Achieving energy saving in the public sector through "Energy Performance Contracts": Is it the right tool?

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Abstract

In this paper, we examine the use of Energy Performance Contracting (EPC) as a mean to implement energy conservation measures in public buildings and to achieve energy efficiency. The use of EPC for energy conservation projects is promoted by the legislator, while public entities may also appeal to other alternative tools for such projects. Hence, it is essential to understand the specificity and the limits of EPC. To this end, we review recent developments in the economic literature on the theory of contracts, with a particular focus on incentive properties of contracts that rely on performance measures. This review of the literature allows us to identify some pitfalls associated with EPC, and enable us to understand the conditions under which EPC may be an effective means to implement energy conservation in public buildings. We discuss the strengths and weaknesses of EPC along three important dimensions: the incentive properties of a contract, the potential difficulties in measuring and in contracting on performance, and the long term dimensions of such contracts. Drawing on our literature review, we argue that once transaction costs are accounted for, EPC may be particularly adapted for simple and standard energy conservation projects. Indeed, successful implementation of energy conservation projects through EPC may involve important *ex post* monitoring and control on an energy services company (ESCO), leading to potentially high overall costs when projects are complex.

Introduction

Compared with existing energy contracting used to procure energy services, Energy Performance Contracting (EPC) add a new incentive mechanism: the performance guarantee. For instance, in France, energy services for public buildings can be procured through various "traditional" public procurements, dealing with various aspects of energy services. Such contractual arrangements may involve energy supply contracts ("*contrats d'approvisionnement*" or "*contrats de fourniture d'énergie*", which can then depend on whether a public authority procures primary energy sources e.g. fuel, or the end energy product such as heat), and various exploitation contracts ("*contrats d'exploitation*").[1, 2]

EPCs are lately seen as a major policy tool towards improving efficiency of energy use. In the European Union, a legal framework for such contracts has been adopted in 2006 (Directive 2006/32/EC), with the hope that this would encourage public authorities to take initiatives towards enhancing energy efficiency of public buildings. It is also hoped that such contractual tools would deliver innovative solutions with respect to energy efficiency measures by promoting a real partnership between the public and the private sector. Indeed EPC is considered as a private-public partnership (PPP). EPCs are therefore viewed as one of the policy tools towards realizing the goals of the EU Climate Change and Energy objectives

1. Various forms of exploitation contracts are: *marché de prestation forfaitaire PF* or *PFI*, *marché à forfait MF* ou *MFI*, *marché corrigé en température MT* ou *MTI*, *marché au comptage de chaleur MC* or *MCI*, *marché combustible prestation CP* or *CPI*. These combinations result from the combination of various energy posts (P1, P2 and P3) and the characteristics of energy supply contract for P1.

2. In France, it is also possible to use maintenance contracts ("*contrats de maintenance*") to procure energy service, but these contracts are generally used for the maintenance of heating equipments.

in the public building sector, in recognition of the fact that this sector has a huge potential for energy savings (Directive 2010/31/EU).

An EPC, legally defined as "*a contractual arrangement between the beneficiary and the provider (normally an ESCO) of an energy efficiency improvement measure, where investments in that measure are paid for in relation to a contractually agreed level of energy efficiency improvement*" by the EU Directive 2006/32/EC which lays the legal foundation for such contracts in the EU, may distinguish itself from more "traditional" public procurement arrangements in that two ways according to this definition: Firstly, EPCs are "objective oriented", in the sense that a private contractor's revenue under an EPC depends at least partly on energy savings that have been achieved. Furthermore, such contracts allow or compel public authorities to adopt a more global approach towards energy efficiency services, since the use of EPC implies delegating investments decisions to the private contractor. It is hoped that both features would provide adequate incentives to the private operator along two dimensions: firstly, by linking the operator's payment with realized energy savings, the operator may have adequate incentives to provide energy services in an economically efficient way during the exploitation phase of the contract; and secondly, by bundling the investment and the operational phase of the project, it is hoped that EPCs would also provide adequate incentives to the private operator to invest in energy producing equipments that are not only cost effective but also energetically efficient. Hence, it is the strong incentive proprieties of EPCs that makes them attractive policy options to promote energy efficiency in public buildings.

While the idea of using performance measures in contracts as a mean to provide monetary incentives is quite intuitive and appealing, recent developments in the economic literature, which has extensively studied the properties of incentive contracts, have emphasized potential limits and costs associated with such contracts. In particular, it has been shown that incentive contracts in general, and the use of performance measures in these contracts in particular, may be paved with pitfalls and difficulties. For instance, incentive contracts are commonly used to regulate local monopolies in network industries, such as energy, water and transport sectors, to prevent companies exploiting their market power, through higher prices and reduced quality, in the long run. To provide adequate incentives to companies, the regulator must be able to set objectives that are both realizable and sufficiently ambitious. This task requires a reliable measure of actual performances and of realizable performance improvements, which is constrained by informational asymmetries for the regulator. Some regulatory tools, like benchmarking methods, are used to limit these informational asymmetries and measure firms' performances. However, these tools are imperfect and measurement errors may occur, reducing the credibility of the regulation and the power of incentives provided to companies, as it is underlined in the case of Ofwat (the UK regulator of the water sector) for instance.

This raises the issue of whether EPCs, as a class of incentive contracts, may be adapted under all circumstances to meet the expectations of policy makers to achieve cost effectiveness and innovative approaches to implement energy efficiency measures in public buildings. To shed light on this issue, we draw on recent developments in the economic literature on contract theory to examine the efficiency and potential pitfalls of EPCs, while trying to account for specificities of such contracts in what follows. We believe that an in-depth examination of this issue is all the more important as public authorities, at least in France, do not seem to be adopting EPCs for their energy conservation projects despite their attractiveness in theory and their popularity with legislators.[3]

Our discussion will be organized along two important aspects of EPCs, namely the use of performance measures as incentive devices, and the long term nature of such contracts due to the fact private operators have to be given sufficient time to recoup on their investments under such contracts. Before this, we briefly present the basic framework that is widely used in economics to study the issue of incentives, and discuss why such a framework is relevant to study the incentive properties of EPCs.

