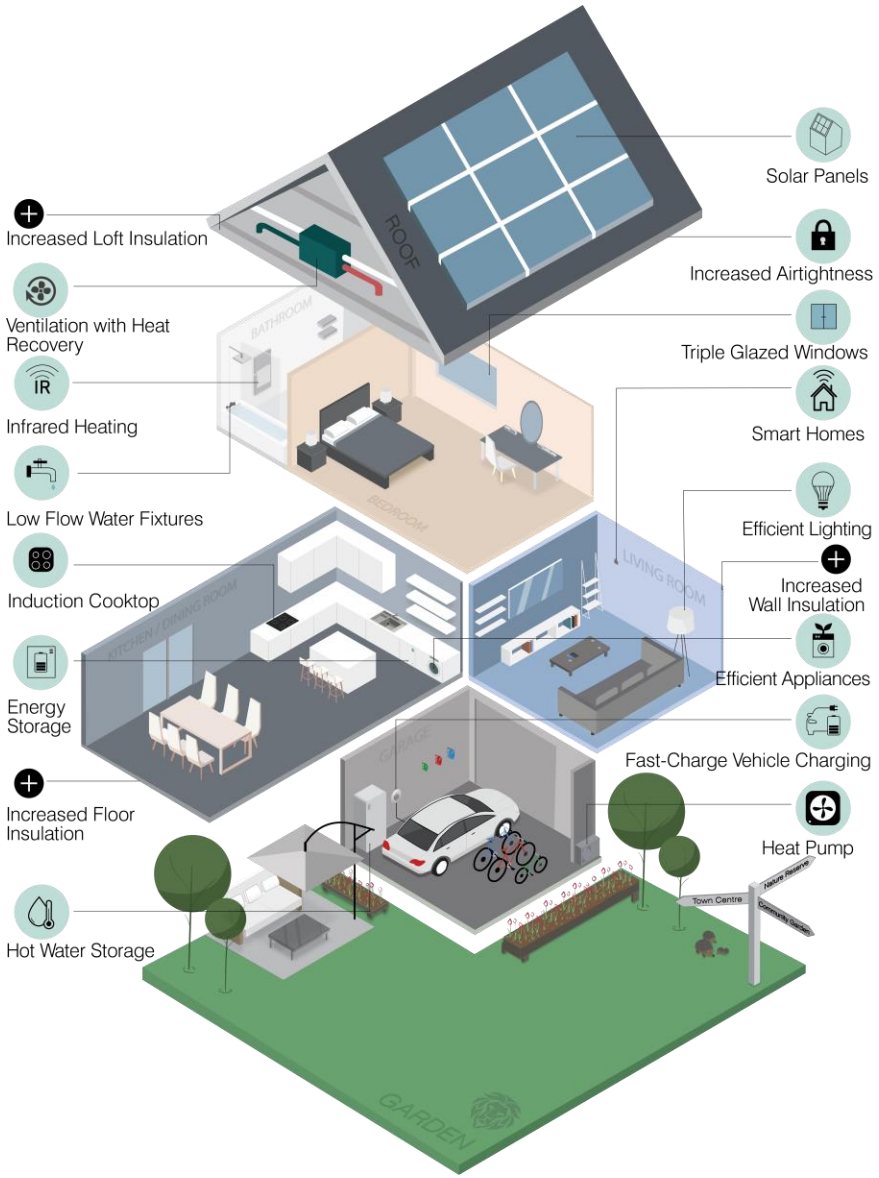
Future Homes Hub

Supply chain for low carbon homes

An initial assessment of supply chain and procurement strategies

October 2022



Foreword

The UK's goal to create high-quality homes which are sustainable and zero carbon ready, coupled with the need for significant reduction of carbon emission within business operations has substantial implications for current supply chains and supplier relationships.

The role of the Future Homes Hub is to facilitate the collaboration needed across the homebuilding value chain, to ensure not only that we meet the climate and environmental challenges we face as a society but that we build better homes for customers at the same time.

Developers need to source the right products of the right quality in the right numbers at the right time. Suppliers need to be able to predict the volume and nature of demand to scale up supply on time. There are also opportunities for greater collaboration between developer, designers and suppliers to understand the potential of innovation in the market to design homes that are constantly better to live in and cheaper to run.

Alongside our work to develop the solutions to the uplifts in Parts F, L, O and S of the building regulations, and the Future Homes Standard we're now setting up more formal dialogue between the homebuilding and supplier communities needed to scale up innovative solutions.

In doing this we are also keen to create mechanisms to help smaller developers access the products they need.

This report intends to provide an initial assessment of some of the most important technologies needed to meet the Future Homes Standard and build zero carbon homes.

It is written against a backdrop of global fluctuations in raw material prices, coupled with unpredictable and rising logistics costs which can make sourcing products particularly challenging, and uncertain. Understanding the cost drivers of products / services and where cost and contractual levers can be used are key throughout supplier selection and negotiations.

Our work with the supply chain will deepen over the next months as we work together on reducing the embodied carbon of the homebuilding supply chain and other linked issues such as water and resource efficiency.

We are grateful to Argon and co for their work and hope it is useful as a starting point. Please do give us feedback on this initial assessment and share your ideas about how we can best work together.

Ed Lockhart. CEO, Future Homes Hub
October 2022

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Cover image credit: Thakeham homes

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Key themes influencing procurement

The drive towards net zero, coupled with more homes being built in the UK than ever before, means procurement teams must reinvent their current supply chains. However, this delivers the opportunity to focus on lowering emissions while taking steps to mitigate cost. Below highlights some of the key themes which are driving this call to action.

Changing building regulations

- Updated Part L Building Regulations 2010 require rethinking of heating and energy technologies
- Future Homes Standard implementation from 2025

Increasing costs

- Fluctuating raw material costs
- Unpredictable costs and reliability in the global logistics market
- Global increase in demand for low-carbon technologies

Zero carbon future

- Changing technologies play a key role for a zero carbon home
- Need for low-carbon technologies to be integrated within building materials of the home

Construction market

- Government pledge to build 300,000 houses by mid-2020s
- In 2020/21, ~216,000 net additional homes were built, continuing an upward trend from a low in 2012/13 (~125,000)

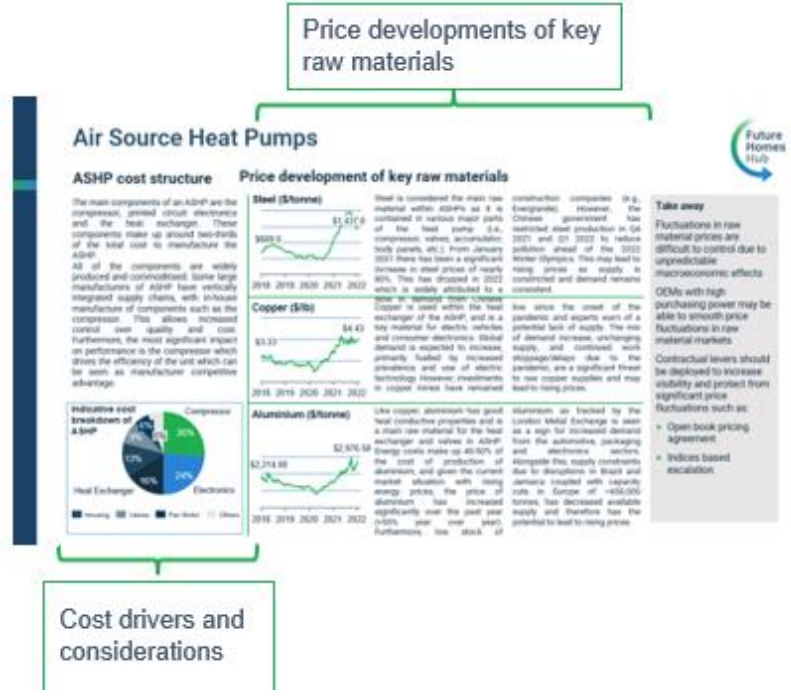
Introduction

The objective of this report is to lay out procurement and supply chain considerations for selected building technologies.

The following low-carbon building technologies were explored in the first phase of work:

- Air Source Heat Pumps
- Solar Photovoltaic
- Insulation

For each of these technologies we have assessed the Supplier & Installer Capacity, cost drivers and price developments of raw materials



Introduction

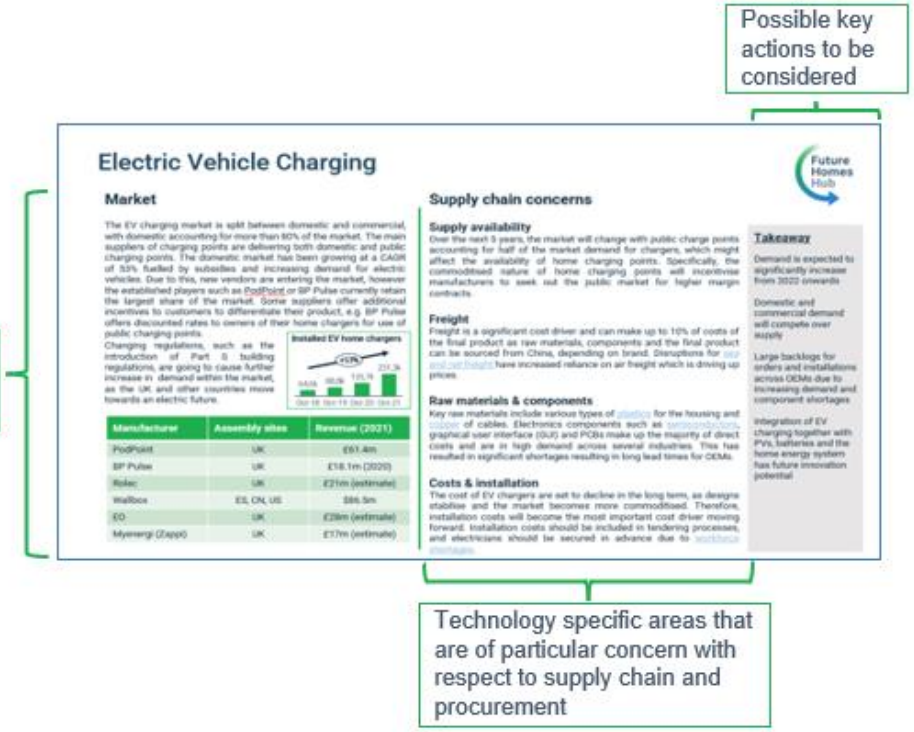
After consulting with home building procurement teams, we also assessed the following technologies:

