SEAI Sustainable Energy Authority of Ireland

Rialtas na hÉireann
Government of Ireland

Ireland's Sustainable Energy Supply Chain Opportunities

March 2025

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Sustainable Energy Authority of Ireland
SEAI is Ireland's national energy authority investing in, and delivering, appropriate, effective and sustainable solutions to help Ireland's transition to a clean energy future. We work with the public, businesses, communities and the Government to achieve this, through expertise, funding, educational programmes, policy advice, research and the development of new technologies.

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Contents

Executive Summary

This report examines in detail how well the Irish supply chain is positioned to capture new business as a result of the ongoing transition to sustainable energy systems in Ireland and beyond. The report highlights the potential market size for a selection of key sustainable energy technologies in Ireland, the EU and globally, and areas of the supply chain where Irish businesses in the manufacturing, construction and services sectors could capture a share of the market.

The purpose of this report is to initiate discussions and debate between government agencies and departments, industry and other stakeholders on how to harness the sustainable energy supply transition to both reduce greenhouse gas (GHG) emissions and stimulate economic growth, exports, foreign direct investment and jobs.

This report is structured around five technology areas that will be critical to meeting Ireland’s greenhouse gas mitigation targets i.e., renewable electricity generation, energy storage and grid balancing, low-carbon transport, energy in buildings and energy in industry. Each of these sections begins with an introduction to the evolving policy and market landscapes in Ireland, the EU and globally.

Explanations are provided for the critical technologies within each technology area:

- **Renewable electricity generation**: Onshore wind, solar photovoltaics (PV), microgeneration (including small-scale wind, micro hydro and rooftop solar PV) and offshore renewable energy[1]
- **Energy storage and grid balancing technologies**: smart grids (including transmission technology, grid forming inverters and grid-scale storage)
- **Low-carbon transport**: Electric vehicles and charging stations
- **Energy in buildings**: Smart buildings and homes (including building control, automation and information systems), energy efficient construction (including building shells, insulation, glazing, windows, etc.), sustainable biomass heating (including wood chips/pellets) and district heating
- **Energy in industry**: Electrification of industrial processes (including heat pumps), and biomass anaerobic digestion

The report studies the technologies listed above and presents the scope for Irish suppliers to capture a share of investment in these sustainable energy technologies in Ireland. A systematic modelling exercise was employed for the sustainable energy technologies analysed as part of this study, with the exception of offshore renewable energy. A detailed assessment of the potential for fixed offshore wind, floating offshore wind and wave energy to play a role in Ireland's decarbonised electricity system has been captured in the Offshore Renewable Energy Technology roadmap.[2]

The Irish policy and market landscape

Ireland's energy policy and market are undergoing rapid and continuous transformation as the country works to meet its ambitious climate and renewable energy targets. The overarching goals are to decarbonise the energy system and enhance energy security through the rapid expansion of renewable energy generation.

Beyond the power sector, Ireland is pursuing decarbonisation across transport, buildings, and industry through measures like electric vehicle incentives, building energy efficiency upgrades, and support for industrial fuel switching. Underpinning these efforts is a focus on enhancing energy security by reducing reliance on imported fossil fuels.

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[1] Offshore renewable energy technologies covered in this study include offshore wind and wave energy

[2] Details of supply chains for offshore renewable energy can be found in the Offshore Renewable Energy Roadmap. SEAI (2024),‘*Offshore Renewable Energy Technology Roadmap*,’ https://www.seai.ie/sites/default/files/publications/ORE-Technology-Roadmap.pdf

However, the transition is not without its challenges, and ongoing policy development and market reforms will be critical to navigating this complex and rapidly evolving energy landscape.

- ***Renewable Electricity Generation:*** Although Ireland generates a higher proportion of its electricity from onshore wind than most countries in Europe,[3] electricity generation was still responsible for approximately 23% of Ireland's energy-related carbon dioxide equivalent (CO_{2eq}) emissions in 2023.[4] Ireland's 2024 Climate Action Plan (CAP) commits to an increase in the share of renewable energy in electricity generation of up to 80% by 2030.[5] There are schemes to support this target including the Renewable Energy Feed-in-Tariff (REFIT)[6] and Renewable Electricity Support Scheme (RESS).[7] This target will be met primarily through the expansion of onshore and offshore wind in addition to growth in solar PV.

- ***Energy storage and grid balancing***: Smart grids are important to the future of electricity transmission in Ireland, especially considering the ambitious decarbonisation targets to be achieved by 2030. EirGrid's "Delivering a Secure, Sustainable Electricity System" (DS3) programme has been effective at adding flexibility and resilience to the grid. In 2022, a significant milestone was achieved when EirGrid successfully integrated an instantaneous penetration of 75% renewable energy into the grid, as part of the DS3 programme.[8] The revised 'Shaping Our Electricity Future' roadmap outlines a pathway for Ireland to meet its enhanced 2030 electricity ambitions and provides the foundation for the broader net zero transition by 2050.[9] Another crucial component of the country's efforts to modernise its electricity grid is its National Smart Metering Programme, through which over 1.9 million smart meters have been installed across Ireland.[10] The programme aims to upgrade all electricity meters to smart meters, providing benefits such as facilitating energy efficiency, cost savings, and enhanced grid management. This supports the integration of energy storage technologies and other grid flexibility measures to accommodate the increased renewable penetration.

- ***Low-carbon transport***: Transport is the largest and fastest growing source of energy-related GHG emissions in Ireland, accounting for 34% of energy-related CO_{2eq} emissions in 2023.[11] Ireland's CAP sets a target of increasing the number of electric vehicles on road to almost 1 million by 2030[12] and outlines plans to ban new petrol and diesel vehicles from that year. [13] Several measures are in place to support this deployment, including tax benefits, grants for the purchase of new electric or hybrid vehicles and the installation of home and public charging points.[14]

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[3] Pg 85, REN21 (2024), '*Renewables 2024 Global Status Report: Energy Supply*', https://www.ren21.net/wp-content/uploads/2019/05/GSR2024_Supply.pdf
[4] Table 7.1, SEAI (2024), '*Energy in Ireland*' https://www.seai.ie/sites/default/files/publications/energy-in-ireland-2024.pdf
[5] Pg 19, Government of Ireland (2024*), 'Climate Action Plan 2024'*, Department of the Environment, Climate and Communications (DECC), https://assets.gov.ie/296414/7a06bae1-4c1c-4cdc-ac36-978e3119362e.pdf
[6] Government of Ireland (2020), '*Renewable Energy Feed-in Tariff (REFIT) Scheme*' DECC, https://www.gov.ie/en/publication/9bf994-renewable-energy-feed-in-tariff-refit-scheme/
[7] Government of Ireland (2019), '*Renewable Electricity Support Scheme (RESS)*', DECC, https://www.gov.ie/en/publication/36d8d2-renewable-electricity-support-scheme/
[8] EirGrid (2021), '*DS3 Programme - Delivering a Secure Sustainable Electricity System*', https://www.eirgrid.ie/ds3-programme-delivering-secure-sustainable-electricity-system
[9] EirGrid, SONI (2023), '*Shaping Our Electricity Future Roadmap*' https://cms.eirgrid.ie/sites/default/files/publications/Shaping-Our-Electricity-Future-Roadmap_Version-1.1_07.23.pdf
[10] ESB Networks (2023), '*Smart meters*', https://www.esbnetworks.ie/services/manage-my-meter/about-smart-meters
[11] Table 7.1, SEAI (2024), '*Energy in Ireland*' https://www.seai.ie/sites/default/files/publications/energy-in-ireland-2024.pdf
[12] Pg. 39, Government of Ireland (2024*), 'Climate Action Plan 2024'*, DECC, https://assets.gov.ie/296414/7a06bae1-4c1c-4cdc-ac36-978e3119362e.pdf
[13] Government of Ireland (2023), '*General Scheme of the Climate Action Amendment Bill*', https://www.gov.ie/en/publication/36892-general-scheme-climate-action-amendment-bill/
[14] Government of Ireland (2024), '*Zero Emission Vehicles Ireland*' https://www.gov.ie/en/campaigns/18b95-zero-emission-vehicles-ireland/?referrer=https://www.gov.ie/zevi/

- ***Energy in buildings***: After transport and electricity generation, the residential sector is the next biggest source of energy-related CO_{2eq} emissions in Ireland, accounting for over 15% in 2023.[15] Ireland's CAP sets out significant ambition for decarbonising heat generation and improving the energy performance of Irish homes, including a target of 680,000 heat pumps to be installed in both new and existing housing by 2030.[16] Regulatory standards in Ireland are shifting towards more efficient and low-carbon home heating systems. A combination of incentives, information and regulatory measures are being used to progressively phase out the use of fossil fuel-based heating systems as the default option in new dwellings, and promote the uptake of more efficient and renewable heating technologies such as heat pumps.[17] According to Ireland's revised building regulations the nearly zero energy buildings (NZEB) standard applies to all new buildings occupied after the 31st December 2020.[18] Furthermore, retrofits for all buildings are being promoted through the National Residential Retrofit Plan which aims to address the challenges around decarbonising existing building stock.[19] SEAI's Home Energy Upgrade Scheme supports these measures with grants to upgrade the energy efficiency of homes.[20]

- ***Energy in industry:*** Industry is responsible for 10% of energy-related CO_{2eq} emissions in Ireland.[21] Industry also accounts for a large portion of the gross final consumption of heat from renewable sources. It has been observed that an increased use of renewable wastes in industry has contributed to a recent growth in Ireland's renewable energy use for heat. [22] Despite the indicated growth, Ireland has substantial room for improvement as it has the lowest shares of renewable sources for heating and cooling, compared to the rest of EU.[23] Ireland's CAP aims to develop and stabilise the indigenous supply of biomass for renewable heat, and SEAI's Support Scheme for Renewable Heat (SSRH)[24] provides installation grants for heat pumps and on-going support for the use of solid biomass and anaerobic digestion systems by non-domestic heat users. Ireland also has policies aimed at promoting energy efficiency in industry, including the carbon tax[25] and the Energy Efficiency Obligation Scheme (EEOS)[26] introduced in 2010 and 2014, respectively.

These policies and measures will drive increased investment. When combined with targeted enterprise support, they will enable Irish companies to both capture the benefits of investment in Ireland and gear them towards capturing the potential in overseas markets.

The estimations, findings and recommendations made in the following sections are based on the supply chain analysis carried out as part of this study and engagement with relevant stakeholders. The analysis was carried out for each technology to primarily (i) estimate its Ireland, EU and global market size and (ii) calculate the potential Irish share of the three markets.

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[15] Table 7.1, SEAI (2024), '*Energy in Ireland*' https://www.seai.ie/sites/default/files/publications/energy-in-ireland-2024.pdf
[16] Pg. 39, Government of Ireland (2024*), 'Climate Action Plan 2024'*, DECC, https://assets.gov.ie/296414/7a06bae1-4c1c-4cdc-ac36-978e3119362e.pdf
[17] SEAI (2024), *'Heat pumps'* https://www.seai.ie/heatpumps
[18] SEAI (2023), '*Nearly Zero Energy Building Standard*', https://www.seai.ie/plan-your-energy-journey/for-your-business/standards/nearly-zero-energy-building-standard
[19] Government of Ireland (2022), '*National Retrofit Plan*', DECC, https://www.gov.ie/en/publication/5052a-national-retrofit-plan/
[20] SEAI (2024), '*Home Energy Upgrades*', https://www.seai.ie/home-energy/home-upgrades/
[21] Table 7.1, SEAI (2024), '*Energy in Ireland*' https://www.seai.ie/sites/default/files/publications/energy-in-ireland-2024.pdf
[22] Figure 8.15 SEAI (2024), '*Energy in Ireland*' https://www.seai.ie/sites/default/files/publications/energy-in-ireland-2024.pdf
[23] Eurostat (2024), '*Renewable energy for heating & cooling up to 25% in 2022*', https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20240227-2
[24] SEAI (2024), '*Support Scheme for Renewable Heat*', SEAI, https://www.seai.ie/grants/business-grants/support-scheme-renewable-heat
[25]Parliamentary Budget Office (2024), '*Carbon Tax Series Part 1 of 3: What is the Carbon Tax?', Publication 13 of 2024,* https://data.oireachtas.ie/ie/oireachtas/parliamentaryBudgetOffice/2024/2024-02-29_carbon-tax-series-part-1-of-3-what-is-the-carbon-tax_en.pdf
[26] SEAI (2023), '*Energy Efficiency Obligation Scheme (EEOS)*', https://www.seai.ie/business-and-public-sector/business-grants-and-supports/energy-efficiency-obligation-scheme/

The analysis also involved creating models of supply chains for each technology, breaking down costs along the supply chain and ascertaining the equipment and services that are likely to be domestically sourced versus imported. The methodology has been further detailed in Chapter 1.1. Approach to supply chain mapping and analysis.

Market potential at national and EU level

At the national level, the total estimated capital expenditure in 2030 across the technologies considered in this study could amount to between €17 and 19 billion per year. The majority of the total investment is anticipated to be in low-carbon transport, energy in buildings and renewable electricity generation.

Beyond the estimated investment in Ireland, significant markets are developing with the closest trading partners across Europe, in the UK and further afield. Outside of Ireland, the estimated market in the EU-27 and UK for the technologies studied is over €1.5 trillion per year. This growing international market offers Irish suppliers of sustainable energy products and services an export opportunity. However, it has been identified that there are currently limited capabilities to effectively engage with EU and global markets.

Ireland has a wealth of wind and ocean energy potential. Building a strong local market in Ireland can help create a springboard for export to wider markets by showcasing Irish products and services and enabling companies to establish revenue streams. An example of strategic action in this context is the '*Powering Prosperity - Ireland's Offshore Wind Industrial Strategy*' which aims to enhance both domestic and international supply chains, with a focus on increasing the number of Irish companies engaged in the offshore wind sector. This initiative recognises the critical need for collaboration among various stakeholders to effectively implement strategies that unlock the economic potential and facilitate export growth. By fostering partnerships and implementing strategic actions, such initiatives can address existing challenges in the supply chain and facilitate significant growth in the sustainable energy market.[27]

Position of Irish organisations to capture investment

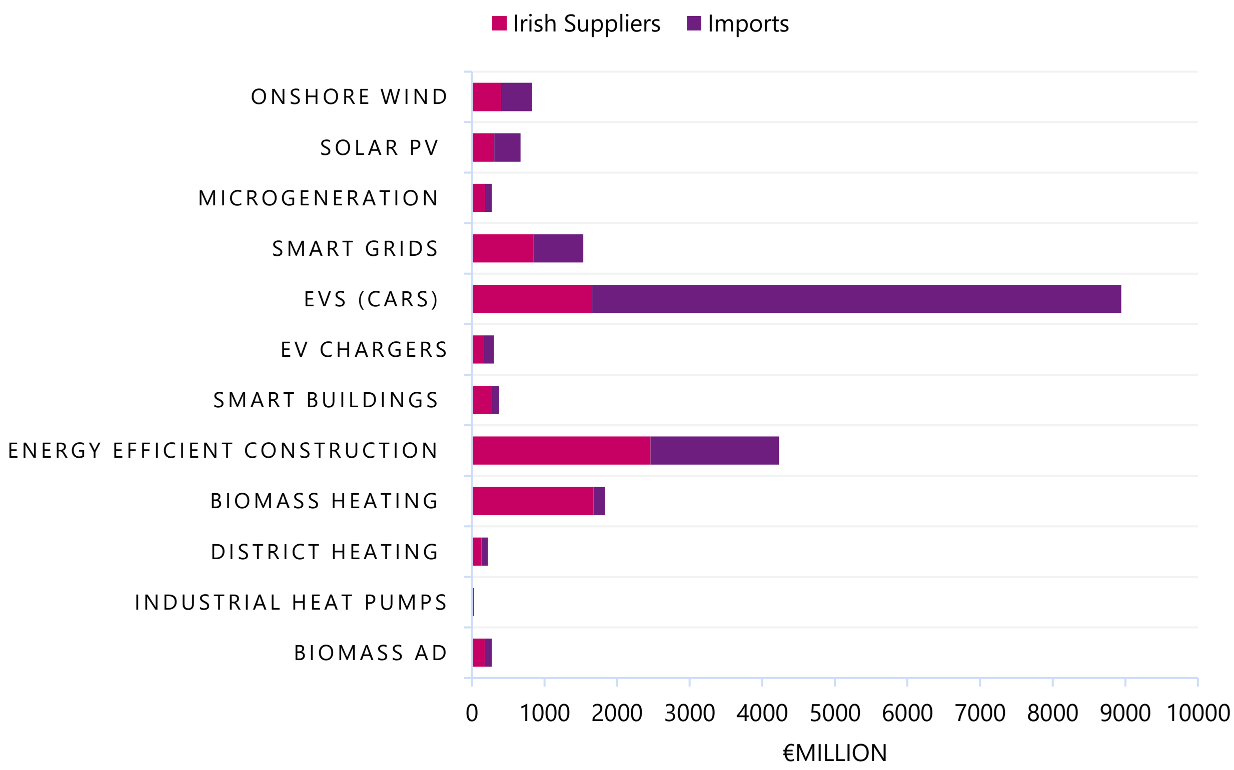
Supply chain analysis indicates that there is considerable scope for Irish suppliers to capture a share of the investment in sustainable energy technologies in Ireland, particularly in relation to construction, engineering services and financial services.

Although Ireland is unlikely to manufacture the key components of the technologies studied, local enterprises could still capture a share of the market by providing some services and equipment. It is essential to direct sufficient funding towards enhancing and expanding local manufacturing facilities and service businesses. This approach will not only support the growth of the domestic supply chain but also strengthen Ireland's position in the sustainable energy market.

Figure 1 presents the total size of the Ireland market in 2030 and the potential for an Irish share for each of the supply chains mapped. The biggest potential internal markets for Irish enterprises are in energy efficient construction, electric vehicles, sustainable biomass heating and smart grids. Irish companies are well placed to capture a share of these four markets.

[27] Government of Ireland (2024), *'Powering Prosperity: Ireland's Offshore Wind Industrial Strategy'* , DETE, https://enterprise.gov.ie/en/publications/powering-prosperity.html

Figure 1: Irish market size and potential Irish share in 2030



Source: SEAI Supply Chain Analysis

Over 40% of the total anticipated expenditure in Ireland in 2030 is estimated to be within areas of the supply chain where Irish organisations are very well positioned or well positioned to capture investment in goods and services markets. Overall, the Irish supply chain landscape is primarily tailored to serve the domestic market, with limited capabilities to effectively engage with the EU and UK markets.

Across the EU and UK markets, the main opportunities for Irish suppliers are likely to relate mainly to the provision of high value-added specialist products and services. In most other areas of the EU and UK market, Irish companies are likely to struggle to gain market share, as there is a strong preference for the use of local providers of goods and services.

There are strategic opportunities for Irish Research and Development (R&D) teams to contribute to the development and testing of the next generation of sustainable energy technologies. Targeted interventions to build technical expertise, enterprises and markets will allow Ireland to continue to foster opportunities in the sustainable energy technologies of the future. For example, Ireland's Offshore Wind Industrial Strategy proposes the establishment of a National Offshore Wind Centre of Excellence (OWCE) which would be an industry-led facility focused on specific areas of offshore wind and would contribute to fostering an offshore wind Research, Development & Innovation (RD&I) ecosystem.[28]

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[28] Pg 51, Government of Ireland (2024), '*Powering Prosperity: Ireland's Offshore Wind Industrial Strategy*', DETE, https://enterprise.gov.ie/en/publications/publication-files/powering-prosperity.pdf

Recommendations to maximise supply chain opportunities

Since the 2014 findings regarding supply chain opportunities in Ireland,[29] the landscape has evolved, particularly in response to global challenges and rising energy costs. The focus areas for maximising sustainable energy supply chain opportunities include:

- **Develop skills and certifications**: Establish targeted training programs and accreditation frameworks to develop the necessary skills and certifications for installers and energy experts.
- **Leverage R&D capabilities:** Utilise Ireland's strong R&D capabilities to advance emerging renewable technologies.
- **Promote sustainable practices:** Encourage businesses to adopt sustainable practices such as green procurement and comply with EU directives and legislation for sustainable and responsible business.
- **Focus on high-value markets:** Effectively harness the opportunities presented by the transition to sustainable energy systems by prioritising high-value markets such as energy efficient construction, sustainable biomass heating, electric vehicles, and smart grids.
- **Capture the preliminary phase of the supply chain for key technologies:** Focus on capturing the market for planning, permitting and design of technologies such as onshore wind farms, utility solar PV, microgeneration units, smart grids, EV charging, smart buildings & homes, energy efficient construction, sustainable biomass heating, industrial heat pumps and AD. This includes feasibility studies, project planning, financial, legal, environmental, commercial and technical services and advisory roles.
- **Capture the installation and commissioning markets:** Focus on capturing the market for the installation and commissioning of technologies such as onshore wind, utility solar PV, microgeneration, EV charging infrastructure, smart buildings & homes, energy efficient construction, district heating systems, and AD. This could create substantial opportunities for electrical, mechanical and civil engineers, engineering firms and qualified electricians.

