PROCUR3D
WORK SMARTER

CATAPULT
Energy Systems

Solar Energy Generation

Market Intelligence Report

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NORTHERN POWERHOUSE
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Prepared by
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for
Energy Catapult Systems

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01 Context

The UK Government is committed to reach a net zero emissions target by 2050. This is supported by a policy that recommends that by 2035, the UK will be powered entirely by clean electricity, subject to security of supply [1]. This policy target is supported by substantially increasing electricity generation from nuclear, as well as increasing generation from other renewable sources.

The UK's capacity for electricity generated from all renewable sources in the period 1996 to 2021 went from 2.3 Gigawatts (GW) to 49.7 GW, a 21-fold increase [2]. This is largely as a result of increased capacity through the use of wind-turbines. Furthermore, the use of solar PV to generate electricity has gone from 95 Megawatts (MW) in 2010 to 13,800 MW in 2021, a 145-fold increase over a period of just 11 years. Consequently, there are now over a million solar PV installations across the UK.

The UK market in solar PV is dominated by installations of less than 4 kW generation capacity, accounting for 92% of all installations up to 2021. However, the major contribution to the total generation capacity comes from the circa 400 5 MW to 25 MW schemes which generates 31% of the sector's output.

The use of Solar in the UK has experienced a 145 fold increase in 11 years. The UK's current solar generation capacity is 14.6 Gw. The UK target for 2030 is 40 Gw.

Figure 1 *A Solar Farm in the UK.*

In the context of global demand, the generating capacity from solar PV is a very similar story to that of the UK, with the USA growing from 0.34 GW in 2008 to 126 GW today. Furthermore, the EU is generating capacity standing at more than 160 GW in 2021 from 10 MW in 2008 [3].

It is expected that the vast majority of solar PV schemes will be smaller than 5 MW and thereby governed by Local Authority planning requirements and the Smart Export Guarantee (SEG) which was introduced in Great Britain in January 2020. This seeks to support small scale renewable energy generation of up to 5MW by providing payments for surplus electricity.

In the Climate Carbon Committee's (CCC) Balanced Pathway (to 2050), demand for electricity will increase to 460 TWh in 2035 of which 335 TWh should be met by renewables. Of the 335 TWh, the CCC has predicted that up to 145-615 GW could be provided by solar power. Additionally, solar capacity is growing to meet demand year on year at a rate of about 300-400MW between 2017 and 2021. It would be a reasonable assumption that this demand curve will only increase with the recent pressure on fossil fuel prices.

[1] Net Zero Strategy: Build Back Greener, October 2021, HM Government
[2] UK Energy in brief 2022, Department for Business, Energy and Industrial Strategy
[3] Solar Energy Industries Association June 2022

02 Report Objectives

Procur3d Consulting (Procur3d) have been engaged by Energy Systems Catapult (ESC) to support the procurement of multiple renewable energy capital works projects on the Unlocking Clean Energy in Greater Manchester scheme. Several of these projects were within the solar energy generation market.

ESC and its key stakeholders have found the procurement of these projects challenging, due to a number of market factors.
This report provides a focus on these factors and analyses the supply chain that is involved in delivering medium sized solar energy generation projects. This report's recommendations may not be suitable for large (>10Mwp) seeking Development Consent Orders or small domestic installations.

The purpose of this report is to:

- provide context to some of the challenges the industry is currently facing,
- provide a solar procurement 'playbook' to aid local authorities in achieving best value, and
- analyse some of the public sector frameworks for public sector organisations to procure from.

This report provides a snapshot of the market, however, due to unprecedented supply chain disruption due to the energy crisis, the findings in this report are subject to change. Therefore, we recommend revalidation of the key recommendations prior to their implementation.

Who Are We?

Procur3d Consulting are a specialist commercial and procurement consultant, operating across the construction, engineering and infrastructure industries.

Our knowledge and network across the market enables us to access greater market intelligence which helps our clients make informed decisions and achieve greater value for money.

IN DEVELOPING THIS REPORT WE:

- Analysed key contract databases and latest market trends.
- Engaged over 30 suppliers, including major global suppliers.
- Interviewed all key aspects of the UK solar PV supply chain including Engineers, EPC/ Installers, Equipment Manufacturers, Distributors and Independent Connection Providers.

