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The economics of energy service contracts

Steve Sorrell*

Sussex Energy Group, SPRU (Science & Technology Policy Research), Freeman Centre, University of Sussex, Falmer, Brighton, BN1 9QE, UK

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Abstract

Energy service contracting can provide a cost-effective route to overcoming barriers to energy efficiency. Energy service contracts allow the client to reduce operating costs, transfer risk and concentrate attention on core activities. However, the energy services model may only be appropriate for a subset of energy services and energy using organisations. A challenge for both business strategy and public policy is to identify those situations in which energy service contracting is most likely to be appropriate and the conditions under which it is most likely to succeed.

Energy service contracting is a form of outsourcing. It will only be chosen where the expected reduction in the *production cost* of supplying energy services can more than offset the *transaction cost* of negotiating and managing the relationship with the energy service provider. Production costs will be determined by a combination of the physical characteristics of the energy system and the technical efficiency of the relevant organisational arrangements, including economies of scale and specialisation. Transaction costs, in turn, will be determined by the complexity of the energy service, the 'specificity' of the investments made by the contractor, the competitiveness of the energy services market and the relevant legal, financial and regulatory rules. This paper develops these ideas into a general framework that may be used to assess the feasibility of energy service contracting in different circumstances. The framework leads to a number of hypotheses that are suitable for empirical test.

Keywords: Energy services; Performance contracting; Transaction cost economics

1. Introduction

Energy service contracting involves the outsourcing of one or more energy-related services to a third party. In its simplest form, an energy service contract may guarantee supplies of hot water and/or electricity at reduced cost, but in a more sophisticated form the contract may guarantee particular levels of service provision, such as lighting levels, room temperatures, humidity and 'comfort'. In its most developed form, energy service contracting allows the client to minimise the total bill for the services that energy provides through a single contract with an energy services provider. This contrasts with the traditional model in which energy consumers contract separately for each energy commodity and for different types of energy conversion equipment. Energy service companies (ESCOs) typically offer comprehensive contracts that include energy information and control systems, energy audits, installation, operation and maintenance of equipment, competitive finance, and fuel and electricity purchasing. These contracts allow the client to reduce energy costs, transfer risk and concentrate attention on core activities.

Energy service contracting has been endorsed for both business and environmental reasons (Hansen and Weisman, 1998; Bertoldi et al., 2003), but has attracted little academic scrutiny. Most of the existing literature is from industry and government sources and makes little reference to economic theory.[1] The energy services model has important parallels with other forms of outsourcing and with the private financing of public sector infrastructure, but insights from studies into these topics have rarely been applied to the energy field. As a result, the determinants of the size and nature of the energy services market are poorly understood.

This paper seeks to explain why energy service contracting is suitable for some energy services in some

*Tel.: +44 1273 877067; fax: +44 1273 685865.
E-mail address: s.r.sorrell@sussex.ac.uk.

[1]Useful publications include Hansen and Weisman (1998), Bertoldi et al. (2003) and Singer (2002).

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circumstances and not for others. It does so by developing a theoretical model of energy service contracting that draws upon ideas from transaction cost economics (TCE). These ideas have been successfully tested in numerous applications (Shelanski and Klein, 1995; Reindfleisch and Heide, 1997) and appear particularly well suited to the outsourcing decision. The model assumes that the primary objective of energy service contracting is to minimise the *total* cost of supplying energy services, given by the sum of production costs and transaction costs.

The paper is structured as follows. Section 2 proposes a definition of energy service contracts, Section 3 develops a general method of classifying those contracts and Section 4 illustrates the type of contracts that are currently available. Section 5 argues that the total saving in production costs must outweigh the transaction costs incurred for such contracts to succeed. Section 6 explores how contracting can reduce the production cost of providing energy services and identifies the determinants of production cost savings, while Section 7 explores the nature and origin of transaction costs and identifies the determinants of these for an energy service contract. Section 8 combines these insights to propose some testable hypotheses. Section 9 concludes.

2. The nature of an energy service contract

It is standard practice for organisations to use external companies to perform one or more activities related to the provision of energy services: for example, installing, commissioning and maintaining equipment, purchasing energy commodities and identifying energy saving opportunities. But the conditions under which these activities can be classified as *energy service contracting* and the companies that provide them as *energy service companies* (ESCOs) is disputed. The industry itself uses a variety of terms to refer to contracting activities,[2] and defines these activities in a variety of ways.[3] Nevertheless, a necessary feature of an energy service contract appears to be (Sorrell, 2005):

> the transfer of decision rights over key items of energy equipment under the terms and conditions of a long-term contract, including incentives to maintain and improve equipment performance over time.

In a conventional 'turnkey' project, the contractor is responsible for design, specification, construction and commissioning and is paid on project completion. The contractor may be liable if the equipment does not work or does not perform to specification, but is not involved in operating the equipment and has neither the incentive nor the means to optimise equipment performance subsequent to project delivery. In contrast, an energy service contract establishes a link between contract payments and equipment performance and schedules these payments at intervals over a long-term period. This provides the contractor with a long-term incentive to maintain and improve equipment performance.

In a typical energy service contract, the contractor may:

- Install new energy conversion, distribution and/or control equipment at the client site.
- Finance this investment, or assist in obtaining finance for the client.
- Assume decision rights over a significant proportion of the useful energy streams and final energy services within the host site.
- Assume decision rights over a significant proportion of the organisational activities required to provide those streams and services.
- Assume property rights over some of the assets required to provide energy services.
- Guarantee a particular level of savings in energy consumption or energy costs.
- Take on the majority of the risks related to the provision of energy services, including equipment performance risk, energy price risk and credit risk.

However, none of these appear to be essential features of an energy service contract. For example, it should be possible to establish a contract that is relatively limited in scope (e.g. confined to heat supply from boilers), does not include third party financing (e.g. investment is financed by the client), does not guarantee a particular level of energy cost savings and does not transfer legal ownership of the assets. But if the performance incentive condition were met, this would still qualify as an energy service contract.

3. Classifying energy service contracts

The above definition encompasses a wide range of contract types offered by an equally wide range of organisations—not all of which would describe themselves as ESCOs. It is proposed here that all energy service contracts can usefully be described by three variables: *scope*, *depth* and method of *finance*.

The scope of an energy services contract defines *what* is included in terms of energy technologies and systems. This may be illustrated with the help of Fig. 1, which shows the energy flows within a general customer site. Here, *delivered energy* represents energy commodities such as coal, gas and electricity, which are traded through conventional energy markets. Primary conversion equipment, such as boilers and CHP plant, convert the delivered energy into various forms of *useful energy*, such as steam, hot water and coolant. In turn, secondary conversion equipment such as radiators, fluorescent lighting and machining equipment convert the useful energy into final *energy services*, such as

[2] Examples include Performance Contracting (US), Energy Savings Performance Contracting (US Federal Energy Management Programme), Facility Contracting (Germany), Chauffage (France); First in, First out (Canada), Third Party Financing (Austria, Germany, European Commission) and Contract Energy Management (UK).

[3] For example, risk transfer, the provision of finance, the comprehensive nature of the contract and so on.

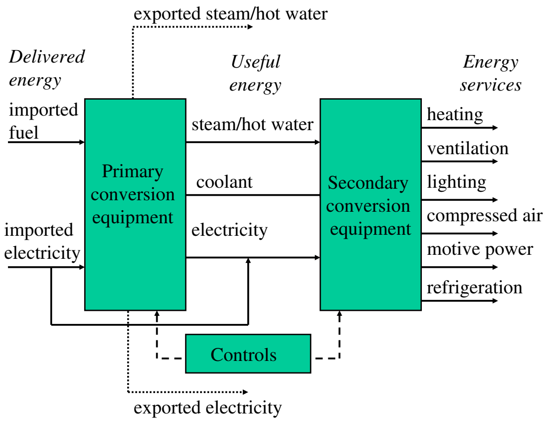

Fig. 1. Final energy, useful energy and energy services within a client site.