Overall, these areas reflect a broader strategy to build a more resilient, efficient, and sustainable supply chain ecosystem in Ireland.

[29] SEAI (2014) *'Ireland's Sustainable Energy Supply Chain Opportunity'*, https://www.seai.ie/sites/default/files/publications/Ireland__s-Sustainable-Energy-Supply-Chain-Opportunity.pdf

1 The sustainable energy supply chain opportunity

In line with the 2015 Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC), Ireland and the European Union have set ambitious goals of achieving net zero GHG emissions by 2050. The next decade will be critical to achieving this target. Ireland is committed to achieving a 51% reduction in emissions from 2021 to 2030, and to achieving net-zero emissions no later than 2050.[30]

Meeting this challenge will require fundamental changes to the way in which Ireland generates, distributes and uses energy. A reliable supply of safe, secure and clean energy is essential in order to deliver a phase-out of fossil fuels. By 2030, Ireland aims to increase its reliance on renewables in electricity generation to 80% adding 9 GW of onshore wind capacity, 5 GW of offshore wind capacity and 8 GW of solar PV capacity.[31]

Ireland will need to facilitate the increased electrification of heat and transport, which will create rapid growth in demand for electricity that must be planned and delivered in a timely and cost-effective way. Steps will be required to ensure energy is used more efficiently, for example, through energy efficient construction and smart buildings and homes.

The rapid decarbonisation of Ireland's energy system presents both challenges and opportunities. Achieving net zero will require significant investment in sustainable energy technologies. By leveraging its strengths in business, services, industry and manufacturing, Ireland can generate economic value and create quality jobs, benefiting both sustainability and the economy.

The International Renewable Energy Agency's (IRENA) Transforming Energy Scenario (TES) highlights that a global cumulative investment of $150 trillion is required to realise the 1.5°C target by 2050. [32] Thus indicating that a scale up of investments is required across all sectors for the remainder of this decade.

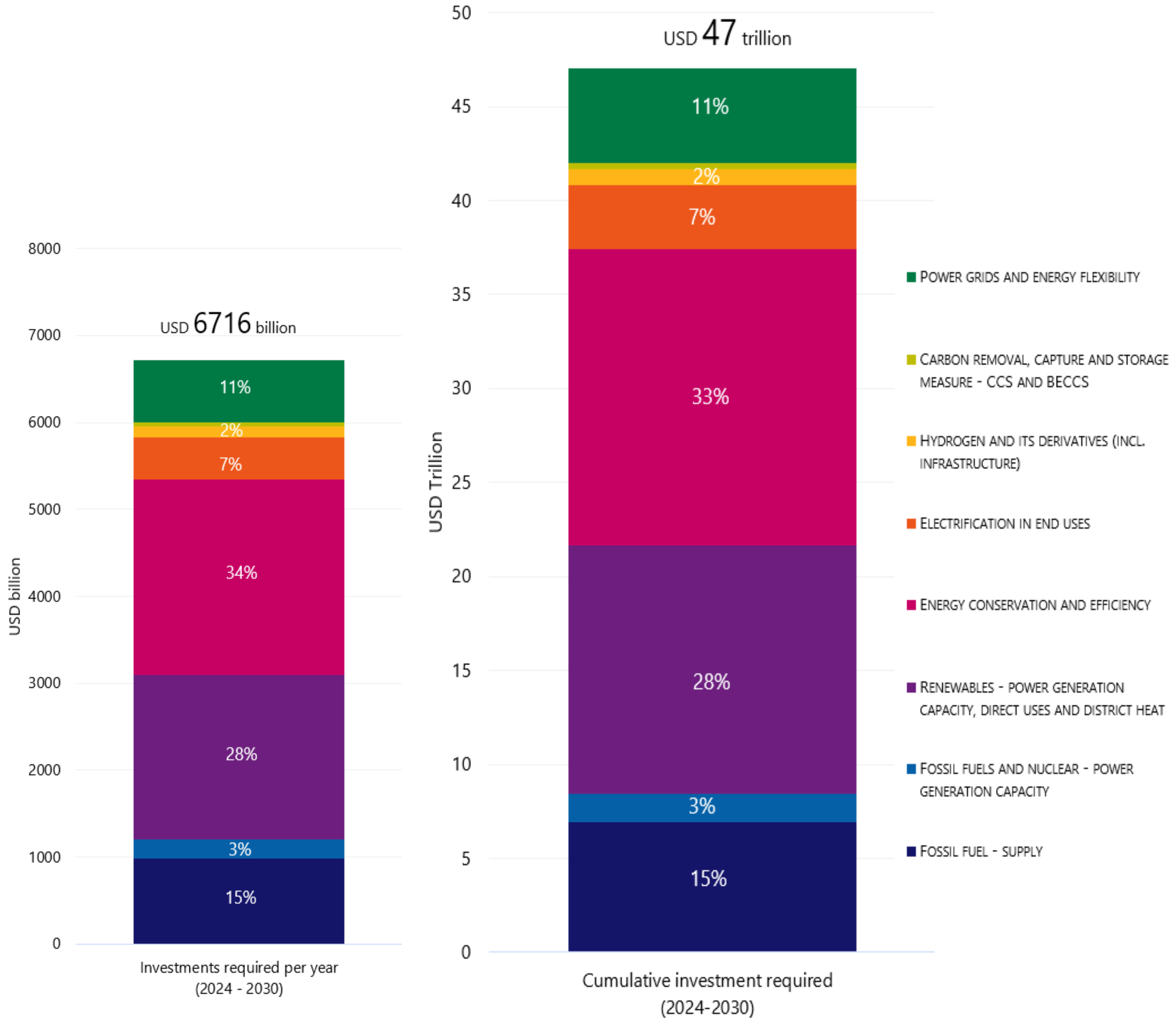
The recent IRENA study further suggests that under the 1.5°C Scenario, cumulative investment across the entire global energy system would need to reach $47 trillion by 2030, averaging over $6.7 trillion in annual terms. Figure 2 breaks this investment down by technological area.[33]

As an attractive place for foreign companies to do business and a member of the EU common market, Ireland could contribute to Europe's growing demand for sustainable energy technology, particularly, high value-added specialist products and services. Building a strong local market in Ireland can help create a springboard for export to wider markets by showcasing Irish products and services and enabling companies to establish revenue streams.

This report examines in detail how well the Irish supply chain is positioned to capture new business as a result of the anticipated investment in the sustainable energy related products and services.

[30] Pg 24, Government of Ireland (2024), '*Climate Action Plan 2024*', DECC, https://assets.gov.ie/296414/7a06bae1-4c1c-4cdc-ac36-978e3119362e.pdf
[31] Pg 161, ibid.
[32] Pg 146, International Renewable Energy Agency (IRENA) (2023), '*World Energy Transitions Outlook 2023: 1.5°C Pathway, IRENA*', https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2023/Jun/IRENA_World_energy_transitions_outlook_2023.pdf
[33] Based on figure S2 on Pg 19, IRENA (2024), '*World Energy Transitions Outlook 2024: 1.5°C Pathway, IRENA*' https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Nov/IRENA_World_energy_transitions_outlook_2024.pdf

Figure 2: Global annual and cumulative investment by technological avenue: 1.5°C Scenario 2024 -2030 ($trillion)



Source: IRENA (2024), World Energy Transitions Outlook 2024: 1.5°C Pathway
Note: BECCS = bioenergy, carbon capture and storage; CCS = carbon capture and storage.

1.1 Approach to supply chain mapping and analysis

A systematic approach was used to map the supply chains of key sustainable energy technologies in Ireland, and identify areas where Irish enterprises could capture a share of the expanding market. Initially, a longlist of 32 sustainable energy technologies was developed, that will be critical to decarbonising the energy system globally.[34] Energy policy and market developments in Ireland, the UK, the EU and worldwide were examined, including evolving policy frameworks; levels of investment in research, development and demonstration (RD&D). Estimates of the Global, EU, UK and Irish market size in 2030 and 2050 were also examined. A shortlist of technologies was then derived through a survey and a workshop with experts from the Irish energy sector who used a multi-criteria assessment approach to rank each longlisted technology against both decarbonisation potential and enterprise goals.

The shortlist of 13 technologies identified and the five technology areas include:

- **Renewable electricity generation:** (1) Onshore wind, (2) Solar photovoltaics (PV), (3) Offshore renewable energy including offshore wind and wave energy,[35] (4) Microgeneration including small-scale wind, micro hydro and rooftop solar PV.
- **Energy storage and grid balancing technologies:** (5) Smart grids including transmission technology, grid forming inverters, and grid-scale storage.
- **Low-carbon transport:** (6) Electric vehicles and (7) EV charging stations.
- **Energy in buildings:** (8) Smart buildings and homes including building control, automation and information systems, (9) Energy efficient construction including building shells, insulation, glazing, windows, etc., (10) Sustainable biomass heating including wood chips/pellets, and (11) District heating.
- **Energy in industry:** (12) Electrification of industrial processes including heat pumps, and (13) Biomass anaerobic digestion.

Models of the supply chains for the technologies were created, breaking them down to their main components and service levels. These dynamic models calculated the relative contribution of research and development, planning, design, manufacturing, installation and operation to the overall value chain. A detailed assessment of the potential for fixed offshore wind, floating offshore wind and wave energy to contribute to Ireland's decarbonised electricity system has been captured in the Offshore Renewable Energy Technology roadmap.[36]

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[34] The technology areas and the longlist of 32 sustainable energy technologies considered include:

- **Renewable electricity generation** – (1) Onshore wind, (2) Offshore wind, (3) Tidal, (4) Wave, (5) Geothermal, (6) Biomass power generation, (7) Solar PV (rooftop and ground-mounted), (8) Micrgeneration
- **Energy Storage, and grid balancing technologies** – (9) Smart grids/transmission tech, (10) Demand response, (11) Hydrogen, (12) Batteries, (13) Vehicles to grid systems
- **Low-carbon Transport** – (14) EVs and EV components, (15) EV charging stations, (16) Biofuels, (17) Hydrogen vehicles, (18) Hydrogen refueling stations, (19) Other LEVs (CNG, LNG)
- **Energy efficient buildings** – (20) District heating, (21) Heat pumps, (22) Alternative renewable heat (AD, biomass, solar thermal), (23) Smart buildings and homes, (24) Energy efficient appliances, (25) Building control, automation and information systems, (26) Energy efficient construction
- **Energy efficient industry** – (27) Use of low-carbon hydrogen, (28) Biomass AD, (29) Biomass CHP, (30) Waste and other alternative fuels for process heating, (31) Industrial heat pumps, (32) CCUS

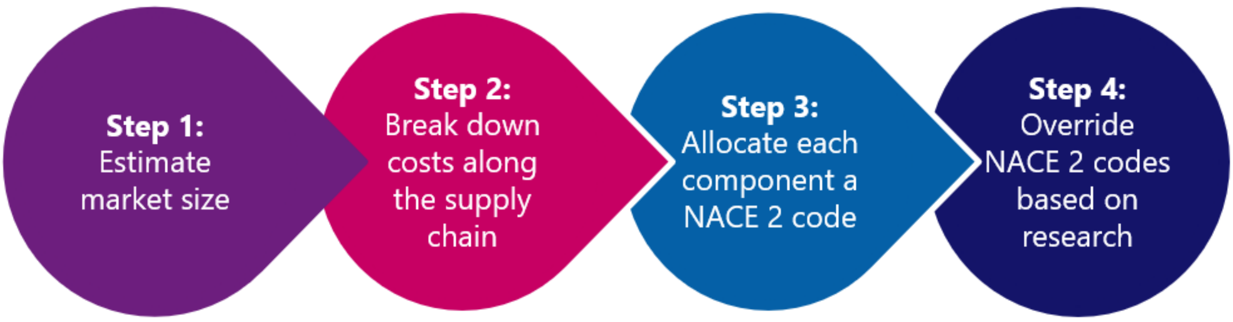
[35] For offshore renewable energy (offshore wind and wave) detailed supply chain analysis can be found in the Offshore Renewable Energy Roadmap. https://www.seai.ie/sites/default/files/publications/ORE-Technology-Roadmap.pdf

[36] SEAI (2024),'Offshore Renewable Energy Technology Roadmap,' https://www.seai.ie/sites/default/files/publications/ORE-Technology-Roadmap.pdf

There were 4 key steps required for building the supply chain models, detailed below and shown in Figure 3:

- **Step 1:** Total market sizes are estimated for each technology first to provide a total estimated range of annual investment for the technology in 2030.
- **Step 2:** Technologies are then broken down into the constituent components required in each of the project stages, such as equipment and services, and then given a percentage of the total project costs.
- **Step 3:** Each component is then given a NACE 2 code[37] to ascertain what percentage of the component can be supplied by Irish businesses. The NACE 2 codes have been modelled using the latest Input-Output tables produced by the Central Statistics Office and calculating the import intensity for each sub-sector. Using this information, components and services were assessed to find which are likely to be domestically sourced or imported, and the potential Irish share of EU and Global markets.
- **Step 4:** Finally, if any research showed contradicting evidence for the potential of the Irish economy to supply a specific component in any of the market geographies then the NACE 2 code can be overridden with a manual figure.

Figure 3: Four steps for producing the supply chain models



The supply chain maps produced by the models are featured in Appendix 1 and Appendix 2 of this report. A colour system is used to indicate the estimated potential Irish share of the 2030 domestic, EU and global markets for each component and service of the technology supply chains.

As shown in table 1,[38] the estimated share is based primarily on the existing position of Irish enterprises in different classes of economic activities (i.e. NACE 2 codes), which has been estimated using economic data from Ireland's Central Statistics Office (2022) and the World Input Output Database (2016).

[37] Nomenclature des Activités Économiques dans la Communauté Européenne - it stands for the Statistical Classification of Economic Activities in the European Community and is the standard system used in the European Union for classifying business activity. NACE codes are divided into sectors, such as retail, manufacturing, services etc.

[38] Note: Some data in the tables in this report may add up to less/more than 100% due to the rounding of numbers.

Table 1: Colour key indicating Ireland's potential % market share of the Irish, EU and Global markets

Specific Capacity	*% Ireland Market Share*	*% EU Market Share*	*% Global Market Share*
1. No local supply chain	<= 20%	<0.5%	<0.2%
2. Less well positioned	>20 - 40%	0.5 - 1%	0.2 - 0.5%
3. Averagely positioned	>40 - 60%	>1 - 2%	>0.5 - 1%
4. Well positioned	>60 - 80%	>2 - 5%	>1 - 2.5%
5. Very well positioned	>80 - 100%	>5%	>2.5%

The data provided by the CSO and World Input Output Databases are not technology specific. For example, the CSO provides the average import intensity in Ireland for engineering services in general, but not for engineering specific to district heating. These generic figures were used as default estimates of potential Irish market shares based on the assumption that Ireland's ability to capture markets for emerging technologies in 2030 will depend on the skill sets and types of businesses that exist in Ireland today. Where more specific data on the presence of Irish suppliers in different markets was available, the project team was able to override the default share allocated to Irish enterprises. The estimates of 2030 market sizes are based on new deployment of the key technologies. The markets are split into upfront capital expenditures and operating and maintenance (O&M) costs. The O&M costs are based on a percentage of the total capital expenditure between 2020 and 2030.

This report primarily focuses on potential market size and value, reflecting the significant growth anticipated in the global supply chain management sector. It does not capture the Irish sectors' ability to respond to this market potential or extend focus to other economic indicators. Therefore, it is imperative to recognise the need for discourse around Gross Value Added (GVA)[39] and the potential quality of jobs created within the sector. By fostering dialogue around these aspects, stakeholders can gain deeper insights into the broader benefits and challenges associated with supply chain development in Ireland.

1.2 Structure of the report

This report is structured around five technology areas: Chapter 2 – Renewable electricity generation, Chapter 3 – Energy storage and grid balancing, Chapter 4 – Low carbon transport; Chapter 5 – Energy in buildings and Chapter 6 – Energy in industry. Each of these sections begins with an introduction to the current and forecast markets, followed by a breakdown of the supply chains and Ireland's competitive position for the relevant shortlisted technologies. Chapter 7 and 8 highlight key findings and conclude with a discussion of the sector and technology areas where the Irish economy shows potential for Ireland to secure investment in sustainable energy technologies and the next steps.

[39] Gross Value Added (GVA) is the value that producers have added to the goods and services they have bought. When they sell their wares, producers' income should be more than their costs, and the difference between the two is the value they have added. https://www.cso.ie/en/interactivezone/statisticsexplained/nationalaccountsexplained/grossvalueadded/

2 Renewable electricity generation

Electricity generation was responsible for 23% of Ireland's energy-related carbon dioxide (CO_{2eq}) emissions in 2023[40] and accounts for 22.4% of final energy consumption.[41] Ireland's energy system still relies on large amounts of fossil fuels to generate electricity, primarily natural gas.[42]

Efforts to mitigate climate change in Ireland and globally are underpinned by a rapid shift to renewable electricity supply. IRENA presents the latest cost trends which observe that the global annual fuel savings in the electricity sector have seen a substantial increase between 2010 and 2023 with the deployment of new renewable power generation. The trends further highlight growth in adoption of proven technologies such as utility-scale solar photovoltaics (PV) and onshore wind, reflecting a growing commitment to sustainable energy solutions.[43] A recent IRENA report also suggests that these technologies are becoming increasingly integral to the energy landscape, with substantial investments being directed towards their development.[44] Additionally, emerging renewable technologies are anticipated to play a crucial role in the future energy mix as innovation continues to advance their capabilities and applications.

