International Experience of Risks Sharing Between Public and Private Entities in Energy-from-Waste Plants Construction

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Imagine that you are the mayor of a city named Metropolis and are in charge of school logistics. Before doing so, you might have to ask yourself a few essential questions. What kind of transportation will you provide? Who will it benefit: students, staff or both? Where will the service be provided? When will it be provided: in the evening, morning? And finally, how much will it cost? All these essential questions need to be answered before starting to implement this project and to buy your buses. By doing so, planning, financing, building and operating the chosen mean of transportation will become an easier task. After that, your political decisions will direct the choice of implication of private sector on the different aspects of your project.

This type of situation applies to Energy-from-Waste (EfW) Plants. The design, construction and operation of such plants require specific know-how and means. These infrastructures require an important investment to realize and to manage them under the responsibilities of high-skill competences. The making of such a project needs to be carefully undertaken, answering the same type of questions mentioned above.

While choosing how the plant will be financed, designed, built and operated, the client will have to choose which of these steps will be undertaken by private or public actors. In fact, it is meaning whether the plant or the related services will be made or bought. By settling the terms of the different contracts, the client will acknowledge what the risk sharing balance between public sector and private companies will be. The client could choose among various options: Lots, EPC (Engineering Procurement Construction), Public or Private operation, Public financing or BOT (Built Operate Transfer) or even merchant plants etc.

This Paper will bring back the focus on the importance of risk sharing within projects in the EfW sector. It will start off reviewing the basics of the Energy from Waste markets along with the different types of risks involved in the realisation of such contracts. It will then assess various types of procurement from public to private, underlining the differences between countries. Finally it will demonstrate the various advantages of EPC contracts from the perspective of risks sharing and CNIM's experience in that field.

1. The *Energy from Waste* characteristics

The Energy from Waste plants (EfW) are large infrastructure projects dealing both with the Municipal Solid Waste (MSW) management, but also with the energy production. Let's try to answer some questions to better understand their specific characteristics, referring also to our example from *Daily life* concerning the school transport from Metropolis City indicated in our introduction.

1.1. Whose?

Based on our example from *daily life* concerning school transport, this question is dealing with: *Is the Mayor of Metropolis responsible of school transport or not?*

This fundamental point is concerning the Municipal Solid Waste (MSW) ownership and responsibility. In general, collection and treatment obligations are legally given to local public sector. If this point is not clear by law, there is in fact no client, who is responsible and in position to sign a contract and to pay the service of the waste treatment. Such EfW facility is then quite impossible to build.

This is also meaning that:

- Rules of public market tenders are applied,
- Strict and changing legislation is concerning this public service,
- Management of external interferences has to be done: permitting process, political issues, public opposition etc.

1.2. What?

The fuel for EfW has specific characteristics with an important impact for the design of EfW. MSW is a poor-quality fuel, with heterogeneity, variable composition and high contents of pollutants. Its calorific value or energy content is rather low, similar to fresh wood.

Yet compared to standard fossil fuel power plants, the required technical skills for EfW building and operation are more sophisticated, mainly because of the nature of this specific fuel – the household waste.

Its origin is local, with the advantage of reducing energy dependency from foreign countries. But it is also diffuse, requiring consequently synergies between municipalities for the MSW treatment. The goal is to mutualise the treatment in a common facility to reach a critical size regarding technical and economic aspects.

The high flexibility of standard mass burn EfW technology is also meaning that the fuel supply could be extended to other types of acceptable wastes, such as wastewater sludge, Commercial and Industrial waste (C&I), clinical waste etc.

1.3. How?

EfW plants are large infrastructure projects with tailored technical solution. They are similar to a conventional Power plant on a number of points such as:

- The technical principle (combustion, energy recovery by a steam boiler, flue gas treatment and power production by a steam turbine).
- The energy efficiency concern (to produce more power with less fuel).
- The availability concern, especially for a base power production.

In fact, this EfW technology is even more complex because of:

- The MSW fuel quality regarding its low energy content, its heterogeneity, its variability in composition and its pollutants content.

- The MSW fuel variability in terms of quantity with daily, weekly and seasonal changes. Waste treatment is required 24/7/365.
- The regulation to fulfil, which is stringent and in evolution. This sector is a flagship concerning pollution control and environment concern compared to other industrial sectors.
- The Public tender process, which is requiring a significant and serious feasibility study and know-how. This is not standard *Business to Business* between industrials clients and suppliers. And this is almost always tailored made.

Finally, this EfW system needs technologies which fit to purpose. If we come back to our daily life example, you need a school bus and not a Formula 1 for school transport. And in fact, you are not buying only equipment or a device, but you need also a performance, such as: *Transport **x** passengers to carry in comfort and safety for **y** km/year with a consumption of **z** litters of fuel per 100 km during **n** days/year.*

From time to time, one should find out some *Fashion victims* in this market looking after the miracle solution, which is appearing first as an alternative technology with no default, but finally as a technological mirage.

