Institutions and Electricity Systems Transition towards Decarbonisation : The hidden change of the market regime

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The hidden change of the market regime

Summary

Apart from the UK where it has been widely discussed in the 2011 Electricity Market Reform, energy experts communities are still unaware of the impacts that carbon policies directly focused on the development of low carbon technologies produce on the electricity market regime. Public co-ordination with long term arrangements needs to be introduced as a substitute to long term co-ordination by the market. Indeed, the current market co-ordination makes carbon prices ineffective at orienting investors towards low carbon technologies: fossil fuel generation technologies are preferred because their investment risks are much lower in the market regime. So, in order to avoid delayed investment aiming at the decarbonisation of electricity systems, a number of new market arrangements which lower the investment risk of these technologies are being selected by governments. But, as these low carbon equipments develop, long term co-ordination by the market for the other technologies (peaking units, CCGT) will fade away. That means that in the future, public co-ordination and planning will completely replace market players' decisions, not only for low carbon technologies, but for every capacity development.

Keywords: technology-focused carbon policies, electricity markets, generation investment, risk management criterion, market failures, coordination role of market, planning.

Institutions et transition vers des systèmes électriques décarbonés
L'invisible changement du régime de marché

Résumé

La communauté des économistes de l'énergie et du climat n'est pas encore complètement consciente des changements que les politiques climatiques focalisées sur les technologies bas carbone vont entraîner sur le régime de marché des industries électriques. De telles politiques doivent introduire une coordination publique forte, combinée avec des arrangements de long terme, coordination, qui se substitue à la coordination de long terme par le marché. Cette coordination par le marché est actuellement inefficace car elle ne permet pas au prix du carbone d'orienter les investisseurs vers les technologies bas carbone à coût fixe élevé. On montre que les technologies émettrices sont préférées à ces dernières car la gestion du risque d'investissement est beaucoup plus aisée avec elles et que ce critère prend le pas sur celui du moindre coût marginal de long terme. Aussi, afin d'éviter de retarder la décarbonation des systèmes électriques, les pays doivent adopter rapidement de nouveaux arrangements de marché qui diminuent radicalement le risque d'investissement en technologies bas carbone. Mais, au fur et à mesure que les équipements bas carbone tirés artificiellement dans le marché occupent la majorité du système, les autres technologies flexibles (CCGT) et de pointe à combustibles fossiles et dont on a besoin ne peuvent plus se développer par le marché. En conséquence, à long terme, coordination publique et planification vont complètement remplacer les décisions d'investissement des agents décentralisées pour tous les équipements et pas seulement les équipements bas carbone, reléguant le marché dans une simple fonction de coordination horaire dans l'exploitation des équipements électriques.

Mots-clés: Politiques des technologies bas carbone, marchés électriques, investissement, critère de gestion de risque, défaillances de marché, coordination par le marché, planification.

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1. Introduction

Ambitious decarbonisation objectives of electricity systems – like those promoted by the European Union's Roadmap 2050 or those which would be necessary in the OECD for reaching the 450 ppm stabilization goal[1] – conflict with the electricity market reforms still

[1] In the 450 scenario of the IEA's World Energy Outlook 2011 (IEA, 2011), the proportion of low carbon equipment in the new capacity to install in OECD countries is quite high: 70 % from 2010 to 2020 and 95 % from 2020 to 2035.

championed by a number of OECD and European Union countries. The market regime raises a problem as it impedes the effectiveness of climate policies: besides energy efficiency measures, generators are asked to make low carbon investments which are by nature capital intensive, while they are in parallel made riskier by current electricity markets. The problem is that, since market liberalization, investment and market risks are borne by the investor. In the former regime of vertical integrated utility monopoly, however, the tariff regulation system which aligned prices on averaged costs transferred the investment risks to consumers .Now the price at which an investor in capital intensive technology can sell the electricity he produces bears little or no relation to his own costs, which entails an important risk level for recovering large fixed costs. Problems are not only uncertainty on electricity price but also (1) long term uncertainty on carbon price, (2) unclear competitiveness levels of decentralised renewables (RES-E) and low carbon technologies (LCT) with respect to fossil fuel generation, and (3) the importance of learning investments in large-sized LCT[2] which combine two major risk characteristics: capital intensity (with large upfront costs and long lead times for construction) and high political and regulatory risks (Grubb et Newbery, 2007; Skea, 2010).

