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海上风电并网的经济调控
——将欧洲经验应用于中国(上)

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摘要：[**目的**]文章为两篇论文中的第一部分，着眼于将欧洲国家的经济调控管理经验应用于中国电力系统当前面临的紧迫挑战之一——海上风电的有效并网。[**方法**]文章通过分析比较近期有关监管机制方面文献的研究，总结出海上风电监管机制的五个要素：监管实体、有效非绑定程度、并网价格制定方法、补贴管理方法，以及海上风电并网建设/运行的主体责任制。文中包含了三项有关创新监管机制的研究，并根据以下四项标准进行评定，这四项标准是："价格信号"、"成本效益激励"、"计划编制"和"及时投入并网"。[**结果**]研究表明：TSO 模型、发电机模型和第三方模型提出了三种不同但都行之有效的方式，用以解决海上风电并网所面临的挑战。[**结论**]中国决策者可以从这些经验中得以借鉴，既了解掌握基本监管方法的特性，也对创新监管之道加以知悉。可以借鉴的内容将在文章的第二部分展开讨论。

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Economic Regulation of Network Connection of Offshore Wind: Applying European Experience to China: Part I

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Abstract: [**Introduction**] This paper is Part 1 of two papers, looking at applying European countries′ experience with economic regulation to one of the urgent challenges of China′s electricity systems: namely the effective connection of offshore wind. [**Method**] Using a methodology adapted from recent literature on comparative analysis of regulatory regimes, five components of regulatory regimes for offshore wind are defined: regulatory entity, degree of effective unbundling, connection charging method, tariff regulatory method and entity responsible for constructing/operation of the offshore connection. Regulatory regimes, including three case studies of innovative regulatory regimes, are assessed in terms of four criteria: "Price Signal", "Cost Efficiency Incentives", "Planning" and "Timely Connection Investment". [**Result**] The paper shows that the TSO model, the generator model and the third-party model present three different, but equally successful, paths to address the challenges of offshore wind connection. [**Conclusion**] China′s policy-makers could learn from these experiences, both in understanding the properties of basic regulatory methods, as well as the regulatory innovations. This is further discussed in Part 2 of the paper.

Key words: offshore wind; network connection; institutional and regulatory

0 Introduction

China′s electricity system is facing enormous challenges. Having served the economic growth of the country over the past decades through extensive development, the time has come to "shift gear" towards efficient operation. This paper is Part 1 of two papers, looking at applying European countries′ experience with economic regulation to one of the urgent challen-

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ges of China's electricity systems: namely the effective connection of offshore wind. The March 2015 electricity reform programme envisages major changes to the electricity sector policy and regulatory framework in China, including the introduction of a separate mechanism of economic regulation for network companies. The two papers analyse the envisaged regulatory regime, comparing it with advanced European approaches, and concluding that the new regulatory methods still need refinement. For the connection of offshore wind in particular, the most recent European regulatory innovations would provide useful lessons for China.

The two papers draw on literature from a number of fields: regulatory economics, RE network integration issues in Europe and China and China's 2015 electricity reform. Its methodology is adapted from recent literature on European offshore connection regulatory regimes, particularly Meeus et al. (2012)[1] and Meeus(2014)[2].

This Part 1 of the series describes some basic characteristics of offshore wind connection to the network and defines and analyses regulatory regimes for offshore wind in Europe, including three case studies of innovative regulatory regimes.

1 Offshore wind

In recent years, both in Europe and in China, offshore wind power development is becoming more prominent. In Europe, technological and economic challenges related to both the wind farms and the issues of transmitting power from them over large distances are being addressed by the industry and the policymakers in a concerted way. A group of 11 of Europe's largest energy companies has pledged to drive down costs of OWPs from current average EUR141/MWh to EUR80/MWh by 2025, and 9 European countries have signed a memorandum of understanding for co-operation on spatial planning, grids, finance, technical standards and regulation. A European offshore grid is anticipated.

The drivers for rapid expansion of offshore wind seem less powerful in China than in Europe, and the progress compared to targets reflects this. While European countries' offshore wind development is on-track with official targets and predictions, China's 12th FYP offshore wind targets are only 15% met, and for the next 5 years, during the 13th FYP, the development is expected to be "pragmatic" and "in an orderly fashion"(NDRC, 2016)[3].