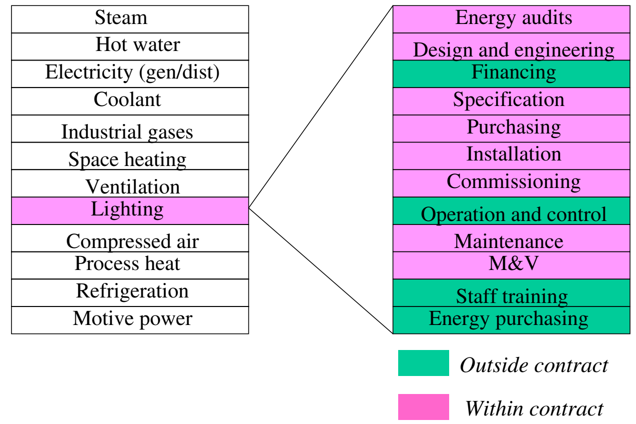

Fig. 2. Contract depth for a single final energy service.

space heating, light and motive power. Electronic controls are standard for both types of conversion equipment and frequently link the two. These controls may be dedicated to a single useful energy stream or final energy service (e.g. lighting), or may coordinate the delivery of several energy streams and/or services (e.g. Building Energy Management Systems).

The scope of an energy service contract may then be defined as: *the number of useful energy streams and/or final energy services that are wholly or partially under the control of the contractor*. In general, a contract will include one or more streams of useful energy, and/or one or more types of final energy service. At one extreme, a contract could include a single useful energy stream or a single final energy service, while at the other extreme a contract could include all the useful energy streams and all the final energy services for an entire site.

The provision of an individual useful energy stream or final energy service involves a number of organisational activities, including: the purchase of energy commodities; energy audits; project design and engineering; project financing; equipment specification and purchasing; installation, commissioning and maintenance of equipment; operation and control of equipment; monitoring and verification of performance; and staff training (Fig. 2). For an individual useful energy stream or final energy service, contract depth may be defined as: *the number of organisational activities required to provide that stream or service that is under the control of the contractor*. Contract depth may vary from one stream or service to another, but in practice is likely to be relatively uniform across the streams and activities that are within the contract scope. By definition, contract depth is 'zero' for those services and streams that are not within the contract scope.[4]

[4]This definition assumes that the individual organisational activities are either under the control of the contractor or under the control of the client. In practice, some sharing of control is likely to take place, but one party is nevertheless likely to play a dominant role.

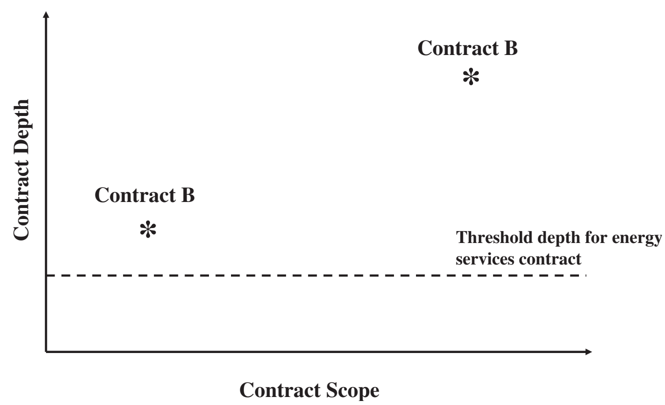

Fig. 3. The scope and depth of an energy service contract.

The combination of contract scope and contract depth is illustrated in Fig. 3. Here, Contract A represents a 'shallow' contract with relatively 'narrow' scope, while Contract B represents a 'deeper' contract with relatively 'wide' scope.

Increasing (decreasing) contract scope will increase (decrease) the number of useful energy streams or final energy services that are within the contractor's control. Generally, the greater the scope of the contract, the more (less) control the contractor (client) will have over the overall energy system. In the extreme, all the energy systems and services for the entire site may be outsourced.

Similarly, increasing (decreasing) contract depth increases (decreases) the control the contractor has over the cost of producing the relevant useful energy streams or final energy services. This implies a threshold for contract depth below which a contractor is unable to offer an energy service contract owing to insufficient control over equipment cost, operation and performance. Generally, the more control the contractor has, the less risk it assumes.

Finance for an energy service contract refers to *the source of capital for investment in new energy conversion and control equipment*. Most energy service contracts involve new investment, although this is not a necessary feature. The basic choices are:

- Internal financing:
  - o Working capital provided by the contractor.
  - o Working capital provided by the client.
- Lease financing:
  - o Operating lease
  - o Capital lease
- Third party financing:
  - o Debt undertaken by the client.
  - o Debt undertaken by the contractor.
- Project financing.

The appropriate choice will depend upon the context, including the familiarity of lenders with financing different types of project, the credit status of energy service providers, the credit status of the client, public sector procurement rules and the accounting rules for tax and depreciation. Generally speaking, energy efficiency projects are more difficult to finance than energy supply projects and difficulties in obtaining financing are regularly cited as one of the biggest barriers to developing an energy services market (Painuyly et al., 2003).

US commentators use the term *guaranteed savings* to refer to contracts where the client takes on debt and *shared savings* to refer to contracts where the contractor takes on debt. But this confuses the source of finance with the treatment of cost savings: in practice, 'sharing' of savings is implicit in all energy service contracts, and both sharing and guarantees of savings can apply to contracts where neither party undertakes additional debt. Client financing has proved particularly attractive in the US public sector, where both state and federal clients qualify for tax-exempt loans. The same is not true in Europe, where government procurement, accounting and budgeting rules have led many public sector organisations to seek off-balance sheet financing (Sussex, 2001). This difference goes a long way to explain the differing size and focus of the US and European energy service markets (see Table 1).

4. Types of energy service contract

Many of the energy service contracts in operation in Europe may be termed *supply* contracts, since they cover one or more streams of useful energy but do not cover final energy services (Fig. 4). Hence, the contractor has some control over primary conversion equipment together with the associated control equipment, but little or no control over either secondary conversion equipment or the demand for final energy services. As a result, the contractor has little or no control over the demand for useful energy and only limited control over the demand for delivered energy.

In contrast to supply contracts, *performance* contracts cover one or more final energy services (Fig. 5). The contractor has some control over secondary conversion equipment, such as lights and radiators, together with the associated control equipment. This in turn gives the contractor control over the demand for final energy services (e.g. through occupancy controls for lighting) and therefore over the demand for useful and delivered energy. In addition, the contract *may* also provide the contractor with direct control of one or more useful energy streams, such as when the replacement and operation of

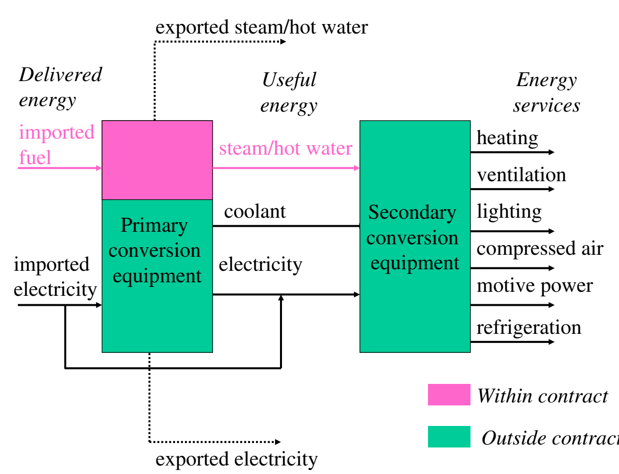

Fig. 4. Scope of a supply contract.

