his connection, the remaining 30% are financed by distribution company. This 30% came from the use of system charge paid by all users, including the one that is being connected. If this proportion changes with time, and later another user finances only 40% of the connection, the distribution company would then finance 60% from the use of system charge. This would mean that the first user not only had he paid larger part of the proportion, but he had participated in paying larger part of the second user's connection through now enlarged use of system charge. The result is that the first user has been discriminated twice, for paying larger part of the connection (70% instead of 40%), and for participating in larger use of system charge (paying for someone else's 60% instead of 30% through the use of system).

Next question is connected to who will finance the replacement of the assets once their useful life is over. Answer to this question is connected to the treatment of the depreciation of the connection assets. One possibility is that the user finances the connection, and the depreciation of the assets to be excluded from the costs of the company. In this case, once the life of the assets expires distribution company should ask the user for a new payment for the "new" connection. This kind of solution brings

numerous question regarding the treatment of the assets that have been written off, but can still be used, treatment of the residual value should user require to be disconnected from the system, as well as practical problem of explaining to users why do they have to pay for this, new connection after, let's say, 25 years through which they have been using the system.

Second approach is also possible, according to which the company finances the construction of connection which allows them to have costs of depreciation of the assets in the costs approved by the regulator. This means that by the end of the useful life of the assets company should have enough money to replace the fully depreciated assets.

There is, also, a third solution where the user finances the connection, but the depreciation is treated as a cost to the company and is approved by the regulator. This means that the replacement of these assets would have to be done by the company. This approach raises the question of correctness of such approach as it enables the company to collect money for the assets that it hasn't finance at the first place. From the economic point of view the assets financed by the user don't belong to the company, meaning that it shouldn't be allowed to raise funds on them. At the same time not only had the user financed the connection, but he also pays for the replacement of those assets through the use of the system charge.

Next question in regard to the financing of the connection is connected to the problem of "sharing" of the connection when used by two or more users. Such a case occurs when a new user is connected to the equipment financed by existing user. The assumption is, of course, that the connection has been fully financed by the existing user, and that there is technical possibility to supply both users through same equipment. Having in mind that the part of the connection that both users are using has been financed by the first user, a question can be raised whether the second user should be allowed to connect free of charge, that is – should he be allowed a free ride. Possible solution in cases like this is for the regulator to set up compensatory mechanism through which the second user could reimburse the first one for the part of the assets that he (the second) will be using. This compensatory mechanism can set up the time frontier, beyond which there'll be no reimbursements, i.e. after which new users will be allowed to connect to the assets in question without reimbursing anyone.

Question that is also valid is the treatment of the existing users, or should users that are already connected at the moment of introduction of new connection rules pay for their connection, or should they just continue using the network. Since it would be very hard, if not impossible to roll back value of all the investments that have been made in order to identify the costs of each connection, the existing situation is usually taken as given, meaning that it is allowed for the existing users to continue using the system without payment for the connection.

Finally, when previous question have been considered, there is a question of how to settle the financial obligation of users toward the distribution companies, in other words what should the dynamics of payments look like. It is possible for the users to pay everything in advance, so called one-off payment, or they could be paying through the time, in annuities. Third solution would allow for the participants (user and the company) to create financial arrangement that would suite them both.

One-off payment, or payment through several identical portions, prior to physical connection to the network, is usually applied with the standard connection. Other possibility is payment through annuities, during the lifetime of the asset. Calculation of the annuities is not simple division of value of the assets by their assumed life. This calculation should encompass: depreciation cost, costs of maintenance and certain return on the capital invested in those assets. Payment through annuities brings the question of what happens if the user decides (or is forced) to disconnect from the network before he pays off the value of the assets. As a solution a so called termination payment is introduced. Termination payment enables the company to collect the residual value from the user, as well as the immediate costs of disconnection of that user from the network.

5 STANDARDIZATION AND APPLICATION OF CONNECTIONS IN SERBIA

Regulatory agencies are aware of all strengths and weaknesses of different approaches to calculation of costs of connection. They are interested in setting up methodologies that will enable continuous connection of new users, that will be clear, cost funded, and that will bring disputes between users of the network and distribution companies to minimum.

5.1 Possible Ways of Connection Standardization

Having in mind all virtues and drawbacks of two basic principles (deep / shallow), the shallow approach can be considered as more appropriate and easier to implement. However, this would be the case only if all other costs, including cost of network development, could be covered from the use of system charge.

