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Evolution of wind energy pricing policies in France: opportunities and new challenges

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Abstract

The wind energy market is in continuous development since the last decade. This market accounts more than 600 GW of installed wind turbines in 2018, with 14 GW of onshore wind turbines installed in France. With the new Act of 17 August 2015 on energy transition for green growth, France committed fully to energy transformation, with an objective of national renewable energy share of 35% in 2030. Thus, incentives and many provisions were applied to enhance public and private investments in mature renewable energy sources. Within these energy sources, the wind energy market gets a new twist in pricing policies and new actors have emerged. The purpose of this paper is to describe the current state of art of pricing policies and describe the role of the industry's recent actors (wind farm managers and manufacturers, aggregators, CRE...). These policies are then discussed to outline their opportunities and challenges in the French wind energy market.

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1. Introduction

Wind energy is nowadays one of the highest renewable energy sources integrated in national energy mixes (Sorknaes, et al. 2019) (IEA 2019). This market accounts more than 600 GW of installed wind turbines in 2018, with 14 GW of onshore wind turbines installed in France (TheWindPower 2019). Driven by concerns about CO₂ emissions, and promoting provisions of circular economy and a better waste management, the Act of 17 August 2015 on French energy transition for green growth (LTECV, 2015) led to the development of renewable energies in

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France and more particularly wind energy. This development is also illustrated worldwide to face climate change, rising of non-renewable prices and convergence toward energy security. With more than 14 GW of onshore installed wind turbines, France aims to increase its share of renewable energies from its energy mix to 35% in 2030 (ADEME, 2015). To do so, the French act provided more than 50 provisions already applied to social, economic and technological sectors. The pricing policies are among the major changes in the wind energy market, where the purchase obligations (named CODOA) will be no more valid to lead the way to other incentives and feed-in tariffs. The objective of this paper is to describe the state of art of the pricing policies in the French wind energy market over the past decade, present the roles of new emerged actors and outline the opportunities and challenges needed to be overcome for the average 10-year-old national onshore wind farms. To do so, we firstly present and discuss all previous and current pricing policies available for French onshore wind turbines. The assessment of this state of art is also confronted to expert and actors' reviews. Thus, opportunities and major challenges of the French onshore wind energy were discussed. These experts and actors were either wind turbine manufacturers, operation & maintenance managers, aggregators, academics, associations and wind energy investors. The questionnaire provided was about wind energy in France, including actors' perceptions on reliability, economic, legislation and environmental assessments of wind turbines.

2. The French wind energy market

During the past decade, the French wind energy market was subject to different pricing policies and incentives to enhance wind energy investments and to reach national and European energy targets (since the green paper of 2006 until the 2050 objectives). Different acts and legislation were adopted in order to evaluate the pricing policy and to fix the buyback rate or the feed-in tariff of the wind electricity. The main pricing policies are listed as following, taking into account its legislation.

2.1. Purchase obligation agreement

In order to increase wind energy deployment in France, a first purchase obligation agreement was introduced since 2000 by the French state (Obligation, 2000). This first Act guarantees a fixed feed-in tariff of wind turbine electricity for the 15 years contract. Thus, wind energy investors were able to have a 15-year overview of the economic and investment health of their projects. This Act was also an incentive that offer a feed-in tariff higher than the electricity market. The feed-in tariff was evaluated for each wind farm according to its capacity factor as presented in Table 1.

Table 1. Feed-in tariff 'T' of the purchase obligation agreement (Obligation 2000).

Annual operating time [hours]	Feed-in tariff 'T' during the first 10 years of operation [c€/kWh]	'T' during the last 5 years [c€/kWh]
Less than 2400 h	8.2	8.2
Between 2400 h and 2800 h	8.2	Linear interpolation
2800 h	8.2	6.8
Between 2800 h and 3600 h	8.2	Linear interpolation
More than 3600 h	8.2	2.8

As shown in this Table 1, the first feed-in tariff for wind turbines was fixed between 2.8 c€/kWh and 8.2 c€/kWh. These tariffs were then indexed annually according to the French labor cost and production costs (Insee, 2016).

Nowadays, this Act was repealed since January 2016 and new Acts and incentives were introduced. However, wind farms projects that requested this obligation act before 01/2016 can still benefit from it. We account this year an average of 5460 wind turbines that still benefit from the purchase obligation agreement. This is mainly due to the administrative procedure for grid connection that can be up to 6 years. Since this last Act was repealed, the new European arrangements of 2014 sets directives to promote the transition to a competitive pricing policy for French wind energy (EC, 2014).