Table 1
Financing investments within energy service contracts

Client finances investment through debt	Contractor finances investment through debt
Client has separate contracts with ESCO and finance company	Client has single contract with ESCO
	ESCO has separate contract with finance company
Assets appear on client's balance sheet	Assets appear on ESCOs balance sheet
ESCO assumes performance risk	ESCO assumes both performance and credit risk
Lower cost of capital	Higher cost of capital
Higher proportion of energy cost savings to client	Lower proportion of energy cost savings to client
Lower proportion of energy cost savings to ESCO	Higher proportion of energy cost savings to ESCO
Increases debt-equity ratio for client	Increases debt-equity ratio for ESCO
Favours projects with longer paybacks	Favours projects with shorter paybacks
Feasible for small ESCOs	Only feasible for large ESCOs
Requires creditworthy client	Can serve clients that have difficulty accessing financing

Source: Based on Singer (2002).

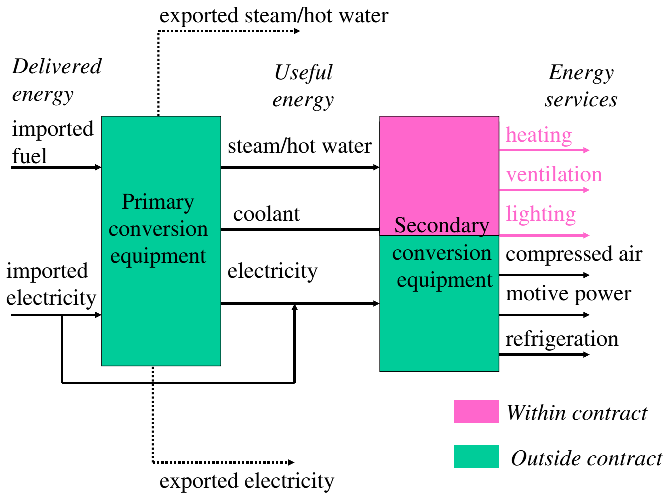

Fig. 5. Scope of a performance contract.

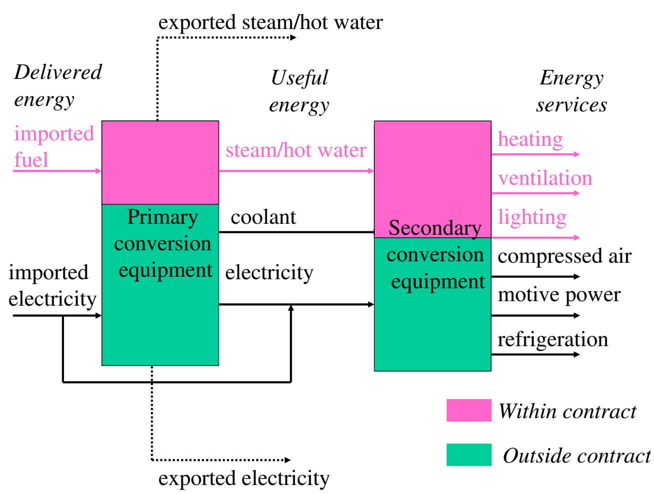

Fig. 6. Scope of a more comprehensive performance contract.

boilers is included within the contract scope (Fig. 6). This will increase the contractor's overall control of both the demand for delivered energy and the total cost of providing final energy services.

In the most comprehensive performance contracts, the contractor has control of the majority of the useful energy streams and final energy services for the entire site. This approach was pioneered by Enron, and is sometimes referred to as *total energy management* (Fig. 7).

The inclusion of one or more final energy services may be considered a necessary feature of a performance contract, while the inclusion of one or more useful energy streams may be considered a contingent feature. Most performance contracts cover several final energy services and seek to combine comprehensive scope with depth, but others cover only a single final energy service and cede only partial control to the contractor. The differences between supply and performance contracts are summarised in Table 2.

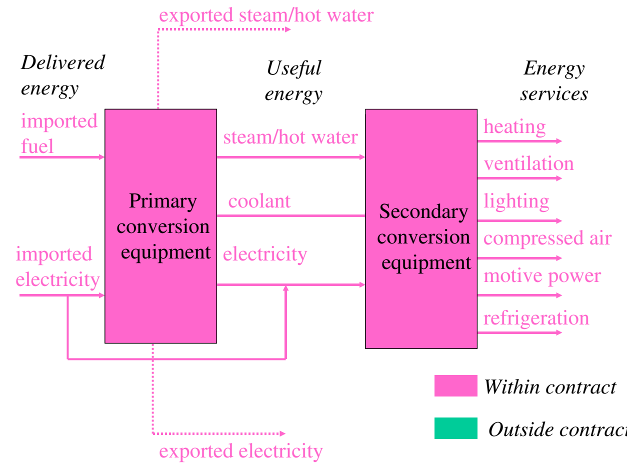

Fig. 7. Scope of total energy management.

In practice, contracts can take a variety of hybrid and intermediate forms. For example, supply contracts often include the provision and operation of electronic controls for both primary and secondary conversion technologies. These facilitate the remote monitoring of utilities plant and give the contractor some control over the demand for final energy services (e.g. by controlling space temperatures). Similarly, performance contracts may begin with a single final energy service (e.g. lighting) and then expand over time as the relationship with the client becomes established. As a result, the boundary between supply and performance contracts is blurred.

It is increasingly common for supply contracts in the industrial sector to extend beyond energy to include water treatment, water supply and wastewater disposal, together with the supply of industrial gases. It is much less common for such contracts to extend into wider *facilities management* activities such as telecommunications, security and grounds maintenance. In the UK at least, the facilities management and energy services market appear to be largely separate.

Vendors of secondary conversion equipment are increasingly offering performance contracts focused on a single final energy service. For example, motor equipment vendors are providing ancillary equipment such as controls, sensors and variable speed drives, together with associated service packages such as financing, commissioning, installation, servicing and remote monitoring (Neal Elliot, 2002). Similarly, compressed air suppliers are offering contracts for outsourcing compressed air services, including design, installation, finance, operation and maintenance. While the scope of these contracts is relatively narrow, their depth is comparable to that of a conventional performance contract.

In general, a variety of companies offer energy service contracts under a number of different terms (Fig. 8). Most of these companies provide energy service contracting alongside other types of services and in many cases it forms only a small part of their business. Many of the companies

Table 2
Comparing two approaches to energy service contracting

Variable	Supply contracting	Performance contracting
Focus	Useful energy streams	Final energy services
Typical sector focus	Industry	Public and commercial buildings
Typical technologies	Boilers, CHP, refrigeration, compressed air, industrial gases	HVAC, lighting, motors and drives, building fabric.
Contract scope	Narrow	Wide
Typical providers	ESCOs Suppliers of primary conversion equipment	ESCOs Suppliers of secondary conversion equipment. Controls companies.
Potential for production cost savings	Low to medium	Medium to high
Anticipated transaction costs	Low to medium	Medium to high
Typical payment terms	Unit price for delivered energy, commonly combined with a capacity charge	Guaranteed reduction in the total cost of providing final energy services *or* a percentage share of the cost savings achieved, both with respect to a specified baseline

Source: Based on Helle (1997).

