Distribution network connection pricing framework and methodology: identification of areas of improvement for Sarawak Energy Berhad Connection Charges Guidelines through modified delphi method

J K Tan¹,² and N Abas¹

¹ UTM Razak School of Engineering and Advanced Technology, Universiti Tekonologi Malaysia, Jalan Sultan Yahya Petra, Kuala Lumpur, Malaysia
² Sarawak Energy Berhad, Kuching, Sarawak, Malaysia

E-mail: jookok@gmail.com

Abstract: Complaints on issues and matters related to connection charges have been very common for electricity supply utility companies around the world including Sarawak Energy Berhad. In order to identify the areas that can be improved, a mixed method of exploratory research involving qualitative and quantitative methods have been designed and undertaken rather than a single method of survey. This will ensure a more comprehensive and detailed understanding of the issues from various target groups. The method is designed under three phases, employing Modified Delphi Technique for phase 1 through a series of stake holder engagements, online and offline survey questionnaires to be filled by internal wiring contractors for phase 2 whilst under phase 3, case studies shall be carried out on the issues identified from phase 1 and phase 2 of the study. This paper presented the findings from the Modified Delphi Technique. The findings revealed that there are areas of improvement for Sarawak Energy Berhad connection guidelines in term of differentiation of dedicated and shared assets which leads to unfairness to the connecting customers, inconsistency and non-transparent in charging. The findings of Modified Delphi Technique shall be used for implementation of phase 2 and phase 3 of the study.

1. Introduction

Complaints on connection charges issues related to electricity supply are prevalent throughout the world for electricity supply utility companies such as Sarawak Energy Berhad (SEB), as this involves dollars and cents that customers pay to get connected to the distribution electrical network.

Some of the common issues raised are mostly related to the pricing, technical problem or the related application process and procedures, which has direct impact to the connecting customers.

In order to gain a more understanding on this topic and to explore any deficiency in SEB connection charges, a mixed method of exploratory research was employed, in view of the fact that connection charges is a technical issue but it is not totally an engineering problem. The conventional use of single survey method may not be adequate to fully reflect the true picture of the topic under study. An extensive review on mixed method could be found by studies published by Plano Clark et. al.[1].
2. Proposed Research
The study was undertaken via reviewing and understanding connection charges policy of SEB. Identification of areas for improvement on SEB connection charges guidelines were undertaken in phases through dialogues, engagement, questionnaires and case study for various groups of customers. This paper will discuss the results/findings based on the surveys done using the Modified Delphi Method.

3. Literature Review
3.1 Typical Connection Frame Work Model
Figure 1 shows the supply connection of a customer from the distribution intake substation for SEB. It is also the typical connection frame work model used for computation of the connection charges and the policies for other utilities.

![Figure 1. Typical distribution network connection frame work model for computation of connection charges](image_url)

It is made up of the following chargeable sectors:

- Development of High Tension (HT) intake (33KV substation): Covers the development of major distribution substation, typically at 33KV and with voltage transformation to 11KV before distributing to various customers as indicated in Figure 1 as “A”.

- Development of High Tension (HT) system: Covers the development of HT system which includes the underground cables, overhead lines, transformers and all related accessories as indicated in Figure 1 as “B”.

- Development of Low Tension (LT) system: Covers the development of LT system which includes the underground cables, overhead lines and all related accessories as indicated in Figure 1 as “C”.

3.2 SEB Connection Charges Guidelines
Table 1 summarized the key components of current connection charges guidelines of SEB based on components spelt out in figure 1, extracted from their connection charges guidelines [2].
| Item                        | Description                                                                 |
|-----------------------------|-----------------------------------------------------------------------------|
| HT Intake (33KV substation) | Case to case basis. No clear guidelines on the charging methodology          |
| HT System                   | Covers the:                                                                 |
|                             | - Connection to existing HT network                                          |
|                             | - Extension of HT network                                                     |
|                             | - Installation of HT transformer                                              |
|                             | Housing and shop houses development:                                         |
|                             | - Capacity charge of RM500/KVA + Actual HT costs (if more than 1km from the nearest HT connection point) |
|                             | Single residential, commercial and industrial premise:                       |
|                             | - Capacity charge of RM500/KVA + Actual HT charge for HT cost that exceed 300% of the capacity charge + Actual HT costs (if more than 1km from the nearest HT connection point) |
|                             | Government and temporary supply:                                             |
|                             | - Estimated project actual cost                                              |
| LT System                   | Estimated actual project cost                                                |