The costs of the offshore transmission connection depend on the technology used and some additional considerations from investors and transmission companies. When considered in the context of economic regulation, the following features are noteworthy:

1) Offshore transmission costs are highly uncertain, contributing to the increased risks of connection investments.

2) In Europe, offshore transmission costs are a much larger share of overall investment costs (up to 25%) than for onshore (5%) (Weissensteiner et al. 2011: 4632)[4]. In China, this difference is less pronounced −15% compared to 14%.

3) Offshore connection investments required are very large; admittedly in China the costs projected for offshore wind connection are much lower than for onshore wind; however, the question of an optimal regulatory regime to deliver the offshore transmission investments in China is of economic significance.

2 Regulatory regimes for offshore wind connection

2.1 Components of regulatory regimes

For this paper the term "regulatory regime" encompasses the complex of organisational arrangements, methods of economic regulation and pricing structures applied to (and by) transmission network companies in the context of connection of offshore wind generators. These specific regulatory regimes for offshore wind connection are based on/ determined by the general regulatory regime for transmission network companies. Figure 1 depicts the five components of the regulatory regime considered in this paper within the business model of the transmission network company and the entity responsible for offshore connection

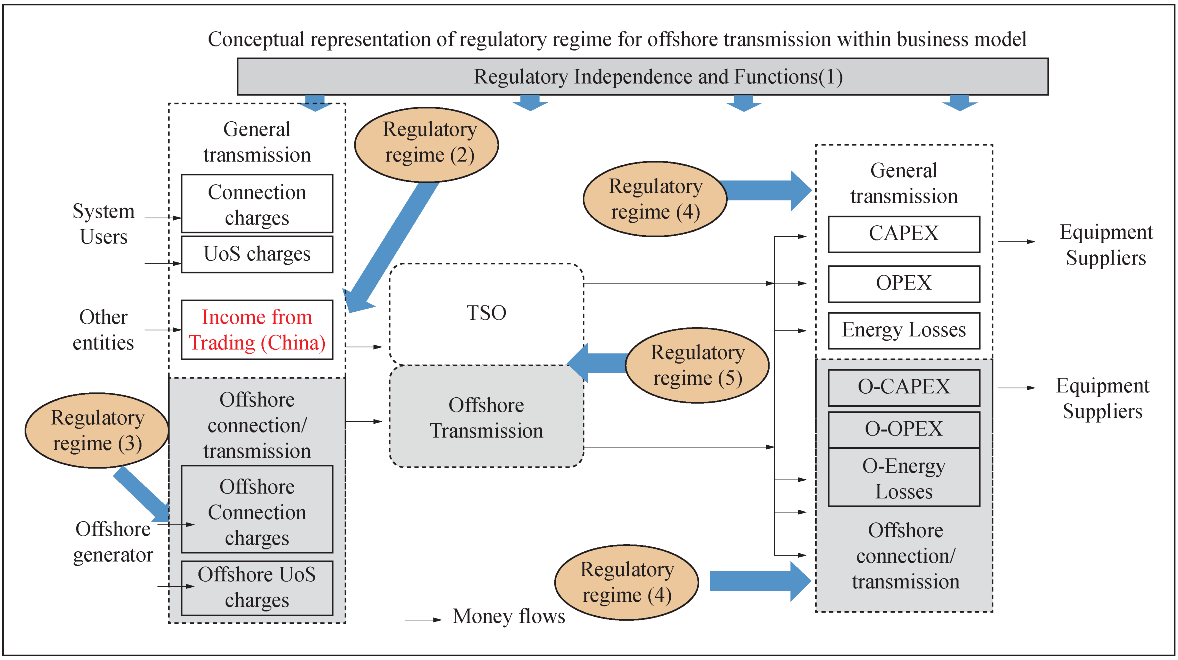

Fig. 1 Conceptual representation of regulatory regime for offshore transmission within network companies' business model.

Source: Adaptation from Joode et al. (2009: 2908)[5]

and transmission. They are in detail explained below.

1) The characteristics of the entity undertaking the economic regulation (i. e. the regulator) in terms of its independence and responsibilities.

