



Infrastructure finance review

Insights for district heat network
investment in the UK

A report to the Department for Business, Energy & Industrial Strategy
July 2018

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Deloitte in Energy

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We specialise in advice in the rapidly developing area of energy technology including distributed energy and district heat networks. Our team advises on a wide range of transactions including finance raising, acquisitions and disposals, and procurements. Increasingly, generation assets are being bundled with energy technology such as battery storage and/or distributed control systems to enhance value. Energy technology also includes the data being collected from the network and being used to make the generation, grid balancing, and consumption of electricity more reliable and to optimise returns. See inside back cover for team contacts.

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Glossary

Term or expression	Meaning
Availability	A basis of payment reflecting an asset (and any related services) being capable of being used to some defined standards of capacity, performance and reliability. In general this basis is quantified in a contract or licence and does not include any exposure to the level of demand by consumers for the use of the asset
BEIS	The Department for Business, Energy & Industrial Strategy
Bond	A form of loan, usually listed on an exchange and therefore capable of being traded readily
CATO	Competitively Appointed Transmission Owner, a form of licence for new build electricity transmission projects, which Ofgem intends to introduce
CfD	Contract for Difference, a form of revenue stabilisation provided to certain eligible forms of low carbon generation on a competitive basis
Corporate financing	Financing based on retained cash generated by existing operations and/or debt or equity raised on the basis of the corporate's balance sheet assets and cash flow from its businesses
Cost of capital	The cost of finance, usually expressed in percent per annum, of the capital of a business. This will typically comprise a cost of equity, reflecting expected future dividend receipts and possibly also future sale of the equity; and (if applicable) a cost of debt reflecting, primarily, interest payments
CPI-H	The Consumer Prices Index including owner occupiers' housing costs, produced by the Office of National Statistics
Credit rating	A measure of the credit quality of a borrower based on a methodology and used by lenders as part of their process to decide whether to lend and what pricing and terms to require. Credit ratings may be internal to a particular lender or public and published by a credit rating agency engaged by the borrower
Debt	Loan capital of a business, usually with a fixed repayment schedule and bearing an interest rate. Senior debt interest and principal obligations of a business normally have to be satisfied, for a relevant period, before a dividend can be paid to equity holders
Defra	The Department for Environment, Food & Rural Affairs
Demand risk	The risk of the selling price and/or the volume sold of a product or service being different from an expected level, causing fluctuation in the likely revenues of a business
District heating network	A distribution system of insulated pipes that takes heat from a central source and delivers it to a number of domestic or non-domestic buildings
DNO	Distribution network owner
DPC or Direct Procurement for Customers	A model for new-build water or wastewater projects, as devised by Ofwat
EfW	Energy from Waste, that is, power generation based on waste used as a fuel

Term or expression	Meaning
EPC contract	Engineering, procurement and construction contract, in this context usually for the construction of a new-build infrastructure project
Equity	Share capital of a business, with rights of ownership and management control depending on the proportion of the total equity of the business held by the relevant investor. Equity investment usually receives its return in the form of a dividend from the business
FID or Final Investment Decision	The decision by a corporate to invest in a project using its own corporate financial resources, typically taken at board of directors or other senior management level following an investment appraisal process
Financial close	The point in time when the financing documents for a project financing have been signed and become effective, following approval and due diligence processes by the equity investors and lenders involved
Gilt yield	Yield to maturity on UK sovereign bonds (gilts), a measure of the current interest rate payable by UK Government on its borrowings
GW	Gigawatt, a unit of electrical energy capacity, equal to 1,000MW
HNDU	The Heat Networks Delivery Unit, of BEIS
HNIP	The Heat Networks Investment Project, of BEIS
IDNO	Independent distribution network owner
Infrastructure fund	A form of medium to long term investment business focusing on investments in infrastructure. As defined by the US Securities and Exchange Commission, means a specialized fund or scheme that invests primarily (minimum 90% of scheme's net assets) in the securities, secured loans or securitized debt instruments of: <ul style="list-style-type: none"> a) infrastructure companies; or b) infrastructure capital companies; or c) infrastructure projects; or d) special purpose vehicles which are created for the purpose of facilitating or promoting investment in infrastructure, and e) other permissible assets including revenue generating projects of infrastructure companies or projects or special purpose vehicles.
Interconnector	A physical link which allows the transfer of electricity or gas across a border (land or sea), sometimes across a significant body of water in one country
Investment grade credit rating	A credit rating of BBB – or higher, on the Standard & Poors' or Fitch credit rating agency scales. The equivalent level is Baa3 or higher on the Moodys credit rating agency scale
LU	London Underground
Project financing	Financing based on the projected cash flows of a particular project business, rather than corporate financing

Term or expression	Meaning
Limited recourse financing or non recourse financing	Usually, another term for project financing. Non recourse financing is financing in which equity investors are only required to contribute their agreed equity investment and provide no other support to lenders. Limited recourse financing may include elements of additional support for lenders but would not include guarantees of the project's debt by its equity investors
Margin	In the context of debt finance, an element of the interest rate set by the lender to reflect the credit risk of the borrower and the required return the lender seeks to earn on its funding, among other things
Merchant	A revenue basis which includes exposure to demand volume and price risks
MFTS	Military Flying Training System, a PPP project of the Ministry of Defence for the purpose of training aircrew
MW	Megawatt, a unit of electrical energy capacity
MWh	Megawatt-hour, a unit of energy
NAO	The National Audit Office
NGET	National Grid Electricity Transmission
NHS	The National Health Service
Ofgem	The Office of Gas and Electricity Markets, a non-ministerial government department and the economic regulator for the gas and electricity industries in England and Wales
OFTO	Offshore Transmission Owner, a form of licence granted by Ofgem to offshore electricity transmission links from offshore wind farms
Ofwat	The Water Services Regulation Authority, a non-ministerial government department and the economic regulator for the water industry in England and Wales
p.a.	per annum
Part merchant	A revenue basis with an element of merchant exposure in the revenue stream but also with an element of fixed revenues
Partnerships UK	Partnerships UK was a public/private body established to assist and advise Government Departments, local authorities and other public sector bodies primarily on PFI and PPP matters
PF2	Private Finance 2, the successor to the PFI with certain modified features
PFI	Private Finance Initiative, a form of public procurement of capital assets and related services in the UK usually based on project financing
PipeCo	A pipe network company for a district heating network, separate from the heat source and the heat supply business – a potential form of structure for a district heating project

Term or expression	Meaning
PPP	Public Private Partnership
Primary infrastructure market	The market to finance new-build projects
Project MODEL	A PPP project of the Ministry of Defence concerning the financing of the upgrade of certain assets from a phased process of property sales
RAB or Regulated Asset Base	The asset base of a business subject to economic regulation, usually under statute, and often an electricity cable, water or gas pipeline, telecommunications, or railway network
RPI	The Retail Prices Index, produced by the Office of National Statistics
ROC	Renewables Obligation Certificate, a subsidy instrument for certain low carbon generation
Secondary infrastructure market	The market to acquire and/or refinance existing projects
Senior debt	The highest ranking debt in a business or project
SPV or Special Purpose Vehicle	An entity, typically a company, established to undertake a single business only, for example an infrastructure project
Swap rate	A measure of the interest rate on a bank loan of the relevant maturity before adding the credit margin to be charged for the particular borrower
TO-SPV model	Transmission Operator – Special Purpose Vehicle model for new-build electricity transmission projects, as devised by Ofgem
TTT	The Thames Tideway Tunnel, an infrastructure project in London
UK Green Investment Bank	A lending and investment institution established by the UK Government to provide financing in certain sectors in response to market failures, later sold to Macquarie Group Limited and now the Green Investment Group
WIDP	The Waste Infrastructure Development Programme, of Defra
Yield	The return in cash on a financing instrument, which may be dividends or interest and repayments depending on the type of instrument.

1. Executive Summary

1.1 Introduction

Deloitte NWE LLP (Deloitte) has been engaged by the Department of Business, Energy & Industrial Strategy (BEIS) to perform a review of key UK infrastructure sub-sectors. The purpose of the review has been to identify lessons learnt from relevant infrastructure sub-sectors that will help unlock third party finance for district heat/cooling networks in England and Wales. This report presents the findings of our work, and is intended to help:

- accelerate the deployment of third party finance in the district heat/cooling network projects under development, and
- increase the number and scale of district heat/cooling network projects executed in England and Wales.

The report aims to address the needs of public and private sector developers of district heating network projects, in preparing their projects for initial discussion and later formal presentation to investors and lenders. We have aimed to highlight the priority issues for infrastructure equity investors and lenders. Deloitte has undertaken the work to produce this report on the basis of a contract with BEIS, following a competitive tender process.

1.2 The investor's perspective

Our brief from BEIS's Heat Networks Delivery Unit (HNDU)¹ has been to produce a report that brings together findings based on discussions with investors, review of literature, and our own experience. The priority is to provide insight for the district heating sector from an investor's perspective, and the term "investor" is to be interpreted as a third party capital provider which includes lenders.

BEIS further noted that while subsidies may influence investment decisions in certain infrastructure sub-sectors, they were at least as interested in understanding the role of other market factors and the extent to which such factors could influence the cost of capital. Infrastructure as an asset class and related financing considerations are discussed in Chapter 2. The lessons for district heating network investment, which we draw from the interviews with equity investors and lenders, our literature review, and our experience in other infrastructure sub-sectors, are described in the following sections. We gratefully acknowledge the input of the interviewee equity investors and lenders, which are listed in the Appendix.

1.3 Summary of possible implications for district heat networks

In the table below we describe the possible implications for district heat networks of selected characteristics of the infrastructure sub-sectors we have reviewed. In sections 1.4 and 1.5 following the tables, we describe in high level terms the key and secondary factors for the successful establishment and expansion of an infrastructure sub-sector from a financing perspective. The findings for each sub-sector are described in detail in Chapter 3.

Table 1. Infrastructure sub-sectors and possible impicators for district heat networks

Infrastructure sub-sector	Selected characteristics	Possible implication for the pipe/meter network element of district heat networks
Energy from Waste (EfW)	<ul style="list-style-type: none"> • In part-merchant projects, of which there are a limited number, 60-70% of revenue is typically long term contracted with the remainder at merchant risk • Location is very important for part-merchant EfW projects in order to have as good a prospect as possible of capturing local/regional market share 	<ul style="list-style-type: none"> • Anchor customers, such as local authorities for their buildings, hospitals, leisure centres, and other public sector bodies or corporates are likely to be an important component of the customer mix for many district heating schemes • Investors can get comfortable with a minority component of demand being committed only for a shorter term, although this does constrain debt capacity and increase cost of finance • The benefits of more customer flexibility in having a shorter period or volume of commitment need to be considered in comparison with the implications for increased cost of finance and possibly a shorter period over which to recover fixed capital costs (requiring higher annual charges) • For district heating network projects the physical configuration, in particular the distance from the heat source and the amount of construction work needed to make connection to particular building(s), can have a significant impact on the economic viability of the scheme for financing
Offshore wind and ground – mounted solar generation	<ul style="list-style-type: none"> • Competitive allocation of subsidy support, and earlier administrative determination of subsidy support 	<ul style="list-style-type: none"> • Competitive allocation of subsidy support can help reduce the levels of subsidy required, especially if an energy market price benchmark is available • The amount of subsidy support can be reduced in line with cost reduction in the relevant industry, even when the subsidy level is determined administratively • Specialist, smaller scale investors may open up a new sub-sector before larger scale investors become involved as a new sub-sector grows and uncertainties are reduced

¹ For further information about BEIS's Heat Networks Delivery Unit and its work please see: <https://www.gov.uk/guidance/heat-networks-delivery-unit>

Table 1. Infrastructure sub-sectors and possible impicators for district heat networks

Infrastructure sub-sector	Selected characteristics	Possible implication for the pipe/meter network element of district heat networks
Smart meter portfolios	<ul style="list-style-type: none"> Regulation mandating smart-meter roll out has created a clear and quantifiable pipeline of investment required Ofgem's Supplier of Last Resort regime contributes to confidence that the meter assets are likely to have continuity of use 	<ul style="list-style-type: none"> In the absence of formal industry regulations, such as for Regulated Asset Base (RAB) network businesses, planning obligations accompanied by a development strategy (such as the Greater London Authority's London Plan) are a potential way for local authorities to achieve similar local outcomes for installation of district heating in developments There may be a role for a Supplier of Last Resort regime in district heating, subject to suitable powers to recover the costs of such a regime from a sufficiently broad base of consumers
Licensed offshore transmission links (OFTOs)	<ul style="list-style-type: none"> Payment is made for availability of the asset rather than for use of system Construction risk is taken by a different party, namely the offshore wind farm developer 	<ul style="list-style-type: none"> District heating networks, separate from the heat supply business, might consider availability payments rather than use of system charges as a mechanism for attracting a greater range of financing sources and possibly lower cost financing. However, such a structuring approach will probably have risk allocation implications either for the generator or the customer (or both). Financial viability of all elements will need to be considered Public sector support could be focused on mitigating construction risk in district heating schemes

Table 1. Infrastructure sub-sectors and possible impicators for district heat networks

Infrastructure sub-sector	Selected characteristics	Possible implication for the pipe/meter network element of district heat networks
Electricity inter-connectors – Ofgem's cap and floor regime	<ul style="list-style-type: none"> A mechanism (cap and floor) to provide a revenue envelope based on a range of approved investment returns has been accepted by corporate investors and is also being used by certain project financed interconnectors in development The floor element of the regime in effect provides that electricity consumers underwrite a minimum level of revenue, if the interconnector cannot achieve that level from periodic auctions of its capacity, subject to certain conditions 	<ul style="list-style-type: none"> For district heating schemes with public sector anchor loads, the level of base investment returns attributable to the public sector offtaker can be quantified. The public sector anchor loads providing a long term minimum take-or-pay commitment give more certainty, and probably enable better credit quality for projects. This can reduce cost of finance, by attracting debt, and also attract a wider range of investors for district heating network projects A revenue floor regime would potentially be attractive for district heating networks, particularly from the perspective of debt capacity. However, the underwriting of the floor would need to be subject to appropriate conditions to mitigate sub-floor revenues, and provisions to spread the cost over a suitably broad base of consumers
Licensed Regulated Asset Base (RAB) networks under economic regulation	<ul style="list-style-type: none"> Operator licences and an agreed customer pricing mechanism with periodic reviews which take account of changes in costs and financial market conditions 	<ul style="list-style-type: none"> Subject to suitable legal powers, local licencing, e.g. within a town, with a set pricing mechanism for new and existing customers could be a means for encouraging new investment in district heating networks through competition for licencing rights Subject to legal powers, potentially district heat networks could be added to existing RAB network businesses, if Ofgem and the industry parties were willing, and benefit from existing regulatory structures

Table 1. Infrastructure sub-sectors and possible implicators for district heat networks

Infrastructure sub-sector	Selected characteristics	Possible implication for the pipe/meter network element of district heat networks
Infrastructure Provider model as used in Thames Tideway Tunnel	<ul style="list-style-type: none"> Existing customers can, in certain circumstances, carry part of the cost of financing new infrastructure in its construction phase if there is sufficient resulting benefit in reduced financing costs 	<ul style="list-style-type: none"> Where public sector project sponsors are also future heat offtakers it may be feasible to provide investors with a construction period service charge revenue. This could help lower the long-term heat tariff and enable the projects to attract a wider range of investors during construction which should reduce the cost of finance Public sector value for money appraisals might include such mechanisms for consideration within project development, subject to appropriate risk management and milestones
PFI/PF2	<ul style="list-style-type: none"> Revenues, in most cases, are based on assets/service availability and are not demand-based Standardised contracts were produced to help authorities obtain better risk allocation and value for money. This standardisation helped make project financing viable for smaller projects (£20 million capital value) viable than would otherwise have been the case The use of industry publications and journals helped provide visibility of the capital value of the project pipeline to a wide investor pool 	<ul style="list-style-type: none"> PipeCo models for the distribution element of district heat networks, separate from the heat supply business, might consider availability payments rather than use of system charges as a mechanism for attracting a greater range of financing sources and possibly lower cost financing. However, such a structuring approach will probably have risk allocation implications either for the generator or the customer (or both) Currently few, if any, UK district heat network investment opportunities are advertised or reported in industry publications and journals aimed at financiers, unlike PFI/PPP/PF2 projects. Project sponsors and/or BEIS's HNDU could promote district heating projects looking for finance in such publications Standardised documents could be developed for district heat networks. However, these need not be full contracts but could set out the key risk allocation in core heads of terms. These can be developed into full documentation with mechanisms to share learning across the sub-sector, particularly from projects in receipt of any subsidy

Table 1. Infrastructure sub-sectors and possible implicators for district heat networks

Infrastructure sub-sector	Selected characteristics	Possible implication for the pipe/meter network element of district heat networks
PPP	<ul style="list-style-type: none"> Ministry of Defence's Project MODEL (Ministry of Defence estate in London): investors (construction and property sector corporates) have provided services to refurbish certain assets based on proceeds of a medium term programme of disposing of surplus property assets and bridge financing 	<ul style="list-style-type: none"> Identifying and awarding a pipeline of projects to a group of contractors and investors can help lower costs In certain cases, works can be funded from the proceeds of surplus property sales with sharing of profits between public and private sector

The table below shows the infrastructure sub-sectors that we reviewed and which of the key and secondary factors for financing, detailed in section 1.4 after the table, which they satisfy, and also certain other relevant features.

Table 2. Infrastructure sub-sectors and key and secondary factors for financing

Infrastructure sub-sectors	Energy from Waste	Offshore wind and ground mounted solar generation	Smart meter portfolios	Licensed offshore transmission links (OFTOs)	Licensed electricity interconnectors – Ofgem’s cap and floor regime	Licensed Regulated Asset Base (RAB) networks under economic regulation	Licensed Infrastructure Provider as used in Thames Tideway Tunnel	PFI/PF2	PPP
Key factors									
Predictability and stability of the revenue stream	✓	✓	✓	✓	✓	✓	✓	✓	✓
Adequacy of the level of net cash flow	✓	✓	✓	✓	✓	✓	✓	✓	✓
Visibility of sufficient value of future similar projects or large individual projects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Secondary factors									
Accepted technical solutions	✓	✓	✓	✓	✓	✓	✓	✓	More complex or innovative technical solutions may be involved
Standardised key terms for the licence or contract	PFI: ✓ Non PFI has developed its own market practice	✓	Based on aggregate effect of a set of regulations	✓	✓	✓	✓ With bespoke Government Support Package	✓	Customised depending on the project
Sufficiently short development periods	For non PFI projects, large corporate developers usually required	✓	✓	✓	Development periods and costs are a challenge in this sector, particularly for smaller developers	Development costs generally can be recovered as part of licensed revenues	Development costs recovered by Thames Water in its customer charging during development	✓ Authorities have funded their development costs	Development periods tend to be longer due to project specific requirements

Infrastructure sub-sectors	Energy from Waste	Offshore wind and ground mounted solar generation	Smart meter portfolios	Licensed offshore transmission links (OFTOs)	Licensed electricity interconnectors – Ofgem’s cap and floor regime	Licensed Regulated Asset Base (RAB) networks under economic regulation	Licensed Infrastructure Provider as used in Thames Tideway Tunnel	PFI/PF2	PPP
Secondary factors									
Stable regulatory regime	✓ Waste PFI programme ended	✓ Subsidy support has gradually reduced	✓	✓	✓ Relatively new regime	✓ Some recent changes tending to increase risk	✓ With bespoke Government Support Package	✓ Contract based	Usually project specific and contract based
Other features helpful to financing									
No demand risk exposure	Limited or minimal	Minimal: ✓	✓	✓	Minimal: ✓	✓	✓	✓ Availability based structures in most cases	Minimal or none
Medium to high capital value individual projects	✓	Offshore wind: ✓	Requires portfolio aggregation	✓	✓	✓	✓	✓ £20 million lower limit introduced by Government	✓
Relatively standardised volume produced equipment		✓	✓						

1.4 Key lessons to be drawn from other infrastructure sub-sectors

The lessons for district heating network investment, which we draw from the interviews with equity investors and lenders, our literature review, and our experience in other infrastructure sub-sectors, are as follows:

The **key factors** for the successful establishment and expansion of an infrastructure sub-sector, requiring significant initial capital investment from private sector investors are as follows. These factors are described in more detail in section 3.3.