Public co-ordination and new market arrangements are thus needed to de-risk RES-E and LCT investments by shifting risks towards government or more efficiently on consumers, and by output-based subsidization. Symptomatically the pioneering country in electricity market liberalization, the United Kingdom, is implementing a quite radical reform to allow large investments in low carbon technologies and to monitor it by a planning process (DECC, 2011). The challenge in designing these new market arrangements is to combine public and market co-ordinations in order to maintain some incentives, while simultaneously reducing the risks inherent to the market regime sufficiently so as to ease investments. Another issue that is likely to arise from the implementation of these two combined co-ordinations is that the rapid deployment of low carbon technologies they will enable, will induce an erosion of the long term market price signal for investing in the other generation technologies (combined cycle gas turbine (CCGT) and peaking units), which are needed for long term security, flexible back-up of intermittent RES-E and semi base-load supply.

[2] Large sized LCTs include off-shore wind, new nuclear, carbon capture and sequestration (CCS) and concentration solar power (CSP).

We first present the different market failures that impede the investment in low carbon technologies. Then in the following sections, we analyze two types of policy responses. The first one consists in decentralised approaches either by guaranteeing prices over the long term or by imposing a clean energy obligation on retailers. The second consists in strong public co-ordination for planning and risk management through long term contracting. Finally we conclude to the progressive shift from the market paradigm to a hybrid regime in which public planning has the central role and market co-ordination is progressively demoted, receiving only the modest role of ensuring the co-ordination of market players.

2. Market failures and investment in low carbon investment

The electricity market has two co-ordination functions. The first one, which concerns the short term, is to ensure the efficient operation of the set of competitors' equipment. The second is to indicate scarcity through a price signal to orient investors' decisions in the long term. In textbook electricity market theory, there is total consistency between short and long term market co-ordination in a perfect informational environment. The optimal technology mix that results from market players' investment decisions is identical to utility planners' optimum in the former regulated utility regime.

Because of the non-storability of electricity, the wholesale market is a (semi-)hourly market, and the clearing price is set every hour by the marginal bid that satisfies the load demand. Generators offer energy for each hourly market at a price sufficient to recover their running costs (the sum of fuel and carbon costs), but with no profit margin so as to increase their chances of being dispatched. This marginal bid price is paid to all dispatched generators, whatever their individual offers under this price. So each dispatched generator with lower running costs than the hourly price receives extra-revenue above his short term costs, called the "infra-marginal rent". The theory says that, under this marginal pricing model, the sum of these hourly rents will cover the fixed costs of each new plant whatever the cost strture of its technology.[3] Peaking units however constitute a special case. When the physical

[3] Given the non-storability of electricity, it is efficient to use a set of different technologies with a specialization of low capital intensive ones for the peak load, and the capital intensive ones for the base load.

equilibrium of the system is tight, all the generators could, by an implicit entente, bid at a price very much higher than the marginal cost of their last peaking units (for instance 1500 €/MWh when the running costs of the last dispatched unit is 120€/MWh). They should, indeed, bid in this way because they need such a scarcity rent in order to preserve a chance of recovering the fixed costs of peaking units.[4] Regarding low carbon capacity development, marginal pricing will account for the carbon price because fossil fuel units are always the marginal generator. With a carbon price, electricity producers that have low emissions will thus achieve higher infra-marginal rents than in the counterfactual scenario without carbon policy. This should signal to electricity producers to prefer investment in low carbon technologies rather than in CO_2 emitting technologies to complement their portfolio of equipment. However, the risks attached to the fixed cost recovery of new generation equipment vary considerably depending on the capital intensity of the different technologies. Risk management can thus supersede the cost minimization criteria in investment choices, at the detriment of investment in large upfront cost technologies, and in particular low carbon ones.

- **Market failure for capital intensive investments**

The low carbon technologies being very capital intensive, market failures may preclude their development. They present cost structures and risk profiles which differ totally from those of their fossil fuel alternatives. Whatever climate policies in electricity markets, gas technology (CCGT) is systematically preferred by investors over capital intensive technologies, despite higher levelised cost expectations. Indeed, low carbon technologies' investment costs represent more than 65% of their levelised cost (respectively 75.6% for nuclear, 66.8% for coal with CCS, and 83.5% for wind power) with a 10% capital cost[5], in sharp contrast with around 17% for CCGT and 40% for coal generation (see Table 1). The situation is the same for decentralised RES-E.

