

**Market Access for Smaller Size Intelligent Electricity Generation (MASSIG)**

**Delivery 6.2**

**Actions “How to start entering the big markets as a small player”**

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**Abstract:**

In the EU-project MASSIG, <http://www.iee-massig.eu/>, an important goal is to promote and increase the participation of small scale power producers in the electricity markets, e.g. the spot market and the electricity balancing markets. In this Delivery 6.2 are described actions “How to start entering the big markets as a small player”, exemplified through examples from Denmark, Germany, Poland and UK.

## Contents

|   |  |    |
|---|--|----|
| 1 | <b>Introduction</b> .....  | 2  |
| 2 | <b>How to start entering the big markets</b> .....                       | 3  |
| 3 | <b>Example of How to start entering the big markets in Denmark</b> ..... | 5  |
| 4 | <b>Example of How to start entering the big markets in Germany</b> ..... | 11 |
| 5 | <b>Example of How to start entering the big markets in Poland</b> .....  | 18 |
| 6 | <b>Example of How to start entering the big markets in UK</b> .....      | 23 |
| 7 | <b>Summary</b> .....   | 28 |

## 1 Introduction

Small and medium size distributed generation (DG), including renewable energy generators (RES) will play an increasing role in the overall system of energy supply in Europe in the upcoming years. When replacing more and more conventional power plants by DG / RES it becomes necessary to integrate those new generators both in the grid operation and the power markets and to make them more independent from subsidies and feed-in tariffs. Besides the future *obligation* for market integration this also involves *chances*, meaning to earn money by offering services the market needs and doing this at the right time.

The European research project MASSIG (<http://www.iee-massig.eu>) investigated, which market options are most promising for DG / RES technologies and under which circumstances market participation could already pay off today (or at least in the near future). Detailed results regarding the market mechanisms, access conditions and operation schemes are given in a number of Deliverables available via the MASSIG webpage. But this lot of information might distract a bit the understanding about the decision making process and the elementary steps to go from an initial consideration of perhaps getting involved in intelligent marketing to finally become a qualified market participant. So in this Deliverable we have taken the position of answering the questions of a plant owner or decision maker, telling them what to do and what to take care of.

In accordance to the project results, we concentrate on the two main market options “spot market” and “electricity balancing market” even though there exist some more market options, partly being country specific. But also framework conditions and regulations for those markets are different from country to country – so we have picked up four quite different but typical European countries, where we explain in detail the steps you have to go to enter the big markets as a small player. These countries are Denmark, Germany, Poland and UK. The examples we give you are mostly real existing ones, so what we explain in the document has been implemented in practice and such practical experience contributed feed-back to the recommendations we are giving you.

Notice, that of course the solutions applicable for your situation are technology specific. So, if you own a fluctuating wind turbine your market chances are different from those of owners of co-generation units (CHP) equipped with heat storage and perhaps gas-burner, which could much more easily adapt to market requirements. But the methodology of determining market chances and looking for partners to build up alliances on the markets is almost the same and the steps given in Chapter 2 can be applied quite generally.

## 2 How to start entering the big markets

We suggest that you organize your work about entering the big markets in the 4 steps mentioned below:

- Step 1: Select the big energy markets to be considered for your generation unit;
- Step 2: Clarify, if it is technically possible to enter these big energy markets with your generation unit;
- Step 3: Clarify, if it is economically advisable for you to enter these big energy markets;
- Step 4: If you can not (or want not) become an active trader yourself, contact any other energy trader or service provider offering to operate your plant in these big energy markets.

Step 1: Select the big energy markets to be considered for your generation unit

You can find inspiration for selecting the energy markets to be considered for your generation unit in MASSIG Delivery 6.1, where we have made a critical survey of requirements, opportunities and barriers for market participation of small scale intelligent generators in Denmark, Germany, Poland, and UK.

In MASSIG Delivery 6.3 is described some present market options for small scale intelligent generators in Denmark, Germany, Poland, and UK that already today are interesting for small scale power producers.

Identify homepages, from where you can get the prices in the markets.

Step 2: Is it technically possible to enter these big energy markets with your generation unit?

All big energy markets issue detailed brochures or manuals defining the technical requirements for market admittance. In the Deliverables of MASSIG Work Package 4 you will find concise descriptions of the technical requirements of entering the "big markets" by "small generation" for the four countries mentioned. Be careful regarding recent changes.

Step 3: Is it economically advisable for you to enter these big energy markets?

It is an extremely important requirement that it is economically feasible to enter the selected big energy market. If you cannot show that you can earn money when entering the "big markets" nothing will happen. In the Deliverables of MASSIG Work Package 5 you will find the description of different tools that can be used for analyzing the feasibility.

If it is an existing generation unit you typically need to compare the earning it has on current Feed in Tariffs or Must Pay Prices with the earning it will have in the selected big energy market.

Step 4: Contact an energy trader, which offers to operate your plant in these big energy markets

If such an energy trader does not exist, you may be in the challenging position that you need together with other owners or operators of DG and RES generation to establish a new company, which can offer to operate the plant in these big energy markets.

### 3 Example of How to start entering the big markets in Denmark

If you are an owner or operator of a Danish Small Size CHP-plant bigger than 500 kW we suggest that you go through the following 4 steps:

#### **Step 1: Select the big energy markets to be considered for your generation unit**

We suggest that your Small Size CHP-plant participate in both the Spot Market and the Regulating Power Market.

As a Small Size CHP-plant you have of course still the opportunity to be paid the triple tariff for the produced electricity (*the triple tariff is a Danish feed in tariff for Small Size CHP-plant, in which the payment for electricity is high in Peak load hours, lower in High load hours and lowest in Low load hours*), but the value for the electricity system of your plant is bigger, if the plant only produces when the price in the spot market is relatively high. That is why the Danish electricity law states, that if you leave the triple tariff and you sell the electricity at the spot market you will receive a monthly production independent support. This support has a size that will secure you a minimum earning exactly equal to the earning you have on the triple tariff - in the case that you continue to produce as if you were paid the triple tariff but in reality are only paid the spot price.

You need to make a contract with an energy trader taking care of selling your electricity at the spot market.

Choosing to sell the electricity at the spot market has another advantage. If you sell the electricity at the Spot Market you are also allowed to participate in the Regulating Power Market (Regulerkraftmarkedet). This will give you an additional earning.

It is the energy trader that besides selling electricity at the spot market takes care of offering your CHP-unit in the Regulating Power Market.

Notice that your earning in the Regulating Power Market is split into three components. In the hours in which your CHP-unit is not used in the spot market you will be able to offer it to be available for upward regulation in the Regulating Power Market. Depending on the chosen bidding prices for being available for upward regulation you will in some hours win your bids, thus earn money by just being available.

In these hours the CHP-unit will also earn money if being activated. There are two conditions to be met for winning activation. There is an imbalance in the electricity system and Energinet.dk (*the Danish transmission system operator*) decides to remove it through the Regulating Power Market. The second condition is that your activation bidding price is competitive with the bids made by other plants.

In the hours in which your CHP-unit has sold energy into the spot market, you will be able to offer the CHP-unit to be downward regulated. Please remember that in these

hours you have already received the money from the spot market, so being downward regulated will probably save you some money for buying fuel etc. Therefore you are able to offer Energinet.dk money for being downward regulated. The Spot Market and the Regulating Power Market (both availability and upward and downward regulation) are organized as marginal price markets, that is to say that the most expensive price accepted will determine the price for all accepted bids.

