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DSO TARIFF STRUCTURE

SUITABILITY OF THE SUBSCRIPTION MODEL AS A FUTURE-PROOF NETWORK TARIFF DESIGN METHODOLOGY

Prepared for Institut Luxembourgeois de Régulation

REPORT

Table of contents

Project name:	DSO tariff structure	DNV Energy Systems
Report title:	Suitability of the subscription model as a future-proof network tariff design methodology for Luxembourg	EMT NEMEA Veritasveien 1, N 1363 Høvik
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Date of issue:	2021-04-16	
Project No.:	102 68 877	
Organisation unit:	EMT	
Report No.:	2021-0373, Rev. 0	

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Keywords:

Rev. No.	Date	Reason for Issue	Prepared by	Verified by	Approved by
0	2021-04-16	First issue			

1 EXECUTIVE SUMMARY

A subscription-based bandwidth model has several key benefits over the current tariff schemes applied in Luxembourg:

- It better reflects the cost structure of the power grid, with a large share of the costs being allocated through capacity-based, rather than energy-based, charges.
- It provides flexibility and incentivises customer choices that contribute to lower growth of overall grid costs than current charging structure.

The aim of this report has been to explain if, and how, the implementation of such a subscription-based bandwidth model could be done in Luxembourg.

The findings show that a subscription-based bandwidth model is applicable both for low voltage customers as well as for customers in the medium and high voltage grid. Although the parameters would differ between the grid voltage levels, the structure should be comparable. The key principles are:

- A relatively low volumetric fee (eurocent/kWh)
- A fixed fee per month depending on the subscribed bandwidth, such that
  - Customers are invited to chose subscription from a limited number of max capacities
  - The specific subscription fee (monthly payment/subscribed capacity) is not increasing (but potentially decreasing) with larger subscriptions
- A relatively high exceedance fee for consumption outside the subscribed capacity

For medium and high voltage grids, it should be considered to check compliance with the subscribed bandwidth during system peak instead of measuring each customer's individual peak. Irrespective of grid voltage level, it is recommended that the bandwidth model only apply to load, i.e. withdrawal from the grid, in order to comply with EU regulations.

A subscription-based model could allow for sharing of energy and self-consumption by implementing a net consumption approach where the network charges are calculated on a 15-minute interval based on total consumption minus total production behind a connection point. This can be implemented both for individual prosumers, for multi-family houses and other sharing arrangements behind a single connection point. We do not recommend the net consumption approach for local energy communities unless operations are confined to a single low voltage segment and a favourable impact on network cost can be demonstrated. For non-local energy communities, we do not recommend the net consumption approach at all.

The suggested model structure in this report is rather generic and allows for large variations in the different parameters, which need to be tailored appropriately. As an example, the ratio between the subscription fee and the exceedance fee should be observed carefully. A trial period and step-by-step implementation and adaption by the DSOs and regulator is recommended.

2 BACKGROUND

In 2019, DNV published a white paper on “Effective and cost reflective distribution tariffs”, highlighting the importance of creating a future-proof tariff model that fits well with the requirements that apply to all grid charges: to be fair and cost-reflective, transparent, and provide incentives to stimulate an efficient use of the grid. In the paper, DNV concludes that the tariff should primarily be capacity-based, rather than energy-based, and that the capacity should be based on the customer’s grid usage, rather than on the physical capacity. The network costs should be allocated fairly among the customers and one should ensure economic efficiency in the future. One tariff model that seems fit for the task is the subscription-based bandwidth model, which is briefly explained in section 2.

In Luxembourg however, the current tariff scheme is primarily energy-based: Around 75% (low voltage) and 50% (medium and high voltage) of the network costs are recovered through an energy-based charge. Moreover, the scheme does not provide clear incentives to adapt consumption to the network capacity as customers cannot subscribe to a lower capacity than the standard connection capacity (3x40A, which is approximately 27 kW), and customers are not incentivised to use the grid efficiently, within the standard available connection capacity. In order to facilitate the energy transition in Luxembourg while keeping the investments in the distribution grid as low as possible, the tariff structure thus needs to change.

In light of this, Institut Luxembourgeois de Régulation (ILR) has asked DNV to further explain how the implementation of a subscription-based bandwidth model is likely to look and work in practice in Luxembourg.

