edgeFLEX

D6.5 V 1.0

A new financing model for RES, to simplify investments in RES beyond subsidy schemes

The research leading to these results has received funding from the European Union's Horizon 2020 Research and Innovation Programme, under Grant Agreement no 883710.

Project Name	edgeFLEX
Contractual Delivery Date:	30.09.2020
Actual Delivery Date:	30.09.2020
Author(s):	ALPQ
Workpackage:	WP6 – Fostering Adoption of and Support for edgeFLEX Results
Security:	P
Nature:	R
Version:	V 1.0
Total number of pages:	**18**

Abstract
We describe a new business and financing model for variable RES, to enable and simplify investments in RES when the subsidy schemes now come to an end. The existing and new model and mechanism in detail in a study including impact of the new model on different risks and inflow of capital. Finally, we present a framework for the pricing of the various components of a PPA, reformulated in a pure physical operations part and a pure financial part using Green Power Swaps.

Keyword list
Renewables, Risk reward, Green Power Swaps, Balancing Cost

Executive Summary

This report aims to develop a new business and financing model for variable RES, to enable and simplify investments in RES when the subsidy schemes now come to an end.

Firstly, this report describes the financial metrics and various risks faced by renewable investment project. It describes in detail how that changes based on the regulatory and contractual environment chosen. With feed in tariffs regulatory environment removes most risks except volume risk, while a project exposed to the market forces completely faces many incl. price and imbalance risk. This has traditionally been solved with PPAs, long term contracts for hedging those two risks.

A new model separating physical and financial operations is introduced and the impact thereof analyzed. The overall risk is the same but by separating the risk each risk taker takes it is shown that more investors are fit to partake, improving the price conditions, i.e. making the RES project more profitable.

Finally, the report describes equations and approaches to determine in a transparent way the fair price of imbalance management and energy price for a renewable project, increasing efficiency. The way identified is transparent and straight forward and understandable which should accelerate its adoption.

It still remains to be seen if those approaches will be adopted quickly or if the PPA market adopts this thinking step by step with adaptation of contract terms.

The work, even though written by the authors reported in the aforementioned authors' list, is based on expertise and prior work from various people within the Energy AI team of Alpiq.

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1. Introduction

We have developed a new business and financing model for variable Renewable Energy Sources (RES), to enable and simplify investments in RES when the subsidy schemes now come to an end.

This report describes the various risks a renewable investment project faces and how that changes based on the regulatory and contractual environment chosen.

The impact of the new business model, separating physical and financial operations, has been shown qualitatively to be likely to increase investments in renewable energy projects by improving returns for investors and reducing risk.

Finally, the report describes equations and approaches to determine in a transparent way the fair price of imbalance management and energy price for a renewable project, increasing efficiency.

The work, even though written by the authors reported in the aforementioned authors' list, is based on expertise and prior work from various people within the Energy AI team of Alpiq.

1.1 Scope of this document

This document describes the environment of investments for renewable projects, the new suggested business model, the impact of that and finally a framework for defining a fair price for imbalance management and energy offtake, two of the main risks a renewable projects are exposed to.

1.2 Relationship to project workplan

This deliverable is the result of work in WP 6, specifically in Task 6.1, and the results from this will be used for dissemination in Tasks 6.2-6.3.

1.3 How to read this document

In this report the current setup for renewable investments is described as well as a new business model to improve it.

Chapter 2: Definition of target segment, setting up of a model renewable project and the risks that act on that in different regulatory environments. Finally, it introduces a new business model.

Chapter 3: Description of the impact the new business model has, both on risk and on the inflow of capital.

Chapter 4: Description of an approach and method for defining a fair price for imbalance management and financial energy offtake contracts.

Chapter 5: Conclusions

2. Description of existing business models

This section recalls the history of the business models that have evolved to support financially the development and operation of intermittent energies. With this aim, this section describes the type of renewable investments under consideration, describes the actors involved in such investments and finally defines a simplified profit and loss statement model to use as a discussion object.

2.1 Choice of target group and target group description

This report focuses on large renewable assets such as large wind and solar parks. This choice is motivated by three reasons. Firstly, these larger parks account for a large part of the installed capacity of solar and wind. Secondly there is a large change of environment facing these plants due to the removal of feed-in-tariffs. Lastly, considering the involvement of highly professional and financially influenced investors a small change in the risk-reward distribution can drastically influence the inflow of capital and thereby the number of realized projects. This effect is stronger than with smaller projects with less professional investors, where the focus is on return-on-investment and other factors such as green thinking might compensate for changed risk-reward distribution.