03 UK Solar PV Sector Overview - Delivery Models

The approach to delivering solar projects requires careful planning, as well as an assessment of stakeholder capabilities to ensure that all parties work collaboratively and deliver optimum results. There are several potential delivery models and we have included three of the most commonly used examples below.

Power Purchase Agreement (PPA):

The client procures a supplier to engineer, procure, install and manage the solar project. The client then pays the supplier an agreed tariff post completion of the project.

Design & Build (EPC):

The client undertakes an early-stage design. Once complete, the client procures a supplier to engineer, procure, install and manage the solar project.

Build only:

The client undertakes the full design. A supplier is then procured to install the scheme.

There are many considerations that should be taken into account when selecting a delivery model, including:

Client-side Factors

- Appetite for risk.
- Internal skills, experience and capacity.
- Portfolio opportunities.
- Budget (both Capex & Opex).
- Ability to specify / undertake early design.
- The likelihood of consent/ planning issues.
- Capability to monitor consultant performance.
- The need to change the design as the project evolves.

Market-side Factors

- Prevailing market conditions.
- Supply chain appetite for the model.
- Minimum/ maximum value of the scheme.
- Likelihood of repeat work with client.
- Administrative burden or opportunity cost.
- Early engagement.

Clients should carefully balance their requirements against both their own and the markets capacity to deliver at any given stage in the project's lifecycle. Of the various findings identified within this report, it is clear the solar PV market is an incredibly dynamic and fast-moving sector. This means there is an onus on clients to be expeditious in procurement delivery once their strategy and budgets have been set, but also that at critical points in the process, the market is tested to ensure client outcomes are achieved.

In the context of delivery models highlighted above, each carries its own risk profile to the client and should be carefully considered in ensuring it best achieves the clients' outcomes. We have seen from our engagement of the solar PV installer market that the majority of suppliers would prefer an earlier engagement on the project to better influence the outcome, indicating an appetite to a more collaborative delivery approach.

03 UK Solar PV Sector Overview - What makes a PV solar system?

Reference to the solar PV market as a single entity implies this is serviced by one service provider, but this is not the case. The contractors who are engaged to install solar PV of any magnitude, rely on a complex supply-chain that includes raw-material extraction, manufacturers, distributors, fabricators and subcontractors, with each link of the chain experiencing different supply/demand characteristics, constraints and elasticity.

There are multiple components and services required for a typical solar PV installation, each of which call upon multiple supply-streams. This illustration gives simplified insight into the volume of activity required in order to achieve a completed solar PV installation.

Equipment

PV Solar Modules
- Consolidated supply chain (non-UK)
- 30-40% of system cost

Invertors
- Consolidated supply chain (non-UK)
- 5-10% of system cost

Panel Mounting / Structural Frames
- Fragmented supply chain (UK)
- 5-10% of system cost

Cabling, wiring and consumer units
- Fragmented supply chain (non-UK)
- 5% of system cost

Works & Services

Business Case & Consents
- Consolidated supply chain (UK)
- 10-15% of system cost

Design & Surveys
- Fragmented supply chain (UK)
- 10-15% of system cost

Installation (EPC)/ Civil Works
- Fragmented supply chain (UK)
- 20-25% of system cost

Grid / Storage Connection (ICPs)
- Fragmented supply chain (UK)
- 10-15% of system cost

The UK solar PV market is a mix of fragmented UK national installers which is im contrast to a highly consolidated equipment market. The equipment supply chain is mostly based in non-UK countries meaning a significant exposure to international supply chain pressures, with the UK competing globally for its equipment components.

03 Solar PV Sector- Manufacturers

We engaged with solar PV equipment manufacturers on a series of questions designed to identify their capacity and appetite for direct engagement with the public sector.