This report gives a short re-cap of the discussions and workshops between ILR and DNV, with the end result being:

- A suggestion to how the bandwidth model can be tailored to the specific situation in Luxembourg.
- Further emphasis and justification of certain elements of the model, such as using dynamic tariff elements.
- Further details on how the tariff model is to be implemented, such as meter-specific challenges and stepwise implementation.
- Key concerns for application of a future-proof design in the medium and high voltage distribution grid.

3 A SHORT INTRODUCTION TO THE SUBSCRIPTION MODEL

In a subscription-based bandwidth model, the customer subscribes to a certain level of capacity (a bandwidth) for a fixed fee. This applies to both withdrawal and injection, and the fixed fee varies with the chosen bandwidth.[1] Using a fixed fee to collect a major share of the payment for each customer fits well with the cost structure of the distribution grid, where the key cost driver is installed capacity. Since subscription models are common in e.g. telecom services, the customers are likely to understand and accept such a model and its consequences.

For households and other small consumers, using only a few thousand kWh annually, we recommend not applying any volumetric fee for (net) consumption within the band[2].

Consumption (or feed-in, see next paragraph) outside the band is subject to an exceedance fee. The exceedance fee is used to reflect that capacity expansion of the grid is relatively costly and should be charged accordingly. However, the exceedance fee needs to be set 'just right': Setting the exceedance fee too low will remove the incentive for customers to adjust their consumption pattern to stay within the band, while setting it too high will remove the incentive for customers to subscribe to a lower bandwidth (thus removing incentives for applying necessary consumption/behaviour changes in order to stay within this lower band). Although not discussed in the DNV whitepaper about the subscription model, the exceedance fee can be designed to vary depending on how much power and for how long you exceed the band, when you exceed the band (off-peak or peak hours), whether the exceedance relates to additional off-take or additional feed-in, etc. This is discussed further in Chapter 5.

Commission Regulation (EU) no 838/2010 places limits on annual average transmission charges paid by producers in each Member State. In line with this, the **transmission** charge for producers (injection fee) is zero in more than half of the EU Member States, including Luxembourg, Germany and the Netherlands. A non-zero injection fee at the distribution level will discriminate production not connected directly to the transmission network. Even if the level is set in compliance with regulation 838/2010, it is unclear if a positive injection fee at distribution level is in line with the Electricity Regulation 2019/943 if the injection fee at transmission level in the same country is set to zero. In the case of Luxembourg, it thus seems reasonable that an application of the bandwidth model is applied only for off-take.

1 Hence, the bandwidth model is primarily relevant for households and other small consumers or prosumers.

2 In the whitepaper, DNV discusses how introducing an energy-related payment within the band may complicate the tariff scheme. For households using around 3000 kWh of electricity per year, the annual cost of marginal losses is around 15 to 20 EUR. As such, the cost of collecting these payments might outweigh the income. This does not hold true for households using far more electricity, as for example in Norway where a normal household uses around 20 000 kWh of electricity per year.

4 LOW VOLTAGE DISTRIBUTION GRID

4.1 Current tariff scheme

Each customer pays a fixed, monthly access fee depending on the fuse size. The access fee includes the fee for metering services. In total, the network companies recover 25% of the total network costs via the access fee. The remaining 75% of the total network costs are recovered through a volumetric fee (per kWh). The volumetric fee applies to all consumption. No volumetric fee is charged for injection.

For prosumers, a second meter is necessary to measure production and a fee for metering services is charged for the second meter. If the production comes from renewable sources, no volumetric fee is charged for self-consumption. However, self-consumption is almost non-existent today since the feed-in tariffs have traditionally been higher than the tariffs for consumption (including taxes). As such, it has been more beneficial to inject all production into the grid and extract all consumption from the grid to maximise feed-in revenues.[3]

With lower feed-in tariffs for new installations (e.g. of PV), and the period of guaranteed revenue soon expiring for many existing installations (15 years from date of installation), self-consumption becomes more attractive.

Pure producers (generators) are only charged the monthly access fee, i.e. they contribute to the 25% of the total network costs mentioned above.

4.2 Suggested new tariff scheme

DNV suggests implementing a subscription-based bandwidth model where most of the grid costs are recovered through capacity-based charges, to better reflect the cost structure of the grid. The total payment from the customers should not be changed dramatically, but there will likely be a redistribution of costs between customers depending on their capacity need and their specific load/generation profile.