[4] It is noteworthy that the scarcity rent during extreme peak benefit to every equipment and is on the top of the infra-marginal rents for the other equipment.

[5] In market regime the weighted average capital cost is close to 10%, while in the regulated utility regime it is close to 5%, that increases the levelised cost of a nuclear or CCS equipment by 30% around.

***Table 1: Comparison of generation cost structures** (with a 10% capital cost)*

	Nuclear	Coal	Coal with CCS	CCGT	Wind power	Solar PV
Investment* ($ per kW)	4100	2133	3840	1070	2350-onshore (4000-offshore)	6000
Size of the units	1.500MW	700 MW	700 MW	400 MW	20MW onshore	2 MW
Levelised costs ($/MWh)	98.75	80.05	89.95	92.11**	137,1 (220.0)	618.55
Investment cost %	75.6 %	39.8%	66.8%	17.3%	83.5%	94.9%
O&M %	14.9%	7.5%	15.1%	4.9%	16.5%	4.0%
Fuel costs %	9.5 %	22.8%	14.5%	66.4%	0%	0%
CO_2 cost *** %	0 %	29.9%	3.6%	11.4%	0%	0%

*Overnight cost. ** Hypothesis on gas price : $7.8/MMbtu . *** Hypothesis on CO_2 price: 30/tCO2

Source: NEA/IEA, 2010. *Projected cost of electricity generation.* Tables 5.2, 6.1. & 6.2.

This has an important consequence for investing in RES-E and LCTs in this market environment. Indeed, their cost recovery will depend upon the market price which in annual average, will never be aligned on their cost-price per MWh. They will operate as baseload, ahead of coal generation and CCGT, because they are cheaper to run in terms of variable costs. But the considerable gap between their variable cost and their average cost is full of risk for the recovery of their fixed costs. Even if they can run as much as possible, there is an intrinsic risk that periods of low prices happen, with as a consequence a net revenue which will be lower than the level they need for their fixed cost recovery and their debt payment. It contrasts with CCGTs which not only benefit from low need of capital per kW, but also from a cost structure which allows it to be self-hedged. Indeed in most of the electricity markets, it is a CCGT unit which is the marginal dispatched unit during most of the year. So CCGT running costs i.e. their fuel and carbon costs, are narrowly correlated with electricity prices. The conclusion is surprising: Because hourly electricity prices are highly correlated with fuel and carbon prices, investment risks in fossil fuel generation are much lower than those in

LCTs and RES-E. Consequently carbon price is ineffective to orient investors towards low-carbon high fixed-cost technologies.

- **Other market failures for low carbon technologies**

This market failure amplifies the effects of other market failures and regulatory imperfections which also create barriers for every low carbon power technology. First, the uncertainty that concerns the carbon price's future trajectory, and which reflects huge uncertainty on long term climate policy, suppresses the incentive that carbon pricing intended to create to invest in these technologies (Blyth et al., 2007). Second, the benefits derived from cumulative learning of new low carbon technologies are not captured by the investors, while the social benefits would balance the cost of learning investment (Jaffe, Newell and Stavins, 2005). Third, the characteristics of large-sized technology and the complexity of their systems (off-shore windpower, new nuclear, CCS, CSP) magnify learning costs and risks, the chain of innovations being too long, too complex and diverse. Moreover these larger investment risks, inherent to learning investment, are magnified by important regulatory (licensing, planning, change of safety rules) and political risks exist, with implications for costs, financing conditions and earnings. (Grubb et al., 2006; Finon et Roques, 2008; Finon, 2011).