1.4. Where? When? How much?

Similarly to Power Plants, the interfaces in terms of adaptation to the site, physical environment, architectural design and technical parameters are quite complex with tailored solution in general. The Figure 1 hereafter is showing the example of the extension in *brownfield* of the EfW of Sheffield in UK with very complex constraints for the building site.

Nevertheless, the best is to install these EfW close to the city center to reduce waste transports and optimise the energy reuse in district heating for example.

As well as for classical Power Plants, the preliminary studies phase and the construction time for EfW is quite long (several years in total) and the delivery risks are significant concerning delay, budget and performances. A cost-effective and on time completion with the performances fulfilment of this important infrastructure are also required to avoid there a shortage in the essential waste treatment capacity.

Finally, these EfW units are also quite capital intensive with long term investment return and energy efficiency concern. But contrary to the conventional combustion technologies for power production, EfW technologies' economic performance is positively affected by the input MSW fuel prices. Waste has a negative price: the waste producer or *owner* has to pay a **gate fee or tipping fee** at the entry of the EfW plant. This is forming the basis of major source of income for the EfW plant owners. The major costs associated with these EfW plants are the investment technology costs, linked to the characteristics of this particular fuel. Apart from this, generation of electricity and heat is another source of income. Of course, the objective is to minimize this gate fee for this waste treatment service. One should understand the importance of availability and performances to reach this cost optimum. But in the waste treatment hierarchy, this EfW process is the most economical way to treat the MSW when excluding waste disposal by landfilling, which should be avoided according to the European directives.

The development of alternative technologies such as gasification or pyrolysis is also subject to this cost reduction goal. Some systems might be proven, but are often not reliable or cheap enough to compete with classical mass burn combustion. Some others are Science fiction.

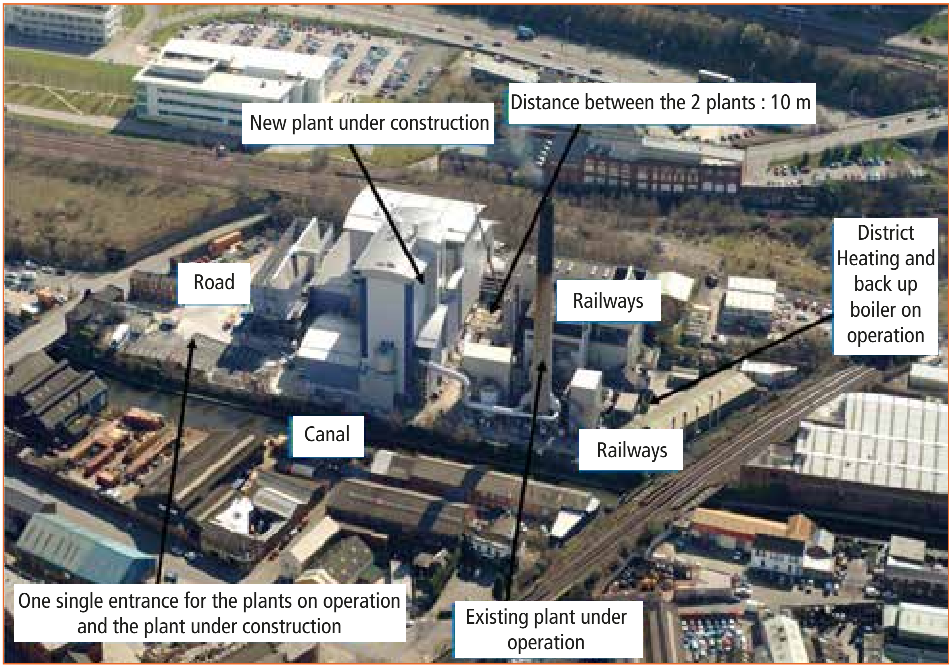

Figure 1: Specific constraints for the extension of Sheffield EfW plant in UK

1.5. Who?

The main typical actors are the following:

a) **Public entities** – Municipalities or Public Companies in charge of the waste management – acting directly or through private companies under a waste disposal contract

b) **Waste management or power production private industry** taking care – when required – of providing waste management and/or energy production services to the public entities

c) **Plant constructors** providing to a) or b) the entire plant on turnkey bases (EPC contract) or systems thereof

d) **Operation and Maintenance (O&M) Companies** ensuring to a) or b) the O&M services when they do not perform it directly.

Some other actors are very important and active or reactive in this market, such as:

- Power industry recovering produced energy – electricity, district heating, steam, etc.,
- Investors, banks, lenders, etc.,
- Advisors, consulting engineers, etc.,
- Permit and Control authorities, etc.,
- Public, neighbours and associations.

Therefore the success of Energy from Waste plants depends on several parameters such as the supply of the waste, the adopted technology but also the framework of the different organizations involved in the realization of the EfW facility and the contractual relations established among them.