A crucial part of most electricity reforms worldwide has been the establishment of an independent regulator. It is the recommended approach of the World Bank for all developing countries (Jamasb 2003)[6] and has been proven to be the single essential ingredient in successful electricity sector reform (Pollitt 2009[7], Zhang et al. 2006[8]). In the EU, the establishment of an independent regulatory authority with clear responsibility for price regulation in the sector has become a legal requirement of the Third EU Energy Package. Decisions are made in a technical rule-based framework and not influenced by short-term policy considerations. The existence of an independent regulator undertaking economic regulation will be seen to advance the fulfilment of all assessment criteria used in this paper.

2) The source of income/scope of activities (and hence degree of unbundling) of the regulated transmission company.

The unbundling of network activities, which are natural monopolies, from the potentially competitive activities of generation and supply is another fundamental ingredient of electricity sector reforms. The crucial point here is the separation of the transmission network from generation. The complete unbundling of network activities from generation is crucial for the proper operation of both the competitive wholesale market and the regulatory methods employed for the TSO. Complete unbundling of network activities from generation is therefore essential for the fulfilment of all assessment criteria used in this paper.

3) The extent to which offshore generators have to pay for their connection to the network.

There are three main methods of connection charging that can be employed:

(1) Super-shallow: The generator bears costs only for the actual power plant, including internal wiring; the costs of all other connection assets and for required network reinforcements are paid for by all users of the transmission system.

(2) Shallow: The generator bears the costs for the actual power plant, including internal wiring, and also

for the connection assets required for the particular connection; the costs for required network reinforcements are paid for by all users of the transmission system.

(3) Deep: The generator bears the costs for the actual power plant, including internal wiring, and also for the connection assets required for the particular connection and also for network reinforcements.

Figure 2 illustrates them with regard to an OWP connection.

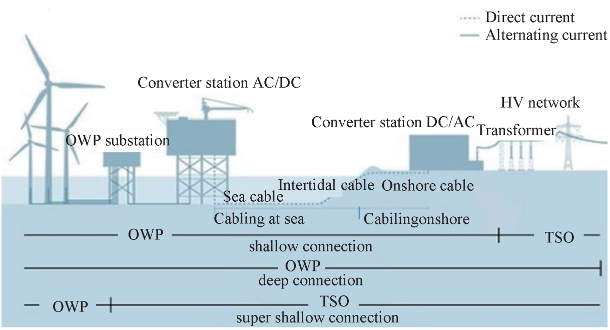

Fig. 2　Illustration of three charging approaches for offshore wind connection (HVDC example).
Source: Adaptation from Tenne T (2013)[9]

The deeper the charging method, the better (theoretically) is the price signal. If the prospective generator is confronted with deep connection charges, the location for the plant will take into account the required connection costs, including grid reinforcements. However, in a meshed transmission system, in which the configuration of generators and load is changing all the time, it is impossible to fairly calculate and allocate the system costs caused by any particular connection. Therefore, deep charging is not a realistic option. Shallow charging avoids the need to calculate the costs of network upgrading in the overall system while still providing some price signal, but it still has the problem that subsequent connections in the same location might make use of assets paid for already by the "first mover". For this reason, and in order to give additional support to RE, many countries use a super-shallow charging approach for RE facilities.

Independently from who first pays for connection, all costs will, eventually, be paid by the electricity customers, but the super-shallow model results in some overall cost savings under certain conditions. Consequently, within the framework of this paper, deep or shallow charges would be positive in terms of a price signal, but there might be cost advantages in super-shallow charging compared to shallow charging.

4) The method of economic regulation used for determining the allowed revenue overall and for offshore connection and transmission.

Four main choices are relevant here: Rate of return (RoR); Incentive regulation; Hybrid methods (combination of RoR and incentive regulation); No explicit method❶.

Under RoR regulation, the regulator determines the allowed revenue for the transmission company, annually, based on actual costs from the past year and a RoR on the regulated asset base (RAB). The RAB is the value of the network related assets employed by the company, and the RoR is determined as the weighted average cost of capital (WACC). The idea is to compensate all costs and provide a fair return. In the past, this method was widely used. It provides certainty for recovering investments, but lacks incentives to increase efficiency. It also suffers from the so called Averch-Johnson effect-the tendency to over-invest in capital.