The provision of incentives in theory and the incentive properties of EPCs

THE BASIC PRINCIPAL-AGENT MODEL

The theory of incentives, also known as the Principal-Agent model or normative agency theory, provides the basic framework in economics to study the provision of incentives through contractual means. To this end, the basic theory examines an agency relationship, where an agent (known as the Principal) hires another agent (referred to as the Agent) to accomplish some tasks on the Principal's behalf that involves the delegation of some decision-making autonomy from the Principal to the Agent. In the case of EPCs, the Principal is the public authority, whereas the ESCO represents the Agent.

The issue of incentive provision arises because of asymmetric information in the agency relationship: the Agent, being the one who performs the tasks, may have superior information compared to the Principal due to his position in the relationship, and therefore, may take advantage of his superior information to the detriment of the Principal. In presence of asymmetric information the Principal should duly motivate the Agent in order to ensure that the Agent would have proper incentives to work in the Principal's best interests.[4] The theory's goal is then to shed light on how this can be optimally done through the use of contracts (Laffont and Martimort, 2002).

Generally, the theory distinguishes two types of asymmetric information to study the optimal contractual form to adequately motivate the Agent in an agency relationship: *ex ante* asymmetric information and *ex post* asymmetric information. *Ex ante* asymmetric information is also known in the literature as adverse selection, and relates to the case where the Agent detains superior information at the moment when he contracts with the Principal. Similarly, *ex post* asymmetric information

3. To date, and to the best of our knowledge, there are only three Public-Private Partnerships type of EPC that have been signed in France according to information from the French maPPP (Mission d'Appui à la Réalisation des Contrats de Partenariat) of the Ministry of Economics and Finance.

4. Asymmetric information between contracting parties poses a serious problem for exchange. As shown by (Akerlof, 1970), asymmetric information may lead to market failure i.e., prevents socially efficient exchanges from taking place. This explains why the topic has received widespread attention in economics for the past few decades.

relates to the case where the Agent's superior information appears only after the signature of a contract with the Principal (i.e., information is imperfect, but symmetric during the process of contracting). This is also referred to in the literature as a moral hazard problem, and arises when the Agent's private information relates to the decisions or actions that can be undertaken in the contractual relationship.

The theory shows that because of asymmetric information between the Principal and the Agent, it is costly for the Principal to motivate the Agent to work towards the Principal's best interest. Hence, in terms of contract design, the Principal should optimal trade off the costs and benefits of incentive provision. In particular, in an adverse selection setting, the Principal will have to give up informational rents to the Agent in order to make the Agent reveal his private information during the contracting process (or induce the Agent to use this information to the best advantage of the Principal). Costly informational rents lead the Principal to sacrifice some allocative efficiency in the contracts proposed to the Agent. On the other hand, in a moral hazard setting, the contract's role will consist in providing incentives to the Agent to take actions in the best interest of the Principal. An implicit assumption in this setting is that asymmetric information prevents the Principal from having a perfect control on the Agent's actions or decisions. The theory shows that adequate incentives may be provided by making the Agent's payment scheme contingent on outcomes that the Principal cares about. This would induce a better alignment between both agent's interests. However, by doing so, the Principal inevitably transfers some risks to the Agent. To the extent that the Agent may be adverse to risk, incentive provision in a moral hazard setting would require that the Principal pay a risk premium to the Agent. Hence, the optimal contract (and therefore, the power of incentives) results from this trade off between a higher risk premium to be paid to the Agent and the benefits of a better alignment in terms of both agent's interest. In both cases, incentives to motivate the Agent to behave in the interest of the Principal can be achieved by making the Agent's payment dependent on the outcome of his tasks: the higher the dependence on the outcome, the greater the power of incentives. In other words, incentives provision may be achieved by making the Agent residual claimant on his profits. However, incentive provision comes at a cost: informational rents and/or risk premium that have to be paid to the Agent.

THE INTEREST OF THE PRINCIPAL-AGENT MODEL FOR EPCS

This basic model, and subsequently theoretical developments in the field, both provide an interesting framework to assess EPCs' efficiency conditions. Indeed, when appealing to EPCs, public authorities are delegating the task of implementing energy efficiency measures and managing energy services to an energy service company (ESCO). By the mere fact of delegation, ESCOs may gain access to information not available to public authorities such as the types and opportunity costs of technologies available, the precise nature of the technologies and the adequacy between various technologies and the problem at hand.[5] Furthermore, under EPCs, ESCOs are also given the discretion to decide how best to achieve energy savings in a particular project i.e., they are able to take actions that could have an impact on the resulting efficiency of energy saving measures. One could therefore see that asymmetric information is likely to plague the relation between a public authority and an ESCO. The rationale behind appealing to an EPC then becomes clear: by making the revenue of an ESCO dependent on the amount of energy effectively saved (contracting on performance outcomes), EPC provides strong incentives to an ESCO to use its private information and to take actions that are closer to the interest of the public authority i.e., cost-effective technologies and actions that allow to save energy use in public buildings.

CONDITIONS FOR EFFICIENT INCENTIVES IN EPCS

Nevertheless, one should note that such incentives come at a cost: informational rents and/or potentially higher risk premium due to a greater proportion of risk supported by the ESCO. We can see from this theoretical framework that EPCs are useful contractual tools to achieve energy efficiency in public buildings if the benefits from higher incentives offset the costs of appealing to such contracts. These considerations suggest that EPCs may be particularly relevant for projects for which *(i)* there are a large scope for innovations and a large palette of choices of technologies can be chosen to realize energy conservation, among which the public authority may lack the require expertise to choose; and *(ii)* energy conservation requires important and recurring management tasks in order to realize the full potential of energy savings. In both cases, information is valuable, and it may be worthwhile for a public authority to provide incentives through a contract to ascertain that the objectives of energy conservation are achieved. EPC, given its strong incentive properties, may be helpful since benefits of duly motivating an ESCO may be sufficiently high.