- Electric Vehicle Charging
- Waste Water Heat Recovery System
- Passive Flue Gas Heat Recovery System
- Infrared Heating
- Mechanical Extract Ventilation

For each of these technologies we have assessed the market and provided an overview of supply chain and procurement considerations and key takeaways

We have also assessed a number of wider factors that are impacting the industry more widely:

1. Raw materials: Crude oil, Aluminum, Copper & Steel
2. Semiconductors
3. Labour
4. Logistics
5. Embodied carbon and emissions



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Air Source Heat Pumps

Air Source Heat Pumps

1. The Future Home Standard, which comes into effect in 2025, will result in no new-build homes being connected to the grid, requiring a new type of heating technology
2. The UK government has identified ASHP as a core technology to de-carbonise heating and hot water production in homes
3. Currently, the UK has a low level of installed ASHPs compared to its European peers, with annual installations below 30,000 units per year

Main considerations for homebuilders:

- Ensure access to supply of ASHP given planned installation of ~600,000 units p.a. by 2028
- Secure and develop trained ASHP installer capacity, due to the current shortfall
- Availability and fluctuating raw material prices

Air Source Heat Pump: Supply and Installer Capacity

OEMs

OEM	Manufacturing Facilities	UK Market Share
Mitsubishi Electric	UK, JP	31-35%
DAIKIN	BE, CZ, GE,TR	16-20%
SAMSUNG	CN, SK	11-15%
GRANT	IR	6-10%
NIBE	SE, NO	6-10%

ASHPs require similar components and manufacturing techniques to air conditioning units, therefore, the supplier market is dominated by air-conditioning manufacturers capitalising on the economies of scale and oil/gas boiler manufacturers who are looking to diversify their product portfolio.

Asia and Europe are the main manufacturing locations for ASHPs. Currently, 69% of ASHPs installed in the UK are imported, of which 73% come from elsewhere in Europe. Therefore, there is currently a high reliance on importing this technology into the UK.

Currently the UK accounts for ~1% of global demand for ASHP and UK manufacturing facilities support ~0.6% of worldwide demand for ASHP. However, this is expected to increase as companies such as Mitsubishi and Valliant are investing in the UK to cater for the rise in demand. Additionally, on a global scale the large electronic, air-conditioning and boiler companies are able to leverage global facilities and capacity to meet increasing consumer demand. Therefore there is no manufacturing capacity constraints for ASHPs globally.

Take away

- UK capacity to manufacture ASHP is expanding
- Global facilities can be leveraged to meet consumer demand

Distributors

Distributors sell multiple brands and models of ASHP, including from companies who are not directly present in the UK market. This is the most common route to market for ASHP as the distributor acts as an intermediary between multiple OEMs and housebuilders.

Using a distributor has multiple advantages:

- Distributors negotiate prices with OEMs and bundle the demand of all clients, increasing their purchasing power
- Distributors have strong relationships with OEMs
- Inventory is held at locations across the UK, which can reduce warehousing needs and cost
- Access to multiple brands and industry knowledge
- Other products are available through distributors, and contracting multiple products together ("bundling") may result in savings

Take away

- Consider negotiation power with OEMs
- Contracting multiple products through distributors
- Remember to consider warehousing needs

Installers

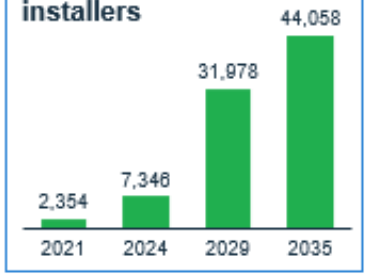
For housebuilders, access to installers is essential, as qualified heat pump installers are required to install the heat pumps and the necessary plumbing.

The Heat Pump Association estimates that by 2029 over 30,000 installers will be required, growing to over 44,000 in 2035. However currently, there are only 1,134 companies registered with the MCS with ASHP installation accreditation. There are more than 100,000 Gas Safe boiler installers in the UK, and as this industry declines, there needs to be pressure to increase low-carbon technology installers by retraining the gas boiler installer network.

It is important, that housebuilders share forecasts of installation capacity requirements so the government, installers and OEMs can increase training availability and marketing to push upskilling this current workforce, alongside the creation of apprenticeship schemes Without this, demand for ASHP installers will surpass supply resulting in costs increasing.

Furthermore, accreditation by MCS is important to ensure that consistent high standards of installation is maintained throughout the industry. It is recommended that MCS accreditation for all low-carbon technologies is a condition during the sourcing process.

Potential required installers



Take away

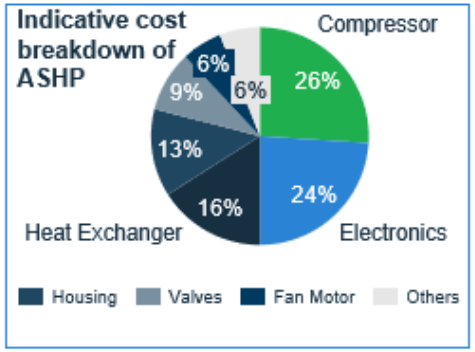
- Ensure trained workforce is available by sharing forecast requirements with installers and promoting training/standards

Air Source Heat Pumps

ASHP cost structure

The main components of an ASHP are the compressor, printed circuit electronics and the heat exchanger. These components make up around two-thirds of the total cost to manufacture the ASHP.

All of the components are widely produced and commoditised. Some large manufacturers of ASHP have vertically integrated supply chains, with in-house manufacture of components such as the compressor. This allows increased control over quality and cost. Furthermore, the most significant impact on performance is the compressor which drives the efficiency of the unit which can be seen as manufacturer competitive advantage.



Price development of key raw materials

Steel ($/tonne)

Steel is considered the main raw material within ASHPs as it is contained in various major parts of the heat pump (i.e., compressor, valves, accumulator, body panels, etc.).

Further detail on raw materials, including steel, and their influence on the supply chain is detailed on slide 42.

Copper ($/lb)

Copper is used within the heat exchanger of the ASHP, and is a key material for electric vehicles and consumer electronics.

Further detail on raw materials, including copper, and their influence on the supply chain is detailed on slide 42.

Aluminium ($/tonne)

Like copper, aluminium has good heat conductive properties and is a main raw material for the heat exchanger and valves in ASHP.

Further detail on raw materials, including aluminium, and their influence on the supply chain is detailed on slide 41.

Take away

- Fluctuations in raw material prices are difficult to control due to unpredictable macroeconomic effects
- OEMs with high purchasing power may be able to smooth price fluctuations in raw material markets
- Contractual levers should be deployed to increase visibility and protect from significant price fluctuations such as an open book pricing agreement

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Solar Photovoltaic

Solar Photovoltaic (PVs)

Catching some sunshine

1. The updated Part L of the 2010 Buildings Regulations requires new homes to have ~30% lower emissions from June 2022 and can be achieved using PVs
2. The global PV industry is well developed and has excess manufacturing capacity
3. UK installed PV stock (~200W/capita) is significantly less than its European counterparts (e.g., Netherlands: ~400W/capita)

Main considerations for homebuilders:

- Secure access to supply & timely delivery of PVs as global shipping routes continue to be stressed
- Work with Value Added Resellers to reduce Balance of System cost and secure installation capacity
- Include PV sourcing early when planning for new developments to estimate volume requirements

Solar Photovoltaic: Supply & Installer Capacity

OEMs

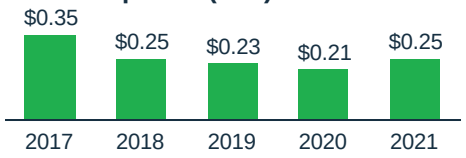
OEM	Manufacturing Facilities	Capacity (in GW)
JinkoSolar	CN, MY, USA	45
JA SOLAR	CN	23
LONGi	CN, IN, MY	60
CanadianSolar	CA, CN, ID, VN, BR	23.9
Trinasolar	CN, VN, TH	24.8
Hanwha	KR, DE, USA	12.4

The PV value chain is dominated by Chinese manufacturers, with over 70% of PV modules being produced in China. This means that production capacity, supply and pricing can be influenced by Chinese government legislation as seen through recent limits on energy consumption of manufacturing businesses, constricting supply and raising prices.

Along the four stages of PV module production (polysilicon production, wafer, cell and module manufacturing), competition increases towards the end of the manufacturing process. This is due to high barriers to entry in polysilicon production and a highly commoditised market for finished PV modules. The largest manufacturers are vertically integrated through the manufacturing process, and it is common for the largest manufacturers to have their own cell production facilities feeding into their module assembly. This provides manufacturers with opportunities for economies of scale and upstream supply security.

Due to the commoditised nature of the module, modules are compared on a cost per watt basis. This cost has been declining due to process improvements, efficiency gains and continuous manufacturing capacity expansion. However, module prices increased in 2021 behind Poly-Si price increase due to capacity constraints,.

Module prices ($/W)



Take away

- Module manufacturing capacity is continuously expanding
- Cost per watt is expected to fluctuate

Distributors

Distributors act as intermediaries between the global solar PV module manufacturers and customers. OEMs mainly deal with utility scale operations, meaning that distributors and value-added resellers manage smaller installations.