Besides, a new actor was created to ensure the electricity and gas markets in France since 2000. Thus, the French energy regulatory commission (CRE) objective is to regulate the energy market and ensure that energy policy objectives are reached. Since 2016, new support mechanisms were introduced gradually in France.

2.2. Additional remuneration contract: the open window mechanism

Through the publication of the French ministerial Act of 6th May 2017, the pricing policy in wind energy projects changed definitively from purchase obligation to additional remuneration mechanisms. Among these new regulations is the open window mechanism valid for 20 years’ duration and only available for wind farms under the following conditions.

- Installations (wind farms) of 6 wind turbines or less, with an individual nominal power of 3 MW or less.
- The grid connection request should have been requested after the 1st of January 2016.
- Minimal distance of 1500 meter from the closest wind farm project. The additional remuneration tariff takes into account the capacity warranty, energy and operating premiums as following (Eq.1).

$$CR = \sum_{i=1}^{12} E_i(T_e - M_{oi} + P_{gestion}) - (Nb_{capa} \cdot P_{ref.capa}) \tag{1}$$

Where ‘CR’ is the additional remuneration tariff, ‘i’ is the month, ‘E_i’ is the energy to be delivered to the French energy market over the accounted hours, ‘T_e’ is the reference tariff [€/MWh], ‘M_{oi}’ is the market reference tariff [€/MWh], ‘P_{gestion}’ is the operation and management premium over the contract duration and fixed at 2.8 [€/MWh], ‘Nb_{capa}’ is the capacity warranty number in [MW] that represents the commitment of the wind farm to produce a certain amount of energy during the winter peak period, ‘P_{ref.capa}’ is the capacity reference tariff [€/MWh].

The additional remuneration tariff (via ‘T_e’) is also indexed annually according to the French labor cost and production costs (Insee, 2016). Depending on the wind turbine’s rotor diameter, the amount will be paid monthly according to the reference tariff as presented in Table 2.

Table 2. Value of ‘T’ of the additional remuneration tariff.

Diameter of the biggest wind turbine of the power plant	Value of ‘T’ for the first ‘P’ MWh produced annually [€/MWh]	Value of ‘T’ for the next MWh produced annually [€/MWh]
Less or equal to 80 meters	74	40
Between 80 and 100 meters	Linear interpolation	40
More than 100 meters	72	40

As discussed with the different French wind energy actors, one can note that the value of ‘T’ and thus ‘CR’ is not indexed on the annual operating time or the capacity factor of the wind farm but mostly on the technological performances of the wind turbines (rotor diameter), their number in the wind farm project and the contract lifetime. Besides, the ‘CR’ also have an annual cap that varies according to the number of wind turbines and their rotor diameter. The produced energy cap ‘P’ is calculated as following (Eq.2).

$$P = \frac{1}{20} \sum_i^n \frac{13}{D_i/100} \times \pi \times \frac{D_i^2}{4} \tag{2}$$

Where ‘n’ is the number of wind turbines in the wind farm (from 1 to 6 max) and ‘D_i’ is the diameter of the wind turbine ‘i’.

When the number of wind turbines in a wind farm exceeds 6 wind turbines, one cannot benefit anymore from the open window additional remuneration, but can get involved in a tendering procedure through a closed window process.

2.3. Additional remuneration contract: the tendering procedure

For wind farm projects of more than 6 wind turbines, investors need to answer a call for tenders organized by the French energy regulatory commission (CRE). The first tender was launched in May 2017. The main conditions to participate in this tender are:

- Wind farms with more than 6 wind turbines.
- Wind farms with wind turbines' capacities of more than 3 MW.
- Wind farms which would justify a refusal of an application for a 'CR' contract according to the Act of the 6th May 2017.

Besides, this tendering procedure's aim is to reduce additional remuneration tariffs by grouping wind farm projects and by allowing new financing mechanisms such as crowdfunding projects. Thus, the CRE has released a call for tenders over 6 periods with a cumulated capacity of 3 GW. Each period of the tendering procedure is opened in November and May of each year until 2020. The expected cumulated capacity of each call for tenders' period is 500 MW.

Each successful candidate will then get an additional remuneration contract with EDF. The additional remuneration tariff 'CR*' of the tendering procedure is calculated as following (Eq.3).

$$CR^* = \sum_{i=1}^{12} E_i \times (T_e - M_{oi}) \quad (3)$$

With 'CR*' is the additional remuneration tariff that the candidates get after the tendering procedure. The successful candidate is also able to change with a range of $\pm 10\%$ of its initial capacity declared in his offer.