You can download the prices in these markets at Energinet.dk's homepage <http://www.energinet.dk/en/menu/Market/Download+of+Market+Data/Download+of+Market+Data.htm>

Downloaded prices for the 1. of September 2009 are shown in Figure 1.

| Date       | Hour | Elspot Price, DKK/MWh | Real-time market, DKK/MWh                     |  | Purchase of reserves - daily auction,                  |   |
|------------|------|-----------------------|---|--|--|---|
|            |      | DK-West               | DK-West: Price for balancing power - downward | DK-Vest: Price for balancing power - upward regulation | DK-West: Availability compensation - upward regulation | DK-West: Availability compensation - downward |
| 01-09-2009 | 1    | 250,06                | 211,38  | 250,06   | 7,00   | 0,00  |
| 01-09-2009 | 2    | 240,16                | 240,16  | 262,41   | 7,00   | 0,00  |
| 01-09-2009 | 3    | 174,15                | 174,15  | 259,51   | 7,00   | 0,00  |
| 01-09-2009 | 4    | 158,52                | 158,52  | 259,51   | 7,00   | 0,00  |
| 01-09-2009 | 5    | 171,54                | 171,54  | 263,83   | 7,00   | 0,00  |
| 01-09-2009 | 6    | 238,22                | 238,22  | 284,28   | 7,00   | 0,00  |
| 01-09-2009 | 7    | 275,88                | 275,88  | 275,88   | 8,00   | 0,00  |
| 01-09-2009 | 8    | 321,95                | 321,95  | 321,95   | 9,00   | 0,00  |
| 01-09-2009 | 9    | 327,46                | 327,46  | 327,46   | 10,00  | 0,00  |
| 01-09-2009 | 10   | 328,72                | 328,72  | 328,73   | 10,00  | 0,00  |
| 01-09-2009 | 11   | 302,00                | 302,00  | 400,00   | 10,00  | 0,00  |
| 01-09-2009 | 12   | 303,87                | 303,87  | 420,00   | 10,00  | 0,00  |
| 01-09-2009 | 13   | 295,98                | 295,98  | 450,00   | 10,00  | 0,00  |
| 01-09-2009 | 14   | 301,78                | 301,78  | 398,00   | 9,00   | 0,00  |
| 01-09-2009 | 15   | 298,95                | 244,91  | 298,95   | 9,00   | 0,00  |
| 01-09-2009 | 16   | 293,97                | 100,00  | 293,97   | 9,00   | 0,00  |
| 01-09-2009 | 17   | 275,96                | 275,96  | 285,00   | 9,00   | 0,00  |
| 01-09-2009 | 18   | 284,52                | 284,52  | 287,92   | 7,00   | 0,00  |
| 01-09-2009 | 19   | 275,96                | 275,96  | 275,96   | 7,00   | 0,00  |
| 01-09-2009 | 20   | 299,55                | 299,55  | 299,55   | 7,00   | 0,00  |
| 01-09-2009 | 21   | 296,13                | 296,13  | 296,13   | 7,00   | 0,00  |
| 01-09-2009 | 22   | 293,82                | 293,82  | 293,82   | 7,00   | 0,00  |
| 01-09-2009 | 23   | 284,81                | 284,81  | 284,81   | 7,00   | 0,00  |
| 01-09-2009 | 24   | 274,91                | 274,91  | 274,91   | 7,00   | 0,00  |

**Figure 1: Download prices from Energinet.dk's homepage. (Availability compensation is given in DKK/MW)**

In Figure 1 you can see if there is an imbalance in the electricity system and Energinet.dk removes it through the Regulating Power Market. If the price for upward regulation or downward regulation is different from the spot price Energinet.dk buys

regulation. E.g. in hour 13 Energinet.dk buys upward regulation (the upward regulation price, 450 DKK/MWh is bigger than the spot price).

To illustrate how you can earn money on activation in the Regulating Power Market the prices in Figure 1 are used in some examples below.

|   |                    |
|---|--------------------|
| <b>Example 1:</b>   |                    |
| A CHP-plant offers upward regulation in hour 13 (together with others).   |                    |
| Offered upward regulation   | 1 MW               |
| Bidding price   | 300 DKK/MWh        |
| <b>Payment from the TSO to the CHP-plant</b>                              | <b>450 DKK/MWh</b> |
| <b>Example 2:</b>   |                    |
| A CHP-plant offers downward regulation in hour 13 (together with others). |                    |
| Offered downward regulation   | 1 MW               |
| Bidding price   | 290 DKK/MWh        |
| <b>Payment from the CHP-plant to the TSO</b>                              | <b>0 DKK/MWh</b>   |

In example 2 the CHP-plant does not win downward regulation, due to that Energinet.dk does not need downward regulation in this hour.

|   |                    |
|---|--------------------|
| <b>Example 3:</b>   |                    |
| A CHP-plant offers -upward regulation in hour 15 (together with others).  |                    |
| Offered upward regulation   | 1 MW               |
| Bidding price   | 300 DKK/MWh        |
| <b>Payment from the TSO to the CHP-plant</b>                              | <b>0 DKK/MWh</b>   |
| <b>Example 4:</b>   |                    |
| A CHP-plant offers downward regulation in hour 15 (together with others). |                    |
| Offered downward regulation   | 1 MW               |
| Bidding price   | 290 DKK/MWh        |
| <b>Payment from the CHP-plant to the TSO</b>                              | <b>245 DKK/MWh</b> |

In example 3 the CHP-plant does not win upward regulation, due to that Energinet.dk does not need upward regulation in this hour.

In example 4 the CHP-plant offer to pay 290 DKK/MWh for being downward regulated. It wins downward regulation, but because another plant has offered only 245 DKK/MWh for being downward regulated this becomes the price to be paid by all.

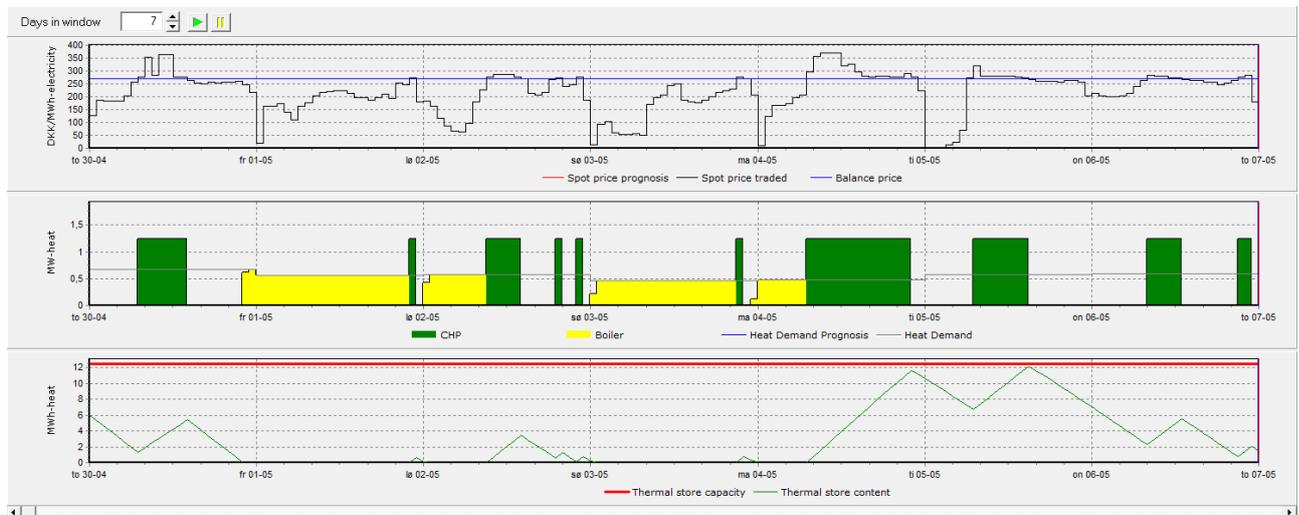
## Step 2: Is it technically possible to enter these big energy markets with your generation unit?