Under incentive regulation the regulator analyses the company's actual (and some forecast) costs only at the beginning of each regulatory period (often every 3～5 years). The regulator then sets a revenue cap for the whole regulatory period ahead in such a way that each year the allowed revenue adjusted for inflation, (for example the Retail Price Index RPI) decreases based on the application of an efficiency factor (so called *X* factor). This factor reflects the degree of efficiency improvements the regulator considers reasonable (RPI-X).

Incentive regulation works well for efficiency inducement, but it comes under pressure when the network company needs to undertake large risky capital

❶ This option has been added for the application to China. It does not exist in Europe.

investments as is the case with integrating RE. If the regulator has an interest in ensuring that grid expansion investments are in line (timing and size) with newly established production facilities (which are not under control of the transmission company or the regulator, as it is in the competitive generation market), the regulator must chose a relatively high price cap. However, this conflicts with the other desirable features of this regulatory method-the drive for efficiency.

The result of such dilemmas is the use of hybrid regulatory methods, for example the so called "building block approach" with explicit CAPEX projections, used in the UK, or the separate regulation of exceptional investment measures. This latter method will be explored in the German case study. A good overview of regulatory methods used specifically for transmission companies in Europe is contained in CIGRE (2012)[10].

For the assessment, it is important to note that there is no clear-cut preference: RoR regulation lacks good price signals and cost efficiency, but gives more assurance for investments. RPI-X is good for efficiency improvements, but it is difficult to predict required costs for a long future regulatory period. When considering offshore wind connection, the problem is that it requires a method which gives good incentives for efficiency (especially as it uses new technology), but also security to the investments-something very difficult to reconcile within any standard regulatory framework.

5) Entity responsible for constructing the offshore connection and for operating it.

Traditional regulatory economics would consider the establishment and operation of offshore grid infrastructure a natural monopoly and hence it should be less costly if these economic activities are carried out by one firm compared to two or more firms. Similar to the onshore grid, the TSO should be best placed to realise the efficient co-ordination of the demands of all potential users when constructing and operating the offshore transmission infrastructure. This is the TSO model.

However, there is an alternative view. Namely, that the connection of isolated single offshore wind farms is not characterised by natural monopoly characteristics, and hence should be a competitive activity. Moreover, in practice, it turns out that both developers and regulators have a preference for such a generator model. Developers feel they have more control over costs, design and timing of the connection. In addition, the very high connection costs and the uncertainties related to rapid technological development make it attractive for the regulator to use competitive elements in order to assert pressure for cost efficiency.

In this situation, an intermediate organisational option, developed in the UK but subsequently contemplated by other countries, is to have a third party owning and operating the offshore transmission assets-a party who can have a wider focus than a single offshore generator, a party that fulfils the EU unbundling obligations and can be separately regulated, and yet this party would be appointed by a competitive process, allowing some cost savings. This is the third-party model.

In terms of the assessment for this paper, the TSO model favours the planning criteria, and in connection with super-shallow charging it might also have cost efficiency properties. However, under the standard incentive regulation method, the TSO model might not achieve timely connections-unless the regulator forgoes cost efficiency by allowing a very high price cap. The generator model scores well on price signal, cost efficiency and timely connection-because of the competitive drive of the generator to complete the connection on time and at lowest possible cost. However, the planning criteria would not be fulfilled. The third-party model retains some of the advantages of the generator model and adds the possibility of wider planning.

2.2 Case studies

The case studies below set out three distinct models for offshore wind connection which co-exist in Europe: the TSO model, the generator model, and the third party model (Meeus 2014)[2].

The models differ in terms of their combinations of components (3), (4) and (5) of the regulatory regime, i. e. regulatory method, charging approach and organisation of responsibilities. This is depicted in Figure 3.

Case studies have been chosen to illustrate the differences and methods employed: Germany for the TSO model, the UK system, until 2009, for the generator model, and the UK system, after 2009, for the third-party model.

2.2.1　Case 1: The TSO model (Germany)

The TSO model assumes that offshore network infrastructure has the same natural monopoly features as onshore and hence the TSO, regulated by economic regulation, should have the sole responsibility for constructing and operating this infrastructure.

