Trading process and flexibility energy service exchange

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***Abstract*— As flexibility services and markets are new concepts to all electricity market participants, thus an easy to understand and to use, as well as affordable, flawless and secure payment and billing process is critical for local flexibility market players' decision to participate and exchange flexibility services (FSs). The aim of this paper is to elaborate on the possible billing and payment scenarios that could be successfully applied to different flexibility market models.**

Keywords—flexibility services, energy market, DSO

I. INTRODUCTION

Receiving a payment in exchange for provided service is the key element behind any trading process and flexibility energy service exchange is not an exception. Trading parties get into a deal that would deliver a "fair" net value for each party. This means that if the transaction cost, that includes the payment transaction fee, the technology, administration and human resources (HR) cost for issuing, sending and handling invoices, is too high, the net deal value could be jeopardised and the total transaction value might be seen as marginal [1-10].

As flexibility services and markets are new concepts to all electricity market participants, thus an easy to understand and to use, as well as affordable, flawless and secure payment and billing process is critical for local flexibility market players' decision to participate and exchange flexibility services (FSs) [11-20].

The aim of this paper is to elaborate on the possible billing and payment scenarios that could be successfully applied to different flexibility market models.

II. BILLING AND PAYMENT AS PART OF THE MARKET DESIGN CHAIN

Payment and billing are two particularly important elements of the whole flexibility service trading and supply chain. Based on how the previous stages have progressed, the process for billing, payment and the following invoicing within the FlexiGrid project can be predicted.

Figure 1 represents a simplified flexibility service trading process chain, pointing at some elements of importance with regard to billing, invoicing and payment, at each step.

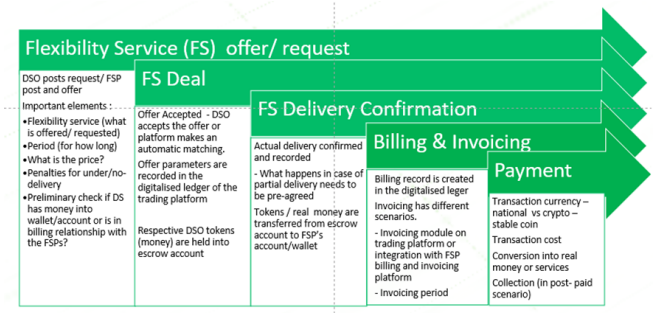

Fig. 1. Flexibility services (FS) trading process

When talking about flexibility services and methods of their payment, it is important to note that the electrical industry is a strategic sector (critical infrastructure, sector of vital importance) for every country and as such it is highly regulated. In many European and none European countries, DSOs are not allowed to directly be involved in electricity trading, instead energy trading and contract with end-users are performed by third-party companies – either a DSO's daughter commercial companies or a completely separate company.

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Legislation like this makes impossible for the DSOs who are the procuring party in the flexibility service exchange to be in direct (commercial) relationship with the FSPs. This makes some of the most obvious solutions for payment and billing currently impossible until the legislation frame is changed.

EU directives such as "Clean energy for all" will require the national low to include regulations forcing DSO's to consider flexibility solutions to network issues and enabling prosumers, consumers and producers to be more energy efficient, enabling the transformation towards smart grid and introducing new electricity market business opportunities.
Until the respective legislation is changed FlexiGrid needs to research solutions that are easy to implement and use, solutions that are not costly and that respect the local legislation at the same time.

On the other hand, flexibility is made possible due to the adoption and application of new technologies and the flexibility trading platform eFlex, developed in FlexiGrid is a good example of this. "With the emergence of crypto-assets (including so-called 'stable coins') they may soon be offering disruptive payment solutions based on encryption and distributed ledger technology (DLT)". as stated in a recent document by the EU Commission on Retail Payments Strategy for the EU.

III. BILLING AND PAYMENT OPTIONS

In this part, we will focus on the options that has for billing and payment, highlighting what has been discussed between different market participants, focusing on advantages and limitations for each option and their application to the different flexibility market models.

Potential options considered for the billing and payment are as follows:

- Currency - National vs Crypto currency:
  - National

Pros:

- As a principle, flexibility services are exchanged on a local level aiming to relieve local grid issues. This makes the local/national currency an obvious solution for the local flexibility trading.

Cons:

- The size of a single transaction is especially important for the calculation of the related transaction costs. In case of micropayments the transaction cost might exceed the value of the payment.

  - Crypto currencies

Pros:

- Payments are made with very low (or none) transaction costs.

Cons

- The challenge comes in converting crypto coins into real money. The process might seem complicated for many actors and high trading fees may apply.