Predictability and stability of the revenue stream

Predictability and stability of the revenue stream over the economic life of the relevant capital assets.

This is a fundamental requirement for raising infrastructure capital financing rather than seeking other, probably more costly, sources of capital. It can be achieved using a variety of mechanisms, as shown in the commentary on particular infrastructure sub-sectors in Chapter 3. Typically the strongest form of this predictability and stability is achieved by a contract or a licence under economic regulation. Interestingly, however, something close can be achieved to enable affordable financing and terms where the market position² of a business is particularly strong, or there is a joined-up interaction of regulatory requirements. Examples include part-merchant EfW projects with suitable technology, and smart meter portfolio financings. The timing of finance raising in the project development life-cycle needs to take account of how this key requirement for predictability and stability of the revenue stream is to be met.

Further detail is at section 3.3.

Findings for each infrastructure sub-sector are at sections 3.7-3.15.



Adequacy of the level of net cash flow

Adequacy of the level of net cash flow from the business to remunerate the types of equity investment and debt which have appetite for the proposition, often described as an acceptable risk/reward relationship for financing.

The physical scope of projects proposed for financing needs to take account of this key requirement, in particular where there are choices in deciding the scope to include and if there differences in the net cash flow generation of differing parts of the overall asset or network.

Further detail is at section 3.3.

Findings for each infrastructure sub-sector are at sections 3.7-3.15.



Visibility of sufficient value of similar future projects

Visibility of sufficient value of similar future projects, which may be small numbers of large projects or large numbers of smaller projects.


The general view of respondents was that unique individual projects below £10-20 million capital value³ would probably suffer from a diseconomy of the effort needed by equity investors and lenders to get them developed and negotiated. This would restrict the appetite of finance providers and limit competition. It can be mitigated by having common technical and commercial features among a sufficient number of individually smaller projects, and avoiding excessive complexity. A likely future pipeline of at least £300-400 million of projects in aggregate would be preferred, particularly by the larger scale equity investors and lenders. Providing visibility of this pipeline through both public sector and infrastructure finance trade press sources is also important.


Further detail is at section 3.3


Findings for each infrastructure sub-sector are at sections 3.7-3.15.


² This can arise from an advantageous physical location near major demand or supply sources, and/or difficulty in future of establishing competing new facilities for example

Certain **secondary factors** can also have a significant impact by increasing equity investor and lender interest in infrastructure sub-sectors and by stimulating competition to help drive down pricing. However, they are unlikely to offset a shortfall in the three key factors described above. These other features are measures which help to reduce development and negotiation periods prior to the start of construction, such as having:

 **Accepted technical solutions**, preferably having demonstrated capacity and reliability and previously having been accepted by financiers in successful projects.


 **Sufficiently short development periods**⁴. Infrastructure financiers' interest is strongest in projects and businesses that are sufficiently developed and so can be negotiated to financial close/ final investment decision (FID) within 12-15 months.


 **Standardised key terms for the licence or contract** for the infrastructure business's revenues which address the allocation of risk, how payment and performance relate to each other and provide the basis for predictable and stable revenues.

 **A stable regulatory regime** for consumer protection (where applicable) and producers/ suppliers which is understood and accepted by financiers. This is linked to sufficiently broad political support for the policies underlying the regulatory regime, whether based on licences or contracts.

These secondary factors are described further in section 3.4.

1.5 Other considerations

 There is a **spectrum of appetite for risk and reward levels across different infrastructure sub-sectors** but there are, in practice, distinct limits to the upper level of risk that will be accepted before the volume of finance available declines, and its price rises. Both of these aspects of finance can be affected substantially. Demand volume and/or price risk and construction/technology risk are in most cases the key drivers of whether a business is within these de facto limits. Generally, such limits are established by analysis, precedents, and market practice rather than being set in prescribed rules or regulations. An exception to this, for some equity investors and lenders, are the minimum credit rating level requirements set in regulations, such as Solvency II⁵ for EU based insurance companies. The EfW sub-sector provides examples of where the de facto limits have been explored in projects which have been able to include somewhat higher risk levels than in most other infrastructure sub-sectors – see section 3.8 for further details.

 Respondents felt, and we agree, that there is an important role for the public sector, industry press, and advisors to play in **increasing the engagement of project sponsors with the infrastructure finance markets** and enabling a wider understanding of the type of risk analysis expected.


In particular, because infrastructure finance is usually priced lower than finance in sectors with more risk, infrastructure financiers will typically wish to spend time early in the analysis process thinking about key downside cases. Their purpose is to understand how the applicable risk mitigations would work in practice in different commercial scenarios. This does not indicate a negative attitude; it is merely the normal process in the infrastructure sector.

Standardisation of the risk allocation and approach to calibration of payment terms for the main district heating propositions could also help these questions to be answered more quickly. This would improve the process, especially if individual projects are moderately sized. These main propositions would include new-build residential schemes and schemes with public sector heat offtakers. Key areas to be addressed in standardisation of risk allocation would include:

- expected maximum proportion of demand volume risk (that is, how low any take-or-pay heat offtake volume level is),
- range of tenor/maturity of heat offtake commitments taking account of public procurement considerations and retail consumer protection,
- expected maximum exposure to fuel price fluctuation risk (that is, not passed through to heat supply customers or retained by the heat generator),
- choice of any index/indices to be used in periodically revising charges payable to heat network owner,
- party to be responsible for different from expected efficiency (heat yield) from generation plant,
- approach(es) to allocating common element costs between different phases for multi-phase district heating networks, and approach to splitting projects of longer than a four year construction period into more than one phase⁶ to match finance availability periods (see also section 3.3.2),
- expected range of credit ratings of public sector and corporate heat offtakers (or relevant parent company guarantee providers or other providers of contingent support, in the event of financial distress of an offtaker),

- any permissible arrangements for the district heating network to recover losses due to defaulting customers from other customers, and
- basis of compensation to finance providers for early termination of a heat supply agreement or early retirement of a heat source.

The key purpose of this standardisation would be to enable equity investors and senior lenders to understand the degree of risk of fluctuation in, respectively, equity returns and cashflow available for debt service that there would be in different scenarios. The standardisation of key terms would also encourage aggregation of projects, potentially yielding economies of scale.

 In general, **first and early projects that open up a new infrastructure sub-sector to private sector finance** are expected to have higher returns than later projects when precedents have been established and less development work is required. Infrastructure financiers are willing to invest their time in helping structure and negotiate projects in new sub-sectors⁷, where there is a prospect of a significant pipeline of further business. However, this does not appear to extend to a willingness to compromise on the three key factors above. The cost of finance tends to decline⁸, and certain terms may be loosened to a degree, as new sub-sectors become more established as projects are financed. For these reasons, there is little incentive for financiers to provide discounted facilities or softer terms for the initial projects in a new sub-sector. The initial investors may sell the operating project(s) to subsequent investors who will often aggregate smaller early projects as the sub-sector matures.

³ Below this capital value, projects have less access to the infrastructure investors and lenders are most likely to be financed from a corporate balance sheet or equity only rather than being project financed with a mix of debt and equity. This is due to the costs of structuring and negotiating project financing

⁴ Development period refers to the period prior to construction of the assets of the project. In practice there can be financing discussions at any time during the development period; however more active engagement by financiers is more likely when FID/financial close is expected to be within 12-15 months.

⁵ Further information at: <https://www.bankofengland.co.uk/prudential-regulation/key-initiatives/solvency-ii>

⁶ The balance of public and private financing and risk profile may vary between phases if the public sector is willing to provide either additional support for risks or financing in earlier phases

⁷ The projects in new sub-sectors may be new in their technical nature, or their contractual or regulatory structures

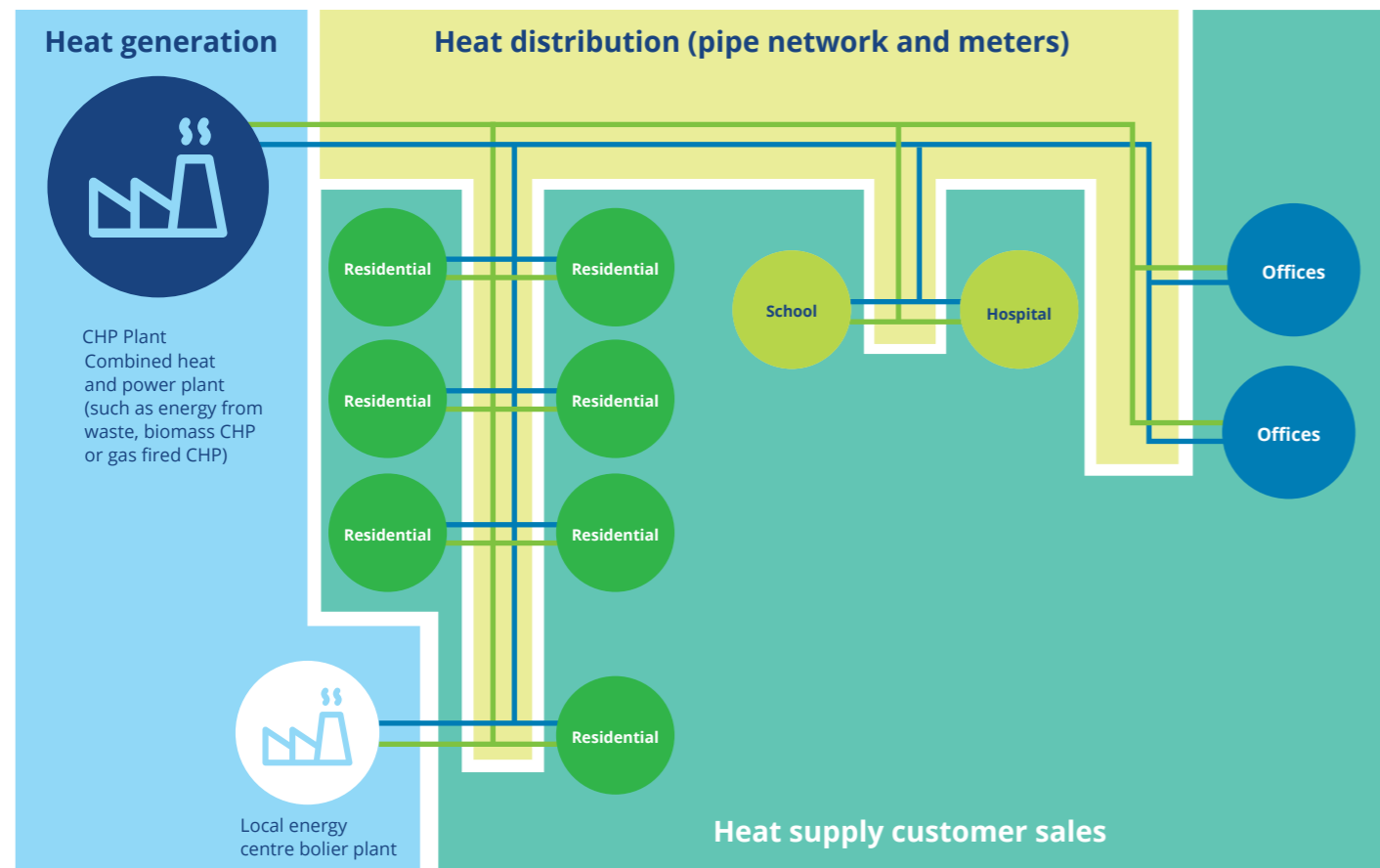
⁸ However, this may not be the case where there is market disruption, recession, an increase in underlying interest rates by central banks, or financial crisis.

£ Infrastructure equity investment and debt market conditions are positive at present (early 2018) as the financial crisis period of 2008-14 (in the UK, continental Europe and the US) recedes. Equity investors and lenders in the infrastructure sector work on a trans-national basis in developed country markets, and so financial market conditions in major countries and regions are linked. These positive conditions have been reflected in somewhat lower pricing of equity and debt for infrastructure, increased appetite for larger equity investments and loans than in recent previous years, and willingness to consider propositions with somewhat higher credit risk than has been the case over the past decade.

This is a positive background for the district heating network sector to develop commercial structures that put in place its version of the key and secondary factors identified above and described in more detail later in this report.

1.6 Heat generation, distribution, and supply roles in district heating network projects

Figure 1. Elements of a district heating scheme



The diagram above illustrates the different elements of an example district heating scheme, starting with a heat source (generation), a pipeline and meter networks which brings the heat to individual buildings (distribution), and sale of heat to customers (supply). These three elements of a district heating business can relate to each other commercially in different ways ranging from full integration to separate ownership of each.

The infrastructure sub-sectors which we have reviewed are similar to the heat distribution element (that is, the pipe network from the heat source up to the heat meter points) of district heat/cooling networks. The revenue regime of the other infrastructure sub-sectors we have reviewed in this report is often structured to be paid a fee on an availability basis, or a use of system basis with a sufficiently high take-or-pay floor revenue level. The exceptions are the EfW sub-sector and the Ofgem electricity interconnector cap and floor regime (see sections 3.8 and 3.10 respectively).

Providing a highly de-risked revenue stream to the distribution business may shift so much risk onto the heat generation and/or supply businesses to make them unviable. It is necessary to optimise the overall risk allocation across the three elements to achieve a competitive and value for money solution that works for all of the parties. In general, the higher the levels of assured heat demand and the longer the period of this confidence the more feasible a relatively lower cost and longer term financing approach should be feasible. See also section 2.6.

2. Infrastructure through an investment lens

2.1 Chapter overview

In this chapter we outline certain key context matters in the infrastructure sector affecting how it is viewed by investors, lenders, and other stakeholders. We provide the detailed findings of our work in Chapter 3.

2.2 “Infrastructure” means different things to different people

Although the term is commonly used, the word “infrastructure” often carries different meaning and implications when used by different parties. On one hand, often for some financial investors, “infrastructure” means diversified portfolios of existing operational assets with low or no demand risk over their economic lives. On the other hand, often for some public stakeholders, “infrastructure” means individual new facilities, to be constructed, then operated over their economic lives, but for which there may be some form of alternative, competing facility or solution. For this reason it is necessary for financing purposes to be clear what sort and characteristics of infrastructure are being discussed.

There are important distinctions between the characteristics and risks of the various sub-sectors within the broad category of “infrastructure”. Key for financiers is the distinction between infrastructure businesses that include a significant degree of demand volume and/or price risk versus those which have stable, highly predictable revenues over the economic life of the relevant assets. This distinction is important for the:

- cost of capital,
- appetite of certain categories of equity investor and lender, and
- volume of finance available.

If too much demand volume and/or price risk is included, the asset or proposition ceases to be pure infrastructure in the eyes of most equity investors and lenders. The consequence is that the asset or proposition will likely need to seek more expensive and shorter maturity capital from different investors, targeting capital in more contested sectors that is accustomed to more upside potential (and probably also more downside exposure). However, in the current debt market we have seen evidence of increased appetite for infrastructure with a quantifiable and limited degree of additional risk⁹ because insurance companies and pension funds are seeking higher yields than are available on sovereign bonds and traditional core infrastructure.

In this report we have addressed the infrastructure sector broadly, but included infrastructure sub-sectors in which:

- there is some element of demand volume and/or price risk. This is because these characteristics are common to many heat network projects being developed in the UK, and
- infrastructure equity investors and lenders have been able to get comfortable with the overall risk/reward balance and provide significant amounts of capital.

We have termed such sub-sectors “quasi-infrastructure” in this report, although other expressions such as “core-plus infrastructure” are also used in the markets.

2.3 Infrastructure as an asset class

The market for infrastructure investments and debt is typically divided into two areas:

- **Primary market:** New projects that are, or will be, under construction. Here, the project developers are seeking equity investors and lenders (where applicable) directly.
- **Secondary market:** Typically, projects in operation. Here, the project already has investors and often lenders, but they are seeking to sell either their equity stake or their debt. Within the secondary market, the project equity owners may also seek to refinance their existing debt to achieve lower pricing, higher gearing, and/or longer maturity.

⁹ This is quantified as credit quality of approximately BB/Ba/BB on the Standard & Poor’s/Moody’s/Fitch credit rating agency scales

Infrastructure as an investible asset class is characterised by a number of key features, which we summarise below and note how these may appear or be treated in district heat networks, which are at an early stage of development as an infrastructure financing proposition. We discuss how such risks are mitigated in section 3.7 onwards for selected existing infrastructure sub-sectors.

Table 3. Key feature in existing infrastructure sub-sectors as related to district heating networks

	Key feature in existing infrastructure sub-sectors	Likely manifestation and treatment in district heating networks
1	A construction period of typically 1-4 years during which time the assets are built and no revenues are generated. Projects with longer duration construction may be undertaken in phases, and there may be revenues from existing related infrastructure assets. Investors and lenders funding projects in the primary market face higher risk than for operational projects due to the possibility of construction delays and cost overruns.	Similar, although phasing may be more common as district heat networks are expanded over time.
2	An operational period of typically 15-25 years where project revenues are generated. Typically, such a long operating life is needed to justify the capital-intensive initial investment and to make the usage of the assets affordable to the relevant customers or authority. Transactions in this period are in the secondary market, and benefit from a lower risk profile and cost of finance because construction is complete and revenues are clearer.	The pipe and network assets of a district heating network would have a similar, or longer, economic life. The heat source may have a shorter life than the network assets, depending on the technology used.
3	Demand and revenue that is predictable, stable, and adequate. "Pure" or "core" infrastructure has demand and revenue characteristics which are relatively certain and which do not fluctuate significantly with economic cycles. In most cases, regulatory or long-term contractual mechanisms are needed to secure the benefits of this relative stability. Investors and lenders will assess a project's viability and credit quality, and the period of demand price/volume certainty. Infrastructure financing requires a relatively high level of certainty. Moreover, financing is more accessible where the revenues are based on the assets being available for use (e.g. an asset is operational and not down for maintenance), rather than being exposed to demand risk.	Various district heating projects are considering to what degree the pipe network and metering elements of the project can be provided with more stable revenues over a sufficiently long period to optimise the spreading out (amortisation) of capital costs. If the pipe network and metering elements can be shielded from some or all of the demand risk, without imposing excessive risk on the heat generation or heat supply parts of the business, then they will have more infrastructure-like risk characteristics. In some cases, local authorities may be willing to consider the pipe network and metering elements to be local core infrastructure that would encourage future investment and which they are willing to finance over the long term, subject to an acceptable risk profile and their budgetary position.

Table 3. Key feature in existing infrastructure sub-sectors as related to district heating networks

	Key feature in existing infrastructure sub-sectors	Likely manifestation and treatment in district heating networks
4	Protection from inflation , whereby revenues generated from the assets track an inflation index (in the UK this is typically RPI or, increasingly, CPI-H), is more attractive to investors with liability risk such as pension funds and institutional investors. Where revenues are on a fixed-price basis (without inflation indexation), this can restrict access to finance. The infrastructure owner may have certain obligations to hedge or bear an element of inflation risk on its capital replacement and/or operating costs in return for being provided with indexed revenues.	District heating is likely to be cost competitive with alternative heating solutions in order to maintain consumer acceptance in residential schemes, which may constrain the extent to which indexation can be provided. The degree of need for indexation is likely also to be linked to the degree of replacement capital expenditure required, and this may be lower in a district heating network than more dispersed long distance networks in RAB network businesses.
5	The technology and approach to construction should be well-established with known risks, so much so that lower returns are acceptable as long as there is confidence that the technology will perform as expected. To support financing, the preference is for proven, reliable technology with no or very low risk of obsolescence to minimise risk of reduced returns or the capital itself.	We understand that the technology of district heating is well understood and established and the sector does not require unproven technical solutions.
6	Regulatory support can be critical for large projects by providing predictability, transparency, and, in certain cases, regulatory duties to ensure company "financeability". Licensing can also be seen as a tool to secure demand and act as barrier to new competition.	We understand that regulation in the district heating sector is currently focused on metering arrangements.
7	Where revenues are not subject to a regulatory regime, the revenue should be contract-backed to provide sufficient confidence in projected cash flow, and minimise market risk. These contracts will need to be with counterparties of sufficient credit quality to bear the payment and liability obligations of the contracts. The proportion of revenues that need to be contract-backed will depend on the nature of the project and market, as well as the financing risk appetite and debt levels. Construction costs should similarly be predictable, and supported by suitable forms of contract taking account of the relevant assets to be built and supply chains.	We understand that long term contracts are the principal means of providing certainty of revenues to district heating networks from corporate or public sector heat offtakers.