Currently, China dominates the global renewable electricity market, with nearly triple the installed capacity of the USA, the next biggest market (figure 4).[45] China also had the largest share of renewable energy related patent filings in the power industry in Q3 2024. [46]

Figure 4: Installed capacity (GW) by country in 2023

Source: Statista (2023), Renewable energy capacity worldwide by country 2023

While China may be the frontrunner, the transition to renewable electricity will be widespread. The European Union's Net-Zero Industry Act (NZIA) was adopted in 2023 and aims to enhance local manufacturing capabilities for clean technologies in the EU and reduce dependency on external suppliers, thereby fostering a more resilient and competitive renewable energy sector within Europe.[47]

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[40] Table 7.1, SEAI (2024), '*Energy in Ireland*' https://www.seai.ie/sites/default/files/publications/energy-in-ireland-2024.pdf
[41] Pg 73, Ibid.
[42] Pg 27, Ibid.
[43] Page 55, Figure 1.16, IRENA (2024), *'Renewable Power Generation Costs in 2023'*, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Sep/IRENA_Renewable_power_generation_costs_in_2023.pdf
[44] Page 18, *IRENA (2024), 'IRENA World Energy Transitions Outlook 2024*, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Nov/IRENA_World_energy_transitions_outlook_2024.pdf
[45] Statista (2023), '*Renewable energy capacity worldwide by country 2023*', https://www.statista.com/statistics/267233/renewable-energy-capacity-worldwide-by-country/
[46]Power Technology (2024), '*Renewable energy related patent activity in the power industry*', https://www.power-technology.com/dashboards/patents/patent-activity-renewableenergy-power-industry/
[47] European commission (2024), '*Net-Zero Industry Act explained*' https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/green-deal-industrial-plan/net-zero-industry-act_en

A total of 148 countries have included quantifiable renewable energy targets to their current Nationally Determined Contributions (NDCs) to the UNFCCC, but only 12 countries had committed to a percentage of renewables in their overall energy mixes. A recent IRENA study analyses the renewable energy targets in the NDCs, their level of ambition with regard to the 1.5°C Scenario and calls for tripling renewables globally by 2030.[48] Meeting the climate targets will require large increases in renewable power investment at all scales. While $2.6 trillion of energy transition investments in 2023 was a record, it falls significantly short of what is required. IRENA has estimated that $47 trillion needs to be invested by 2030 to meet the 1.5°C target, requiring annual investments of over $6.7 trillion globally.[49]

In Ireland, the 2024 CAP commits to an ambitious target of achieving 80% of electricity demand from renewable sources by 2030. Some of the key supports and initiatives that are driving the efforts to meet this target include Renewable Electricity Support Scheme (RESS),[50] Offshore Renewable Electricity Support Scheme (ORESS),[51] Micro-generation Support Scheme (MSS),[52] and Small-Scale Renewable Electricity Support Scheme (SRESS).[53] Additionally, there is the establishment of an Accelerating Renewable Electricity (ARE) Taskforce, and its working groups and implementation plan can be seen as central to defining and achieving milestones to deliver the country's 2030 renewable energy target.[54]

This section maps the supply chains for renewable electricity technologies that are expected to play a central role in the decarbonisation of Ireland's energy system i.e. onshore wind, solar photovoltaics (PV), and microgeneration (including small-scale wind, micro hydro and rooftop solar PV). For each, it discusses Ireland's competitive position along the supply chains. Offshore renewable energy (ORE) is discussed in Section 2.4 but more in-depth analysis of the supply chains for these technologies has been carried out in the SEAI ORE Technology Roadmap.[55]

2.1 Onshore wind

Onshore wind will be a key technology for Ireland to achieve its target of providing 80% of total electricity from renewable technologies by 2030, and to meet its decarbonisation targets by 2050. In 2023, the cumulative global wind power capacity exceeded the 1-terawatt (TW) milestone, with a year-on-year increase of 13%. Global installed onshore wind capacity surpassed the 100GW mark for new capacity installed worldwide within a single year the first time, with a year-on-year growth rate of 54%. Offshore wind installations also performed strongly, reaching a total of 10.8GW of new offshore wind commissioned in 2023 resulting in a total global offshore wind capacity to 75.2 GW.[56] A revised forecast of 107 GW for total wind power capacity additions for the period between 2024 and 2030 has been made which indicates year-on-year growth of 10%.[57]

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[48] Pg 14, IRENA (2023), '*NDCs and renewable energy targets in 2023: Tripling renewable power by 2030*', https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Jan/IRENA_NDCs_renewable_energy_targets_2023.pdf
[49] Pg 19, International Renewable Energy Agency (IRENA) (2024), '*World Energy Transitions Outlook 2024: 1.5°C Pathway, IRENA*' https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Nov/IRENA_World_energy_transitions_outlook_2024.pdf
[50] Government of Ireland (2024), *'Renewable Electricity Support Scheme (RESS'),* DECC, https://www.gov.ie/en/publication/36d8d2-renewable-electricity-support-scheme/
[51] Government of Ireland (2024), '*Offshore Renewable Electricity Support Scheme (ORESS)*', DECC, https://www.gov.ie/en/publication/5099a-offshore-renewable-electricity-support-scheme-oress/
[52] Government of Ireland (2023), *'Micro-generation Support Scheme (MSS)'*, DECC, https://www.gov.ie/en/publication/b1fbe-micro-generation/#micro-generation-support-scheme-mss
[53] Government of Ireland (2025), '*Small-Scale Renewable Electricity Support Scheme (SRESS)*', DECC, https://www.gov.ie/en/publication/96110-small-scale-generation/#small-scale-renewable-electricity-support-scheme-sress
[54] Government of Ireland (2024), '*Accelerating Renewable Electricity Taskforce*', DECC, https://www.gov.ie/en/publication/13d00-accelerating-renewable-electricity-taskforce/
[55] SEAI (2024), 'Offshore Renewable Energy Technology Roadmap', https://www.seai.ie/sites/default/files/publications/ORE-Technology-Roadmap.pdf
[56] Pg 14, Pg 148, Global Wind Energy Council (GWEC) (2024), 'Global Wind Report 2024', https://www.gwec.net/reports/globalwindreport
[57] Pg 16, Ibid.

Onshore wind technology is seen as cost competitive to fossil fuel power plants in some parts of the world, with new onshore wind costing less than keeping existing coal plants in operation.[58] Onshore wind is also relatively quick to install, potentially possible to be implemented in a matter of months. Ireland generates a higher proportion of its electricity from onshore wind than most other EU countries.[59] In 2023, wind generation provided 33.7% of electricity supply in Ireland and saw a 4.5% growth in Ireland's wind capacity to 4.74 GW compared to the previous year. [60]

Ireland's CAP aims to nearly double the country's onshore wind capacity with a target of 9 GW installed capacity by 2030. Over the last 10-years, Ireland has added wind capacity at an average rate of 0.28 GW per annum, although this has dropped in recent years. Achieving the ambitious CAP targets would require approximately 0.6 GW of new capacity to be added each year.[61] With this level of added capacity, the market for onshore wind in Ireland is expected to remain strong. The findings of this study indicate that onshore wind represents an economic opportunity for Ireland. However, it is important to view the estimated economic benefits in light of the challenges posed by onshore spatial planning barriers[62] and local community acceptance.[63] Addressing these planning issues is crucial to fully realising the opportunities presented by onshore wind energy in Ireland. Furthermore, supportive policies on onshore spatial planning are necessary in order to maintain a strong onshore wind market in Ireland and to reach the estimated market value highlighted in the summary of findings.

Onshore Spatial Planning: Despite progress in renewable energy development, Ireland still faces barriers in onshore spatial planning. Some of the challenges are (i) a need for alignment between county development plans and national policy, (ii) approval rates for new wind projects and (ii) the dependence on imported fossil fuels. To address these barriers, the Irish government has implemented several supportive policies. The Accelerating Renewable Electricity Taskforce (ARET) focuses on key areas such as (i) route to market, (ii) grid development, and (iii) planning, to accelerate onshore renewable electricity deployment. Regional renewable electricity capacity allocations have been included in the updated draft of the National Planning Framework, and the recent enactment of the Planning and Development Act 2024 aims to reduce planning delays and ensure a strong pipeline of renewable projects.

Although progress has been made, given the ongoing challenges, there is a need for stronger policy support to maintain and repower existing renewable energy generation. Thus, ensuring alignment between national and local planning policies, addressing grid connection bottlenecks, providing clear guidance to the planning system, and in-turn, enabling a strong pipeline of renewable projects into the future.

As part of the supply chain analysis, the market size for onshore wind in Ireland, the EU and globally was estimated to provide a total estimated range of annual investments for the technology in 2030. The potential Irish share, or the ability of Irish enterprises to capture the domestic and EU markets, was then calculated. The approach and methodology have been detailed in chapter 1.1 and a summary of findings has been presented in the following section.

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[58] Pg 59, IRENA (2024), '*Renewable Power Generation Costs in 2023*', https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Sep/IRENA_Renewable_power_generation_costs_in_2023.pdf

[59] Pg 85, REN21 (2024), 'Renewables 2024 – Global Status Report', https://www.ren21.net/wp-content/uploads/2019/05/GSR2024_Supply.pdf

[60] Pg 29, SEAI (2024), '*Energy in Ireland*' https://www.seai.ie/sites/default/files/publications/energy-in-ireland-2024.pdf

[61] This has been calculated based on the data in Pg 10. Table 1, Eirgrid (2024), '*Annual Renewable Constraint and Curtailment Report 2023*' https://cms.eirgrid.ie/sites/default/files/publications/Annual-Renewable-Constraint-and-Curtailment-Report-2023-V1.0.pdf

[62] Pg 2, Wind Energy Ireland (2024), *'Repowering Ireland: How we stay global leaders in onshore wind energy,'* https://windenergyireland.com/images/files/final-repowering-ireland-report-june-2024.pdf

[63] Pg 4, UCC, *'Community Engagement in Wind Energy: Innovative approaches to achieving a social license to operate (CoWind)'* https://www.ucc.ie/en/media/research/environmentalresearchinstitute/documents/CommunityEngagementinWindEnergy.pdf

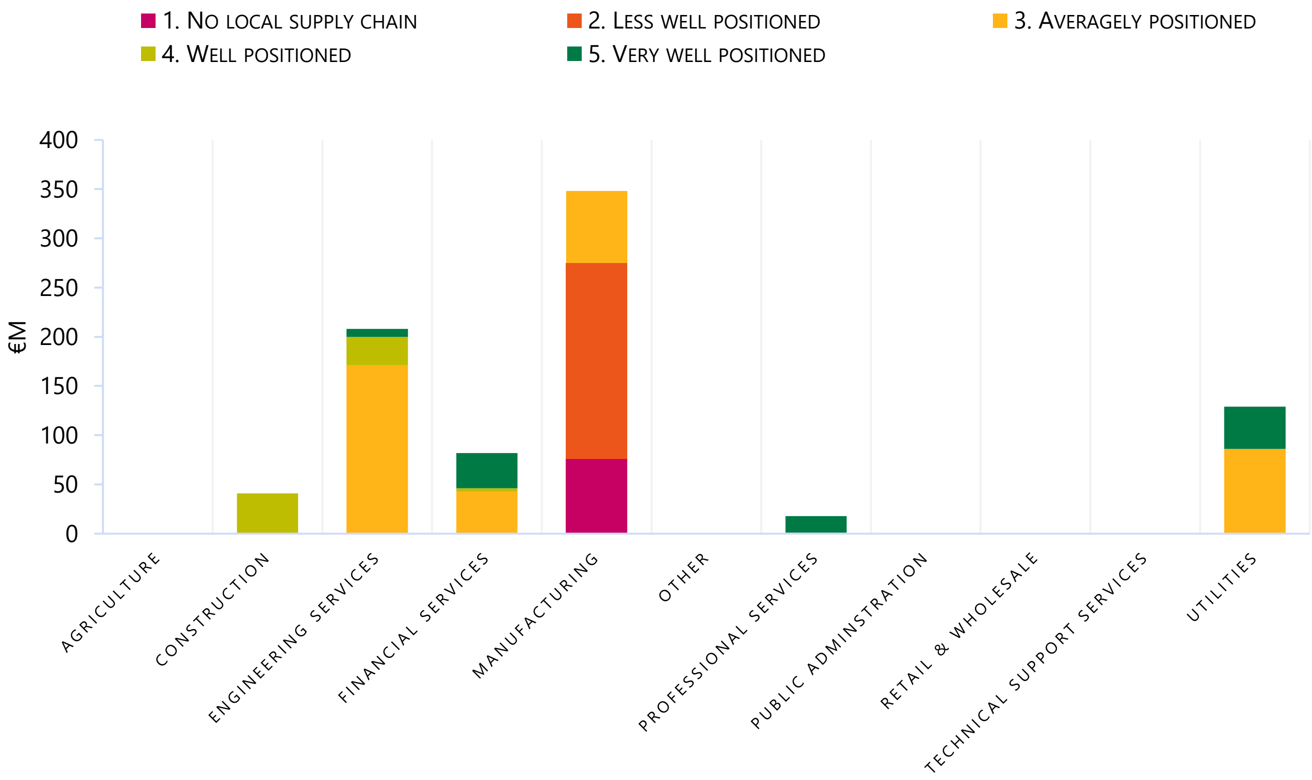
Summary of Findings: Onshore wind represents a large economic opportunity for Ireland. As seen in table 2, the estimated total value of the Irish onshore wind market in 2030 is €827 million. Irish enterprise could potentially supply an estimated 48% of the total domestic market for onshore wind in 2030, or €400 million, in accordance with the analysis carried out.

Table 2: Market size in 2030 and Irish Share for onshore wind in Ireland and EU-27+UK

Capacity	Irish Market		EU-27+UK Market	
	Market Size (M€)	Irish Share (M€)	Market Size (M€)	Irish Share (M€)
1. No local supply chain	76	8	11,412	29
2. Less well positioned	199	60	133	1
3. Averagely positioned	373	186	0	0
4. Well positioned	74	52	0	0
5. Very well positioned	105	95	0	0
Total	**827**	**400**	**11,545**	**30**

Figure 5 breaks down the €827 million of estimated total value of Irish onshore wind market by sector. It further highlights how Irish enterprises are positioned to capture the domestic market for onshore wind in 2030.

Figure 5: Market size by sector in 2030 for onshore wind for the Irish Market



Source: SEAI Supply Chain Analysis

A model supply chain for onshore wind was created to break down costs along the supply chain and ascertain the equipment and services that are likely to be domestically sourced. This has been presented in Appendix 1 (Fig 29) and Appendix 2 (Fig 41) and the key findings for this technology have been summarised below.

Manufacturing and supply of materials accounts for the largest share of capital costs, 70.1%. Irish companies are not strongly positioned to supply the tower, blades, gear box or the components required for the electrical generation and conversion.

Irish companies are well positioned or very well positioned to supply other services for feasibility studies, planning & permitting, design, installation and commissioning of onshore wind farms, including environmental consulting, legal and financial advisory services, electrical engineering, and civil engineering, among others. However, these services represent a much smaller portion of the overall market.

Data on the decommissioning costs of onshore wind plants is scarce and as such has not been included in the analysis. It is predicted that there will be more decommissioning cost data in the coming decade as more plants start to reach the end of their operation.

Overall, the domestic onshore wind market presents an opportunity for growth driven by increasing demand for renewable energy and the government's commitment to sustainable practices. However, it must be noted that Irish enterprises are not as competitively positioned to compete in the broader EU and global markets. In 2030, Irish companies could potentially supply an estimated 0.3% of the total EU market for new deployment onshore wind.

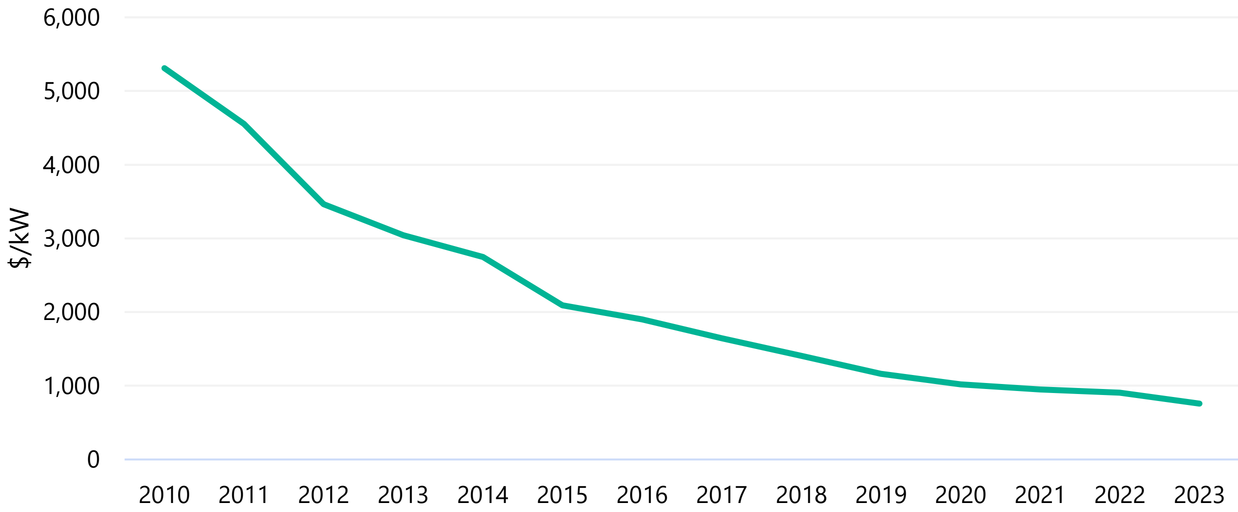
2.2 Solar PV

Globally, solar photovoltaic (PV) is one of the most important technologies in the transition to renewable electricity generation.[64] The cost declines experienced by solar power from 2010 to 2023 represent a remarkable rate of cost deflation, in many countries. Technological improvements, reduced O&M costs and increased module efficiency have contributed to considerably reduced installed costs.[65] The cost of crystalline solar PV modules sold in Europe declined by over 90% from the end of 2009 to the end of 2023.[66] Inverter costs also declined, although the rate of cost decline is lower than for module costs.[67]

Figure 6 captures the global weighted average total installed costs for newly commissioned solar PV between 2010 and 2023. It presents the downward trajectory in the costs associated with solar PV over the period analysed.[68]

[64] Note, in this "Solar PV" section we consider only ground-mounted, utility-scale installations. Residential, rooftop PV installations are encompassed in the "Microgeneration" sector.
[65]Pg 51, IRENA (2024), '*Renewable Power Generation Costs in 2023*' https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Sep/IRENA_Renewable_power_generation_costs_in_2023.pdf
[66]Pg 81, Ibid.
[67] Pg 101, Ibid.
[68] Created from figure 1.5 on page 38 of IRENA (2024), 'Renewable Power Generation Costs in 2023', https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Sep/IRENA_Renewable_power_generation_costs_in_2023.pdf

Figure 6: Global weighted-average total installed costs from newly commissioned solar PV 2010-2023



Source: IRENA (2024), Renewable Power Generation Costs in 2023

The IEA is forecasting that utility-scale and distributed solar PV growth is expected to more than triple by 2030, accounting for almost 80% of renewable electricity expansion worldwide.[69] Utility-scale solar installations were competitive with fossil fuels in most countries by 2023.[70] Utility scale solar power systems continue to dominate the solar market, but rooftop solar is growing rapidly.[71] Europe installed a record 65.5 GW of new solar PV capacity in 2024. However, growth is expected to slow in the coming years as the market faces challenges such as grid capacity availability.[72]

Recent studies have suggested that Ireland's solar power sector is set for considerable growth.[73] As of 2024, Ireland has 1,185 MW (1.1 GW) of solar PV generation connected to its electricity network. With over 600 MW (0.6 GW) of utility-scale solar connected to the grid, Ireland reflects substantial progress in expanding solar power infrastructure. [74] Looking ahead, the Irish government has set an ambitious target of 5.5 GW of utility-scale solar PV by 2030 as part of its overall 8 GW solar PV goal.[75]

As part of the supply chain analysis, the market size for solar PV in Ireland, the EU and globally was estimated to provide a total estimated range of annual investments for the technology in 2030. The potential Irish share, or the ability of Irish enterprises to capture the domestic and EU markets, was then calculated. The approach and methodology have been detailed in chapter 1.1 and a summary of findings has been presented in the following section.