Distributors receive and manage inventory of PV modules, acting as a buffer in the global supply chain, reducing potential for supply availability issues.

Distributors work closely with OEMs to offer a variety of different module types and sizes, alongside offering other products (such as ASHP) which allows customers to bundle demand, increase contract size and achieve cost efficiencies.

Take away

- Distributors hold high inventory levels and can act as a buffer in the supply chain
- Increasing spend through distributors may result in cost efficiencies

Value added resellers

Value-Added Resellers (VAR) offer integrated solar PV solutions including modules, balance of systems (BOS) and installation. VARs design the BOS, meaning the electric and physical infrastructure in the house to accommodate a PV system. The design of the BOS and the installation requires expert knowledge to achieve the most efficient system at the lowest cost. The BOS accounts for ~60% of total project cost, and is therefore a key driver during negotiations. This cost is driven primarily by the inverter, mounting hardware and labour.

Partnering with VARs offers the opportunity to benefit from savings as VARs work closely with OEMs and order in bulk. Therefore, VARs have the benefits of a distributor and can provide installation and design of the system.

For the installation and grid connection, installers should be certified by MCS and register the system with the MCS after its installation. Currently, MCS lists more than 500 companies that are registered.

Selecting the right VAR partner is essential for a successful use of PVs across the development.

Take away

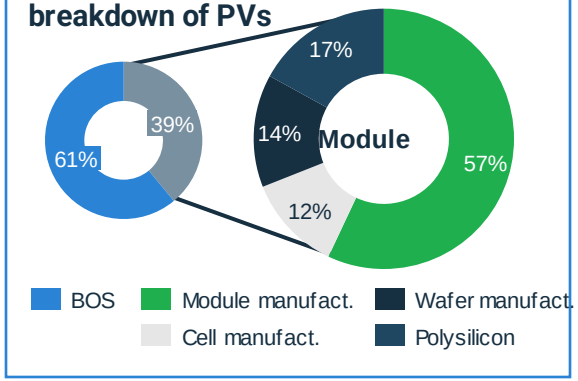
- VARs are integrated service providers combining purchasing of modules with installation and design
- Work with VARs to reduce BOS cost through design and access to market, while securing installation capacity

Solar Photovoltaic

PV cost structure

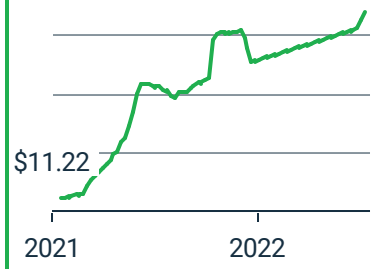
The key component of a PV module is the individual cells, and the availability and price of polysilicon has a significant influence on the cell manufacturing price. However, as housebuilders do not buy PVs directly from OEMs, the entire system must be taken into consideration.
The Balance of Systems (BOS) includes the installation hardware, wiring, inverter and labour for installation, and is the main cost driver for a PV system. The BOS is the main cost driver, responsible for more than 60% of cost of the system. BOS are designed and implemented with an installer or VAR, which is why a strong partnerships is essential.

Indicative cost breakdown of PVs



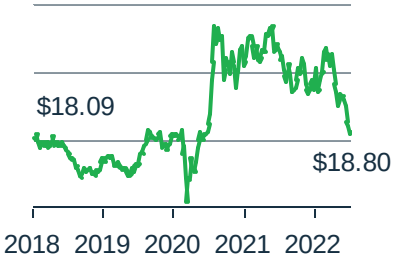
Price development of key raw materials

Polysilicon ($/kg)



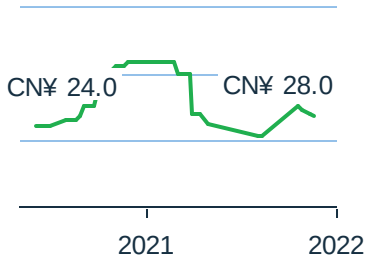
Polysilicon is the main cost driver in module production accounting for ~17% of manufacturing cost.
Nearly 80% of global supply is produced in China with global capacity increasing from 2015. The main use of polysilicon is for the manufacturing of PVs. Since the start of 2021, polysilicon prices have increased by 348% due to interventions on electricity consumption by the Chinese government in late 2021. Even though further polysilicon capacity was authorised by China last year, growing global demand, fires in current plants (e.g. East hope), and slow ramp up periods in new ones, are expected to keep the market tight and prices high.

Silver ($/ounce)



Silver is a core material for the manufacturing of cells for solar PV modules. It accounts for around 6% of total module costs.
Reducing the amount of silver in the manufacturing of modules is a common way for OEMs to further reduce manufacturing cost of modules.
11% of global silver demand is currently used for the manufacturing of PVs. A large portion of sliver is used for the electronics industry and other industrial applications (~40%), investments (~25%) and jewellery (~17%). Price of silver is influenced by rising demand, but also fiscal and monetary policy, inflation pressure and interest rates.

PV glass (RMB/m^2)



Glass for PVs are typically produced in China as for PVs the glass has an anti-reflective coating to improve efficiency of the module.
Prices have been falling from Q1 2021, and attributed to a decline in demand and an increase in manufacturing capacity that has been added.
A primary reason for concentration of PV glass manufacturing being in China is the price for energy. However, high shipping costs of relatively low value glass does not make it attractive to ship glass by itself, and therefore is shipped as part of a module.

Take away

- Polysilicon is the single biggest price driver for PV modules
- Government interventions relating to polysilicon capacity increases, have a significant influence on prices
- The cost of a PV system is influenced heavily by the Balance of Systems
- Contractual levers with VARs such as open book pricing should be considered during the sourcing process

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Insulation

Insulation

Insulating against new regulation

1. Widely used insulation materials such as PUR offer the opportunity to improve energy performance, particularly in combination with other low-carbon technologies
2. The latest version of Part L and the Future Homes Standard update the allowed U-values for homes, making insulation requirements more stringent for housebuilders
3. Insulation manufacturers are located across the UK and Europe, offering a variety of materials, applications types and standards to meet any new requirements

Main considerations for homebuilders:

- Determine how purchasing of insulation can be used to co-innovate and increase negotiation power
- Regular modelling of insulation demand to avoid ordering on backlog with OEMs
- Ensure insulation prices are continuously monitored as costs have increased significantly

Insulation: Supply & Installer Capacity

OEMs

OEM	Manufacturing Facilities	Group revenue
Kingspan	Insulation	>€2,000m
KNAUF INSULATION	Industrial and construction materials	€38,180m
SAINT-GOBAIN	Construction materials	€637m
BAUDER		
pcc	Chemicals	€718m

The insulation production market is dominated by several large, multinational manufacturers that have operations in the UK and across Europe. There are also a large number of smaller insulation manufacturers that produce in the UK.
The insulation market is commoditised as products have standardised heat conductive properties based on the underlying material that is used.
Based on the building U-values requirements, prices for different materials can be compared.
Other differentiation factors aside are mainly heat and fire, water and vapor resistance, as well as weight.

Take away

- There are many OEMs producing insulation across the UK
- Collaboration with OEMs to develop innovative insulation applications and lower cost

Distributors

Distributors are a key route to market for insulation OEMs and present an opportunity for housebuilders to have access to a wide variety of different insulation types.
The type of insulation depends on which part of the house requires insulation. The wide selection offered by distributors gives housebuilders the opportunity to match the right material to each use case, which can reduce waste while maximising efficiency.
Insulation materials are distributed by the large building products distributors, giving builders the opportunity to bundle purchases and contracts to increase purchasing power and leverage spend across multiple spend categories.

Take away

- Distributors offer a variety of insulation products from many OEMs
- Bundling purchases through distributors can increase purchasing power

Design and installation

It is important to include insulation design early in the planning phase of any building to ensure that the minimum product achieves maximum efficiency to save cost.
With updated U-value requirements (see below) in Part L of the Building Regulations and the Future Home Standard coming into effect in 2025, insulation is key to deliver the energy savings required and comply with regulation.
Installation of insulation is not a specialised job, but rather performed by general contractors. It is important that the installers are trained on the correct way of installing the different types of insulation to ensure that U-value requirements and regulations are met.
.

Element type	Maximum U-value W/(m²*k)
All roof types	0.16
Wall	0.26
Floor	0.18
Party wall	0.20
Swimming pool basin	0.25
Window	1.6
Rooflight	2.2
Doors	1.6

Take away

- Work with installers to maximise efficiency while reducing waste and therefore cost

Insulation

Insulation materials

Insulation, specifically foam-based insulation materials (e.g., EPS, PUR, PIR, etc.), are mainly manufactured from crude oil chemicals produced.

However, there are other insulation products, that are based on more sustainable raw materials such as sheep wool, cork, and wood wool. For those alternative insulation materials, it is important to ensure that they similar performance on heat and vapour permeability.

Additionally, insulation materials are further developed to include graphite (grey EPS) or added aluminium foil to improve thermal performance.

Take away

- Most modern insulation is crude oil based
- There are a range of sustainable alternatives such as wool or cork

Price development of key raw materials

Crude oil ($/barrel)

Crude oil is the main raw material for a large number of modern insulation materials such as EPS and PIR.

Further detail on raw materials, including crude oil, and their influence on the supply chain is detailed on slide 41.

PPI: Polystyrene foam

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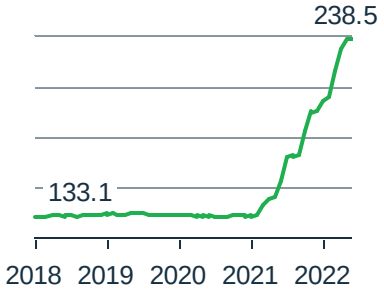

Based on the produce price index (PPI) reported by Fed, production costs for foams used for insulation materials have increased sharply since the beginning of 2021.
Polystyrene foam is a central element for insulation material. The increase in the PPI indicates the impact of rising oil and chemical prices on building materials, while demand remains high across the construction industry.
The simultaneous effects of a supply shortage, demand increase and inefficient global supply chains are leading to significant price increases.
Additionally, crude oil and other foams for packaging are experiencing similar demand increases, meaning that prices continue to be affected.