Table 3. Key feature in existing infrastructure sub-sectors as related to district heating networks

	Key feature in existing infrastructure sub-sectors	Likely manifestation and treatment in district heating networks
8	Government support and policy environment similarly can assuage concerns on revenue or demand uncertainty, lowering the project risk, and providing a potential recourse to government guarantees or protection. Construction contracts or regulatory support for large construction projects are typically influenced by government policies.	Government is providing the Heat Networks Investment Project ¹⁰ (HNIP) scheme of support as a means of stimulating development of the district heating sector.
9	Low volatility and risk of returns, and preferably with investment grade credit rating , is required for infrastructure investors and lenders. Moreover, whilst incrementally lower returns might be tolerable, there should very little, if any, stranding or total loss (sometimes referred to as “wipe-out”) risk. This is the result of the features above and the test of whether in aggregate they have achieved the required result. Investment grade credit rating of debt is discussed in section 3.3.1.	This is the goal being sought in the district heating sector, in addition to appropriate levels of returns and scale of opportunity

2.4 A mandate for investment: equity investor and senior lender perspectives

Most infrastructure provision requires the raising of a large volume of initial capital financing for construction of the assets, followed by a long period of operation to spread out the costs on an affordable basis. This also makes it necessary to achieve a longer maturity (in years) of financing and lower cost of capital (in percent per annum) than for businesses in non-infrastructure sectors. In most cases financing for infrastructure will be provided in a combination of equity and debt.

Financing for new infrastructure may be raised by a corporate entity with a range of similar existing assets, as is the case in most licensed network businesses such as water supply networks, and electricity and gas networks. Alternatively, it may be raised by a business which will only own the specific infrastructure asset to be built and operated. This is known as “project financing”, as distinct from “corporate financing”. In project financing a newly-established special purpose vehicle (SPV), usually a company, is used to own the relevant assets. Usually, such SPVs are not permitted to undertake other businesses.

The two major classes of capital finance provider for infrastructure are equity investors and senior lenders and we show at Appendix 2 the names of the interviewee businesses for this report. There are also additional types such as tax-based equity (related to Venture Capital Trusts and Enterprise Investment Schemes) and leasing, but it is outside the scope of this report to detail all of these.

2.4.1 Equity investors

Equity investors¹¹ are looking to deploy capital to earn a return at or above a target level, and expect an ability to manage the ownership of the businesses subject to the scale of their investment. This may provide investors with the opportunity to realise economies of operation and/or administration and/or debt financing. In some cases it may also be feasible to earn additional revenues by aggregating assets into a larger business. Typically, in infrastructure sub-sectors the equity investment decisions are being made by investment managers who are following a mandate from the investors or pension fund which prescribes the nature and level of acceptable risks, the investment returns sought, and the time horizon over which the returns have to be realised.

In the case of infrastructure equity investment, lower risks are required than would be the case for non-infrastructure businesses which are subject to (more) competition, but lower returns¹² can also be accepted. Some types of equity investor will invest in regulated network infrastructure businesses while others have appetite to provide equity to project SPVs, as discussed further below. Equity investors may also inject some of their capital in the form of subordinated debt, which has the benefit of tax-deductibility subject to certain rules, particularly in the case of project financing.

To give a sense of the scale of infrastructure investment flows across all sub-sectors, a league table of the 50 largest international infrastructure investment managers produced by Infrastructure Investor¹³ based on funds raised over a five year period between 2012 and 2017 showed a range from US\$36.5bn to \$1.3bn raised, in first and 50th places respectively.

¹⁰ See: <https://www.gov.uk/government/publications/heat-networks-investment-project-hnip>

¹¹ BEIS’s HNDU maintains a listing of investors interested in the district heat sector at <https://www.gov.uk/guidance/heat-networks-overview#investing-in-heat-networks>

¹² For example, see: <https://am.jpmorgan.com/blobcontent/1383271579721/83456/Infrastructure-Investing-Key-benefits-and-risks.pdf>

¹³ See: <https://d16yj43vx3i1f6.cloudfront.net/uploads/sites/16/2017/11/2017-II-50-1.pdf> (registration required)

Most equity investors expect the infrastructure businesses in which they invest to also raise debt, but some do not. “Unlevered equity” is provided by certain institutions which prefer to provide equity financing which is not accompanied by debt. The providers of this category of equity emphasise their greater ability to deal with construction and roll-out (expansion) risks more easily since there is no need to service debt and agree the covenants and constraints which project financing lenders would require.

In our interviews it was noted that UK pension fund investors tend to have a strong desire for index-linked returns to match their liabilities, in comparison to their non-UK equivalents.

2.4.2 Senior lenders

Senior lenders in infrastructure sub-sectors are seeking to earn fees and a margin¹⁴ over their funding costs from providing debt to infrastructure businesses. Such businesses may be owned by corporates, established organisations such as local authorities, or project SPVs. Senior lenders normally do not have access to upside benefits, that is, their income from the project is fixed and not related to performance. Even if the project does better than anticipated due to lower costs or additional revenues achieved by management of the business, lenders usually do not see additional income (although in some cases they may be repaid earlier than originally scheduled), unlike equity investors.

Consequently, senior lenders place greater emphasis on downside protections. These protections can include mechanisms such as limits on total borrowings, cash reserve accounts, and the ability to constrain dividend pay-outs in certain circumstances. Lenders therefore undertake due diligence on markets, regulation, technology, counterparties, legal matters and insurance. Their priority is the timely payment in full of principal, interest, and fees on their loans. These infrastructure lenders may be banks or other financial institutions which buy bond debt (or provide private placements of debt).

In the infrastructure finance markets, larger volumes of debt at lower pricing and less onerous terms are available for higher credit quality borrowers, such as listed¹⁵ regulated network businesses, than for project SPVs. This is particularly the case during the construction phase of project financings where the revenue-producing asset is being built and there is not yet cashflow being produced.

The following comments in this sub-section regarding senior lenders are from our interviews. Insurance company lenders based in the EU are subject to the Solvency II regulations, which influence their appetite for debt of different levels of credit quality. In particular, this makes it more difficult for them to provide large volumes of debt below single-A credit rating level. Consequently, they have less appetite for projects involving construction risk, which usually involves a lower credit rating, than for operational infrastructure.

Pension funds provide a certain allocation of financing for infrastructure debt. Their appetite is generally for investment grade (BBB – level or higher) because they are not subject to the EU’s Solvency II regulations. Some funds also have an allocation to sub-investment grade debt. A flow of interest payments from year one, often referred to as “yield”, is usually required which makes new build assets more difficult to finance from this source.

In the case of debt from infrastructure funds, the credit quality required will depend on the fund objectives, and the investors it attracts. They will typically have a mix of the insurance company and pension fund institutional investors, with the commensurate credit rating and return targets.

2.5 Contracted versus regulated basis for revenues

In most cases for infrastructure assets the basis of the level of demand and the pricing of the output is either set in a long term contract or controlled by an economic regulator. In general, once a project is contracted, or a business is licensed to carry on its business, in the infrastructure sub-sectors considered in this report the project/business is subject either to no demand price or volume risk or only strictly limited amounts of such risk.

The presence of material amounts of demand risk (more than approximately 10-15% of revenues) marks a boundary with quasi-infrastructure businesses and projects. Examples of quasi-infrastructure businesses include:

- ports and airports with relatively strong market positions which are able to raise significant amounts of medium term debt in addition to equity;
- real toll (as distinct from availability-based shadow¹⁶ toll) roads;
- light rail projects with (typically, limited) demand risk; and
- part merchant (that is, having to find customers and probably only have relatively short term (1-3 year) contracts with them rather than benefiting from a long term contract for all of the waste inflow) waste projects.

The manner in which the demand risk in quasi-infrastructure projects appears can vary. In some cases, there may be an element of contracted demand but a portion is merchant. In other cases there is not a contracted minimum level but features such as historical experience and factors such as a dominant market position reinforced by planning constraints may provide financiers with sufficient confidence. In some sub-sectors, expert forecasts on levels of demand and feasible pricing have been used, for example for toll roads, in combination with analysis of alternative options for customers. In almost all cases the proportion of debt which can be raised by such businesses is lower and its maturity shorter than for pure infrastructure businesses.

Usually there is not a particular, distinct cut-off point of “unfinanceability” as demand certainty reduces. However, for context most private sector businesses in contested sectors can only borrow for 3-5 years at most which is too short to spread out the cost of most infrastructure assets. The cost of equity also rises with the greater risk. Consequently, the impact of too little certainty of demand is that the project becomes unaffordable (or uncompetitive) due to the inability to spread its capital cost over a sufficient period using debt, and its cost of capital being too high. The lack of sufficient long maturity debt is usually the critical factor.

¹⁴ A loan interest rate usually comprises a margin or spread in addition to an underlying base or reference interest rate

¹⁵ Quoted on a stock market, such as the London Stock Exchange

¹⁶ In a shadow toll road, drivers do not pay a toll but the road owner receives an availability-based revenue stream, which may include a limited component linked to traffic or congestion levels and/or be subject to certain deductions based on quality of surface and/or other metrics.

2.6 Roles of heat supply versus heat distribution and generation

In general, pure infrastructure businesses do not supply retail customers that have a choice of provider or technical solution. However, there are moves to introduce a degree of competition for water and sewerage companies in England and Wales. The customers of the quasi-infrastructure businesses above do generally have a choice of port, airport, road, public transport mode, or waste treatment plant to use.

Private investors are assessing where on the spectrum of pure infrastructure to quasi-infrastructure UK district heating projects lie, and consequently the terms of private sector finance that might be applied. Potentially the pipe network and heat meters of a district heat network can be pure infrastructure businesses, subject to:

- customers either not having a practical alternative heat source, or in the case of large public sector or corporate customers there is a mechanism to compensate financiers to an appropriate degree if the customer(s) withdraw from a heat offtake contract and this adversely affects the net cashflows of the district heat network business; and
- sufficient confidence that the heat source will remain available (and be renewed if it has a shorter life cycle than the district heat network).

The closer to pure infrastructure any district heating proposition can be made, then the lower the pricing, longer the maturity, and better the terms of finance that could be achieved. For example, based on our experience and the interviews conducted, these cost of finance benefits should be realised if, for example:

- it is highly unlikely (or impossible) that connected consumers will change from the district heating solution, and/or
- where the network is to supply new build properties that all phases of a development will be built, occupied and start taking heat in the expected timing, and/or

- sufficiently long maturity, and high volume (where a volume based charging mechanism is adopted) heat purchase commitments can be provided by corporate and/or public sector offtakers in schemes where such offtakers are participating.

However, it is also necessary to retain an appropriate degree of future flexibility (as opposed to fixed price and volume commitments) for public sector bodies in their energy purchasing arrangements. Residential heat consumers require appropriate consumer protections and assurance of quality of service. Certain of these considerations of degree of commitment in future demand levels and period of commitment, for example taking account of public sector procurement regulations regarding the expected maximum term of long term contracts, may cause the cost of finance to be somewhat higher than it might otherwise be in less flexible arrangements.

In the next chapter, we present our detailed findings from the interviews conducted and our literature review.

3. Our findings by infrastructure sub-sector

3.1 Chapter overview

This chapter covers the characteristics of selected infrastructure sub-sectors. By drawing on lessons from the literature, case studies, interviews with investors, and our experience, we provide insights into which characteristics are key for attracting and sustaining investment. Firstly, we describe which characteristics attract investment in an infrastructure sub-sector. Secondly, we describe our findings in each of the infrastructure sub-sectors considered, in sections 3.8-3.15 as shown in the table below.

Infrastructure sub-sector	Section	Page
PFI/PF2 projects (including Scottish hub projects)	3.14	66
PPP projects	3.15	71

Infrastructure sub-sector	Section	Page
Energy-from-waste projects	3.8	38
Renewable power: offshore wind and ground-mounted solar	3.9	43
Case study: Smart metering	3.9	47
Competitive offshore electricity networks: Offshore Transmission Owner (OFTO) licences	3.10	50
Case study: Ofgem's Cap and Floor Interconnector Regime	3.10	53
Monopoly networks: Regulated Asset Base companies in energy and water sectors	3.11	56
Case study: Thames Tideway Tunnel	3.12	59
Forthcoming competitive onshore networks: Ofgem's Competitively Appointed Transmission Owner (CATO) and Transmission Owner-SPV models and Ofwat's Direct Procurement for Customers model	3.13	62

The margin component of the interest rate on a loan or bond mostly reflects the risk of the borrower, the maturity period of the loan, the identity of the owner(s) of the borrower, and the level of lender interest in the relevant sub-sector. The margin is added to the relevant swap rate²¹ or gilt yield to produce the total interest rate. Margins for infrastructure projects are generally in the range of 1.5-2.75% p.a. for new-build infrastructure projects without demand risk, although they were higher at times during the financial crisis period of 2008-14.

Longer maturity debt usually carries higher interest rates within this range. Yields and spreads have been increasing slightly over the past year, as measured for example by the yield on Sterling BBB rated 10 year bonds as shown in the chart from the Bloomberg financial database below, but are still below their levels of late 2013 to mid 2016. One of our interviewees noted that in sub-investment grade debt the margin would probably be 3% p.a. minimum.

Figure 2. Yields on 10 year Sterling BBB rated bonds by non-financial issuers 2013-2018



Source: Bloomberg

In addition, there will also be some initial fees, of up to 1.5-2% of principal amount. There will also be ongoing administration fees on the debt, which vary between types of debt and are higher if construction period financial structuring and monitoring is required. Bank loans are generally at a floating rate of interest and infrastructure lenders typically require these to be swapped into fixed or index-linked bases to match the project's revenue structure, with additional costs.

For RAB network utility businesses, which are usually required to have an investment grade credit rating in the licensed business, debt yields in the listed bond market are in the region of 2.8-3.2% p.a. in recent markets, a credit spread/margin of 1-1.4% p.a. over the UK Government debt securities (gilts) of comparable maturity.

The timing of yield requirements²² also vary between investor types and whether a cash yield is needed from the first year of investment or if the investor can accept a build period of a limited number of years before cash returns are received as initial dividends.

In general, construction periods of up to four years can be considered by certain investors that are accustomed to taking construction period risk, as is the case in the PFI/PF2/PPP market. Regulated network businesses may undertake longer programmes of work, but it is rare for individual projects to have longer than a 3-4 year period before revenues are received. Infrastructure funds and institutional investors typically require returns within a year of initial investment and for this reason their investment mostly focuses on operational assets.

One of our interviewees pointed out that if a cash yield is available during construction then this cash can, if necessary, be recycled into the project to provide a buffer from cost overruns and avoiding the need for further new finance, subject to the amounts of overrun and cash yield during construction.

Construction periods of longer than four years are rare for individual projects, and where they occur are more likely to require a strategic decision by an investor as to why something exceptional should be done for a particular project in the light of the project or sub-sector opportunity. Such projects with long construction periods are also more likely to be of high capital value and may involve more bespoke commercial and financial arrangements, as was the case for example for Crossrail, High Speed 2 and the Hinkley Point C nuclear power station. Investors and lenders are likely to seek ways of splitting projects into phases if the construction period is longer than four years because this suits the availability of finance better.

In some infrastructure sub-sectors, reaching an adequate level of revenues and returns has required a subsidy component to be added to revenues. In recent years there has been a move to greater use of competitive processes to allocate subsidies or reduce charges that will be passed through to customers. This appears to have had the effect of reducing required subsidy amounts or charges, and possibly eliminating the need for subsidies in certain cases. Examples include OFTO tenders, CfD auctions, and aspects of the Transmission Owner-SPV model and Direct Procurement for Customers proposed by Ofgem and Ofwat respectively. There is wide variation across infrastructure sub-sectors as to whether subsidies are required, depending on policy objectives, technology maturity, and progress towards achieving economies of scale. District heating networks are at a very early stage of the process of accessing private sector long term financing by comparison with the infrastructure sub-sectors considered in this report.

21 In general, banks price their loans over swap rate and bonds and private placements are priced over a gilt (UK sovereign bond) of equivalent weighted average maturity

22 Measured in % p.a. over the relevant investment horizon, usually after taking account of tax in the investee infrastructure business and in nominal terms, for example as an equity internal rate of return (IRR). The yield expected to be received in individual years is also important and many lower cost types of investor require yield to be stable rather than delayed or heavily back-ended in the investment period

3.3.3 Visibility of sufficient value of similar future projects

The scale of future opportunity across a whole sub-sector is key when equity investors and lenders are considering entering a new sub-sector in which they have not previously invested. Investors require visibility of sufficient value of future projects, which may be small numbers of large projects or large numbers of smaller projects. The general view of respondents was that individual projects below £10-20 million capital value²³ would probably suffer from a diseconomy of the effort needed by equity investors and lenders to get them developed and negotiated, unless there was a sufficient pipeline of similar projects. An insufficient pipeline would constrain the appetite of, and competition by, finance providers.

Equity fund managers do not normally consider investment of less than £10m as the investment of time to assess these opportunities, and therefore the fees they need to charge, make smaller investments uneconomic for them. Aggregation of smaller projects, with standardised structures, can help in making small projects viable to evaluate and finance. For large lenders, £30-100m is a typical range of single project commitment per lender, but in some cases larger scale lenders can provide up to £250m per project.

A likely future pipeline of at least £300-400m of projects in aggregate in an infrastructure sub-sector would be preferred, particularly by the larger scale equity investors and lenders. This pipeline is required to:

- justify up-front costs of assessing in detail a new sub-sector and its initial project(s);
- provide a prospect for long-run efficiencies and a competitive advantage; and
- cover an element of trial and error whereby a failed offer to finance a project could be learned from and recompensed through winning future ones.

Without such a future pipeline, project capital expenditure sizes of less than £10m-£20m will be difficult to invest in or lend to on a basis suitable for sponsors'/procurers' affordability requirements, due to financiers' costs relative to the potential returns available. One of our interviewees commented that even £100m is still too small a pipeline since it is unlikely that any one financier will win all of the projects, unless it is a niche market where the financier has a competitive advantage.

3.4 Secondary factors

There are also several further, secondary factors which, although less critical than those above, also make a significant contribution to the growth in financiers' appetite for equity investments and lending for infrastructure sub-sectors, as follows.

3.4.1 Accepted technical solutions

Most of our respondents, particularly lenders, mentioned the need for reliable technical solutions that could be considered proven technology in order for the overall risk proposition to be suitable for infrastructure financing.

New technology is considerably more challenging to finance in the infrastructure sector, particularly for lenders. Lenders are typically looking to see several reference plants, with a history of operation, in order to establish that a technology is proven. Infrastructure equity investors are more likely to consider less established technologies, but within limits and their appetite for this category of risk is far less than that of technology or venture capital investors. This is also reflected in the relatively longer time horizons and lower cost of finance of infrastructure equity investors than these other categories of investor.

Construction risk for new projects is reflected in credit ratings or credit assessments. The extent to which time and cost overrun risks can be mitigated will influence the availability and pricing of finance. The impact of time overruns can be worse due to foregone revenues as well as the increased costs that usually accompany delays.

The type of construction contracts for a new-build project will be significant in determining the credit rating²⁴ of the project in its current stage, as will the credit quality of the construction contractor (or major equipment supplier in the case of manufactured items such as trains or gas turbines). Due to the risk of cost overruns, investors with a mandate for low-risk and low-volatility will have a preference for wrapped construction contracts (such as EPC) where the contractor takes more risk but for a higher contract price. However, this is a less significant consideration if other aspects of the project are below investment grade or the high end of non-investment grade.

3.4.2 Standardisation of licence or contract

Standardisation of the key terms of the main documentation, whether contract or licence, providing the basis for revenues across projects in a sub-sector helps justify high up-front investment/transaction costs with the expectation that efficiencies will be made. Moreover, gaining familiarity with this documentation forms part of a financier's intellectual property and commercial advantage. Whilst the public sector has led some document development and standardisation, such as PFI and PF2, the private sector has had a larger role elsewhere, such as with smart metering.