**Table 1. Key components of current charging methodology of SEB as per extracted from their connection charges guidelines**

3.3 *Generic Characteristics of Connection Charges*

Connection charges cover all categories of customers that require connection of supply to utilities’ network, at various voltage level. In a study by Mark Cox [3], fourteen (14) countries covered under his study revealed a few issues regarding their respective connection charges policies which include: inappropriately designed rules, complex procedures, in-transparent and high connection costs. All these issues can create barriers for the realization of new connections, especially to household customers. G Strbac, J Mutale and D. Pudjiyanto [4] also raised the same concerns regarding the connection charges from the perspective of the regulator, network companies and the customers.

In order to deliver the most appropriate network pricing (tariff and connection charges) to customers of electricity, and to ensure that the utilities is able to operate the system efficiently as well as are able to sustain their business on long term basis, it is necessary to ensure that during computation or revision of network pricing, it shall be able to meet the utility’s financial objectives and to address the issues faced by the utility from time to time.
G Strbac, J Mutale and D. Pudjianto [4] presented in their working report to Office of Gas and Electricity Market (OFGEM) on the fundamental objectives for computation of network pricing that will address the issues faced by the regulators, network operators as well as the customer.

In their report, it is mentioned that in order to achieve effective economic efficiency, the computed network pricing shall distinguish between different user categories and at different locations at which a customer is connected in order to avoid cross subsidies between customers.

On the other hand, from the utility company point of view, the network pricing shall also reflect an efficient network investment and to avoid over investment that will affect the company’s financial standing. A network pricing based on shallow approach will trigger additional investment from the utility companies hoping that the upfront investment can be recovered through long term collection from the customers through tariff. Likewise, a deep approach will trigger collection of fund from the customer to develop the system for future use.

From the regulator point of view, excessive network charges are always the main culprit of complaints. Though lower the network prices would solve the problem, the utility companies may not be able to generate enough revenue to invest in network operation and development thus affecting the service quality to the customers. With the appropriate network pricing computed, it will enable the company to deliver the required revenue to ensure company sustainability in operating, maintaining and upgrading the assets.

However, besides considering the network pricing based on the financial standing of the company, G Strbac, J Mutale and D. Pudjianto [4] mentioned that it is necessary to ensure that the network pricing is stable and predictable. This is an important aspect that influence a connecting customer’s decision. A right balance must however be struck between price stability and flexibility allowing prices to respond to changing situations.

In addition to this, the network price shall also be transparent, auditable and consistent [5][4] to allow the interested connecting customer to understand the structure of the fee and to make necessary decision for connection to the existing system.

Guy Nicholson, an independent specialist in the Grid Integration of renewable Energy, who has carried out design and costing studies for 8 out of 13 UK offshore windfarms commented that the connection charges may not need to be low but it must be reasonably charged based on the Use of System (UoS) [5]. It is also supported by G Strbac, J Mutale and D. Pudjianto [4] where it is mentioned that the connection charges should be charged based on the capacity used or applied for. This is to ensure that all customers are fairly treated.

Mark Cox [3], in his working paper to OFGEM commented that in order to determine an appropriate framework to sustain for long term distribution charging, a few charging principles shall be considered which are all in line with [4][5], which can be summarized as below:

- Cost reflectivity
- Simplicity
- Transparency
- Predictability

3.4 The Delphi Technique
The Delphi Technique is a widely accepted method for gathering opinions from experts in particular area. It was originally created in 1950 by the RAND Corporation [6]. It is a process of gathering
information and opinions from the respondents within their area of expertise through several iterations of communication with the respondents.

It is carried out by gathering information in the first iteration of communication. The information is consolidated and to be used to generate more detailed questionnaires in the subsequent round of communication. The iteration process will continue until convergence is achieved.