Besides that you shall leave the triple tariff, there are only three requirements for participating in the Regulating Power Market:

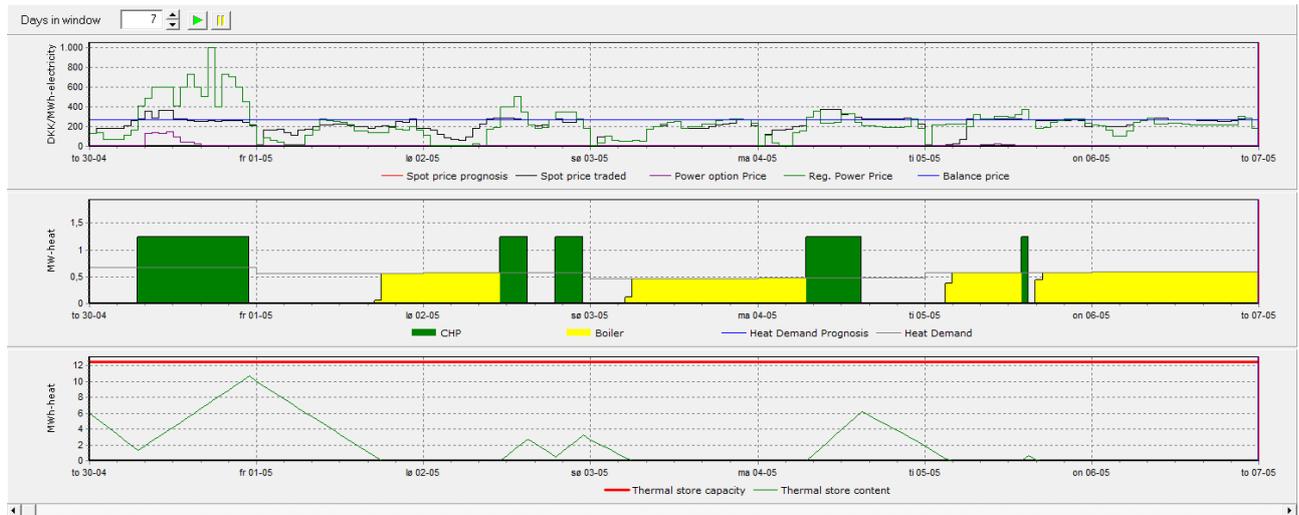
- You shall be able to start the CHP-unit in 15 minutes, which is no problem for most CHP systems. You need to make sure that you can use the produced heat or (in worst case situations) get rid of the heat using coolers.
- Your CHP-unit shall be directly connected through the internet with the central computer at your energy trader, allowing this computer to start and stop the CHP-unit.
- The least offer in the Regulating Power Market is 10 MW, so you need to be aggregated with other Small Size CHP-plants.

## Step 3: Is it economically feasible for you to enter these big energy markets

To show you an example of the value of participating in both the Spot Market and the Regulating Power Market we have simulated (*in energyTRADE*) a 7 days operation period: 30-04-2009 to 06-05-2009.



**Figure 2: A Small Size 1 MW CHP-plant participating only in the spot market in the period: 30-04-2009 to 06-05-2009.**



**Figure 3: A Small Size 1 MW CHP-plant participating in both the Spot Market and the Regulating Power Market in the period: 30-04-2009 to 06-05-2009.**

The simulations in Figure 2 and Figure 3 show that the operation of the plant depends a lot on if it only participates in the spot market or it participates in both the Spot Market and the Regulating Power Market.

In Figure 4 it is shown, that the CHP-plant can reduce its Net heat production costs by 21% in this chosen week, if it participates in both the Spot Market and the Regulating Power Market. This is a quite typical result and similar gains can be expected in future. Notice that the optimum bidding strategy requires to have some reasonable expectations about the day ahead spot price. Especially when offering upward regulation this has implications on your spot market trading, since day ahead availability is traded before day ahead spot and the spot trade volume is reduced according to the availability results.

| Simulation of a 7 days operation period: 30-04-2009 to 06-05-2009 |           |                     |
|---|-----------|---------------------|
| All amounts in DKK  | Only Spot | Spot + Regul. power |
| Sale at spot market   | 13.344    | 4.861               |
| Availability payment  |           | 1.955               |
| Payment for upward activation                                     |           | 12.352              |
| Payment for downward activation                                   |           | -1.370              |
| Net heat production costs   | 42.147    | 33.498              |
| Profit of participating in both markets                           |           | 8.649               |
| Reduction of Net heat production costs                            |           | 21%                 |

**Figure 4: Comparing the two simulations.**

#### **Step 4: Contact an energy trader, which offers to operate your plant in these energy markets**

Unless you want to become a trader yourself (which might be an option worth considering), you need to contact an energy trader, which offers to operate your plant both in the Spot Market and the Regulating Power Market.

At the Energinet.dk homepage

<http://www.energinet.dk/en/menu/Market/Shippers+and+players/Balance+responsible+market+players/Balance+responsible+market+players+in+Eastern+and+Western+Denmark.htm>

you will find a list of these energy traders (production responsible traders).

You can either ask the energy trader to calculate the value for your plant of being operated in both the Spot Market and the Regulating Power Market, or you can pay a consultancy company for doing so.

But certainly for most of the Small Size CHP-plants it will be an advantage to participate in both the Spot Market and the Regulating Power Market, even if they have to invest in an internet connection to the central computer at the energy trader.

## 4 Example of How to start entering the big markets in Germany

If you are an owner or operator of a German Small Size CHP-plant we suggest that you go through the following 4 steps. These 4 steps will be exemplified through a German 6 MW CHP installation to participate in the Spot Market and the Minutenreserve Market (badenova Showcase).

### Step 1: Select the big energy markets to be considered for your generation unit

We suggest that for Germany your Small Size CHP-plant participates in both the Spot Market and the Minutenreserve Market (tertiary control).

As an example for trading electricity from CHP into these markets, we chose a 6 MW CHP installation located in Southern Germany, called “Freiburg Weingarten”, operated by the German utility badenovaWÄRMEPLUS. It consists of 2 gas engines with a total of 5.8 MWe<sub>el</sub> installed (thermal power 6.3 MW<sub>th</sub>), 3 additional gas boilers with a total of 28 MW<sub>th</sub> for covering thermal peak loads, and a thermal storage of 360 m<sup>3</sup>. The installation is connected to a 40 km district heating grid. In 2008 the system delivered 68,000 MWh heat and 38,600 MWh electricity.