With regards to the wider prevailing market conditions, a common theme that emerged from our interviews with suppliers is that they consider the market to be overheating as a result of the increasing cost of fossil fuel prices and multiple countries aspiring to build alternative energy sources due to the war in Ukraine.
This has seen unprecedented demand, with most countries vying for materials and equipment from a small pool of manufacturers. There was anecdotal evidence that some national protectionism is taking place, for example, material or component suppliers were being provided with preferential treatment from local governments.
In relation to UK public sector procurement, the key findings from our research into the Solar PV manufacturers include:

- Of the suppliers surveyed, 44% stated they had no strong interest in supplying solar modules directly to UK public sector clients. The reason cited for this include:
  - The public sector isn't a large enough market segment.
  - Certain suppliers focussed solely on residential.
  - Most prefer to sell via a distributor and have minimum order requirements ranging between 2MW and 5 MW.
- Over 90% of respondents sourced their solar modules from Asia, in particular China, typically due to availability and price.
- All respondents provided manufacturers guarantee which suggest the quality of the products is in line with industry norms.
- Certain module materials are still likely to come from regions that have links with modern slavery. As such, public sector clients should ensure they check full chain of custody for equipment.
- European modules, mainly produced in Germany, do provide an alternative solution to the Asian market but they are currently unable to compete on cost.
- 31% of solar panel installers and suppliers surveyed specified there are still supply constraints. The main reasons cited for this included:
  - Logistical issues (in particular Rotterdam Port).
  - Material constraints (sourcing semi-conductor chips in Asia are still constrained).
  - Ethical constraints disaggregating the supply chain.
- The majority (72%) of panel suppliers provide extensive manufacturers warranties. Module suppliers tended to offer a 12-year product and 25-year performance guarantee with inverter suppliers also providing a standard 12-year (up to 25 year) warranty.
- The majority of panel makers had no interoperability issues with other systems.

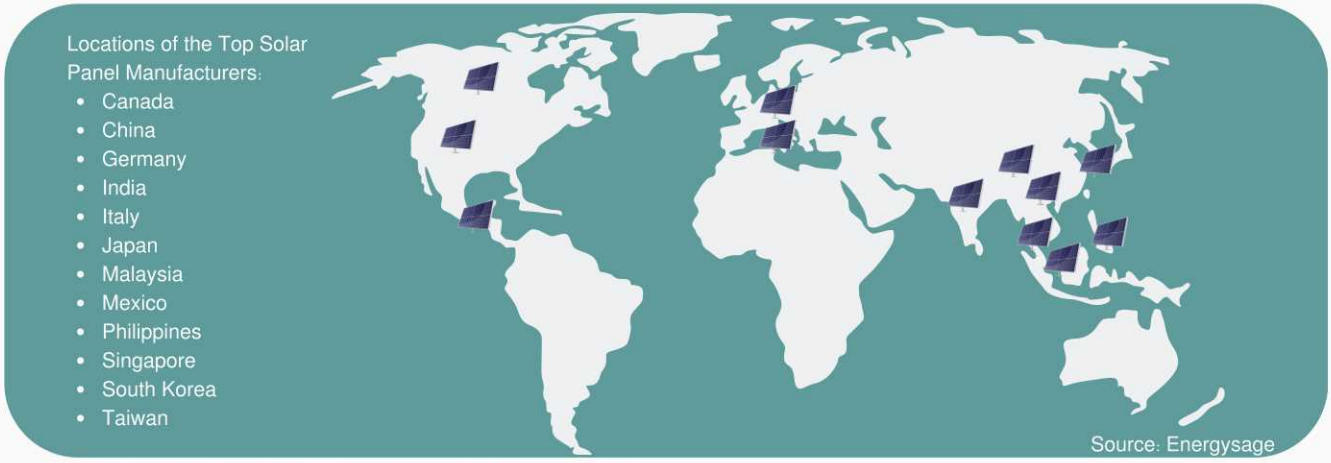


Figure 3 A global map of the top solar panel manufacturers

03 Solar PV Sector - Manufacturers (Cont.)

In terms of market forces impacting the solar PV manufacturer market, our findings were:

- Suppliers are pivoting towards using national or regional based materials suppliers where possible to increase their resilience to meet growing international demand, including:
  - securing semi-conductor chip supply from EU-domiciled companies, such as Infineon, rather than the Asian suppliers such as Samsung.
  - a growing EU-based materials supply of silica rather than reliance on Chinese suppliers, and
  - mitigating against supply-chain choke points such as the Port of Rotterdam or the Suez Canal.