In line with the absence of an injection fee at transmission level in Luxembourg, it is suggested that the bandwidth model is implemented without a limit on injections (see also further discussion in section 5.2). Hence, in the examples below, we focus on the limit for withdrawal from the network. This also reflect the current cost structure of the grid in Luxembourg, where capacity need in the low voltage grid is mainly due to consumption.

To achieve a relatively simple tariff scheme, with a generic structure applicable for as many customers as possible, we will discuss single and multiple customers (legal entities) behind a connection point, multi-family buildings, energy communities in the same LV grid (referred to as Local EC (Energy Community)) and energy communities spanning multiple LV grids (Other EC), separately.

The aim is to explain why identical tariff principles can be applied for both ordinary customers and active customers (prosumers), and to what extent these principles are fit for purpose for ECs of different kind.

4.2.1 Single customer behind the connection point: consumers and prosumers

A suggested model structure for customers in the LV grid is shown in Table 4.1. The monthly access fee is replaced by a subscription fee, following a ‘price ladder’ structure with decreasing charge per kW for increasing bandwidth (see explanation below the table). The customer subscribes to a chosen bandwidth, which typically would be lower than their fuse level to incentivise self-consumption as well as efficient grid use through flexible demand. Note that the suggested numbers are for illustrative purposes only; there are endless opportunities to design an asymmetric band.

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3 Note that the term self-consumption here refers to the financial treatment of electricity only; the physical flows do not depend on whether the prosumer decide to ‘self-consume’ or not.

As there are around 60,000 consumers using less than 1000 kWh per year in Luxembourg today, it might be beneficial to distinguish between such ‘small’ consumers (<1000 kWh per year) and ‘normal’ consumers (>1000 kWh per year). For the ‘small’ consumers, one option is to simply ignore the capacity use and charge a relatively high fixed fee, with no limit to the bandwidth and no volumetric fee. The customer can thus have as high load as his connection can physically deliver, at least to the extent that consumption is held below 1000 kWh per year. An alternative approach, which might be easier to explain, would be to impose a minimum subscription capacity, e.g. the 2 kW subscription indicated in the table below.

Table 4.1: Potential structure of the new tariff scheme for LV customers

Bandwidth (withdrawal)	**Subscription fee per kW** EUR/kW/month	**Exceedance fee** EUR/kWh outside the band
No limit, but total consumption must be below 1000 kWh per year	High fixed fee (regardless of consumption)	N.A.
2 kW	High	Moderate
4 kW	Moderate	Moderate/ progressive?
8 kW	Low	Moderate/ progressive?
16 kW	Lower	Moderate/ progressive?
Etc.		

The subscription fee indicated in the table is to be considered as the charge per kW. The numbers must be set so that a customer subscribing for 4 kW pays more for his subscription than a customer subscribing for 2 kW. However, the 4 kW customer should not pay more than twice the fee payed by a 2 kW customer. Hence, the payment per kW can be somewhat lower for the 4 kW customer as compared to the 2 kW customer. The logic behind this structure is simply that the cost per kW of adding or building network capacity decreases with increasing capacity – the investment cost doesn’t double if the capacity is doubled.

Note that the granularity of the subscription ladder is in itself a steering parameter. The cost of increasing the subscription to the next step will likely increase with lower granularity, all else equal. To motivate low consumption peaks, one might consider a progressive ladder structure. However, this contradicts the cost structure of the networks. Limiting the number of available steps is thus a compromise between cost reflectivity and encouraging reduced peak loads.

The subscription fee represents the sum of metering, invoicing and administrative costs and the customer’s contribution to cover the capacity-related costs of the network. Whether this is communicated as one subscription fee, or a fixed (metering) fee plus a capacity fee (based on chosen subscription) is mostly a communication question – for a chosen subscription, it will anyway represent fixed payment per month or year. In the table above, it is implicitly assumed that the subscription fee includes the costs of one meter, similar to the current access fee. An additional meter fee can apply to customers with additional meter(s), also similar to the current model.

An exceedance fee is applied per kWh used outside the band. In the case of Luxembourg, an exceedance fee for injections is obsolete. The exceedance fee could also be dynamic, e.g. differ for off-peak and peak hours, which is discussed more in Chapter 5.