Take away

- Crude oil is the main raw material for most types of foams and insulation materials
- Supply of oil is a particular concern as OPEC+ has not been able to meet its output target
- Insulation materials are high in demand and producers have long order books
- Secure supply early and model demand going forward
- Establish multiple sources for insulation material to avoid supply constraints

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Electric Vehicle Charging

Electric Vehicle Charging

Charging ahead

1. Newly introduced Part S requires all new build homes to have an EV charging point
2. EV charging standards and regulations are changing frequently, as safety and efficiency benchmarks adapt
3. Producers of EV chargers are expanding their offerings to include integration into home energy management

Main considerations for homebuilders:

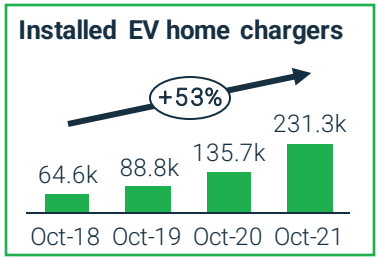
- Shortage of qualified installers at present
- Anticipate longer lead times given rising demand and freight issues
- EV suppliers will be interested in holistic Home Energy Management Systems

Electric Vehicle Charging

Market

The EV charging market is split between domestic and commercial, with domestic accounting for more than 80% of the market. The main suppliers of charging points are delivering both domestic and public charging points. The domestic market has been growing at a CAGR of 53% fuelled by subsidies and increasing demand for electric vehicles. Due to this, new vendors are entering the market, however the established players such as PodPoint or BP Pulse currently retain the largest share of the market. Some suppliers offer additional incentives to customers to differentiate their product, e.g. BP Pulse offers discounted rates to owners of their home chargers for use of public charging points.

Changing regulations, such as the introduction of Part S building regulations, are going to cause further increase in demand within the market, as the UK and other countries move towards an electric future.



Manufacturer	Assembly sites	Revenue (2021)
PodPoint	UK	£61.4m
BP Pulse	UK	£18.1m (2020)
Rolec	UK	£21m (estimate)
Wallbox	ES, CN, US	$86.5m
EO	UK	£28m (estimate)
Myenergi (Zappi)	UK	£17m (estimate)

Supply chain concerns

Supply availability

Over the next 5 years, the market will change with public charge points accounting for half of the market demand for chargers, which might affect the availability of home charging points.

Freight

Freight is a significant cost driver, particularly as raw materials, components and the final product may be sourced from Asia, depending on brand. Disruptions for sea and rail freight have increased reliance on air freight which is driving up prices.

Raw materials & components

Key raw materials include various types of plastics for the housing and copper of cables. Electronics components such as semiconductors, graphical user interface (GUI) and PCBs make up the majority of direct costs and are in high demand across several industries. This has resulted in significant shortages resulting in long lead times for OEMs.

Costs & installation

The cost of EV chargers are set to decline in the long term, as designs stabilise and the market becomes more commoditised. Therefore, installation costs will become a significant cost driver moving forward. Total costs of the technology would be assessed as part of the tendering process.

Take away

- Demand is expected to significantly increase from 2022 onwards
- Large backlogs for orders and installations across OEMs, due to increasing demand, component shortages and shortage of qualified installers
- Integration of EV charging together with PVs, batteries and the home energy system has future innovation potential

Future Homes Hub

Waste Water Heat Recovery

Waste Water Heat Recovery System (WWHR)

Utilising shower power

1. WWHR can be a cost-effective way to achieve a higher SAP score and reduce homeowner energy costs
2. Effects on the demand will be determined in the coming months following the release of SAP 10.2
3. WWHR are becoming more popular in the UK and potentially could be included in the Future Homes Standard

Main considerations for homebuilders:

- Compare efficiency and material composition of different brands
- Copper and steel are the main product materials, their prices have reduced significantly in the last 3 months

Waste Water Heat Recovery System

Market

WWHR is becoming increasingly popular globally, with some Canadian and US states making the technology mandatory in new build homes. There is an increase in uptake throughout the EU, however the UK is expected to lead EU market demand in the short term. The uptake of the technology will be dependent on the release of SAP 10.2 which involves changes to how energy performance of new buildings is calculated. SAP 10.2 was introduced in June 2022, and its' effect on demand will become evident in the second half of 2022. WWHR can be used in any shower setting, creating demand for both domestic and commercial uses. WWHR is primarily sold through plumbing merchants and distributors such as Wolseley, Travis Perkins and Jewson. However, it is recommended that homebuilders develop relationships with OEMs to ensure investment in manufacturing capacity to meet demand, and to secure supply.

OEM	Assembly Sites	Revenue
Recoup	NL	<$5m
Showersave	NL	<$5m
Powerpipe	SE	$16m (2020)
Heatrae Sadia	UK	$10.1m
Zypho	PT	€3.7m (estimate)
RenewAbility Energy	CN	$3.1m
Ecoinnovation	CN	$1.2m
Watercycles	CN	$1.0m

Supply chain concerns

Supply availability

Currently WWHR global manufacturing capacity is higher than demand, and OEMs have the ability to quickly ramp up to meet significant increases in demand. However, as WWHR becomes more widely used, purchasing power of homebuilders needs to be considered. The size of order, length of contract and future relationship are relevant parameters. Forming relationships with OEMs is important to secure supply and ensure that OEMs can invest in the necessary infrastructure to meet all demand. This highlights the importance of sharing long term forecasts for mutual gain.

Manufacturing labour

Some OEMs have automated their production, making their process efficient and scalable. However, others rely on labour intensive processes, which can be affected by the availability of labour in the area.

Raw material costs

The majority of manufacturers use copper or steel as the heat exchanger within the system, and this accounts for >85% of material used. The outer pipe and connectors are made from plastic, usually PVC.

Take away

- Share forecasts with OEMs as far in advance as possible to secure supply
- Discuss scalability of manufacturer processes to meet increasing demand
- Utilise existing relationships with plumbing merchants and distributors
- Compare efficiency and cost of copper vs steel heat exchangers

Future Homes Hub

Passive Flue Gas Heat Recovery System

Passive Flue Gas Heat Recovery System (PFGHRS)

Boiling up the future

1. Systems are predominantly installed in new build housing, with a limited retrofit market
2. The technology may be used as an interim solution for Part L building regulations, but will become obsolete in new build housing with the introduction of the Future Homes Standard in 2025
3. Effects on the demand will be determined in the coming months following the release of SAP 10.2

Main considerations for homebuilders:

- Inventory levels and contractual commitments must be consumed before cut over
- Compare boiler OEM products to third-party manufacturers for total heating system costs

Passive Flue Gas Heat Recovery System (PFGHRS)

Market

PFGHR systems are produced by and made available through boiler manufacturers. SAP requirements are the primary market driver, therefore systems are commonly sold either as an accessory or built into boilers for new build homes. There is a limited retrofit market due to high pay back period, with homeowners choosing load or weather compensation to meet Boiler Plus regulations. There is limited innovation in the market as developments in technology have been focused on boiler efficiency. Additionally, the market for PFGHR is likely to become obsolete with the introduction of the Future Homes Standard, as new build housing will be fitted with low-carbon heating technologies. Significant changes, although unlikely, to "Boiler Plus" could create a retrofit market for the product. PFGHR can be procured directly with boiler OEM or through heating and plumbing merchants across the UK.

Manufacturer	Manufacturing sites	Revenue (2021)
Ideal	UK, FR	£306m (2020)
Worcester Bosch	UK	$387m (2020)
Cochran	UK	£13.4m (2020)
Baxi	UK	$1.2b
Vokera	IT	£22.3m (2020)
Vaillant	DE	€2.7b (2020)
AO Smith	NL	$2.99b

Supply chain concerns

Changing regulation

The management of supply and inventory in relation to the transition of low-carbon heating technologies is key. Homebuilders must ensure that:

- OEMs understand volume requirements in advance to ensure continuity of supply until cut over
- Inventory held or contracted is consumed before the transition to low-carbon heating technologies

Cost of unit

The unit is primarily made from copper (heat exchanger), and stainless steel (outer casing), of which fluctuations in price will have some impact on manufacturing prices. However, as the demand for PFGHR reduces and manufacturers look at using production capacity for other products, customers may face higher prices for orders with short lead times.

Installation

Installation of PFGHR is undertaken at the same time as installation of the boiler, hence supply chain coordination is paramount to have boiler and PFGHR systems at hand at the same time. Specifically, when sourcing systems from third-parties rather than the boiler OEM these considerations are significant in order to keep the building schedule.

Take away

- Create plan for transition to low-carbon heating and share with boiler manufacturers to secure supply until cut over
- Ensure consumption of inventory in line with transition plan
- Third-party systems are an option for some boiler systems, promoting competition

Future Homes Hub

Infrared Heating

Infrared Heating

Winter sun in the home

1. Potential changes to regulations could result in an increase in demand for both new builds and retrofits
2. IR heating is a solid-state heating method without any moving parts, reducing maintenance and service costs
3. The technology is readily available

Main consideration for homebuilders:

- Aluminium is a key determinant of price, and the price of aluminium remains higher than 2020 pricing

Infrared Heating

Market

For enclosed domestic use, Far Infrared (FIR) panels are used and they are available in a large variety of sizes and are customisable. The market is fragmented with a large number of manufacturers with production facilities globally. Some manufacturers sell white label products imported from China and others offer contract manufacturing services. The UK is currently a nascent market, however potential changes to regulations will, according to industry experts, result in a large increase in demand for both new builds as well as retrofits. Several manufacturers have stated there is surplus manufacturing capacity therefore the market is able to meet surges in demand.