Typically, the Delphi Techniques comprises of four rounds of iterations of communication and the conventional method of communication used are through questionnaire to aggregate the opinions of a group of individual. There are now many different types of Delphi Technique. For this study, the modified Delphi Technique was used. Instead of conducting the survey through questionnaires, the modified Delphi Technique will comprise of engagements, dialogue sessions and questionnaires.

In theory, the process of the Delphi can be optimized with more iterations until a perfect consensus is achieved. However, some researchers have found that three iterations are adequate for data collecting and reaching a consensus [7]. It is thus decided that three (3) iterations for this study. Three iterations of the Delphi Technique included face-to-face engagements and dialogues, written questionnaires seeking for opinions based on the summarized, controlled feedback from the engagements/dialogues and literature review.

Undertaking surveys through Delphi Technique provides several advantages: It offers a platform for investigator to have at least two to four iterations of opinion seeking in a controlled manner also giving the respondents extensive opportunities to provide feedback and to review and to reconsider their initial opinion generated in the previous rounds. In addition to this, Delphi Technique can reduce the effect of “noise”; that is, extraneous or error driven information.

4. Research Methodology
4.1 Target Participants
Representatives who are fluent and familiar with SEB CCG were drawn from various government departments and non-government agencies to make up “the Delphi panel”. These departments and agencies are also the ones who have raised concerns over the SEB CCG to Minister of Public Utility (MPU) and have attended the lab session conducted by MPU [8]. The departments and agencies invited are as below:

- Ministry of Housing (MOH) Sarawak
  - Agency that is fluent in any policy dealing with various housing and real estate development
  - Represented by the 2 active officer in charge
- Ministry of Industrial Development (MID) Sarawak
  - Agency that is dealing with all the large, medium and small industrial estate
  - Represented by the 2 active officer in charge
- Association of Consulting Engineers Malaysia (ACEM) Sarawak Branch
  - Association dealing with all the potential connecting customers and to provide technical and financial advices
  - Represented by 4 members of ACEM who are also the active electrical consultants dealing with various electricity connecting customers
- Sarawak Housing And Real Estate Developer Association (SHEDA)
  - Association dealing and ensure the interest of housing and real estate developers is well taken care
  - Represented by the 2 members of active council members

The survey shall be conducted in four different locations, namely Kuching, Sibu, Bintulu and Miri, being the four (4) main city/town of Sarawak. This made up of a total of 40 respondents for the survey.
The usual panel in a Delphi study is typically less than 50 [9]. More subjects will ensure diversity in the reference groups and to ensure that the judgements will not be biased and compromised.

The forty (40) respondents were provided with details of this research and invited to participate in the survey.

4.2 Procedures for Implementation
The three (3) rounds of the modified Delphi Technique were coordinated using email and face-to-face engagements to introduce the study and its goals, to answer questions and to invite participation in the study. All respondents were maintained anonymous throughout the whole study.

**Round One (R1)** of Delphi implementation was undertaken through engagements in the form open-ended dialogue sessions with an explanation of the study’s purpose. It is an information gathering session and all respondents are free to give comments and feedback on any issues they faced with SEB CCG.

This first round of Delphi Technique aimed to sought the Delphi panel’s views on the preliminary findings from MPU lab session on their concerns over SEB CCG. After receiving the responses from the Delphi panel, the collected information is analysed individually using content analysis for themes and overlap. A consolidated summary of the findings shall be used as the basis for **Round Two (R2)** questionnaires formulation.

In **Round Two (R2)**, statements from R1 were used to compose questionnaire requesting the panel to review the summarized items discussed in R1. All the panels were asked to reconsider and to revisit the information feedback in R1 to ensure all relevant issues are covered. This round was done through face-to-face engagement. The panel was then asked to rate the impact of each issue and to establish priorities for if the issue can only be solved one-by-one using a 4-point scale, ranging from 1 (least impact/priority) to 4 (high impact/priority). The respondents are also offered the opportunity to comment on any items shall it was missed out during R1 engagement.