- Some of the larger manufacturers (10%) are developing their product offering to provide a full solar PV equipment ecosystem offering (modules, inverters and storage). Currently, solar PV manufacturers mostly (circa 90%) have no interoperability for other manufacturers components with their own. However, the development of more end-to-end offerings by some suppliers and some evidence that a small portion of manufacturers are constraining some of their products to work either with their own or their partners products only (circa 10%) means interoperability cannot be assumed.

- A general opinion that supply-chain disruption from Covid-19 and Brexit was settling into a predictable pattern and that suppliers were able to 'price in' the cost of those delays as a result of China's Zero-Covid-19 policy and UK import delays.

- Suppliers are recognising the opportunity that large scale utility or public sector clients offered, as a result of the increasing demand for renewable energy, rather than just the traditional supply to EPC/ Installers or distributors.

- Some suppliers (circa 20%) recognise they could further mitigate against UK supply-side constraints, particularly around Asian component supplied units being shipped directly to UK ports, rather than being shipped to EU ports and then onward forwarded.

This could also reduce reliance on ports such as Rotterdam and circumvent issues around CE/ CA marking for modules being shipped to the EU initially.

So, what conclusions can we draw from the current manufacturer supply chain ecosystem and how it could be shaped to meet future UK renewable energy demand? We see these as:

<u>Early equipment procurement</u>

Given global demand and logistical challenges, early securing of equipment is important and should be considered within public sector procurement strategies for solar PV projects.

<u>Direct equipment procurement</u>

There is manufacturer appetite to deal directly with public sector, however this would be subject to public procurement regulations, minimum order values and the impact on scheme appetite by the EPC/ Installer market.

<u>Widening market of PV material supply</u>

Wider availability of materials with the EU region seeing better supply availability. For example, semi-conductor chips required for solar PV modules.

03 Solar PV Sector Overview - Installers

The solar panel installation market has a diverse mix of small and large firms, with smaller firms specialising in certain types of solar installations. The common types are either solar-farms in green-fields settings and roof mounted installations to existing buildings or solar car ports.

Solar farms will typically be larger in size and output, however roof mounted, and car port schemes can be just as complex because the design needs to consider additional factors such as interruption of other services and the existing condition of the asset.

This section of the report covers the key findings associated with solar panel installer market.

Demand is Soaring

As expected, demand for solar projects is putting increased pressure on solar installers across the UK. The public sector is facing increased competition from the private sector in securing solar panel installers.

Many private sector firms are not constrained by public sector procurement regulations and therefore suppliers can engage with them more dynamically and build long-term partnerships more easily. For suppliers this means a reduction in the burden of tendering greater long-term opportunity.

All suppliers stated they were experiencing increased demand and their ability to tender for new projects was constrained. Consequently, all contractors were being selective with the projects they would tender for. One firm stated 'we will not bid for projects that includes a tender list that exceeds 3 other firms'.

Over 50% of solar PV installers said they were unlikely to tender for projects below £250k. This highlights the need to ensure public sector organisations are seeking opportunities to combine projects.

80% of the Solar Panel Installer's stated their turnover had increased exponentially with a preference for larger projects. Owing to rapid growth of many solar companies, coupled with inflationary pressures, there is a heightened risk of supply chain failure.

So, what does soaring demand mean for public sector projects? Public sector organisations must make their projects more attractive to suppliers in order to compete with the private sector. In order to do this, we recommend:

Public Sector organisations should undertake earlier engagement with the supply chain to optimise the project's delivery model and explore opportunities to share risk.

Aggregating demand and/or demonstrating repeat work through pro-active pipeline management. Reduce the supplier assessment burden by creating common assessment standards for certain portfolios of work.

Implement robust supply chain failure strategies and ensure financial testing and quality assurance is monitored.

Review how each project can be made more attractive to suppliers in comparison to other sectors. For example, innovation opportunities, improved cashflow or the creation of strategic partnerships.