Manufacturer	Manufacturing sites
Herschel	DE, IR, CN
Heat4All	AT
Welltherm	DE
Lucht LHZ	DE
Infrared Heating Products	UK
Redwell	AT
RS Components	White label

Supply chain concerns

Freight - The main supply to the UK is from within Europe, however several manufacturers have Chinese operations that have been affected by an increase in the cost of sea freight. As the UK IR heating market is still relatively small, there may be a requirement to work with logistics companies to import more supply from China.

Distribution - European and UK distribution hubs are used for both commercial and direct-to-consumer distribution. Currently, not all manufacturers have established distribution systems, but rather work on an ad-hoc basis. However, some do work with electrical wholesalers across the UK. For large scale home development projects, efficient distribution networks may need to be set up.

Components & manufacturing - Aluminium is a key raw material in FIR. Key components include resistor wire, heat sensors and the thermostat. IR OEMs tend to have strong partner relationships with component manufacturers despite their commoditised nature. Manufacturing facilities for IR are located worldwide, however manufacturing capability is starting to grow within the UK.

Installation
The installation of IR panels is completed by a qualified electrician during the building process, meaning that the locations of the panels have to be included in the design of the house. Communication with suppliers on specifications and availability of panels is necessary.

Take away

- IR heating is a readily available
- For larger developments, longer lead times should be expected
- IR heating can be a selling point for home buyers due to low lifecycle costs

Future Homes Hub

Mechanical Extract Ventilation

Mechanical Extract Ventilation (MEV)

Blowing away fossil fuels

1. MEV reduces humidity from the home by extracting moisture and discharging it into the atmosphere
2. Certified installers help achieve the maximum SAP benefit and improve efficiency of the system
3. MEV provides continuous 'low level' background ventilation, but does not bring in fresh air or improve heating efficiency like a MVHR system

Main consideration for homebuilders:

- Freight issues will impact components being imported from China

Mechanical Extract Ventilation (MEV)

Market

MEV is the mid range of ventilation solutions, situated between intermittent fans, and Mechanical Ventilation with Heat Recovery (MVHR). The market for MEV is fairly commoditised with a large number of manufacturers and distributors supplying the technology. Assembly for UK demand is largely located within the UK or Europe with components sourced from the UK and China. MEV uptake in the UK is relatively low due to few ventilation requirements in the UK compared to Europe, and often builders and home owners choose to apply the more effective MVHR units. Manufacturers have a relationship with developers; however products are purchased through distributors and contractors based on prices agreed with manufacturers.

Manufacturer	Manufacturing sites	Revenue (2021)
Vent-Aixa	UK	$57m
Manrose	UK	£29.6m (2018)
Envirovent	UK, ES	$57m
Domus Ventilation	UK	$63m
Nuaire	UK	$199m
Systemair	ES, IN, DE, CA	£691m
Vectaire	UK	£17.8m (2020)

Supply Chain Concerns

Raw materials and components
The key components of the MEV system are the DC motor, fan, and plastic casing, with plastic ducting and insulation required during installation. These components are typically readily available and can be responsive to demand, however freight issues may affect components being imported from China.

Manufacturing capacity
Demand has not exceeded supply due to the basic manufacturing process required for MEV and an industry preference for MVHR. New manufacturing facilities are being commissioned by larger ventilation suppliers for their entire product range, therefore future capacity is not a concern. OEMs hold low inventory of finished product and production is often triggered at point of order, resulting in inaccurate building schedules or delays, causing backlog at the OEM. Communication on schedule requirements or changes should be communicated to OEMs.

Installation
Installation of MEV systems are recommended to be carried out by BPEC or NICEIC approved electricians/plumbers as this provides a SAP benefit and ensures maximisation of efficiency of the system.

Other technologies
MVHR is a far more popular ventilation system which supplies filtered air into the home, as well as extraction. These are currently popular in high pollution urban areas like central London. Manufacture occurs alongside MEV, therefore manufacturing investment in MVHR will benefit the MEV market. As there is not a significant price difference between the systems, procurement teams should assess price, functionality and alignment to SAP requirements when sourcing.

Take away

- Share forecasts with OEMs to secure capacity and manage lead times
- Compare efficiency and SAP impact of MEV vs other ventilation systems such as intermittent fans, and MVHR
- Capacity for MEV does not seem to be an issue as MVHR is more popular both in the UK and Europe

Future Homes Hub

Housebuilder procurement and supply chain considerations

Procurement & supply chain considerations (1/2)

The following are high level considerations for procurement and supply chain teams to address during the sourcing of low-carbon technologies and the subsequent management of related suppliers and supply chains.
This list is not exhaustive, however highlights key issues which have been raised throughout this document.

General Considerations

- ✓ Is spend visible across the supply chain, segmented by category, location and supplier?
- ✓ Are near-shore suppliers considered to reduce potential logistics costs and delays?
- ✓ Are Emissions Trading System allowances understood through the value chain?
- ✓ Has the procurement impact of new low-carbon technologies on other building materials been considered?
  - ✓ Inventory burn down plan of obsolete products
  - ✓ Increase in building materials required to make technology efficient
  - ✓ End of contract management for obsolete product suppliers
  - ✓ Re-training current installer base to MCS standards

Planning

- ✓ Are detailed demand forecasts shared with suppliers and logistics providers?
- ✓ Are the costs of late deliveries/unavailable stock understood?
- ✓ Has buffer time been included for international shipments?
- ✓ Where is inventory stock stored? Has total cost of just in time been compared with in-house warehousing?
- ✓ How are suppliers planning capacity and storage to manage ramp up requirements?
- ✓ Do suppliers have the ability to be flexible with sudden demand increases?
- ✓ Are emissions production by mode of transport taken into consideration when planning delivery routes?

Procurement & supply chain considerations (2/2)

Sourcing

- ✓ Are there contracts in place with all key suppliers?
- ✓ Are requirements clear or should supplier/industry expertise be sought?
- ✓ Has negotiation power been maximized through route to market? i.e., can contract value be increased through distributors
- ✓ Are key price drivers understood throughout the value chain?
- ✓ Has the suppliers buying power been considered?
- ✓ Has dual sourcing been considered?
- ✓ Are KPIs discussed during the sourcing process?
- ✓ Are cost reduction benefits shared between parties?
- ✓ Are price increases fixed, linked to indices or are open book cost models deployed?
- ✓ Are supplier ESG policies and roadmaps discussed and understood?
- ✓ Has electric/green transport been requested?

Supplier Relationship Management

- ✓ Are the following conversations happening regularly with the supplier base?
  - ✓ KPI performance and improvement
  - ✓ Supplier ESG policies, roadmap and performance
  - ✓ Opportunities to maximise efficiency and reduce cost
  - ✓ Developments within the technology landscape
  - ✓ Reduction of emissions through transport
- ✓ Are suppliers involved in future house design considerations?
- ✓ Are training requirements consistent across the supplier base?
- ✓ Is the relationship between manufacturers, distributors and installers documented and reviewed regularly?

Future Homes Hub

Opportunities for the Hub to help

Opportunities for the Future Homes Hub – Short term

These opportunities to be led by the FHH as a collaborative effort intend to de-risk the low-carbon technology supply. These opportunities can be deployed quickly in the short term to address immediate needs

	Description	Benefits
1. Create a centralised supplier database	▸ Centralised list of supplier names, contact details, websites, product offerings and locations ▸ Searchable based on product and location	▸ Connect housebuilders with regional and local suppliers ▸ Promote suppliers
2. Host supplier events	▸ Connecting housebuilders with suppliers through online and in-person events to share market view of suppliers and learn more about products	▸ Build relationships and understanding ▸ Increase collaboration
3. Promote MCS accreditation	▸ Promote the need of MCS accreditation across current UK installer base to ensure consistent high standards are maintained throughout products and installers	▸ Develop trained, capable installer base ▸ Ensure installers and products are certified to a consistent high standard
4. Promote training for installers	▸ Promote ASHP training to current boiler installer base, alongside further training to maximise efficiency of low-carbon technologies	▸ Develop trained, capable installer base ▸ Encourage new installers in the low-carbon sector ▸ Ensure installers are skilled in specific products to maximise efficiency

Opportunities for the Future Homes Hub – Med/long term

These opportunities to be led by the FHH as a collaborative effort intend to de-risk the low-carbon technology supply. These opportunities will take longer to organize and deploy and are therefore for implementation in the medium – long term.

	Description	Benefits
5. Provide guidance on technologies	▸ Continue to provide relevant, value-add research and reports in procurement, supply chain and emissions to target areas requested by housebuilders	▸ Housebuilders can understand nuances of specific technologies and markets ▸ Increase procurement knowledge in regards to low-carbon technologies
6. Create awards for suppliers	▸ Creation of an award based system for suppliers who are meeting or exceeding targets, and leading the construction industry's efforts towards the race to zero carbon	▸ Encourage suppliers to go "over and above" government requirements ▸ Increase collaboration
7. Determine need for buying group	▸ Organise bundling of requirements across smaller housebuilders to increase purchasing power	▸ Increase purchasing power for smaller housebuilders ▸ Potential for better value for money and cost savings
8. Discuss standardisation of scope 3 carbon accounting	▸ Promoting the need for standardisation of scope 3 carbon accounting, the FHH taskforce can provide a roadmap, guidance and hold discussions to standardise across the industry	▸ Allow comparisons across companies within the construction industry ▸ Promote collaboration across the supply chain

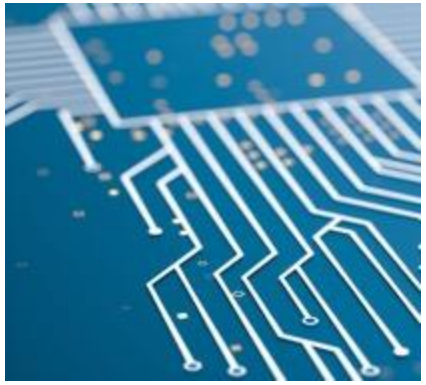
Future Homes Hub

Influencing factors affecting the supply chain

Influencing factors on the supply chain

This section looks at key areas and factors that may pose risk to new and current supply chains in relation to low-carbon technologies and highlights key takeaways to mitigate risk, delays and cost.