2.2 Description of a typical large-scale renewable project

A typical renewable project is usually initiated by a project developer. To do this, the project developer might set up a legal entity called Project Special Purpose Vehicle. To simplify the language this is assumed to always be the case, the investment project could just as well be a part of project developer's organization. This would not change any of the following assumptions.

The project developer usually brings in only small investment (or brings in an investor with that investment) but focuses on getting other contributors onboard with capital, usually low risk seeking infrastructure investors. This could be a private equity fund, bank or any other actor. In order to bring capital onboard most risks must be mitigated. To do that, the project developer, or more specifically the Project Special Purpose Vehicle, brings other parties onboard to take on parts of the risk or activities needed to be executed by the Special Purpose Vehicle.

Some of the activities required, in addition to project developer and financier, are the Market Access Partner, Trader, and Technical Operator. The Market Access Partner is the party which fulfills the physical part of energy delivery: market connection, nominations, operations and settlement. The Trader is the party which takes on price risk of the energy generated, and Technical Operator is the party responsible for the Technical Operation & Maintenance of the renewable project. Each of these roles can be either performed inside the SPV or contracted out.

The return (both magnitude and variability) of the Financier and Project Developer depends on the cost of these activities, as well as on how well the risk is mitigated. Therefore, the intent of any business model innovation should be to make this risk mitigation easier and cheaper for the project developer, leaving higher risk-free rewards behind.

Table 2.1 summarizes the different actors in a typical renewable investment project as well as their typical risk appetite.

Table 2.1: List of different actors in a typical renewable investment project

Actor Description	Risk Appetite
Project Developer: The entity initiating the renewable asset project.	Medium
Project Special Purpose Vehicle (SPV): A legal entity formed by project developer to handle the development and operation of the renewable asset.	Low
Investor: The provider of the equity of the SPV.	Medium

Financier/bank/pensions funds etc.: An entity providing financing to SPV in the form of loan or other means.	Low (or managed / transparent)
Market Access Partner: The entity providing market access and handling regulatory requirements for trading for the SPV.	Low
Trader: An entity taking risk in exchange for return.	High
Energy Trader: An entity which has capability to be both a trader and Market Access Partner. Typical counterparty for PPAs.	High

2.3 Various energy related risks renewable projects face:

In Section 2.2 the risks that the project faces are mentioned. Some are specific to renewables, and others concern all energy related projects. Following sections describe the main risks that an SPV faces.

2.3.1 Price Risk

This risk is a straightforward one. It describes the probability that the market price for electricity goes down. This cannot be avoided but can be managed by taking a position in the opposite direction or by fixing the price of the sale with a counterparty.

2.3.2 Volume Risk

Due to the nature of renewable assets it is not possible to know exactly how much they produce. This can be estimated by historical data, but variation always exists. This can result in fewer sold kWhs or lack in fulfilling contractual obligations in case those have been made.

2.3.3 Profile Risk

The profile risk is since even if the volume of production stays like what was planned the production can happen at hours with lower energy price. For example, wind production at night when prices are usually lower. Another example is the risk that when there is a lot of solar energy connected to a certain market the price of energy can go down exactly when there is a lot of sun produced. Therefore, this can result in lower average price for the renewable energy.

2.3.4 Balancing Risk

Balancing risk takes into the cost the difference of scheduled production (usually scheduled the day before) and the actual production. This firstly considers the cost of adjustment of the schedule throughout the day (by adjusting position on the intraday) as forecasts are updated. This also considers the potential penalties for the final difference between your position and the schedule.

2.3.5 Downtime Risk

This considers the risk of any sort of technical downtime of the renewable plant resulting in lost production. Apart from lower revenues this could incur penalties in case of any contractual obligations.

2.4 Risk comparison – Simplified model of profit and loss statement

In this report it is assumed that cost of assets, production volume and market prices cannot be influenced the cost. Focus is put on how the risks mentioned above can be mitigated with different contractual setups and business models.

In order to compare the risk and rewards a system of comparison is needed. For this a simplified profit-and-loss statement is utilized. First the model is introduced and then the risk related to each of the values is described, i.e. how each of the values in that model goes up or down as well as how variable it is.