This basic framework may be extended to understand how and when a global approach to energy conservation in public buildings may be desirable i.e., the issue of bundling the investment phase of a project and its exploitation within a same contract. (Martimort and Pouyet, 2008) and (Iossa and Martimort, 2008) explore this dimension using the moral hazard framework. To study this issue, the authors assume that there are two sequential phases involved in a project: an initial investment phase on the infrastructure, and the subsequent exploitation phase, and consider two potential contractual arrangements: bundle both phases in a global contract or use a separate contract for each phase of the project (i.e., unbundle the two phases of the project). During both phases, actions that have an impact on the investments and the outcome of the exploitation may be undertaken. In particular, they assume that an Agent may take actions to put in place investments of a higher quality, and to efficiently manage the exploitation phase of the project. Furthermore, the quality of the investments may also have an impact on the exploitation phase i.e., there is an externality between the two tasks: investments that are better in terms of quality may lead to a reduction in the cost of exploitation, or it may lead to a higher cost of exploitation. Under this setting, (Iossa and Martimort, 2008) show that bundling is associated with a higher transfer of risk in the contract, and leads to better overall incentive for the Agent in the two tasks associated with the project. In particular, from an Agency theory perspective,

5. This may be a reflexion of ESCOs' higher level of expertises and know-how in terms of energy efficiency technologies.

if the quality of investments leads to a decrease in exploitation costs, the Agent will have a strong incentive to improve on the quality of investments under a bundling approach. In other words, bundling induces the Agent to internalize the externality between the two phases of the project. Therefore, under a bundling approach, more risks will be transferred to the Agent in order to boost incentive.

When high quality investments may lead to higher exploitation costs, the overall efficiency of bundling both tasks when compared to unbundling depends on what is contractually feasible when one appeals to separate contracts for each of the tasks. More specifically, (Pouyet and Martimort, 2008) show that separate contracts may outperform a global contract when performance measures for the quality of investments are available. To the extent that higher quality investments are socially desirable, the Principal can then appeal to such measures to boost the quality of investments. The unbundling approach therefore avoids introducing conflicting incentives to the Agent, which would be the case under a global contractual approach, and enables to obtain higher quality investments during the first phase of the project. Moreover, given that high quality investments are socially desirable and performance measures are available as contractual tools, unbundling, together with the use of an incentive contract during the investment phase of the project, can allow the Principal to obtain better quality investments when compared to the bundling approach. Unbundling is therefore preferred in this situation. On the other hand, as shown by (Iossa and Martimort, 2008), when quality performance measures are unavailable, both the bundling and unbundling approach would yield the same results in terms of motivating the Agent to put in place high quality investments: under both approaches, a profit-maximizing Agent would refrain from undertaking those high quality investments that could result in higher exploitation costs. In this case, bundling always (weakly) dominates unbundling from an Agency theory perspective.

One can therefore readily see from the above discussion the benefits of a global approach made possible by EPCs: EPCs may lead to a greater overall efficiency for implementing energy conservation in public buildings projects. In particular, when such projects imply some investments in infrastructure and/or innovation, EPCs may create a stronger incentive for ESCOs to take into account the dependency between the investment phase and the exploitation phase of a project. This may be especially valuable in the case where better quality investments can result in higher levels of energy conservation, and therefore, a higher payment for an ESCO. Nevertheless, as the previous discussion also shows, one has to be wary when better quality investments may lead to an increase in exploitation costs. In this case, the efficiency of EPCs would depend on whether it is possible for a public authority to contract on some performance quality indexes for the investments. If no such possibility exists, then EPCs can do no worse than feasible separate contracts for energy conservation projects from a purely Agency perspective. We should note here that quality indexes are often very difficult to find in reality, making EPCs an interesting approach to boost incentives for ESCOs to put in place high quality investments and exploit these investments in a cost-effective way.

As we have seen from the above discussion, the theory of incentive provides a simple framework to understand the channels through which incentives are provided in EPCs, and the costs involved with the provision of such incentives. This has provided us with some theoretical insights on the strengths and limits on EPCs as efficient contractual means to deliver good results in energy conservation projects in public buildings. We should, however, note that this framework, and the results derived thereby, is built on various important simplifying assumptions which may be questionable. The examination of these assumptions, as well as the consequences of relaxing them, may have an impact on our understanding of the effectiveness of EPCs. In particular, in our opinion, two simplifying assumptions in this basic framework may be especially strong for EPCs, namely the issue of performance measures, and the assumption of contractual completeness. In the following, we appeal to recent developments in the literature to derive implications for the efficiency of EPCs.

The issue of performance measure

THE BASIC PROBLEM OF DISTORTED INCENTIVES

An important assumption in the standard theory of incentives lies in the fact that the performance measure used in the contract reflects perfectly the objectives pursued by the Principal, and that such a measure is observable and verifiable (so that the contract is *ex post* enforceable). In this case, the Principal can write a contract using this performance measure to make the Agent's payment dependent on this measure. This in turn creates a link between the Agent's payoff and the Principal's objectives, and therefore attenuates any divergence of interest between the Principal and the Agent. In other words, by using such a performance measure in a contract, the Principal provides incentives to the Agent to undertake actions and/or make decisions in the best interest of the Principal, to a certain extent.