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[69] Pg 33, IEA (2024), '*Renewables 2024 – Analysis and forecast to 2030*' https://iea.blob.core.windows.net/assets/17033b62-07a5-4144-8dd0-651cdb6caa24/Renewables2024.pdf
[70] Pg 46, *IRENA (2024), 'Renewable Power Generation Costs in 2023'* https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Sep/IRENA_Renewable_power_generation_costs_in_2023.pdf
[71] IEA (2024), '*Solar PV power capacity in the Net Zero Scenario, 2015-2030*', https://www.iea.org/data-and-statistics/charts/solar-pv-power-capacity-in-the-net-zero-scenario-2015-2030
[72] SolarPower Europe (2024), '*EU Market Outlook for Solar Power 2024 – 2028*', https://www.solarpowereurope.org/insights/outlooks/eu-market-outlook-for-solar-power-2024-2028/detail
[73] ISEA (2024), '*Harnessing Solar Power: Ireland's Bright Future in the Global Market*', https://www.irishsolarenergy.org/post/harnessing-solar-power-ireland-s-bright-future-in-the-global-market
[74] ISEA (2024), '*Scale of solar*', https://www.irishsolarenergy.org/_files/ugd/f7484d_13925c5011d3410e88b0857370b4abd2.pdf
[75] Pg 165, Government of Ireland (2024*), 'Climate Action Plan 2024'*, DECC, https://assets.gov.ie/296414/7a06bae1-4c1c-4cdc-ac36-978e3119362e.pdf

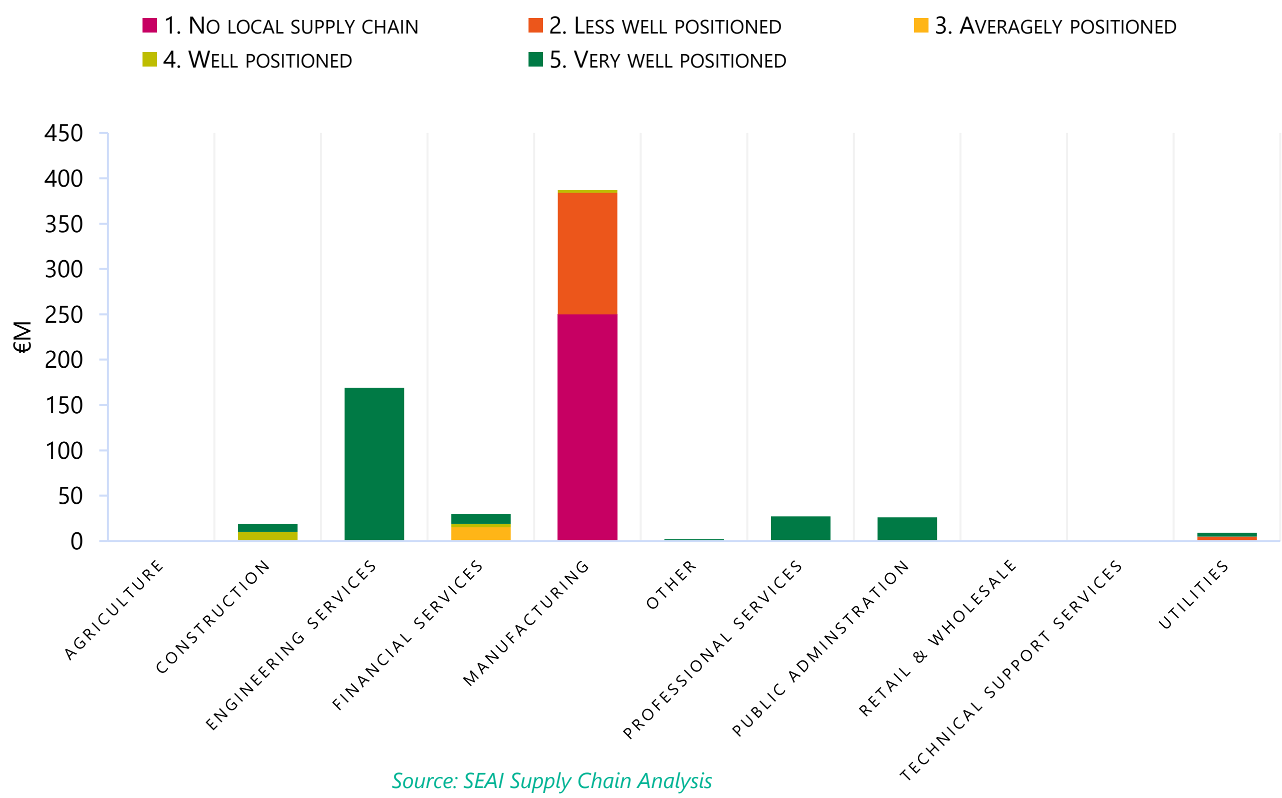
Summary of Findings: The Irish market for the deployment of ground-mounted solar PV is expected to increase. As presented in table 3, the estimated total value of the Irish solar PV market in 2030 is €669 million in 2030. This growth offers a strong opportunity for Irish enterprise, which could potentially capture nearly half the market, or €309 million.

Table 3: Market size in 2030 and Irish Share of utility scale solar PV Ireland and EU-27+UK

Capacity	Irish Market		EU-27+UK Market	
	Market Size (M€)	Irish Share (M€)	Market Size (M€)	Irish Share (M€)
1. No local supply chain	250	25	39,826	101
2. Less well positioned	140	42	7	0
3. Averagely positioned	16	8	0	0
4. Well positioned	17	12	0	0
5. Very well positioned	247	222	0	0
Total	**669**	**309**	**39,883**	**101**

Figure 7 breaks down the €669 million of estimated total value of Irish solar PV market by sector. It further highlights how Irish enterprises are positioned to capture the domestic market for the technology in 2030.

Figure 7: Market size by sector in 2030 for utility scale solar PV for the Irish Market



Source: SEAI Supply Chain Analysis

A model supply chain for solar PV was created to break down costs along the supply chain and ascertain the equipment and services that are likely to be domestically sourced. This has been presented in Appendix 1 (Fig 30) and Appendix 2 (Fig 42) and the key findings for the technology have been summarised below.

Capital expenditures represent the largest portion of the market for the deployment of ground-mounted solar PV. Manufacturing makes up 63.4% of capital costs. Irish enterprise is poorly positioned to capture investment in this area due to the lack of a significant manufacturing base in PV panels, mounting systems, control and instrumentation or other relevant electrical equipment. Several aspects of Irish utility-scale solar PV currently have a strong reliance on overseas providers for key services and components due to their cost competitiveness. However, Irish companies could gain domestic market share in areas related to planning and permitting for ground mounted solar, which makes up 8.0% of capital costs and includes financial, legal and commercial services.

The O&M phase of a PV project typically lasts 20–35 years. O&M costs for utility scale solar PV are expected to equate to 2% of the capital expenditures annually. It is observed that Ireland is well positioned to provide O&M services including maintenance, metering and communications, security services, among others. However, Ireland is less well positioned to capture the market for decommissioning and recycling, which equates to 9.5% of O&M costs. In addition, there is very little opportunity for Irish enterprise to compete in international solar markets.

2.3 Microgeneration

Microgeneration encompasses small-scale energy production technologies. The three microgeneration technologies included for the purpose of this mapping exercise are small-scale wind, rooftop solar photovoltaics (PV) and small hydroelectric (hydro) power.

Small-scale wind: The global small wind power market expected to reach $23.85 billion by 2032, growing from $10.89 billion in 2023 at a compound annual growth rate (CAGR) of 9.1% during 2024-2032.[76] This growth is driven by increasing demand for distributed renewable energy generation and supportive policies in various countries. Small scale wind deployment in Ireland is expected to increase in coming years, given the high wind resource in the country. However, domestic-scale wind turbines are generally only suitable for rural locations.

Rooftop solar photovoltaics (PV): Global deployment of solar PV systems has increased significantly in recent years as a result of supporting policies and falling costs.[77] The total installed costs in the residential rooftop solar PV market are higher than utility-scale solar due to their smaller size, however, as a result of economies of scale, costs have decreased significantly in recent years.

In 2024, the market share for residential rooftop solar in the EU was 20% and the commercial and industrial rooftop market share was 38%.[78] There are circa 60,000 residential homes in Ireland with solar panels on their rooftops[79] and it is recognised that solar can play an important role in Ireland's future energy mix. The deployment of solar technology in Ireland is required to diversify the country's renewable generation portfolio, and the market size is expected to grow as a result.

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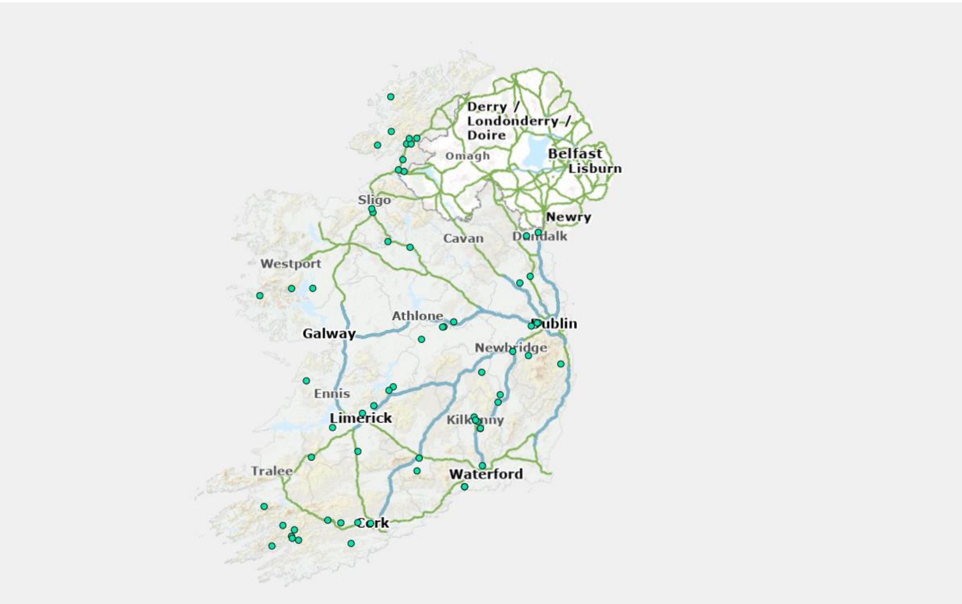
[76] Market Data Forecast (2024), '*Small Wind Market | Size, Share, Growth Report | 2024 to 2032*', https://www.marketdataforecast.com/market-reports/small-wind-market
[77] IEA (2024), '*Solar PV – Latest Findings*' https://www.iea.org/energy-system/renewables/solar-pv
[78] Pg 11, SolarPower Europe (2024), *EU Market Outlook for Solar Power 2024 – 2028*', https://api.solarpowereurope.org/uploads/Solar_Power_Europe_EMO_2024_v1_aea4b6803a.pdf
[79] ISEA (2023), https://www.irishsolarenergy.org/news-1/ireland%27s-solar-revolution

Small hydroelectric (hydro) power: The global small hydropower market size is expected to reach circa $3.2 billion by 2031, rising at a market growth of 3.8% CAGR during the forecast period (2025-2031).[80] Small hydropower, a renewable energy source known for its low environmental impact, has seen substantial growth on a global scale. This global market is expanding steadily, driven by the increasing demand for renewable energy worldwide. Furthermore, several key trends are shaping its future, including technological innovations, favourable government policies, grid integration, the rise of microgrids, and initiatives aimed at rural electrification.[81] The installed capacity of small hydro in Ireland stands at 58.5 MW which is around 80% of the potential capacity in the country.[82]

A recent SEAI initiative to map hydropower across Ireland indicates an increase in small hydro capacity with small-scale hydroelectric producers in Ireland generating a total installed capacity of over 200 MW.[83] Figure 8 presents the connected hydro generators in Ireland as mapped in SEAI's Hydro Atlas.[84]

Figure 8: Hydro Atlas - connected hydro generators in Ireland



Source: SEAI (2024), Hydro Atlas

As part of the supply chain analysis, the market size of microgeneration in Ireland, the EU and globally was estimated to provide a total estimated range of annual investments for the technology in 2030. The potential Irish share, or the ability of Irish enterprises to capture the domestic and EU markets, was then calculated. The approach and methodology have been detailed in chapter 1.1 and a summary of the findings has been presented below.

Summary of Findings: Overall, deployed microgeneration capacity is expected to grow in Ireland, especially with existing supports such as the Microgeneration Support Scheme.[85]

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[80] Global Info Research (2025), '*Global Small Hydropower Supply, Demand and Key Producers, 2024-2030*', https://www.globalinforesearch.com/reports/2338076/small-hydropower
[81] Pg 145, Ibid.
[82] Pg 6, Table 2, UNIDO, ICSHP (2022), '*World Small Hydropower Development Report 2022 – Northern Europe*', https://www.unido.org/sites/default/files/files/2023-08/NORTHERN_EUROPE_2022.pdf
[83] This has been calculated based on the connected hydro generators data in SEAI (2024), *'Hydro Atlas,* https://experience.arcgis.com/experience/89eb4f55bb9c4eecb86be02b47ed7497
[84] Ibid. The SEAI map displays all small-scale hydroelectric producers identified in the 1985 Department of Energy report "Small Scale Hydro Electric Potential of Ireland"
85 Government of Ireland (2023), '*Micro-generation Support Scheme (MSS)*', https://www.gov.ie/en/publication/b1fbe-micro-generation/#micro-generation-support-scheme-mss

However, due to falling costs of wind and solar, the domestic market size for microgeneration is expected to be slightly lower in 2030. As presented in table 4, the domestic market size for microgeneration is estimated at €274 million in 2030. This figure includes €56 million expenditure in O&M costs for the installed base. Ireland could potentially capture more than half of the domestic market for microgeneration.

Table 4: Market size in 2030 and Irish Share for microgeneration in Ireland and EU-27+UK

Capacity	Irish Market		EU-27+UK Market	
	Market Size (M€)	Irish Share (M€)	Market Size (M€)	Irish Share (M€)
1. No local supply chain	61	6	11,375	28
2. Less well positioned	0	0	1,240	10
3. Averagely positioned	19	10	0	0
4. Well positioned	51	35	0	0
5. Very well positioned	143	129	0	0
Total	**274**	**180**	**12,615**	38

Figure 9 breaks down the €274 million of the estimated total value of the Irish microgeneration market by sector. It further highlights how Irish enterprises are positioned to capture the domestic market for onshore wind in 2030.

Figure 9: Market size by sector in 2030 for microgeneration for the Irish Market

Source: SEAI Supply Chain Analysis

A model supply chain for microgeneration was created to break down costs along the supply chain and ascertain the equipment and services that are likely to be domestically sourced. This has been presented in Appendix 1 (Fig 31) and Appendix 2 (Fig 43) and the key findings for the technology have been summarised below.

Manufacturing and materials supply represent nearly half of the capital costs. Although the manufacturing of microgeneration technologies such as solar PVs and inverters is already captured elsewhere, Irish enterprise is well positioned for small hydro (3.3% of the microgeneration capital costs) and the instrumentation and controls for small scale wind (7.8% of the capital costs).

The biggest opportunity for Irish enterprise is in installation and commissioning of microgeneration units: Equipment installers (16.7% of capital costs); Electricians (11.8% of capital costs); Civil engineers (13.2% of capital costs); and Project management (2.1% of capital costs)

Irish companies are also very well positioned to deliver all of the services associated with planning and design of microgeneration installations, which represent 4.7% and 3.6% of the capital costs, respectively. Irish enterprises are either very well or well positioned to deliver all O&M services. Ireland's limited manufacturing base for microgeneration technology, and the local nature of markets for installation and commissioning, means that the export opportunities associated with microgeneration are small and consist mainly of specialist and niche market products.

2.4 Offshore Renewable Energy

Offshore wind is a rapidly growing market, benefitting from continued innovation and higher and more consistent wind speeds than onshore locations. Turbines optimised for offshore are also larger, typically 9.7 MW for those installed in 2023.[86] It is anticipated that the size of offshore turbines will continue to increase. Positioning wind turbines out at sea brings challenges related to securing the base onto the sea floor or exploring floating mounts. The larger equipment size and the more challenging access requirements, mean that the equipment, installation, operation and maintenance costs for offshore wind tend to be higher than the onshore equivalent. Floating foundations anchored to the seabed have the potential to reduce costs, at greater depths, but the technology is nascent. As of 2024, Europe's installed capacity of offshore wind was 35 GW, making up 13% of total wind power capacity installed in the region.[87] Although Ireland has a great deal of potential for offshore power generation, its market remains relatively small with only 25 MW installed capacity as of 2024.[88]

Ireland's updated Climate Action Plan includes an ambitious target of 5 GW installed offshore wind capacity by 2030, an increase on the previously set out ambition of 3.5 GW.[89] As a result, the domestic market for the deployment of offshore wind is expected to grow considerably. The ORESS 1 Final Auction Results were published in 2023, with four out of six projects being successful in the auction.[90] In early 2024, the Government published an indicative roadmap for ORESS 2.1[91] and consulted on the auction design for ORESS 2.1 in mid-2024.[92]

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[86] Pg 96, Global Wind Energy Council (2024), *'Global Offshore wind report'*, https://www.gwec.net/reports/globalofffshorewindreport
[87] WindEurope (2024), *'Latest wind energy data for Europe*, https://windeurope.org/intelligence-platform/product/latest-wind-energy-data-for-europe-autumn-2024/
[88] SEAI (2024), *'Offshore Renewable Energy Technology Roadmap,'* https://www.seai.ie/publications/SEAIMC24005-Executive-Summary-ORE-Roadmap.pdf
[89] Pg 19, Government of Ireland (2024), *'Climate Action Plan 2024'*, DECC, https://assets.gov.ie/296414/7a06bae1-4c1c-4cdc-ac36-978e3119362e.pdf
[90] EirGrid (2023), *'ORESS 1 Final Auction Results'*, ORESS-1-Final-Auction-Results-(OR1FAR).pdf
[91] Government of Ireland (2024), *'ORESS 2.1 Indicative Roadmap'*, DECC, https://assets.gov.ie/277705/e8b1ddf7-7692-477c-a9ed-3c70dd27fe1e.pdf
[92] Government of Ireland (2024), *'Consultation on ORESS 2.1 Auction Design : Draft Terms and Conditions'*, DECC, https://www.gov.ie/en/consultation/6ac43-consultation-on-oress-21-auction-design-draft-terms-and-conditions/

The global offshore wind sector is at a relatively early stage of development and there are opportunities for industry to grow their offering in this sector. Renewable energy solutions have been installed across the country over the past 20 years and Ireland has a well-established maritime industry that has the potential for skills transfer to the offshore wind sector. Thus putting the country in a strong position to scale up and deliver offshore developments.[93]

The SEAI Offshore Renewable Energy Technology Roadmap identifies a number of supply chain areas in which Ireland has an opportunity to capture inward investment, and therefore jobs and economic benefit.[94] These include (i) construction and marshalling ports (both fixed and floating), (ii) tower manufacturing and (iii) synthetic cable manufacturing. The roadmap further highlights that with the expansion of its domestic offshore wind industry, Ireland has the potential to benefit significantly from export opportunities, especially if the above investments are captured.[95]

This underscores the need for a clear pipeline of projects and an attractive environment for investment to build a strong and resilient offshore wind supply chain in Ireland (both domestic and international). In alignment with this vision, a recent report published by the Department of Enterprise, Trade and Employment (DETE) outlines Ireland's Offshore Wind Industrial Strategy.[96] The strategy aims to maximise the number of companies in Ireland working across the offshore wind supply chain, both domestically and across global export markets. It also emphasises the importance of Foreign Direct Investment (FDI) and international supply chain development for Ireland's offshore wind energy sector. Key actions outlined in the strategy are also designed to drive industry engagement in research, development, and innovation for offshore wind, ultimately fostering a thriving ecosystem that supports both domestic growth and international competitiveness.[97]

Global development of wave energy has not progressed at the pace anticipated in previous forecasts. In spite of its considerable potential, electricity generation from wave energy is currently in the demonstration phase, with testing conducted at both individual and scaled levels, typically ranging between TRL 5 to 7.[98] The Market Study on Ocean Energy 2018 from the European Commission observed that most activity in wave energy to date has been in Europe.[99] In 2023, Europe continued to lead the world in ocean energy deployments, with significant progress made in both wave and tidal energy sectors. However, other regions like the USA and China are also making notable advancements. Europe's ocean energy pipeline includes 137 MW of tidal and wave energy projects expected to seek deployment in the next five years, underpinned by EU funding and national revenue support. So far, 30.5 MW of tidal stream technology and 13.3 MW of wave energy have been deployed in Europe since 2010.[100] Furthermore, annual wave installations in Europe rose to 595 kW in 2023,[101] up from 46 kW in 2022.[102]

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[93] IDA (2024), '*Grasping the Renewable Energy Opportunity for Ireland*', https://www.idaireland.com/latest-news/insights/renewable-energy-opportunity-for-ireland
[94] Pg 5, SEAI (2024), '*Offshore Renewable Energy Technology Roadmap – Executive Summary*,' https://www.seai.ie/publications/SEAIMC24005-Executive-Summary-ORE-Roadmap.pdf
[95] For more information and a detailed analysis refer to the roadmap on SEAI's website here.
[96] Government of Ireland (2024), *'Powering Prosperity: Ireland's Offshore Wind Industrial Strategy'* , DETE, https://enterprise.gov.ie/en/publications/publication-files/powering-prosperity.pdf
[97] Appendix A, Table of Actions, ibid.
[98] Pg 53 and 54, SEAI (2024), *'Offshore Renewable Energy Technology Roadmap'*, https://www.seai.ie/sites/default/files/publications/ORE-Technology-Roadmap.pdf
[99] Pg 13, European Commission (2018), '*Market Study on Ocean Energy*', Publications Office of the EU, https://op.europa.eu/en/publication-detail/-/publication/e38ea9ce-74ff-11e8-9483-01aa75ed71a1
[100] Pg 6, Ocean Energy Europe (2024), '*Ocean Energy Stats & Trends 2023*', https://www.oceanenergy-europe.eu/wp-content/uploads/2024/05/Ocean-Energy-Stats-and-Trends-2023.pdf
[101] Ibid
[102] Pg 3, Ocean Energy Europe (2023), '*Ocean Energy Stats & Trends 2022*', https://www.oceanenergy-europe.eu/wp-content/uploads/2023/03/Ocean-Energy-Key-Trends-and-Statistics-2022.pdf

Ireland aims to have a national suite of infrastructural facilities to enable technology development and progression towards commercial viability. This includes:

- A small-scale site including state-of-the-art wave tanks comprising of a deepwater basin and wave test tanks, that allow for scaled testing in a controlled environment, addressing TRL (Technology Readiness Level[103]) 1-4, located at the Lir National Ocean Test facility in Cork.
- An intermediate scale site, for marine energy and monitoring technology, addressing projects at TRL4-6 stage, formerly located at the SmartBay ocean test site in Galway Bay.[104]
- A large scale site for the full-scale testing of Marine Energy devices in their final stages of pre-commercial development, TRL 7-9, this is intended to be located at the AMETS (Atlantic Marine Energy Test Site) off the Mayo coast.