Remember that usually smaller CHP electricity is paid according to the German CHP Act (“Einspeisevergütung nach KWKG”). The payment typically consists of the “fair price” (average spot price for baseload electricity of the past quarter), the avoided grid utilisation (“vermiedene Netznutzungsentgelte”) and (depending on the type and size of the CHP) a fixed bonus (“KWK-Zuschlag”). After 10 years of operation the CHP in Freiburg Weingarten isn’t considered by the German CHP Act anymore. This means the grid operator will not buy the produced electricity and the plant operator is forced to sell the electricity on a market. As operation driven by the heat demand may lead to an uneconomic result you need to run your plant dependent on electricity prices of the market. Therefore, a peak/offpeak contract was negotiated with a German trader. In the first quarter of 2010 the average price was 38,2 €/MWh. The last quarter of 2009 covered by the CHP Act has given an average price of 42 €/MWh. For the second and third quarter an even lower, uneconomic price is expected on the peak/offpeak market. Therefore you need to look for alternatives to sell you electricity.

One alternative is participating in the German electricity spot market (EPEX SPOT run by EEX) and offer tertiary control in the regulating power market (Minutenreserve).

You need to make a contract with an energy trader or operator of a Virtual Power Plant (see step 4) taking care of selling your electricity at these markets and fulfilling all requirements from the balancing group manager.

Notice that your earnings in the Regulating Power Market are split into two components.

1. In the hours in which your CHP unit is not used in the spot market you will be able to offer it to be available for upward regulation in the Regulating Power Market (positive Minutenreserve). Depending on the chosen bidding prices for being available for upward regulation you will win your bids in some hours, thus earning money by just being available (Leistungspreis).
2. In these hours the CHP unit will also earn money if being activated (Arbeitspreis).

For the hours in which you are going to sell the CHP unit to the spot market, you will be able to offer the CHP unit to be downward regulated (negative Minutenreserve). Please remember that in these hours you have already received the money from the spot market, so being downward regulated will probably save you some money for buying fuel etc. Therefore you are able to offer money for being downward regulated at [www.regelleistung.net](http://www.regelleistung.net).

The Spot Market is organized as a marginal price market, that is to say that the most expensive price accepted will determine the price for all accepted bids. The Regulating Power Market (both availability and upward and downward regulation) is organised as a pay-as-bid market, where bids are accepted following a merit order (Gebotspreisverfahren).

Downloaded market prices for September 1<sup>st</sup>, 2009 are displayed in the table below.

| Date       | Hour | EPEX Spot, €/MWh                     | Minutenreserve Arbeitspreis, Euro/MWh                                    |   | Minutenreserve Leistungspreis, Euro/MW per hour       |   |
|------------|------|--------------------------------------|--|---|---|---|
|            |      | Hourly contracts at EPEX (Day ahead) | Average price for balancing power - down regulation (to be paid by CHP!) | Average price for balancing power - up regulation | Average availability compensation - upward regulation | Average availability compensation - downward regulation |
| 01.09.2009 | 1    | 26,96                                | 0,10   | 264,27  | 1,36  | 51,14   |
| 01.09.2009 | 2    | 22,23                                | 0,10   | 264,27  | 1,36  | 51,14   |
| 01.09.2009 | 3    | 13,44                                | 0,10   | 264,27  | 1,36  | 51,14   |
| 01.09.2009 | 4    | 8,64                                 | 0,10   | 264,27  | 1,36  | 51,14   |
| 01.09.2009 | 5    | 8,18                                 | 0,10   | 262,55  | 2,73  | 43,62   |
| 01.09.2009 | 6    | 20,05                                | 0,10   | 262,55  | 2,73  | 43,62   |
| 01.09.2009 | 7    | 31,16                                | 0,10   | 262,55  | 2,73  | 43,62   |
| 01.09.2009 | 8    | 40,49                                | 0,10   | 262,55  | 2,73  | 43,62   |
| 01.09.2009 | 9    | 44,55                                | 18,10  | 347,50  | 26,50   | 0,48  |
| 01.09.2009 | 10   | 47,58                                | 18,10  | 347,50  | 26,50   | 0,48  |
| 01.09.2009 | 11   | 53,47                                | 18,10  | 347,50  | 26,50   | 0,48  |
| 01.09.2009 | 12   | 52,94                                | 18,10  | 347,50  | 26,50   | 0,48  |
| 01.09.2009 | 13   | 48,99                                | 18,10  | 332,57  | 20,48   | 0,49  |
| 01.09.2009 | 14   | 46,96                                | 18,10  | 332,57  | 20,48   | 0,49  |
| 01.09.2009 | 15   | 45,10                                | 18,10  | 332,57  | 20,48   | 0,49  |
| 01.09.2009 | 16   | 43,57                                | 18,10  | 332,57  | 20,48   | 0,49  |
| 01.09.2009 | 17   | 39,84                                | 18,10  | 332,57  | 4,08  | 0,48  |
| 01.09.2009 | 18   | 42,00                                | 18,10  | 332,57  | 4,08  | 0,48  |
| 01.09.2009 | 19   | 44,00                                | 18,10  | 332,57  | 4,08  | 0,48  |
| 01.09.2009 | 20   | 44,15                                | 18,10  | 332,57  | 4,08  | 0,48  |
| 01.09.2009 | 21   | 47,98                                | 9,60   | 366,74  | 2,87  | 4,22  |
| 01.09.2009 | 22   | 45,96                                | 9,60   | 366,74  | 2,87  | 4,22  |
| 01.09.2009 | 23   | 41,73                                | 9,60   | 366,74  | 2,87  | 4,22  |
| 01.09.2009 | 24   | 34,06                                | 9,60   | 366,74  | 2,87  | 4,22  |

**Table 1: Examples of the payments in the German spot and regulating power market**

Sources: [www.regelleistung.net](http://www.regelleistung.net), [www.eex.com](http://www.eex.com)

Now you find two examples of the Weingarten CHP trading into EPEX Spot and offering Minutenreserve on September 1<sup>st</sup>, 2009:

Example 1: Payments in the German spot and regulating power market in an hour, where **upward regulation is needed** (The example is about hour 18 on September 1<sup>st</sup>, 2009).

|  |               |                 |
|--|---------------|-----------------|
| A CHP offered upward regulation in hour 18 (together with others).   |               |                 |
| The CHP has sold in the spot market in hour 18                       | 0             | MW              |
| Payment to the CHP from the spot market                              | 0             | EURO            |
| Offered upward regulation  | 5             | MW              |
| Bidding price availability   | 4,08          | EURO/MW         |
| Bidding price upward regulation                                      | 332,57        | EURO/MWh        |
| Payment availability   | 20,40         | EURO            |
| Payment upward regulation  | 1247,14       | EURO            |
| <b>Total Net Payments to CHP</b>                                     | <b>1268</b>   | <b>EURO</b>     |
| <b>Payment to CHP (per MWh)</b>                                      | <b>254</b>    | <b>EURO/MWh</b> |
| A CHP offered downward regulation in hour 18 (together with others). |               |                 |
| The CHP has sold in the spot market in hour 18                       | 5             | MW              |
| Payment to the CHP from the spot market                              | 210           | EURO/MWh        |
| Offered downward regulation  | 5             | MW              |
| Bidding price availability   | 0,48          | EURO/MW         |
| Bidding price downward regulation                                    | 332,57        | EURO/MWh        |
| Payment availability   | 2,41          | EURO            |
| Payment down regulation (none, since upward needed)                  | 0             | EURO            |
| <b>Total Net Payments to CHP</b>                                     | <b>212,41</b> | <b>EURO</b>     |
| <b>Payment to CHP (per MWh)</b>                                      | <b>42,48</b>  | <b>EURO/MWh</b> |

Example 2: Payments in the German spot and regulating power market in an hour, where **downward regulation is needed** (The example is about hour 16 on September 1<sup>st</sup>, 2009).