The connection between P&L and the success of the business model is that the more profit there is in a specific project the more the interest from Project Developers due to higher profit as well as from financiers, since the project is more likely to succeed and higher return can be paid (either as interest on loans or as return on investment).

Table 2.2 describes the general P&L statement. First, the revenues are listed. In principle, those are the revenues from energy sales as well as any subsidies or public support.

Next the costs are listed. The main costs are: firstly, the cost of maintenance and operation of the project, secondly the cost of market access and operations, thirdly fuel cost if applicable, fourthly imbalance cost and finally asset depreciation and capital costs.

For some of these values equations are provided for others (which are not in the key focus of the study) only a description is provided.

Table 2.2: Simplified P&L model of a SPV

Revenues	
Energy sales' revenues	$\text{Energy Sales} = \sum_{t=0}^{T} \text{Price}_t * \text{Energy}_t$ Where t to T represents the timesteps of the year.
Subsidies	Any public support or subsidies if applicable.
Costs	
Technical operation & maintenance	Cost of annual technical maintenance and operation of the park.
Market access and operations	Cost of physical operation of the asset on the market (i.e. market connection & operations)
Fuel costs	If applicable
Capital cost	Interest rate on any financing.
Imbalance cost	$\text{Imbalance Cost} = \sum_{t=0}^{T} \Delta_t * P_{\Delta,t} + \text{Rebalancing cost}$ Where Δ_t and $P_{\Delta,t}$ represent the amount of imbalance and the imbalance price of a particular hour.
Asset depreciation	According to investment assumptions.

As mentioned, in Section 2.2, the difference between revenues and costs can be used to remunerate the project developers or to pay off capital costs.

Even though values above are presented with equations those values can vary significantly as represented in the risks outlined in Section 2.3. In order to secure financing to realize the project those risks must be managed. Next section will describe how these vary and then impact of different regulatory environment will be described.

2.4.1 Base-case - SPV its own bearing the risks, i.e. fully exposed to market prices and other risks.

First, let's let us consider how the above P&L statement would be impacted if the SPV has no management of risks related to energy markets. Considering that we are not looking at cost of assets, maintenance cost and other such effects we assume that the SVP has contracted those out or bought insurance against those.

The price can change drastically due price evolution, liquidity and profile risk. Then, volume is dependent on weather and finally Imbalance cost is highly unpredictable due to nature of the renewables and the imbalance pricing mechanism. Table 2.3 shows in red high-risk elements of the market.

When considering Table 2.3, one can see that the profit of the SPV is highly unpredictable.

Table 2.3: P&L fully exposed to the market risks

Revenues	
Energy sales' revenues	Price can change both through trend as well as due to liquidity limitations on market. Volume still dependent on weather and uptime.
Subsidies	Zero, fixed or volume-based subsidies based on regulation in each site. Fixed in a contract.
Costs	
Technical operation & maintenance	Fixed with a long-term contract.
Market access and operations	Fixed with a long-term contract (or inhoused)
Fuel costs	Zero
Capital cost	Fixed with a long-term contract with financier.
Imbalance cost	Cost is highly unpredictable both due to nature of imbalance penalty schemes, cost of rebalancing and nature of Wind/Solar assets.
Asset depreciation	Predictable through assumptions within SPV.

2.4.2 State-subsidized situation using feed-in-tariffs

The dramatic increase in investments during the time of feed-in-tariffs in countries like Germany can not only be traced back to increased amount of money coming from feed-in-tariffs but also the amount of security those tariffs create i.e. the risk they remove.

With feed-in-tariffs the government guarantees a fixed long-term price of the energy sales regardless of when it is produced and without the need to consider imbalance risk. This is depicted in Table 2.4 by showing the values in green.

As one can see from Table 2.4, the profitability of the SPV is highly predictable with the only unknown the volume produced (which depends on long term weather patterns).

Table 2.4: P&L with feed-in-tariffs

Revenues	
Energy sales' revenues	Price fixed with a long-term contract for a favourable price. Volume still dependent on weather and uptime.
Subsidies	Zero. Included in the favourable price above.

Costs	
Technical operation & maintenance	Fixed with a long-term contract.
Market access and operations	Zero
Fuel costs	Zero – Wind/Solar
Capital cost	Fixed with a long-term contract with financier.
Imbalance cost	Zero.
Asset depreciation	Predictable through assumptions within SPV.