According to the actors' feedback on the tendering procedure, it seems that the first period (call for tenders) was successful and led to a cumulated capacity of 508.4 MW from the first 500 MW with an average a proposed tariff of 64.4 €/MWh. However, the second call for tenders was ditched because of a judicial imbroglio and led to a cumulated capacity of 118.2 MW out of 500 MW. Besides, we couldn't get access to the selling tariff of the successful candidates.

To sum up, all the French pricing policies applied to wind energy projects are presented in Table 3.

Table 3. French support mechanisms of the wind energy sector.

Incentive introduction	Before 2016	From 1st January 2016 to 30 July 2017	After July 2017	
Installed capacity	All	All	Up to 6 wind turbines	More than 6 wind turbines
Feed-in tariff architecture	Purchase obligation	Additional remuneration	Additional remuneration	Additional remuneration
Attribution method	Open window	Open window	Open window	Tendering procedure
Power purchase certificate attribution (CODOA)	Mandatory	N/A	N/A	N/A
Reference tariff	82 [€/MWh] over 10 years, then 28 to 82 [€/MWh] over the next 5 years	82 [€/MWh] over 10 years, then 28 to 82 [€/MWh] over the next 5 years	72 to 74 [€/MWh] then 40 [€/MWh] for the MWh exceeding the contracted cap over 20 years	According to the candidate offer (from 0 to 74.8 [€/MWh]) over 20 years
Operation and management bonus	N/A	2.8 [€/MWh]	[€/MWh]	Included in the candidate offer
Corresponding Act and regulation	Act of the 17th of June 2014	Act of the 13th of December 2016	Act of the 6th of May 2017	Call for tenders of the 5th of May 2017

As for the operation and management bonus, the last CRE report mentioned that this bonus needs to be reevaluated (CRE 2016). This report follows the German energy regulation commission that decides to delete this bonus for all new installations (EEG 2014).

3. Challenges and opportunities of the new pricing policies: survey’s feedback

With the introduction of these new directives under the regulation of the CRE, a simplification of the administrative procedure of wind energy projects’ investments was achieved. Thus, all experts and actors agreed that thanks to the CRE and the repeal of the power purchase certificate (CODOA), the wind energy sector can achieve its installed capacity targets by 2020 and 2030. One of the main opportunities emerged from these directives is also the implementation of ‘environmental authorization’ that regroups all authorization procedures for a wind energy project. This document contains all wind energy project’s information concerning the ICPE authorization, air navigation, historic sites, construction permit.... Thus, a more stable and secure regulatory framework seems to be implemented. One can also notice that the new pricing policies increase the competitiveness of the French wind energy sector and also promote wind energy crowdfunded projects. The survey’s feedback also mentioned that repowering activities of previous wind farms did profit from the additional remuneration procedures. New actors and roles have also emerged, aggregators and private/power purchase agreements have been implemented since. To sum up, the flowchart presented in Fig. 1 gives an outlook on the current French pricing policies in the wind energy sector.