When setting the exceedance fee, an important metric to monitor is the ratio between the subscription fee and the exceedance fee. The ratio signals the breakeven point between number of exceedance hours and increased subscription; a rational customer is likely to prefer an increase of the subscription by 1 kW if the expected number of exceedance hours is higher than the ratio. Whether the subscription can be increased by as little as 1 kW depends on the granularity of the subscriptions.

A numerical example is provided in Figure 1. Note that it is assumed that the cost of the meter is the same for all relevant subscriptions and capacities. If the cost of the meter is higher for the larger customer, this could cause the lines to be less smooth, with e.g. a ‘bump’ in the dark blue line when the more expensive meter eventually applies. In line with the table above, it is also assumed that the subscription intervals are larger than 1 kW.

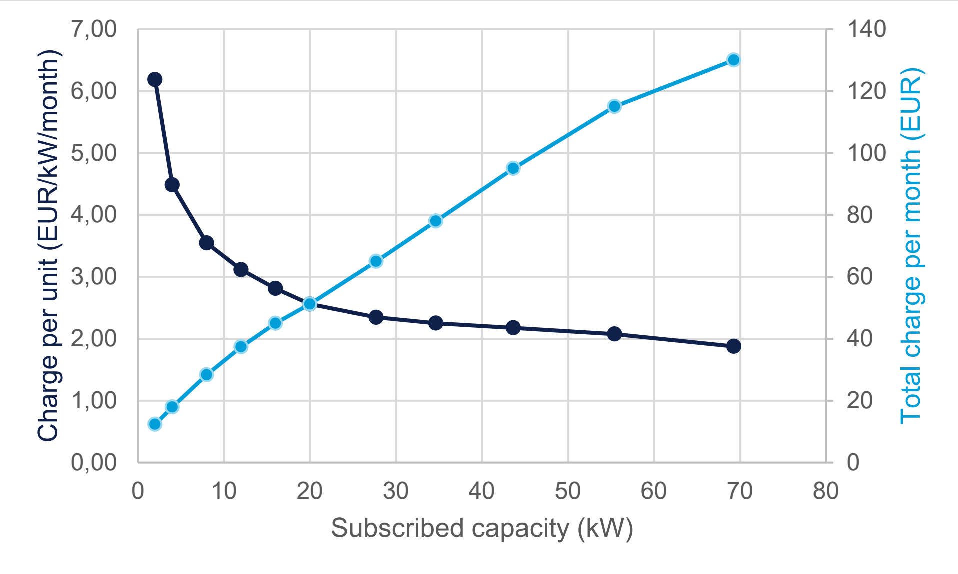

Figure 1 Numerical example of a price ladder structure – for illustration only

Self-consumption will be incentivised by calculating the grid charge based on net consumption. In practical terms, this means calculating the network charges based on total consumption minus total production per 15 minutes behind the connection point, regardless if there is one meter or two separate meters (for consumption and production separately). If all grid charges and all taxes depending on energy use, both capacity-related as well as energy-related, are based on the physical exchange with the network, the customer is incentivised to minimise net consumption and/or move consumption to hours with high own production.[4]

4.2.2 Multiple customers at the same location

For multiple customers behind the same connection point and a multi-customer building, a similar bandwidth model based on net consumption can be applied. If the customers share energy between themselves, e.g. an owner of a PV system sells the energy to other consumers behind the same connection point, the resulting total grid charges should be similar to that of a single, equally sized prosumer behind a connection point.

Each customer (or meter) behind the connection point would then subscribe to a chosen bandwidth based on their net capacity needs, similar to that for a single customer behind the connection point, e.g. based on expected peak

[4] Note that net consumption as explained here is not the same as net metering as defined in Commission Staff Working Document “Best practices on Renewable Energy Self-generation“, Commission Staff Working Document, July 2015, COM(2015) 339 final (http://ec.europa.eu/energy/sites/ener/files/documents/1_EN_autre_document_travail_service_part1_v6.pdf) which states that «Net metering is a regulatory framework under which the excess electricity injected into the grid can be used at a later time to offset consumption during times when their onsite renewable generation is absent or not sufficient. In other words, under this scheme, consumers use the grid as a backup system for their excess power production».

consumption minus the customer's share of the expected production during peak hours, i.e. an adapted net consumption approach.