The relevant level of detail would be risk allocation, with explanation of the risks to be transferred to equity investors and lenders to enable pricing of these risks and could include heads of terms rather than having full draft contracts in the manner of PFI standardisation. In some cases, there has been more than one standard or closely related type.

Where a sub-sector is establishing itself, one equity interviewee considered that pioneer projects should establish the standards rather than aiming for perfection first, which would delay the market. However, public sector parties in the infrastructure sub-sectors also have to consider their responsibilities to achieve value for money and their governance scrutiny.

3.4.3 Sufficiently short development periods

Development periods for new-build projects before being able to deploy capital should preferably be less than 12-15 months, both to minimise the development costs but also because of the need of many infrastructure equity investors to deploy funds within 3 years of closing them (i.e. raising the fund finance) to achieve their target returns.

3.4.4 Stable regulatory regime

A stable regulatory regime for consumer protection (where applicable) and producers/suppliers which is understood and accepted by financiers is a significant positive factor for infrastructure equity investment and lending. This is linked to sufficiently broad political support for the policies underlying the regulatory regime, whether based on licences or contracts. Historically, this has been the case in the UK which has not seen the retrospective changes to infrastructure support regimes that took place in certain other EU countries in the financial crisis period. This positive feature of the UK regulatory environment has been a significant attractive feature of the UK.

²³ Value of capital expenditure

²⁴ See <https://www.moodys.com/researchandratings/methodology/003006001/rating-methodologies/methodology/003006001/003006001/-/1/0/-/1/en/global/rr> for examples (registration required)

3.5 Other considerations

The other considerations influencing equity investment and lending appetite which were raised in our interview discussions were as follows.

- In general, **first and early projects that open up a new sub-sector to private sector finance** are expected to have higher returns than later projects when precedents have been established and less development work is required. Infrastructure financiers are willing to invest their time in helping structure and negotiate new classes of project, where there is a prospect of a significant pipeline of further business. However, this does not appear to extend to a willingness to compromise on the three key requirements described above. Over time, the cost of finance tends to decline and certain terms may be loosened to a degree, as new sub-sectors become more established. An exception is when other factors such as market disruption, recession, or financial crisis cause an increase. For these reasons, there is little incentive for financiers to provide discounted facilities or softer terms for the initial projects in a new sub-sector. The initial investors may sell the operating project(s) to subsequent investors who will often aggregate smaller early projects as the sub-sector matures. In some cases, the initial investors will recycle their capital in the same or other sub-sectors depending on the relative risk/reward opportunities available.
- Investments are steered by **opportunity and where the competition is**. Some investors seek smaller scale investments to find a new opportunity or niche in the market which has not been recognised or assessed by larger scale institutional investors. The solar sub-sector started as a niche but has matured rapidly driven by the pace of cost reduction²⁵ for photo-voltaic solar panels, moderate capital cost of projects, ease of obtaining planning consents, and the availability of subsidy support in the UK and many other countries.

As sub-sectors of infrastructure move from newly emerging to established status the cost of finance tends to reduce as knowledge about how to evaluate, negotiate and price the projects spreads around the market as more projects reach financial close or FID. In this way competition tends to increase over time, unless some particular event takes place to change perceptions of the risk of the relevant sub-sector or financial market conditions deteriorate, reducing the availability of finance.

- **Environmental, social, political, and reputational factors** are important, but generally to a lesser degree. Their importance will depend on the revenue proposition; where this depends on Government support, such as ROCs, then a change in regime is fundamental. Political risk has risen in the UK. Through interviews, some investors raised the Equator principles²⁶, low carbon agenda, and good governance. Rarely do social factors override a poor credit rating or economics. Where there is a combination of satisfactory project returns relative to risks, and also positive social, political, and regulatory factors, then investors are more interested.

3.6 Investing in new asset classes

Our interviewees all sought the right balance of returns to risk. Their investments were largely determined by the preferred key infrastructure characteristics in sections 3.3 and 3.4, and detailed further later in this chapter for specific sub-sectors. However, there are other factors that can play a role, for example:

- Strength of the flows of finance into the relevant parts of the market, which varies with monetary and economic conditions. These flows are relatively strong in developed countries at present in early 2018 as the financial crisis period of 2008-14 recedes,

- Relevant experience from other infrastructure sub-sectors can sometimes be applied to help open up new sub-sectors with comparable characteristics, as was the case for OFTOs which drew on experience from PFI projects,
- Nature of the mandate from the source equity investors, in particular risk appetite, as well as a need to balance a portfolio. For example, some investors may not invest in airports due to their GDP exposure, which does not fit with the risk objective of the fund,
- Opportunities in the market and competition, including the maturity of the relevant market where cheaper sources of finance tend to be available to more mature sub-sectors where investors and lenders have more experience and competition is greater, and
- Macro trends, such as inflationary pressure and economic growth, and the political landscape, for example the likelihood of a consistent political approach to the relevant infrastructure sub-sector.

3.7 Introduction to infrastructure sub-sector lessons learnt

In the following sections 3.8 to 3.15, we describe the key lessons for each from our experience, our literature review and our interviews with equity investors and lenders.

3.8 Energy-from-Waste projects

3.8.1 Introduction

Rationale for inclusion in this study: Certain Energy from Waste (EfW) projects include merchant capacity and therefore have a somewhat higher risk profile than most PFI/PF2 projects, OFTOs, or licensed RAB network companies and so provide a relevant precedent for district heating schemes which may have some demand risk, and also show how infrastructure financiers approach such a higher risk proposition.

A significant programme of EfW projects has been procured by local authorities based on private sector capital provision. The need for this programme came from an EU directive²⁷ of 1999 which prescribed a programme, backed by financial penalties for EU Member States, to reduce the use of landfill for biodegradable municipal wastes. The UK had historically made extensive use of landfill for such waste disposal and so this shift in regulatory approach created the need to find or procure alternative solutions to deal with large flows of municipal waste. These local authority projects in most cases have been based on a version of the PFI form of contract.

²⁵ See <https://www.scientificamerican.com/article/why-china-is-dominating-the-solar-industry/>

²⁶ See <http://equator-principles.com/>

²⁷ See http://ec.europa.eu/environment/waste/landfill_index.htm, <https://publications.parliament.uk/pa/cm201719/cmselect/cmeuleg/301-xii/30115.htm>, and <https://www.nao.org.uk/wp-content/uploads/2009/01/080966.pdf> – pages 4,5

Defra's Waste Management Plan for England²⁸, of December 2013, noted that Government had allocated a total of £3.5 billion in grant funding to 28 projects in the waste treatment sub-sector but that no further such grant support (similar to PFI credits but later known as Waste Infrastructure Credits) was planned. That Plan further noted that the Government had introduced other mechanisms to stimulate investment in waste infrastructure, principally through the Green Investment Bank and the Infrastructure Guarantee Scheme of HM Treasury. In October 2010 the Government withdrew funding²⁹ for seven PFI projects that had yet to reach financial close, which resulted in the removal of PFI subsidies for six incinerators, explaining that: "on reasonable assumptions, will no longer be needed to meet landfill diversion targets set by the European Union".

A number of major UK residual waste infrastructure projects were financed using the PFI model between 2000 and 2012 under Defra policy to meet landfill diversion targets. The NAO estimated in 2009 that PFI contracts would cover 80% of the waste processed by new infrastructure coming into operation by 2013. In 2010 Defra³⁰ ended its financial support for a number of future projects, after it had projected that the UK's landfill diversion target was on course to be met.

Later, it was found that waste projects to deal with industrial and/or commercial waste were significantly more difficult to finance in the private sector due to the lack of long term waste supply contracts with creditworthy parties. Consequently, when the Green Investment Bank³¹ was established in 2011/12 industrial and commercial waste treatment was one of its priority sectors³² to support from its initial allocation of £3 billion of capital from HM Treasury.

In mid 2006, Defra established a delivery unit, the Waste Infrastructure Delivery Programme³³ (WIDP), to accelerate the delivery of waste infrastructure and to provide greater support to local authorities undertaking the projects. WIDP had approximately 30 staff, from Defra, Partnerships UK and 4ps. According to the 2009 NAO report, WIDP increased the focus on energy from waste solutions and agreed with the market PFI terms relevant to waste projects and improved oversight of the projects, with a view to reducing delays and achieving better deals. The NAO noted that prior to 2006, few new PFI waste facilities were delivered.

A standard form contract for residual waste treatment was developed by the WIDP unit of Defra and issued in mid-2009. This form of contract³⁴ and its schedules were updated in late 2010, which was the last updating. The contract contains an extensive section pertaining to the respective works and services, termination events and compensation upon termination as well as general terms, such as sub-contracting, intellectual property and change in ownership in the contractor. It also provides drafting guidance whenever alternative clauses to those suggested in the standard form contract might be considered. This information was transferred to the National Archives in January 2013 and WIDP's role appears to have ended in 2013/2014.

The NAO report³⁵ of 2009 noted that waste projects can have risks that differ from typical PFI projects such as planning permission difficulties, uncertainty over future waste throughput, risks of different types of waste treatment technology, and finding markets to sell products from waste treatment. The EfW and waste treatment sub-sector has in some cases higher demand and technology risk than many other PFI/PF2 and other infrastructure projects so we discuss these further below.

3.8.2 Revenue/demand risk

Municipal waste projects in the UK typically have two main revenue streams, as follows:

- An approximately 25 year waste supply agreement under which a local authority commits to supply specified volumes of waste with certain parameters and commits to paying gate fees to the waste treatment business to share these waste flows treated in the agreed manner; and
- A power purchase agreement under which the electrical output of the EfW plant is sold typically to a utility or industrial consumer.

Industrial/commercial waste projects typically have a number of waste supply agreements of a shorter maturity than those used in local authority projects. This is because most industrial/commercial customers, apart from large waste specialist businesses, have lower waste volumes to dispose of than municipalities and do not wish to enter into long term waste supply commitments. Industrial/commercial waste customers are more subject to the effects of cycles in economic growth than infrastructure businesses and the life cycle of their equipment assets is typically shorter than for infrastructure, and may change manufacturing locations if market conditions change. This difference in appetite for long term fixed price contracts is a key difference between local authority based waste projects and industrial/commercial ones.

3.8.3 Technology and construction risks

EfW projects generally include a combustion or gasification process for power generation, in addition to various facilities to handle and sort the waste flows. In some cases Mechanical Biological Treatment (MBT) processes have been specified for waste treatment. We understand from discussions with lenders that, for debt financed projects, combustion-based technologies have the greatest degree of acceptance with limited acceptance of certain gasification technologies.

According to our interviewees, MBT processes^{36,37} are now rarely debt financed in UK waste projects following problems in a number of such plants. The Greater Manchester waste PFI project³⁸, one of the largest at £640m capital value, has been terminated apparently due to a combination of problems with MBT facilities, reduced waste volumes and declining prices in the market for waste treatment.

3.8.4 How the EfW sub-sector satisfies key infrastructure investor and lender requirements

From our experience, literature review, and interviews relating to the EfW sub-sector, the manner in which the three key factors for infrastructure investment have been satisfied is as follows:

- **Predictability and stability of the revenue stream** over the economic life of the assets is achieved by long term waste supply contracts with sufficiently creditworthy counterparties and specified gate fees. These counterparties are typically local authorities or tier 1 waste supply companies. In the case of "merchant" waste projects, up to approximately 30-35% of the gate fee revenues of a project can be under short term contracts provided that the location of the project relative to waste sources and competing facilities, types of waste to be processed, and market position of the project owner are judged to be satisfactory by financiers. Electricity sales, up to approximately one third of total project revenues, are typically under long term contracts (e.g. power purchase agreements) matching the debt maturity plus about one year, but can be at variable market prices. Some are also eligible for the Renewables Obligation. The threshold ratio is typically 40-60% contracted supply to ensure sufficient debt capacity.

28 See: <https://www.gov.uk/government/publications/waste-management-plan-for-england>

29 See: <http://ukwin.org.uk/2013/02/22/defra-drops-funding-for-final-three-waste-pfis/>

30 See: <https://www.gov.uk/government/news/changes-to-pfi-programme> and https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/251567/pb13883-forecasting-2020-waste-arising-131017.pdf

31 See: <http://greeninvestmentgroup.com/news-and-insights/2014/capacity-gap-means-uk-needs-more-waste-infrastructure/and> https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/658386/GIB_Examining_the_Case_for_Continued_Intervention_-_FINAL.PDF

32 See: <https://www.gov.uk/government/news/uk-green-investment-bank-opens-for-business>

33 See: <http://webarchive.nationalarchives.gov.uk/20130405030457/http://www.defra.gov.uk/environment/waste/local-authorities/widp/>

34 The 2010 suite of WIDP guidance is at: <http://webarchive.nationalarchives.gov.uk/20130124021347/http://www.defra.gov.uk/environment/waste/local-authorities/widp/widp-guidance/>

35 See: <https://www.nao.org.uk/report/department-for-environment-food-and-rural-affairs-managing-the-waste-pfi-programme/>

36 See: <https://www.mrw.co.uk/latest/derby-efw-delayed-by-energys-fallout/10020251.article>

37 See: <https://www.letsrecycle.com/news/latest-news/essex-urbaser-balfour-beatty-for-court-case/>

38 See: <http://www.constructionenquirer.com/2017/05/03/manchester-waste-pfi-deal-to-be-scraped/>

- **Adequacy of the level of net cashflow** has been established by price levels in the market for waste treatment services. The opening of this market was significantly assisted by the Waste Infrastructure Development Programme (WIDP) run on behalf of Defra from 2006 to 2013/4. This included a budgetary support mechanism, namely waste infrastructure credits up until 2010, paid by central government to local authorities entering into waste projects with a business case approved by WIDP.
- **Visibility of sufficient value of future similar projects** was established by regulatory requirements on local authorities to reduce the use of landfill for waste disposal. This requirement arose from an EU directive of 1999, which was backed by a regime of fines on EU Member States in the case of non-compliance. Although most waste projects contracted fully by local authorities have now been financed, at least one large part-merchant waste project³⁹ of approximately £400 million in capital value is currently negotiating financing. Each such project represents a significant financing opportunity if the requirement for predictability and stability of revenues can be satisfied.

Our experience, literature review, and interviews identified the following other significant factors for infrastructure financing in the EfW sub-sector:

- **Standardisation** of projects has facilitated a number of investors engaging in the market. This particularly relates to the same type of technology being used across projects, where the technology due diligence requirements would otherwise pose a hurdle.

- **Technologies** used in the sub-sector vary. Most debt lenders will only finance tried-and-tested technology, and will wait for new technology to establish itself before lending. Investors are prepared to pay for better technology to ensure it works, since this is a fundamental risk to revenues. Lender appetite for gasification technology and mechanical biological treatment has been much more limited than for grate-based combustion technology.
- The **UK Green Investment Bank (UK GIB)**^{40,41}, now the Green Investment Group post privatisation, had a policy role in providing finance to commercial and industrial waste projects as one of its priority sectors when established by Government. As its target sectors matured and financial markets recovered, it was possible for the Green Investment Bank to evolve towards being a portfolio investor and lender on sufficiently commercial terms to be privatised. The National Audit Office⁴² found that the UK GIB had attracted private capital into the businesses that it invested in, in a ratio of 2.5:1 on average for every £1 that UK GIB provided. UK GIB participated in 100 projects prior to its sale in 2017.
- **Location** is more important for waste projects than for certain other types of infrastructure, according to our interviewees, because waste markets are typically regional based on the market strength of waste companies in that region and practical considerations of transport distances from the main sources of waste to the waste treatment/EfW plant.

In the table below we describe the possible implications for district heat networks of selected characteristics of the EfW sub-sector from our work, and this is also included in Table 1 in section 1.3 of the Executive Summary.

Infrastructure sub-sector	Selected characteristics	Possible implication for the pipe/meter network element of district heat networks
Energy from Waste (EfW)	<ul style="list-style-type: none"> • In part-merchant projects, of which there are a limited number, 60-70% of revenue is typically long term contracted with the remainder at merchant risk • Location is very important for part-merchant EfW projects in order to have as good a prospect as possible of capturing local/regional market share 	<ul style="list-style-type: none"> • Anchor customers, such as local authorities for their buildings, hospitals, leisure centres, and other public sector bodies or corporates are likely to be an important component of the customer mix for many district heating schemes • Investors can get comfortable with a minority component of demand being committed only for a shorter term, although this does constrain debt capacity and increase cost of finance • The benefits of more customer flexibility in having a shorter period or volume of commitment need to be considered in comparison with the implications for increased cost of finance and possibly a shorter period over which to recover fixed capital costs (requiring higher annual charges) • For district heating network projects the physical configuration, in particular the distance from the heat source and the amount of construction work needed to make connection to particular building(s), can have a significant impact on the economic viability of the scheme for financing

39 Source: Infrastructure Journal

40 See: <https://www.gov.uk/government/organisations/uk-green-investment-bank>

41 See: <https://www.nao.org.uk/report/the-green-investment-bank/>

42 See: <https://www.nao.org.uk/wp-content/uploads/2017/12/The-Green-Investment-Bank.pdf> – page 4

3.9 Renewable power: offshore wind and ground-mounted solar

3.9.1 Introduction

Rationale for inclusion in this study: The offshore wind and ground-mounted solar power generation sub-sectors were selected because they have moved from being present only on a small scale in the UK to being well-established within 10 years, based on government support schemes. In the case of offshore wind the ROC scheme was introduced in 2002, and in the case of ground-mounted solar a suitable banded level of support was introduced in 2009. The amount of subsidy (per MWh of generation or MW of capacity in new projects) has been reduced over time.

The offshore wind power and ground-mounted solar renewable generation sub-sectors had their initial policy support from Government on the basis of the Renewable Obligations Certificate (ROC)⁴³ scheme which provided a fixed subsidy per MWh of generation for a period of 20 years. Ofgem revises the buy-out price of the ROC each year based on retail prices inflation. This scheme was introduced in 2002 and has subsequently been replaced by Contracts for Difference⁴⁴ (CfD) which are allocated in competitive auctions. The last projects under the ROC regime were accredited in 2017. Ofgem reported⁴⁵ that the cost of support under the ROC scheme in 2015-16 was £58.07 per MWh supplied and the cost of greenhouse gas savings under the scheme was £111.08 per tonne (CO₂e). From the start of the scheme in 2002 until the end of 2015-16, Ofgem accredited 20,789 generating stations with a total capacity of 25.5GW.

Subsidy support was withdrawn from solar generation schemes (apart from those of up to 5MW capacity which are eligible for support under the separate Feed-in Tariff scheme) after the first CfD auction in 2014-5 but has continued to be allocated for offshore wind power projects. Subsidy support has remained available for the offshore wind power sub-sector in the second CfD auction.

3.9.2 How the offshore wind power and ground-mounted solar sub-sectors satisfy key infrastructure investor and lender requirements

From our experience, literature review, and interviews relating to the relevant parts of renewable power generation sub-sector, the manner in which the three key factors for infrastructure investment have been satisfied is as follows:

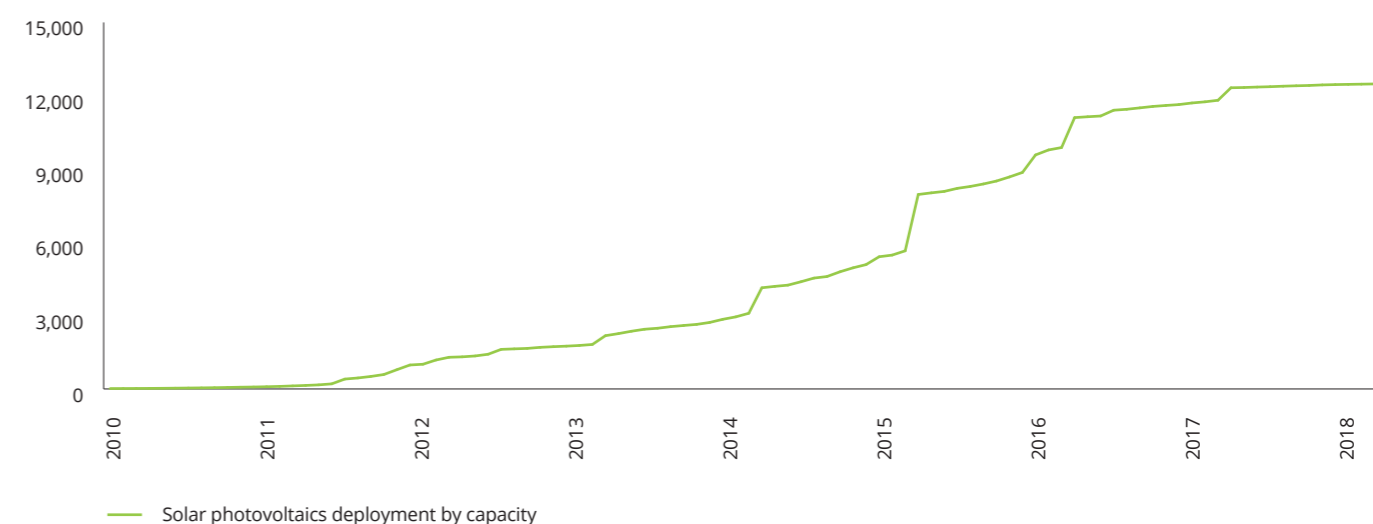
- Predictability and stability of the revenue stream** over the economic life of the assets for eligible renewable power generation projects is currently achieved via contractual stabilisation of the revenue stream using a 15 year contract for difference (CfD). This brings the unit revenue up or down to an agreed strike price by reference to a market reference price⁴⁶ which the generation project owner has to achieve to the extent possible. Smaller scale solar PV, as well as onshore wind, has been supported through a subsidy mechanism known as the Feed in Tariff (FiT). This offers a stable 20-year revenue stream for each unit of electricity generated. Export tariffs are also payable (though for unmetered installations, which are typically domestic, these are based on a notional own use versus export ratio). The FiT scheme was introduced in 2010 to guarantee payments to a range of renewable technologies up to a certain capacity, now reduced to 5MW.