Ireland is well placed for wave energy. The Offshore Renewable Energy Technology Roadmap has assessed the potential for wave energy to play a role in Ireland's decarbonised electricity system. This roadmap recognises that wave energy could play a role in meeting Ireland's offshore renewable energy ambition, if sufficient progression in technology readiness and price reduction is achieved.[105] However, the roadmap also raises concerns regarding the competitiveness of wave energy compared to fixed and floating offshore wind technologies. It remains uncertain whether wave energy can compete on price or deliver enough additional benefits to justify any potential price premium. Realising this potential will likely require substantial investment in research and development, with no guarantee of success at this stage.[106]

In summary, Ireland has the opportunity to benefit significantly from the rollout of Offshore Renewable Energy.[107] The SEAI ORE Technology Roadmap highlights the various supply chain and local economic benefits as well as identifying 50 recommendations for Ireland to drive forward deployment of ORE, maximising the domestic economic benefit of this effort and ensuring ORE deployment is supported by the Irish research and development sector.

[103] Technology Readiness Levels (TRLs) are a method for understanding the technical maturity of a technology during its acquisition phase. Systematic addressing of TRLs is required, allowing a technology to evolve from conception through to research, development and deployment. The following are the three levels of TRLs:

- Deployment ready (TRL 9) – Actual system proven in operational environment.
- Demonstration (TRL 7-8) – System prototype demonstration in an operational environment and qualified.
- Research and Development (TRL 1-6) – Basic scientific research to prototype demonstration in a relevant environment.

[104] The Foreshore Lease for the SmartBay ocean energy test site in Galway Bay was successfully challenged by way of a Judicial Review in the High Court 2024. The subsequent Order of the High Court quashing the foreshore lease has resulted in the permanent closure of the SmartBay test site. There are now consultations with stakeholders to determine the next steps in supporting intermediate-scale marine renewable energy activities in Ireland.

[105] Pg 78, SEAI (2024), 'Offshore Renewable Energy Technology Roadmap' https://www.seai.ie/sites/default/files/publications/ORE-Technology-Roadmap.pdf

[106] Pg 4, SEAI (2024), '*Offshore Renewable Energy Technology Roadmap – Executive Summary*,' https://www.seai.ie/sites/default/files/publications/SEAIMC24005-Executive-Summary-ORE-Roadmap.pdf

[107] For more information and a detailed analysis refer to the roadmap on SEAI's website here.

3 Energy storage and grid balancing

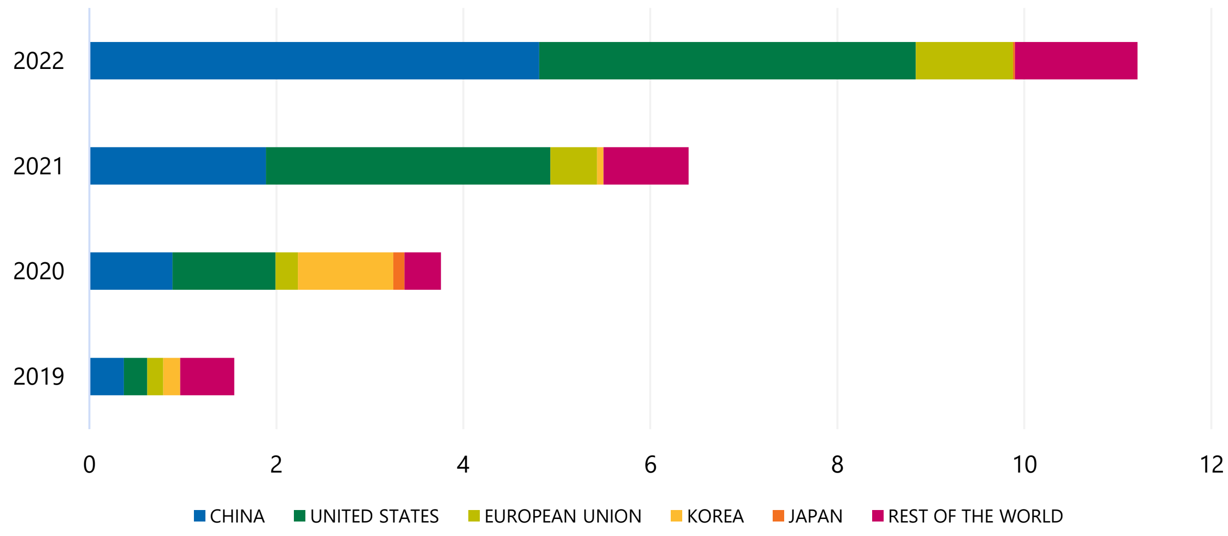
Grid flexibility is critical to the large-scale roll out of variable renewables. In traditional power systems, large-scale and centralised generators provide a unidirectional supply of electricity that can be scaled up or down to match demand. Renewable power plants, in contrast, tend to be relatively small and decentralised. Some renewable resources are 'variable', for example, only supplying electricity on windy or sunny days.

The variability of renewable energy creates significant technical challenges in balancing electricity supply with demand. Electricity systems based on high levels of renewable energy supply must be more sophisticated to balance the generation and transmission of electricity from distributed, variable sources with the varying electricity demands of diffuse end users.

Smart grids, smart meters and storage technology can provide the flexibility required to integrate variable sources of renewable electricity. Smart grids use advanced monitoring systems, digital control equipment and communications networks to intelligently manage supply and transmission. Smart meters provide access to real-time monitoring of electricity consumption, allowing consumers to use electricity more efficiently. They serve as a tool for accessing consumption data, which in-turn enables demand response, peak shaving, or demand shifting. The true potential for these practices arises from the development of robust electricity markets, time-of-use (TOU) and dynamic tariffs, as well as the emergence of smart energy services. These elements together empower consumers to engage in smart and flexible energy solutions, such as demand response, by shifting their electricity usage to times when renewable energy supply is highest and CO_2 intensity is lowest. Electricity storage technologies further help integrate variable renewable energy sources, providing greater system flexibility and smoothing aggregate supply over time.

The global landscape for energy storage is evolving, with pumped-storage hydropower being the most widely used technology. By the end of 2022, total installed grid-scale battery storage capacity reached nearly 28 GW, marking a more than 75% increase from 2021, with significant contributions from the United States and China.[108] Figure 10 presents the annual grid-scale battery storage additions between 2019 and 2022.[109]

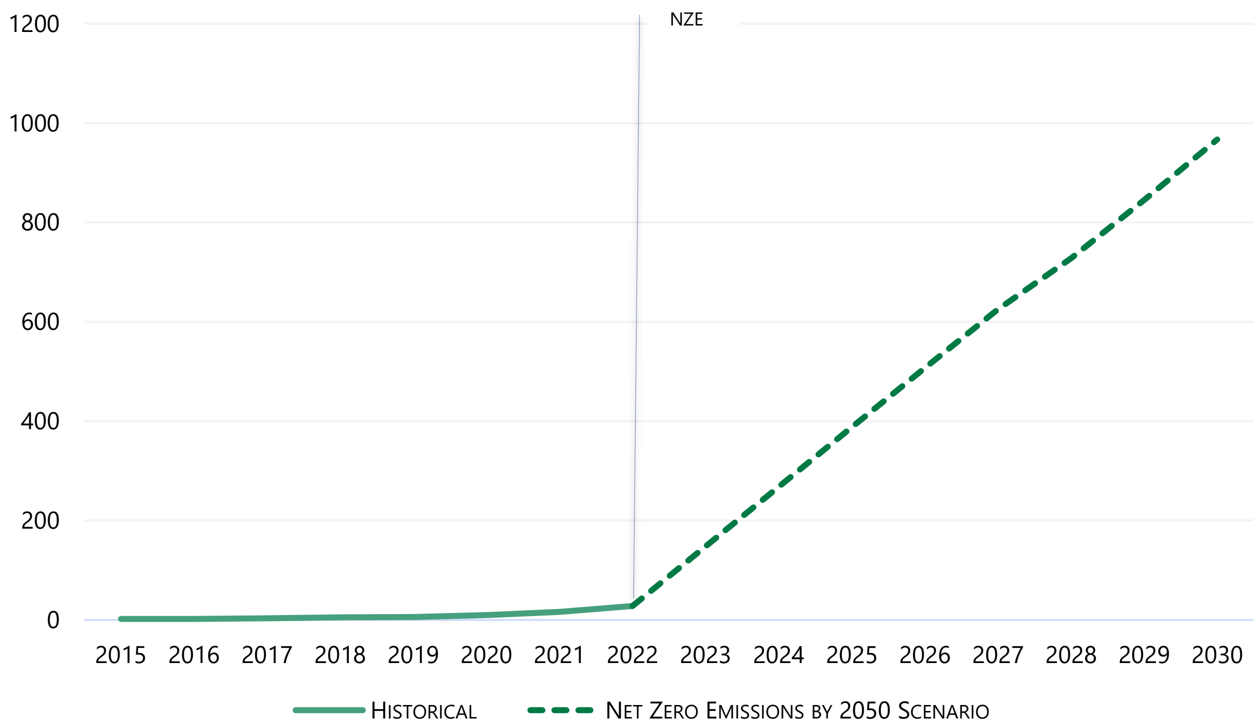
Figure 10: Annual grid-scale battery storage additions (2019-2022)



Source: IEA (2023), Data and statistics - Annual grid-scale battery storage additions

[108] IEA (2023), '*Grid-scale Storage*', https://www.iea.org/energy-system/electricity/grid-scale-storage#tracking
[109] Based on IEA (2023), '*Annual grid-scale battery storage additions, 2017-2022*', IEA, https://www.iea.org/data-and-statistics/charts/annual-grid-scale-battery-storage-additions-2017-2022

Figure 11: Global installed grid-scale battery storage capacity in the Net Zero Scenario, 2015-2030



Source: IEA (2023), Data and statistics - Global installed grid-scale battery storage capacity in the Net Zero Scenario

The rapid scale-up of energy storage is critical to meet the flexibility needs in a decarbonised electricity system. Grid-scale battery storage is expected to experience substantial growth. In the Net Zero Scenario, the installed capacity of grid-scale batteries is projected to increase by 35 times from 2022 to 2030, reaching nearly 970 GW (Figure 11).[110]

The World Energy Outlook 2024 highlights the critical need for substantial investment in electricity networks and grid infrastructure to support the global energy transition. Global power sector investment averaged over $1 trillion per year from 2019 to 2023 and electricity grids accounted for one-third of the global total.[111] This underscores the urgency to upgrade and expand grid capabilities to accommodate rising renewable energy sources. The report projects that annual investment in transmission and distribution grids will rise to $690 billion 2030[112] under the announced pledges scenario (APS).[113] This investment is essential for enhancing grid flexibility, ensuring reliable electricity supply, and facilitating the integration of clean energy technologies. The IEA emphasises the importance of coordinated planning and innovative financing mechanisms to mobilise the necessary resources for this transformation.[114]

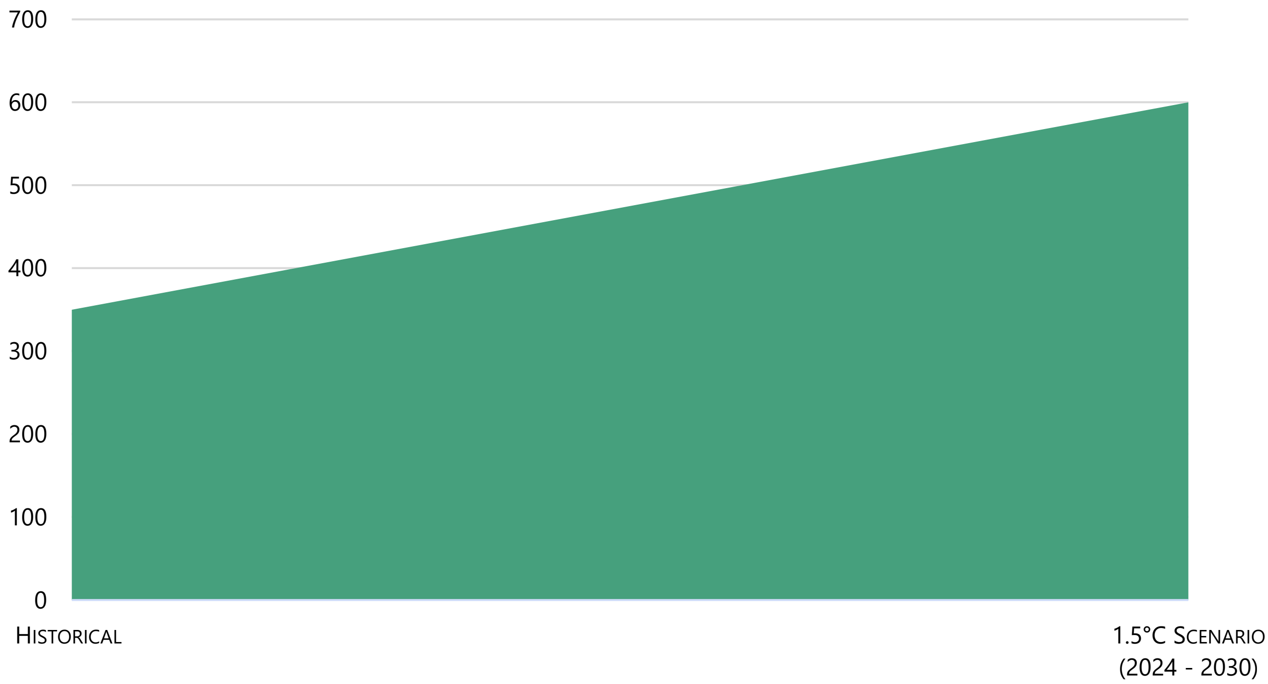
[110] IEA (2023), '*Global installed grid-scale battery storage capacity in the Net Zero Scenario, 2015-2030*' IEA, https://www.iea.org/data-and-statistics/charts/global-installed-grid-scale-battery-storage-capacity-in-the-net-zero-scenario-2015-2030
[111] Pg 132, IEA (2024), '*World Energy Outlook 2024*', IEA, https://iea.blob.core.windows.net/assets/140a0470-5b90-4922-a0e9-838b3ac6918c/WorldEnergyOutlook2024.pdf
[112] Pg 133, Ibid.
[113] Pg 16, Ibid, "The Announced Pledges Scenario (APS) examines what would happen if all national energy and climate targets made by governments, including net zero goals, are met in full and on time."
[114] Pg 135, IEA (2024), '*World Energy Outlook 2024*', IEA, https://iea.blob.core.windows.net/assets/140a0470-5b90-4922-a0e9-838b3ac6918c/WorldEnergyOutlook2024.pdf

Additionally, the potential for residential and commercial energy storage plays a vital role in this transition. By incorporating energy storage solutions, consumers can better manage their electricity use, shifting consumption to periods when renewable energy supply is highest and CO_2 intensity is lowest.

Clean, reliable and resilient electricity systems need smart grids more than ever. Investment in smart grids is on the rise, driven by more ambitious network strategies aimed at supporting the electrification of the economy and the integration of renewable energy sources. Several major economies have announced substantial new funding to modernise and digitalise their electricity grids.[115] The European Commission presented the EU action plan "Digitalisation of the energy system" at the end of 2022. The Commission expects about € 584 billion of investments in the European electricity grid by 2030, of which €170 billion would be for digitalisation (smart meters, automated grid management, digital technologies for metering and improvement on the field operations).[116]

The global market for smart grid and electricity storage technologies is expected to grow rapidly. IRENA highlights that the 1.5°C Scenario by 2050 would see an exponentially increased investment in power grids and energy flexibility, including transmission and distribution networks, smart meters, pumped hydropower and decentralised and utility-scale stationary battery storage (coupled mainly with decentralised PV systems). To align with the1.5°C Scenario, an average of $ 600 billion a year is required between now and 2030 to enhance and modernise power grids and create flexibility (Figure 12).[117]

Figure 12: Required average annual investments in power grids and energy flexibility under the Planned Energy Scenario and 1.5° C Scenario, 2024- 2030 ($billions)



Source: IRENA (2024), World Energy Transitions Outlook 2024: 1.5° C Pathway

[115] IEA (2023), '*Smart grids*', https://www.iea.org/energy-system/electricity/smart-grids

[116] Pg 1, European Commission (2022), '*Digitalisation of the energy systems – EU action plan*', https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022DC0552

[117] Based on Table 2.3, Pg 66, IRENA (2024), '*World Energy Transitions Outlook 2024: 1.5°C Pathway*', https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Nov/IRENA_World_energy_transitions_outlook_2024.pdf

Battery management systems: Battery Management Systems (BMS) are essential electronic systems designed to monitor and manage the performance of rechargeable batteries, ensuring their safety, longevity, and efficiency. BMS play a critical role in applications ranging from electric vehicles (EVs) to grid-scale energy storage, regulating charging and discharging processes while providing valuable data on battery health and performance.[118] The potential for Irish industry in the field of Battery Management Systems (BMS) is significant, especially in light of EU Regulation 1542/2023, which mandates that all medium and large-scale batteries, including domestic, electric vehicles (EVs), industrial, and grid-scale systems, must incorporate advanced BMS capable of receiving and reporting data.[119] This regulatory shift presents a unique opportunity for Irish industry to enhance its competitiveness.

3.1 Smart grids

Smart grid technology will play a central role in decarbonising Ireland's energy system, given its expected reliance on variable wind resources. The potential addition to variable renewables, as a result of the ambitious target of 80% renewable electricity, will impact power system planning, operation and market design. It will necessitate the creation of a smart grid that can control the generation, distribution and storage of electricity in response to the country's demands. This will require investment in a number of areas encompassing electrification, renewables integration and digitalisation of the grid.