Raw materials



Semi-conductors

Labour

Logistics

Emissions

Raw materials

Crude Oil

The availability and price of crude oil directly affects many industries including plastics, logistics ar utilities. The US (20%), Saudi Arabia (12%) and Russia (11%) are the largest global producers, and ge political forces have a significant effect on this industry. The recent attack on the Jeddah Oil Depot, ar the Russian sanctions, have had a significant impact on the market as price per barrel which has near doubled from 2018 levels since the beginning of 2022, the highest price since 2008. Russia is attemptir to continue exporting throughout the conflict and offering discounts to countries such as India. Howeve it is unlikely brent crude prices will fall back to previous rates, but a small reduction has been perceive recently ahead of the OPEC and Non OPEC meeting. The outcome was an agreement on increasir capacity and re-adjusting oil production. Previously, OPEC+ had been unable to regularly achieve the committed production volumes. This was coupled with slow investment and construction of US oil rig primarily due to shortages of personnel, fracking crews and shareholder uncertainty. A new oil rig ca take up to 12 months to construct, meaning there will be little reprieve for the combined 11.6% of glob production that Russia/Ukraine will not be fulfilling. The gap in supply may cause countries to use reserves, and therefore create price volatility.

Take away

- Oil production and availability may begin to improve as an OPEC agreement on capacity has been reached

Crude oil ($/barrel)

Aluminium

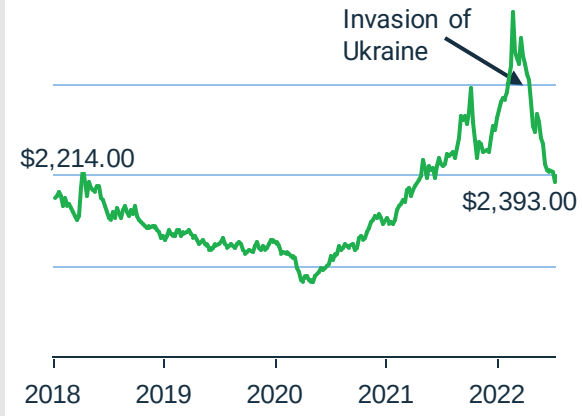
Global production of aluminium is led by China, producing 10x more than Russia, the 2nd largest producer. Since Mid 2020, China has changed from a net exporter of aluminium to a net importer, having a significant impact on global supply and demand. The Chinese government is promoting manufacturing decarburization, enforced in ways such as reduction of the use of aluminium in the construction sector through legislation, and refusing the commissioning of additional aluminium smelting plants. Aluminium production, is an extremely energy intensive process, with utilities contributing 40-50% of the overall cost (see Crude Oil prices above). China has witnessed rolling power outages in the last year where officials have diverted energy to households, away from heavy industry, reducing domestic production and increased import demand. The effect on the market of the decrease in Chinese production is compounded with the drop in output from Russia due to the current conflict. Alongside sanctions, western companies are severing ties with Russia.

However, China's Zero-Covid policy combined with increased global interest rates due to recession fears has led to Aluminium price drop in the past months.

Take away

- The industry is reliant on China, who has become a net importer, and Russia, who is heavily sanctioned by Western countries

Aluminium ($/tonne)



Raw materials

Copper

Chile is the largest producer of copper, supplying 28% of global supply, with Chilean state-owned Codelco being the largest copper mining company globally. In Jan 2022, Codelco had their lowest production yield (year-on-year) in a decade due to reasons such as water scarcity and lower ore quality. Historically the copper price has remained relatively stable, however, reducing yield, increasing demand, and lack of investment in the industry has resulted in a steady increase in price over the past two years, with increased volatility. China is the top consumer of copper, and due to resurgence of COVID-19 cases and lockdowns across the country, copper prices have dropped over concerns demand will not be consumed. In addition, prices dropped even further recently due to recession fears. Although this is viewed as a short term concern due to growing demand. Russian copper supply issues may attribute to price volatility as Russia provides around 4% of global demand. Logistical issues and potential sanctions will create pressure on supply of the commodity. Currently copper is exempt from EU, US and UK sanctions, however there is pressure from groups such as LME's Copper Committee who have voted to ban new deliveries of Russian copper into the LME system.

Take away

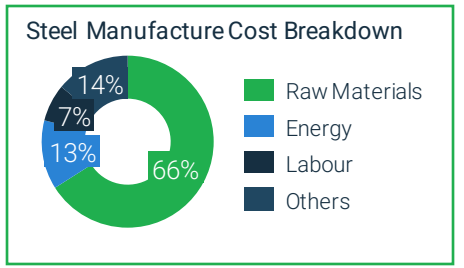
- Historically stable, copper is facing a price drop due to recession fears and worries that demand will not be consumed

Steel

China is the world's largest steel producer supplying over 50% of the market. Efforts to reduce air pollution, prior to the Beijing Winter Olympics, began in August 2021 and reduced industry output, leading to a monthly 10% output reduction This translated to a 5.7% reduction globally which, coupled with other factors, drove prices up through 2021. As China entered a new stage of lockdown with a Zero – Covid policy, global demand has dropped and combined with increased energy prices this has led to a reduction in steel prices. Chinese Steel output is expected to recover, and with the conflict continuing between Russia and Ukraine, prices will remain volatile in the short term. The main raw materials are iron ore, coal and scrap steel, accounting for up to 66% of the cost. Steel production uses up to 80% scrap content, of which availability is dependent primarily on global booming construction and automotive sectors, with scrap being returned to China for recycling. However, China's surge in COVID cases and lockdowns are affecting major cities and ports. The backlog in the sea freight industry is compounding this problem, making the input material more scarce.

Take away

- Macroeconomic factors mean continuing volatility with steel pricing



Semiconductors

Semiconductors are essential for many electronic appliances and social infrastructure which support our everyday life. They'll be a key component of future smart homes.

Interdependency of market

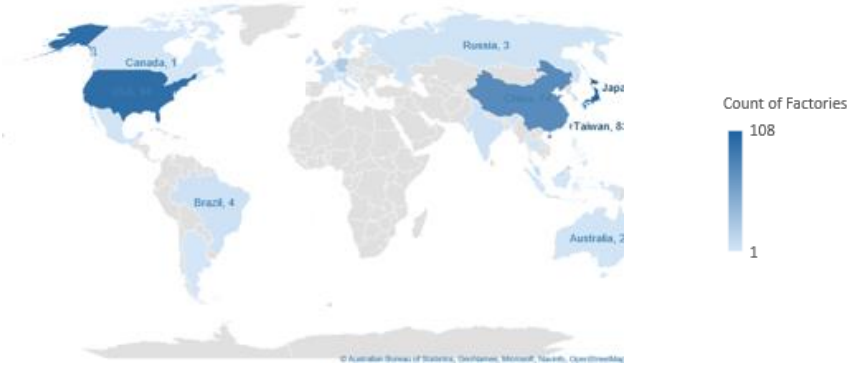
The industry is dominated by the US, Taiwan, South Korea and China. There is no single region which can manufacturer all steps in the supply chain, resulting in the interdependency between countries for production. As per the Semiconductor Industry Association, 57% of the semiconductor materials and 56% of wafer fabrications come from Asian countries, with the US leading in logic and electronic design automation. This segregation of processes and technologies is due to significant barriers to entry and technical complexity which produces a highly fragile industry. Any macroeconomic effect on the industry such as trade wars, natural disasters or geo-political impacts will have a domino effect across countries and companies, with the potential to disrupt supply. US and China trade wars caused customers to over-buy for fears of lack of supply, utilizing all excess capacity, reducing supply and driving up prices. This was followed by snow storms in Texas, earthquakes in Japan and droughts in Taiwan which had significant impacts on ability to manufacture. This further reduced supply, created a significant backlog of orders and drove up prices. The order to delivery lead time is currently 40 weeks and is expected to increase.

Impact on material inputs

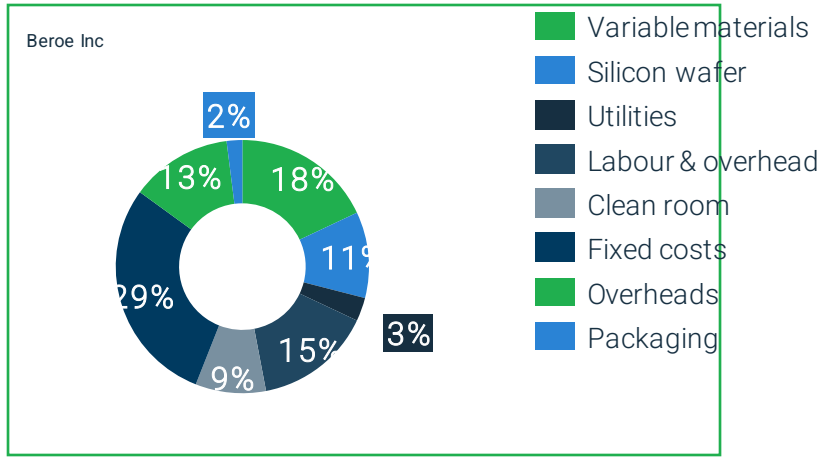
Variable material costs account for nearly 20% of manufacturing costs, resulting in increasing raw material commodity pricing having a significant effect on cost. Examples, driven by the war in Ukraine highlight this. Neon is critical within the lithography step of semiconductor production. Ukraine is the leading crude neon exporter, responsible for supplying up to 75% of global demand, and it is produced by refining by-products from the Russian steel industry. When Russia annexed Crimea in 2014 neon prices increased by over 600%, and the semiconductor industry is already being forced to use reserve supplies or attempt to source supply elsewhere.