- Adequacy of the level of net cashflow** has been established in a multi-round tendering process, with descending prices, in which bidders indicate the minimum value per MWh of CfD support which they will accept. Solar projects were removed from eligibility for CfD support after 2015. The first CfDs, for offshore wind projects, had their strike prices determined administratively by DECC, as the value of ROCs had been. The value of ROC support for offshore wind and solar projects was found by developers to be sufficient, and was progressively reduced by Government with projects continuing to be financed⁴⁷.

For solar and other onshore renewable power technology, the FiT level started at 43.3p/kWh, although this fell substantially for installations after August 2012 (to 12.92p/kWh), was reduced again from January 2016 (to 4.39p/kWh), and has continued to step down after this. These lower rates have led to longer loan repayment periods being required by financiers, closer to the economic life of the assets.

As the costs of solar PV have fallen substantially, whilst the FiT is a constant tariff and solar PV is not the price maker, efficiencies can lead directly to higher net revenues. This has driven a period of consolidation in the solar sub-sector as individual projects, and small portfolios, have been acquired to create large portfolios which can be operated and managed and financed more efficiently. Nonetheless, the market has seen a slowdown in the volume of new projects being financed as the FiT level has reduced. Although there have been a couple of announcements about intending to develop solar projects without subsidy in the UK, our review of Infrastructure Journal entries about solar generation for 2017 to date indicated that activity was focused on acquisitions of existing solar projects and no new-build solar financings were reported there for the UK. The chart⁴⁸ below indicates a slower rate of solar capacity additions as subsidy support has reduced.

Figure 3. GB Solar Generation Cumulative Capacity 2010-March 2018



Source: BEIS/National Statistics

43 See <https://www.ofgem.gov.uk/environmental-programmes/ro/about-ro>

44 See <https://www.gov.uk/government/publications/contracts-for-difference/contract-for-difference>

45 See: <https://www.ofgem.gov.uk/ofgem-publications/113760> – page 7

46 In the case of many projects based on CfDs the owners or operators are large enough to have access to energy trading functions which have the capability of capturing the market reference price. However, the feasibility of the smaller organisations present in the district heating network sector being able to capture, for example, a gas market reference price and how fluctuation of this would relate to the price of gas supplied to commercial or retail customers would need to be considered

47 See: <http://www.ref.org.uk/energy-data/notes-on-the-renewable-obligation>

48 Source: <https://www.gov.uk/government/statistics/solar-photovoltaics-deployment>

• **Visibility of the sufficient value of future similar projects** was achieved by a combination of Government stating its ambition^{49,50} for the development of the renewable power generation sub-sector, combined with the availability of sites for solar and offshore wind projects, and the introduction of the ROC support regime which required licensed electricity suppliers to source at least part of their electricity from renewable generation. At its introduction⁵¹, according to Ofgem the amount of the Renewables Obligation started at 3% of total electricity supplied to customers in Great Britain in 2002/2003 and was set to reach 10.4% in 2010/2011. The Crown Estate granted rights to sites for 18 offshore wind farms in its first round of allocation⁵² in 2001 with capacity of up to 1.5GW.

Solar technology is well suited to being scaled or repeated, which reduces the technology risk and facilitates the investment process for large numbers of panels. For offshore wind project, the Crown Estate has undertaken three rounds of allocation for offshore wind project sites since 2000, with increasing sizes and some of these sites are still being built out and some expect to be bid in the future CfD auctions.

The following other favourable factors were noted in our interviews in connection with the financing of offshore wind power and ground-mounted solar generation.

- **Investment sizes** of from approximately £2m and up to £60m in the solar generation sub-sector and from approximately £50m up to approximately £3bn in the offshore wind sub-sector. Although the low end of the investment size range in solar generation is smaller than in other infrastructure the mass manufactured nature of solar panels and their relatively low installation cost in ground mounted form have offset the diseconomy of small scale investment. As noted above, there is also a significant process of aggregation of portfolios in progress in the sub-sector.
- **Regulatory and government support** has been particularly important in offshore wind, and in ground mounted solar generation until the latter technology ceased to qualify for CfD support. Achieving commercial and financial viability of new-build solar power generation in the UK without subsidies, given the low levels of solar irradiance here, is probably dependent on obtaining suitable power purchase agreements with corporate customers and further reductions in the costs of the projects.

In the table below we describe the possible implications for district heat networks of selected characteristics of the offshore wind power and ground-mounted solar generation sub-sector from our work, and this is also included in Table 1 in section 1.3 of the Executive Summary.

Infrastructure sub-sector	Selected characteristics	Possible implication for the pipe/meter network element of district heat networks
Offshore wind and ground – mounted solar generation	<ul style="list-style-type: none"> • Competitive allocation of subsidy support, and earlier administrative determination of subsidy support 	<ul style="list-style-type: none"> • Competitive allocation of subsidy support can help reduce the levels of subsidy required, especially if an energy market price benchmark is available • The amount of subsidy support can be reduced in line with cost reduction in the relevant industry, even when the subsidy level is determined administratively • Smaller scale investors may open up a new sub-sector before larger scale investors become involved as a new sub-sector grows and uncertainties are reduced

In the course of our interviews in the power sub-sector, the example of financings achieved in the smart metering sub-sector was raised by a commercial bank as an example of how regulatory requirements have provided the basis for project financings. We include below a case study on this sub-sector which has received less publicity than many of the others considered in this report.

49 See: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/243987/bis-13-1092-offshore-wind-industrial-strategy.pdf

50 See: <http://news.bbc.co.uk/1/hi/uk/1651496.stm>

51 See: https://www.ofgem.gov.uk/sites/default/files/docs/2004/02/6193-renewables_obligation_0.pdf – page 18

52 See: <https://uk.reuters.com/article/us-britain-offshorwind-timeline/timeline-development-of-uk-offshore-wind-idUKTRE68M11L20100923>

Case study: Smart metering

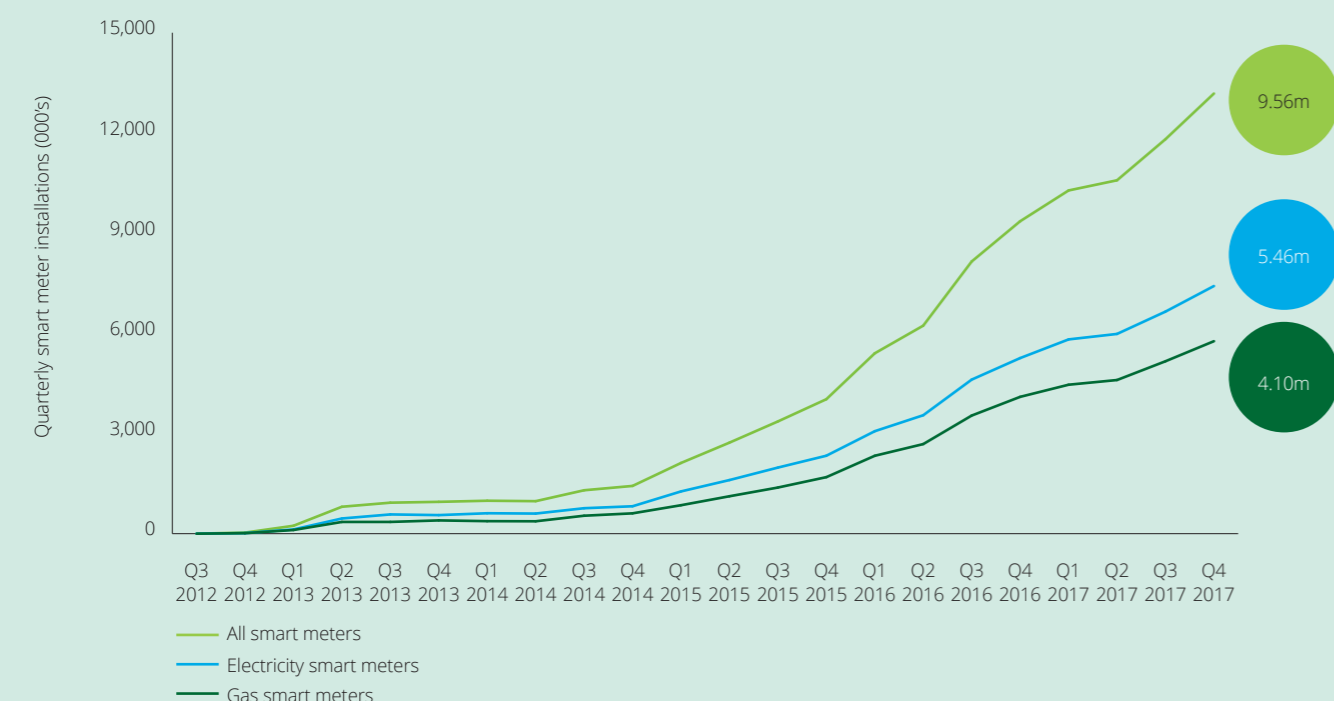
Introduction

Rationale for inclusion in this study: smart metering is an example of a sub-sector in which a combination of regulatory requirements has created a basis for project financing structures without a specified form of revenue contract developed by the public sector, as in PFI/PF2, or a periodic price control regime as for RAB network companies.

The rollout of smart meters is being led by energy supply businesses, who are responsible for installing smart metering equipment, consisting of a smart electricity meter, a smart gas meter, a communications hub and an in-home display at no upfront cost to consumers. Gas and electricity suppliers are required by their licence to take all reasonable steps to roll out smart meters to all of their domestic and small business customers by the end of 2020⁵³. According to Smart Energy GB⁵⁴, there are 26 million homes in the UK each of which is expected to have to be fitted with a smart meter.

In 2017, BEIS reported⁵⁵ that it had “continued to focus on ensuring all parties are making the necessary preparations to begin installing SMETS2 meters at scale and transition from SMETS1 metering. Good progress continues to be made on the rollout of smart meters, with the latest statistics showing over 8.6 million smart and advanced meters operating across homes and small businesses in Great Britain up to 30 September 2017 and a total of 3.3 million meters installed in the first three quarters of 2017”. The chart⁵⁶ below shows the progress of the smart meter programme to date.

Figure 4. Number of smart meters installed by the large energy suppliers in domestic properties, by fuel type and quarter



Source: BEIS

53 See <https://www.ofgem.gov.uk/gas/retail-market/metering/transition-smart-meters> and https://www.ofgem.gov.uk/system/files/docs/2017/11/smart_metering.pdf

54 See <https://www.smartenergygb.org/en/smart-future/about-the-rollout>

55 See https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/671930/Smart_Meters_2017_update.pdf

56 Source: <https://www.gov.uk/government/statistics/statistical-release-and-data-smart-meters-great-britain-quarter-4-2017>

Unlike certain of the other types of infrastructure financing the project financings for smart meters have arisen as the result of innovation by electricity suppliers and financiers to produce financing structures based on commitments by the electricity suppliers, in turn based on their regulatory obligations. This in contrast to structures such as PFI/PF2, OFTOs, and CATOs where financing has been provided based directly on public sector (or regulator's) tenders for, or relating to, infrastructure assets.

Various equity and debt investments in smart metering have been reported in the project finance press, in addition to meters financed by utilities on their own corporate balance sheets. The overall cost of the smart metering programme, excluding the central data hub is estimated to be £7 billion⁵⁷. One of the larger financings in the sub-sector was reported as being in December 2016 when Calvin Capital, then owned by Infracapital, raised £1 billion to support the roll-out of seven million smart meters, from the European Investment Bank, Barclays, Credit Agricole, HSBC, Mitsubishi-UFG, Santander and SMBC^{58 59}.

How the smart meters sub-sector satisfies key infrastructure investor and lender requirements

From our experience, literature review, and interviews relating to the smart meters sub-sector, the way in which the three key factors for infrastructure investment have been satisfied is as follows:

- **Predictability and stability of the revenue stream** over the economic life of the assets is achieved by virtue of a combination of regulatory requirements concerning obligations on suppliers for each consumer to have a meter, a required timetable for deployment of smart meters, the replacement of failing electricity suppliers, and the existence of a supplier of last resort.

Revenue/demand certainty is provided through a combination of factors that individually would probably be insufficient. These are (1) a regulatory requirement in the industry that requires suppliers to install smart meters by 2020, (2) suppliers are licensed by Ofgem, with a licence condition that the 'dumb' meters be replaced by smart meters, which effectively compels suppliers to install smart meters, and (3) Ofgem's Supplier of Last Resort regime which mitigates the risk of total loss because in the worst case scenario of a supplier in liquidation, there is still confidence that payments into the smart meter financing special purpose vehicle will be made.

- **Adequacy of the level of net cashflow** has been established through the relationship between fees for metering services paid by electricity suppliers and the cost of meters (mass-produced electronic equipment, available from a variety of manufacturers, unlike many types of infrastructure) and their installation. Expected returns are fairly low, despite the active market. This is driven by the scalability and pipeline of potential tranches of smart meter installations. Debt tenors tend to be lower (10 years) compared with other sub-sectors such as OFTOs and PFI/PF2 (which typically have 20-25 year tenors).

- **Visibility of sufficient value of future similar projects** has been achieved through the regulatory requirement in licences for electricity suppliers “by their licence to take all reasonable steps” to fit smart meters for their residential and small business customers by 2020. Equity investment sizes of £10-20m, with larger amounts of debt, are common due to the possibility to scale. Size depends on the tranche of smart meter installations. With large suppliers, such as British Gas, EDF Energy, E.ON, Npower, ScottishPower, and SSE, there are correspondingly large requirement for financing.

57 See <https://www.energylivenews.com/2017/02/03/smart-meter-rollout-to-cost-1bn-more-than-government-estimates/>

58 Source: Infrastructure Journal

59 See also: <https://publications.parliament.uk/pa/cm201719/cmpublic/smartmeters/memo/smb09.pdf>

The following other favourable secondary factors were noted in our interviews in connection with the financing of smart meters:

- **Technology risk** is fundamental in the smart metering sub-sector, since a non-functioning smart meter increases operating costs and undermines consumer confidence. This is managed through mandated specification, robust testing, and manufacturer guarantees. Further, with standardisation of requirements, developers and investors can mitigate supply chain risks, and demand risk (since consumers can switch without replacing the meter). As such, there is limited risk of investing in the ‘wrong’ smart meter, or supply being provided by the ‘wrong’ manufacturer.
- **Standardisation** is offered similarly through minimum technology requirements. This has facilitated initiatives to roll out smart meters on a relatively large scale of 100,000 units with an energy supplier.

In the table below we describe the possible implications for district heat networks of selected characteristics of the smart meters sub-sector from our work, and this is also included in Table 1 in section 1.3 of the Executive Summary.

Infrastructure sub-sector	Selected characteristics	Possible implication for the pipe/meter network element of district heat networks
Smart meter portfolios	<ul style="list-style-type: none"> • Regulation mandating smart-meter roll out has created a clear and quantifiable pipeline of investment required • Ofgem’s Supplier of Last Resort regime contributes to confidence that the meter assets are likely to have continuity of use 	<ul style="list-style-type: none"> • In the absence of formal industry regulations, such as for Regulated Asset Base (RAB) network businesses, planning obligations accompanied by a development strategy (such as the Greater London Authority’s London Plan) are a potential way for local authorities to achieve similar local outcomes for installation of district heating in developments • There may be a role for a Supplier of Last Resort regime in district heating, subject to suitable powers to recover the costs of such a regime from a sufficiently broad base of consumers

3.10 Competitive Offshore Networks: Offshore Transmission Owner (OFTO) licences

3.10.1 Introduction

Rationale for inclusion in this study: The OFTO sub-sector has been included because it was established within the past 10 years by a programme developed by the energy regulator, Ofgem, and it has attracted vigorous competition by bidders and finance providers.

An OFTO project comprises the undersea and on land electricity cable links from an offshore windfarm to a connecting point, at an on land sub-station, on the National Grid Electricity Transmission plc (NGET) high voltage electricity transmission network. Ofgem reported in December 2016 that to date over £3bn of investment⁶⁰ had been committed to OFTO projects in the UK.

To date these assets have been constructed by the developer of the relevant offshore wind farm and then submitted to a tender process run by Ofgem to select the future owner (the OFTO licence holder) of the particular cable link and related assets. Ofgem determines the sale price for the assets and the potential OFTO licence holders for the project bid in the competitive tender process (run by Ofgem). The bidding is based on the tender revenue stream amounts proposed by these bidders.

The OFTO licence is of 20 year duration and entitles the OFTO to receive the agreed tender revenue stream from NGET. The tender revenue stream includes RPI indexation in an agreed proportion. This proportion is as proposed in the winning bid and this is typically 100% (full) indexation. The relevant assets will have been constructed, commissioned and entered commercial service before the OFTO takes over their ownership at the end of the tender process. We understand that no significant life-cycle renewal is expected to be required for the main assets of OFTOs within the 20 year licence period.

In collaboration with the Department of Energy and Climate Change (now part of BEIS), Ofgem established the regulatory regime for offshore transmission owner licensed networks (OFTOs). The regime is designed to ensure offshore renewable generation projects are economically and efficiently connected to Britain’s electricity grid.

The initial consultation⁶¹ by DTI and Ofgem which included the potential for competitive tenders for OFTOs, based on powers in the Energy Act 2004, commenced in July 2005. Ofgem started the OFTO tender programme in mid 2009, with tender round one. Ofgem developed the OFTO licence including consultation with potential equity bidders and lenders. To launch the programme, Ofgem selected an initial group of nine OFTOs⁶² with a capital value of approximately £1.1bn to be offered in the first tender round. Ofgem estimated the total investment in OFTOs to be £3.1bn⁶³ up to and including tender round 4; Tender round 5 is currently in progress.

All OFTO tenders are run by Ofgem, the energy regulator. The main OFTO investors to date are Amber/International Public Partnerships, Balfour Beatty, Diamond Transmission (a subsidiary of Mitsubishi Corporation), Equitix, Macquarie, and 3i. These businesses are a mix of medium-large sized financial investors and the investment arms of corporates.

60 Source: https://www.ofgem.gov.uk/system/files/docs/2016/12/offshore_transmission_ofto_revenue_report.pdf

61 See: <https://www.ofgem.gov.uk/sites/default/files/docs/2005/07/11190-17805.pdf>

62 See: <https://www.ofgem.gov.uk/electricity/transmission-networks/offshore-transmission/offshore-transmission-tenders/tender-round-1> – pages 18,19

63 Source: <https://www.ofgem.gov.uk/ofgem-publications/104325> – page 7

3.10.2 How the OFTO sub-sector satisfies key infrastructure investor and lender requirements

From our experience, literature review, and interviews relating to the OFTO sub-sector, the manner in which the three key factors for infrastructure investment have been satisfied is as follows:

- **Predictability and stability of the revenue stream** is established by the entitlement to the tender revenue stream as part of the licence of the relevant OFTO, granted by Ofgem at the end of the particular tender process. The tender revenue stream is established separately for each OFTO in its tender process. The tender revenue stream is paid by National Grid Electricity Transmission, on an availability basis with a maximum deduction of 10% for unavailability, and also taking account of the availability of insurance cover for a sufficient range of events that may require repair of offshore and/or subsea elements. This combination of availability model, limiting losses and penalties has been well received by investors. Financiers have been able to take this as a committed revenue stream not subject to competition in the licence period after the tender process.