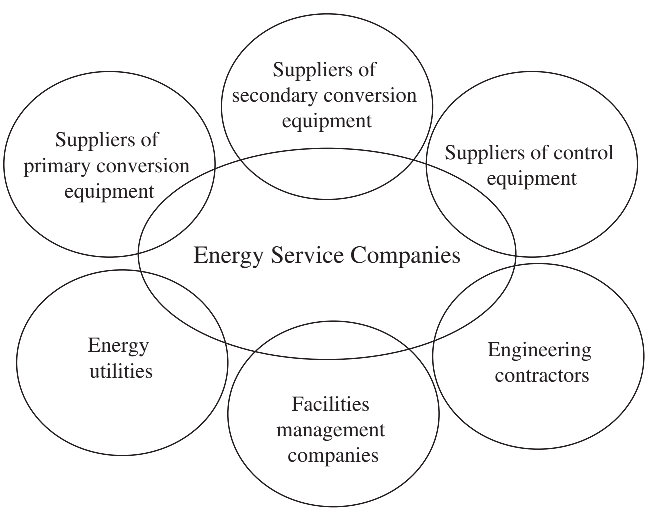

Fig. 8. Providers of energy service contracts.

providing energy service contracts do not describe themselves as ESCOs and are members of several different trade associations. CHP represents an important subset of the energy services market, but the economics of CHP are only partially correlated with those of the broader market for energy services.[5] Potential clients are therefore confronted with a spectrum of companies selling a variety of non-standard 'products' without a commonly agreed system of classification.

[5]The primary driver of the CHP market is the differential between gas prices and the price for imported electricity (the 'spark spread'), while the primary driver of the contracting market is the overall level of energy prices. While CHP is a subject of a specific government target in the UK (10GW of installed capacity by 2010), with corresponding political attention, the contracting market is viewed simply as one of several delivery mechanisms for achieving government targets on energy efficiency and carbon emissions.

5. The condition for a viable energy service contract

It is assumed here that a client's primary motive for entering into an energy service contract is to reduce the total cost of supplying the relevant useful energy streams and final energy services.[6] Total costs are the sum of the expenditures for inputs such as fuel and electricity (*production costs*), and the costs associated with organising (or 'governing') the provision of those streams and/or services (*transaction costs*).

Production costs include the financing costs of any replacement conversion, distribution and control equipment, the staff and material costs for operation and maintenance and the purchase cost of energy commodities. The last will depend upon the technical and operational efficiency of the relevant equipment and the demand for the relevant energy streams or services. Transaction costs include the staff, consulting and legal costs associated with searching for a supplier, negotiating and writing the contract, monitoring contract performance, enforcing compliance, negotiating changes to the contract when unforeseen circumstances arise and resolving disputes. They also include the costs associated with opportunistic behaviour by either party, such as when a contractor fails to maintain equipment to an adequate standard (Williamson, 1985).

Production and transaction costs will be incurred by the client for the in-house provision of energy services as well as for contracting. In the case of the latter, production and transaction costs will also be incurred by the contractor. Generally speaking, we would expect contracting to reduce overall production costs but increase overall

[6]An individual client may have a range of motivations for entering into an energy service contract, but the majority of these can be incorporated within a cost-benefit framework (Sorrell, 2005).

transaction costs. To illustrate, let:

P_{CL} = Production costs incurred by client
P_{CON} = Production costs incurred by contractor
T_{CL} = Transaction costs incurred by client
T_{CON} = Transaction costs incurred by contractor
PAY = Payments to contractor

Also, let the superscripts IN and OUT refer to in-house and outsourced provision respectively. Then, the first condition for a viable contract is that the contract payments are less than the total savings achieved by the client (Sorrell, 2005):

$$PAY \leqslant (P_{CL}^{IN} - P_{CL}^{OUT}) + (T_{CL}^{IN} - T_{CL}^{OUT}).$$

The second condition is that the contract revenues are greater than the total costs incurred by the contractor:

$$PAY \geqslant (P_{CON}^{OUT} + T_{CON}^{OUT}).$$

The third condition is that the total saving in production costs achieved through the contract must be greater than the total increase in transaction costs:

$$P_{CL}^{IN} - (P_{CL}^{OUT} + P_{CON}^{OUT}) \geqslant (T_{CON}^{OUT} - T_{CL}^{OUT}) - T_{CL}^{IN}.$$

The saving in production costs is the key to a successful energy services contract, and contractors will invest substantial time and money in conducting an on-site energy audit to estimate the savings that can be achieved. Transaction costs (including those for the audit itself) are more difficult to quantify, but their determinants are well established and should be taken into account by both the contractor and the client when making the outsourcing decision. Hence, the claim that a client will outsource energy services if it can reduce the total cost of obtaining those services is perhaps better expressed as: 'a client will outsource energy services if it can reduce its *estimated and anticipated* total cost at the time of making the decision' (Buckley and Chapman, 1997). Similar comments apply to the decision rules for the contractor.

6. The production costs of an energy services contract

The extent to which an energy service contract can lower the production costs for a particular useful energy stream or final energy service will depend upon the technical potential for improved conversion and distribution efficiency through refurbishment, replacement, operation, maintenance and control. Additional savings may be achieved by minimising the purchase price for energy commodities, the staff and material costs for operation and maintenance, the purchase price of new equipment and the cost of financing. There are two main reasons why ESCOs may able to achieve savings relative to in-house provision (Globerman and Vining, 1996, p. 579):

- *Economies of scale*: Since their energy costs are often small in both absolute terms and as a proportion of total costs, many organisations lack the scale to manage energy efficiently. Energy management may be allocated to a single, time-constrained facilities manager who combines inadequate skills and training with multiple responsibilities (Sorrell et al., 2004). In this context, ESCOs that specialise in energy management and contract with multiple clients have the potential to achieve considerable scale economies. For example, ESCOs may obtain bulk discounts on fuel and electricity purchases by having a single supply contract covering multiple client sites. Similarly, ESCOs may have greater access to information, skilled labour and managerial expertise in the relevant areas and may leverage these benefits by having individual staff serve a number of clients. Such staff should be able to develop and apply specialist skills that would not be feasible within the client organisations and to rapidly disseminate learning benefits between different clients.
- *Market incentives*: If energy is managed in-house, the relevant staff will be shielded from the incentives of market competition and senior management may lack adequate monitoring and/or benchmarks to assess staff productivity. The result may be inefficiency or 'monopolistic' pricing of energy services above the marginal cost of supply. Competitive bidding for these services will facilitate benchmarking and provide an incentive to contractors to minimise production costs. The scope for inefficiencies to re-emerge following contract completion may be constrained by performance incentives within the contract or the threat of switching to another contractor, either prematurely or at the end of the contract term.

While contractual provisions such as shared savings schemes can provide an incentive to contractors to maintain and improve performance over time, such incentives could potentially be provided to an *internal* energy management cost centre ('insourcing') (Irrek et al., 2005). Hence, the primary advantage of outsourcing lies not in performance incentives, but in the combination of competitive bidding and the scale advantages of outside providers.

The cost savings achieved through competitive bidding will depend upon the competitiveness of the energy service market. Limited competition provides scope for inefficiency and monopolistic pricing by the contractor, which will be reflected in higher bid prices and inefficiencies in contract execution. Limited competition also provides fewer benchmarks in the form of competing bids against which a client can evaluate a particular offer. Competitiveness may be expected to vary between different countries, sectors and individual energy services.[7] In

[7]For example, UK companies specialising in supply contracts for industry (e.g. ELYO Industrial, Dalkia Utilities, MCL) rarely compete with those specialising in performance contracts for buildings (e.g. Cofatec, Johnson Controls, United Utilities), leaving only a handful of competitors within each market segment.

principle, limited competition may be less of a problem if new contractors are able to enter at relatively low cost (i.e. the market is 'contestable') (Baumol et al., 1982). But in practice, barriers to entry into the energy service market may be relatively high (Sorrell, 2005).