However, it should be recognized that such contractible performance measures that could perfectly reflect the Principal's interests are hard to find in reality. Performance measures used in incentive contracts often only partially reflects what the Principal sought to achieve in delegating a task to an Agent. In such a case, contracting on a measurable and quantifiable performance measure would understandably lead the Agent to work towards increasing on the performance measure that has been contracted on, instead of working towards what the Principal actually desires to achieve. Appealing to incentive contracts in this situation will in some cases create distorted incentives. Such phenomena are quite widespread in organisational studies, as documented by (Kerr, 1975). (Baker, Gibbons and Murphy, 1994) provide a nice illustration of a case where the reliance on an imperfect performance measure led to undesirable effects for the Principal:

> In 1992, Sears abolished the commission plan in its auto-repair shops, which paid mechanics based on profits from repairs authorized by customers. Mechanics misled customers into authorizing unnecessary repairs, leading California officials to close Sears' auto-repair business statewide. (Baker et al. 1994, p. 1125)

The dysfunctional consequences in the above example is due to the fact that the Principal actually cares about long term profit, while at the same time uses short term profits as a performance measure to provide incentives to the Agent.[6] The latter is actually an imperfect measure of the Principal's objective, and the incentive contract used by Principal induces the Agent to take actions to increase his own payoff (by getting customers to agree to unnecessary repairs in order to increase the contracted on performance measure), at the expense of the Principal's interest (loss of reputation and its consequences on the profits for the Principal in this case). More generally, the main problem that this example illustrates is the "*distortion of incentives that resulted when firms 'rewarded for A while hoping for B'*" (Baker 2000, p. 415).[7]

The problem of distorted incentives was first studied by (Holmström and Milgrom, 1991), and subsequently by (Baker, 1992; 2000; 2002). According to these authors, the issue of distorted incentives arises because of either inaccuracy in the performance measure (Holmström and Milgrom 1991), or because the Principal is unable to contract on what he really cares about (Baker, 1992). This strand of literature generally relies on a multitask model in order to examine the issue of distorted incentives (Holmström and Milgrom 1991, Baker 2000, Baker 2002, Gibbons 2005 etc.), where an Agent may undertake two different actions that contribute differently to the objective sought after by a Principal, and an imperfect but contractible performance measure. To illustrate the model used to study this issue, one may mobilize the example above and argue that there may be two ways for a mechanics to earn a higher compensation: by working harder and identify those repairs that are really necessary, or by convincing customers to authorize unnecessary repairs. The former action is one that is valued by the Principal, and while the latter allows the Agent to increase the performance measure more easily. By making the Agent's payoff depend on the imperfect performance measure, the incentive contract used in the above example induces the Agent to undertake the latter type of actions, instead of the former one.

THE ROLE OF PERFORMANCE MEASURE IN INCENTIVE ALIGNMENT

More generally, this strand of literature seeks to understand to what extent the performance measure should be used in a contract as a means to provide incentives to an Agent (i.e., the power of incentives). The literature shows that two types of considerations should be taken into account in this respect: a scaling effect and an alignment effect. The scaling effect captures the relative "size" of the contribution of the Agent's actions to the Principal's objective function with respect to performance measure used in the contract. To understand this, assume that the Agent's actions can greatly increase the performance measure used, but do not increase a lot the Principal's objectives. In this case, the Principal should not reward the Agent too strongly based on the performance measure (i.e., use a low power incentive contract), all else equals. Indeed, a high incentive contract in this case would simply increase the Agent's payment (hence the cost for the Principal), but will have a relatively weak benefit for the Principal. Similarly, the alignment effect captures the idea of how distorted the contractible performance measure will be with respect to the Principal's objective. In particular, if these two variables are perfectly aligned i.e., an increase in the performance measure coincides with an increase in the Principal's objective function, then the reliance on the performance measures will only depend on the scale effect mentioned above. If, on the other hand, the two variables are orthogonal i.e., an increase in the performance measure does not have any effect on the Principal's objective function and vice versa, then the Principal should not appeal to performance measures as a means to incentivize the Agent. Indeed, in this case, reliance on the performance measure will not induce the Agent to take those actions that actually contribute to the Principal's wellbeing at all. Hence, for a given scaling effect, the power of incentives (and the reliance on the performance measures to induce desirable actions) should be higher the more aligned the performance measure used is with the Principal's objective function.[8]

In particular, the discussion above also provides an idea of what could be a "good" performance measure to be used as a basis for incentivizing the agent: a good performance measure is one that induces the Agent to undertake actions that contribute to the Principal's wellbeing. As stressed by (Gibbons, 2005), it is actually not sufficient that a performance measure is correlated with the Principal's objective. When reflecting on the use of a performance measure, it is actually more important (and worthwhile) to reflect on the nature of this correlation. A performance measure is useful if it is correlated with the Principal's objective function because it induces the desired actions by an Agent. Conversely, if a performance measure is strongly correlated with the Principal's objective function, but that correlation arises from other aspects than actions that the Principal cares about (e.g. because of economic and/or business cycles), then it is not particularly interesting to rely on that particular performance measure to incentivize the Agent.

A strong reliance on an imperfect performance measure may not only create an incentive for the Agent to game the measure, but also divert the Agent's effort from productive actions. This may especially be relevant for those actions that are not sufficiently captured by the performance measure used. A strong reliance on performance measures may therefore channel the Agent's effort away from such actions, even if these actions may also be important to deliver the outcome that the Principal seeks. Quality dimensions of a provided service may be particularly relevant in this respect, especially if these dimensions are not easily contracted upon and/or reflected in the performance measure used. To avoid these undesirable effects, the contract

6. In this case, it may hard for the Principal to contract on long term profits, as such measures may not be readily available or easily verifiable.

7. Note, however, that not all incentive contracts that rely on imperfect performance measures will led to dysfunctional consequences. An example where the use of incentive contracts that deliver the desired outcomes for the Principal may be found in (Lazear, 2000).

8. Of interest to our discussion is the observation made by (Baker, 2002), who pointed out the empirical studies on incentive contracts do not provide support for the predictions of the basic agency theory framework as discussed in the previous section in worker compensation schemes. (Prendergast, 1999) surveys the empirical literature on this issue. Furthermore, (Baker, 2002) stresses that the central issue in incentive contracting stems from incentive distortion, but not the underlying trade-off between risks and performance as highlighted in the classical Agency framework.

specifications and *ex post* monitoring may be particular important and should be considered with care.