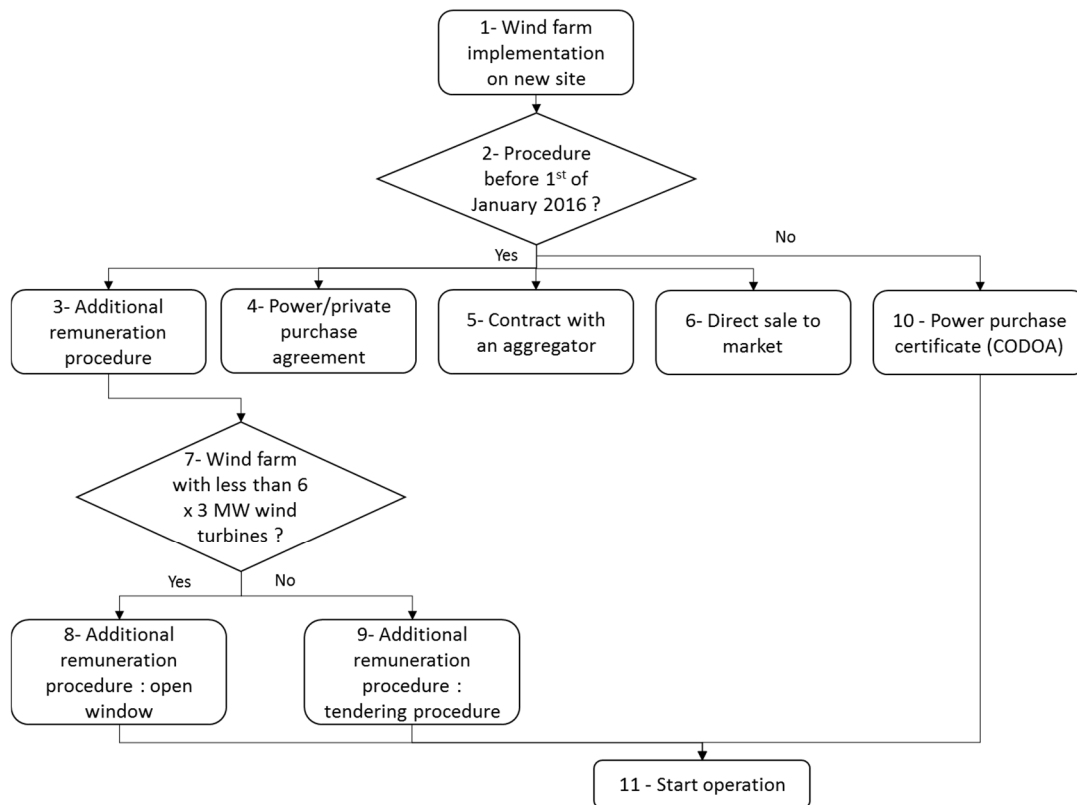


Fig. 1. Flowchart of the current pricing policies in the French wind energy.

As shown in this figure, there is still wind farms that are eligible to power purchase certificate (CODOA). Although aggregators have been included in the roadmap of French wind energy during these last years, power purchase agreement will be the next step for balancing the French wind energy system and its pricing policies. This last agreement has been implemented few years ago in the USA, Germany and the UK, but still in the maturation phase in France. The challenge here would be to develop a standard framework for setting the procedure of implementing a power purchase agreement between two actors. Nowadays, this framework is not clear in France.

Furthermore, when dealing with technological assessment of wind turbines, the experts invited to answer the questionnaire agreed with the CRE and consider that one of the weaknesses of the new tendering procedure is the fixed tariff during the lifetime contract. Indeed, the selling tariff is not reevaluated during the contract's lifetime taking into account technological advances in the wind energy sector, nor the potential research & development works on downsizing wind turbines. All these challenges made the tendering procedure not attractive enough for French wind energy actors and it would be ditched if no procedural changes will be made to improve it.

Another main challenge is the introduction of circular economy objectives in the pricing framework of wind energy facilities. Indeed, while the current contracts (including power purchase agreements) are up to 20 years, no end of life management policy is carried out for French wind turbines. Besides, purchase obligation contracts of existing wind farms are about to expire and no regulations about lifetime extension, repowering or end of life management are implemented in France. Furthermore, the frameworks of these pricing policies are set up without taking into account the inclusion of territories and regions. Besides, when dealing with the inclusion of circular economy objectives, one could integrate product-service system (PSS) as a new pricing policy framework, which will decrease not only the levelized cost of wind energy but also its environmental impacts. What is also barely included despite all the opportunities in the wind energy sector is the assessment of the social cost of energy production and use. Indeed, decision makers have now a regulatory framework with the right incentives for increasing renewable energy sources in the national mix, but still don't have a model to identify which renewable energy source (including wind energy) is suitable for their energy policy. i.e. the French energy roadmap still needs a global pricing policy that doesn't provide pricing models for each renewable energy source independently.

4. Conclusions

The new pricing policies introduced under the supervision of the energy regulatory commission CRE for the French wind energy have proven to be not only cost effective but they also simplified the administrative procedure of wind energy projects in France. It will also lead to meet the French energy targets by 2020 and 2030. Among the presented policies for French wind energy, the private/power purchase agreement is considered to be the future basis for next frameworks of balancing and incentive mechanisms. Although these mechanisms will quickly lead to a price convergence of the real levelized cost of wind energy, it still faces some challenges on including circular economy objectives toward a green and sustainable energies that meet the 7th sustainable development goal (SDG). Besides, any development of wind energy pricing policy should take into account the inclusion of territories, end of life management framework, the balance capacity of these installations and the possibility of reassessing the contracted tariffs during the contract's lifetime according to the technological advances in the wind energy sector. The next steps are to assess offshore wind energy tendering procedure, assess the capability of French wind energy and provide a comprehensive comparison with the other European wind energy pricing policies. Furthermore, we will continue the work with all the French wind energy actors to develop an effective framework of the post contract period for French wind farms. Up to now, the prospective scenarios for the future wind farm with an expired selling tariff contract are either to continue producing energy, repower, retrofit, settle a private/power purchase agreement or dismantle the wind farm.

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