With increasing penetration of renewables, greater grid-scale energy storage will also be required. Ireland has a strong pipeline of storage projects, with current developments indicating that there is over 4 GW of grid-scale battery storage in various stages of planning and construction. This includes 2.5 GWh of projects already submitted[120] and an additional 1.5 GWh forecasted to be connected to the grid by the end of 2025.[121]

Ireland has been making substantial efforts around smart grid development. EirGrid, Ireland's transmission system operator, had successfully managed high levels of renewable energy, achieving an instantaneous penetration of 75% in March 2022.[122] The Irish government and various stakeholders are investing in smart grid technologies and infrastructure, as evidenced by initiatives such as the Smart Grid Ireland Innovation Conference[123] and being a member of the IEA's collaborative research network – International Smart Grid Action Network (ISGAN), which focuses on smart grid development.[124]

EirGrid is one of the most globally advanced Transmission System Operators (TSOs) at accommodating variable renewable electricity. 'Shaping Our Electricity Future', EirGrid's roadmap[125] to achieve our renewable ambition for the electricity sector, highlights that EirGrid and SONI have started to develop credible pathways for the evolution of the power system in 2035, 2040 and 2050. EirGrid and SONI, have also identified significant investments required to modernise the grid, with ESB Networks committing € 10 billion by 2030 to develop a smarter and more flexible electricity network.[126]

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[118] Onepointech (2025), *'What is a Battery Management System (BMS)?'*, https://bms.onepointech.com/what-is-a-battery-management-system-bms/
[119] European Union (2023), 'Regulation (EU) 2023/1542' EUR-Lex, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023R1542
[120] Pg 5, SEAI (2024), '*Manual of Consenting Procedures – Battery Storage*', https://singlepointofcontact.seai.ie/renewable-energy-guides/Battery-Storage-Manual-SEAI.pdf
[121] Energy Storage News (2024), '*Ireland utility-scale energy storage forecast to exceed 1.5GWh in 2025*', https://www.energy-storage.news/ireland-utility-scale-energy-storage-forecast-to-exceed-1-5gwh-in-2025/
[122] EirGrid (2021), '*DS3 Programme - Delivering a Secure Sustainable Electricity System*', https://www.eirgrid.ie/ds3-programme-delivering-secure-sustainable-electricity-system
[123] Smart Grid Ireland (2024), '*Smart Grid Ireland Innovation Conference*', https://sgi2024.org/
[124] SEAI (2023), '*International Smart Grid Action Network TCP*', https://www.seai.ie/data-and-insights/international-energy-agency/technology-collaboration/international-smart-grid/
[125] EirGrid (2023), *'Shaping Our Electricity Future'*, https://www.eirgrid.ie/shaping-our-electricity-future
[126] Pg 23, Government of Ireland (2024), '*Electricity Storage Policy Framework for Ireland*', DECC, https://assets.gov.ie/297822/61a6926f-37d8-4a02-aea3-72a53a69a6ff.pdf

Future investment will be required across a range of digital technologies, including advanced metering infrastructure, utility automation and electric vehicle charging infrastructure, as well as updating existing transmission grids. Ireland's National Smart Metering Programme was established to upgrade Ireland’s electricity meters to next generation smart meters. As of 2024, approximately 1.9 million smart meters have already been installed across the country.[127] According to the National Energy and Climate Plan, these smart meters will form the cornerstone of Ireland’s plans to future-proof the energy sector, facilitating detailed energy usage data to consumers; which could in-turn promote reduced energy consumption with the support of complementary measures and targeted education.[128] Significant investment will also be required in the modernisation of the transmission grid to make it fit-for-purpose in an increasingly decarbonised, decentralised and digitalised power system.

As part of the supply chain analysis, the market size for smart grids in Ireland, the EU and globally was estimated to provide a total estimated range of annual investments for the technology in 2030. The potential Irish share, or the ability of Irish enterprises to capture the domestic and EU markets, was then calculated. The approach and methodology have been detailed in chapter 1.1 and a summary of findings has been presented in the following section.

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[127] ESB Networks (2023), *‘What is the national smart metering programme?’*, https://www.esbnetworks.ie/services/manage-my-meter/about-smart-meters

[128] Pg 110, Government of Ireland (2019), *‘National Energy and Climate Plan 2021 - 2030’* https://www.gov.ie/pdf/?file=https://assets.gov.ie/94442/f3e50986-9fde-4d34-aa35-319af3bfac0c.pdf#page=null

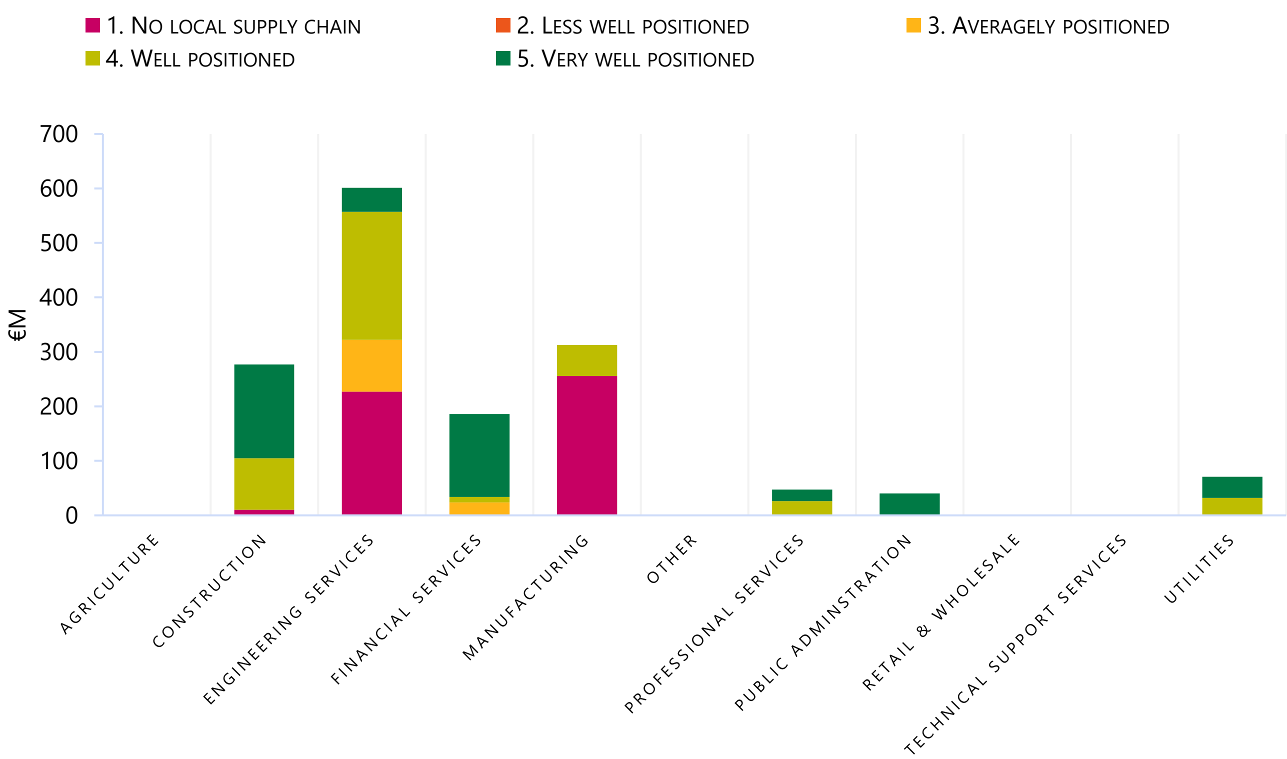
Summary of Findings: The Irish market for the deployment of smart grids is expected to grow significantly this decade. As seen in table 5, the domestic market size for smart grids is estimated at €1.5 billion in 2030, including €0.3 billion in expenditure on O&M costs on the installed base. Ireland could potentially capture over half of this market, an estimated potential share of €847 million.

Table 5: Market size in 2030 and Irish Share for smart grids in Ireland and EU-27+UK

Capacity	Irish Market		EU-27+UK Market	
	Market Size (M€)	Irish Share (M€)	Market Size (M€)	Irish Share (M€)
1. No local supply chain	494	49	89,390	223
2. Less well positioned	0	0	1,025	8
3. Averagely positioned	118	59	0	0
4. Well positioned	455	318	0	0
5. Very well positioned	467	420	0	0
Total	**1,535**	**847**	**90,415**	**231**

Figure 13 breaks down the €1.5 billion of estimated total value of Irish smart grid market by sector. It further highlights how Irish enterprises are positioned to capture the domestic market for the technology in 2030.

Figure 13: Market size by sector in 2030 for smart grids for the Irish Market



Source: SEAI Supply Chain Analysis

A model supply chain for smart grids was created to break down costs along the supply chain and ascertain the equipment and services that are likely to be domestically sourced. This has been presented in Appendix 1 (Fig 32) and Appendix 2 (Fig 44) and the key findings for this technology have been summarised below.

Smart grids represent a large economic opportunity for Irish enterprise. Manufacturing and materials supply represent the largest share, at 44.5% of capital costs. Irish companies are not well positioned to manufacture or supply most of these components, aside from the supply of towers (4.6% of capital costs).

Irish companies are well positioned however, to capture the bulk of the market for installation and quality assurance, which collectively represents over 40% of capital costs. Notable opportunities for job creation exist in:

- Safety and accommodation (11.2% of capital costs)
- Civil engineering (7.2% of capital costs)
- Tower erection (7.7% of capital costs)

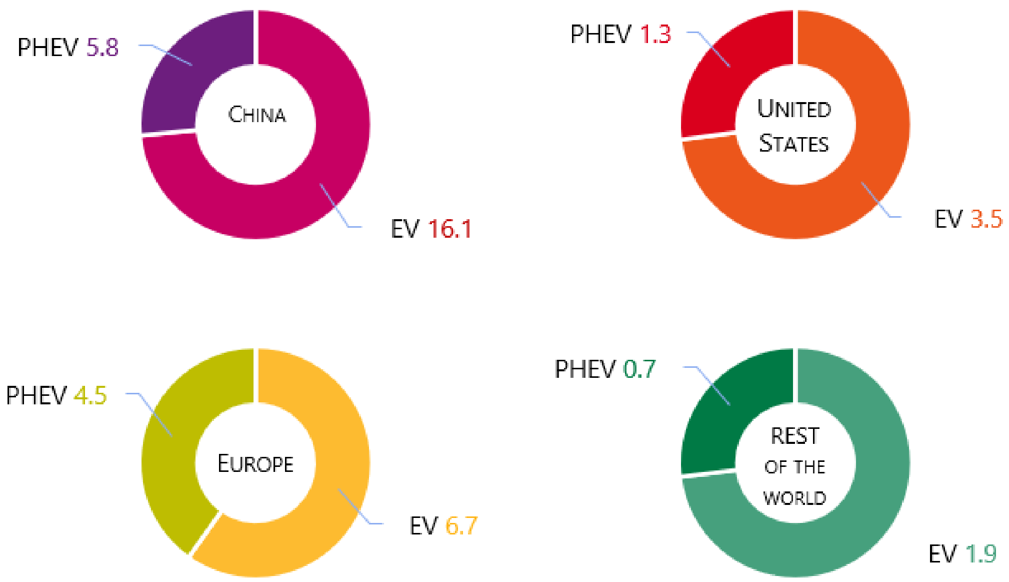
Ireland is also very well placed to capture investment during the feasibility studies (1.6%), planning and permitting (6.7%) and design and procurement (5.3% of capital costs) phases of smart grid development. Irish enterprises are well positioned to provide services associated with mechanical and electrical repairs to smart grids, each of which represent 31.6% of O&M costs.

4 Low carbon transport

Transport is the largest and fastest growing source of energy-related GHG emissions in Ireland, accounting for 34% of energy-related CO_{2eq} emissions in 2023.[129] Globally, transport accounts for more than a third of CO_2 emissions from end-use sectors.[130]

Battery electric vehicles (EVs) are emerging as the primary low-carbon technology choice for light duty and heavy-duty vehicles, having seen significant improvements in range per charge, cost and market share in the last decade. To achieve GHG emission reductions, the roll out of EVs must coincide with the decarbonisation of the electricity system. For other modes of transport, including road freight, aviation and shipping, the low-carbon transport solutions are less clear. Decarbonisation is likely to occur through a mix of electrification, biofuels, carbon-neutral synthetic fuels and hydrogen. This section focuses on EVs, as it is the low-carbon transport technology that is expected to see the fastest growth in the next decade. Figure 14 presents global electric car stock in 2023.[131]

Figure 14: Global electric car stock in 2023 (millions)



Source: IEA (2024), Global electric car stock
Note: Plug-in Hybrid Electric Vehicles (PHEV) and Battery Electric Vehicles (EV)

The global deployment of EVs is on the rise with nearly one in five cars sold in 2023 being electric. Electric car sales neared 14 million in 2023, 95% of which were in China, Europe and the United States. Electric cars accounted for around 18% of all cars sold in 2023, up from 14% in 2022.[132]

[129] Table 7.1, SEAI (2024), '*Energy in Ireland*' https://www.seai.ie/sites/default/files/publications/energy-in-ireland-2024.pdf
[130] IEA (2024), '*Transport – Energy System*', https://www.iea.org/energy-system/transport#tracking
[131] Figure 14 was created using data from the graph IEA (2024) '*Global electric car stock, 2013 – 2023*' https://www.iea.org/data-and-statistics/charts/global-electric-car-stock-2013-2023
[132] Pg 11, IEA (2024) '*Global EV Outlook 2024*', https://iea.blob.core.windows.net/assets/a9e3544b-0b12-4e15-b407-65f5c8ce1b5f/GlobalEVOutlook2024.pdf

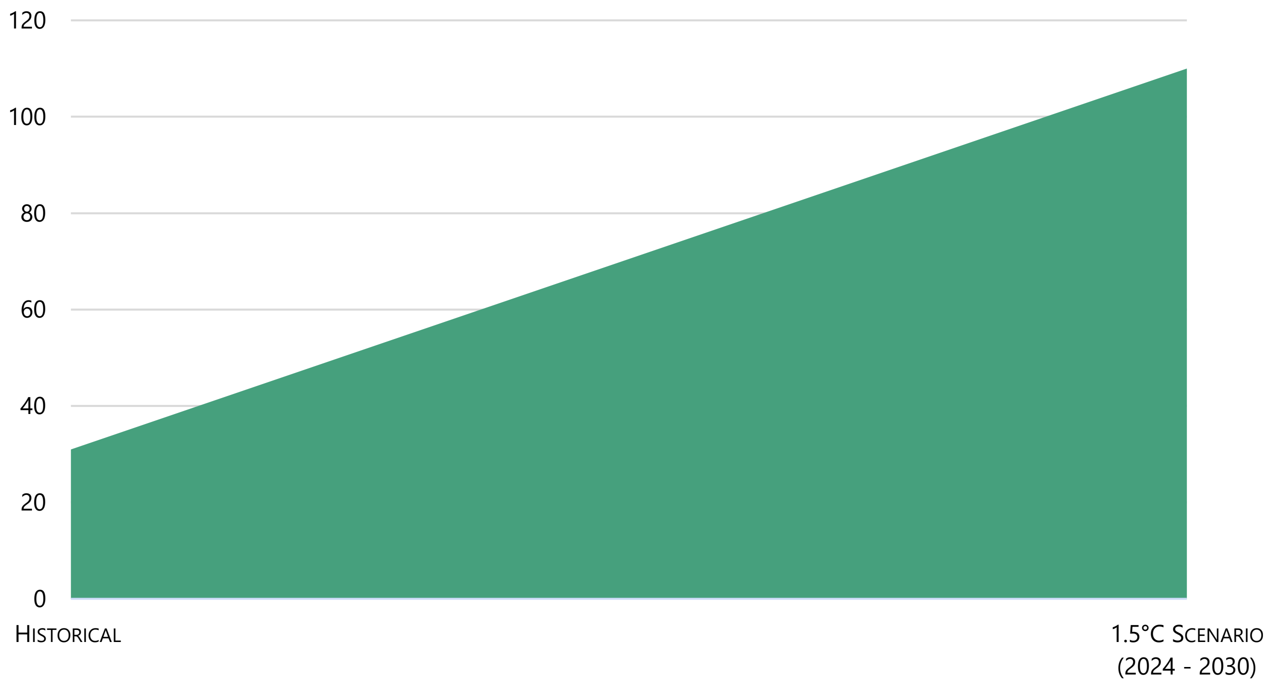
These trends indicate that growth remains robust as electric car markets mature. Battery electric cars accounted for 70% of the electric car stock in 2023.[133]

The market for EVs is expected to grow exponentially over the next decade. The IEA Global EV Outlook 2024 report observes that policy support and expectations of strong growth are bolstering investment in the EV supply chain and building confidence that the rapid electrification will continue. However, it is important to note that the pace of transition hinges on affordability of EV models and roll-out of public charging that keeps pace with EV sales.[134]

IRENA outlines that to achieve climate targets, the total investments in transport would need to rise to $2.1 trillion by 2030. EV charging infrastructure would account for 25% of this total, while energy efficiency would represent 34%, transport electrification 13%, and hydrogen stations and bunkering facilities the remaining 28%.[135]

Between 2024 and 2030, aligning with IRENA's 1.5°C Scenario would require an average annual investment of $110 billion towards charging infrastructure of EVs and EVs adoption support (Figure 15).[136]

Figure 15: Required average annual investments for charging infrastructure of EVs and EVs adoption support under 1.5° C Scenario, 2024-2030 ($billions)



Source: IRENA (2024), World Energy Transitions Outlook 2024: 1.5° C Pathway'

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[133] Page 17, (IEA 2024) *'Global EV Outlook 2024'*, https://iea.blob.core.windows.net/assets/a9e3544b-0b12-4e15-b407-65f5c8ce1b5f/GlobalEVOutlook2024.pdf
[134] Pg 13, IEA (2024) *'Global EV Outlook 2024'*, https://iea.blob.core.windows.net/assets/a9e3544b-0b12-4e15-b407-65f5c8ce1b5f/GlobalEVOutlook2024.pdf
[135] Pg 67, IRENA (2024) *'World Energy Transitions Outlook 2024: 1.5°C Pathway'* https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Nov/IRENA_World_energy_transitions_outlook_2024.pdf
[136] Figure 15 has been created from data in table 2.3 on page 66 of IRENA's *'World Energy Transitions Outlook 2024: 1.5°C Pathway'*, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Nov/IRENA_World_energy_transitions_outlook_2024.pdf

A rapid transition to EVs necessitates the introduction of more affordable models. In 2023, two-thirds of the electric vehicle models available globally were larger vehicles such as sports utility vehicles or pick-up trucks, which has contributed to elevated average prices. Although the timeline for achieving price parity is subject to a range of market variables, prevailing trends indicate that this parity could be attained by 2030 for most vehicle models in major EV markets outside of China.[137]

The ban on the sales of new petrol and diesel passenger vehicles from 2035 in a number of European states[138] will accelerate this development, and the Irish market is anticipated to be part of this transformation. Projected growth indicates that electric cars would represent about one in four cars sold in Europe.[139] This growth is driven by a target of 30 million zero emission vehicles in operation by 2030 and by 2050 for nearly all cars, vans, buses and heavy-duty vehicles to be zero-emission.[140] The EU continues to aim for the above highlighted targets and its efforts are supported by a comprehensive legislative framework aimed at promoting the adoption of zero-emission vehicles and achieving broader climate goals. [141]

The market for light commercial vehicles and buses is increasingly driven by the requirements for zero-emission deliveries and operations in city centres, particularly across Europe. However, there remains a smaller selection of models available for LCVs, and limitations on battery range may pose barriers to adoption, particularly compared to the challenges faced by passenger vehicles.