PERFORMANCE MEASURE AND CONTRACTUAL DESIGN

More generally, as argued as early as 1976 by Goldberg and Williamson (Goldberg 1976; Williamson 1976), contract design and enforcement issues are essential if one intends to benefit from strong incentives of commercial contracts. Appealing to such contracts will generate transaction costs that will have to be supported by contracting parties. A general (and important) lesson from the economic literature in this respect is the idea that one should account for transaction costs in choice of contractual arrangement. A more recent study, undertaken by (Levin and Tadelis, 2010), explicitly take this consideration into account by investigating the choice between contracting on performance versus contracting on means. As they argue, contracting on performance will allow the Principal to benefit from strong incentive properties, but resources should be devoted to the initial contract design and subsequently to monitor compliance with the initial contract. These transaction costs could be more important for projects that are more complex. Indeed, both contract specification and *ex post* monitoring would be all the more necessary to ensure a sound relationship between the Principal and the Agent under a contract based on performance for complex projects. Such extra costs may not be worthwhile in very complex projects, as the benefits from strong incentives may be insufficient to justify the amount of such costs. They also provide some empirical evidences of their theory in the way by which US local governments organize various local public services. This suggests that contracting on performance is likely to be more efficient on the overall (after accounting for transaction costs) for projects that are simple and fairly standard. In this case, *ex ante* contractual costs, as well as *ex post* monitoring costs should be lower than for fairly complex projects.

We believe that these aspects of contracting on performance measures are particularly relevant when considering the use of EPCs. Indeed, incentives in EPCs are provided through the fact that ESCOs are paid by realized energy savings. An important aspect of EPCs is therefore the reliance on such contracts on a performance measure, here energy savings. How efficient an EPC can be in achieving energy conservation depends on how energy savings are measured and contracted on in an EPC, and how this measure relates to the objective function of the public authority. The answer to this question will also depend on the extent to which an EPC can be discouraged from gaming the performance measure, and to what extent important dimensions (e.g. quality) can be contracted and enforced by a public authority to avoid an ESCO from focusing too much effort on the contracted performance aspects to the detriment of non-contracted aspects. This relates to the issue of contractual specification and monitoring as we have suggested above. Consequently, we will examine how performances are being contracted under an EPC to shed light on these issues.

CONTRACTING PERFORMANCES IN EPCS

We should first note that energy savings cannot be directly measured (CEATI, 2008). (ADEME-CSTB-EcoCampus, 2010) and the EU Directive 2006/32/EC provide a basis on which energy savings can be defined and contracted on in an EPC. In particular, energy savings are legally defined to be the difference between "*consumption before and after implementation of one or more energy efficiency improvement measures, whilst ensuring normalisation for external conditions that affect energy consumption*" (EU Directive 2006/32/EC, article 3(d)). Hence, when defining the energy saving measures used in an EPC, a public authority has to first proceed to an energy audit in order to assess the energy consumption of (a) building(s) within a project before an EPC is launched. This consumption level is then used to define a reference baseline scenario, where the public authority takes into account various exogenous factors beyond the control of an ESCO but which could have an impact on energy consumption such as climate conditions, changes on the use of building spaces, changes in the amount of time where building spaces are effectively used etc. (ADEME-CSTB-EcoCampus, 2010, pg. 26). The performance measure finally obtained reflects the difference between energy effectively consumed under an EPC and the volume of energy defined by the reference baseline scenario, and can therefore be attributed to the efforts undertaken by an ESCO to improve on energy efficiency. In particular, if the energy saved is lower than a certain contracted threshold, then the ESCO is penalized under an EPC.

A first difficulty to overcome in contracting for the performance measure is the definition of a baseline scenario and various adjustments that could have an impact on energy savings. Obviously, these adjustments are included in the energy saving measure used in a contract in order to preserve the comfort of uses, so that an ESCO will not have incentives to save energy at the expense of users' comfort and/or the end usage of public space. This again shows the importance of accounting for distorted incentives when using performance measures as a means of providing strong incentives towards particular goals. Therefore, a first step towards an effective EPC is to reflect on the performance measure that serves as the basis for incentive provision.

In particular, the factors leading to adjustments must be large enough to account for various potential future uses of (a) public building(s), and clearly formulated in a contract. While some of these factors may be easily formulated and anticipated (e.g. climate conditions, where objective, quantifiable and publicly observable measures can be found[9]), other factors on the use of public building spaces may be harder to translate into objective, quantifiable and verifiable measures to be included in the formulation of an adjustment mechanism. As a simple illustration of the latter situation, one may think that the affluence of users in public space, the hours of lighting and heating, the type of activities carried out in these spaces etc. may strongly vary in time (especially when contract is meant to last for a long period of time), and can have a strong influence on effective energy consumption. Two issues can turn up when one tries to quantify these factors so that some adjustments may be made: firstly, it may be difficult to find proxies that capture adequately the underlying factor to be adjusted; and secondly, the used measures may not be easily verifiable. Public information may not be easily available and accessible that allows third party to

9. Even so, there may be different measures available to account for climate conditions e.g. temperature as measured by a simple thermometer and felt temperature. A choice between these different available measures will have to be made.

enforce a contract (in our example, a judge may be unable to know whether different information provided by different parties may be sufficiently reliable). In both cases, conflicts may arise when one has to determine the performance achieved in an EPC, giving rise to bargaining costs borne by contracting parties.