As in the case of a single customer behind the connection point, this arrangement will incentivise sharing of energy. Consumers and producers behind the connection point who agree to share, will be subject to the same bandwidth model as a prosumer with net consumption at the point of connection every 15 minutes. With sharing, the consumers can subscribe to a lower bandwidth (than without sharing) if they are able to coordinate their consumption with the production (directly or by means of energy storage) on a structural basis. This will eventually lower their total network charges. Consumers and producers who do not agree to share, will have a higher injection and withdrawal at the point of connection (and potentially, a higher subscription is needed).

4.2.3 Local energy communities

An energy community can be categorised as customers who share e.g. a production or a storage unit but where the customers and/or production unit are not located behind the same connection point. They can be located either behind the same substation and within the same section of the low-voltage network (a local EC), in the same DSO area or even in different DSO areas (other ECs).

The benefits of increased self-consumption behind a MV/LV grid towards the HV/MV grid are evident, yet the impact on the LV grid itself is less evident since the produced energy still needs to be transported (distributed) locally.

The important question is if application of the adapted net consumption approach (as explained in section 4.2.2) to the subscription model for each member is fit for purpose, or if the model should be adapted further. The crux of the issue is to what extent it is effective to promote self-consumption in a local energy community.

Without making any assumptions about the timing of consumption, it might not be straight forward to answer this question. If we, however, assume a consumer with an afternoon/early evening peak in the consumption, a similar consumption pattern for all customers connected to the same LV network, and a community PV with hardly any production at peak consumption time and peak production when the consumption is relatively low, the following holds true:

- If such a consumer, that owns a part of the community PV, would like to benefit from self-consumption, he will need to lower his peak demand.
- Since his peak demand typically does not coincide with moments when PV energy is produced, the consumer needs to move demand in time in order to benefit.
- One option would be to charge a vehicle during the day when PV energy is being produced, instead of charging the vehicle in the evening. The benefit for the network will not be achieved during the PV peak hours (at times when consumption is generally low), but will be achieved at other times, when PV energy is typically not produced.
- This means that the main impact on the grid happens during grid peak hours, identically to the situations described above (section 4.2.1 and 4.2.2). In this case, the positive impact is not limited to the MV/HV grid, but also the LV grid.

But what if the consumer already has its peak demand at times when the community PV production is high? Unless the consumer is considering any changes in demand – increase due to a need for more energy or decrease due to e.g. some energy saving activity – charging based on net consumption would not incentivise any further change in behaviour. However, it still holds true that at the margin, charging the net consumption of this customer will incentivise more consumption during the PV peak hours and less consumption during consumption peak hours.

Similarly, we can consider the alternative; that community generation coincides with community peak consumption. Charging based on net consumption will yield an incentive to community members to move more consumption towards peak production hours and may ultimately cause overload of a line or a substation. If the community resource is not generation, but electrical storage, the issue is even less trivial, and there is a risk that self-consumption and charging based on net consumption will fail to comply with the technical limitations of the LV grid.

Hence, while it typically holds for PV that the adapted net consumption approach, taking into account the consumer's share of the actual community generation per 15 minutes when calculating grid charges, stimulates efficient changes in consumption patterns, this may not be the case in all cases.

4.2.4 Other energy communities

The concept of sharing energy across LV grids, between customers/members that are not located in the same LV grid, does not impose similar cost savings for the electricity network. Matching consumption of a customer in area A with production from a community member in area B does not imply lower network costs than if these two did not know of each other. This seems evident for sharing PV in LV networks. For the HV/MV networks, it cannot be taken for granted that there are no benefits at all – this will depend on the coincidence of peaks in different parts of the network. CEER (2019) notes:

> *However, virtual energy sharing will only have a positive technical impact on network costs if it incentivises its participants to change their consumption or production pattern in a way that is consistent with the needs of the system. This will only happen if consumption is actively managed by the participants of the sharing scheme and the physical limitations of the network or the power system is taken into consideration. This is not a trivial task and requires deep knowledge of the grid, as it implies accounting for the grid's technical current and voltage limits adjusted for real-time losses, in order to avoid network constraints.*
>
> *To truly reduce network costs, measures such as load management for local sharing have to avoid grid constraint persistently. Therefore, it is critical that the measures are also effective during extreme situations, both on a diurnal and seasonal basis.*
>
> *Given the difficulty of exactly aligning price signals with grid constraints, there is a desire to ensure that participants in energy sharing schemes receive price signals that are at least as effective as those sent to "standard" customers. This is necessary both to ensure that:*
>
> - *Virtual energy sharing schemes bring incentives that are generally efficient; and*
> - *Network cost are distributed evenly and fairly without discriminating against vulnerable customers and those who are not able to participate in peer-to-peer energy sharing or self-generation.*[5]