It is reported that in 2023, the heavy electric vehicle market in Europe saw significant growth. Sales of electric trucks nearly tripled, surpassing 10,000 units, which accounted for over 1.5% of total truck sales in Europe.[142] Electric buses achieved a sales share of over 43% among city buses, reflecting strong progress towards the goal of 100% zero-emission city bus sales by 2035. The overall trend indicates increasing momentum for heavy electric vehicles, driven by supportive policies and growing infrastructure, although electric buses still represent a larger share of sales compared to electric trucks. [143]

4.1 Electric vehicles

Ireland's Climate Action Plan sets a target of deploying 845,000 private electric vehicles (EVs) and 95,000 commercial EVs.[144] As of 2024, there were over 125,000 EVs registered on Irish roads.[145] Therefore, achieving the target would require approximately one third of all vehicles sold during the next decade to be BEV or PHEV vehicles. To further promote the purchase of EVs, the plan also outlines a ban on new petrol and diesel vehicles from 2030.[146]

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[137] Pg 13, IEA (2024) '*Global EV Outlook 2024*', https://iea.blob.core.windows.net/assets/a9e3544b-0b12-4e15-b407-65f5c8ce1b5f/GlobalEVOutlook2024.pdf
[138] European Parliament (2023), '*EU ban on the sale of new petrol and diesel cars from 2035 explained*', https://www.europarl.europa.eu/pdfs/news/expert/2022/11/story/20221019STO44572/20221019STO44572_en.pdf
[139] Pg 29, '*Global EV Outlook 2024*', https://iea.blob.core.windows.net/assets/a9e3544b-0b12-4e15-b407-65f5c8ce1b5f/GlobalEVOutlook2024.pdf
[140] Pg 3, European Commission (2021), '*Sustainable & Smart Mobility Strategy*' https://transport.ec.europa.eu/system/files/2021-04/2021-mobility-strategy-and-action-plan.pdf
[141] European Commission (2020), '*Sustainable and Smart Mobility Strategy - putting European transport on track for the future*', https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0789
[142] Pg 62, IEA (2024), '*Global EV Outlook 2024 – Trends in heavy electric vehicles*' https://iea.blob.core.windows.net/assets/a9e3544b-0b12-4e15-b407-65f5c8ce1b5f/GlobalEVOutlook2024.pdf
[143] Pg 60, Ibid.
[144]Pg 39, Government of Ireland (2024*), 'Climate Action Plan 2024'*, DECC, https://assets.gov.ie/296414/7a06bae1-4c1c-4cdc-ac36-978e3119362e.pdf
[145] Department of Transport (2024*), 'Zero Emission Vehicles Ireland'* https://www.gov.ie/en/campaigns/18b95-zero-emission-vehicles-ireland/
[146] Pg 95, Action 80, Government of Ireland (2019) *'Climate Action Plan 2019'* https://assets.gov.ie/25419/c97cdecddf8c49ab976e773d4e11e515.pdf

As of 2024, several measures are in place to support the deployment of EVs in Ireland, including several tax benefits and grant supports. This includes, (i) a maximum grant of up to €3,500 towards the purchase of a privately bought electric vehicle, (ii) a maximum grant of up to €3,800 towards the purchase of a commercially bought electric vehicle, (iii) a grant amount of €7,600 for large panel vans and (iv) an Electric Vehicle Home Charger Grant of up to €300.[147]

In addition, the Electric Vehicle Apartment Charging Grant provides financial assistance to residents and owners of apartments and multi-unit developments who want to install home chargers for their electric vehicles. The grant covers up to 80% of the infrastructure costs and offers €600 per charging socket installed for the owners' management companies, housing bodies, local authorities, and landlords who apply for bulk installations of chargers at a single location.[148] In addition, SEAI runs a public awareness campaign for EVs.

The Climate Action Plan calls for further development of the EV charging network, planning rules and guidelines across residential and non-residential parking locations for EV charging infrastructure. In response to this, Zero Emission Vehicles Ireland (ZEVI) has launched several initiatives to enhance EV infrastructure across the country:

- The EV Infrastructure Strategy 2022-2025[149] outlines a comprehensive approach to developing the necessary charging facilities, with significant government investment aimed at accelerating the rollout of EV charging stations.

- Additionally, the Universal Design Guidelines for EV Charging Infrastructure[150] have been published to ensure that charging stations are accessible and user-friendly. These guidelines provide essential considerations for the design, installation, and operation of charging stations, promoting a seamless experience for users.

- Furthermore, the National Charging Implementation Plan[151] outlines specific actions and timelines for the expansion of charging infrastructure, ensuring that the necessary facilities are in place to support the growing number of electric vehicles on Irish roads.

These initiatives collectively aim to create a robust and efficient EV charging network, aligning with Ireland's climate goals and facilitating the transition to electric mobility.

As part of the supply chain analysis, the market size for electric vehicles in Ireland, the EU and globally was estimated to provide a total estimated range of annual investments for the technology in 2030. The potential Irish share, or the ability of Irish enterprises to capture the domestic and EU markets, was then calculated. The approach and methodology have been detailed in chapter 1.1 and a summary of findings has been presented in the following section.

[147] SEAI (2024), '*Electric Vehicle Grants*', https://www.seai.ie/grants/electric-vehicle-grants/grant-amounts/, SEAI (2024), '*Electric Vehicle Home Charger Grant*', https://www.seai.ie/grants/electric-vehicle-grants/electric-vehicle-charging/electric-vehicle-home-charger-grant
[148] SEAI (2024), '*Apartment Charging Grant*', https://www.seai.ie/grants/electric-vehicle-grants/apartment-charging-grant/
[149] Government of Ireland (2024), '*EV Infrastructure Strategy 2022 – 2025*', DoT gov - EV Infrastructure Strategy 2022-2025 (www.gov.ie)
[150] Government of Ireland (2024), '*Universal Design Guidelines for EV Charging Infrastructure*', DoT, https://www.gov.ie/en/publication/34be2-universal-design-guidelines-for-ev-charging-infrastructure/
[151] Government of Ireland (2024), '*2024 Implementation Plan*', DoT, https://www.gov.ie/en/publication/105d8-2024-implementation-plan/

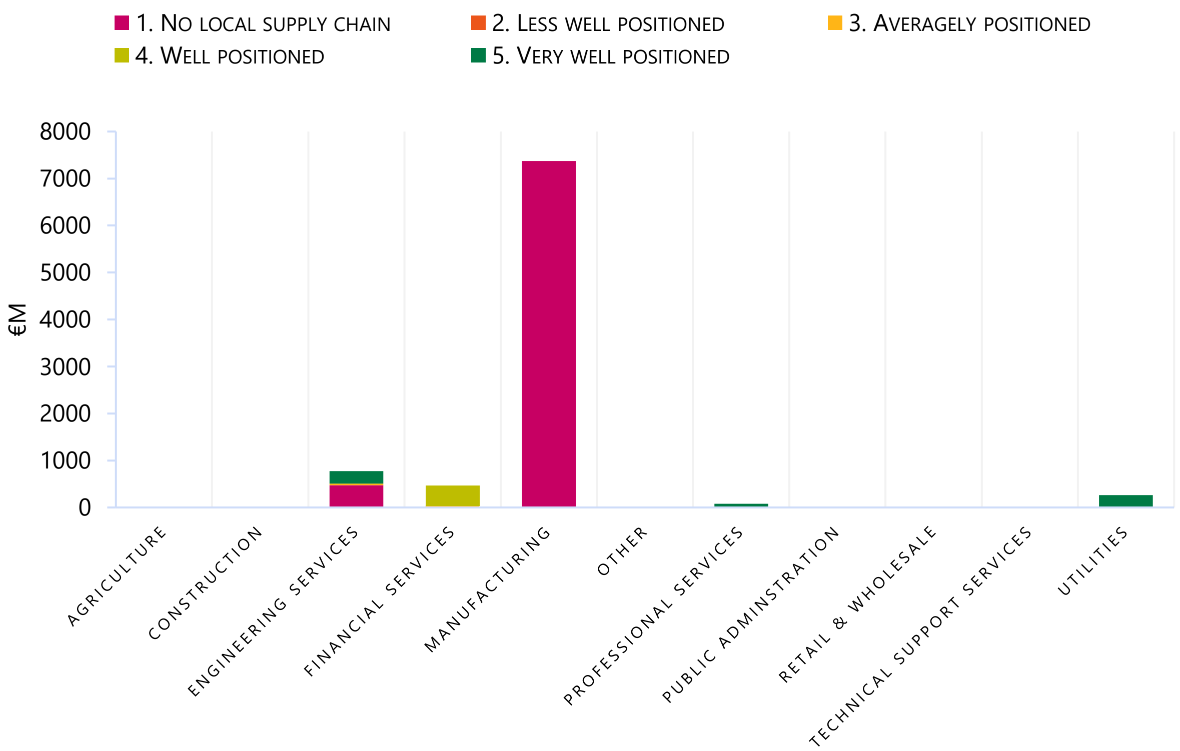
Summary of Findings: The domestic market size for the deployment of new electric vehicles, including both BEV and PHEV, is expected to grow significantly. As presented in table 6, the domestic market size for electric vehicles is estimated at €8.9 billion in 2030. Ireland enterprises could capture an estimated 18.5% of this market, or approximately €1.7 billion.

Table 6: Market size in 2030 and Irish Share for electric vehicles, including both BEV and PHEV, in Ireland and EU-27+UK

Capacity	Irish Market		EU-27+UK Market	
	Market Size (M€)	Irish Share (M€)	Market Size (M€)	Irish Share (M€)
1. No local supply chain	7,845	784	714,285	1,786
2. Less well positioned	0	0	0	0
3. Averagely positioned	78	39	0	0
4. Well positioned	424	297	0	0
5. Very well positioned	597	538	0	0
Total	**8,945**	**1,659**	**714,285**	**1,786**

Figure 16 breaks down the €8.9 billion of estimated total value of Irish EV market by sector. It further highlights how Irish enterprises are positioned to capture the domestic market for the technology in 2030.

Figure 16: Market size by sector in 2030 for electric vehicles for the Irish Market



Source: SEAI Supply Chain Analysis

A model supply chain for electric vehicles was created to break down costs along the supply chain and ascertain the equipment and services that are likely to be domestically sourced. This has been presented in Appendix 1 (Fig 33) and Appendix 2 (Fig 45) and the key findings for the technology have been summarised below.

Upfront capital costs represent 90% of the EV market, and of these, manufacturing and material supply accounts for 97%. Expenditure on O&M is estimated at €865 million in 2030. Cost breakdown information is challenging to come by, but battery pack costs have decreased to 21% of the total upfront price (in Dec 2020).[152] Battery pack prices less than $100/kWh have been reported for batteries for e-buses in China in 2020. Lithium-ion battery pack prices, which were over $1,100 per kWh in 2010, have fallen to a record low of $139/kWh in 2023, and average battery pack prices are expected to be $80/kWh by 2030,[153] which will mark the point at which vehicle manufacturers should be able to market EVs at the same price and margin as ICE vehicles, with no subsidies involved. Developments in cathode chemistry have helped to reduce the costs, as have the larger volumes and battery production plants operating at higher utilisation rates. Overall, key trends observed in the EV battery industry include a decline in EV battery prices, growth in demand for batteries and critical minerals, and accelerated plans to develop more affordable chemistries and novel designs.[154] This reflects the rapid evolution of electric vehicle technology, which continues to improve driving range and efficiency.

There is limited vehicle manufacturing in Ireland. It is unlikely Irish enterprise is well placed to secure significant additional value from the manufacture of EVs as many of the manufacturers are updating existing production facilities to meet growing demand. Irish enterprises are therefore not well positioned to capture manufacture and supply core components of EVs, such as the battery pack (20.9% of capital costs), drive chain (17.1%), vehicle body (15.7%) or chassis (7.2%). The supply of EV batteries is a new element of the automobile supply chain. Manufacturers are both producing batteries in house and partnering with existing battery producers and ramping up production. For example, Volkswagen has highlighted suppliers in Sweden and Germany,[155] and BMW notes suppliers in Germany[156] as well as the US and China.[157]

There are, however, potential opportunities that could be explored for Ireland to supply components for EVs linked to smart driving and smart vehicles. Vehicle software is particularly relevant for EVs with their increased software basis (replacing the complex mechanical systems of ICE vehicles) and with the rapidly expanding need for both EV management, autonomous elements of driving and connected vehicles. Users now expect high levels of features and connectivity in new vehicles, and this is likely to remain a focus area for OEMs, with the opportunity to licence software into the OEMs.

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[152] BloombergNEF (2020), '*Battery Pack Prices Cited Below $100/kWh for the First Time in 2020, While Market Average Sits at $137/kWh*', BloombergNEF, https://about.bnef.com/blog/battery-pack-prices-cited-below-100-kwh-for-the-first-time-in-2020-while-market-average-sits-at-137-kwh/

[153] BloombergNEF (2023), '*Lithium-Ion Battery Pack Prices Hit Record Low of $139/kWh, BloombergNEF*', Lithium-Ion Battery Pack Prices Hit Record Low of $139/kWh | BloombergNEF (bnef.com)

[154] IEA (2024), '*Global EV Outlook 2024 – Trends in electric vehicle batteries*', https://www.iea.org/reports/global-ev-outlook-2024/trends-in-electric-vehicle-batteries

[155] Volkswagen AG (2022), '*Volkswagen invests a further €500 million in sustainable battery activities with Northvolt AB*', https://www.volkswagen-group.com/en/press-releases/volkswagen-invests-a-further-500-million-in-sustainable-battery-activities-with-northvolt-ab-16763

[156] Electrive.com (2021), '*BMW to launch battery production in Leipzig*', https://www.electrive.com/2021/04/30/bmw-to-launch-battery-production-in-leipzig/

[157] Electrodrive (2020), '*BMW to launch battery module mass production in 2021*', https://www.electrive.com/2020/09/23/bmw-to-launch-battery-module-mass-production-in-2021/

There are market opportunities for Ireland associated with the O&M of EVs. Irish enterprises are well placed to deliver the O&M services for EVs including:

- **Insurance and Electricity** (70% of O&M costs)
- **Electrical and mechanical engineering for servicing / maintenance** (each 15% of O&M costs)

Finally, Ireland also has several research teams operating at the forefront of battery research and materials chemistry.[158] While negligible in terms of market share, this **R&D could yield longer-term opportunities as battery chemistry continues to develop and as other chemistries such as solid state and lithium silicon batteries are explored.**

As Ireland's manufacturing base for cars is focussed on high value specialist components and niche market products, export opportunities associated with EVs are likely to be limited to an estimated 0.3% of the European market.

Hydrogen for transport: In September 2023, the Department of Transport (DoT) initiated an inter-Departmental Alternative Fuels for Transport Working Group to enhance visibility on policy development related to alternative fuels in transport.[159] This group aims to coordinate various ongoing actions concerning alternative fuel and electric infrastructure as well as the supply of renewable energy across transport sub-sectors, including land, aviation, and maritime. DoT is developing a draft update to Ireland's National Policy Framework (NPF) on Alternative Fuel Infrastructure in line with Regulation (EU) 2023/1804 on the deployment of alternative fuels infrastructure (AFIR).[160] Hydrogen is one of the alternative fuels in the NPF on Alternative Fuel Infrastructure, however assessing near-term demand growth for hydrogen in Ireland was too challenging at the outset of the development of this report and therefore, hydrogen in transport is something that could be considered in a future iteration of the report.

4.2 Electric vehicle charging stations

The charging infrastructure for electric vehicles remains a key aspect of the sector's progress. The charging requirements of battery EVs will increase the demand for electricity and the load on the grid. Smart chargers that communicate with the vehicle and the grid, and optimise charging times are now available. Also available are simpler chargers that enable end-user programming for off peak charging i.e. users can set their chargers to operate during periods when electricity demand is lower. Both of these options enable owners to delay charging periods and to utilise potentially cheaper electricity overnight, which encourages an appropriate spread of the electricity load, and is likely to be encouraged by the utility supplier through relevant tariffs. This has value to the domestic consumer as much as the fleet manager. Such flexibility can then potentially be extended into vehicle to grid (V2G) systems,[161] and this becomes a matter for the utility companies and the network operators. It is highly likely there is further scope for innovation in this space. There is a possibility for smart charging to contribute to grid balancing when demand is high and it is possible to make use of surplus energy in situations where there is excess supply.[162]

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[158] University of Limerick (2024) *'Bernal launch new facility "AMPEiRE" to revolutionize battery production'* https://www.ul.ie/bernal/news/bernal-launch-new-facility-ampeire-to-revolutionize-battery-production; https://ambercentre.ie/ncf-ev-batteries/, Amber centre (2024), *'AMBER Investigators receive National Challenge Funding to improve EV batteries'* https://www.tcd.ie/engineering/news/2023/sfi-national-challenge-fund-trinity-college-dublin-drive--improving-thermal-management-of-batteries-in-electric-vehicles/

[159] Oireachtas (2024), '*Energy Policy - Dáil Éireann Debate, Wednesday - 23 October 2024*', https://www.oireachtas.ie/en/debates/question/2024-10-23/56/

[160] Government of Ireland (2024), '*Update of the National Policy Framework for Alternative Fuels Infrastructure for Transport*', DoT, https://www.gov.ie/en/consultation/441f2-update-of-the-national-policy-framework-for-alternative-fuels-infrastructure-for-transport/

[161] Vehicle-to-grid (V2G) describes the system or process by which electricity is feed from the vehicle into the electricity grid.

[162] Pg. 20, Gridserve (2024), *'Demonstration design and implementation - Electric Freightway Report 2'*, https://www.gridserve.com/wp-content/uploads/2024/10/Electric-Freightway-Report-2.pdf

Although public chargers are only used for about 5% of charging events, their physical presence is necessary both to facilitate charging for those who do not have ready access to off road charging and to building confidence in the technology in general. The vast majority of charging happens at home and at work. Evidence from Norway, the most developed EV market in Europe, shows that as the EV market matures, there is a need to focus more on public charging facilities and fast charging becomes increasingly important.[163]

Slow chargers have power ratings less than or equal to 22 kW, whereas fast chargers have a power rating of more than 22 kW and up to 350 kW.[164] For domestic/work-based charging 7kW chargers are establishing as the common facility, and these can in some cases charge up to 22kW.[165] Rapid and ultra-rapid charging are commonly seen at service stations on trunk roads. The charging picture is complicated by various types of connectors being used across the different vehicle models, and this in particular complicates the rapid charging options.

The Combined Charging System (CCS) is increasingly recognised as the standard for electric vehicle charging, especially in Europe, reflecting a shift towards greater interoperability across different vehicle brands. In contrast, North America is witnessing a different trend, with many vehicle manufacturers adopting the Tesla fast charging standard. Meanwhile, Japan is likely to continue using the CHAdeMO standard for its EVs.[166]

Currently the number of charge points recommended in EU guidance is 1 public charger per 10 EVs (current AFID)[167], and Ireland achieves this target. The expected increase in number of EVs on the roads will necessitate an increased level of public charging provision. The EU Alternative Fuels Infrastructure Regulation (AFIR) is a key document, as are the funding mechanisms discussed as part of the European Green Deal in terms of supporting the ambitious EU recharging infrastructure plan of 1 million public charge points by 2025 and 3 million by 2030.[168]

The rapid increase in the deployment of EV vehicles expected in the next decade may mean there is space in the market for new suppliers to enter the market, and there will be significant demand for installations at all types of charging infrastructure that require suitably qualified electricians and electrical engineers.

As part of the supply chain analysis, the market size for electric vehicles charging in Ireland, the EU and globally was estimated to provide a total estimated range of annual investments for the technology in 2030. The potential Irish share, or the ability of Irish enterprises to capture the domestic and EU markets, was then calculated. The approach and methodology have been detailed in chapter 1.1 and a summary of the findings has been presented in the following section.