With technical recommendations and existing praxis in mind, it can be concluded that the standardization of connections is realistic only with the consumers wishing to connect to the low voltage network. This type of standardization is very important because the biggest number of connections is performed on this voltage level. Standardization simplifies the procedure of customer connection and defines in advance what will be the price of connection. First level of standardization can be introduced regarding the type of the network. In this manner overhead, underground and combined connection can be identified. Second basis for standardization is connection with one phase, and three-phase connection. Depending on the nominal capacity of the fuse (i.e. requested capacity), and having in mind the type of equipment that will be used, connections can be standardized in two groups: up to 7.5 kW for one-phase, and from 11.5 to 50 kW for three-phase connections. Next criteria would be the number of flats (i.e. number of meters) in the building which is being connected to the system. According to this criterion single and group-connections can be separated. Single-connection is relatively simple, one user, or one household applies for the connection, one meter is to be installed, and costs depend on the type of network (overhead or underground) and number of phases. Here, it's easy to define the equipment belonging to this type of connection hence it's easy to define corresponding costs. On the other hand, when there is larger number of apartments in one building that needs to be connected things gets complicated. Here, all the equipment (except meter and fuses) is mutual. To be even more complex, the same equipment could be used for different number of apartments. According to technical conditions for construction of the connection one type of equipment is used for connection up to four apartments. Therefore, one type of standardized group-connections can be connection up to four meters (or apartments). For larger number of apartments, equipment of a larger capacity is used. Number of apartments that can be connected to the said equipment depends on the type of heating, i.e. whether the apartments use distant heating or electricity for this purpose. For apartments that use distant heating a group-connection can be identified with maximum 64 apartments, while for apartments heated with electricity this number, due to larger power requested per apartment, is 32. Finally, last criterion for standardization of connections is the distance of the object from the network. Basically, all users that are positioned on a distance less than given pay the same amount for their connection. Customers distant more than given border pay certain addition per each meter above the border. According to existing praxis in Serbia, if the distance between the object and the network is less than 25 meters no additional poles are needed for construction of overhead-type connection, therefore, this could give good value for this border.

As a conclusion, it might be said that the importance of the capacity of the connection that is requested is diminished now to what it used to be. If instead of the shallow a deep approach would be implemented, the importance of the capacity of the connection would be considerably higher. This occurs due to the fact that the costs of connection deep in the network are closely related to the capacity that is required. This doesn't mean that with the shallow approach the user doesn't have to think on the capacity (or the fuse) that he'll require. In the tariff system for the use of distribution system one of the elements has to be capacity, as a reflection of fixed costs of the network.

5.2 Problems in Application of Connection Methodology

Methodology that defines the costs of connection has to be cost reflective, but it also has to be applicable. Naturally, legal limits set by the Energy Law mustn't be crossed.

The Energy Law requires for the distribution company to build the connection, while the only function of the user is to pay for it. However, new definition of connection treats the inner infrastructure as a part of connection, which means that the distribution company has to build and maintain this part too. This can lead to problems in application, since this installation has to be installed while the object is being built. This requires that the phase of connection of the object to the network has to be coordinated with other works on it. Besides works on construction, all the administrative procedures

that used to be obligation of the user are now on the distribution companies to perform. This has to be performed in time, in order not to disable other construction works on the object.

Shallow approach assumes the obligation of distribution companies do develop their network development plans. In accordance with these, they should issue energy permits. On the other hand, these plans have to be considered through the use of system charge in order for the companies to be able to fulfill their task of development of the network.

6 CONCLUSION

This paper shows limitations and dilemmas that the regulatory agencies face while defining connection costs methodologies. Two basic approaches for calculation of these costs have been marked – the shallow and the deep approach, together with their strengths and weaknesses. After a careful analysis authors conclude that the strengths of the shallow approach prevail to the deep approach, but with the condition that the costs of the development of the distribution system have to be covered through the use of system charge.

The paper gives the possibility of standardization of the connections on the low voltage level. Here, the costs calculation would be based on the average costs, which is possible since the actual costs of connection of customers belonging to one type of connection are on the average equal. It has been stressed that the standardization increases simplicity and transparency of the calculation for the large number of consumers. Administrative procedure and relationships between users, companies and the regulator are also simplified. Different ways of standardization have been given.

It has been shown that the connection could be financed by the distribution company, but that it is usual that for the user to bare these costs. Small users usually pay connection costs in advance, as one-off payment, while large users can be given possibility to pay through time in equal portions. In the latter case, attention has to be paid on the costs that haven't been covered should the customer decide (or be forced) to disconnect prior to paying his connection in full.

Finally, the practical problems that can occur, in Serbia, in front of the distribution companies, as well as in front users have been shown.

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