Hence, granting an energy community lower network charges, e.g. in the form of the adapted net consumption approach, will easily conflict with the requirement to ensure that network charges are cost based, unless the community only has members behind one connection point.

Thus, we advise that members of other energy communities face exactly the same network charges as non-members. If the criterion of cost reflectivity is ignored, it is conceivable to apply the principles described for local energy communities. It will, however, potentially lead to weird solutions and potentially disturb e.g. the retail competition: supplier or aggregators would be able to reduce their customers' network costs if they bundle customers cleverly, without any change in behaviour and thus with no apparent impact on network costs. It may also incentivise new production (in the LV grid) at locations with unfavourable network conditions, as it potentially will remove or neutralise any attempt from DSOs to locate new production at locations where it may reduce current or future network costs.

[5] From CEER: Regulatory Aspects of Self Consumption and Energy Communities, Ref: C18-CRM9_DS7-05-03 25 June 2019, https://www.ceer.eu/documents/104400/-/-/8ee38e61-a802-bd6f-db27-4fb61aa6eb6a

4.3 Conclusions

Based on the discussions above, we recommend a structure as illustrated by Figure 1 above. The ratio between the subscription fee and the exceedance fee should be observed carefully. Together with the granularity of the ladder structure for the subscription fees, it may help the DSO and the regulator to balance the various signals.

The net consumption approach, i.e. calculating the network charges based on total consumption minus total production per 15 minutes behind the connection point, can be implemented for individual prosumers, for multi-family houses and other sharing arrangements behind one connection points. For local energy communities, we do not recommend the net consumption approach, unless operations are confined to a single LV segment and a favourable impact on network cost can be demonstrated, e.g. as typical for sharing of community rooftop PV within a single LV segment.

For non-local energy communities, we do not recommend the net consumption approach.

5 MEDIUM AND HIGH VOLTAGE DISTRIBUTION GRID

5.1 Current tariff scheme

Each consumer is subject to both a capacity-based and a volumetric-based fee. Combined, they make up the total grid costs in the medium and high voltage grid. For each voltage level, the tariffs depend on whether the user has an annual utilization rate (annual consumption in kWh divided by annual peak load in kW) below or above 3000 full load hours. The capacity-based tariff is applied to quarter-hourly measured annual peak offtake. The volumetric fee applies to all withdrawal from the grid, as well as to energy that is self-consumed and produced from non-renewable sources.

For prosumers and producers, no volumetric fee is charged for injection. If the production comes from renewable sources, no volumetric fee is charged for self-consumption either.

5.2 Feasibility of the subscription model

In the transmission network, the injection tariff is regulated by the EU. The Commission Regulation (EU) No 838/2010, part B, article 3 states that: "The value of the annual average transmission charges paid by producers shall be within the range of 0 to 0,5 EUR/MWh"[6]. This does not seem to prevent distribution network owners from charging their customers for injection in the MV and HV sections of their network. However, the rules for transmission connected production should be observed when designing the tariff structure for the MV and HV customers. Similarly, it is relevant that transmission connected production in Germany and the Netherlands do not pay network charges beyond shallow to super-shallow connection charges. Hence, we suggest setting the injection fee to zero also for generators connected to the DSOs' MV and LV networks.

For consumers and prosumers connected to the MV or HV network, we suggest applying a bandwidth model similar to that of LV customers. The bandwidth would need to be adjusted according to the volumes in the MV and HV grid. For example, you could have MW instead of kW bandwidth and MWh instead of kWh exceedance and volumetric fee (if any).

For such customers, the similar principles as in the LV network could apply. The bandwidth applies for net consumption only, and the volumetric fee on injection is set to zero. This would encourage both self-consumption and subscribing to a lower withdrawal bandwidth. A volumetric fee reflecting network losses should be applied to all MV and HV customers.