2.4.3 Classical Power Purchase Agreement model

With the feed-in-tariffs coming to an end Project Developers are looking towards Power Purchase Agreements or PPAs. These are essentially long-term agreements on the sale of energy. As this is a very flexible contract instrument these agreements can vary greatly and include various clauses. Here we take an example of a fixed price variable volume PPA which is the most common one.

As shown in Table 2.5, the same party is responsible for covering the price risk as well as imbalance risk and market access. This covers the imbalance costs very well as well as the price. Volume is still variable as it is in the models discussed above.

Table 2.5: P&L with traditional PPA model

Revenues	
Energy sales' revenues	Price fixed with a long-term contract, PPA. (1) Volume still dependent on weather and uptime.
Subsidies	Zero, fixed or volume-based subsidies based on regulation in each site. Fixed in a contract.
Costs	
Technical operation & maintenance	Fixed with a long-term contract.
Market access and operations	Fixed - Included in PPA (2)
Fuel costs	Zero – Wind/Solar
Capital cost	Fixed with a long-term contract with financier.
Imbalance cost	Fixed - Included in PPA (3)
Asset depreciation	Predictable through assumptions within SPV.

If we look at Table 2.5 and consider that the same agent takes care of part (1), (2) and (3) there are not many parties that offer that service i.e. only parties that have the market access and operations capability, Energy Traders. Therefore, few players can offer this and competition is small. It is also a complex financial/operational product, so pricing is harder to perform and less transparent resulting in higher risk margin on top for the Energy Trader.

The results are that the risks are covered for the SPV but the profit is a bit lower than ideal.

Note that this is a highly flexible contract framework and most likely the market will adapt in some way to allow more actors to part take.

2.4.4 New business model: Separation of the pure physical operations part and pure financial part

The final setup that we consider in this report is the separation of physical and financial operations. The objective is to make each item simple and transparent so that they can be priced independently. The physical operations and imbalance cost are offered for a fair price based on historical data which allows the price to be wrapped into a green power swap which the SPV can sell or keep depending on the risk appetite.

Table 2.6: P&L with separation of financial and physical operation part

Revenues	
Energy sales' revenues	Price wrapped into a green power swap can be fixed or kept floating at will and adjusted in length at will by SPV depending on risk appetite. (1) Volume still dependent on weather and uptime.
Subsidies	Zero, fixed or volume-based subsidies based on regulation in each site. Fixed in a contract.
Costs	
Technical operation & maintenance	Fixed with a long-term contract.
Market access and operations	Offered as a service for a fair price. (2)
Fuel costs	Zero
Capital cost	Fixed with a long-term contract with financier.
Imbalance cost	Offered as a service for a fair price. (3)
Asset depreciation	Predictable through assumptions within SPV board.

By providing (2) and (3) in Table 2.6 as a service for a fair price, which can be calculated in a transparent way based on historical performance, part (1) can be offered as a pure & simple financial product which can be priced in a simple way. This would enable a higher price for the SPV through inviting more counterparties to the table and by having a more transparent standard pricing.

This results in a similarly stable and risk-free operation. In chapter 3 we will discuss how this will impact the risk for different parties and the risk premium and through that on the overall P&L of the project.

3. Impact of the New Business Model on parties' risk, risk premium and P/L of the renewable project

This section compares the different aspects of the models presented in section 2.4.3 and 2.4.4, impact on risk, risk premiums and ultimately P&L of the project.

As mentioned in 2.4 the risks covered can be no different between the proposed approach and the traditional PPA approach. The only difference is who holds that risk and who is able to participate in the risk-taking. The only exception to that is that considering how simple the instrument of GPS is, the SPV can decide to hold some of that risk themselves, increasing their upside.

This chapter considers which actor is hold the risks and how it will influence prices and ultimately how that will influence the number of big renewable plants built.

3.1 Increased competition

The main impact is expected to come from changed prices. In the traditional PPA case there is the same agent who takes care of part price risk, operations and imbalance risk there are not many parties that offer that service and therefore competition less. It is also a complex financial/operational product, so pricing is harder to perform and less transparent.

By providing operations and imbalance management as a service for a fair price, which can be calculated in a transparent way based on historical performance, the price risk part can be offered as a pure & simple financial product (GPS) which can be priced in a simple way through standards methods resulting in a higher price. The fact that this is a pure financial product means that more counterparties can partake, i.e. not only Energy Traders but all Traders could participate.