Challenging Commercial Strategies

All suppliers surveyed stated their preference is to undertake the design and build for projects. 62% of suppliers stated they would prefer to be involved in the early stages of design via a 2-stage design and build tender process.

"Early contractor involvement is helping us to understand risks better, procure earlier and mitigate inappropriate early-stage designs. We are finding more clients are choosing this approach."

Figure 4 Supplier feedback on contract models

Table 1 illustrates the suppliers most significant concerns in project delivery. Solar panel mountings were a significant point of note in the 'Other' column. The issues with panel mountings were linked to wider issues in the steel industry.

Inflation was a consistent concern for suppliers, since they found the public sector particularly challenging as they were often being asked to hold prices for long durations.

The early procurement of long lead items was another primary concern. 80% of suppliers indicated that this was leading to longer project completion timescales and/or escalation of costs. Suppliers felt there was significant benefit if public sector organisations were to rethink their commercial approach to the procurement of long lead items.

The majority of suppliers responded to say they were struggling to their hold quotations for longer than 30 days due to changing plant and equipment prices. Therefore, contracts that did not include a mechanism for inflationary increases were less attractive. 37% of suppliers mentioned they are seeing more clients procure parts separately and provide these free of charge to the contractors in order to mitigate the risk of inflation.

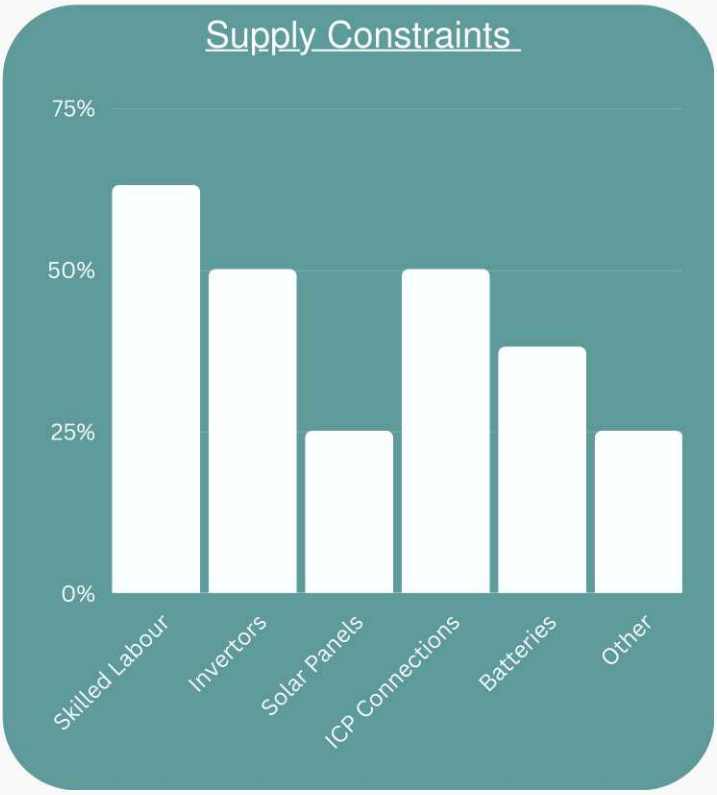


Table 1 The number of supply side constraints referred to by the survey respondents.

Contracts that place the risk of poor ground conditions onto the Contractor were less attractive to suppliers. However, suppliers were more accepting of this risk if they were involved earlier in the design process because it enabled them to undertake ground surveys.

Contracts that included delay damages (these are damages charged for late completion of the project) were also less attractive to suppliers. However, this risk was acceptable if the project programme was seen to be reasonable and the scope well defined.

The majority of suppliers would accept being liable for the full design of a project. Over 80% of the suppliers stated they had full design capabilities which meant they could support clients at the investment decision stage. 50% of suppliers mentioned that adopting early-stage design which had been produced by other consultants was sometimes problematic.

03 Solar PV Sector Overview - Installers (cont.)

All suppliers were able to provide guarantees and warranties for project performance. However, the terms of these differed significantly.