In this model the regulatory method employed for the TSO onshore grid is extended to cover the new offshore operations. In Germany, this system is incentive regulation undertaken by Germany′s regulator, the Bundesnetzagentur (BNetzA). This method involves a thorough cost analysis at the beginning of each regulatory period (every 4 years), a projection of certain cost components for the whole regulatory period ahead, and an efficiency comparison (by special statistical methods assessing the overall costs - called TOTEX benchmarking) resulting in the determination of an efficiency factor (X factor). The allowed revenue to be earned over the coming 4 years ahead is set in advance based on costs, adjusted for inflation, minus yearly mandatory efficiency savings (X factor). Any additional efficiency savings the company can make within the regulatory period are retained as extra profit.

The advantage of incentive regulation is a focus on cost efficiency, and this is especially pronounced with TOTEX benchmarking. When the TSO has to connect a large number of OWPs, with the associated technical challenges and uncertainties, this creates large risks. Moreover, for offshore wind Germany employs a super-shallow charging method called "Plug-At-Sea".

At the beginning, the German regulatory system experienced serious problems with regard to connecting OWPs. In order to overcome them, Germany introduced some modifications to its regulatory regime:

1) From 2016 onwards, the right of each individual offshore wind farm to be connected at the time of commissioning has been replaced by the "O-NEP"— the Offshore Network Development Plan (recent version see 50 Hertz et al. 2015[11]). The O-NEP, which is updated

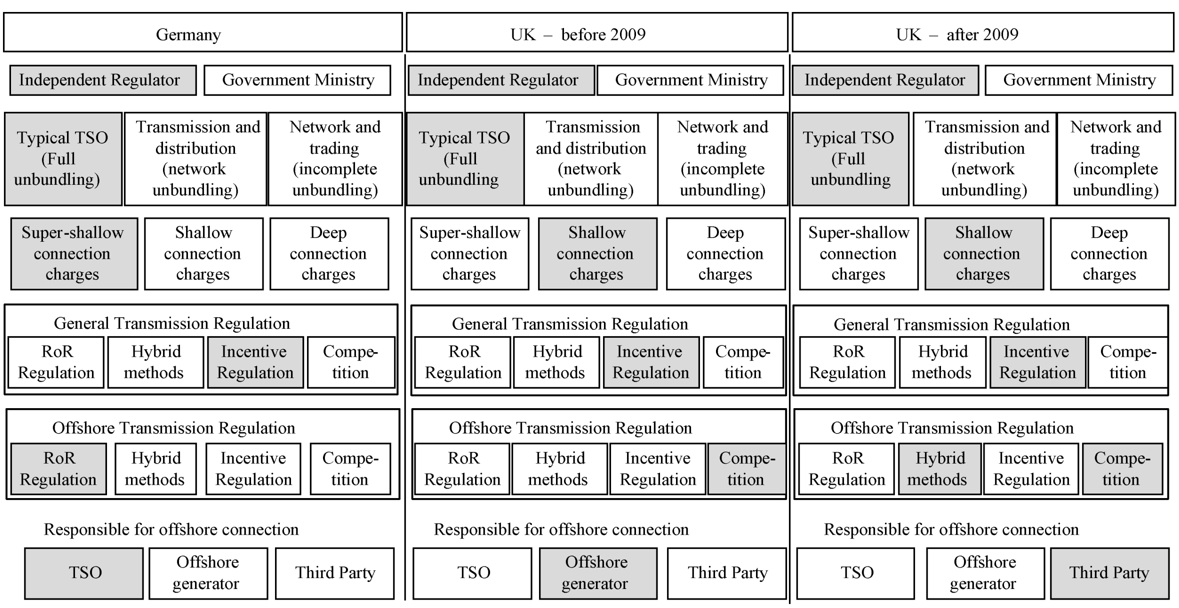

Fig. 3　Comparative representation of regulatory regimes

and approved by the regulator every two years after society-wide consultation, contains binding plans for the co-ordinated and efficient construction of connections of OWPs and the overall offshore grid system.

2) The incentive regulation method was modified to take account of the special characteristics of the offshore connection investments. Capital costs incurred for connection of OWPs are not part of the usual incentive regulation-instead they are added to the allowed revenue for the regulatory period. At the end of the regulatory period these costs do not enter the inter-company efficiency comparison.