The impact level as well as the priority of each issue raised were computed and ranked. The summary of response from R2 was transmitted to respondents for the final consideration in R3.

In **Final Round (R3)**, the respondents received a summary of responses from R2 through presentation for their final consideration of the issues raised in SEB CCG. All respondents are given another opportunity to make further clarifications of any issues before a consensus was reached. The respondents were also asked to give comments on how would the issues can be solved and what are the strategies that can be taken on implementing SEB CCG.

The returned responses of R3 were summarized to reach for a consensus. The high impacts issues that should be prioritized were identified. The potentials solution proposed by the respondents were also summarized and categorized into different categories. Focus area for the model construction is identified.

4.3 Implementation Plans and Timelines
The whole Delphi Process shall be carried out in four main stations, one month apart for each station. one months upon completion of the last engagement sessions, R2 questionnaires shall be sent out to the relevant respondents to feedback within a month. R3 questionnaires shall then be sent out 1 month after all the R2 questionnaires were all returned. The whole process shall take up to maximum of 6 months.

Out of the 40 participants, 35 of them completed all three rounds of the modified Delphi method, for a response rate of 87.5%.
5. Results and Findings
The Delphi Technique was modified to operate in three rounds to collect data to identify the gap/deficiency in SEB connection charges guidelines. The result of the Delphi Technique is as shown in Table 2:

| Rank | Description |
|------|-------------|
| 1    | Inconsistent treatment of charging: Different customers applying for the same energy demand but was charged differently |
| 2    | Inconsistency in the charging: The connecting cost varies from station to station with the same scope of work or connecting to same number of living units |
| 3    | Difficult to budget for connection charges: The connection cost per living unit come out to different values. This makes it difficult for developers to budget for connection cost. |
| 4    | Positioning of substation: Developer is often requested to position the substation at a prime location within a development which significantly taken up the opportunity cost of the whole development. |
| 5    | Inconsistent charging of shared and dedicated asset: Some customers pay full cost of the network development whilst some customers pay portion of the network construction cost |
| 6    | Manipulating of applied load: SEB connection charging policies allow for customers to pay less when applying for higher energy demand |
| 7    | Different customers make different contribution to shared HT System Development (11KV and below): RM500/KVA is imposed on all customers regardless of if any augmentation is required on HT system |
| 8    | Land for substation: The land required or constructing distribution substation and zone substation affect the overall project development cost |
| 9    | Change of Policies/Regulations: SEB often changes policies without giving adequate lead time for implementation makes for an uncertain market to the developer |
| 10   | Complexity and transparency: Clients are in the opinion that SESCO connection charges guidelines are being too complex and not transparent to the customers |
| 11   | Channel for appeal: There is no proper contact to lodge a complaint on any “high” connecting cost imposed by the company |
| 12   | Time frames for approvals of application: Typical application for electricity supply takes a long time, typically up to 6 months. |
| 13   | Inconsistent / Unclear process for assessing application: For any application, there is no clear guidelines on how the company assesses an application. |
| 14   | Cost increases driven by SEB: The price of connecting customers to electricity has been going up over time and it is due to change of SEB policy on electrical designs |
No clear guidelines on assisting disadvantaged customer:
Disadvantaged customers pay high connection cost to be connected to SEB network

Table 2. The compiled result of the Delphi Technique.

The issues/limitations computed were categorised into three categories as shown in Table 3 below. For the paper, the study will emphasis on issues related to pricing methodology.

| Categories                   | Description                                                                 |
|------------------------------|-----------------------------------------------------------------------------|
| Processes and procedures     | • Inconsistent / Unclear process for assessing application                  |
|                              | • Time frames for approvals of application                                  |
|                              | • Channel for appeal                                                        |
|                              | • No clear guidelines on assisting disadvantaged customer                   |
| Pricing methodology          | • Inconsistent treatment of charging                                        |
|                              | • Inconsistency in the charging                                             |
|                              | • Difficult to budget for connection charges                                |
|                              | • Different customers make different contribution to shared HT System       |
|                              | Development (11KV and below)                                               |
|                              | • Inconsistent charging of shared and dedicated asset                        |
|                              | • Manipulating of applied load                                              |
|                              | • Complexity                                                                |
| Technical standards          | • Cost increases driven by SEB                                              |
|                              | • Positioning of substation                                                 |
|                              | • Change of Policies/Regulations                                            |
|                              | • Land for substation                                                       |