This organization is a fundamental prerequisite to give the possibility to control efficiently the waste flow in order to treat it by an optimum way. A balanced risk sharing between these actors is determinant to allow a stable and fruitful situation. As this infrastructure deals with public service, it has to follow the rules of the public market tenders with the legally binding public procurement notices. The impact of the public/private approach in waste management is therefore very important.

2. Public procurement for energy from waste

Usually, public sector is buying a wide range of goods and services, from the purchase of standard and low value products to highly complex infrastructure and services. Procurement processes, techniques and issues differ a lot in this range. For the simplest, the buyer knows precisely what he wants to buy and can clearly specify the required product. There is a competitive market that can meet the requirement with available items. At the other extreme, buying an asset such as Energy-from-Waste plant is considerably more complex and requires appropriate skills and expertise, suitable governance structures and advanced procurement tools and processes.

Sources of complexity in this type of procurement for EfW plants are the following:

- **Rules of public market tenders:** this is often leading to costly tender process requiring significant know-how on both sides – client and supplier,
- **Project scale** this is involving many different trades and skills to coordinate and implement through several linked procurements or one general contractor contract,
- **Project duration:** the contract after the signature, leads to more than to 2 or 3 years of relationship between the owner and the supplier as opposed to a simple and almost immediate delivery,
- **Internal interfaces:** for example the project, in addition to comply with the technical specifications required by the client, should integrate elements coming from site conditions, architecture, process demands for the compliance with standards and regulations, connections with existing infrastructures,

- **Extensive regulations:** very stringent and continuously changing legislation, regulations and norms, which are often based on international directives in Europe and implemented in national and local laws and rules,
- **External interfaces:** the project is exposed to market risks, political opposition or interfaces with existing waste management, public involvement or other contingencies such as planning or permit granting conditions,
- **Solution and scope:** while it is not always possible to define in full details the technical solution up front as it requires the development of tailored solutions; the use of unproven technology or proven technology under new circumstances could increase the complexity,
- **Financial structure:** because of the size and long-term return of the investment the financial structure is not easy to settle without a detailed feasibility study up stream,
- **Competition situation:** due to the high level of know-how required and to the costs of tenders elaboration, the numbers of competent suppliers interested by an inquiry could be excessively reduced if a project has not been seriously prepared or if the contract conditions require the assumption by the supplier of unacceptable risks,
- **Delivery risks:** completing the project within fixed budget and time schedule is some time really challenging.

3. Risk management

All infrastructure projects are subject to risks. In fact, such risks can be divided into two groups: on one side risks which are internal and on the other, risks which are external.

Internal risks mainly cover commercial risks such as follow:

- **Commercial viability:** In fact, does the overall project make sense?
- **Completion risks:** Can the project be completed on time and on budget? The realization time can exceed the anticipated schedule and costs can exceed what was expected
- **Revenue Risks:** Will operating revenues be as projected? The performances might not be at the expected level
- **Operating Risks:** Is the project capable of operating at the projected performance level and costs? The O&M (Operation & Maintenance) costs might exceed the ones that have been assumed, the quality of the equipment or the O&M performances might cause lack of availability
- **Input Supply Risk:** Can raw materials or other inputs be obtained at the projected costs? The quantity or the quality of the wastes might not be as expected with fewer *consumers* than planned or with different energy/pollutants content.

External risks cover risks involved in the current economic and political spheres; the projects are implemented in such as macroeconomic dynamics and political risks:

- **Inflation:** construction costs are vulnerable to inflation based increases,

- **Interest rate risks:** interest rate swaps/cap, scale and timing of interest rate hedging,
- **Exchange Rate risks:** hedging of currency risks, financing of the project in more than one currency, catastrophic devaluation,
- **Investment Risks:** currency convertibility and transfer, expropriation of the project by the state, political violence,
- **Change of law risks,**
- **Quasi-political risks:** breach of contract and court decision, sub sovereign risks and expropriation.

Each and every one of these risks should be allocated to the most appropriate parties. Such parties should be able to face and manage these risks through a proper and fair contractual structure. Appropriate risk allocation is essential to the efficient delivery of a project. Risks are usually allocated among main group of actors: public entities, waste management industry, plant constructors and operation/maintenance companies.

Contractual structuring and risk allocation are essential steps in the making of a project as it allow to reduce the likelihood of under-performing them. The following chapter will try differentiating private and public procurements and their contrasting risks sharing approaches.

4. Risk sharing between public and private

4.1. Impact of the public/private approach in waste management

The legal frame conditions of the Municipal Solid Waste treatment in a country have an impact on the organization and the sharing of responsibilities between the different involved actors.

Generally speaking in Europe, the most common situation is that local public sector organizations, such as cities, districts or associations of towns, have, by law, collection and treatment obligations for the household and other municipal wastes. These local authorities bring this power attributed by the law into effect over their territory to recover the wastes from the waste producers which are the citizens. An essential key driver is that these territorial entities come together to achieve the size needed to avoid the fragmentation of the waste management system depending on the local municipal structures organization.