The scale advantage of the contractor will depend upon its 'size' relative to the client. More specifically, it will depend upon the ratio of the total production costs for energy services for all the organizations served by the contractor compared to the total production costs for energy services for all the sites owed by the client.[8] While smaller clients may lack both staff and technical resource for energy management, larger clients should have a dedicated and competent in-house team.[9] Hence, we would expect the contractor's advantage in terms of economies of scale to be inversely related to the 'size' of the client organization. It need not follow, however, that there is a maximum client size beyond which contracting has no advantages.

The size and learning advantages of the contractor should also depend upon the nature of the technologies required to provide the relevant energy services. Contractors primarily have expertise in generic technologies, such as building management systems, boilers, chillers and lighting systems. These are proprietary and accessible technologies, which are relatively standardised and utilised by a range of sectors. In contrast, most contractors do not have comparable expertise in process technologies such as machining, distillation or fractionation. These tend to be specific to an individual sector (or even site), inaccessible to non-experts and sensitive to clients, who are concerned about continuity of production, product quality and 'maintaining control'.[10]

6.1. Production costs and contract viability

These considerations suggest that the achievable saving in production costs should be influenced by four factors, illustrated in Fig. 9. Table 3 lists the circumstances that are favourable and unfavourable to achieving production cost savings.

The savings in production costs (in £k) must be sufficiently large to offset the transaction cost of contracting. The saving should be proportional to the in-house

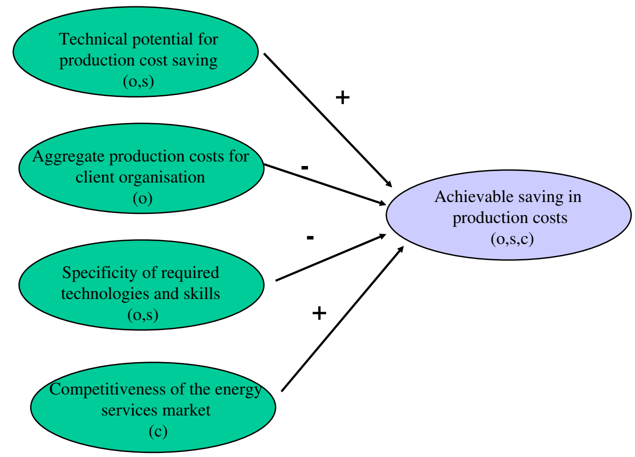

Fig. 9. Determinants of achieved saving in production costs.

benchmark production costs for the energy services covered by the contract. At the same time, the potential for realising those savings through contracting should be inversely proportional to the aggregate production costs for the client organisation, since this influences the scale advantages of the contractor. The net result is a slightly complex relationship between cost savings and different measures of client 'size' that is illustrated in Fig. 10.

7. The transaction costs of an energy services contract

7.1. The nature of transaction costs

The notion of transaction costs was introduced by Coase (1937) and later formalised by Williamson (1985). The term transaction refers to the transfer of goods, services or property rights, whether externally within markets or internally within organisations. They will be costs associated with such transfers, as illustrated in Table 4.

Transaction costs are claimed to result from two features of human behaviour: *bounded rationality* and *opportunism*. Bounded rationality implies that individuals seek to make rational decisions, but are limited by both cognitive capacity and incomplete information. Since they do not have the capacity to foresee every contingency that might arise, any contracts they engage in will be 'incomplete' in that they will not specify the actions to be taken in all circumstances. Opportunism refers to '. . .the incomplete or distorted disclosure of information, especially to calculated efforts to mislead, distort, disguise, obfuscate or otherwise confuse' (Williamson, 1985, pp. 47–48). Since bounded rationality and incomplete information prevent fully effective monitoring of contractual behaviour, there is always the risk that the other party will act opportunistically—for example, by claiming that cost reductions result from performance improvements, when their real origin lies elsewhere.

Williamson claims that market, organisational and contractual arrangements are chosen to minimise transaction

[8]'Production costs' here refers to the total costs for supplying energy services, but a useful proxy is the annual purchase costs for energy commodities.

[9]The relevant variable is the aggregate energy costs for the client organisation, even if only a portion of those costs is to be included within an energy service contract. This is because it is the aggregate energy costs that will determine the resources the client devotes to energy management. However, both the pattern of energy consumption at the site and the scope of the contract may be complicating factors (Sorrell, 2005).

[10]It is important to separate two issues here, however. Sensitivity to production interruptions, combined with a desire to maintain in-house control, may well be an obstacle to contracting. But this is separate from the relative competence of the client or contractor in installing and operating the relevant technology.

Table 3
Circumstances that are favourable to maximising production cost savings in energy service contracts

	Favourable for maximising production cost savings	Unfavourable for maximising production cost savings
Technical potential for production cost savings for energy services included in contract	High	Low
Aggregate production cost for energy services within client organisation	Low	High
Specificity of required technologies and skills for energy services included in contract	Low	High
Competitiveness of the energy service market	High	Low

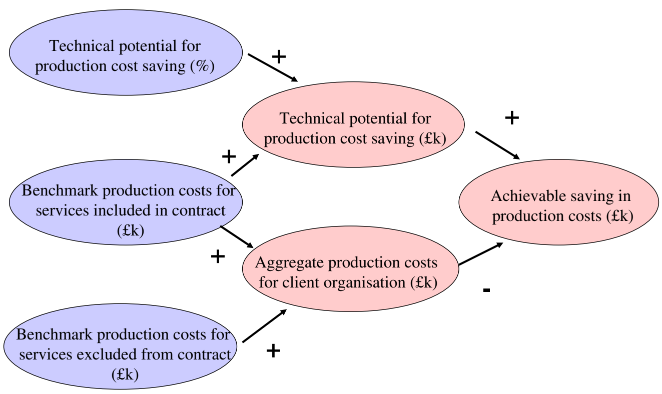

Fig. 10. Relationship between measures of client 'size' and the achievable saving in production costs.

costs—or more specifically '…to economise on bounded rationality while at the same time safeguarding against the hazards of opportunism' (Williamson, 1985, p. 32). Transaction Cost Economics (TCE) locates these so-called *governance structures* on a spectrum, with spot markets at one end and hierarchical organisations at the other. Market structures provide powerful incentives for exploiting profit opportunities and allow quick adaptation to changing circumstances, but expose parties to the risk of opportunistic behaviour when investment in 'specific assets' is required (see below). In contrast, hierarchies reduce the scope for opportunistic behaviour but provide weaker incentives to maximise profits and lead to additional bureaucratic costs. In between these two idealised forms are contractual relationships of increasing duration and complexity, together with hybrid forms such as joint ventures and 'partnering'. Energy service contracting represents a shift from a hierarchical form of organisation to a more market-based form.

Transaction costs may be incurred both prior to or during contract negotiation (ex-ante) and subsequently during contract execution (ex post). The latter may usually be anticipated and allowed for during the negotiating stage—for example the costs involved in monitoring contract compliance. Hence, the proposition that transaction costs explain the choice of governance structure implies that the relevant transaction costs are uncertain—they include costs that are estimated at the time of making a decision (Masten, 1993).

Transaction costs also represent both real and opportunity costs (Reindfleisch and Heide, 1997). For example, negotiating changes to a contract in response to external changes represents a real cost, while failure to adapt effectively to those changes represents an opportunity cost. Both may influence the choice of governance structure and the subsequent performance of that structure (e.g. the success of the contract).