ADJUSTMENT MECHANISMS IN EPCS

Notwithstanding the issue of measuring exogenous factors that has to be accounted for to calculate the final energy saving performance measure used in a contract, parties also have to determine how these exogenous factors should be adjusted to yield the final performance measure. This adjustment mechanism could be a sensitive issue in EPCs, since they play an important role not only in determining an ESCO's payoff under a contract, but will also influence on whether a public authority has effectively achieved the goals of energy conservation through the contract. Indeed, a too important weight used to adjust for the various factors may result in a too high energy saving measured by the index used with respect to what has been effectively saved in terms of energy conservation. In this case, the performance measure used may not provide adequate incentives to an ESCO to implement effective energy conservation measures under an EPC, and/or not be cost-effective from the public authority's viewpoint. Moreover, such measures may not truly reflect energy savings for the public authority, and therefore do not allow the public authority to achieve the goals of energy conservation.[10] On the contrary, a too low weight used to adjust for these factors may result in shifting too many risks of exogenous factors on energy consumption to the ESCO. Obviously, this would imply paying a higher risk premium to the ESCO, and may even lead to *ex post* renegotiation of the contract if the performance measure is unable to ensure a fair compensation for the ESCO. Lastly, how these weights are contracted may also result in distorted incentives for the ESCO. A too high weight given to a pass-through factor may induce strategic behaviour from contracting parties, especially when parties may partially influence such factors. Similarly, public authorities may be tempted by the form of the performance index to strategically influence the outcome of the index so as to be seen in a better light. Ideally, the adjustment mechanism should reflect the contribution of the factor to energy consumption in order to avoid some of these problems. However, the extent to which factors influence on energy consumption may be difficult to determine correctly and entirely, and contracting parties have discretionary power to fix the adjustment mechanism. It is therefore important that great care be exercised when contracting on the adjustment mechanism. Furthermore, an important dimension that should be considered is the extent to which factors giving rise to adjustments may be submit to *ex post* strategic manipulation by both contracting parties.

Furthermore, it should be recognized that the use of public building spaces are decided on the basis of objectives pursued by public policies and that energy services and conservation play a supporting role in these uses. Hence, factors that may be absent from the computation of the final performance index may be just as important as factors that have been taken into account in terms of generating incentive distortion. Usages that are not contracted for, and/or not accounted for in the measurement process may be at the origin of conflicts and can be another source of renegotiation costs, especially when the usages may have an important impact on energy consumption. Furthermore, such conflicts may prevent the public authority from carrying out her duties and obligations in promoting general public interest through the use of public building spaces. For instance, situations may arise when a public authority would need to use public buildings to shelter citizens in case of adverse events (e.g. snowstorm, homeless etc.) which may imply some abnormal levels of energy consumption. If these circumstances are not accounted for in the contract and/or reflected in the performance index, the ESCO may prevent or hinder the public authority from performing her duties in a satisfactory manner. Therefore, a public authority should be careful to detain rights to decide independently of the usages to which public building could potentially be put to under an EPC.

USERS' BEHAVIOUR, EXOGENOUS FACTORS AND PERFORMANCE MEASURE

Energy consumption may be influenced by users' behaviour as well. In this case, the use of an energy saving performance measure should take into account users' behaviour when computing the index, so that an ESCO is not penalized for energy consumption due to factors that are beyond his control. Indeed, a performance measure that makes an ESCO support such extra risks may be inefficient, and may result in higher premia paid under an EPC. The size of incentives provided through the use of the performance index should be lower if the performance index cannot be computed in a manner that does not neutralize the effects of energy consumption beyond an ESCO's control, or the scope of energy conservation project should be designed in such a way that the ESCO will not be liable for bad performances for which he is not responsible. This issue should be particularly relevant and acute not only for energy conservation project in the social housing sectors, where energy consumption may imply a change of behaviour by tenants, but also for projects where users' cooperation may be important to ensure an efficient use of the technologies implemented by an ESCO. In the latter case, for instance, the public authority may already have at her disposal an internal service in charge of supplying energy and maintaining energy installation for public buildings. The public authority may wish to conserve such a service (or may be unable to change such a situation) when opting for an EPC.[11] This implies that the ESCO chosen for the EPC may have to work in cooperation with existing agents for energy conservation, and the ESCO's performance would depend crucially on how cooperative these agents are with respect to decisions and behaviours that have an impact on energy consumption of public buildings. In particular, such a configuration may be yet another source of bargaining costs and EPC may potentially give

10. Note that to the extent that such measures may look good for a public authority on the paper, if the public authority is motivated by private self-interest, she may also have a strong incentive to adopt these measures in order to show her positive "achievements."

11. For example, the Paris City Hall EPC project for primary school falls into this category. Indeed, energy supply for certain primary school in Paris is organized in-house through public employees. When the City Hall decides to appeal to an (global) EPC to implement energy conservation projects for a number of primary schools, schools whose energy services are supplied in-house or through an external operator are included within the EPC.

rise to an inefficient outcome in terms of energy conservation. Therefore, we believe that this issue could be further explored to determine how EPCs and/or performance measures may be used as a basis for incentive provision.

EX ANTE COMPETITION AND ENERGY SAVINGS

Lastly, it is worthwhile to note that the use of performance measure in an EPC may generate common uncertainty for ESCOs. Such common uncertainty may be generated through the factors used in adjusting and computing the final performance index. This uncertainty could be particularly problematic if a public authority decides to award the EPC through an auction-based mechanism. Indeed, such common uncertainty may be strong enough to lead to a winner's curse phenomenon, whereby bidders may anticipate that they may win a contract not because they are inherently more efficient than their competitors, but merely because that they are being overly optimistic on how the uncertainty may resolved in the future. Rational bidders anticipating such a dimension may therefore be more cautious in their bids, leading to weak competition. Moreover, auctions may lead the public authority to choose an inefficient ESCO for a given project because of such uncertainty. We believe that the interaction between award procedures and the contract design should therefore also be given due consideration so as to ensure an effective EPC leading to concrete energy savings.

To conclude this section, the difficulties in measuring and verifying energy savings and performance is becoming more and more recognized in the literature, and progress has been made in this direction. To illustrate this point, an International Performance Measurement and Verification Protocol IPMVP (Efficiency Valuation Organization, 2007) has been devised and is currently freely distributed. Likewise, in France, efforts to draw up a protocol to measure and verify energy savings are being undertaken. Our discussion above points to the fact that a public authority's internal competency and familiarity with energy conservation and techniques in measuring performance in terms of energy savings may be particularly important in ensuring a successful and effective implementation of an EPC. This discussion led us to believe that EPCs may be particularly adapted for simple and standard projects, instead of more complex ones. Indeed, measurement issues should be more straightforward in this case, and usages of public spaces may be more easily anticipated and contracted for under an EPC. This recommendation is in fact in line with classical predictions of transaction costs economics (Williamson, 1975, 1985; Levin and Tadelis, 2010 etc.).