- All suppliers surveyed would pass through manufacturers guarantees if asked for them.
- Supplier guarantees for the installation of the works varied significantly (between 2 and 12 years).
- Manufacturers product and performance guarantees were more consistent in regard to duration. But some came with onerous constraints relating to maintenance.
- Generation output guarantees could be provided. However, owing to a number of factors these were less favourable.

Tendering for Public Sector Opportunities

Bidding for public sector contracts was a concern to the suppliers we surveyed. There were many reasons for these concerns, however the following themes appeared:

- 25% of suppliers stated their bid teams were struggling to keep up with demand for tenders.
- Suppliers are struggling with the influx of public sector frameworks that appear to be solar related. This is leading to them missing opportunities.
- 100% of suppliers said they had experienced tender periods that were not commensurate to the level of effort required to bid. 5 weeks for a design and build project was seen as a minimum requirement.
- Suppliers were consistently being asked to hold quotations for over 90 days. This either resulted in a loss of interest in bidding for the opportunity or made the supplier include significant contingency provisions in its price.
- Often the information about the site received with the tender was insufficient. Where a client did not opt for early contractor involvement, suppliers require a site visit during the tender period along with the client providing at least topographical survey of the site.
- Suppliers raised that some public sector frameworks were not well defined, which led to a loss of interest by the supplier.
- 50% of suppliers felt the quality to commercial evaluation ratio was not always appropriately balanced. Suppliers did not want to see a price weighted at over 40% of the total evaluated score.

So, what does this mean for public sector projects? Public sector organisations must adapt their commercial strategies to consider the wider procurement landscape. In order to do this, we recommend:

Analyse pre-existing routes to market. New frameworks may not attract interest from suppliers given the market is already saturated with them.

Engage the market prior to the tender event to ensure the market has the ability to meet the tender timeline.

Provide a balanced evaluation model and assess the tendering burden against the opportunity's value.

Include sufficient information about your project(s) site. Engage with suppliers early to understand the minimum information requirements.

04 PROCUREMENT APPROACHES

This section of the report looks at the benefits of different procurement approaches and how they could mitigate some of the issues identified in section 3 of this report. These approaches are not exhaustive and there are other options available. We would suggest that before starting a project or group of projects, that advice is sought from commercial and procurement professionals.

The development stages identified in figure 2 below are indicative of a client's typical project development process.

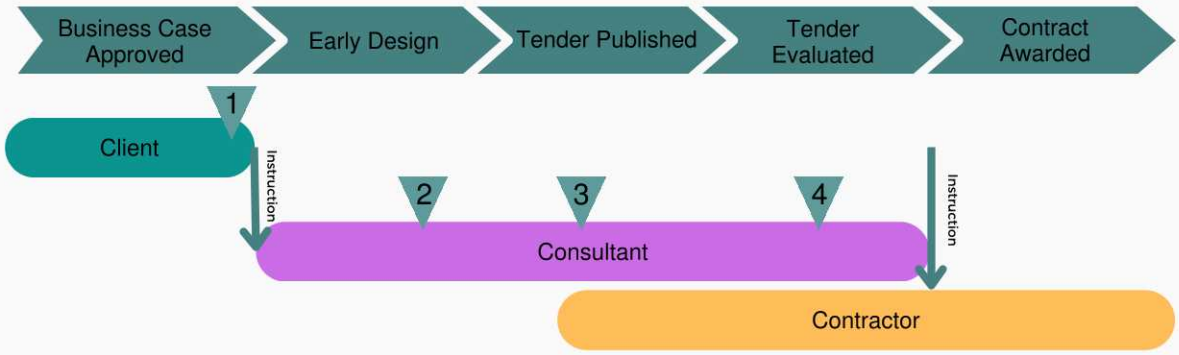
Owing to the challenges facing the solar market, our conclusion is that more collaborative procurement models should be considered when procuring solar project(s). The model should focus on earlier engagement and input from those building the project. Not only would this make the project more appealing to the market, but it would also enable earlier risk identification and mitigation and improve cost certainty. This ethos is aligned to the UK Government's September 2022 'Construction Playbook' which recommends early supplier involvement.

Below is a comparison of a traditional procurement model with some alternative models that could be considered.