These public local authorities can then involve to a certain extent the private sector for the treatment of the waste depending on their competences and responsibilities:

- **Public ownership, construction and operation** with a complete public management for the design, the construction and the operation of the owned Energy-from-Waste facilities – Municipal ownership, responsibility and management;
- **Public ownership, private construction and public operation** with a sub-contracting of the design and construction to private companies – Municipal ownership and management with private design and construction competences;

- **Public ownership and private construction and operation** with a subcontracting of the design and construction to private companies and with the subcontracting also to private companies of the plant operation – Municipal ownership with private design and construction and operation competences;
- **Private ownership (temporary or definitive), construction and operation** with private financing. In general in this case, the private sector is a service provider to the public communities, which obtain a treatment service for a fixed price rather than investing, building and owning assets. A private sector contractor finances any required facilities and is then paid for the services actually provided by reference to pre-agreed prices. The ownership could be temporary, like in a BOT contract – Build, Operate and Transfer, – such as in the case of Delegation of Public Service to a private waste management company, or definitive like in a full concession with financing and owning – Private ownership, responsibilities and management.

A lot of other situations are also found in Public Private Partnership (PPP) types depending on the country legislation and the contractual and legal aspects.

For commercial and non-hazardous industrial wastes management, the full responsibility is usually handled by the private sector. The treatment is then realized by private facilities (merchant plant). But this commercial and industrial waste can also be used to complete the municipal waste treatment plants feedstock to increase their capacities and thus reduce their treatment costs.

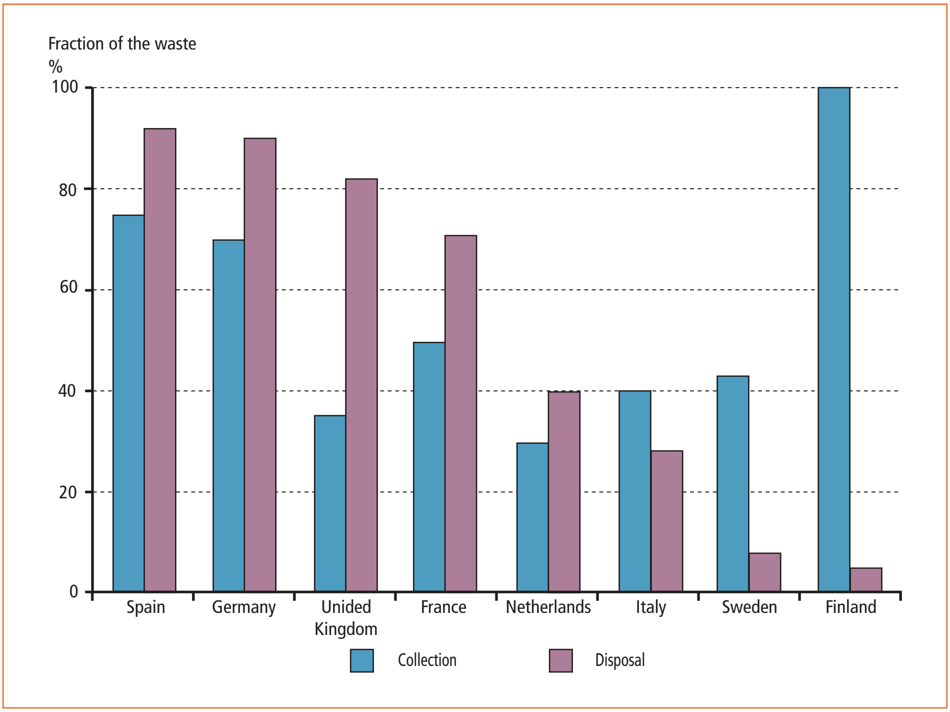

Figure 2: Fraction of the waste market outsourced to private companies in some EU countries

Source: CIRIEC Antonioli 2011

This is adding some complexity in the waste mass flow management and produces a panel of various situations.

The Figure 2 is showing some differences in the development of private involvement for the municipal waste collection and disposal for different countries in Europe.

4.2. Examples of Energy from Waste market organization in different countries

4.2.1. France

In France, there is a strong and technical public organization and a traditional extensive public service concept. The cities are responsible for the collection and the treatment of the household and other municipal wastes whereas the responsibility for the commercial and industrial wastes remains in the hands of the producers. Because of its experience, the public structure is often able to define the needs and the technical solutions for the treatment of its municipal waste.

Typically the French EfW plants are owned by the municipalities, often gathered in inter-municipal associations called *Syndicats inter-communaux*. But almost all of them (85 percent) have subcontracted the operation of these facilities to private companies. Some cities have also conceded to the private sector the public service of the treatment through contract for the Delegation of Public Service for a long but limited period (typically twenty years). A transfer of the units back to the public sector is planned at the end of this contract.