3.2 Counterparty risk

The counterparty risk will change a little bit. The parties will be more, which is generally a good thing, and the choice of counterparties should be more diverse considering the increased competition seen in Section 3.1. However, considering that more parties might be simpler trading houses instead of traditional utilities care and due diligence should be taken.

3.3 Operational efficiency

By having a separate agent focused on imbalance management for a fair price this agent can focus on operational automation and therefore lower operational cost.

3.4 Impact on flexibility

The change in business model is not considered to have any direct impact on flexibility. However, by enabling more renewable investments and thereby the installed capacity of renewable assets one can argue that this the proposed business model could drive need for more flexibility in the system. .

3.5 Overall impact

As shown in the sections above the new method would keep risk the same while lowering operational costs, lowering imbalance management cost and improve the price for renewable energy. The above impacts, all taken together, should improve the return of the Project resulting in increased numbers of renewable projects.

4. Expression of fair price for the various segments of risk that have to be managed – model description and case study

4.1 Description of challenge

In order to allow for the above, clearly desirable model, we would like to show that there is a way to calculate in a simple way the answer for the following questions:

The model described in Section 2 relies on the ability to properly answer the following questions:

- What is a fair price for imbalance management?
- What is a fair price for park energy output?

In particular, the answer to the first question helps determine a non-speculative service fee for imbalance management, and the answer to the second one brings transparency to the transactions.

This section shows that it is possible to answer to both questions above and calculate in a simple and efficient way fair prices.

4.2 Approach and results

The approach taken is to avoid assumptions regarding price development. Instead a quantitative approach is taken based on historical data of the park and existing market prices in the forwards to get a fair indication of the price development assumption the market believes. Therefore the inputs to the price definitions are historical production and historical forecasts, historical spot energy price, imbalance penalty and current prices on the forwards' market (Phelix).

The results are, as it turns out, that there is a straight forward way to describe the fair prices. Having a straight forward way further improves transparency and increases likelihood of acceptance.

Prices for next years are taken from the current prices in the forwards market, using a park quality factor and production normalization factor to consider hourly price-curve effect, i.e. does the park produce energy mainly at high or low-price hours.

In a similar way the balancing cost can be calculated by considering spot price, imbalance price penalties and the deviation.

As these are all future looking statements, expected values are used, and depending on available historical data confidence bands can be calculated. The only figure not needing that is the price in the forwards market as that is available directly.

Table 4.1 describes the exact formulas for the above-mentioned methods.

Table 4.1: Describes formulas used for calculation of fair prices

Wind Capacity Factor	$C_f = \frac{\sum_i^N V_i}{\text{Installed Capacity}}$
Park Quality Factor	$R = \frac{E[\sum_i^N S_i V_i]}{E[\sum_i^N S_i * \sum_i^N V_i]}$
Covariance (production normalized)	$\sigma = \frac{Cov(\sum_i^N S_i, \sum_i^N V_i)}{C_f * \text{Installed Capacity}}$

Balancing Cost	$X=\frac{E\left[\sum_i^N (V_i^{DA\ fc}-V_i)*(S_i-I_i)\right]}{E\left[\sum_i^N V_i\right]}$
Fair Price	$f=R*\left(p_{phelix}+\sigma\right)+GO_{HKN}-(X+O_{operations})$
	Where V_i is produced volume, S_i is the spot price, I_i is the imbalance penalty at quarter i and N the number of quarters. GO stands for the guarantees of origin price.

Our tests, discussions with experts internally and discussions with our customers have shown that these calculations and equations can become a common ground for negotiations. That gives a good indication for future adoption. The calculation of the expected value for each case will become a discussion point for each site though.

5. Conclusion

This report has described the various risks a renewable investment project faces and how that changes based on the regulatory and contractual environment chosen.

The impact of the new business model, separating physical and financial operations, has been shown qualitatively to be likely to increase investments in renewable energy projects by improving returns for investors and reducing risk.

Finally, the report describes equations and approaches to determine in a transparent way the fair price of imbalance management and energy price for a renewable project, increasing efficiency.

All of the targets were reached; however, it remains to be seen what the adoption will be. Perhaps this new business model will be adopted directly or perhaps this sort of thinking slowly finds its way into the existing PPA landscape with market players adopting it as clauses in their existing contracts.

6. List of Tables

7. List of Abbreviations

GPS	Green Power Swaps
PPA	Power Purchase Agreement
P&L	Profit and Loss
SPV	Special Purpose Vehicle