5.3 Alternative approach for MV and HV customers

A potential alternative to a bandwidth subscription model for the larger end-users and prosumers, connected to the MV or HV grid, could be to replace the subscription with the actual use while applying a similar volumetric fee representing network losses to the net consumption. There are multiple alternatives for designing the basis for settlement (how to interpret and measure actual use, see below); the main difference to the subscription model is simply that the customer does not subscribe, and hence there is no exceedance and exceedance fee (by definition).

The key design choice in such a model is how to define and measure the actual network use. There are several features to consider:

- One question is the definition of capacity; should it be MWh/h or MW, or something in between, e.g. MWh per quarter of an hour.
- Another question is if the annual capacity-based payment should be related to the maximum meter reading for the entire year, the monthly peak (potentially with different capacity fees per month), or alternatively if an

[6] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:250:0005:0011:EN:PDF

average of multiple meter readings should be employed. One could use the average of e.g. the three or five highest peaks for one year, or the average of the single highest peak for each of the past three or five years, or a combination of these. A variant is also to do the meter readings (for all the variants) during system peak instead of measuring each customer's individual peak.[7]

- With the last option, basing the capacity related payment to the average usage of the past year(s), one must also decide how to consider new customers. Should lack of previous meter readings be considered as a zero, effectively giving an 'introduction offer' on the capacity related fee, or should the average be calculated based on those meter readings that are available? An 'introduction offer' might be justified if it concerns electrification of previously fossil consumption but can potentially conflict with state aid rules.

While models based on actual use can be equally cost reflective as a properly designed subscription-based bandwidth model, it does come with some clear disadvantages. If the size of the peak load for the network is hard to predict for the grid company, it might be hard to determine a capacity fee that collects the allowed revenue with a reasonable precision. That would cause recalculation of the tariffs for the same year or changes in the tariffs for the next years. If the peak load is quite volatile for an individual customer, the annual payment from this customer might be quite volatile as well, while the associated impact on the actual network costs is likely to be less volatile. The issue about volatility may, however, be significantly reduced by using averages of multiple meter reading.

While such a model will clearly incentivise end-users and prosumers to keep net consumption (total consumption minus production at the same connection point) as low as possible, the strength of this incentive depends on only one factor; the structure of the charge per kW. If the logic of the fee structure follows the nature of network costs, the structure would be similar to that of the bandwidth model, with a decreasing fee per kW (or MW) for larger loads. Without an exceedance fee, the incentive to keep consumption low will be weaker, the higher the peak load is for each customer.

Also, the incentives might be perceived as relatively static, in the sense that once the annual peak is 'reached', there is hardly any incentive to further adapt the use of the network to the actual network conditions for the rest of the year or month (although this partly depends on the features of volumetric fees also). This feature is essentially similar for all tariff models that focus on capacity use during a (or a few) peak period(s), except that for a subscription based bandwidth model, customers exceeding the bandwidth in January and paying an exceedance fee for that event, are still incentivised to stay within the band in the remainder of the year. The size and potential variation of a volumetric fee might also incentivise efficient network use also outside peak periods.

A final question related to metered capacity usage rather than subscribed capacity, is that metered alternatives seem to create a somewhat closer relation between daily network use and the network charges to be paid by the customer, in contradiction with the fact that grid costs are mostly independent of short term decisions to consume or not to consume. For industrial end users in Norway that are directly exposed to the transmission tariff, a marginal reduction in consumption during system peak hours is often observed. This has typically no impact on the network costs as these are, for such customers, mostly driven by expected peak for the customer, regardless the timing. The only result is thus that these customers reduce their network bills, but with no impact on network costs.

7 The Norwegian TSO settles consumption charges based on consumption during the system peak hour, averaged over the past five years. The individual peak of each customer can thus be higher than what is used as basis for settlement.

5.4 Conclusions

Based on the discussion above, a bandwidth model also in the medium and high voltage network is indeed feasible, allowing for charging based on net consumption for consumers with own production in close vicinity of the consumption site. While the exact parameters would obviously be different from the low voltage tariffs, the structure should be comparable. If proceeding with a bandwidth approach, it should be considered to check compliance with the subscribed bandwidth during system peak instead of measuring each customer's individual peak. This can be achieved by having a relatively low (or zero) exceedance fee except during system peak.