4.2.2. United Kingdom

In UK, the choice of the complete privatization of this sector has been made, especially through the Private Finance Initiative (PFI) procedure. That's why almost all the EfW facilities are now owned by private companies coming mostly from the waste sector. They are taking care of the financing, building and operation of these plants. One should notice that due to the British principle of public law (*common law*), it is necessary to clarify in the contractual documents any possibilities of any events which could occur even with a low probability but with a high level of impact on the economy of the project such as *force majeure*, changing law or acts of government...This is radically different from the written French law which is providing the fundamental principles of legislation with consideration of the administrative case law (*jurisprudence*).

4.2.3. Denmark

In Denmark, the municipalities have the responsibility of treatment of the household wastes, but also since 1989 of all the other types of wastes including commercial and industrial, including the hazardous ones. This legislation obliges the private waste generators to use the facilities proposed by the municipalities. This is allowing a public control of the flows of all types of wastes. Therefore a large majority of the EfW plants are owned and operated by the public municipal companies without any profit. The design and construction are normally contracted to private companies. Some other laws have also promoted heat and power supply delivered by these plants. The other Scandinavian countries have a similar approach.

4.2.4. Poland

In Poland, a new law about the waste has been adopted by the Polish Parliament in May 2011. It is transferring to the municipalities the ownership of the municipal wastes, which was not the case up to now. This new organization is fundamental to have a clear institutional framework which could enable to limit the risk of the waste supply for Public Private Partnership.

4.2.5. Italy

In Italy, despite the long history of waste management ownership by local authorities, the trend is towards private management. The use of public procurement is common, although in many instances private and public companies have been amalgamated – for example in multi-utilities companies mixing both municipalities shareholding and quotation on the Stock Exchange. A lot of private waste management companies are partially owned and therefore regulated by municipalities.

The market approach seems to show some differences between North and South of the country. It could be observed in the North efficient and dynamic waste utilities providing a valuable service to municipal shareholders. In the South, some past inefficiency seem to persist with some public companies.

4.3. *Make or buy* and risk sharing

The variety of procurement approaches can be summarized as a choice between *Make or Buy*. This choice depends on some fundamental political choices translated in laws and regulations in each country but most importantly on the risk sharing. The Table 1 is summarizing the different choices according public/private responsibilities in a simplified approach.

Table 1: *Make or Buy* choices for the different parts of waste treatment infrastructure

	MAKE →				**BUY**
Approach public/ private	**Lots**	**EPC**	**Private operation**	**BOT**	**Merchant plant**
Final ownership	public	public	public	public	*private*
Financing	public	public	public	*private*	*private*
Operation	public	public	*private*	*private*	*private*
Design	public	*private*	*private*	*private*	*private*
Construction	*private*	*private*	*private*	*private*	*private*
Competences	***PUBLIC*** →				***PRIVATE***

Public client's choice between *Make or Buy* includes a variety of risks. Clients therefore should estimate the best risk sharing between the different actors along with the lowest cost of risk coverage according to the competences and interfaces. For the waste treatment business, one can identify four main levels of risks in this complex public procurement:

- The risks associated with the demand – waste supply guarantee, authorizations, judicial review, changing laws, electrical revenues, district heating revenues…,
- The financing risks,
- The risks associated with the performances and availability during operation,
- The risks associated with the plant's design and construction.

The Table 2 is summarizing the typical impact on risk sharing of these different organisations. This point will be developed in the following chapters.

Table 2 : Risks sharing according *Make or Buy* choice

	MAKE →				**BUY**
Typical risks sharing	**Lots**	**EPC**	**Private operation**	**BOT**	**Merchant plant**
1- *Demand* risks (waste supply, laws...)	public	public	public	public	*private*
2- Financing	public	public	public	*private*	*private*
3- Performances and availability during operation	public	public	*private*	*private*	*private*
4- Plant design and construction	public	*private*	*private*	*private*	*private*
Competences	***PUBLIC*** →				***PRIVATE***

Generally speaking, depending on the risk sharing framework, more or less risks of technical and contractual interfaces between the actors can be added to this list. The public client (the waste owner) has to analyse how to share the risks between the actors. The goal should be to ask to the one who has the best competences for a type of risk to manage it. But the final client should aim for a good risk balance to avoid excessive extra-costs due to the overestimation of the risk coverage, especially for risks which are external or impossible to assess by the private sector and to allow a sufficient level of fair competition between private suppliers.

5. Different types of procurement for energy from waste building

5.1. Conventional public procurement for the building

In the case of public ownership, the public sector will use a conventional public procurement for the plant construction. This is generally characterized by input-based specifications, public sector funding and rather short-term contracts – three years compared to typically twenty years for a concession.