The amount of deduction from the tender revenue stream for the OFTO assets not being available for use is limited to a maximum of 10% of the base revenue stream. This serves to limit exposure to operational period risks, in particular subsea repair work which can take significant periods to organise and execute if it becomes necessary.

- **Adequacy of the level of net cashflow** The OFTO bidders propose capital financing solutions, typically highly geared (85-90%) limited recourse project finance structures using bank, private placement or bond debt and have to put these in place to provide the funding to acquire the relevant assets from the offshore windfarm developer.

The tender process allows OFTO bidders to propose a revenue level which they can finance from market sources of equity, subordinated debt, and senior debt. This is based on an acquisition price determined by Ofgem and provided to the bidders during the tender process. These financings make use of the 20 year licence period, subject to the tail period (difference between the loan maturity period and the licence period) required by the senior lenders.

National Grid Electricity Transmission recovers the cost of paying the tender revenue stream to OFTO licence holders from its transmission use of system charges levied on electricity generators connected to its network and from electricity suppliers.

- **Visibility of the pipeline of future investment/lending requirements** has been achieved through the regulatory requirement for each offshore windfarm developer to divest its offshore transmission assets in GB waters within approximately 18 months of commissioning via a standardised tender process run by Ofgem. The earlier ROC and current CfD revenue support regimes of BEIS for offshore wind have driven the pipeline of offshore wind projects in the UK, which provides the OFTO opportunities.

Since each offshore wind farm in GB waters has to sell its cable link in an OFTO tender, the programme of offshore wind projects under the ROC programme and now the CfD auctions shows what the OFTO projects will be coming to market in about 3-4 years after FID on the wind farms. Typical OFTO projects have increased in value over time, related to the increasing capacity and distance from shore of offshore wind farms as the sub-sector has matured. The estimated transfer values in OFTO tender round 1⁶⁴ ranged from £36m to £317m with most around £50-100m, while in OFTO tender round 5 which is still in progress, the equivalent values range from £313m to £530m⁶⁵.

The following other favourable factors were noted in our interviews in connection with the financing of OFTOs:

- **Construction risk in the transmission assets of OFTOs has been managed by the offshore wind farm developers.** Ofgem assesses the construction cost of the assets to be transferred to the OFTO licence holder and may disallow expenditure that it considers not to have been incurred efficiently. Any reduction in value arising from such a disallowance is suffered by the windfarm developer and not the OFTO licence holder.

Generally, the OFTO licence holder's exposure to construction risk is limited by the limit on deductions for non-availability under the OFTO licence, insurances to the extent that they cover defects discovered or arising after transfer of the assets to the OFTO licence holder, and warranties under the transfer agreement with the offshore wind farm developer. We understand that there have been instances of faults arising or discovered in OFTO assets during the licence period. This has led to insurance claims being made, some of which have been paid. The absence of construction risk has attracted institutional investor and lender involvement in the sub-sector.

- **Credit quality of the key counterparty is relatively high** in the private sector because National Grid Electricity Transmission, which pays the tender revenue stream to the OFTO, has investment grade credit ratings from three of the major international rating agencies for long term publicly listed debt. Specifically, these are A3/A-/A from Moody's/Standard & Poor's/Fitch respectively⁶⁶.

64 See: <https://www.ofgem.gov.uk/publications-and-updates/offshore-electricity-transmission-invitation-tender-document-first-transitional-tender-round>

65 See: <https://www.ofgem.gov.uk/ofgem-publications/104325> – page 9

66 Source: National Grid – <http://investors.nationalgrid.com/debt-investors/credit-ratings>

In the table below we describe the possible implications for district heat networks of selected characteristics of the OFTO sub-sector from our work, and this is also included in Table 1 in section 1.3 of the Executive Summary.

Infrastructure sub-sector	Selected characteristics	Possible implication for the pipe/meter network element of district heat networks
Licensed offshore transmission links (OFTOs)	<ul style="list-style-type: none"> • Payment is made for availability of the asset rather than for use of system • Construction risk is taken by a different party, namely the offshore wind farm developer 	<ul style="list-style-type: none"> • District heating networks, separate from the heat supply business, might consider availability payments rather than use of system charges as a mechanism for attracting a greater range of financing sources and possibly lower cost financing. However, such a structuring approach will probably have risk allocation implications either for the generator or the customer (or both). Financial viability of all elements will need to be considered • Public sector support could be focused on mitigating construction risk in district heating schemes

Following the establishment of the OFTO programme Ofgem has established a new regulatory framework for electricity interconnector projects, namely the Cap and Floor Regime which has been used for the Nemo interconnector between the UK and Belgium and is expected to be used by various other interconnectors in development.

Case study: Ofgem’s Cap and Floor Interconnector Regime Introduction

Rationale for inclusion in this study: the cap and collar interconnector regime has been developed by Ofgem in 2011-3 to address the likely fluctuation in revenues earned by interconnector projects due to fluctuations in wholesale electricity market conditions at each end of the interconnector. It is also intended to address the restrictions on capacity contracts because of the requirements to ensure open access by means of regular auctions of interconnectors’ capacity.

Ofgem has developed the Cap and Floor regime⁶⁷ to encourage the development of further electricity interconnection with continental Europe. Prior to this regime, development was restricted to a merchant approach or EU exemption (e.g. Eleclink, IFA, BritNed, Moyle and East West). The Cap and Floor regime was pioneered by the 1GW Nemo interconnector between GB and Belgium, developed by National Grid and Elia, of Belgium.

The regime built on Ofgem’s Strategic Wider Works model for assessing new-build electricity transmission proposals, with a Needs Case assessment (known as the Initial Project Assessment) and a cost and technical efficiency assessment (known as the Final Project Assessment). However, the regime relates to the OFTO model in using post-construction assessment although its scope differs (known as the Post Construction Review), and discretionary operational-period reopeners. The four stages work together to provide certainty on a range of key investment issues.

⁶⁷ See: <https://www.ofgem.gov.uk/electricity/transmission-networks/electricity-interconnectors> and <https://www.ofgem.gov.uk/publications-and-updates/cap-and-floor-regime-summary-second-window>

Ofgem describes the cap and floor as being constructed using a ‘building block’ approach⁶⁸. These building blocks include its assessment of efficient construction costs, a return on capital and an assessment of operating expenditure. For example for the Nemo interconnector, Ofgem calculated the cap and floor levels based on the final regime design and its assessment of costs. This generated an annual floor level of £50.4m and an annual cap level of £80m (2013/14 prices). These were subject to final adjustments following Ofgem’s final assessment of costs after construction.

Construction and technology risk for interconnectors to/from GB is relatively high due to the complexity of laying subsea transmission cables. These risks have tended to be mitigated commercially to the extent feasible in construction arrangements and otherwise managed through the corporate financial resources available to the project owners. The developer/owners are often large transmission owner corporates such as National Grid in the UK and Réseau de Transport d’Electricité in France, or joint ventures of such companies, although certain interconnectors are proposed on at least a partial project finance basis such as FABLink from GB to France.

From our experience and literature review relating to the Cap and Floor interconnector sub-sector, the manner in which the three key factors for infrastructure investment are satisfied is as follows:

- **Predictability and stability of the revenue stream** is provided by the cap and floor. Uniquely to this regime, the cap and floor levels are based largely on costs (though also other variables such as availability), and provide investment with return certainty. Where market revenues from operating the interconnector are below the floor level, they are ‘topped up’ through higher tariffs to all users of the national electricity transmission system. Consumers effectively underwrite the risk that interconnectors are unable to cover their investment costs. Above this level, the interconnector is exposed to merchant risk on demand, but with its costs – including debt finance – covered by the floor, this risk affects only the net revenue. Ofgem requires that any revenues above the cap, however, are returned to consumers.
- **Adequacy of the level of net cashflow** is established in the Ofgem approval process for the cap and collar licence for the particular interconnector. The project developer puts forward its costs and proposed level of cap and collar revenues, and Ofgem evaluates these figures and the supporting information provided and decides what level of cap and collar revenue to approve, which is then set in the licence.
- **Visibility of sufficient value of similar future projects.** Investment sizes tend to be large for subsea interconnectors due to the capital costs involved for each project. This diminishes the need for a standardised approach, but provides an advantage to larger investors/developers. While the projects can be developed by any entity, subject to the above assessments by Ofgem, to date most have been developed by National Grid (Nemo, NSL, IFA 2, Viking Link), with the exception of the proposed FAB Link and Greenlink interconnectors.

⁶⁸ See: <https://www.ofgem.gov.uk/publications-and-updates/decision-cap-and-floor-regime-gb-belgium-interconnector-project-nemo>

In the table below we describe the possible implications for district heat networks of selected characteristics of Ofgem’s Cap and Floor Interconnector Regime from our work, and this is also included in Table 1 in section 1.3 of the Executive Summary.

Infrastructure sub-sector	Selected characteristics	Possible implication for the pipe/meter network element of district heat networks
Electricity inter-connectors – Ofgem’s cap and floor regime	<ul style="list-style-type: none"> A mechanism (cap and floor) to provide a revenue envelope based on a range of approved investment returns has been accepted by corporate investors and is also being used by certain project financed interconnectors in development The floor element of the regime in effect provides that electricity consumers underwrite a minimum level of revenue, if the interconnector cannot achieve that level from periodic auctions of its capacity, subject to certain conditions 	<ul style="list-style-type: none"> For district heating schemes with public sector anchor loads, the level of base investment returns attributable to the public sector offtaker can be quantified. The public sector anchor loads providing a long term minimum take-or-pay commitment give more certainty, and probably enable better credit quality for projects. This can reduce cost of finance, by attracting debt, and also attract a wider range of investors for district heating network projects A revenue floor regime would potentially be attractive for district heating networks, particularly from the perspective of debt capacity. However, the underwriting of the floor would need to be subject to appropriate conditions to mitigate sub-floor revenues, and provisions to spread the cost over a suitably broad base of consumers

3.11 Monopoly networks: Regulated Asset Base companies in energy and water sub-sectors

3.11.1 Introduction

Rationale for inclusion in this study: we have included RAB network companies because of the physical comparability with district heat networks, and that RAB monopolies, with statutory economic regulation, have been successful in attracting large volumes of capital.

Ofgem, the GB gas and electricity markets regulator, and Ofwat, the GB water regulator, set price controls for the natural monopoly companies that operate Britain’s gas and electricity, and water and wastewater networks. These price controls determine the amount of revenue that these companies can recover for providing network services to their customers.

The energy network costs for distribution and transmission are significant, accounting for around £292⁶⁹ of an average bill of £1,123. Whilst network costs have fallen since privatisation of the networks, a number of factors have seen energy network companies forecast significant underspend against their total allowances under Ofgem’s RIIO⁷⁰ (Revenue = Incentives + Innovation + Outputs) price regulation and achieve returns higher than anticipated.

Both Ofgem and Ofwat have duties to protect the interests of existing and future customers. In the context of network company regulation, this means carefully balancing the costs of maintaining and operating energy networks with security of supply, and accommodating a shift towards less environmentally damaging practices (e.g. decarbonisation in energy or lower abstraction in water). On top of this, in performing its duties, each regulator also needs to take into account the network companies’ ability to finance their licensed activities.

In order to address the future challenge energy networks are facing, Ofgem introduced a new set of price controls known as RIIO in 2010. This new RIIO framework marked a significant shift from the previous RPI-X approach to more incentive-based regulation. This exposes investors to more revenue risk, but tends to be equally balanced with higher upside potential. Ofgem acknowledges the mixed success of RIIO to date⁷¹.

When Ofgem established the first price control on the current basis, RIIO-1, there was debate⁷² with the regulated industries and investors as to whether network company investors needed to achieve low double digit equity returns⁷³ of around 10% p.a. In practice, however, the majority of network companies are delivering stronger returns at the top end of Ofgem’s expectations for each sector. This outperformance is one reason for the 40-50% premiums⁷⁴ to regulatory asset value paid for acquiring energy network companies in the two latest transactions of SSE Scotia Gas Distribution and National Grid Gas Distribution networks.

Each of the 14 electricity distribution network operators (DNOs) covers a separate geographical region of Great Britain. Independent Distribution Network Operators⁷⁵ (IDNOs) develop, operate and maintain local electricity distribution networks, usually smaller networks located within the areas covered by the DNOs. IDNO networks are directly connected to the DNO networks or indirectly to a DNO via another IDNO. IDNO networks are mainly extensions to the DNO networks serving new housing and commercial developments.

69 See: <https://www.ofgem.gov.uk/publications-and-updates/infographic-bills-prices-and-profits>

70 See: <https://www.ofgem.gov.uk/network-regulation-riio-model>

71 See: https://www.ofgem.gov.uk/system/files/docs/2017/07/open_letter_on_the_riio2_framework_12_july_final_version.pdf

72 See: https://www.ofgem.gov.uk/sites/default/files/docs/2011/04/investor-workshop-feb-11_0.pdf

73 On the basis of equity as measured for regulatory purposes

74 See: https://www.ofgem.gov.uk/system/files/docs/2017/07/open_letter_on_the_riio2_framework_12_july_final_version.pdf – page 3

75 See: <https://www.ofgem.gov.uk/electricity/distribution-networks/connections-and-competition/independent-distribution-network-operators>

IDNOs are regulated in the same way as DNOs, except the IDNO licence does not have all the conditions of the DNO licence. Ofgem regulates the amounts that IDNOs can charge their customers for using their networks via a 'Relative Price Control'. This requires IDNO charges to be capped for all customers at a level broadly consistent with the DNO equivalent charge⁷⁶.

3.11.2 How the RAB company sub-sector satisfies key infrastructure investor and lender requirements

From our experience and literature review relating to the RAB company sub-sector, the manner in which the three key factors for infrastructure investment have been satisfied is as follows:

- **Predictability and stability of the revenue stream** over the economic life of the assets is achieved through the regulatory licence, and the related periodic price controls every five or eight years as applicable. The credibility of these network licences is based on the UK's statutory framework for economic regulation and the strength of the regulators, and its rules-based approach that facilitates predictability and low volatility. For example among Ofgem's duties it must have regard to, among other things, the need to secure that licence holders are able to finance their licenced activities⁷⁷.
- **Adequacy of the level of net revenue** is provided by the regulatory framework that allows for recovery by the network companies on the regulatory asset base of the (notional) cost of debt and equity. In addition, there are performance incentives that may adjust the actual net returns above or below these levels. Ofgem uses a 10-year trailing average for debt (an iBoxx⁷⁸ index).

It used costs of equity in the range of 6.7-7.0% p.a. (post-tax real) in the RIIO-T1⁷⁹ electricity and gas transmission and the RIIO-GD1⁸⁰ gas distribution price controls. Ofgem used a real cost of equity of 6-6.4% p.a. for the RIIO-ED1⁸¹ price control for electricity distribution. Ofwat has used a cost of equity of 5.65% p.a. (post-tax, real) for its price review of water companies in 2014, known as PR14⁸², and intends to use 4.01% p.a. (real, RPI basis) for PR19⁸³. Through our interviews we have heard the regulatory methodology is of paramount importance over the rates themselves, because this allows predictability. Investors in utility companies we spoke with expected returns to be kept in line with the market rates (and to fall as such rates fall), and indeed stated a preference for non-excessive returns because they were more likely to be sustained long term.

- **Visibility of sufficient value of future similar projects** for financiers of RAB network companies is established in the programmes of investment which are agreed as part of the five or seven yearly price controls for each RAB network company with the relevant regulator. The RAB network companies have relatively large physical networks which require significant ongoing programmes of capital expenditure⁸⁴, typically financed by a combination of borrowings in the public bond markets and retained earnings.

The following other favourable factors were apparent in our consideration of RAB network company financing:

- **Investment grade credit ratings** are required by regulators for the licensed entities in many of the industries with RAB network companies those duties that require the regulator to ensure its licensed companies remain financeable⁸⁵. These credit ratings provide a significant degree of comfort that the companies will have access to the public bond markets which are a highly liquid source of debt finance at a wide range of maturities.
- **Limited exposure to competition in RAB network businesses** through barriers to entry (they are frequently natural monopolies), scale, and asset types, which minimises the risk of stranding or fall in revenues for equity investors and lenders.

In the table below we describe the possible implications for district heat networks of selected characteristics of RAB companies sub-sector from our work, and this is also included in Table 1 in section 1.3 of the Executive Summary.

Infrastructure sub-sector	Selected characteristics	Possible implication for the pipe/meter network element of district heat networks
Licensed Regulated Asset Base (RAB) networks under economic regulation	<ul style="list-style-type: none"> • Operator licences and an agreed customer pricing mechanism with periodic reviews which take account of changes in costs and financial market conditions 	<ul style="list-style-type: none"> • Subject to suitable legal powers, local licencing, e.g. within a town, with a set pricing mechanism for new and existing customers could be a means for encouraging new investment in district heating networks through competition for licencing rights • Subject to legal powers, potentially district heat networks could be added to existing RAB network businesses, if Ofgem and the industry parties were willing, and benefit from existing regulatory structures

76 For example: https://www.ofgem.gov.uk/system/files/docs/2017/08/g2en_uos_charging_methodology_approval_letter.pdf

77 See: <https://www.ofgem.gov.uk/publications-and-updates/powers-and-duties-gema>

78 A provider of bond index information, see: <https://ihsmarkit.com/products/iboxx.html>

79 See: <https://www.ofgem.gov.uk/ofgem-publications/53602/4riiot1fpfinancedec12.pdf> – page 11

80 See: https://www.ofgem.gov.uk/sites/default/files/docs/2012/12/1_riiogd1_fp_overview_dec12.pdf – page 35

81 See: <https://www.ofgem.gov.uk/ofgem-publications/91564/riio-ed1finaldeterminationoverview.pdf> – page 40 and https://www.ofgem.gov.uk/system/files/docs/2017/01/guide_to_riioed1.pdf – page 61

82 See: https://www.ofwat.gov.uk/wp-content/uploads/2015/11/prs_pre201412pr14investor.pdf – page 3

83 See: <https://www.ofwat.gov.uk/wp-content/uploads/2017/12/Appendix-12-Risk-and-return-CLEAN-12.12.2017-002.pdf> – page 18

84 For example see: https://www.ofwat.gov.uk/wp-content/uploads/2015/10/det_pr20141212svt.pdf – page 28 additions to regulatory capital value, which reflect capital expenditure, for Severn Trent Water for the period 2015-20

85 See: <https://www.ofgem.gov.uk/ofgem-publications/37070/jrg-report-cost-capital-and-financeability-final-march-2013-pdf> – page 13

3.12 Water industry Infrastructure Provider model: Thames Tideway Tunnel

3.12.1 Introduction

Rationale for inclusion in this study: the Infrastructure Provider⁸⁶ model was introduced by Ofwat to enable individual large new build projects to be financed in the regulated water sub-sector. This model was developed in co-operation with private sector finance providers. The Thames Tideway Tunnel (TTT) project⁸⁷ is the first application of this model and it was developed by a private sector utility, Thames Water.

The TTT is a 25km, £4.2bn⁸⁸ (2012 prices) tunnel which is to run through London and along the river Thames to capture, store and drain nearly all of the 39 million tonnes of the sewage that currently overflows into the Thames at times of heavy rain.

In 2001 the Thames Tideway Strategic Study suggested the TTT project as the only solution to its named objectives to (1) protect the ecology of the Thames Tideway, (2) Reduce aesthetic pollution, and (3) protect the health of recreational users. In 2007, Government confirmed support for the TTT project and requested Thames Water to go ahead with developing the scheme. Specification of the TTT project by the Secretary of State⁸⁹ in 2014 under relevant regulations relieved Thames Water from complying with that duty in relation to undertaking the project, and instead required it to procure a separate Infrastructure Provider to finance, design, build, own, operate and maintain the bulk of the Tunnel. That procurement process was completed in 2015, with a new company called Bazalgette Tunnel Ltd being designated by Ofwat as the Infrastructure Provider for the project and being awarded a project licence.