|   |               |                        |
|---|---------------|------------------------|
| A CHP offers upward regulation in hour 16 (together with others). |               |                        |
| The CHP has sold in the spot market in hour 16                    | 0             | MW                     |
| Payment to the CHP from the spot market                           | 0             | EURO                   |
| Offered upward regulation   | 5             | MW                     |
| Bidding price availability  | 20,48         | EURO/MW                |
| Bidding price upward regulation                                   | 332,57        | Euro/MWh               |
| Payment availability  | 102,41        | EURO/MW                |
| Payment upward regulation (none, since downward needed)           | 0             | EURO/MWh               |
| <b>Total Net Payments to CHP</b>                                  | <b>102,41</b> | <b>EURO</b>            |
| <b>Payment to CHP per MWh</b>                                     | <b>n/a</b>    | <b>(no generation)</b> |

|   |               |                        |
|---|---------------|------------------------|
| A CHP-plant offers downward regulation in hour 16 (together with others). |               |                        |
| The CHP has sold in the spot market in hour 16                            | 5             | MW                     |
| Payment to the CHP from the spot market                                   | 217,85        | EURO                   |
| Offered downward regulation   | 5             | MW                     |
| Bidding price availability  | 0,49          | EURO/MW                |
| Bidding price downward regulation   | 18,10         | Euro/MWh               |
| Payment availability (from TSO to CHP)                                    | 2,44          | EURO/MW                |
| Payment downward regulation (from CHP to TSO)                             | 67,875        | EURO/MWh               |
| <b>Total Net Payments to CHP</b>  | <b>152,41</b> | <b>EURO</b>            |
| <b>Payment to CHP per MWh</b>   | <b>n/a</b>    | <b>(no generation)</b> |

**Step 2: Is it technically possible to enter these big energy markets with your generation unit?**

The requirements for trading into the EPEX Spot market are easily to be met, as the least offer is 0,1 MWh per hour, with hourly increments of 0,1 MWh. Connection fees, licenses and other fix/variable costs may be covered by the energy trader (might be subject to negotiations).

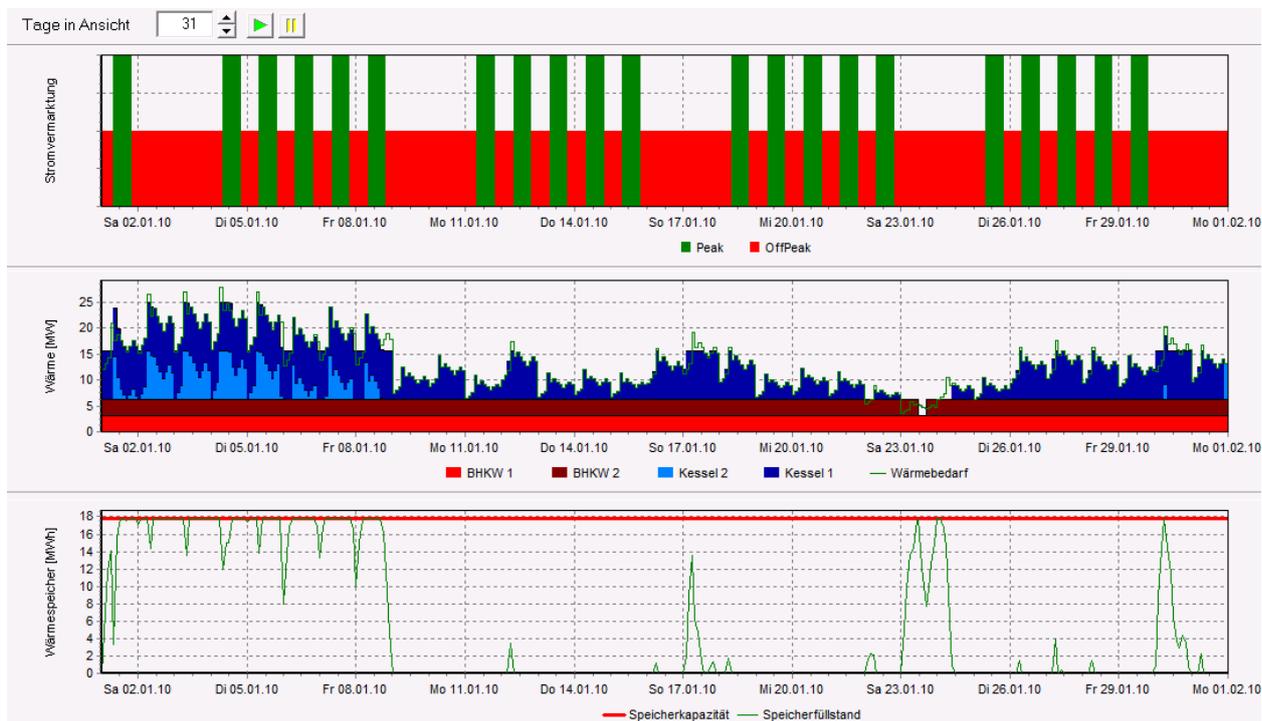
There are a few requirements for participating in the Regulating Power Market:

- You shall be able to start the CHP unit in 15 minutes.
- Your CHP unit shall be directly connected through the internet with the central computer at your energy trader, allowing this computer to start and stop the CHP unit.
- The least offer in the Regulating Power Market (Minutenreserve) is 15 MW, so you need to be aggregated with other Small Size CHP plants or other generators. Being aggregated in a pool alleviates some of the other technical requirements (like online connection to the grid operator).

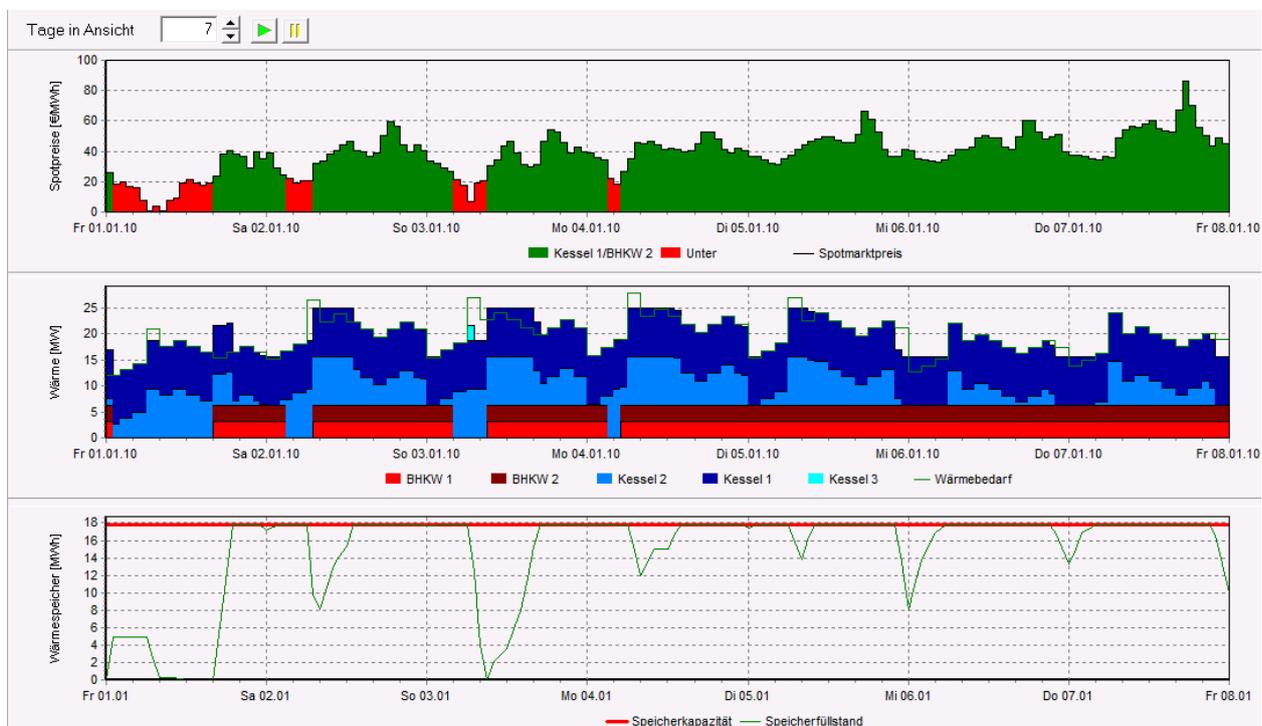
**Step 3: Is it economically feasible for you to enter these big energy markets?**