Two main approaches could be foreseen:

- **Supply allotment:** The public sector first realizes or procures a basic and/or a detailed design of the process and the building. Then it procures separately from the contractors to build the infrastructure, in general by lots. This approach could be used intensively for pure civil works, but it is difficult to manage for such complex process as EfW plant. This requires a very high level of technical skills in the public administration for the management of complex technical and contractual interfaces created between the lots. Because of this complexity and the specificity of each supplier process, in general the number of lots is limited for EfW construction. EfW allotment would typically consist of a number of lots varying in general from two lots (Civil work/process) to five or six lots (Civil work/combustion/flue gas treatment/energy production/electricity/control command for example). At the end, some costs, performances and time delay risks may end up with the public sector client, for example through change orders due to interface problems. There is generally limited contractual integration with maintenance and operation phase after the plant has been delivered.
- **Design and build (DB) contract with typical EPC/Turnkey supplier (Engineering, Procurement and Construction):** A design and build (DB) contract could be given to one supplier in which an integrated project team is responsible for both the design and construction of the asset. Risks are typically shared between the public and private sectors through appropriate contract terms; for example, the risk of late delivery and global performance might be transferred to the private sector. A detailed description of this typical EPC (Engineering, Procurement and Construction) approach will be detailed hereafter. The payment of the construction is paid by the public owner along the schedule of the erection. The other risks such as waste supply (n°1) and financing (n°2) remain supported by the public sector. These risks are not always easy to control and even to quantify. The risks for operation (n°3) could remain handled by the public sector or largely transferred to the private operating company in case of sub-contracting of this scope. Nevertheless it is much more limited than in Private initiative as the operation risk is only starting when the plant is commissioned, therefore has shown that it is fit to purpose.

5.2. Private procurement for the energy from waste construction in case of concession

In case of waste management *privatization*, the authorities approach is to shift the risks of financing (n°2), the risks of design and build, especially for the construction costs and time delays (n°4) and the risks of operation (n°3) to the private sector contractor through a fixed gate fee price for the service of the waste treatment. Under this organization, the eventual additional costs to complete the project are supported by the private contractor and shared with its subcontractors in accordance with the subcontracting arrangements – and in more extreme cases by those who have provided debt finance to the concerned project. They bear risk up to their capacity or their limit of liability.

A number of contractual structures were developed involving the private sector in project delivery and risk sharing beyond the construction phase. These structures were known by various acronyms, such as BOO (Build Own Operate), BOOT (Build Own Operate Transfer), DBMO (Design Build Maintain Operate), DBFM (Design Build Finance Maintain), DBFO (Design Build Finance Operate) etc. In UK, these types of delivery models are in the frame of a PFI (Private Finance Initiative) and are usually involving a performance-related payment which begins after construction and only once the project has demonstrated that it is fit for purpose and has entered into service. Under these contractual organizations, the private sector is involved not only in operating and maintaining the asset and providing the service, but it is also amortizing its cost of constructing the plant over the lifetime of the operation, which may be twenty to twenty five years. This requires the private sector contractor to raise long-term finance at risk, only allowed under bankability conditions.

For example, one could discover in the following Table 3 the risks sharing between the Public Client named as Employer and the Private Concessioner named as Contractor for the Cornwall PFI waste treatment contract.

Table 3: Risk allocation for the Cornwall waste PFI contract

Factor	**Responsibility**
Planning permission (non-EfW)	Employer for facilities post-financial close
Planning permission (EfW)	Contractor uses *all reasonable endeavours*. Long Stop Date mechanism beyond which planning becomes an Employer risk
Municipal waste input	Volume and mix Employer/Contractor shared
Third party waste input	Contractor
Capex	EfW indexation formula between closing and notice to proceed
Opex	Basket of indices for an annual price review
Landfill costs	Contractor
Landfill tax and landfill penalties	Employer risk with a general total cap on all deductions if O&M does not achieve landfill diversion targets
Interest and exchange rate	Before closing: Employer risk – after closing : Contractor risk
Payment mechanism	Employer/Contractor shared – payment linked to performance
Revenues from power/recyclables	Contractor
Changes in law	General change in law: Employer risk after three years Discriminatory change in law: Employer risk Specific change in law (waste): Employer risk

Source: Gev Eduljee

In return for managing these risks, private sector investors expect a return result and a risk capping for this exposure. The more risky is the project, the higher is the required return. Nevertheless it is almost impossible for the private sector to cover all the risks linked to the demand (n°1) by a simple increase of the return interest as these risks are threatening the project bankability. If the public sector is, through the chosen contract structure, transferring some or all of the project risks, it should take into account the higher required rate of return implied. Generally speaking, a State or public authorities are likely to be able to cover any given risks cheaper than the private sector as they might spread them to the entire population at cost without any profit. This is the same principle applied for the Public self-insurance. Private sector cost of capital is also higher by essence. The public sector could also obtain cheaper financing than the private sector. Even if it is foreseen to hope to get lower operation costs through improved efficiency with private sector, it remains uncertain that private ownership and operation are actually producing an economic benefit because of the increased costs relating the covering of the risks involved. One should also consider that very long term contracts commit often expenditure. They are often incomplete or inadequate on long period. This is meaning first a continuous public monitoring and control, but nevertheless, frequent renegotiation or modifications are happening by nature with a lack of competitive tendering afterwards.

Therefore this Public Private Partnership has the main *advantage* for Public entity to be an alternative to Public Deficits by deferring payments and debts. But this is not an alternative source of revenues: Public entity pays at the end of the day and often more compared to a fully public solution.