The issue of enforcement and adaptations

Finally, it should be recognized that EPCs may be long term contracts. This would be the case if the underlying project involves important investments that have to be amortized over the duration of a contract. This long term dimension of the contract implies two related issues: uncertainty with respect to future conditions is likely to be strong and the contract is likely to be incomplete. As we have pointed out previously, the incompleteness of the contract may result in distorted incentives under an EPC.

Strong uncertainty and incompleteness of the contract also implies that *ex post* adjustments may be necessary in order to adapt the contract and the duties of each contracting parties during the execution phase of a contract. (Guasch, 2004), (Guasch, Laffont and Straub, 2006; 2007) show that such non anticipated adaptations are quite common in infrastructure concession contracts between public authorities and private operators. Equally insightful is the observation that adaptations may in fact happen at a very early stage of the contract.[12] Hence, it is important to take ex post adaptations into account when one analyses contracting practices between public authorities and private firms.

THE ECONOMIC COSTS OF EX POST ADAPTATIONS

It should be noted that such adjustments or adaptations may be warranted and may lead to decisions that enhance the welfare of both contracting parties (e.g. de Brux, 2010), but they may also be purely opportunistic where the contractual conditions are modified in favour one of the contracting parties at the expense of the other party. For instance, the adaptations will lead to one party expropriating due returns on investments of the other party. A question that naturally arises in this case is the following one: why should one party give in to demands by the other party that could be detrimental to her own welfare? The answer to this question is a classical one: both parties may find themselves locked in within the contractual relationship. Lock-ins may result from the fact that parties undertake specific investments[13] within the contractual relationship, in which case they are unable to breach the contract at reasonable costs (Williamson, 1975; 1985). This is the well known hold-up problem in the economic literature. In the following, we will explore why such adaptations may influence on transactional efficiency. Independently of whether the adaptations are welfare enhancing or opportunistic, the mere fact that parties have to renegotiate the initial contract in order for adaptations to take place is in itself a source of transaction costs. Indeed, whatever the nature of these adaptations, parties will have to renegotiate to adapt the contract. Parties will have to devote resources to these renegotiations, which can be substantial as stressed by (Williamson, 1975; 1985), (Crocker and Reynolds, 1993), and (Corts and Singh, 2004) for instance. Hence, the renegotiation process is in itself a source of transaction costs. Of course, when adaptations are opportunistic, these renegotiations may be more costly as haggling and conflicts may be more present. In their investigation on procurement contracts for highway undertaken by the Californian Department of Transport, (Bajari, Houghton and Tadelis, 2007) show that firms participating in such contracts actually take into account potential costly future adaptations to the initial contracts. In particular, they estimate that additional costs due to *ex post* changes are quite substantial, and account for 10 % of total bids submitted by firms on the average. According to them, this estimate corresponds to costs due to *ex post* bargaining, haggling, eventual lawsuits over the changes and loss due to disrupted workflows due to renegotiation. Note that this estimate only corresponds

12. According to (Guasch, 2004), 50 % of such modifications happen in the first two years after a contract has been signed.

13. Specific assets refer to those assets whose value outside a given contractual relationship is very low. These are assets which are not easily redeployed to other uses or transactions than the one considered. Hence, these are assets that are tailored to a given transaction with a given contracting partner. Investments in specific assets are at the origin of quasi-rents.

to costs borne by one of the contracting parties that are incorporated into their bids. Hence, the total costs due to *ex post* adjustments are likely to be higher.

Ex post renegotiations and adaptations due to the incompleteness of a contract can also lead to *ex ante* inefficiencies in a transaction, whether such adaptations are of an opportunistic nature or are necessary and well justified. It is well known from transaction cost economics that such *ex post* renegotiations may induce contracting parties to underinvest because of the fear of being held up by opportunistic partners (Williamson 1975, 1985 etc.). Indeed, anticipating that adaptations may allow a contracting party to expropriate part of the quasi-rents generated by one's investments in specific assets, a partner may decide strategically to underinvest in the first place. Some exchange surplus will therefore be sacrificed. Even when such *ex post* adaptations may be fully efficient (i.e., when renegotiations are costless in terms of resources, and will lead to the best decisions *ex post*), contracting parties may still have an incentive to underinvest in the first place as shown by the Incomplete Contract Theory (Grossman and Hart 1986, Hart and Moore 1988, etc.). In this theoretical framework, the underinvestment problems originate from the fact that surplus that results from the *ex post* best decision may have to be shared between contracting partner in order for the partners to strike an agreement during the *ex post* renegotiation phase. *Ex post* adaptations and contractual incompleteness can therefore lead to inefficient investment decisions, leading to global inefficiencies when a contract is relied on to govern a given transaction.

BENEFITS OF BETTER INCENTIVES VERSUS COSTS OF ADAPTATIONS: THE ROLE OF CONTRACT DESIGN

Recent developments in the economics of contract literature have also shown that contractual forms may have an impact on the efficiency of non-anticipated *ex post* adaptations, and therefore, on the overall efficiency of contracts to govern a given transaction. More specifically, (Bajari and Tadelis, 2001) show that there may be a trade-off between incentives provision and the efficiency of how *ex post* adaptations may be implemented. In particular, they consider the fact that one of the contracting parties may detain superior private information during the renegotiation process. In this configuration, they show that a strong incentive contract tends to reduce costs of a project, but at the same time these incentives will also dissipate *ex post* surplus during the renegotiation process under asymmetric information. This leads to inefficiency in the outcome of the adaptation process. On the other hand, low incentive contracts do not induce cost-effectiveness of the overall project, but they may preserve surplus during the renegotiation process, and therefore lead to easier *ex post* adaptations of a contract. Consequently, a major result from their study is that contract design (high versus low incentive) should take into account the scope of *ex post* renegotiation. More specifically, in situations where *ex post* adaptations are likely, it may be optimal for contracting parties to appeal to a low incentive and less complete contract.[14] In particular, their results suggest that more complex transactions should be governed with low incentive contract, whereas simple and standard transactions can appeal to high incentive contracts. The intuition behind this suggestion is rather simple: for complex transactions, it is more likely that *ex post* adaptations will occur and anticipating these adaptations *ex ante* is likely to be very costly. Hence, a low incentive contract will be more useful as it enhances parties' ability to come to an efficient decision on how best to adapt the initial contract given the realized circumstances.