- **Increasing "missing money" to invest in peaking units**

Peaking units which are needed for long term reliability are very capital intensive because their fixed cost could only be recovered from scarcity rents resulting in short term price spikes during very short periods of extreme peaks. But the revenues generated by most price spikes are random and not sufficient to cover these fixed costs for two main reasons: first the out-of-market interventions of the system operator in these situations(for instance by preventively calling reserves), which depresses the market price, and second the price cap decided by regulators in order to maintain reforms acceptation. The two factors limit scarcity rents during peak and extreme peak periods which deter investment in peaking units and have a negative impact on generation adequacy. This is the so-called "missing money" problem (Cramton and Stoft, 2007; Joskow 2008). This issue will be amplified by the development of low carbon equipment because, as they have low variable costs, their hourly productions displace the merit order curve at the detriment of peaking units and gas CCGTs. This reduces scarcity rents on the hourly markets during peak periods which are crucial for the former ones, as well as the number of running hours with infra-marginal rents for the latter ones. In order to solve this "missing money" problem, some regulators adapt the market design by adding a capacity mechanism which distributes a complement of stable revenue to each equipment as a function of their reliability during peaks. RES-E and LCT deployments will increase the need for such a mechanism. To conclude, new market arrangements are needed to de-risk RES-E and LCT investments by shifting the risk towards consumers and government[6] and, for some of them, by long term subsidization of their learning costs. This implies the definition of explicit and consistent roles for the government and credible commitments to interest investors (Helm, 2010 ; Helm and Hepburn, 2008). To ensure this credibility, arrangements which rely on the consumers to subsidize costs and assume major part of the risks should be preferred to those which are based on public budget support (investment subsidy, tax credit on production, loan guarantees) and are thus exposed to policy U-turn risks.

3. Technology-specific policies to replace long-term market co-ordination

The development of RES-E and low carbon equipment should be efficiently promoted by technology-focused policies combining long term market arrangements and specific public governance to manage them. In order to achieve this, alternative policy routes can be followed. The first one aims to stimulate decentralised decisions. This can be done along the two conventional principles of public policies: price incentives with guaranteed revenues by an output-based subsidy for investors, or alternatively, quantitative incentives associated to an obligation borne by competing suppliers/retailers to increase the share of clean electricity in their wholesale sourcing by contracting with new low carbon entrants. However, in order to effectively reach objectives while controlling rent, a third policy route which is based on strong public governance is increasingly contemplated. It consists in monitoring RES-E and

[6] A loan guarantee on 80 % of investment cost of a nuclear plant or a CCS plant helps to reduce the levelised cost by around 30% by decreasing the weighted average capital cost by 3% (MIT, 2009).

LCTs deployment by regular auctioning for long term fixed-price contracts with LCT investors.

- **Pulling low carbon technologies development by feed-in tariffs (FIT)**

In Germany the ambitious decarbonisation policy is solely based on these FIT arrangements. The aim is to increase decentralised and centralized RES-E's share in electricity generation from 20% in 2012, 40% in 2020 and 66% in 2030[8]. This system is presently used in the majority of the European countries for the RES-E promotion because of its effectiveness. The FIT mechanism is a long term public commitment which combines an obligation for the historical supplier in a given region to purchase RES electricity and the definition of a fixed price per generating technology on a 15 to 20 years term. Regulated FITs are technology specific and aligned on anticipated levelised costs[9]; after "trial and error" learning, they evolve in relation to supposed learning factors. The mandated buyers cover their costs by the revenue of a levy on every MWh transported by the grid. In these FIT systems, public governance consists in monitoring the quantitative development of RES-E and LCT by defining the FITs by aligning them on anticipated cost-price for each technology and by regularly tuning their level along the revision rules promulgated by law. Indeed the regulator might decide to decrease the FIT for one technology on any new installations in order to slow its development down when the FIT is too high and developers' rent inadequately important.

- **Clean energy obligation on suppliers' sourcing**

This system has been implemented for the development of RES-E in some European countries (Great Britain, Italy, Sweden, Belgium), Australian states and US jurisdictions where it is called Renewable Portfolio Standards (RPS). It is currently in the process of being

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[8] In this issue Stephan Lechtenböhmer analyzes in detail the German institutional model for the decarbonisation of the electricity system. It combines FITs, reformed balancing mechanisms related to intermittent production development, demand response and electricity saving measures. Offshore wind power will develop with generous FIT arrangements, while in other countries (Germany, France, the Netherlands etc.), long term contracting after tendering will be preferred.