Concerning the construction contract given by the private contractor, one should first notice that the same *standard* technology is generally applied, irrespective of the structure organization. This consideration must be largely balanced by the fact that technology under development or highly innovative with little or no feedback will lead to a significant uncertainty in assessing the performances or availability. This is introducing a risk for the costs of operations and revenues. The bankability principle is encouraging to use reliable and proven technologies.

These business developers, banks, lenders and investors will want to avoid the *completion risk*. It means that once construction has started, the lenders and investors want guarantees that the project will be completed and will start operation on time and in good conditions. Contracts known as EPC (Engineering, Procurement and Construction) or Turnkey are attractive for the financial actors. Under an EPC contract, a general contractor will handle all of the tasks needed to design and build a project according to a set, pre-quoted, fixed price and will deliver the project fully operational. In these cases, because of the limitation of internal interfaces, the completion risk belongs to one company, the EPC contractor, and is secured by a performance bond. The EPC Contractor is contracting with its sub-contractors and coordinates all the tasks involved.

As an alternative to this, the private owner team itself can act as the prime contractor (the role of the EPC), hiring all the engineering, procurement and construction contractors. However, it would need to demonstrate that the project will be completed on time and for the fixed price. A third choice is for the private contracting team to hire a Project Management firm to coordinate the project. But this type of contract is very different from EPC. EPCM is a services-only contract, under which the contractor performs *Engineering, Procurement and Construction Management* services. Once again, over costs are needed to be taken into consideration and completion assured being this Project Management team not involved financially as an EPC company and a huge interface is created between the owner and the Project team.

5.3. EPC/Turnkey general contractor

Engineering, Procurement, and Construction (EPC) is a particular form of contracting arrangement used in some industries where the EPC Contractor is made responsible for all the activities from design, procurement, construction, to commissioning and handover of the project to the End-User or Owner. Other abbreviations used for this type of contract are *Turnkey*, *LSTK* for *Lump Sum Turn Key*, and sometimes also *EPCC* which is short for *Engineering, Procurement, Construction and Commissioning*.

Engineering, Procurement, and Construction Management (EPCM) is a special form of contracting arrangement, which is very different from EPC in terms of risk sharing. In an EPCM arrangement, the client selects a contractor who provides only *management services* for the whole project on behalf of the client. The EPCM contractor only coordinates all design, procurement and construction work. Therefore his responsibility is much more limited for the risks around the plant design or construction.

EPCs are contracts where one entity is taking total responsibility for the design and execution of an engineering project. Under the usual arrangements for this type of contracts, the Contractor carries out all the Engineering, Procurement and Construction: providing a fully-equipped facility, ready for operation (at the *turn of the key Clés sur portes.*). It includes design, manufacture, delivery and installation of the overall plant, including the start-up and the design and execution of civil work.

EPCs are usually most appropriate option for municipalities or other private clients. As a result, the final owner is dealing with a single entry point, which owns expertise in the wide range of knowledge and skills required for designing and developing such tailor-made projects in an effective and reliable manner.

Thanks to continually enhanced expert know-how, the Turnkey Contractor is used to work with different equipment manufacturers and is always seeking the most appropriate partnerships on a project-by-project basis. He thereby creates optimal working conditions in order to complete the whole project successfully on budget and on time.

5.4. EPC/Turnkey responsibility

In order to do so, a trustworthy relationship between the Owner and the EPC contractor needs to be built. This can only be based upon fair contract conditions, including equitable risk sharing. The risk sharing principles benefit both parties, the Owner is signing a contract at a lower price and is only having further costs when particular unusual risks actually happen, and the Contractor avoiding pricing such risks which are hard to evaluate.

For some projects, for example those financed by private funds, it is sometimes necessary for the Contractor to assume responsibility for a wider range of risks than under the traditional practice. To obtain increased certainty of the final price, the Contractor is often asked to cover such risks as the occurrence of poor ground conditions. If the Contractor has to carry such risks, the Owner obviously must give all relevant information and let him the time and opportunity to consider this to increase certainty of the risk estimation and therefore of the final price. The Owner must also realize that asking serious contractors to price such risks will increase the construction costs and result in some projects not being commercially viable. He should also avoid unusual risks transfer which is hard or impossible to evaluate. In any case, the Owner does carry certain risks such as the risks of war, terrorism and the other risks of Force Majeure.

A good balance must be found in the client project definition requiring key performances but allowing Contractor own specific equipment design. This has to be obtained for the bidder interests and the prices optimization with equilibrium between detailed client specifications required to ensure that the contractor is not making a dreadlock in his design and key performance requirements based on the outputs that the contractor is able to comply with according his own specific equipment design.

Some improvements should be considered to allow a fair and reasonable competition such as:

- Realize a serious preliminary feasibility study concerning especially the project definition, but also the financing or the waste supply conditions (risks n°1 and 2) ;
- Implement measures of compensation for unsuccessful bidders – this should reduce the risks of the unsuccessful inquiries, often caused by the lack of this serious feasibility study;
- Initiate a process of standardization of contract terms to avoid unfair and unacceptable conditions attempting to transfer risks that cannot be supported by the Turn Key contractors.