To show you an example of the value of participating in the EPEX Spot market we have simulated (*in energyPRO*) January 2010 as operation period of the Weingarten CHP installation.

Figure 5 is the result of operation management for remuneration after the bilateral contract. The CHP are almost running through, even if off peak electricity prices (upper graph) are not very attractive.



**Figure 5: The simulated operation in January of Weingarten CHP-plant on a Peak/Offpeak contract.**



**Figure 6: The simulated spot market operation in January of Weingarten CHP-plant.**

Figure 6 is the result of operation management for optimised trading into the spot market, where the CHP only produces when spot prices (upper graph, in green) are above the marginal electricity generation costs. We see that CHP operation time is reduced, being replaced by the gas boilers.

Now, if we have a look at the economic results for operation of Weingarten in January 2010, it turns out that with optimised trading into the spot market the operating income increases by 10%.

In the energyPRO example we only had a look at financial benefits comparing bilateral trade and direct trading into the Spot Market. Combined trading into Spot and Regulating Power Market will make further improvements to the economics of the Weingarten CHP installation.

#### **Step 4: Contact an energy trader, which offers to operate your plant in these big energy markets**

Unless you want to become a trader yourself, you need to contact an energy trader, which offers to operate your plant both in the Spot Market and the Regulating Power Market.

In Germany there are few traders taking care of marketing electricity from decentralized generation. Available traders are:

- [www.badenova.de](http://www.badenova.de) (bilateral Peak/Off Peak contracts)
- [www.mvv.de](http://www.mvv.de) (bilateral Peak/Off Peak contracts, Spot Market, Regulating Power Market)
- [www.evonik.de/power-saar](http://www.evonik.de/power-saar) (Spot Market, Regulating Power Market)
- [www.trianel.com](http://www.trianel.com) (bilateral Peak/Off Peak contracts, Spot Market, Regulating Power Market)
- [www.neas.dk](http://www.neas.dk)

Other companies offer general advice for trading CHP electricity, such as

- [www.getec-energie.de](http://www.getec-energie.de)
- [www.internet.swl.de/site/swl/de/geschaeftskunden/main.htm](http://www.internet.swl.de/site/swl/de/geschaeftskunden/main.htm)
- [www.naturstrom.de](http://www.naturstrom.de)

Besides, you may think of becoming your own trader and even offer trade services to other plants by using advanced software (e.g. from KISTERS AG) for planning operation management of your CHP plants.

## 5 Example of How to start entering the big markets in Poland

If you are an owner or operator of a Polish Small Size plant we suggest that you go through the following 4 steps:

### Step 1: Select the big energy markets to be considered for your generation unit

As it has been described in the MASSIG work package WP2, within the present structure of the Polish electricity market, the spot market is the only available competitive market option for small RES and CHP plants. It includes the following trading options:

*Direct trading in the day ahead market of the Polish power exchange (Towarowa Giełda Energii Elektrycznej – TGE, [www.polpx.pl](http://www.polpx.pl)) or in bilateral contracts (over-the-counter market - OTC) signed with traders or with end-consumers by RES or CHP which are independent, passive participants of the balancing market.* In this case the RES plant bears full fixed and variable cost at the power exchange and it has to face full financial risk of imbalances in the balancing market.

*Trading plant's output in the OTC without direct participation in the balancing market.* In this option RES or CHP plants trade their output in bilateral contracts signed with end-customers, however in the balancing market they are represented by a trader playing the role of the Balancing Responsible Party (Operator Handlowy - OH). Following owner's information the trader submits to the TSO aggregated contract position of all units under trader's responsibility. Using individual metering data, DSO and TSO calculate imbalance cost for the whole balancing group and charge the trader for the aggregated imbalances. This cost incurred by the trader is then distributed among all aggregated DG plants. In this situation the DG unit is usually fully exposed to the imbalance risk because the trader settles imbalances according to plant's individual hourly metering data and calculates individual imbalances of each of the clustered plants.

*Indirect participation in the power exchange or OTC spot market using trader services.* The trader aggregates the output of several DG units and sells it in the power exchange, day ahead market or in bilateral contracts. In this option the trader also takes the responsibility for the submission of aggregated contract positions of clustered units to the Balancing Market and settles aggregated imbalances in the balancing market directly with the TSO. The aggregated imbalance is then shared among trader and the owners of the aggregated plants. As the imbalance risk depends now on the bilateral agreement between owner of the plant and the trader, profitability of this marketing option is a trade-off between purchase price offered by the trader (usually below wholesale market price) and reduction of unit's exposure to the imbalance risk.

For very small RES and CHP units the last trading option seems to be particularly interesting, as it helps to reduce the imbalance risk (important issue for RES plants with intermittent output like for example PV or wind plants), to minimize trading costs (including staff and equipment cost) and does not require much effort and good trading skills.

For a little bit bigger and more predictable DG plants, having relevant experience concerning direct trading at the wholesale electricity markets, the second option might be also feasible for entering the competitive electricity market in Poland by RES and small CHP plants.

## **Step 2: Is it technically possible to enter these big energy markets with your generation unit?**

Depending on the grid connection point (network voltage level) and the form of the participation in the wholesale electricity trade, a DG generating unit has to be equipped with:

- metering devices operating with adequate precision (class) and time resolution which allow for the calculation and settlement of imbalances at the balancing market,
- ICT systems, which are used to exchange economic information between owner of the plant or its Operator Handlowy and the TSO, DSO or power exchange taking care of the operation of the particular wholesale energy or ancillary service market,
- ICT systems, which help TSO and DSO to monitor and control directly generating units and to exchange technical information about the state of power plants, which are crucial for the safe operation of the power system.

Unless we consider the participation in the ancillary services market (e.g. tertiary control), which in Poland is reserved only for large power plants, in the case of small DG units connected to LV and MV networks only the first two requirements are important. Therefore for the third type of marketing options recommended in the **Step 1** for small DG plants, which don't participate directly in the balancing market, only proper metering devices are important.

To enter the competitive electricity market in Poland a metering device with a resolution equal to the basic market delivery period (1 hour) is required. Because for small DG plants connected to LV and MV networks the requirements concerning metering devices are not standardized and they are defined individually by a grid connection agreement between DSO and the owner of the plant and because the technical requirements for the participation in the Polish TGC ("green certificates) system influence only location and precision of metering devices, it must be verified whether currently installed meters allow to calculate and store hourly output of the generating units.