[9] These regulated-based arrangements are generally applied to decentralised RES-E, but they could be extended to large-sized low carbon technologies like off-shore wind in Germany. In the policy called "Energy Concept" voted in 2010 in which the offshore wind target by 2030 is 25 GW, this technology will be financially supported by a high FIT tariff and a €5 billion special credit plan from the redevelopment agency financed by the revenue of carbon permit auctioning.

extended into a "clean energy obligation" by including some other low carbon technologies.[10] Market shares of RES-E and LCT generation might be rapidly increased through this mechanism up to 50-60% in 2030, provided that this increase is correctly calibrated in relation to learning constraints and industrial capacities.[11] The obligation is set in relation to the supplier's market share, which avoids distortion in the retail competition. By changing the supplier's license, the regulator establishes a mandate to contract for a specific share of low carbon electricity, with a progressive increase of the obligation. A complementary market for clean energy certificates enables certificate exchanges between developers and suppliers, and between suppliers which are short with those which are long. Enforcement of the obligation is complemented by a penalty which acts as a price cap. In some countries where the government wants to limit obligation costs for the suppliers and the consumers, the penalty is only defined at a modest level and has a function of buy-out price. Suppliers are supposed to hedge their certificates' acquisition on a long term basis either by signing long term contracts at fixed price with new developers (as it is the case in Texas) or by self dealing with their RES subsidiary or their own low carbon equipment, in particular when they are vertically integrated . Two last options exist: to buy on the spot market, and to pay the buy-out price, but they are viewed as adjustments options (Finon and Perez, 2007; Mitchell et al, 2007).

- **Central auctioning of long term energy contracts with LCT entrants**

When in a country, large-sized LCTs deployment is viewed as a major means to decarbonise the electric system, centralized approaches that encompass auctioning and long term contracting should be preferred for reasons of effectiveness. However, decentralised RES-E units could still benefit from FITs because FIT arrangements present much lower transaction costs than tendered contracts. The British government followed this route in its 2011 Electricity Market Reform that can be referred to as a benchmark (DECC, 2010 and 2011).[12] Its target is to reach a 30% share of electricity production by RES-E in 2020, and a 75% share

[10] In the RPS of some jurisdictions in the USA, advanced nuclear and CCS are considered as eligible resources in the standard.

[11] It is noteworthy that in Californian RPS, the RES target which increases from 20% in 2010 to 33% in 2020 (CPUC, 2010) should be consistently prolonged to 50-55% in 2030.

[12] The Electricity Market Reform includes also complementary measures which overlap the incentives provided bylong term fixed price contracts: a carbon price floor (going up from 20£/tCO2 in 2015 to 70£/tCO2), and a decreasing carbon standard on new coal plants to incite to rapidly adopt CCS. This is explained by the governmental firmness in the decarbonisation policy.

by all the low carbon generators in 2030. In this type of centralized policies, scheduled tenders for long term energy contracts on key LCT options (off-shore wind, new nuclear, CCS, large biomass plants, etc.) will be organized in a timely way in order to provide time for building large units. These contracts could be designed so as to keep incentives to operate efficiently (see below). Public co-ordination has two aspects. First ministry defines the capacity to be tendered and the timing of the scheduled tenders. Second an independent delivery agency should be installed to auction, design and settle the contracts for each new vintage of plants. This agency plays the "central buyer" role. In the UK, the government chooses the transmission system operator for these functions.In conclusion governments could choose between different combinations of public governance and long term arrangements to organise the deployment of low carbon generators in electricity markets up to a 60-70% share by 2030. The choice of the institutional arrangement that is retained in the end depends on political beliefs (the environmental priority, the market culture), existing low carbon equipment (hydro and nuclear plants) and is subject to path dependencies with respect to RES-E policy. However, whatever the choice, an increasing share of generators' entries will result from public co-ordination and no more from long term market co-ordination.