Take away

- A highly fragile market easily susceptible to macroeconomic effects which will directly affect price and availability of supply



Semiconductor manufacturing costs



Macroeconomic events affecting semiconductor industry

The ongoing semiconductor shortage has been exacerbated by events over the last 2 years

JAN 2020

US-China trade war

US announce restrictions on Chinese firms such as Huawei, prompting them to order as much as possible before implementation

- All spare production capacity is now utilised, removing any flexibility and available supply

MAR 2020

COVID-19

Chip production paused for almost 6 months due to lockdown and restrictions, while consumer demand increases in the wake of COVID-19

- Sustained supply deficit in the sector which has not yet caught up as facilities are still closed

FEB 2021

Texas winter storms

Snow storms suspend Samsung, NXP and Infineon plant operations

- Large number of US producers now running behind scheduled orders, increasing order lead times

MAR 2021

Wafer Shortage

Persistent wafer shortage following tariffs imposed on Chinese components and blacklist of China's largest manufacturer, exacerbated by natural disasters

- Japanese suppliers suspended line for a week to inspect safety before ramping up following earthquake
- Factory fires in Japan, which holds 30% of integrated circuit market share, causing further global delays

APR 2021

Drought in Taiwan

Lack of water supply increases uncertainty on industry, in water intensive production

- Water cut-offs of two days per week imposed. Manufacturers taking to trucking water into production facility
- Semiconductor lead time reported as all time high of 21 weeks, up from 10 weeks in January '21

OCT 2021

China power outages & COVID

Government enforced power cuts cause production limits and increase backlog in shipping ports

- 4 day closure of Chinese chip factories due to enforced power cuts
- 9 day lockdown in Shanghai results in 300 waiting ships at port, x5 increase from two weeks prior

FEB 2022

Russian invasion

Ukraine supplies 70% of global Neon, Russia 25% of global Palladium which are key in chip production

- Short term impact mitigated as producers hold higher stock following 2014 Crimea invasion. Long term; tariffs or trade limitations could cause line closures, or price increases
- Semiconductor lead time now reported as 44 weeks, up from 15 weeks in October '21

MAR 2022

China "zero covid" policy

51million people ordered into lockdown as COVID surges

- Increasing pressures from rising labour costs in China and worsening Sino-U.S. trade tensions
- Companies considering moving production to SE Asia and India

Labour

Take away

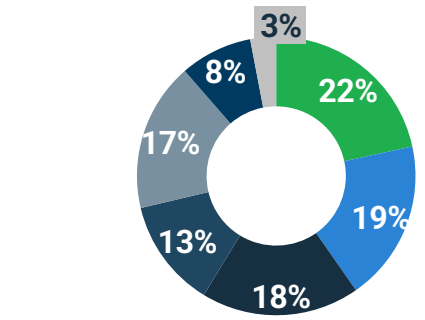
- Secure capacity by providing long term forecasts to regional labour workforces
- Work with the UK Government, FHH and education bodies to promote and fund technical education and new technology training

The UK Government's pledge to "Build Back Better" faces significant challenges around recruiting and retaining the workforce required. To meet government and private sector infrastructure goals, it is believed that the industry will need to hire an additional 53,200 workers per year, on top of maintaining the current workforce. This is coupled with statistics from the Institute of Public Policy Research (IPPR) showing only 20% of tradespeople are under 30, and over the next 15 years 750,000 UK construction workers will retire. Workforce shortages are caused by lack of skilled/experienced workers, workers relocating due to Brexit, and fewer people opting for a career in the trade industry, resulting in the requirement for immediate action to recruit and train the next generation of the workforce.

Construction sector employees	Annual Recruitment Requirement
Manual occupations (e.g., wood trades)	27,770
Non-manual occupations (e.g., project manager)	15,550
Professional occupations (e.g., civil engineer)	9,880
ASHP installers	2,800

Construction output share by industry sector

CITB Construction Skills Network



Recruiting and Retaining

Changing misconceptions on the trade industry is key to recruiting individuals into the field. The CITB's report on perceptions of the industry showed that those external to the industry had some negative perceptions about cultures and behaviours. The industry can be viewed as "insecure", with up to 40% of the construction workforce in the UK being self-employed and many roles are zero-hour contracts.

The industry could benefit from increased diversity, currently only 12% of the industry are female, and >6% identify as BAME. It is believed that more regular working hours and stability or increase in pay could be an easy fix to attract more individuals into the industry, and promote the benefits of careers in the field.

Training

The UK has experienced a large funding gap between academic and technical education over the past decade, which may have played a part in reduced attraction to potential students. This is beginning to change with the creation of the National Skills Fund, but more must be done. In 2021 the government provided free or subsidised training under the BEIS Skills Training Competition scheme to encourage tradespeople to upskill in low carbon heating technologies, but this scheme ended in March 2022. Many OEMs across different technologies, (such as Ideal and Mitsubishi), are investing in the creation of training courses to maximise efficiency of their product & fill the skills gap in the market. Training courses, whether through colleges, university or OEMs should be promoted by housebuilders to maximise the efficiency of the workforce.

Logistics

The logistics industry continues to suffer, struggling significantly with capacity. Although costs reduced somewhat in March 2022, recent worldwide events lead to prices rising again.

China returns to lockdown

China's Zero Covid policy is expected to continue in the near term and disruption, delay and price increases are expected as a result of these lockdown measures. Although Shanghai Pudong, China's busiest air cargo hub will not close, several airlines have cancelled flights and significant staff shortages are expected. Distribution centre closures and trucking delays are expected, which will affect ocean freight as vessels are delayed waiting on cargo, or Chinese ports are skipped. Project44, an online supply chain tracker, revealed that the Shanghai import container wait increased by 163%, from 4.6 days on 28 March to 12.1 days as of 15 April 2022. Some companies are looking to Ningbo or Qingdao ports to ease the disruption, however Qingdao has seen increased vessel waiting time of 2-5 days and the backlog of shipments in Shanghai continues to rise. This is compounded with delays seen by Southern Chinese ports due to dense fog conditions.

Russian/Ukraine conflict

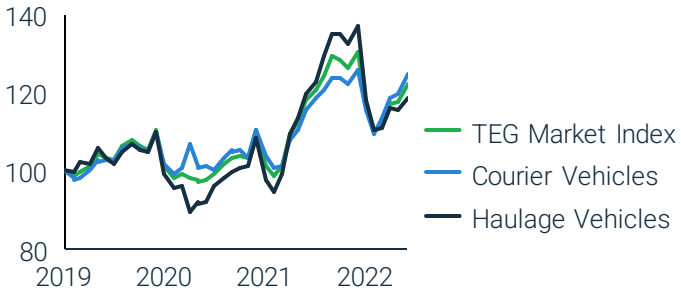
Limited air capacity caused by Ukrainian airspace being shut and airlines avoiding Russian airspace have resulted in airfreight rates spiking. Some flights between Asia and Northern Europe will need to be rerouted via southerly routings over Saudi Arabia, amid restrictions linked to Iran, Syria, and Yemen. These longer routes, increase carbon emissions and use more fuel, with costs further pushed up as jet fuel prices are directly linked to surging oil prices. The United States and Europe have closed their airspace to Russian airlines, resulting in Russian owned AirBridgeCargo and Atran suspending operations, further squeezing air freight capacity. Russian forces are closing shipping routes, and firms are suspending services due to the dangerous conditions in parts of the Black Sea and Sea of Azov. At least five commercial vessels have been damaged by explosions off Ukraine's coast, some with casualties. Lack of capacity is having a direct impact on prices.

Take away

- Cost is not the only concern from a supply chain perspective, lead times are longer and visibility throughout the supply chain is important to understand where there may be potential delays

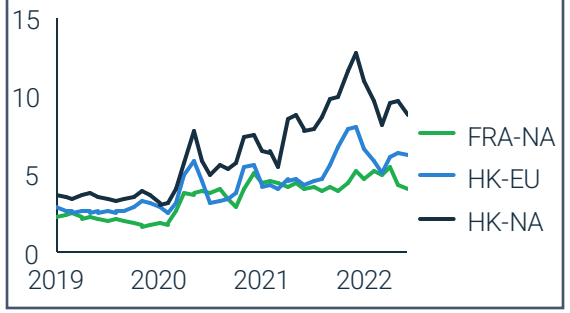
Land Freight

Transport Exchange Group price per mile
2019 = 100



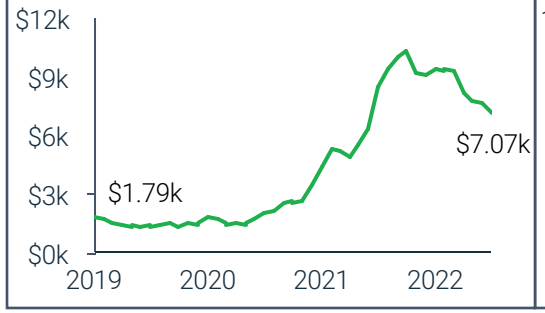
Air Freight

Baltic Exchange Air Freight Index (BAI) $/kg

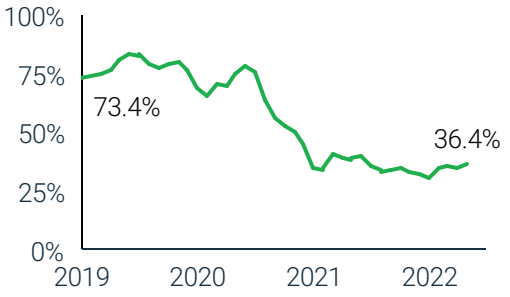


Ocean Freight

World Container Index



Schedule reliability of container vessels



Embodied carbon and emissions

Types of embodied carbon

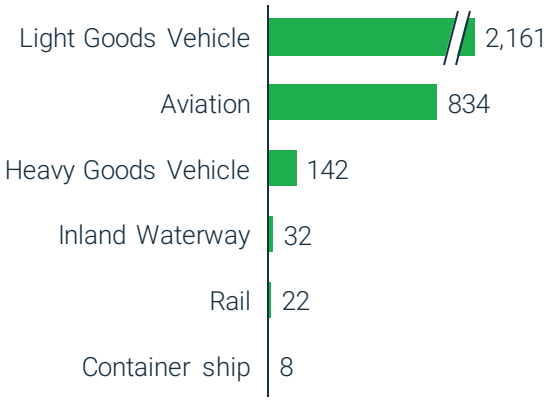
Extract raw material | Transport | Manufacture | Construct building | Maintain the building | End of life

Measuring and tracking emissions throughout the supply chain is key to understanding progress towards achieving our collective zero carbon goals. For low-carbon technologies, emissions tracking should be a key theme throughout sourcing and operations decisions.