- Blockchain – smart contracts for billing and crypto currency as a payment mechanism

Pros:

- Instant, simple – does not require additional steps, transparent for all players
- Familiar/commonly used along with blockchain – the technology that peer-to-peer flexibility trading platform will be built on.
- Scalable in big scale if needed – this makes it applicable to all market sizes - small and local or big scale and serving all possible flexibility market models including peer-to-pool, and peer-to-peer.

Cons:

- If applied today it needs to be connected to an existing billing/invoicing system of the FSP/DSO for invoicing purposes as the current fintech legislations does not allow smart contracts as official documents for accounting and tax purposes.
- Blockchain is energy consuming and the net effect is still under discussion.
- Crypto currency value is highly volatile (Stablecoin could be a potential mitigation).
- Crypto currency trading cost (the cost for converting crypto into real money) is currently high and this will reduce the total net FS exchange revenue/earning for the players that want to convert their earnings into local currency. In addition, the conversion process might seem unclear and too complex to many FSPs and that could be another reason for them not to participate the trading.

  - Separate billing and invoicing system - connected/fed by the trading platform as transaction attributes input.

Pros:

- Familiar way of work.
- In line with current legislation and accounting practices.

Cons:

- Integration cost might be high and integration technically complicated.
- Potential administrative hassle (works slowly, many invoices for small amounts of money, efforts to send invoice to counterparty and follow through on payment).
- Could prove to be a potential barrier for adoption.

  - Including the bill in an existing invoice (if there are any) and deduct or surcharge the monthly bill with the respective FS value provided for the period.

Pros:

- The easiest and most familiar to the involved parties (in respect to the legacy relationship) method
- No additional payment transaction fees for the FS provided during the period as one bill will include all

services exchanged during the respective period – reduces the overall transaction cost

Cons:

- Some FSPs may not be in relationship with the seller/buyer
    - The legislation currently prohibits this kind of transaction

The trading platform or a third party/commercial company to marketise and operate the FS exchange platform as trade platform manager acting as market operator – a selling and buying party to the other actors - aggregates the offers, aggregates FS requests and acts as commercial intermediary to all players. In this scenario the buyer and the seller would be the trading platform and the platform will charge, bill, invoice and manage payments on a B2B basis with other FSM participants.

Pros:

- Familiar and easy to understand (similar model of work as Amazon, Google, etc.).
- Scalable model.
- Accountability - general party that can facilitate the relationship between users, provide security of billing and payment and mediate when and if needed.

Cons:

- The third party needs to be recognisable and knowledgeable to inspire confidence and be able to coordinate market relations.
- The initial process might be slow and bumpy, before the right structure and way of work is found.
- Scalability might be costly.

IV. Defining possible billing and payment solutions based on local market specifics

Based on the feedback from partners, adoption of FS is expected to be low at the beginning and, among other equally important factors, highly dependent on the easiness for taking part in the flexibility market. This may lead to some DSOs choosing to use such platforms only when legislation changes. A possible mitigation for that will be the flexibility platforms for different countries to allow or provide different solutions for payment and billing which are the most suitable for the respective local market.

Concrete aspects that need special attention when making the decision about the most appropriate payment and billing approach include:

- Size and number of transactions (per month)
- Transaction related cost:
    - payment transaction cost – in case of micro payments this cost could be equal of higher the transaction value;
    - cost for issuing and handling invoices (tech, admin, human resource).
- Payment currency – prices and payment in national currency:
    - currency trading cost (convert transaction currency into real money);
    - credit control, treasury and collection (in case of post paid services).
- Legislation – energy and financial legislation in the respective markets.
- Technical and financial savviness of the players.

V. Project usecases feedback and general summary

In respect of the billing and payment aspects mentioned above and in the process of research of the most suitable solution for billing and payment within the scope of FlexiGrid demo cases, interviews were performed (a questionnaire and a following discussion) with use case (UC) leaders within FlexiGrid.

Use cases and demo areas demonstrated in each use case. To better understand each of the demos and how suitable and easy billing and payment processes can be incorporated, the information was collected and analysed from the UC leaders in the following paragraphs:

UCs were asked what would be the usual FSPs in their testing as to better understand the typical users from which the DSO would procure flexibility. Most, if not all the UCs, included in their answer aggregators, individual end-users (generator, consumer or prosumer) as well as specifically in UC3 - V2G (vehicle to grid) station, EV (electrical vehicle) app and battery storage.

It is important to note, that most of the FSPs are connected/contracted to the DSO directly or indirectly. Due to legislative restrictions in some countries the companies have been separated so that the DSO provides grid services while the trading relationship is managed through the retail sister company of the DSO.