Ofwat, supported by Defra and HM Treasury, developed a novel process for awarding the licence for the project due to its large size relative to the balance sheet of Thames Water, the incumbent company. Thames Water competitively procured the design, construction, ownership, financing, operation and maintenance of the Thames Tideway Tunnel. The project would be paid for through an increase in Thames Water's customer bills from project start of construction (before its operation).

Ofwat and the Government sought to attract competitive pricing on construction, operation and financing of the project. In order to achieve this, the Government provided guarantees against a range of risks, including excessive cost overruns. The project benefits from a bespoke Government support package⁹⁰ including in particular provision of a cost overrun threshold of £4.1 billion, or £960 million (30%) above the target price: if Bazalgette Tunnel's costs exceed this threshold, Defra "agrees (under the 'Contingent Equity Support Agreement') to either provide equity to Bazalgette Tunnel; or discontinue the project and pay compensation".

The bid weighted average cost of capital⁹¹ (BWACC) for TTT is a 2.497% p.a. real post-tax WACC during the construction phase. The cost of capital is enhanced if the cost target is outperformed, and reduced if there are delays, through incentive mechanisms similar to those already used in the industry. Protection is offered by Ofwat where the construction costs exceed the threshold outturn due to exceptional events. In these cases, this difference is reconciled with additional revenues, or the Government could provide equity finance. These mechanisms are similar to those applied to other regulated water and sewage companies. There is also the same RPI indexation mechanism on the project.

However, the project differs from the regulatory approach for these companies in other respects. For example, the company managing the TTT project is ring-fenced from Thames Water's operations, meaning overspends, contracts and costs are limited to the TTT company. In addition, competition was introduced at the construction stage and separately at the financing stage. This differs from both the typical price control model where incentive-based regulation is used (rather than competition) and an OFTO-type model where developers propose a single bid supported by separately-arranged contracts and finance.

Exceptionally for a new-build infrastructure projects in the UK, revenues are permitted – through bill increases for Thames Water customers – from the start of construction of the project. This cash flow provides a buffer to investors against cost overruns during the long construction period. It reduces the risk of a need for further equity investment in the case of cost overruns because of the potential to recycle cash that would be paid as dividends to cover such overruns, if they arise and subject to the amounts involved. Finally, investors are provided long-term certainty over elements of cash flows for up to 15 years. These arrangements have enabled institutional equity investors which may otherwise have been unable to invest in a new-build project with such a long construction period and complex construction risk to invest in the TTT at the cost of capital described above.

Thames Water announced⁹² Bazalgette Tunnel Ltd, a consortium consisting of Allianz Infrastructure Luxembourg, Dalmore Infrastructure Investments, IPP (Bazalgette) Ltd, DIF Bid Co Ltd, and Bazalgette (Investments) Ltd, as the preferred bidder for the TTT project in July 2015. Construction began on the project in 2016.

3.12.2 How the water industry Infrastructure Provider model satisfied key infrastructure investor and lender requirements

Our experience, literature review and our interviews relating to the water industry Infrastructure Provider model are as follows:

- **Predictability and stability of the revenue stream** is achieved through a combination of (1) limited upsides and downsides to the project through sharing mechanisms and protection from significant cost overruns, and (2) revenues flowing from the start of construction, rather than from operation, allowing debt to be serviced immediately and gave the option that cost overruns borne by equity investors could be funded from revenues collected during construction, rather than needing to raise further finance. This latter point helped with the issue of the long construction period of 6.5 years, which would otherwise probably have been unacceptable to most infrastructure equity investors.
- **Adequacy of the level of net revenue** is achieved by competitively procuring the contracts, and then allowing the construction costs, cost of finance and inflation indexation through revenues from customers.
- **Visibility of sufficient value of future similar projects** was satisfied by the large scale of the project itself, at £4.2bn and the winning Bazalgette consortium has committed £1.275bn⁹³ of equity to the project determined by the project itself. We understand that the two joint largest equity investments within the winning consortium were approximately £440m each^{94 95}. This represents a significant deployment of capital for the investors involved. There is also the additional (by comparison, minor) benefit for investors of having gained experience of the Infrastructure Provider model which may be used for large future projects in the water sub-sector.

86 See: https://www.ofwat.gov.uk/wp-content/uploads/2015/10/gud_pro201407infrastructure.pdf

87 See: <https://www.tideway.london/>

88 See <https://www.tideway.london/news/media-centre/green-light-for-42bn-london-super-sewer/>

89 See: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/471847/thames-tideway-tunnel-strategic-economic-case.pdf – page 1

90 See: <https://www.nao.org.uk/wp-content/uploads/2017/03/Review-of-the-Thames-Tideway-Tunnel.pdf> – page 36 et seq.

91 See: <https://www.ofwat.gov.uk/pn-0215-ofwat-awards-licence-thames-tideway-tunnel/> and <https://www.oxera.com/Latest-Thinking/Agenda/2015/The-Thames-Tideway-Tunnel-returns-underwater.aspx>

92 See: <http://www.londonstockexchange.com/exchange/news/market-news/market-news-detail/other/12472841.html>

93 See: <https://www.insurancejournal.com/news/international/2015/08/28/379950.htm>

94 See: <https://www.tideway.london/about-us/the-organisation/our-shareholders/>

95 See: <https://www.tideway.london/media/2905/investor-presentation-26-jan-2017.pdf> – page 4

The following other favourable factors were apparent in our consideration of the Infrastructure Provider regime as implemented for the TTT project:

- **The form of contracting and the Government support package** were key to managing construction risk. Thames Water separately procured the construction element of the project. The contracting approach was developed by Thames Water to take account of the project’s scale and complexity⁹⁶. The commercial relationship with the three consortia that will deliver the bulk of the tunnel will be managed via NEC3⁹⁷ contracts. In addition, an alliance has been created between Tideway, the three main works contractors, the system integrator, and Thames Water with the aim of ensuring co-operation between all delivery stakeholders. This relationship is regulated by an alliance agreement. The Government support package is described in outline in section 3.11.1 and in more detail in the material referenced there, in particular the NAO report.
- **The management team** which had developed the project and tendered its construction was an important part of investors’ due diligence, since they would be managing the project itself and interfaces with Thames Water.

- **Development work** conducted by Thames Water under its RAB network business regulated by Ofwat, reported to total £1.4bn⁹⁸ in value, was important to investors since this phase typically extends the time between making an investment and receiving revenues. For an investor in a competitive bidding situation, it is difficult to justify investing in lengthy and high cost planning and design work when there are low odds of winning a project.
- **Collaboration between key parties** emerged as a unique message from these interviews. It was felt that the size and complexity of the project meant that all parties (Government, Ofwat, Thames Water, contractors, and financiers) had to collaborate to make the project a success.

In the table below we describe the possible implications for district heat networks of selected characteristics of Infrastructure Provider regime, as implemented for the TTT project, from our work and this is also included in Table 1 in section 1.3 of the Executive Summary.

Infrastructure sub-sector	Selected characteristics	Possible implication for the pipe/meter network element of district heat networks
Infrastructure Provider model as used in Thames Tideway Tunnel	<ul style="list-style-type: none"> Existing customers can, in certain circumstances, carry part of the cost of financing new infrastructure in its construction phase if there is sufficient resulting benefit in reduced financing costs 	<ul style="list-style-type: none"> Where public sector project sponsors are also future heat offtakers it may be feasible to provide investors with a construction period service charge revenue. This could help lower the long-term heat tariff and enable the projects to attract a wider range of investors during construction which should reduce the cost of finance Public sector value for money appraisals might include such mechanisms for consideration within project development, subject to appropriate risk management and milestones

3.13 Forthcoming Competitive Onshore Networks: Ofgem’s CATO and TO-SPV models and Ofwat’s Direct Procurement for Customers model

3.13.1 Introduction

The CATO, Transmission Owner-SPV (TO-SPV), and Direct Procurement for Customers models are new commercial structures in the power and water sectors developed by Ofgem and Ofwat drawing on contractual and licence based approaches to infrastructure provision, also expected to make use of the project financing structures applied successfully in PFI/PF2 projects and OFTOs.

These policies aim to introduce competition into electricity and water supply networks in order to achieve efficiencies and consumer benefits across the project lifecycle, from design to finance, build, maintenance and operation. There are a number of the policies, with some common features, as described below. These policies have been introduced recently and so projects have not yet been financed on these bases, although a number are in development.

These models are relevant because they draw on successful precedents for competitive tendering and project financing in various infrastructure sub-sectors, including OFTOs and PFI/PF2.

We describe first the evolution of Ofgem’s competition policies in network electricity transmission businesses.

3.13.2 Competitively Appointed Transmission Owner (CATO) framework, in the electricity industry

CATOs, that is Competitively Appointed Transmission Owner licences⁹⁹, are intended to be used in the future for new-build electricity transmission projects of at least £100m capital value. This policy was developed by Ofgem in 2014-16 and CATO tenders are intended to be introduced by Ofgem when appropriate legislation can be passed. This is expected to occur once the substantial quantity of legislation required for the UK’s withdrawal from the EU has been enacted.

96 See: <https://www.tideway.london/about-us/the-organisation/delivery-model/>

97 See: <https://www.neccontract.com/NEC3-Products/NEC3-Contracts/NEC3-Engineering-Construction-Contract>

98 Source: Infrastructure Journal

99 See: <https://www.ofgem.gov.uk/electricity/transmission-networks/competition-onshore-transmission>

CATOs will be transmission links within the GB onshore transmission system, as distinct from OFTOs which link the onshore transmission system to offshore wind farms. The planned CATO programme can be seen as a development by Ofgem¹⁰⁰ of the concept of applying competition to the procurement of transmission projects that was first introduced with the OFTO programme (see section 3.9 above).

Prior to the proposed CATO policy and the recently introduced TO-SPV policy (see below), in 2012/13 Ofgem started to assess large electricity transmission projects separately from the regular price controls of incumbent RAB network corporates. Under the RIIO-T1 framework for electricity transmission network companies (see section 3.10), large infrastructure projects that were insufficiently certain of specification and cost at the time of setting the price control for the relevant RAB network corporate are instead assessed, within the relevant RIIO period, under Ofgem's Strategic Wider Works (SWW) mechanism¹⁰¹. Transmission Owner (TO) RAB network corporates were allowed pre-construction funding only, and not construction funding, by Ofgem under the RIIO Final Proposals.

Three SWW projects have been fully assessed to date: Kintyre-Hunterston¹⁰², Beaulieu-Mossford¹⁰³ and Caithness-Moray¹⁰⁴. Each of these projects was challenged by Ofgem on both the Needs Cases presented, and the Project Assessments. These latter assessments found efficiency savings across all projects, with Caithness-Moray being subject to a material reduction of c.£105m¹⁰⁵ from the TO's plans. Now these projects are underway, the TOs are incentivised to achieve further efficiency savings themselves to underspend the regulatory allowances (and share the underspend with consumers through the sharing rate, all else being equal¹⁰⁶).

Following this, Ofgem has sought to introduce onshore competition to drive savings in large infrastructure projects. This has led to requirements on National Grid's System Operator business to develop the Network Options Assessment¹⁰⁷ (NOA) in order to provide Ofgem with an independent view on network reinforcement needs, and the pipeline of new infrastructure projects.

The NOA assesses each electricity transmission project's suitability for competition against Ofgem's three main criteria of being new, separable, and of high value (over £50-500m capex, the value depending on which of the three regulated electricity transmission businesses is to undertake the project). If a project qualifies against these criteria, Ofgem will seek to compete these projects under its new TO-SPV model¹⁰⁸ (or a proxy for it) as announced in January 2018, until the CATO framework can secure the legislative changes needed.

Similarly introducing competition to onshore networks promises to yield lower costs for reinforcement works, much of which connects new electricity generation to the transmission network. The Integrated Transmission Policy Review¹⁰⁹ (ITPR) supported the development of the Competitively Appointed Transmission Owner (CATO) model. However, CATO policy development has been suspended whilst Ofgem awaits the required legislative changes, ones which would change provisions to allow non-licence holders (including generators) to recover costs after a tender exercise.

Ofgem has therefore begun development on alternatives to the CATO model that would nonetheless introduce effective competitive pressure – or a substitute for it – into the onshore networks. As detailed in the Hinkley-Seabank consultation¹¹⁰, Ofgem has considered two primary options:

- a Competition Proxy model, and
- a TO-SPV model.

These models are described below.

3.13.3 Competition Proxy model, in the electricity industry

The Competition Proxy model sits between the typical cost assessment efficiency saving challenge under RIIO's SWW mechanism and the efficiency challenge that might be extrapolated from the effects of competition – particularly from the OFTO sub-sector. Learning from the cost savings that have been made through competition in OFTOs, Ofgem would set its cost allowances more stringently as if there were similar competitive pressure in the onshore network.

This approach, alongside the TO-SPV model, were consulted on in the recent Hinkley-Seabank transmission project consultation¹¹¹. Ofgem has presented the TO-SPV model and Competition Proxy model as two potential delivery models for the SWW projects that are amenable to competition (as per the NOA assessment) (though there remains some uncertainty around the need for the forthcoming projects of Hinkley-Seabank and the North West Coast Connection).

Ofgem has stated¹¹² that it expects the process for the Competition Proxy model at the Final Needs Case (FNC) assessment stage to be broadly similar to that undertaken under the current SWW arrangements, as set out in its SWW guidance.

After the consultation and confirmation of need at the FNC stage, the project will move into the project costing stage where Ofgem will assess the project costs and determine an indicative project-specific revenue stream. Ofgem would then make changes to the TO's licence as appropriate to give effect to the determined project-specific revenue.

3.13.4 TO-SPV Model, in the electricity industry

Under the TO-SPV model, following identification of a project need and suitability for competition by the System Operator (SO) in its NOA, the transmission owner (TO) would procure an SPV to deliver the end-to-end solution. Many candidate projects are already known and fall under the RIIO price control framework, including National Grid's Hinkley-Seabank Connection, the North West Coast Connections (NWCC), and Scottish network reinforcements (e.g. Western Isles link, Orkney Islands link, Eastern link).

The most similar regulatory examples to the TO-SPV model are Ofgem's OFTO-build model, SHEPD's Shetland project and Ofwat's Direct Procurement for Customers model. Each of these share the central principle that competition in the supply chain, financing and O&M can reduce the costs to consumers compared with the status quo. Moreover, Ofwat's DPC approach, the electricity sector's NG Shetlands Link-Aggrego proposed solution, and the TO-SPV model all share the feature that the incumbent network operator would run the tender (rather than the sector regulator).

The two main benchmarks to measure the success of the TO-SPV model are the current Strategic Wider Works arrangements (the baseline for projects such as Hinkley-Seabank), and the Competition Proxy model, itself extrapolated to some extent from RIIO efficiencies and cost reductions over the OFTO regime tender rounds.

100 See: <https://www.ofgem.gov.uk/electricity/transmission-networks/integrated-transmission-planning-and-regulation>

101 See: <https://www.ofgem.gov.uk/electricity/transmission-networks/critical-investments/strategic-wider-works> and <https://www.ofgem.gov.uk/ofgem-publications/85263/strategicwiderworksfactsheet.pdf>

102 See: <https://www.ssen-transmission.co.uk/projects/kintyre-hunterston/> and https://www.spenergynetworks.co.uk/pages/kintyre_hunterston_link.aspx

103 See: <https://www.ssen-transmission.co.uk/projects/beaulieu-mossford/>

104 See: <https://www.ssen-transmission.co.uk/projects/caithness-moray/>

105 See: <https://www.ofgem.gov.uk/ofgem-publications/91977/decisiononourassessmentofthecaithnessmoraytransmissionproject.pdf>

106 Sharing overspends and underspends with consumers, which is at the totex level rather than project level, is a key tool of incentive-based regulation.

107 See: <https://www.nationalgrid.com/uk/publications/network-options-assessment-noa>

108 See: <https://www.ofgem.gov.uk/publications-and-updates/update-competition-onshore-electricity-transmission>

109 See: <https://www.ofgem.gov.uk/publications-and-updates/integrated-transmission-planning-and-regulation-itpr-project-final-conclusions>

110 See: <https://www.ofgem.gov.uk/publications-and-updates/hinkley-seabank-minded-consultation-delivery-model>

111 See: https://www.ofgem.gov.uk/system/files/docs/2018/01/hsb_condoc_delivery_model.pdf

112 See: https://www.ofgem.gov.uk/system/files/docs/2018/01/competition_update.pdf – page 17

3.13.5 Direct Procurement for Customers, in the water industry

In the water industry, Ofwat has been looking to apply more broadly some of the lessons of competitive approaches from the Thames Tideway Tunnel project (see section 3.11) and OFTOs (see section 3.9), among other precedents. For this purpose it has developed its Direct Procurement for Customers (DPC)¹¹³ policy. DPC¹¹⁴ refers to arrangements whereby a regulated water company procures services, particularly infrastructure projects and which can include the financing of the project, on behalf of customers. Ofwat's intended purpose in introducing DPC is to drive value for customers.

Ofwat noted that Thames Water's procurement of the delivery of the Thames Tideway Tunnel from an independent service provider was an example of the DPC approach (though with a key difference being Ofwat would not licence a DPC SPV, in contrast to the licencing of the Thames Tideway Tunnel). While the Thames Tideway Tunnel has a number of unique characteristics – including the scale and risk of the project and a Government support package – Ofwat considered that the principle of a water company acting to procure major projects or enhancements on behalf of customers could be applied elsewhere.

DPC is a means of promoting the use of third parties – selected competitively – to provide significant infrastructure projects, which would otherwise be provided by the relevant incumbent regulated water company. Ofwat expects that it will reveal information that will help it to regulate more effectively, and enable a less intrusive approach.

Ofwat cited analysis undertaken for Ofgem that showed that the first three tender rounds of Ofgem's OFTO regime will bring savings of over £700m over 20 years. DPC projects are expected by Ofwat also to help to reveal the actual cost of capital for the wider water sector and so potentially help with setting the allowed return in price controls. Ofwat went on to comment that the Thames Tideway Tunnel and the OFTO regime provide longer term price controls for specific infrastructure projects. By providing the option to consider projects outside of the five year price review cycle, a longer term project focus could be achieved and enable lower whole life costs.

Ofwat intends the regulated companies to take ownership of the DPC process^{115, 116}, unlike for example the OFTO tenders which are run by Ofgem. Ofwat does not consider DPC to be mandatory, but rather as an additional tool available to companies. If a company can make a compelling case why it can provide the project at better value for customers than the market, then it is to do so in its business plan submitted to Ofwat. The regulated companies remain responsible for all their statutory obligations, which cannot be contracted away to third parties under DPC arrangements.

In its policy information, Ofwat provided an illustrative value of projects¹¹⁷ that would be subject to consideration for the DPC approach. The regulated water companies are currently working on developing their approaches to the assessment of projects for suitability and the implementation of DPC.

3.13.6 How the forthcoming competitive onshore networks sub-sector is intended to satisfy key infrastructure investor and lender requirements

The set of models considered in this section all seek to meet the key factors for infrastructure investment have been satisfied as follows:

- **Predictability and stability of the revenue stream:**

Competition is used to drive economic savings for customers at different stages, but once the developer has been nominated it will benefit from a stable revenue stream, with no demand risk. In the case of CATOs, this would be achieved by means of a tender revenue stream to which the licence holder would be entitled. For Ofgem's TO-SPV and Ofwat's DPC models, the revenue stream is likely to be provided on a contractual basis between the SPV/third party provider and the licensed network company. In Ofgem's Competition Proxy model, the allowed revenues are determined by a project-specific assessment process undertaken by Ofgem under the relevant company's licence.

- **Adequacy of the level of net revenue** is provided through revenues that are designed to cover the efficient investment costs of the project. The adequacy of the level of net revenue would be determined in the case of most of these models by a competitive tender process undertaken either by the regulator or the incumbent network business as appropriate to the specific model. In the case of the Competition Proxy model the revenue level is to be established in Ofgem's assessment process based on the transmission company's needs case submissions.