3) The transmission companies are obliged to implement the connections and grid reinforcements contained in the O-NEP in accordance with the deadlines of the O-NEP. If they do not fulfil it, the OWP has the right to demand compensation. This liability system was introduced in the 2013 Energy Law amendment.

These modifications have resulted in a marked improvement of the connection of OWPs by the TSOs in Germany. The system has been endorsed by the TSOs and the market participants.

2.2.2 Case 2: The generator model (UK until 2009)

Under the generator model, used in the Uk until 2009, and still applied in some European countries (for example Sweden), each OWP developer is responsible for connecting their station to shore and for operating the connection assets during the lifetime of the project. The offshore generator integrates the connection planning, design, equipment ordering and construction within the overall process of constructing the OWP. As OWP construction is competitive, the benefits of competition (i.e. lower costs) are extended to the acquisition, installation and operation of the connection assets. Moreover, the achievement of timely connection is assured: the developer has full control over the overall process. Many developers prefer to shoulder the connection task themselves compared to it being out of their control, or "a black box".

This approach corresponds to shallow charging, as the OWP pays all costs of the connection up to the onshore substation. The basis of this model is the assumption that offshore connection assets are a mere extension of the OWP. Indeed, as long as only radial connections are contemplated, this position might be justified. Figure 4 below depicts the contrast between radial and integrated connections of OWP.

As can be seen, the co-ordinated method could achieve substantial savings: In the fourth case only two sub-sea cables are required instead of four. However, with the generator model, OWP developers would have difficulties in negotiating the cost sharing and

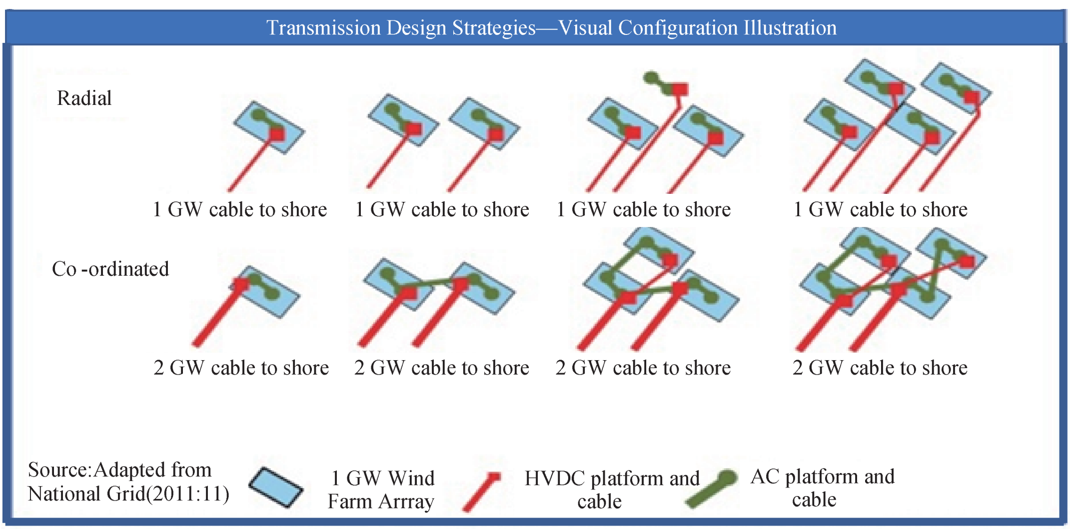

Fig. 4 Radial and co-ordinated network connection (adapted from National Grid, 2011: 11[12])

joint construction arrangements required for the co-ordinated approach. Moreover, as soon as one moves away from simple radial connections, the offshore connections become an offshore grid with natural monopoly characteristics and (in the EU) requirements for unbundling.

2.2.3　Case 3: The Third-Party model (UK after 2009)

Once the offshore sector starts to develop rapidly, the generator model becomes problematic. From 2005 onwards, the UK regulator led a process of analysis and consultations, resulting in the adoption, from 2009, of a special regime for offshore connections in the UK - the third-party model.