While TCE focuses on the role of transaction costs in explaining the choice of governance structures, the choice of governance structure may also influence production costs. Hence, a comprehensive theory of organisational choice must examine the combined effect of the two.

7.2. Determinants of transaction costs

Both the client and contractor will incur transaction costs in preparing, negotiating, establishing, executing, monitoring and enforcing an energy service contract. The size of these costs can be expected to vary with the nature of the outsourced services, the scope, depth and method of finance of the contract and various features of the external environment. TCE reduces this complexity to a small number of relevant variables, which are claimed to explain the choice of governance structure in a wide variety of situations. Hence, if the relative magnitude of these variables for different contracts can be identified, the viability of those contracts may be assessed. Two 'internal' variables are *asset specificity* and *task complexity*[11] while two 'external' variables are the *competitiveness* of the energy service market; and the *institutional context* in which contracting takes place. Each is explored below.

7.2.1. Asset specificity

Assets are required to provide any energy service. In TCE terminology, the relevant assets include both physical systems, such as lighting, and the knowledge and expertise

[11] It is more common within TCE to use the variables *behavioural uncertainty* and *environmental uncertainty*. The framework proposed here effectively subsumes both of these within the single variable of task *complexity*. This approach derives from Globerman and Vining (1996).

Table 4
Types of transaction costs

Type	Examples	
Market (external)	Search and information costs	Searching for parties with whom to contract; communicating; gathering information about price and quality.
	Bargaining and decision costs	Bargaining and negotiating costs; time and legal advice; costs of making any information gathered usable; compensation paid to advisers; cost of reaching decisions.
	Supervision and enforcement costs	Monitoring contract terms; measuring product/service quality; measuring the valuable attributes of what is being exchanged; protecting rights; enforcing contractual provisions.
Organisational (internal)	Establishing organisations	Costs of setting up, maintaining or changing and organisational design, including incentive design, information technology, public relations, lobbying, etc.
	Running organisations	Costs of decision-making, monitoring the execution of orders, measuring the performance of workers, agency costs, costs of information management etc.

Source: Based on Furubotn and Richter (1997, pp. 43–47).

required to install, operate and maintain those systems, such as skilled engineers ('human assets'). While some assets are common, others are dedicated to a particular use and are said to be *specific*. An asset is specific if it makes a necessary contribution to the production of a good or service and has much lower value in alternative uses (Klein et al., 1978). For example, money may be considered a non-specific asset, since it can be transferred from one transaction to another without any loss in value (Aubert et al., 1996, p. 2). In contrast, a lighting system may be considered a specific asset, since there will be relatively limited scope for transferring it to another location if it is no longer needed within an existing contract.

For example, an ESCO that invests in a CHP scheme that is located within a separately owned chemical plant has limited bargaining power should the plant owners demand a lower price for the heat because there is no other customer to whom the heat could be sold. As a result, the ESCO would have to accept a lower price for the heat, since (provided variable costs are covered) this is better than losing the investment altogether. Similarly, the investment by a contractor in understanding a particular client's organisational procedures represents a sunk cost that cannot be recovered if the contract is terminated.

To protect specific assets, the investing party will seek to obtain some form of promise from the other party before making the investment. As the specificity of the required assets increases, these protection clauses are likely to become more numerous, complex and costly, both to establish and to enforce. As a result, the increase in transaction costs could undermine the savings in production costs that the governance structure achieves. When these costs become too high, it may be more appropriate to conduct the transaction in-house.

Three types of asset specificity are relevant to energy service contracts:

- *Site specificity*: Energy service contracts require a contractor to locate physical equipment on the client site. In some cases (e.g. package boilers), this equipment will be relatively easy to relocate and hence will retain value outside of a particular contract, but in many other cases the equipment will be difficult to relocate because it is designed and engineered for a particular site (e.g. a heat distribution network). This equipment may be considered site specific because it has only limited resale or scrap value. Most contracts will rely on both the economic viability of the client and the stability of end-use demand. Uncertainty over either will undermine the potential for contracting. If the site has a rental value (e.g. commercial buildings) it is possible that energy service demand may continue following a change in ownership, but this is likely to require contract renegotiation.
- *Physical asset specificity*: All energy service contracts require investment in data gathering and auditing, some will require specialised equipment, and many will require design and engineering to meet specific physical constraints and technical requirements. This investment represents a sunk cost that will be lost if the contract is either not signed or is terminated early. Contractors frequently conduct a detailed and costly 'investment greater audit' (IGA), which generates information that the client could opportunistically use to implement the energy saving projects itself. To mitigate this risk, contractors may first conduct a feasibility study and then make a proposal that is subject to the outcome of an IGA. The proposal may stipulate that client must pay the full costs of the IGA if it chooses not to take up the contract (Singer, 2002).
- *Human asset specificity*: The extent to which energy service contracts involve specialised knowledge and expertise will depend on the nature of the required technology. As argued earlier, ESCOs tend to specialise in *generic* energy technologies that are suitable for use in a wide variety of applications. Technologies that are specific to an individual industrial process will require investment by the ESCO in hiring and training staff,

> learning by doing and so on. If relatively few potential clients have comparable technologies, this investment may not be readily transferable elsewhere. Hence, not only will an ESCO have fewer advantages with such technologies in terms of economies of scale, it will also be exposed to greater risk if it makes the required investment. As a result, involvement in process-specific technologies is likely to be avoided.

Contractors will seek to safeguard investment in specific assets through increasing contract duration and requiring compensation for contract termination. But longer contracts may limit the client's ability to replace the contractor, to negotiate better terms, or to adapt to changing conditions. Contract duration will also depend on the size, rate of return and depreciable lifetime of the relevant investments, but the contract duration suggested by these variables may not be the same as that suggested by asset specificity. Contracting will be most (least) problematic for energy services that involve high (low) asset specificity and which also require technologies with a low (high) rate of return.

In sum, as asset specificity increases transaction costs may also be expected to increase, making energy service contracts less viable.

7.2.2. Task complexity

Task complexity is defined here as the degree of difficulty in specifying and monitoring the terms and conditions of a contract (Globerman and Vining, 1996). The degree of complexity will depend upon the nature of the service being provided. For example, a contract to purchase energy commodities on behalf of a client would be relatively straightforward, since the price and quality of these commodities can be very easily defined and verified. In contrast, a contract to supply comprehensive energy services to a commercial building would be relatively complex, since a variety of environmental conditions (e.g. illumination levels, air flow) would need to be agreed and monitored.

Greater complexity makes it more costly to specify and negotiate contract terms. Clients, for example, may lack information on the current (reference) cost of providing energy services and may need to hire consultants to help them define appropriate service standards and comfort conditions. Greater complexity may also make it more costly to establish and operate monitoring systems, to determine whether the terms of the contract have been met. Sub-metering of hot water flow from a boiler, for example may be cheaper and easier than monitoring temperature, humidity and airflow within a large building. Greater expenditure on monitoring and verification will reduce the costs savings from improved efficiency, while inadequate monitoring may leave the client vulnerable to opportunistic behaviour by the contractor. Since service quality can be difficult to specify and monitor, the contractor's incentive to reduce costs may override the incentive to maintain or improve quality (Domberger and Jensen, 1996).

Greater complexity may also make the cost and quality of a service more vulnerable to changes in various factors, such as weather conditions, occupancy patterns and occupant/user behaviour (*environmental uncertainty*). Such changes may have their origin either within the client organisation or externally, and need to be anticipated and allowed for during contract negotiation if subsequent disputes are to be avoided. But the greater the degree of environmental uncertainty, the more complex and costly the negotiation process is likely to become. If such changes are unanticipated, they may reduce cost savings, undermine service quality or necessitate additional modifications during contract execution.