DSOs or their sister retail companies have sophisticated billing systems to handle the hundreds of thousands invoices they issue on a monthly basis to their clients. Conversely, many of the FSPs are SMEs (small and medium enterprises) that usually do not issue many invoices per month, and they would therefore prefer to use a manual process of issuing invoices for the flexibility provided. This would mean that if they have too big of an administrative hassle and cost, that could interfere with their desire to participate in the flexibility market. The administrative cost and effort may include time and human and financial resources to implement a regular process for checking the deal ledger issuing and handling invoices and reconcile versus revenues received. To make it easier to imagine, here is an example:

The FSP is a small hydro power plant that yearly generates less than 10 invoices. As to not have additional unnecessary expenses, it does not use a specialized invoicing software or procure such services from an accounting company. Instead, the owner has an invoicing book where he manually writes down an invoice if and when necessary. So, if he were to write down micro-transaction invoices and there were to many, the cost for their accounting and the efforts/time to write them down could exceed the marginal utility of the flexibility services.

In order to estimate the potential administration effort related to billing and payment, the average number of deals procured and their average size in euro was estimated. It is important to have in mind that the flexibility platform is still under development and some UCs are in the process of demo case preparations, not having started yet (as per FlexiGrid project schedule). In line with that, we have suggested to collect the expectations about the average number of FS deals per month in 3 scenarios: Pessimistic, Realistic and Optimistic to define the expected number of participants and monthly deals.

The project UC participants and leaders expect that between 0 and 100 deals might happen per month and about 10% of the registered FSPs would actually be active and make a deal.

The average deal size is thought to be in the microtransaction spectrum. Some partners speculated that the average deal size would be between 3 and 12 euros, while others thought that it would be in the ranges of 0.25 to 2 euros per one hour of flexibility provided. It is important to note that the price of the transaction will and can be dependent on time (how long) and size (MWh flexibility provided) for which flexibility will be procured, so a precise price cannot be provided.

Nevertheless, billing and payment needs to be made simple and easy to use as not to hinder users from taking part in the designed markets. Having in mind the usual billing and payment services of both DSO and FSP, the offered solutions and their price, different models may be needed in the different countries that would implement the solution. One universal solution could be billing and payment based on smart contracts and blockchain, however due to legislation and conservative nature of DSO/FSPs this solution also has its disadvantages.

The results from the questionnaire and discussion with UC participants and leaders on the mechanisms and important elements to consider when deciding the billing and payment model are summarised:

Demo Areas in the project:

1. Grid monitoring, control and flexibility intervention.
2. Local energy market: exchange of energy/grid services.
3. Blockchain & IoT based peer-to-peer demand side response management and energy trading.
4. Flexibility measures form storage, P-2-G and EV

In each of the four Use Cases of the project, flexibility services that will be tested are different (with some small overlap between UC3 and UC4). The performed research and interviews identified variances within the UCs in the following areas:

- expected average monthly number of deals traded on the system;
- the monthly revenues/turnover that will need to be billed and paid between the parties;
- the local legislation varies from more liberal to very strict when it comes to DSOs involvement in commercial relationships with end-users and allowance flexibility and electricity bills to be offset.

Thus, finding one ultimate billing and payment solution that serves all could be a challenge. It is likely that local and different billing and payment solutions for each use case will be applied, at least during the course of the project initial market adoption.

VI. Billing and payment conclusions and recommendations

Billing, invoicing and payment for energy flexibility services are important elements of the FS exchange chain when discussing possible market designs and their potential for market adoption and penetration.

They must be addressed in a scalable, clear, secure, user friendly, risk free and profitable manner that abides by the relevant legislation. The different payment and billing approaches vary and their implementation could be contextual to the specific case, market, and local regulation (including fintech regulation).

The fast development of new technologies, like IoT, blockchain and fintech tools, combined with change and alignment of the EU regulations in energy and financial sectors might help new appropriate billing and payment solutions to emerge in the coming years.

When looking through the prism of peer-to-pool or peer-to-peer energy flexibility market some of these options seem more workable while others do not.

For the peer-to-peer market design (EFLEX), based on the fact that the trading platform is blockchain based and considering the limitations posed by the legislation in some of the UC markets, the best approach for payment and billing solution for the FlexiGrid Use cases to be demonstrated would be:

1) to use EFLEX digitalised ledger for recording the transactions and billing information and
2) to use crypto currency stable Etherium as a payment method.

As the transactions will be peer-to-peer, the actual invoicing will be done case by case/ for each transaction by the FSPs using their current invoicing systems, using the information recorded in the EFLEX ledger.

From DSOs perspective, FS will be procured from FSPs that will be different (in size, technical, financial and administrative savvily). In that respect, the simplest and the easiest way to manage (for all participants in the LFM) solution would be the trading platform to be integrated with the billing/accounting systems of the DSOs so that to exchange/feed with data from the digitalised transaction ledger that will be reconciled on the DSOs accounting/cost management system.

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