Finally, we should also note that *ex post* adaptations and renegotiations may have an impact on the effectiveness of incentive provision. Indeed, it is well known from standard Principal-Agent theory (Laffont and Tirole, 1993; Laffont and Martimort, 2002 etc.) that incentives provided by a contract are effective only when the Principal is willing to tolerate some *ex post* inefficiencies (giving up informational rents to the Agent, or insuring him against risks when he is risk neutral). In other words, the Principal has to be able to credibly commit not to renegotiate the initial incentive contract. Otherwise, an Agent who has doubts over whether the Principal will commit to the initial contract may refrain from revealing his private information and/or not undertake actions that the Principal sought to induce through the use of an incentive contract. As such, the possibility of *ex post* renegotiations may destroy the incentives that the initial contract intends to instil.

LESSONS FOR EPCS: COMPARING ALTERNATIVE SOLUTIONS

We believe that the above discussion is relevant for EPCs to the extent that EPCs are strongly incentive-based long term contracts. Consequently, EPCs are likely to be concerned by issues related to *ex post* adaptations and renegotiations.[15] Moreover, EPCs often involve efforts in terms of innovations and investments programmes to implement energy conservation measures. Together with the long term dimension and the potential incompleteness of a contract, an EPC may not deliver the optimal level of investments and/or innovations. Nevertheless, this in itself does not mean that EPC will not always be effective, since one should compare the efficiencies induced by such a solution to other alternative solutions. EPCs may still be preferable if no alternative solutions can be relied on to deliver better results.

In particular, in a seminal contribution, (Hart, Shleifer and Vishny, 1997) applied framework of the Incomplete Contract theory to show that privatization of a public service will lead the operator to over-invest in cost-reducing technologies and under-invest in quality-enhancing innovation when it comes to the provision of public services and when contracts are incomplete. On the other hand, they also show that in-house provision will lead to weak incentives in terms of cost-reductions and quality-enhancing innovations. Hence, if we apply the analysis of (Hart, Shleifer and Vishny, 1997) to the issue of EPC and compare it to an in-house solution, the relevant dimensions that have to be taken into account are the impact of cost reductions on quality and the benefits of quality enhancing innovations that an ESCO may undertake: When cost-reductions may be contracted for, or when it does not result

14. In their analysis, a less complete contract refers to the case where contracting parties provides for less specification on the design of a project.

15. To our knowledge, an EPC signed by the city of Tours in France in 2007 has already led to more than 15 modifications to the initial contract ("avenants") by 2010.

in too strong adverse impact on the quality dimensions, then EPC should be chosen as it will be able to deliver a more cost-effective outcome than in-house provision. This should be the case when quality dimensions on usages of public spaces and on the service provided by an ESCO can be easily controlled and contracted on. Furthermore, reliance on an ESCO in this situation may be all the more desirable than in-house provision because of stronger incentives to carry out quality-enhancing innovations. On the contrary, when the scope for quality-enhancing innovations are not too large, while cost-reductions may adversely impact on the comfort of use of public spaces due to cost reductions, then in-house provision would be a better alternative solution.

Moreover, one should also not neglect the role of *ex post* adaptations in an EPC, especially when it comes to energy conservation projects on public buildings. Indeed, usages of such public spaces may change over time and may respond to different prerogatives of public policy at different moments. When this happens, one may need to adapt the initial EPC contract to accommodate new usages. However, EPCs being strongly incentive contracts, they may lead to more difficulties and costs for a public authority when they need to change and/or introduce new conditions or specifications into the original contract, as shown by (Bajari and Tadelis, 2001). As a consequence, we believe that it may be useful to rely on a contract with weaker incentive properties for energy conservation projects on public buildings when usages are very likely to change over time. Weaker incentive properties may in this case ensure that *ex post* adaptations are more easily implemented and approved by an ESCO when compared to a high incentive contract.

Conclusion

To briefly sum up our discussion, we believe that EPCs are not always the only optimal solutions to implement energy conservation projects in public buildings. One can summarize the important aspects to take into account when considering the effectiveness of relying on an EPC by appealing to the concept of transaction costs. Indeed, while EPC provides strong incentives for an ESCO to realize energy savings in public buildings at the most cost-effective ways, using an EPC effectively also implies devoting great care to details of a contract and the attributes of the transaction. In particular, we believe that EPCs may be an effective solution for simple transactions, whereas other new or existing contractual arrangements may be more useful to handle more complex projects. Indeed, for such projects, meaningful performance measures may be hard to construct, contracting on the details on the partners' duties may be difficult, contractual clauses may be harder to be verified by third parties, *ex post* adaptations may be more likely, and parties may be more tempted to behave opportunistically. These considerations have also led us to believe that energy conservation projects on public buildings whose usages are likely to change over time should avoid relying on EPC. Indeed, weaker incentives may be needed in order to allows for easier ex post adaptations to new usages. Obviously, the efficiency of EPCs in delivering cost-effective energy conservation depends on examining in care and details the characteristics of a project/transaction.

While our analysis has allowed us to identify potential failures or problems associated with EPCs, we believe that the next step forward should be to identify potential solutions to the difficulties that we have discussed which may partially restore the effectiveness of EPCs; and of course to analyze alternative arrangements to EPCs as a means to achieve the goals of energy efficiency in public buildings. We also believe that it is important to explore issues related with specific types of projects (social housing for instance) and the efficiency of EPCs in delivering energy conservation measures. These are the directions that we believe would be useful to better apprehend and understand EPCs.

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