Bigger units, which might prefer to operate directly in the spot and the balancing market and become OH would need to purchase and install specialized software called **WIRE**<sup>1</sup> and set up communication channels to submit to the TSO contract positions.

### **Step 3: Is it economically feasible for you to enter these big energy markets**

Following the recommendation given in **Step 1** and considering trading in the spot market using trader services (indirect trading), before starting negotiation and signing a bilateral contract with a trader, the owner of the plant should assess the “market value” of the plant and check economic feasibility of selected market options.

To estimate the potential benefits and risks linked to the participation in the wholesale market, the income that might be earned using a selected marketing option should be calculated and compared with the safe, out-of-market income from any “must take” contract. The most probable imbalance cost based on the plant’s typical forecast error should be also estimated.

In case real hourly historical production data and historical production forecast data are available for the plant, both the spot market income and imbalance cost can be easily calculated using the MASSIG Excel spreadsheet developed in the MASSIG work package WP5. Collection of metering and forecast data from the period of at least one year is recommended for such analysis. Market data (reference price of the day ahead market) and trading costs can be downloaded from the Polish power exchange website ([www.polpx.pl](http://www.polpx.pl)).

When hourly historical forecast data records are not available, the typical forecast errors for particular generating technologies might be used. Indicative figures for forecast errors for particular RES technologies can be found in the MASSIG WP4.3 report.

When hourly historical production data records are not available it is recommended to collect first sufficient information about plant’s production profile and production forecast errors using different forecasting methods, starting with very simple ones (e.g. persistence approach, where we assume that day before production will equal the hourly production profile of the next day and neglecting totally weather conditions influencing power plant’s output).

Alternatively, especially in case of more sophisticated forecast methods, it is better to purchase professional forecasting services or contact directly traders with an extensive experience in the production forecasting of the particular DG generating technology asking for the assessment of the forecast error and imbalance cost risk for the plant, which often depends not only on the generating technology, but also on the geographical location of the plant (complexity of the terrain, stability of weather conditions).

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<sup>1</sup> More details about WIRE software and hardware systems has been provided in the work package WP3 of the MASSIG Project

For intermittent RES generating technologies, like for example wind power or PV, energy storage devices are of paramount importance. Looking for the reduction of the imbalance cost and optimization of the trading strategies, the owner of the plant is strongly recommended analyzing usage of existing electricity, thermal or bio fuel storage facilities and considering building new ones to increase flexibility and predictability of the plant.

#### **Step 4: Contact an energy trader, which offers to operate your plant in these big energy markets**

Having enough information about plant's production profiles and forecast errors, following the third trading option recommended in the **Step 1**, the owner of the plant should contact traders and negotiate conditions of the bilateral agreement, including the following most important issues:

What will be the duration of the contract?

How will be electricity price in the contract set up? Which reference price will be used for the settlement between trader and the owner? How the contract price and electricity volume will be adjusted over duration of the contract?

How will be calculated and shared between the trader and the owner of the plant the cost of imbalances incurred in the balancing market?

What kind of fixed or variable fees the owner of the plant will be charged for by the trader for his services?

At the moment there are more than 40 local and global power supply companies active in the Polish electricity market. At least 25 of them are independent traders (trading companies which are not affiliated with distribution companies or large power producers). This kind of small and medium size traders is especially interested in the collaboration with smaller size power plants and usually offers the best contract conditions. The list of traders that small RES and DG plants might contact is given below.

|                          |                                      |  |
|--------------------------|--------------------------------------|--|
| PKP Energetyka S.A.      | ul. Hoża 63/67                       | <a href="http://www.pkpenergetyka.pl">www.pkpenergetyka.pl</a>   |
|                          | 00-681 Warszawa                      |  |
|                          | tel. (22) 474 19 00 (22) 474 19 00   |  |
|                          | fax. (22) 474 14 79                  |  |
| Lumius Polska Sp. z o.o. | ul. Armii Krajowej 220               | <a href="http://www.lumius.cz/pl">www.lumius.cz/pl</a>           |
|                          | 43-316 Bielsko-Biała                 |  |
|                          | tel: (33) 822 44 44 (33) 822 44 44   |  |
|                          | fax: (33) 813 82 71                  |  |
| Fiten S.A.               | ul. Ligocka 103,                     | <a href="http://www.fiten.pl">www.fiten.pl</a>                   |
|                          | 40-568 Katowice                      |  |
|                          | tel: (32) 775 94 63 (32) 775 94 63   |  |
|                          | Fax: (32) 775 94 65                  |  |
| JES Energy Sp. z o.o.    | Ul. Poleczki 23                      | <a href="http://www.jes-energy.com.pl">www.jes-energy.com.pl</a> |
|                          | 02-822 Warszawa                      |  |
|                          | Budynek Platon Park II, wejście F    |  |
|                          | Tel.: (22) 335-22-00 (22) 335-22-00  |  |
|                          | Fax.: (22) 335-22-02                 |  |
| Elektrix Sp. z o.o.      | ul. Krasickiego 19 lok 1             | <a href="http://www.elektrix.com.pl">www.elektrix.com.pl</a>     |
|                          | 02-611 Warszawa                      |  |
|                          | tel. (22) 844 71 33 (22) 844 71 33 , |  |
|                          | fax. (22) 844 17 65                  |  |
| Alpiq Energy SE          | Al. Armii Ludowej 26                 | <a href="http://www.alpiq.pl">www.alpiq.pl</a>                   |
|                          | 00-609 Warszawa                      |  |
|                          | Tel.: (22) 579-65-25 (22) 579-65-25  |  |
|                          | Fax.: (22) 579-65-22                 |  |

## 6 Example of How to start entering the big markets in UK

Smaller size energy producers wishing to participate in the “big” electricity market in the UK should proceed according the following 4 step process.

### Step 1: Select the big energy markets to be considered for your generation unit

Presently in the UK there are no legal prohibitions or restrictions for participation in the “big” nationwide electricity market for the smaller energy producers of less than 5 MW output at a single metering point.

Taking into account the most successful scenario when a power generator, producing renewable energy not less than 1 MWh/h, can afford all market participation conditions listed above we recommend participation in **Day Ahead and Intraday** (Continuous) markets trade.

Some qualifying plants can also enter the short-term operating reserve (STOR) market.

### Step 2: Is it technically possible to enter these big energy markets with your generation unit?

Power generators of 3 MW and above rating can participate in STOR service. STOR is a contracted Balancing service, providing additional active power generation and/or power demand reduction and it has to satisfy the following technical requirements<sup>2</sup>:

- To offer a minimum of 3 MW or more of generation or steady demand reduction (this can be from more than one site);
- To deliver full MW within 240 minutes or less from receiving instructions from National Grid; To provide full MW for at least 2 hours when instructed;
- To have a Recovery Period after provision of Reserve of not more than 1200 minutes (20 hours);
- To be able to provide STOR at least 3 times a week.

Generating units producing renewable energy not less than 1MWh/h and being able to afford all market participation conditions can participate in Day Ahead and Intraday (Continuous) markets trade.