Greater complexity may also increase the information asymmetry between the client and the contractor, which should increase the scope for opportunism (*behavioural uncertainty*).[12] For example, a contractor may blame cost increases on unavoidable external influences, but greater complexity makes it harder for the client to verify this claim. If the energy services market is competitive, opportunism during contract negotiation may be attenuated by the risk of competitors offering more attractive bids. But once the contract is signed, the client is more vulnerable to opportunistic behaviour since there may be significant costs associated with terminating the contract and either replacing the contractor or taking the service back in-house.

In general, the complexity associated with supplying a useful energy stream (supply contracting) should be less than that associated with supplying a final energy service (performance contracting). Transaction costs will be less when equipment performance is defined by technical and easily quantifiable factors, but the move from supply to performance contracting should increase both the number of factors influencing equipment performance and the proportion that are under user control (Helle, 1997). Complexity may also vary significantly from one energy service to another.

In sum, as task complexity increases transaction costs may be expected to increase, making energy service contracts less viable.

7.2.3. Competitiveness

Limited competition in the market for energy services could encourage contractors to behave opportunistically by pricing bids above marginal costs (Globerman and

[12]Interviews with potential UK clients suggest that concern about contractor opportunism is an important obstacle to the acceptance of energy service contracts. One interviewee commented: "It is extremely difficult to prove that an ESCO company isn't doing what they could be doing. If your building goes down, they could blame you…. Unless the university is extremely careful in the way that the contracts are written, they could lose a lot of money. Most contracts look good on the surface until you see the hidden extras. Legally the ESCO will comply, but will try their darndest to get the most money out of it they can."

Vining, 1996, p. 580). However, if the market is competitive, contract prices should be bid down to an efficient level.

In a similar manner, limited competition may create a greater incentive for contractors to behave opportunistically during contract execution, since it is more difficult to find an acceptable replacement. But if the market is competitive, the incentive to 'cheat' will be offset by the risk of losing the contract, either prematurely or at the point of renewal. Hence, by reducing the risk of contractor opportunism, greater competition in the energy services market should reduce the transaction costs for the client.

Limited competition may be less important if the energy services market is contestable, with low-cost entry and exit. But once a contract is signed, the relevant variable is the contestability of the individual contract. If the individual contract involves highly specific assets and substantial sunk costs, the cost of switching may be high. In this case, the contract is likely to be of long duration and to include compensation clauses, which could make contract renewal infrequent and premature termination costly. The incumbent contractor is also likely to have client-specific knowledge of technologies and operating procedures, together with better knowledge of the real costs of supply, which could provide it with an advantage over competing bidders at the point of renewal.

Competitive markets may not be the only inhibitor of opportunism by the bidding or incumbent contractor. Contractor reputation can be considered as a form of irreversible investment that is built up over time at great cost, so contractors may be reluctant to jeopardise it for short-term gain (Wang, 2002, p. 157). Clients may also mitigate the risk of opportunistic behaviour by retaining the capability of bringing the relevant energy services back in-house ('back sourcing'). However, such capability may be expensive to maintain and could undermine many of the benefits of outsourcing. Another alternative would be for the client to retain ownership of specialised and specific assets and to lease these to the contractor, thereby making it easier to change contractors if necessary (Globerman and Vining, 1996).

In sum, as competition in the market for energy services increases transaction costs may be expected to reduce, thereby making energy service contracts more viable.

7.2.4. Institutional context

Transaction costs will also depend upon various features of the legal, financial and regulatory context, such as public procurement legislation, the availability of project finance and the existence or otherwise of specific initiatives to encourage contracting (Sorrell, 2005). For example, the effectiveness with which the legal system establishes, maintains, protects and enforces contractual obligations will affect the viability of the contracting approach (North, 1990).

Some features of the institutional context may actively *inhibit* contracting. For example, despite its apparent synergies with the energy service model, relatively few ESCOs have used the UK government's Private Finance Initiative (PFI) to contract with otherwise attractive public sector organisations. The reasons include the cost and risk of PFI bidding procedures, coupled with incentives for clients to use off-balance sheet financing.

Institutional factors that may actively *encourage* contracting include:

- *Information*: Clients will incur transaction costs in understanding and identifying the opportunities available, while ESCOs will incur marketing costs that need to be recovered from successful contracts. These may potentially be reduced through publicly funded information programmes and demonstration schemes.
- *Procurement*: Transaction costs may be lowered by standardised tendering and procurement procedures and measures to reduce risk. The success of performance contracting in the US public sector owes much to such initiatives at both federal and state level.
- *Accreditation*: Accreditation and certification of ESCOs may reduce the risk of opportunism, enhance ESCOs reputation and give assurance to clients that standards will be maintained. Accreditation effectively acts as a form of 'signalling', to communicate private information in a credible way (Spence, 1973).[13]
- *Monitoring and verification protocols*: Standardised protocols for monitoring and verification may reduce costs for both client and contractor, reduce the risk of opportunism and lower the cost of capital by increasing investor confidence (Kats et al., 1997).[14]
- *Model contracts:* Standardised contracts may reduce the cost to both client and contractor in preparing and negotiating an individual contract, as well as making it easier to compare and evaluate competing bids. The approach may be most appropriate for smaller clients with relatively standardised requirements, for whom the transaction costs of contracting are a particular obstacle.
- *Consultancy*: Clients may benefit from expert assistance in establishing baseline data, defining contract scope, assessing bids and negotiating with contractors. Public funding for this would reduce transaction costs for the client.

[13]The best example is the US trade association (NAESCO), who sponsor an accreditation programme to demonstrate technical and managerial competence and commitment to ethical business practices. This is sufficiently rigorous that only half of the eligible members have qualified.

[14]The International Performance Monitoring and Verification Protocol, originally developed by the US Department of Energy, has found extensive application in US performance contracts (IPMVP, 2001). However, most practitioners in the UK energy services market appear unaware of its existence (Sorrell, 2005).

While measures such as these have been widely advocated and appear to have been successful in some instances (Bertoldi et al., 2003), evidence on their aggregate costs and benefits is limited.

7.3. Transaction costs and contract viability

These considerations suggest that the transaction costs of contracting are influenced by four factors, illustrated in Fig. 11. The circumstances that are favourable and unfavourable to minimising transaction costs are illustrated in Table 5.

It is important to note that there need not be a correlation between asset specificity and complexity. For example, a contract to maintain building environmental conditions is likely to be complex, but need not involve investment in 'human specific' assets since the relevant technologies are generic. In contrast, many process technologies are specific to an individual sector, but are not necessarily complex. However, energy service contracting can be expected to be most problematic for those energy services where asset specificity and complexity are combined.

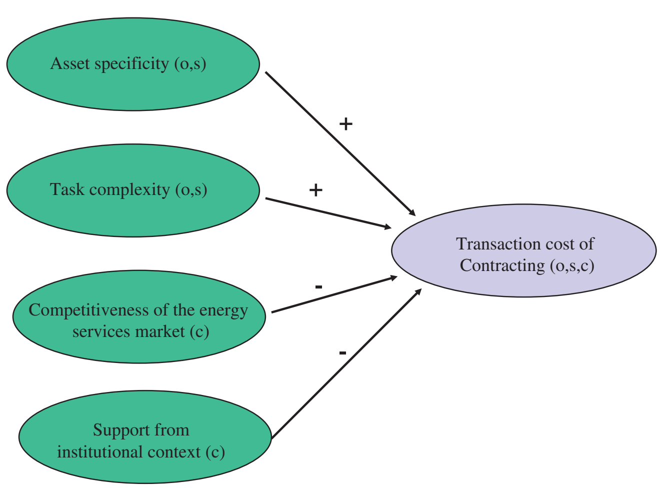

Fig. 11. Determinants of the transaction cost of contracting.