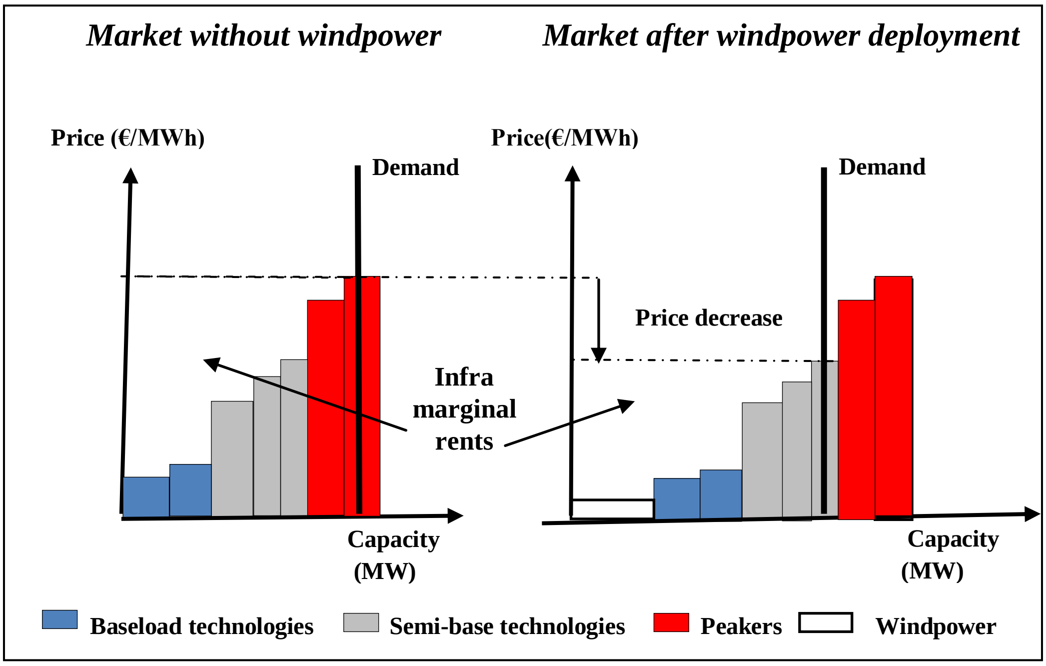
4. The reduction of the role of electricity market co-ordination

Short term market co-ordination can be preserved and incentives maintained for LCT and fossil fuel equipment operational efficiency by obliging the low carbon generators to sell their production on the electricity markets, while they benefit from the hedge offered by the long term arrangements or they get a supplement of revenues on the top of electricity price from the latter. But, as said, an increasing share of generation investment will escape to long term energy market co-ordination, but not only low carbon investment targeted by the policies. Investments in the fossil fuel plants which will still be needed for peaking production and semi-base load will also be affected by market failures. The consequence is that investment in these other fossil equipment should need to be supported. At the end, the objectives of decarbonisation and long term supply reliability should progressively converge and should be pursued by the use of the same market mechanism.

- **Gradual erosion of the market's predominance for long term co-ordination**

Investment in each generation technology will become increasingly exposed to fixed cost recovery difficulties and to risks entailed by RES-E and LCT's large-scale deployment which is favored by new risk-sharing arrangements. Fossil fuel plants will be displaced in the hourly market dispatch merit order because these productions have low variable costs (figure 1). Average annual price will decrease. New equipment's fixed cost recovery will be affected by the lower and random infra-marginal rents anticipated at the moment of decision[13]. This has three institutional effects in the long term.

Figure 1: Reduction of hourly infra-marginal rents after windpower deployment



First, while in terms of levelised costs, the semi-base load technologies (CCGT) remain competitive for this semi-base load production and are needed for the back-up of variable RES generation, given their flexibility, the deployment of especially intermittent RES-E undermines the case for investing in them. Besides the decrease of average annual price, there are indeed two other reasons: the decrease of running hours that they will experiment, and moreover the uncertainty on them. As long as the share of low carbon

[13] This situation is already observed on the Spanish and German markets. Indeed, because of their important windpower capacities, episodes of prices equal to zero or even negative have alerted the electricity community to new risks of investing in any technology, and in particular in the CCGT (Eurelectric, 2011).

generation increases, investors in the semi-base load plants will experience increasing revenues' uncertainty, making fixed cost recovery more risky, even if they still benefit from self-hedging property (see above).