6. CNIM experience as EPC/Turnkey contractor for energy from waste

CNIM is building Energy-from-Waste (EfW) installations since more than fifty years with 283 EfW combustion lines adding up a capacity of thermal treatment of around 25 million tons of municipal waste per year. More than half of these installations were delivered turnkey. For example, CNIM has recently delivered the Energy from Waste plant of Brno (225,000 tons per year), one of the first ones in Czech Republic, but also the first Energy from Waste plant in Baku, in Azerbaijan (500,000 tons per year) and the first one of the Baltic States, in Maardu (Tallinn) in Estonia (220,000 tons per year). The Figure 3 is showing some large Energy from Waste plants (400,000 to 500,000 tons of MSW per year) where CNIM was involved for the construction according different industrial schemes – From Lot Building, EPC for Design & Build, EPC in Design, Build & Operate to EPC in Merchant plant.

The *turnkey* culture of CNIM is anchored in its history: established in 1856, the major activity before 1982 was a leading naval shipyard, which was building very large-sized ships, such as cargo boats, methane carriers or passenger ships. This type of realization requires an organization capable of handling in a limited and short schedule, a complex tailor-made project using a large number of sub-contractors for a fixed budget. This experience is by nature the kind of turnkey projects. This skill has been used in the Energy from Waste sector since the beginning of the 1960‘s and reinforced with the acquisition of the ABB – Alstom Environment in 2002.

For the disposal of municipal solid waste, CNIM is present in the various different types of treatments proposing the energy recovery, the material recovery and the organic treatment.

Energy from Waste plants are now an essential element of a global multi-channel structure for the waste treatment with sorting, recycling and composting on an integrated horizontal approach.

As a general contractor, CNIM produces integrated turnkey solutions, from general design and engineering to commissioning, and through procurement and construction. The Group also has the skill and the resources needed to perform, when required, the operation and maintenance of the plants or to provide the operators with technical assistance or provide an integrated vertical approach for the project development.

CNIM designs and builds thermal waste or biomass treatment plants, that use its own processes, and carries out the detailed design of the essential elements of the installation, also using its own processes, in particular for:

- Combustion (combustion grates through the long term partnership with Martin GmbH and fluidized-beds),
- Energy recovery (boiler units),
- Waste-to-energy conversion (steam and water cycles),
- Flue gas and residue treatment with process supplied by the fully owned subsidiary LAB.

The most sensitive pieces of equipment are manufactured in its own workshops, while other pieces like the steam turbines are entrusted to a network of high quality subcontractors.

CNIM is active both in the production of new installations and in the renovation, extension, and revamping. The knowledge of the processes is fed by the non-stop feedback experience; CNIM is operating several plants today in France, in Great Britain , in Azerbaidjan etc. with commitment on energy recovery of the facility through the sale of steam or electricity to the grid.

These global waste treatment systems are developed through global offer contracts such as concession schemes – PPP. In such contract responsibility environment, the group can participate as a shareholder within the structuration of the deal and then co-invest in it. CNIM's experience in financing projects of this type, most notably in the United Kingdom, show it is a recognized actor in such a field, thus supplying a complete service for communities.

The references of CNIM in Energy from Waste cover the whole range of industrial facilities with capacities of waste treatment, from 2.5 to 50 t/h per line (20,000 to 375,000 tons per year per line). Proof of reliability and performance, almost all *old* units built by CNIM are still working today still providing their service at full nominal load. Among the oldest, those of Paris in France with a total capacity of 100 tons of MSW per hour actually and which started in 1969, celebrate in 2016 their 47 years of operation.

Figure 3: Some large Energy from Waste plants (400,000 to 500,000 tons of MSW per year) with CNIM different types of involvement

From Lot Building, EPC for Design & Build, EPC in Design, Build & Operate to EPC in Merchant plant

7. Conclusion

In the Energy-from-Waste industry, this large scale infrastructure presents some complex mechanisms in term of planning, financing, building and operating, but also involves a large range of actors. Risk sharing is one of the central issues of such capital extensive projects. In fact, when choosing one of the many contractual options: Lots, EPC, private operation, BOT, Merchant plants…, the client also chooses a different risk allocation among public and private actors.

Risks should therefore be carefully allocated among public entities, waste management or power production private industry, plant constructors, operation and maintenance companies able to manage them for an efficient project delivery. EPC contracts often offer best possible alternative as they externalize construction risk. Building a plant requires in fact substantial technical knowledge and should be led by specialized companies.

CNIM, specialized in the delivery of EPC turnkey contracts, offers quite unique services in that realm answering the needs of its clients, while also isolating them from substantial risks. This experience combined with references in operation and maintenance allows proposing optimized services, adapted innovations and an integrated offer.

Aknowledgements

Thank you to Victoria Kuntermann for her support

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