Table 5
Circumstances that are favourable to minimising transaction costs in energy service contracts

	Favourable for minimising transaction costs	Unfavourable for minimising transaction costs
Asset specificity	Low	High
Task complexity	Low	High
Competitiveness of the energy service market	High	Low
Support from institutional context	High	Low

8. A model of the contracting decision

Fig. 12 combines the analysis of the previous two sections. Here, the saving in production cost and the transaction cost of contracting are each determined by four variables, with asset specificity and competitiveness being common to both. In practice, not all elements of asset specificity will be relevant to production cost savings (e.g. physical specificity will be relevant but site specificity will not), but combining the variables in this way is a useful simplification. Fig. 13 links the independent variables directly to the viability of an energy service contract.

This framework suggests six hypotheses, summarised in Box 1.

These hypotheses provide some insight into the appropriateness and likely success of an energy service contract in different circumstances. Four of the independent

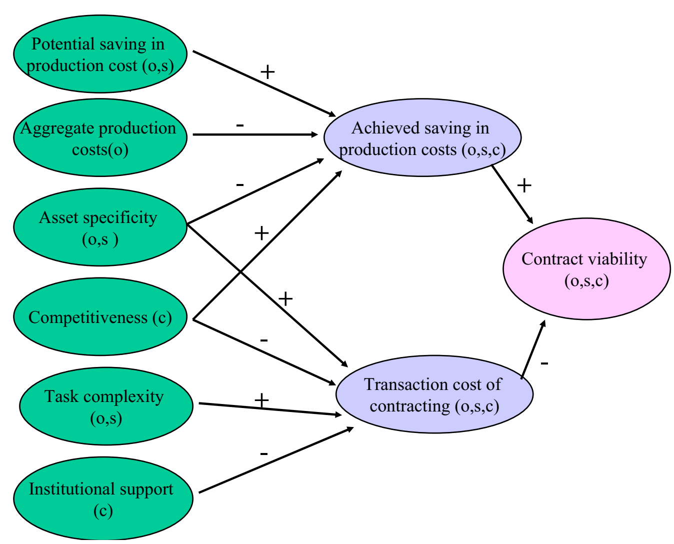

Fig. 12. A model of the contracting decision.

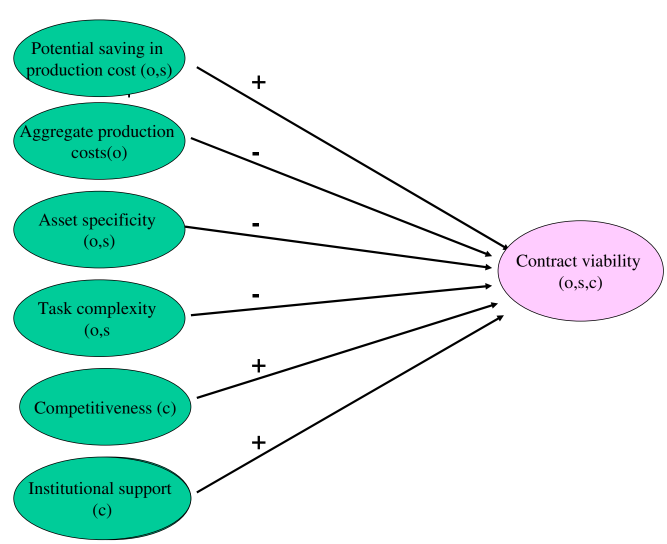

Fig. 13. Determinants of contract viability.

Box 1
Hypotheses regarding the viability of energy service contracts.

Energy service contracting is more (less) likely to be used in situations where:

- *H1*: the technical potential for production cost savings for the energy services included within the contract are large (small);
- *H2*: the aggregate production costs for all energy services within the client organisation are small (large);
- *H3*: the specificity of the assets required to provide the energy services included within the contract are low (high);
- *H4*: the task complexity, as measured by the difficulty in specifying and monitoring contractual terms and conditions is low (high);
- *H5*: the market for energy service contracts is more (less) competitive;
- *H6*: the relevant institutional framework is more (less) conducive to contracting.

Table 6
Suitability of energy service contracting for different types of client

Benchmark production costs for services included in the contract	Aggregate production cost for the client organisation		
	Small	Medium	Large
Small	*	**	*
Medium	***	****	***
Large	****	***	**

Table 7
Suitability of energy service contracting for different types of energy service

Asset specificity	Task complexity		
	Low	Medium	High
Low	*****	****	***
Medium	****	***	***
High	***	**	*

Table 8
Suitability of energy service contracting for different types of market/institutional context

Institutional context	Competitiveness of the energy services market	
	Low	High
Unfavourable	*	**
Favourable	**	***

variables are relevant to explaining why particular organisations choose energy service contracting (o), three are relevant to explaining why particular energy services are included in or excluded from the contract (s), and two are relevant to explaining why the take-up of energy service contracts varies between comparable organisations in different contexts (c) (e.g. the US and the UK). These implications are illustrated in a stylised form in Tables 6–8. In each table, it is assumed that contracting is more likely when both of the relevant variables act in its favour, and less likely when both act against. In all cases, energy service contracting is not in either/or decision, but a continuum of options.

The feasibility of contracting for different 'sizes' of client is of particular interest. For small clients, contracting may offer large percentage savings in production costs, but the absolute savings are likely to be outweighed by the associated transaction costs. Hence, there will be a lower size threshold below which contracting is not viable. For large clients, the percentage saving in production costs may be less since contracting may offer fewer advantages compared to in-house energy management. But the absolute saving in production cost may be sufficient to outweigh the associated transaction costs. As a result, contracting may potentially be most suitable for 'medium' sized clients—as implied in Table 6.

9. Summary

An assessment of the market potential for energy service contracting requires a better understanding of the underlying economics than has been achieved to date. This paper presents a general framework for understanding the contracting decision that identifies the determinants of production cost savings, together with the determinants of the transaction costs associated with establishing and monitoring those contracts. The framework is suitable for empirical test through a variety of means (including a survey of clients with existing energy service contracts) and could potentially be used to develop some quantitative estimates of the potential market that is 'contractable' in the EU. Such work could draw upon the extensive empirical literature on TCE and its application to the economics of outsourcing. To date, however, no research has applied these ideas to energy service contracting.

The model suggests that, while energy service contracting may have an important role to play in a low carbon economy, a wholesale shift from commodity to service supply is unlikely to be either feasible or desirable. Contracting may only be appropriate for a subset of energy services within a subset of organisations, and is particularly unsuitable for final energy services at small sites and process-specific energy uses at large sites. Despite the attention given to comprehensive performance contracting, more limited forms of supply contracting may often be more appropriate.

There may be scope for expanding the market for contracting through institutional reforms that lower the associated transaction costs. Potential measures include model contracts, standardised monitoring and verification schemes and accreditation schemes for energy service companies. At present, however, there is little evidence regarding the relative effectiveness of these mechanisms and they are often treated with scepticism by the ESCOs themselves. Since institutional factors form only one component of the transaction costs of contracting, the ultimate effect of such reforms could be limited. Hence, while policy support for contracting may be appropriate and useful, this can only form one part (and potentially only a small part) of a broader strategy for achieving a low carbon economy.

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