Table 3. The results of Delphi Technique are grouped into three categories.

a) Inconsistent treatment of charging to different customer
It is found that different customer categories of the same applied load would be charged different amount of connection charge. In general, housing/show houses developers are receiving higher subsidy than single premise, industrial and residential customer. For example, assume a housing development and an industrial customer require exactly the same load on the system (and they require exactly the same HT assets to be constructed to serve that load), if the industrial customer breaches the 300% subsidy threshold, then it bears the full HT costs above that threshold, yet in the same circumstances, the housing development would not (Unlimited subsidy)

b) Inconsistency in the charging
The low tension (LT) portion of SEB connection charges guidelines is based on the estimated actual cost of the construction. This cost may vary between stations for the same scope of work to be carried out. This is mainly due to the fact that the estimated cost may be carried out by different planners. In addition to this, the work charges and the material cost may vary from one station to another stations.

c) Difficult to budget for connection charges
With reference to item b) above, which makes the connection charges to be incurred to the customers vary, this makes the developers of housings or shop houses difficult to budget for the connection charges for each premise. This is more difficult to be achieved with the change of technical standards, which makes the per living unit to vary from RM3,000.00 to RM14,000.00.
d) Different customers make different contribution to shared HT System Development (11KV and below)
For charges on HT system development, a standard charge of RM500/KVA is imposed to ALL customers requesting for connection to the system regardless of whether any HT network augmentation is required. It creates unfairness of charging whereby for small customers that does not require any augmentation to the upstream system or requires no dedicated HT assets, would also have to contribute RM500/KVA. On the other hand, a development which requires connection to the existing HT network and extension of HT network up to 1km dedicated to their development would also pay the same. This indirectly cause the cross subsidy between customers whereby the small customers would subsidise the big customers.

e) Inconsistent treatment of HT/LT assets (Shared and dedicated assets)
HT assets, regardless of whether developed to serve a single development (dedicated) or multiple developments (Shared) are covered by the RM500/KVA (+ additional cost funded by SEB) whereas all LT assets are treated as dedicated assets (and all funded directly by the connecting customer) thus inconsistency in the charging of shared/dedicated asset.

f) Manipulation of KVA applied for
The 300% subsidy rule introduced in SEB connection charges guidelines may encourage some industrial and commercial customers to arbitrarily increase their “required” nominated electrical load (KVA) to reduce their connection charges. This will eventually increase SEB’s contribution whilst at the same time leading to the development of oversized asset in the distribution system thus reduction in asset utilization factor.

g) Complexity
Due to the inconsistency of the charging between station and the cost per living unit varies significantly, it is no doubt that it has created the perception that SEB connection charges guidelines is too complicated to be understood and the charging methodology is not transparent to public.

6. Summary and Discussion
The 7 issues/limitations listed under pricing methodology were analysed and it was clearly shown that SEB connection charges guidelines has not demonstrated the four basic criteria of network supply connection models as below, as mentioned in Section 3.3:
- Cost reflectivity
- Simplicity
- Transparency
- Predictability

Revised SEB connection charges guidelines shall comprise of the following fundamental principles:
- Simple and easy to understand charging principle
- Transparency of charging via introduction of schedule of rate for the commonly used scope of work
- Fairer connection charges through “Pay-for-what-you-use” principle
- Apply “least-cost means of providing electricity services to end customers
- Differentiation of charging for dedicated and shared assets
- Equity of charging – Customers require similar assets should impose similar costs, avoiding cross subsidy between customers

Following the above fundamental principle as the frame work, additional work needs to be carried out via:
- Case study to determine and to verify the deficiency of the current connection charges policy
• Financial modelling and financial impact study on the current connection charges policy to determine the current and future financial position of continuing to practice the current policy

7. Reference

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