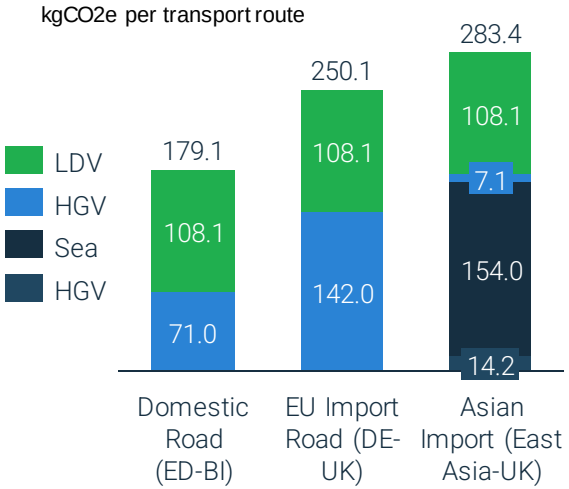
For transport emissions, the location of manufacture, delivery destination and route taken can have a significant effect on the emissions volume. Domestic production does not always guarantee the lowest logistics emissions as maritime shipping and rail transport are significantly more environmentally friendly which can make international travel more attractive than long HGV routes across Europe.

During the sourcing process, it is recommended that there is a focus on the understanding of embodied carbon and environmental goals of suppliers. For example, considerations such as source of energy of manufacture of raw material, components and final product should be understood, as countries/manufacturers dependent on fossil fuels as an energy source will have higher levels of embodied carbon. Roadmaps to address this (such as using PVs as an energy source) should be discussed, with supplier goals included in contract KPIs to highlight the importance of sustainability for the industry.

gCO2e/tkm per mode of transport



Example emission calculation



Take away

- Both the distance and mode of transport should be taken into consideration when understanding logistics emissions
- Environmental policies and road maps, coupled with a supplier's understanding of scope 3 emissions, should be discussed throughout the sourcing process
- Use of KPIs to track supplier performance on achieving goals

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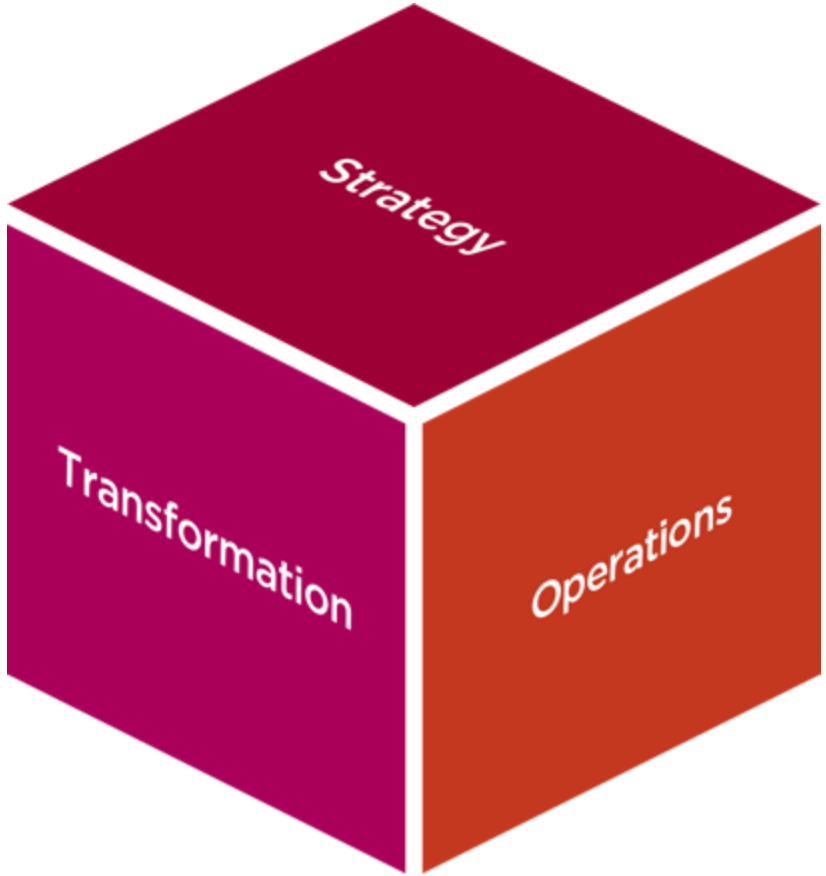

Strategy

- Operating model
- Organisation and people
- Competitiveness
- Working capital improvement
- Mergers and acquisitions
- Operations agility

Operations

- New products
- Procurement
- Supply chain planning
- Manufacturing
- Logistics
- Channels to market
- Maintenance and after sales
- Digital and IT
- Finance, SG&A and HR
- Sustainable operations

Transformation

- Financials and measurement
- Organisation and infrastructure
- People and culture
- Process
- Systems
- Strategy
- Stakeholder management
- Programme management

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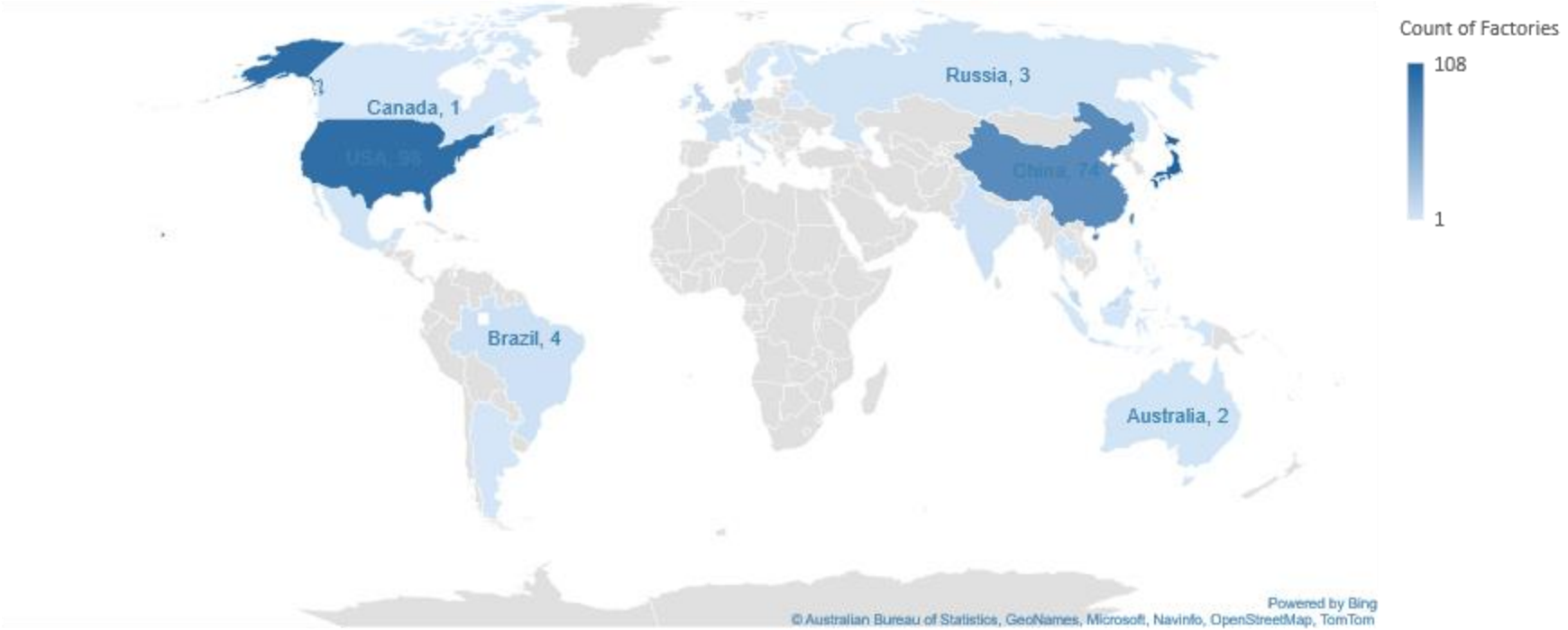
Semi conductor production plants per country



Currently 65% of the total production plants are located in the Asia region, with reportedly 83% of global production of processor chips and 70% of memory chips coming out of Taiwan (83) and South Korea (21). With a large number of the USA plants producing more sophisticated output for Intel, Samsung and other embedded processors for computer systems; the East Asian market is more catered to produce for the technologies discussed. With geopolitical factors combined with extreme draughts and COVID outbreaks; the output of these plants has been reduced for over two years while demand has surged. The result of this being a order to delivery lead time increase of over double to 40 weeks at the end of 2021. Furthermore the worsened backlog of sea freight caused by lockdowns with exacerbate the delivery lead times for UK assembled parts. For orders of products using semi conductors; these will need to be placed well in advance in order to deliver on time, notwithstanding any further delays brought on this sector.

Future Homes Hub

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