This model separates onshore transmission from offshore transmission (as does the generator model), but it treats offshore transmission as a regulated activity, applying a special regulatory method, distinct from the usual regulation of the TSO. The offshore transmission regulatory regime is based on tenders, run by Ofgem, for offshore transmission licenses to be awarded to Offshore Transmission Owners (OFTO)❶. It consists of several stages:

1) Pre-qualification-resulting in a long-list of bidders (pass/fail test).

2) Qualification to Tender-resulting in a short-list of bidders (scored assessment).

3) Invitation to Tender-resulting in choosing the preferred bidder (scored assessment).

4) Issuing of the Offshore Transmission Licence.

The process is elaborately crafted and well organised, aiming to balance the desire for a wide participation of bidders (and hence competition) with the need to ensure that only companies with the necessary technical, managerial and financial capabilities are considered for receiving the respective licences.

There are two main variants to the regime: "OFTO build" means that the OFTO is appointed at the pre-construction stage, and then builds, owns and operates the assets. "Generator build" means the offshore generator builds the connection assets, but on completion he must sell them by tender to an OFTO. In either case, competition is employed in order to drive connection costs down. Ofgem states that competitive tendering is cutting the costs for connecting offshore wind farms to the UK high voltage grid by at least £ 700m (Ofgem 2016)[14].

Ofgem considers that the third-party model is the best approach to meet the challenging 2020 environmental targets, which require an unprecedented amount of OWPs to be built, at high cost. This "step change" in network investment "calls for a more dynamic approach to the development of transmission networks: an open, competitive approach that is built on encouraging innovation and new sources of technical expertise and finance" (Ofgem 2016)[14].

2.3　Assessment of Regulatory Regimes

While the design of regulatory regimes is a matter of intense debate, there is a broad consensus on what a good regulatory regime should try to achieve. Most simply put, good regulation should try to mimic competition as close as possible. Competition would be the first best choice, but regulation is required because of the natural monopoly characteristics of the network activity. Therefore, regulation should strive to achieve what competition would "naturally" deliver-namely allocative efficiency (correct prices and price signals), cost efficiency (and incentives to lower costs), and quality of service.

What do allocative efficiency, cost efficiency and quality mean for offshore wind connection?

Allocative efficiency is concerned with correct price signals, in this case that "generators receive a price signal so that they internalise the cost of their demand for transmission services in the total investment" (Meeus 2014: 4)[2]. Meeus et al. (2012)[1] call it the "beneficiaries pay principle". This cost of the demand for transmission services includes the capital cost of the connection assets, the ongoing costs for operating the connection, including network losses, and the additional costs imposed on the overall transmission system caused by the size and the location of the addi-

❶ See Ofgem (2016)[13] for an example related to Round 4.

tional connection. This paper will use "Price Signal" as criteria for allocative efficiency.

Cost efficiency is concerned with optimising costs and quality of services provided. The achievement of cost efficiency in a regulated context is particularly challenging, as without the pressure of competition, the company does not have an incentive to be efficient. Incentive regulation tries to deal with this issue, but the methods are imperfect, especially in the context of rapid technological change, increased technological risks and innovation. Meeus et al. (2012)[1], Meeus(2014)[2] and Keyaerts and Meeus(2015)[15] therefore advocate using "Element of Competition" as assessment criteria. However, in this paper the criteria will be called "Cost Efficiency Incentives"-being closer to the original wording of regulatory objectives. It is assumed (together with Meeus et al. 2012[1] and Meeus 2014[2]) that cost efficiency incentives can originate either from competition or the application of incentive regulatory methods, but that competition would be preferable in the context of offshore connections (rapid technological change, increased technological risks and innovation).

An additional aspect of cost efficiency relates to investments-particularly the overall investment activity of the transmission companies in relation to offshore wind connections. Costs of connection can be optimised if the whole series of subsequent connection requests are considered together in a co-ordinated and planned approach. Meeus et al. (2012)[1] and Meeus (2014)[2] call this principle "Advanced connection planning", or "Planning".

Quality means that certain standards of quality will be met. For transmission services and connections the standards related to reliability and safety is usually formulated in Grid Codes and similar regulations. The achievement of these standards is then a clear legal requirement, not a criteria of the regulatory regime. However, "Timely Connection Investment" is a quality criteria worth adding. In an unbundled sector the optimisation of investment decisions of transmission companies and generation companies are treated independently from each other, but the regulator has an interest in ensuring that grid expansion investments are in line (timing and size) with the newly established production facilities.