### Step 3: Is it economically feasible for you to enter these big energy markets

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<sup>2</sup>[http://www.nationalgrid.com/uk/Electricity/Balancing/services/balanceserv/reserve\\_serv/stor/](http://www.nationalgrid.com/uk/Electricity/Balancing/services/balanceserv/reserve_serv/stor/)

The prospective market participant has to be able to meet the UK electricity markets requirements which include:

- Technical requirements (bid/offer size- 1MWh/h)
- Financial requirements (membership fees, transaction fees, collateral etc)
- Preparation of the the required documents and obtainment of approval,
- Specific requirements for staff qualifications
- Legal conditions and financial requirements established for market trade participants by APX-ENDEX Commodities Ltd Regulatory Requirements
- Legal conditions and financial requirements established for the market trade participants by N2EX commodity

For very small scale renewable energy plants the above process is complicated, lengthy and costly. In such cases the producer has the option of becoming part of larger group such as a VPP. Otherwise for plants that are large enough and can afford the cost of participation in the market, it is economically feasible to do so. This can be assessed through cost benefit analyses.

**Step 4: Contact an energy trader offering to operate your plant in these big energy markets**

A list of some Virtual Power Plants (VPPs) in the UK is given below. A small scale producer can contact the managers in these companies to obtain information on how to join the existing VPPs or to organize a new VPP in order to participate in the “big” electricity market trade<sup>3</sup>.

| Virtual Power Plant          | UK Post Code |
|------------------------------|--------------|
| Cloudbase Corporation Ltd.   | EH9 1RP      |
| Cloudbase Technology Ltd.    | EH9 1RP      |
| Cloudsoft Corporation Ltd.   | EH9 1RP      |
| Darnaway Venture Capital Plc | EH2 3BU      |
| Dundee Science Centre        | DD1 4QB      |

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<sup>3</sup> [http://www.elsamvpp.com/multimedia/VirtualPowerPlant\\_Auctions1.pdf](http://www.elsamvpp.com/multimedia/VirtualPowerPlant_Auctions1.pdf)

|                             |          |
|-----------------------------|----------|
| Edgecase Uk Ltd.            | EH9 2JL  |
| Gyne Ideas Ltd.             | G33 4EL  |
| Kirklands Consulting Ltd.   | EH3 7PH  |
| Multilayer Ltd.             | EH9 2JL  |
| Palmaris Capital Plc        | ML5 2EU  |
| Seaenergy Plc               | AB15 4YE |
| Sensation Ltd.              | DD1 4QB  |
| St. Andrews Fuel Cells Ltd. | KY16 9DS |

At present the following companies offer consumers and businesses the option of 100% green tariff but they are purchasing their supplies from other businesses rather than having their own sources:

- Green Energy UK (<http://www.greenenergy.uk.com/>) - only green tariffs are offered,
- Eon Go Green Tariff (<http://www.eonenergy.com/At-Home/Going-Green/Go-Green/products-go-green-elec.htm>) is a matched based tariff (e.g., they match what you buy from traditional sources by buying green energy),
- EDF green tariff (<http://www2.savetodaysavetomorrow.com/Green.html>) has a small mix of green energy (current just under 7%) but the rest is traditional,
- Ovo Green Energy (<http://www.ovoenergy.com/our-energy/>) purchases renewable sources' energy from the National Grid.

It is worth noting that the above list is not exhaustive and hence does not provide all the UK's companies that could purchase smaller size electricity products. They only provide a helpful starting point for smaller size electricity traders.

More detailed information is provided on the websites and will be helpful in the set up of necessary contacts and signing bilateral agreements.

A small scale producer can also become a trader in their own right as an N2EX member. The information for becoming a trader can be found on the following website:

<http://www.n2ex.com/physicalmarket/howtobecomeamember/>

The following information should be stated in the application:

A written confirmation stating that the application covers the N2EX physical market (Nord Pool Spot) and N2EX clearing house (NASDAQ OMX Stockholm AB).

Contact information from the applicant:

- Contact details of a person (e-mail address, phone/mobile number and registered company address) responsible for dealing with the N2EX agreements in applicant's company;
- Contact details of a person (e-mail address, phone/mobile number and registered company address) in a Clearing department that is responsible for determination of daily overnight position limit (former 'trading limit') of the company.

The following information should be provided in the application:

- Company's full name, registered address and registration number;
- Most recent annual and interim reports approved by audit – for new companies, the opening balance sheet;
- An original transcript of company certificate (not older than one month) in English;
- Complete signatory authorization in English (not older than one month) of those persons entitled to sign any legal documents on behalf of the company.

To be able to participate in the N2EX market all members must open a collateral cash account and place a cash settlement into account in a settlement bank. The applicant must submit two original signed copies of the collateral security deed (this agreement includes the cash collateral account, schedule 3 of the collateral security deed).

A letter of credit/ bank guarantee is optional and may be used to cover collaterals in addition to the cash collateral account. If applicable submit the applicant one copy of a signed letter of credit/bank guarantee.

### **Base collateral**

Nasdaq OMX Stockholm AB will calculate base collateral for each entity applying for membership. This base collateral has to be posted before trading and clearing can commence. Contact for any additional information: [credit@nasdaqomx.com](mailto:credit@nasdaqomx.com).

### **Elexon (The Balancing and Settlement Code Company)**

Any party wishing to trade in the N2EX market would need to go through the process as a non-physical trader. For more information and guidance visit the **Elexon website**:

<http://www.elexon.co.uk/help/default.aspx>

A copy of the agreement with Elexon has to be sent together with the membership agreement package, and details of the energy account must be entered into Annex 1 of clearing agreement B: clearing accounts and ECV notification data.

VAT number and registration number has to be entered into Annex 2 under contact details and authorization contact.

The application including attachments has to be sent to:

Nord Pool Spot AS  
N2EX Sales  
Att: Bente Handegård  
P O Box 121  
1325 Lysaker  
Norway

Alternatively, application can be sent electronically to [bih@npspot.com](mailto:bih@npspot.com). All documentation must be enclosed in a pdf format.

The documentation listed below can be downloaded from the N2EX website:  
<http://www.n2ex.com/physicalmarket/howtobecomeamember/>

Trading agreement 1: participant agreement,

- Clearing agreement B: clearing membership agreement,
- Clearing agreement C: clearing client agreement,
- Clearing agreement E1: collateral security deed,
- Clearing agreement E2: letter of credit,
- Clearing agreement E3: bank guarantee,
- Clearing agreement B: clearing membership agreement annex 1 + 2,
- Clearing agreement C: clearing client agreement annex 1 +2

Legal information is available at:

<http://www.n2ex.com/physicalmarket/legalframework/>

## 7 Summary

The procedure of becoming an actor on the big markets with small and medium size generation units we described above might sometimes look like a tedious job, but the gain in profit might actually make it worth. The situation about this will significantly improve in future, since feed-in tariffs and subsidies will become lower and more and more decision makers will recognise the value of full market integration of Distributed Generation.

So most certainly the list of market options and service providers offering you help will be already longer when you read this report and you definitely should make a profound recherche in the internet or ask people in your neighbourhood having experience with the actual national or regional situation in your country. Please also do not forget, that we had to choose 4 exemplary countries for our showcases and that for your country some of the above given advices might have to be adjusted accordingly.

It is also worth educating yourself a bit and having some basic knowledge about the market options and technical requirements when talking to service providers, which try to sell you their services for good money. Reading the publications of the MASSIG project, especially the comprehensive Deliverables might be one good way to do so, since you will hardly find this information compiled likewise in other resources (at least today).

And do not forget: tell your politicians and decision makers, that the full market integration of DG / RES directly supports the EC strategy of building up a stable, sustainable and liberalized electricity supply system – so any measure to support this is a step into the right direction.