Traditional Design and Build / EPC

The traditional procurement model provides for a transactional approach to procuring a contractor, resulting in little opportunity for the public authority organisation and the contractors to discuss the scheme. Furthermore, by the time the contractor is engaged, the public authority organisation is constrained by its own design and the ability to change it during the tender period.

Figure 5: Traditional design and build procurement approach against the project stages.



1. Clients rely on the consultant to complete the early design and survey works as well as budget information. Despite their best efforts the consultants aren't responsible for the build phase and may not be aware of changing market conditions.
2. Some market engagement to confirm procurement approach is undertaken but this engagement is limited given the design is nearly complete. This means supply chain innovation and opportunities to mitigate design challenges are lost.
3. Contractors receive the design during tender stage and have limited ability to input leading to reduce interest. Additionally, this can lead to an increase in non-complaint tenders because suppliers design methodology is sometimes misaligned to their consultant's design.
4. Clients only become aware of budget issues at a much later stage, because cost estimate are produced with limited market input. This can result in clients spending more on redesign or abortive costs.

To mitigate these issues, earlier contractor involvement provides many benefits, including:

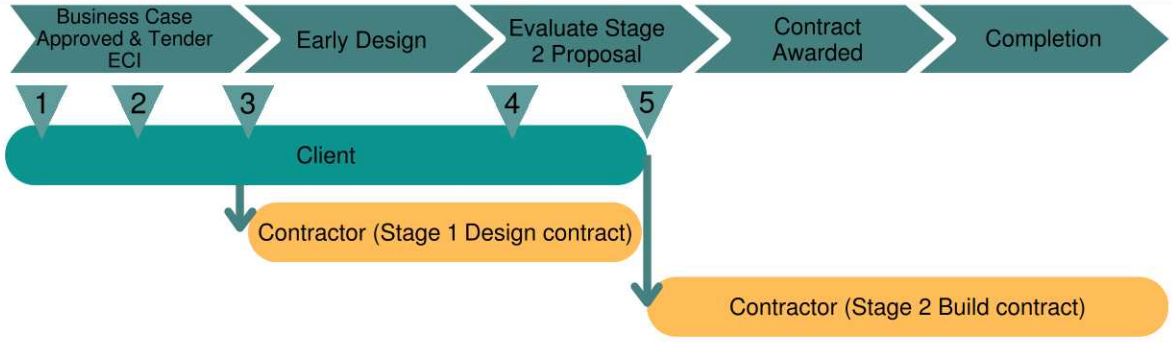
- Earlier design involvement.
- Improved buildability advice.
- Greater risk understanding and mitigation optioneering.
- Reduced project interfaces.

The main disbenefit to earlier contractor involvement is maintaining commercial tension when pricing the construction phase of the project. To some extent, this can be addressed through the project's commercial strategy.

04 PROCUREMENT APPROACHES (CONT.)

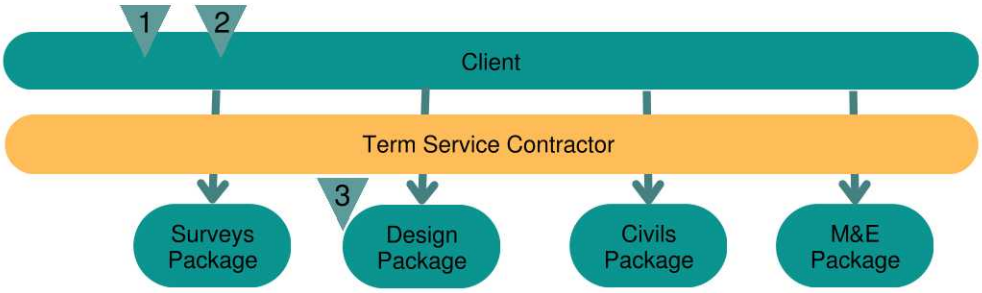
Below are two alternative procurement and delivery approaches which increase early contractor involvement, these models can be adapted to suit specific client needs.