2.4 Discussion and comparison of the case studies

The case studies present three different paths to addressing the challenges of offshore wind connection. They are all moderately successful in addressing the regulatory criteria, as can be seen from the summary assessment in Table 1.

Tab. 1 Summary assessment of case studies

Assessment Criteria/level of achievement	TSO model (Germany)	Generator model (UK)	Third party Model (UK)
Price Signal	Red	Green	Green
Cost Efficiency Incentives	Yellow	Green	Green
Planning	Green	Red	Yellow
Timely Connection Investment	Green	Green	Yellow

Note: Green—Regulatory regime is expected to fulfil criteria well; Yellow—Regulatory regime has some potential to fulfil the criteria; Red—Regulatory regime is expected to not fulfil criteria.

The main points are:

1) First, the approach to charging determines the fulfilment of the price signal criteria. The German TSO model, using super-shallow charges, does not score well for this criterion, while the other two models (shallow charges) do.

2) Secondly, only the TSO model and the third-party model are geared towards larger and co-ordinated deployment of offshore wind. The generator model, despite its considerable advantages for cost efficiency and timely connection, does not provide for a co-ordinated connection approach. Moreover, once the offshore grid infrastructure resembles a transmission grid, the EU unbundling requirements will not allow this model to continue. This means that the "red" scored for the generator model in the criteria "Planning" is a "show-stopper"-at least in the EU; it is worse than the "red" scored for the TSO model for the Price Signal criteria, because it affects the legality of the regime. Consequently, out of the three presented models, in

Europe, only two are likely to have longer-term prospects: the TSO model and the third-party model.

3) Thirdly, while neither of the two prospective models (1 and 3) scores well for all criteria, industry participants and regulators consider both models workable. This is also confirmed by the successful development of the sector in both countries in recent years.

4) Fourth, the success of both prospective models crucially depends on some regulatory innovations:

(1) In Germany, the TSO incentive regulation method was modified by introducing special investment measures, which are regulated separately by a method similar to the RoR approach. In addition, a centralised planning method was imposed on the prospective OWP developers as well as the TSOs-the legally binding O-NEP coupled with legally enforceable compensation claims for connection delays. While the introduction of special regulation for investment measures is less conducive to the cost efficiency of the connection investments, the approach emphasises risk reduction and overall connection planning (and hence it might overall reduce costs). It needs to be stressed that until the special regulatory adjustments were introduced, developers viewed grid regulation as a key barrier in Germany. This was in marked contrast to the UK.

(2) Crucial features of the third-party model are the bundling of the tenders for the OFTOs, and the fair and transparent organisation of these tenders by Ofgem. The bundling of OFTO tenders within the zones of an integrated offshore network development plan improves the planning criteria, which would otherwise not necessarily be fulfilled. The thorough organisation of the tenders by Ofgem and the retaining of the choice to undertake the "Generator build" option with obligatory sale afterwards, allows the criteria of Cost Efficiency and Timely Connection Investment to be retained from the generator model.

5) Fifth, the final comparison between the TSO model and the third-party model comes down to preference and perceptions about achievable advantages from more comprehensive planning (TSO model) versus more cost efficiency arising from competition (third party model). Arguably, this is a matter of basic cultural differences: as can be seen in other areas of regulation, the UK regulator traditionally prefers competition, while the German system emphasises coordination and planning

3 Conclusion

During the 1990s and 2000s most countries established regulatory authorities and developed sophisticated methods of regulating their network companies and associated markets for electricity, gas, telecommunications and water. Within the EU, there are now explicit legal requirements for the independence of regulatory authorities, their functions and powers, and for the principles and methods they should use for regulating the natural monopoly networks.

European electricity regulators have started to modify regulatory methods in response to the challenges of integrating RE into the electricity network. The main area of regulatory innovations is in offshore wind connection, where three different European models currently exist side by side. In principle, all three models presented from Europe, could be applied in China. This is further discussed in Part 2 of the paper.

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Biography:

Ilka LEWINGTON

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