- **Visibility of sufficient value of future projects** is likely to be provided by the regulator in publishing the pipeline of projects. For example, Ofgem has published the projects the NOA has recommended as suitable for competition. Similarly, Ofwat has published information about the indicative nature and scale of projects that may be procured and financed under its DPC policy.

In both cases, the policies have been formulated on the basis of being targeted at projects above certain value thresholds and the chosen levels make the individual projects significant for infrastructure financiers.

In addition these models indicate regulators' desire to make greater use of competitive processes for the setting of regulated revenue streams, and to have participation by a wider range of project construction, operating and financing parties. This trend is consistent with the use of auctions to allocate contract for difference subsidy support, and capacity market contracts, for eligible power generation projects.

3.14 PFI/PF2 projects (including Scottish hub projects)

3.14.1 Introduction

Rationale for inclusion in this study: PFI/PF2 projects are a key contract-based form of individual infrastructure project which has been applied to a wide variety of sectors in the UK and overseas, and at a range of project values comparable with district heating projects.

The initial PFI concept was introduced¹¹⁸ in 1992 with initial projects' key contracts signed in the 1995, in the transport and education sectors. The programme was expanded significantly after 1997 and applied in the health, education, social housing, prisons, transport, and defence sectors. Later, it was applied in the waste sector (this is dealt with in section 3.8 and variations of PFI were also applied in certain Public Private Partnerships (PPPs), in the UK sense of that project type. The PFI programme was scaled down from 2010, reflecting changing political views and the PF2 structure was introduced from 2012, including provision for public sector shareholding in the projects' special purpose vehicles at the option of the public sector. PPP projects (in the traditional UK meaning of that description) have more variation in their features and so are less standardised; two examples are discussed in section 3.15.

113 See: <https://www.ofwat.gov.uk/wp-content/uploads/2017/12/Appendix-9-Direct-procurement-FM.pdf>

114 See: <http://webarchive.nationalarchives.gov.uk/20170603110333/http://www.ofwat.gov.uk/wp-content/uploads/2016/07/2016-06-28-WG1-All-slides.pdf> – page 35

115 See: <https://www.ofwat.gov.uk/wp-content/uploads/2017/10/Direct-Procurement-for-Customers-Industry-Workshop-notes.pdf>

116 See https://www.ofwat.gov.uk/wp-content/uploads/2016/06/prs_web20160606w2020citybriefing.pdf – page 27

117 See: https://www.ofwat.gov.uk/wp-content/uploads/2015/12/pap_tec20150525w2020app5.pdf – pages 3,4

118 See: <http://researchbriefings.files.parliament.uk/documents/RP01-117/RP01-117.pdf>

Over 700¹¹⁹ PFI and PF2 projects have been signed since the start of the programme in the 1990s with capital values¹²⁰ of individual projects in England ranging from £4 million to £2.7 billion.

Although the use of PFI/PF2 in the UK has reduced significantly from its peak in the 2000s, in the UK has fallen recently partly reflecting reduced capital spending by the UK public sector, the equivalent PPP market has remained active in several continental European countries and in Canada and Australia as noted by various of our interviewees.

The PFI/PF2 and overseas PPP programmes are reported in detail in online industry publications such as Infrastructure Journal and InfraNews, including information about forthcoming projects, key down-selection stages in procurements and financial closes. This provides helpful visibility of the pipeline of future projects for financiers, and spreads knowledge of transaction participants and key project features at a high level. It would be helpful if the district heating network project sector's projects expecting to raise private sector finance can achieve similar levels of coverage in the finance industry press.

The PFI programme was developed by HM Treasury and a Task Force for the programme was established in 1997. The project orientated role of the Task Force¹²¹ was succeeded in 2000 by Partnerships UK, itself jointly owned by the public and private sectors. In 2010 this was replaced by the Infrastructure UK unit of HM Treasury, which was later transferred to the Infrastructure & Projects Authority in the Cabinet Office in 2016.

The form of contract for PFI projects, and related procurement processes, was subject to standardisation and was refined successively. The first standardised contract¹²² (SOPC1) was introduced in 1999 and there were three further revisions of the standard, up to SOPC4 of March 2007. PF2 was introduced with a draft standardised contract¹²³ in 2012. The standardisation of the PFI/PF2 commercial proposition and risk allocation was seen by several of our interviewees as useful, although it was commented that it was not necessary to have a fully drafted form of contract to achieve enough standardisation to attract bidders and financiers and encourage competition.

In the cases where asset types proved unsuited to the PFI structure such as in information technology the use of PFI was specifically discontinued. The cost of project finance documentation and due diligence, and the extent of external advice needed by authorities was also found to make PFI unlikely to provide value for money by projects below £20m capital value and the use of PFI was discontinued for such smaller projects from 2003. See HM Treasury's publication "PFI: meeting the investment challenge¹²⁴" of July 2003.

A key reform of the PF2 programme relative to PFI was to shorten procurement periods, the length of which had been a significant criticism of the UK PFI programme, to a maximum of 18 months¹²⁵. Our interviewees commented that development/ procurement periods of no more than 15-18 months are needed to maintain investor and lender interest, and that 12-14 months is preferable.

The hub programme¹²⁶ in Scotland involves public sector organisations within a defined territory working in partnership with each other and with a private sector delivery partner with whom they will form an institutional PPP. The authority contracts with a special purpose vehicle (SPV), a wholly owned subsidiary of the "hubco" for the relevant territory, in a similar way to traditional PFI projects. Equity returns on revenue funded projects must be fixed or capped.

A mechanism has been developed and used in the hub projects in which profits earned by the SPV that would otherwise be paid to equity investors are to be shared equally with the authority once a first threshold level of equity return has been achieved. If profits are high enough that the equity return would exceed a second threshold level if all profits were to be distributed to equity owners, then all further profit distributions above this threshold are payable to the authority. The authority's share of excess profits may either be paid to it in lump sums or be used to reduce the future service payments.

3.14.2 How the PFI/PF2 sub – sector satisfied key infrastructure investor and lender requirements

From our experience, literature review, and interviews relating to the PFI/PF2 sub-sector, the manner in which the three key factors for infrastructure investment have been satisfied is as follows:

- **Predictability and stability of the revenue stream** over the economic life of the assets for PFI/PF2 projects are based on a long term contract with the private sector service provider. Usually, these contracts are an availability or shadow toll basis which does not require the PFI/PF2 Company (or its finances) to take significant demand volume or price risk. The contracts range in length from 15–30 years typically depending on the economic life of the capital assets involved and the available maturity of debt finance, among other factors.

The fewer cases of PFI projects involving revenue risk for the private sector parties are perceived by finance providers to have had more a greater incidence financial distress than availability based projects. The experience of revenue outcomes has included cases in road¹²⁷ and light rail projects where projected revenues were not achieved, due for example to lower than expected usage and in one case to an external metric in the revenue calculation that the project company could not influence significantly. This has led finance providers to prefer availability based projects over those including demand risk.

- **Adequacy of the level of net cashflow** has been established in order to attract viable bids from the private sector, PFI/PF2 projects have had to be able to offer a level of contracted unitary charge payment sufficient to remunerate the debt and equity finance required for the capital elements of the projects and their operating costs and taxes. A key part of the governance and approval process within the public sector was the public sector comparator assessment. This required a comparison to be made of the costs of undertaking the project in the public sector versus in the private sector (using a PFI project). Only if the private sector option was found to be cheaper would the project be approved for procurement as a PFI project.

The preparation of the PFI comparator required an assessment of the underlying construction costs of the project and the overlaid public and private financing options. This process, linked with the budgeting process of the relevant central government department or local authority, gave bidders confidence that the procuring authority could afford the project and that there was limited risk of the procurement stalling or failing due to unaffordability. Nonetheless, some project procurements experienced delays while affordability problems were addressed by adjustments to scope or reallocation of budgets.

119 Source: NAO report "PFI and PF2" of January 2018 – see: <https://www.nao.org.uk/wp-content/uploads/2018/01/PFI-and-PF2.pdf>

120 Source: Gov.uk Private Finance Initiative and Private Finance 2 projects: 2015 summary data – see detailed spreadsheet list at: <https://www.gov.uk/government/publications/private-finance-initiative-and-private-finance-2-projects-2015-summary-data>

121 See: <http://researchbriefings.files.parliament.uk/documents/RP01-117/RP01-117.pdf>

122 See Introduction in: [https://ppp.worldbank.org/public-private-partnership/sites/ppp.worldbank.org/files/documents/UK_Standardisation%20of%20PFI%20Contracts%20\(ver4.2007\).pdf](https://ppp.worldbank.org/public-private-partnership/sites/ppp.worldbank.org/files/documents/UK_Standardisation%20of%20PFI%20Contracts%20(ver4.2007).pdf) and http://webarchive.nationalarchives.gov.uk/20121204162202/http://www.hm-treasury.gov.uk/ppp_standardised_contracts.htm

123 See: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/221556/infrastructure_standardisation_of_contracts_051212.pdf

124 See http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/media/F/7/PFI_604a.pdf

125 See Chapter 3 of HM Treasury publication "A New Approach to Public Private Partnerships" of December 2012, see <https://www.gov.uk/government/consultations/a-new-approach-to-public-private-partnerships-consultation-on-the-terms-of-public-sector-equity-participation-in-pf2-projects>

126 See: <https://www.scottishfuturetrust.org.uk/page/hub>

127 Mostly outside the UK because very few real toll road projects have been undertaken in the UK apart from estuarial crossings

• **Visibility of sufficient value of future similar projects** Following the reforms to the sub-sector of 2003 by HM Treasury to discourage the use of PFI for small projects, later PFI/PF2 projects generally have ranged from approximately £15 million to £2.7 billion in capital value¹²⁸. The pipeline of projects by number has greatly reduced but the remaining expected projects are large individually, for example a new Lower Thames Crossing.

The following other favourable factors were apparent in our consideration of the PFI/PF2 sub-sector:

• **Successful transfer of construction risk** is a key feature, and indeed requirement, of PFI/PF2 projects because they normally involve the construction of capital assets by special purpose vehicle companies which have no revenues until the relevant project is completed and operational to a defined standard. This is combined with facilities management (or operation and maintenance, depending on the asset type) for a 15–30 year term.

For finance providers the ability to transfer this risk to construction contractors (and/or in some cases manufacturers), was a key feature of PFI and remains a key feature of PF2. To enable this construction risk transfer, it was important that the relevant capital assets could be contracted for construction/manufacture a fixed price basis (or close to fixed price). This was so that highly geared financial structures and relatively low cost debt could be used and fixed prices could be offered to the public sector.

• **Credit quality of the key counterparty**, the authority responsible for paying the unitary charge due under the PFI or PF2 agreement, is high in these projects because of the high credit rating of the UK Government and the system of ensuring the financial stability of local authorities in the UK. PFI/PF2 projects are based on a contract between the relevant central or local government authority and a private sector body, usually a special purpose company which raises the necessary limited recourse project financing. The UK Government credit rating is currently AA/Aa2/AA by Standard & Poor's/Moody's/Fitch rating agencies (and it was rated AAA/Aaa/AAA until 2013).

In most cases for PFI contracts involving local authorities, central government reinforced this credit quality by the system of PFI credits to local authorities which provided a specific funding stream from central government linked to designated PFI projects. This system was removed in early 2011 (see HM Treasury publication "Public Private Partnerships – Technical Update 2010¹²⁹" of autumn 2010). The use of PFI and PF2 in the local government sector has reduced significantly since this change was made.

In the table below we describe the possible implications for district heat networks of selected characteristics of the PFI/PF2 sub-sector from our work, and this is also included in Table 1 in section 1.3 of the Executive Summary.

Infrastructure sub-sector	Selected characteristics	Possible implication for the pipe/meter network element of district heat networks
PFI/PF2	<ul style="list-style-type: none"> Revenues, in most cases, are based on assets/service availability and are not demand-based Standardised contracts were produced to help authorities obtain better risk allocation and value for money. This standardisation helped make project financing viable for smaller projects (£20 million capital value) viable than would otherwise have been the case The use of industry publications and journals helped provide visibility of the capital value of the project pipeline to a wide investor pool 	<ul style="list-style-type: none"> PipeCo models for the distribution element of district heat networks, separate from the heat supply business, might consider availability payments rather than use of system charges as a mechanism for attracting a greater range of financing sources and possibly lower cost financing. However, such a structuring approach will probably have risk allocation implications either for the generator or the customer (or both) Currently few, if any, UK district heat network investment opportunities are advertised or reported in industry publications and journals aimed at financiers, unlike PFI/PPP/PF2 projects. Project sponsors and/or BEIS's HNDU could promote district heating projects looking for finance in such publications Standardised documents could be developed for district heat networks. However, these need not be full contracts but could set out the key risk allocation in core heads of terms. These can be developed into full documentation with mechanisms to share learning across the sub-sector, particularly from projects in receipt of any subsidy

128 See: <https://www.gov.uk/government/publications/private-finance-initiative-and-private-finance-2-projects-2017-summary-data>

129 See: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/215079/ppp_technical_update.pdf

3.15 PPP projects

3.15.1 Introduction

Rationale for inclusion in this study: PPP projects, although often having similarities to PFI/PF2 projects, are usually more customised to address particular project features and have less standardisation of documentation. They have been used selectively in the UK in a variety of forms.

The expression Public-Private Partnership (PPP) has two different meanings in infrastructure finance. In the UK it has had the meaning of a public/private sector arrangement (contracted or joint venture) other than one of the standard forms of PFI project. In many countries outside the UK, especially continental Europe and Asia, PPP means project financed new-build infrastructure based on a public procurement and a long term contract between the public sector and a private sector business, that is largely the same meaning as PFI and PF2 have in the UK. In this sub-section we focus on the first meaning of PPP above.

Two examples of PPP structures in the UK are as follows:

- The integrator structures used in the Ministry of Defence's Project MODEL (Ministry of Defence Estate in London) and Military Flying Training System (MFTS) projects, and
- The London Underground Infrastructure PPP projects of 2003 – 2010.

These two examples of categories of PPP project are described below.

3.15.2 Integrator PPP projects

The concept of the integrator is to select a private sector entity which will undertake development work and future procurement on behalf of the public sector for a project with multiple phases and a degree of uncertainty about either the scope of the future works or aspects of the future economics of the project.

In the case of Project MODEL¹³⁰, the objective was to secure the proceeds of disposal from a set of sites surplus to operational requirements in the London area, and to use these proceeds to fund the upgrading of the RAF Northolt buildings. However, the surplus sites required significant preparatory works before they could be offered for sale and the potential proceeds would fluctuate in line with property market conditions. The role of the integrator, selected in a procurement, for project MODEL was to underwrite values for the disposal sites, fund the preparatory works for sale, undertake the site sales and undertake the agreed works on RAF Northolt including raising bridging finance to cover the period prior to final sale proceeds being received. The integrator also agreed to undertake other development and preparatory works in relation to future construction work procurements on a specified fee basis.

In this way the public sector obtained a combination of property marketing and refurbishment work, procurement capability linked to underwriting of surplus property sale proceeds, with the ability to undertake future construction and refurbishment procurements also. This ability to take property market risk and procure construction/refurbishment works could in theory have relevance to district heat networks regarding such networks for new build projects with multiple phases. However, in these cases it is probably a matter for the private sector developers to decide how they wish to procure any district heating network and heat/electricity source.

If the public sector were to return to large scale residential property construction incorporating district heat networks than there may be a role for an integrator undertaking procurement of the district heating network infrastructure and being capable of continuing its work in later phases of the development, not yet contracted as the point of selection of the integrator. However, after Project MODEL the public sector has typically chosen to sell surplus property separately from procurement of works, in order to maximise competition for the land sales and for the works contracts.

In the case of MFTS, the integrator was selected with the objective of later procuring pilot and aircrew training, including simulators, and training aircraft and helicopters. The exact scale of these requirements was only established several years after the initial procurement of the integrator and its earlier packages of training work. In the intervening period there had been significant changes to MOD budget plans. The integrator approach made significant aviation sector technical and commercial expertise available to the MOD for the high value procurements undertaken by the integrator on MOD's behalf. The level of technical specialism in MFTS and its scale make it different from district heating network projects, limiting the applicability of this financing structure precedent.

3.15.3 The London Underground Infrastructure PPP projects (the LU Infraco PPP projects)

The LU Infraco PPP projects were procured in order to upgrade the track, signalling, station, rolling stock, and maintenance depot infrastructure of the London Underground network while keeping responsibility for train operations with the public sector. Two private sector SPV companies were procured to undertake the works to have a capital value of approximately £5 billion in aggregate.

While the projects were in many ways similar to PFI projects of the time they had a number of bespoke features reflecting the large volumes of finance required, the long period of investment and the uncertainty about the physical condition of a large and in many areas very old network. The distinctive features included the following:

- The PPP arbiter¹³¹, the role of which was to resolve commercial disagreements between London Underground and any of the Infraco PPP companies,

- A period of price commitment of only seven and a half years written the 30 year Infraco PPP contract period, with provision for price revisions to be agreed, subject to the PPP arbiter, and
- A letter of comfort from the UK Government for the benefit of the senior lenders to the Infraco PPP companies.

As events transpired, the three LU Infraco PPP contracts were terminated¹³² around the time that the initial seven and a half year committed price commitment period ended. The senior lenders to the projects were compensated under the letters of comfort from the UK Government. The activities of the Infraco PPP companies were taken back under the control of London Underground in the public sector.

While the LU Infraco PPPs did not run for their intended life, the presence of an arbiter was an innovative feature to deal with commercial uncertainties in long duration investments with uncertainty of asset condition. An arbiter or economic regulator could have application in district heat networks if there are commercial uncertainties arising from the pace or scope of construction of multi-phase developments. However, district heating network projects appear to be of far lower capital value than the LU Infraco PPP projects. Consequently, such an approach could probably only be applied to district heating networks at a sector level. This might have use in the form of applying economic regulation to the district heating sector, if this were chosen by Government as an appropriate approach.

130 See: <https://www.nao.org.uk/wp-content/uploads/2005/05/050625.pdf> (page 20,21) and <https://www.bipsolutions.com/docstore/pdf/8433-2.pdf>

131 See: <http://content.tfl.gov.uk/role-of-the-PPP-arbiter-and-lessons-for-future-monitoring-110711.pdf> and http://webarchive.nationalarchives.gov.uk/20110218141116/http://www.pparbiter.org.uk/files/uploads/o_direction/201039204314_42135%20Final%20cost%20directions.pdf

132 See: <http://researchbriefings.files.parliament.uk/documents/SN01307/SN01307.pdf> and <https://www.nao.org.uk/report/london-underground-ppp-were-they-good-deals/>

In the table below we describe the possible implications for district heat networks of selected characteristics of the PPP sub-sector from our work, and this is also included in Table 1 in section 1.3 of the Executive Summary.

Infrastructure sub-sector	Selected characteristics	Possible implication for the pipe/meter network element of district heat networks
PPP	<ul style="list-style-type: none"> Ministry of Defence's Project MODEL (Ministry of Defence estate in London); investors (construction and property sector corporates) have provided services to refurbish certain assets based on proceeds of a medium term programme of disposing of surplus property assets and bridge financing 	<ul style="list-style-type: none"> Identifying and awarding a pipeline of projects to a group of contractors and investors can help lower costs In certain cases, works can be funded from the proceeds of surplus property sales with sharing of profits between public and private sector

Appendix – Interviewee businesses

Name	Type of business (basis of interview)	Infrastructure sub-sectors (as basis of interview)
Aviva Investors	Unlevered equity investment Senior debt lending	PFI/PF2, OFTOs, offshore wind
Dalmore Capital	Equity investment	Thames Tideway Tunnel
Equitix	Equity investment	OFTOs, offshore wind, PFI/PF2
Dutch Infrastructure Fund	Equity investment	Thames Tideway Tunnel, PFI/PF2
Foresight Group	Equity investment	Ground mounted solar
Green Investment Group	Senior debt lending	Energy from Waste projects, offshore wind
John Laing	Equity investment	Energy from waste, PFI/PF2
OMERS Infrastructure Europe	Equity investment	RAB network businesses, smart meters
Royal Bank of Scotland	Senior debt lending	RAB companies, PFI/PF2, energy from waste
SMBC Europe	Senior debt lending	Smart meters, PFI/PF2

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