Alternative Delivery Approach 1:



1. Group purchasing strategies should be explored. For example, establishing frameworks with key panel suppliers to drive volume rebates.
2. Market engagement with the supply chain should be undertaken earlier to establish the site survey strategy, project risks, mitigations and commercial model options.
3. Where appropriate, a Contractor should be engaged based on a two-stage procurement approach. Stage 1 is for the early design and survey works. Stage 2 is the construction phase. Prior to stage 1 occurring:
   a. Key commercial rates are secured at Stage 1 to maintain commercial tension throughout both stages.
   b. Clear deliverables for Stage 1 should be established to monitor stage 1 performance.
   c. Appropriate break points included, for example where planning permission can't be obtained.
4. The price and scope for Stage 2 should be published by the Contractor ahead of Stage 1 finishing to allow the client an appropriate review timescale prior to instructing the Contractor to proceed / not to proceed to Stage 2. Clients should establish a Contractor replacement strategy, should the Stage 1 contract not achieve the required outcomes.
5. In stage 2 the client may implement a joint delivery strategy, including any pre-agreed commercial arrangements (for example client supplied solar panels).

Alternative Delivery Approach 2:



1. The client procures a term service contractor after business case approval for a fixed duration. The Contractor provides a full range of services including surveys, design and construction solutions. Incentivisation is established at a portfolio level that is aligned with the client's key outcomes (e.g. time, cost, quality).

2. This approach allows the Contractor to work closely with the client and reduces the need for early market engagement. Once a project is scoped and priced by the Contractor, the client can seek to tender the opportunity to the market should they feel they are not achieving value for money. However, this option should be used as a last resort.

3. The works can be packaged progressively (for example by work type or activities) and instructed at different stages once the design and relevant consents are in place (for example the early procurement of ICP works). This approach allows the project to progress quicker, and the works can be segmented to suit when approvals are granted. This approach is especially effective for a portfolio of projects in which the exact time and nature of each project is in development.

04 PROCUREMENT APPROACHES (CONT.)

In this section, we have identified some of the public sector available frameworks. This is to help public sector organisations identify a procurement regulation compliant route to contract with suppliers.
With all routes to market, it is important that:

- The Contracting authority organisation is sure they can access the framework (i.e. they have a right to use it under the original contract notice.)
- The scope, duration and value of the framework is suitable for the project.
- The types of organisations awarded to the framework are capable of delivering the project.
- The framework terms don't constrain you from delivering your intended commercial model.
- There is sufficient appetite from suppliers to deliver using this framework.
- Any special project funding arrangements don't cause issues (for example ERDF).

Public sector organisations are encouraged to check this with their procurement teams before exploring whether the Framework or DPS is right for them to use.
Examples of current and upcoming Frameworks or DPS's suitable for solar PV procurements include:

Name	Type	Owner	Status
Heat Networks and Electricity Generation Assets DPS	DPS	CCS	Current
Go Neutral Smart Energy Framework	Framework	GMCA	Current
Demand Management & Renewables (HELGA 2) DPS	DPS	CCS	Planned
Demand Management & Renewables Framework (HELGA 2)	Framework	CCS	Planned
Fusion21 Decarbonisation Framework	Framework	Fusion 21	Current
Renewables & Energy Efficiency Works and Associated Consultancy Services	Framework	Procurement for Housing	Current
Renewable Energy Soultions	Framework	ESPO	Current

Table 2 Examples of solar generation public sector frameworks.

05 REPORT CONCLUSIONS

In conducting this market research, we have drawn the following 5 key conclusions for public sector authorities procuring solar PV in the UK market to consider:

- Implement project packaging strategies that are attractive to the market. To do this, they should research the market segment before proceeding to the procurement phase.

- Utilise combined buying power to attract suppliers and establish long term relationships. This will help suppliers plan their workload and lead to more efficiency in the procurement process.

- Identify collaborative delivery approaches to mitigate project risks and create strategic partnerships. For example, alliancing approaches which offer longer term relationships with increased collaboration over shorter, more transactional, traditional procurement.

- Improve the quality of tender information, for example through early site investigation, and the design of tender events to improve the chances of receiving tenders from suppliers by making tenders as straightforward as possible to respond to.

- Engage with the market regularly to ensure they are aware of upcoming opportunities and to create a continuous feedback loop to inform the early-stage design, scope and commercial strategy.