6 IMPLEMENTATION

To ensure a smooth transition to the proposed subscription-based bandwidth model, a few measures need to be taken:

1. Based on actual, historical meter data and necessary revenue for the DSOs, initial parameters for subscription fees, volumetric fees and exceedance fees should be estimated so as to ensure the tariffs both provide sufficient revenue and not change dramatically the total payment for each customer.
2. Based on such an initial estimate for all parameters, the strength of incentive components should be considered carefully. This concerns issues like:
    a. Granularity of the subscription ladder. Should it be possible to subscribe for any number kW, or should it be limited to e.g. 2, 4, 6, 8, 12, … kW?
    b. Size of the subscription fee. How fast should the subscription fee per kW decrease with increasing subscription level? At what level should the decrease per unit stop?
    c. Size of the volumetric fee. Should the volumetric fee be zero for customers below a threshold line? Where should that line go? Should the fee be constant over the year? Or differ between day and night, or summer and winter?
    d. Size and structure of the exceedance fee. Should it really be constant, or should the fee depend on time of day or on the expected utilisation of the network?
3. Based on revised parameters, it should be analysed if there are customers or customer groups that call for special attention, e.g. because their total tariff cost seems to change quite much unless they can change behaviour.
4. It should be considered if a group of customers should be selected for a pilot study and for experimenting with different parameter values for the various components of the tariff.
5. Each DSO should recommend or allocate an initial capacity subscription to each customer at first, depending on their historical capacity use or fuse level.
6. DSOs together with ILR should prepare extensive information ahead of a change, explaining why this is done, why it is (after all) a relatively small change, and how customers can react or behave in order to save money, both for themselves as well as for the electricity network.

When it comes to the exceedance fee, the cost levels should reflect the intended impact on user behaviour with respect to both choice of subscription level and efficient utilisation of the network. As such, it can be discussed if the fee should be dynamic, e.g. lower for exceedance during off-peak hours and higher for exceedance during peak hours (similar to time-of-use tariffs), and eventually, how and to what extent this dynamic feature should be defined beforehand. However, such features would come at the expense of simplicity, and perhaps also transparency. The similarity with time-of-use tariffs might also cause unintended peaks triggering new network investments. Hence, we do not recommend a dynamic exceedance fee. As previously mentioned, one should also assure that the exceedance fee is neither too low (removing the incentive to stay within the subscribed bandwidth) nor too high (removing the incentive to subscribe to a lower bandwidth).[8] Hence, the DSOs as well as ILR must be prepared to adjust the exceedance fee as time goes and there is practical experience.

The suggested approach to finding the right exceedance fee in combination with the bandwidth level, is to do simulations: Testing out how different combinations will affect different customer types.

8 At the margin, the ratio signals the breakeven point between number of exceedance hours and increased subscription. A rational customer is likely to prefer an increase of the subscription by 1 kW if the expected number of exceedance hours is higher than the ratio. Whether the subscription can be increased by as little as 1 kW depends on the granularity of the subscriptions.

7 CONCLUDING REMARKS

This brief analysis demonstrates that a subscription-based model is conceivable in the LV grid as well as for MV and HV customers, both normal end-users as well as prosumers and producers. In the case of Luxembourg, it makes sense not to apply tariffs for injection in the grid. The subscription would thus only be relevant for load.

The model as suggested is rather generic and allows significant variation in terms of parameters, e.g. the relation between injection and load capacity, the structure of the capacity based charge, the level of the volumetric fee (if any) and the level and structure of the exceedance fee.

Some key benefits of a subscription based approach over the current models applied in Luxembourg are that the fee structure is better reflecting the cost structure of electrical networks, with a larger emphasis on fixed charges, while at the same time being flexible enough to incentivise customer choices that contributes to lowering network costs.

Similar to existing models, a subscription-based model can allow for sharing of energy and self-consumption. This can easily be achieved by calculating the network charges based on total consumption minus total production per 15 minutes behind the connection point.

While this makes most sense in strict economic terms only for customers behind the same connection point, it is feasible also for any sorts of energy communities, from such that only include some of the customers behind a connection point to those that include customers from all over the country. However, we recommend limiting the use of the net consumption approach to local energy communities where operations are confined to a single LV-grid segment, including multi-family houses and other sharing arrangements behind one connection point. For members of other energy communities, we do not recommend the net consumption approach.

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