Second, the large-scale deployment of intermittent production will increase the need for reserve margins. In parallel it will erode, even suppress scarcity rents during extreme peak and heighten price volatility during peak period, which both increase the "missing money" problem for investing in peaking units, because of the larger risk premium in their capital return. So in countries where a capacity mechanism has not yet been implemented as in the European countries, these two evolutions (semi base-load plants and need of larger reserve margin) will create the necessity of a market-wide mechanism in order to provide an additional and stable revenue stream to incentivize investment in reliable capacities, and not only in peaking units, but in every technology.[14]

Third, introducing policies for promoting RES-E and LCTs through these new risk-sharing arrangements might probably lead to a policy lock-in. Indeed, if these policies were removed even LCT technologies which will be commercially mature (i.e. hence having competitive levelised costs after learning) would be a risky investment and would become financially unviable. The reason is simple: the major share of LCT and RES-E equipment with low running costs in the electricity systems, which induces a low marginal price during longer and longer periods. This is a structural fact which has to be underlined.

- **The convergence of carbon policy and capacity adequacy policy**

A more comprehensive approach based on a strong public governance has been proposed to deal with both objectives of decarbonisation and capacity adequacy through the same policy instrument which would be a market-wide capacity forward auctioning (Helm, 2010; Gottstein and Schwarz, 2010; Boot and van Bree, 2010). The capacity auction starts by fixing the quantity of new capacity required and invites bids from investors to provide blocks of incremental capacity. The bid is for a long term contract to supply reliable capacity (to be available during peak), and the counterparty is the TSO. Each provider of capacity in any

[14] In Europe it is the increased share of windpower production which presently is incentivizing the implementation of capacity mechanisms.

technology will receive an "availability" payment for capacity through their revenues from forward capacity contracts, while they receive payment for the electricity they produce through the electricity market for their running costs. So the market keeps its role of short term operational co-ordination.

The difference with the former RES and low carbon arrangements presented above is that it deals with capacity and not with energy. And the difference with the current capacity market mechanisms (which only addresses long term supply security) will be the long time span of forward capacity contracts to guarantee revenue stream on a long period for all new capacities; this is a necessity for low carbon equipment which are capital intensive. A number of studies have been conducted on various aspects of this concept. The British regulator evaluated the possibility to differentiate contracts as a function of the characteristics of the technologies in its Discovery Project on the new market arrangements before the reform (OFGEM, 2010). Helm investigated the best-suited design of the auction to reveal information on the different technologies regarding costs and lead-time of projects (Helm, 2010). Finally Gottstein and Schwarz (2010) looked into the possibility to discriminate between carbon intensive and low carbon technologies. Nevertheless recent experiences of capacity market mechanisms in the USA (in the PJM market and the New England one) show that climate-friendly options such as decentralised generation (in particular cogeneration), demand response programs and energy efficiency contracts, can be introduced in the set of eligible resources to bid in capacity market tendering.

5. Conclusion

Whatever the new arrangements adopted by governments, public co-ordination should increasingly replace the market for pursuing long term decarbonisation objectives. In all these technology-focused policies, the much broader role of the regulator includes: determining quantity of various generation equipment, guaranteeing the contracts with LCT and RES-E entrants, and even defining the prices for these productions in some regulatory options. Low carbon investments can thus be "de-risked" and learning costs subsidized, by shifting risks and overcosts towards consumers via a levy. This marks a significant shift from the market paradigm, where investments are decided by decentralised agents on the basis of market price expectations, and investment risks borne by them.

Moreover these new arrangements not only put the major share of new electricity generation outside the long term price signal given by the market, but this expansion also changes the market's functions for the investment decisions in fossil fuel generation units. Because of the progressive extension of the "missing money" problem to all of them, centralized co-ordination would have to cover the whole range of technologies and new capacities, in particular under the form of a forward capacity auctioning. These changes in the market regime should be rapidly recognized as such by governments, regulators and experts in countries who have liberalized their electricity sector, and by international organizations such as the IEA and the European Commission, which have been fervent promoters of the electricity market regime[15]. The case is particularly crucial in the European Union where, despite the priority of carbon policy objectives, this inevitable change in market regime is not fully recognized, without any perspective of radical modifications in the electricity market Directives and Competition Policy principles, while these changes would ease the needed decarbonisation investments in electricity markets. But it is another story.

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[15] In the IEA, Christina Hood from the Climate Change Unit raises this issue in a short but incisive paper in the annual report *Climate and Energy 2011 (*Hood , 2011)

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