[163] Roland Berger (2024), '*EV Charging Index: Expert insight from Norway*', https://www.rolandberger.com/en/Insights/Publications/EV-Charging-Index-Expert-insight-from-Norway-2024.html
[164] Pg 69, Footnote 15, IEA (2024), '*Global EV Outlook 2024- Trends in Electric Vehicle Charging*', https://iea.blob.core.windows.net/assets/a9e3544b-0b12-4e15-b407-65f5c8ce1b5f/GlobalEVOutlook2024.pdf
Note: "Charging points" and "chargers" are used interchangeably and refer to the individual charging sockets, reflecting the number of EVs that can charge at the same time.
[165] SEAI (2024), '*Charging an electric vehicle*', https://www.seai.ie/plan-your-energy-journey/for-your-home/electric-vehicles/about-evs/ev-charging
[166] CHAdeMO is a type of EV connector that allows rapid charging.
[167] Pg 4, (23), European Commission (2024) '*Alternative Fuels Infrastructure Regulation*', https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0094
[168] Pg 6, European Commission (2021), *Sustainable and Smart Mobility Strategy - putting European transport on track for the future, European Commission*, https://transport.ec.europa.eu/system/files/2021-04/2021-mobility-strategy-and-action-plan.pdf

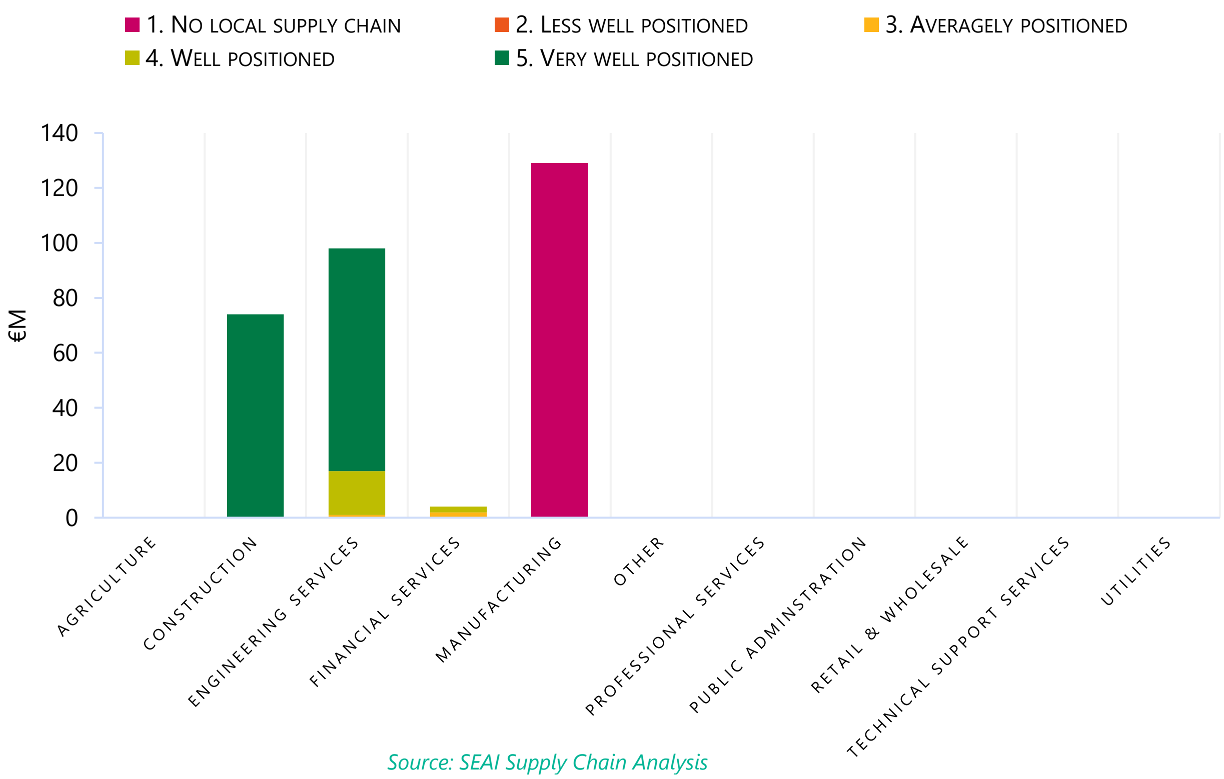
Summary of Findings: The market for the deployment of chargers is expected to increase. As presented in table 7, the domestic market size for electric vehicle charging is estimated at €305 million. Of this, Irish enterprises are positioned to potentially capture 55% of the domestic market.

Table 7: Market size in 2030 and Irish Share for electric vehicle chargers in the Irish and EU-27+UK markets

Capacity	Irish Market		EU-27+UK Market	
	Market Size (M€)	Irish Share (M€)	Market Size (M€)	Irish Share (M€)
1. No local supply chain	129	13	16,853	42
2. Less well positioned	0	0	1,057	8
3. Averagely positioned	3	1	0	0
4. Well positioned	18	13	0	0
5. Very well positioned	155	140	0	0
Total	305	1,66	17,911	50

Figure 17 breaks down the €305 million of estimated total value of Irish EV charging by sector. It further highlights how Irish enterprises are positioned to capture the domestic market for the technology in 2030.

Figure 17: Market size by sector in 2030 for electric vehicle chargers for the Irish Market



Source: SEAI Supply Chain Analysis

A model supply chain for electric vehicle chargers was created to break down costs along the supply chain and ascertain the equipment and services that are likely to be domestically sourced. This has been presented in Appendix 1 (Fig 34) and Appendix 2 (Fig 46) and the key findings for the technology have been summarised below.

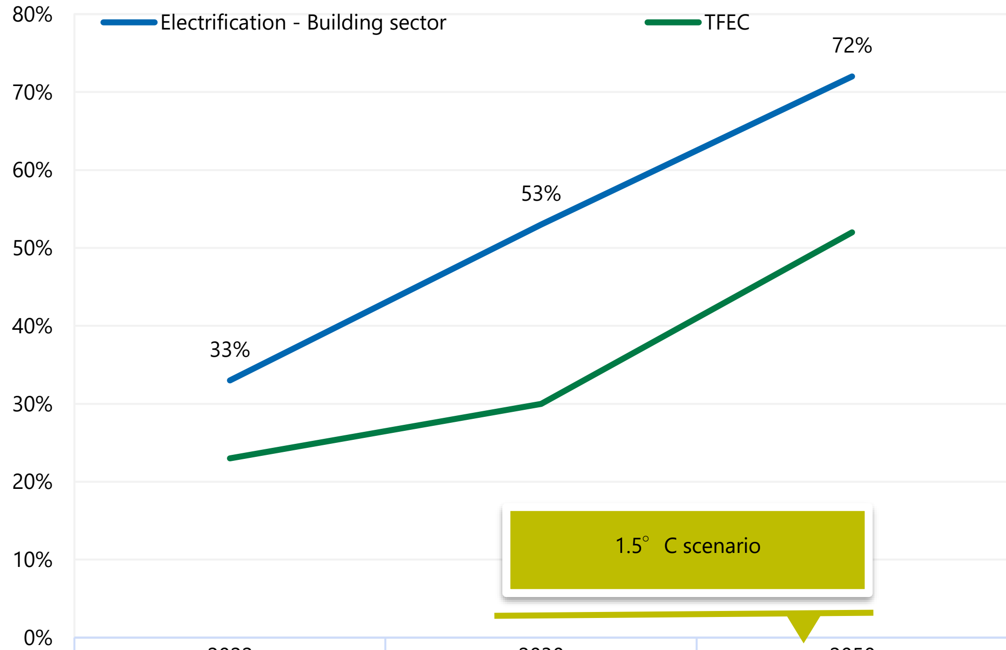
The installation of charging infrastructure in Ireland will rely on the skills and availability of electrical engineers and electricians, while the larger public charging sites will also involve planning permissions, groundworks and construction. Utility companies and network providers will be involved in supply to the larger sites. It is anticipated that the majority of the installation work will be captured by the Irish market, while the charging units are likely to be imported. There is a growing need for software that integrates both private and public charging solutions, enabling smart charging, payment systems and connectivity at all levels., Irish suppliers are well placed to meet this demand. As Ireland's manufacturing base in this area is focused on high value specialist components and software services, the export opportunities associated with EV charging is likely to be limited to an estimated 0.3% of the European market.

5 Energy in buildings

The residential sector is the third biggest source of energy-related CO_{2eq} emissions in Ireland, accounting for 15% in 2023.[169] The operation of buildings (residential, commercial and public) is estimated to account for 26% of global energy-related emissions.[170] In response, the scope and stringency of minimum performance standards and building energy codes can be seen increasing across countries. Additionally, the use of efficient and renewable buildings technologies has also been growing. Although the need to undergo a profound transformation is widely recognised, the sector needs more rapid changes to promote the global energy transition.[171]

IRENA's recent analysis outlines that to align with the 1.5°C by 2050 target, significant increases in the electrification rates are necessary and by 2030, it is anticipated that 53% of the buildings sector will be electrified.[172] Looking even further ahead to 2050, the sector will need to make significant progress, aiming for an electrification rate of 72% (Figure 18).[173] Achieving these electrification targets will require widespread adoption of advanced technologies and increased investment in energy efficiency and clean technologies in the buildings sector.

Figure 18: Global electrification in the building sector and total final energy consumption (TFEC) under 1.5°C Scenario in 2022, 2030 and 2050, under the 1.5° C scenario



	2022	2030	2050
Electrification - Building sector	33%	53%	72%
TFEC	23%	30%	52%

Source: IRENA (2024), World Energy Transitions Outlook 202: 1.5° C Pathway

[169] Table 7.1, SEAI (2024), '*Energy in Ireland*' https://www.seai.ie/sites/default/files/publications/energy-in-ireland-2024.pdf
[170] IEA (2023), 'Tracking Clean Energy Progress 2023 – Buildings' https://www.iea.org/energy-system/buildings
[171] Ibid.
[172] Pg 37, IRENA (2024), 'World Energy Transitions Outlook 202: 1.5°C Pathway', https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Nov/IRENA_World_energy_transitions_outlook_2024.pdf
[173] Based on Fig 1.5. Ibid.

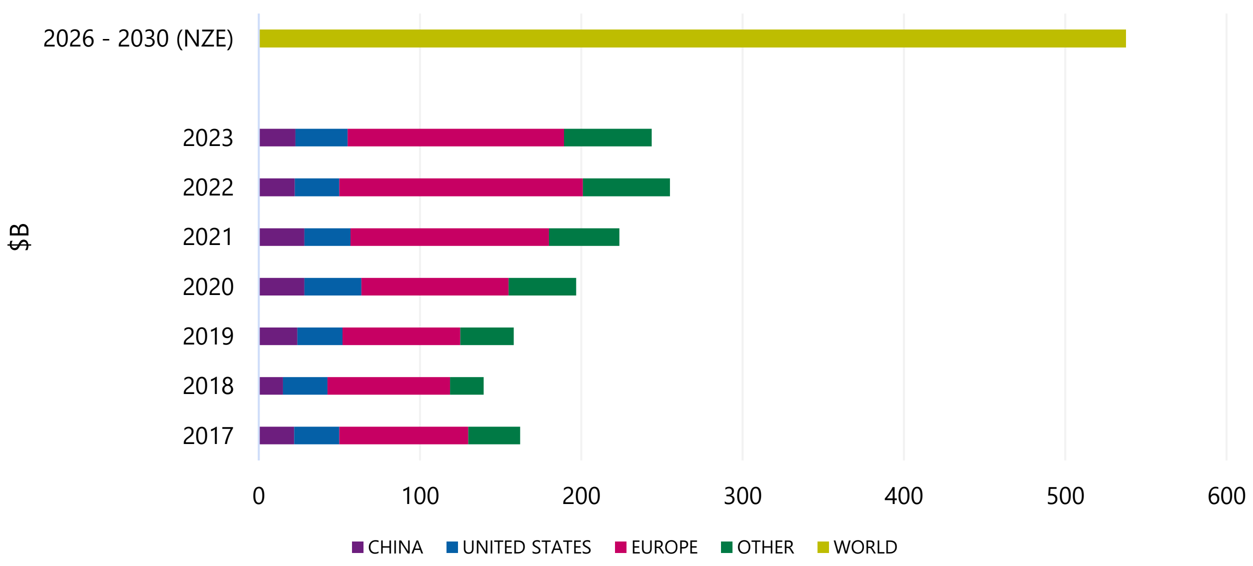
Several measures exist to reduce emissions in buildings in the near term by switching from fossil fuels to lower carbon options. The electrification of heating and cooking can reduce emissions, provided the electricity is supplied by a low-carbon source. Electric heat pumps, which extract heat from outside or ground sources and pump it indoors, are one of the lowest cost options for space and water heating. Boilers can also be fuelled by sustainably produced biomethane or sustainably harvested biomass, including wood chips or pellets. In addition, town-scale district heating systems can make efficient use of waste heat, renewable electricity or sustainable biomass feedstocks.

Beyond fuel switching, decarbonisation of buildings will require more efficient use of energy. Energy efficient construction and retrofits to the building shell, insulation, glazing, windows and doors can significantly reduce the amount of energy required to heat a building. Smart buildings and homes can also increase efficiency of energy consumption. Building facilities that are monitored and controlled by a reliable building control, automation and information systems (BACS) can help maintain the building environment more efficiently and so reduce the building's environmental impact and energy costs.

Furthermore, the adoption of smart technologies and energy management systems is crucial for optimising energy consumption in real-time. Community-level planning that promotes energy-efficient infrastructure, along with effective policies and financial incentives, is necessary to encourage investment in sustainable building solutions. Lastly, engaging occupants and promoting behavioural change through education and awareness campaigns are essential for maximising the benefits of energy-efficient technologies.

Global investment in energy efficiency in buildings has increased by approximately 14%, surpassing $250 billion. This trend reflects the rapid growth observed in recent years. Maintaining similar progress of at least 11% year-on-year growth as seen in figure 19,[174] could put the sector on track to reach 2030 annual investment levels needed to achieve Net Zero Emissions by 2050.[175]

Figure 19: Annual investment in energy efficiency in the buildings sector to achieve Net Zero Emissions (2017-2030)



Source: IEA (2023), Data and statistics - Annual investment in energy in the buildings sector in the Net Zero Scenario

[174] IEA (2023), '*Annual investment in energy in the buildings sector in the Net Zero Scenario, 2017-2030*' https://www.iea.org/data-and-statistics/charts/annual-investment-in-energy-efficiency-in-the-buildings-sector-in-the-net-zero-scenario-2017-2030-2
[175] IEA (2023), '*Tracking Clean Energy Progress 2023 – Buildings*', https://www.iea.org/energy-system/buildings

Heat pumps are a key technology for enhancing energy efficiency and sustainability in smart buildings and homes. They will play a crucial role in reducing reliance on fossil fuels as it is envisioned that their use will grow twelve-fold by 2050 in IRENA's 1.5°C Scenario.[176] When integrated with building automation and control systems, heat pumps can provide intelligent heating and cooling solutions that adapt to occupant needs and environmental conditions. Although this analysis does not capture the supply chain opportunities for heat pumps, this is something that could be explored in the future. Especially, given the comprehensive support for the adoption of heat pump technologies that have been made available in Ireland through various grants and resources.[177]

Ireland's Climate Action Plan sets out significant ambition for decarbonising heat generation, both through the electrification of heat, and deployment of renewable gas, with a target of 680,000 heat pumps to be installed by 2030.[178] Regulatory standards for home heating systems have effectively banned the installation of oil boilers from 2022 and the installation of gas boilers from 2025 in all new dwellings.[179] Ireland will also progressively phase out oil and gas boilers in existing dwellings through a combination of incentives, information and regulatory measures and more information can be found about this in the National Heat study, Net Zero by 2050.[180]

In line with these ambitious goals, the Energy Performance of Buildings Directive (EPBD)[181] Recast 2024 introduces critical measures to enhance building energy efficiency across Europe. The directive emphasises "deep renovation," defined as renovations that align with the energy efficiency first principle and focus on essential building elements. This approach aims to transform buildings into nearly zero energy buildings (NZEB) by 2030 and zero-emission buildings (ZEB) by 2030. The EPBD Recast also mandates that all new buildings meet zero-emission standards from 2030, promoting the integration of renewable energy sources and advanced energy management systems.

Additionally, the directive encourages the establishment of national building renovation plans and building renovation passports to facilitate staged renovations toward achieving zero-emission status, thereby supporting Ireland's commitment to reducing greenhouse gas emissions and improving overall energy performance in the building sector. Complementing these efforts, the Smart Readiness Indicator (SRI)[182] serves as a vital tool under the EPBD, it is designed to assess and enhance the smart capabilities of buildings. Together, the EPBD Recast and the SRI support Ireland's commitment to creating a more energy-efficient built environment, ensuring that both new and existing buildings contribute to national climate targets.

Ambitious policies also exist to increase the energy efficiency of Ireland's building stock. Building Energy Rating (BER) Certificates, which rate building energy performance are used to encourage residential energy efficiency. Ireland's Better Energy Homes Programme, administered by SEAI, provides full or partial grants to households to upgrade the energy efficiency of their homes.[183] Ireland's revised building regulations mandate that all new buildings have to be meet nearly zero energy buildings (NZEB) standards from 31 December 2020.

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[176] Pg 38, IRENA (2024), '*World Energy Transitions Outlook 2024: 1.5°C Pathway*', https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Nov/IRENA_World_energy_transitions_outlook_2024.pdf

[177] SEAI (2024), '*Heat pump system grant*', https://www.seai.ie/grants/home-energy-grants/individual-grants/heat-pump-systems

[178] Page 20, Government of Ireland (2024), '*Climate Action Plan 2024*', https://assets.gov.ie/296414/7a06bae1-4c1c-4cdc-ac36-978e3119362e.pdf

[179] Page 82, Action 60, Government of Ireland (2019), '*Climate Action Plan 2019*', https://assets.gov.ie/25419/c97cdecddf8c49ab976e773d4e11e515.pdf

[180] SEAI (2022), '*National Heat Study Summary Report*', https://www.seai.ie/publications/National-Heat-Study-Summary-Report.pdf

[181] Official Journal of the European Union (2024), '*EPBD recast*', https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202401275

[182] European Commission (2024), '*Smart readiness indicator*', https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/smart-readiness-indicator_en

[183] SEAI (2024), '*Better Energy Homes*', https://www.seai.ie/individual-energy-upgrade-grants

Furthermore, the Better Energy Financing programme supported applied research for developing innovative financing solutions for deeper levels of building upgrades and investigates how to incentivise greater uptake of home retrofit programmes in the residential sector.

The Home Energy Upgrade Loan Scheme launched in early 2024[184] is aimed at facilitating homeowners' investments in energy efficiency. This €500 million initiative, the first of its kind in Ireland, is supported by the European Investment Bank (EIB) and is designed to make homes warmer, healthier, and more cost-effective to run. The scheme allows homeowners to undertake deep retrofits or specific energy upgrades, provided that the projects are supported by SEAI grants[185] and achieve a minimum 20% improvement in the building's energy performance. This initiative aims to lower financial barriers for homeowners, particularly those above the eligibility threshold for fully funded energy upgrades under the Warmer Homes Scheme, thus promoting greater uptake of energy efficiency improvements across the country.

5.1 Smart buildings and homes

Smart buildings and homes can deliver a range of benefits for households and business. These include optimising energy use, reducing costs and freeing up facilities' management resources. They can also enhance living and working environments, increasing productivity and even improving the health of occupants.

Smart buildings and homes can incorporate a wide range of elements to enhance their functionality and efficiency. These include, but are not limited to, building automation and control systems (BACS), heating, ventilation, and air conditioning (HVAC), lighting systems, security systems. These components work together to create a more efficient, comfortable, and secure living or working environment, showcasing the potential of smart technology in modern buildings.

The BACS industry is quite fragmented with many players involved, but a few very large players dominate the market. The top six companies account for 37% of the installed system sales.[186] These large players have traditionally offered closed-source software and systems, meaning that smaller players are entering the market, offering simple home energy management systems (HEMS). As a result, this fragmentation and the shift towards more open and flexible solutions are fostering innovation and competition, ultimately benefiting consumers by providing a wider range of energy management options tailored to their specific needs.

The European smart building market is projected to grow significantly at a robust compound annual growth rate (CAGR) of 19.7% from 2023 to 2030.[187] As the market evolves, it presents substantial opportunities for innovation and investment, making it a critical area for future development in the region.

As part of the supply chain analysis, the market size for smart buildings and homes in Ireland, the EU and globally was estimated to provide a total estimated range of annual investments for the technology in 2030. The potential Irish share, or the ability of Irish enterprises to capture the domestic and EU markets, was then calculated. The approach and methodology have been detailed in, chapter 1.1 and a summary of findings has been presented in the following section.

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[184] DECC (2024), '*New low-cost Home Energy Upgrade Loan Scheme launched by Minister Ryan, Minister McGrath and Minister Richmond*', https://www.gov.ie/en/press-release/4d1f2-new-low-cost-home-energy-upgrade-loan-scheme-launched-by-minister-ryan-minister-mcgrath-and-minister-richmond/

[185] SEAI (2024), '*Home grants*', https://www.seai.ie/grants/home-energy-grants/

[186] Buildings Performance Institute Europe (2016), '*Building Automation and Control Technologies*', https://www.bpie.eu/wp-content/uploads/2016/02/Deep-dive-4-Building-automation.pdf

[187] Fortune Business Insights (2023), '*Europe Smart Building Market to Exhibit 19.7% CAGR by 2030*', https://www.fortunebusinessinsights.com/press-release/europe-smart-building-market-10866

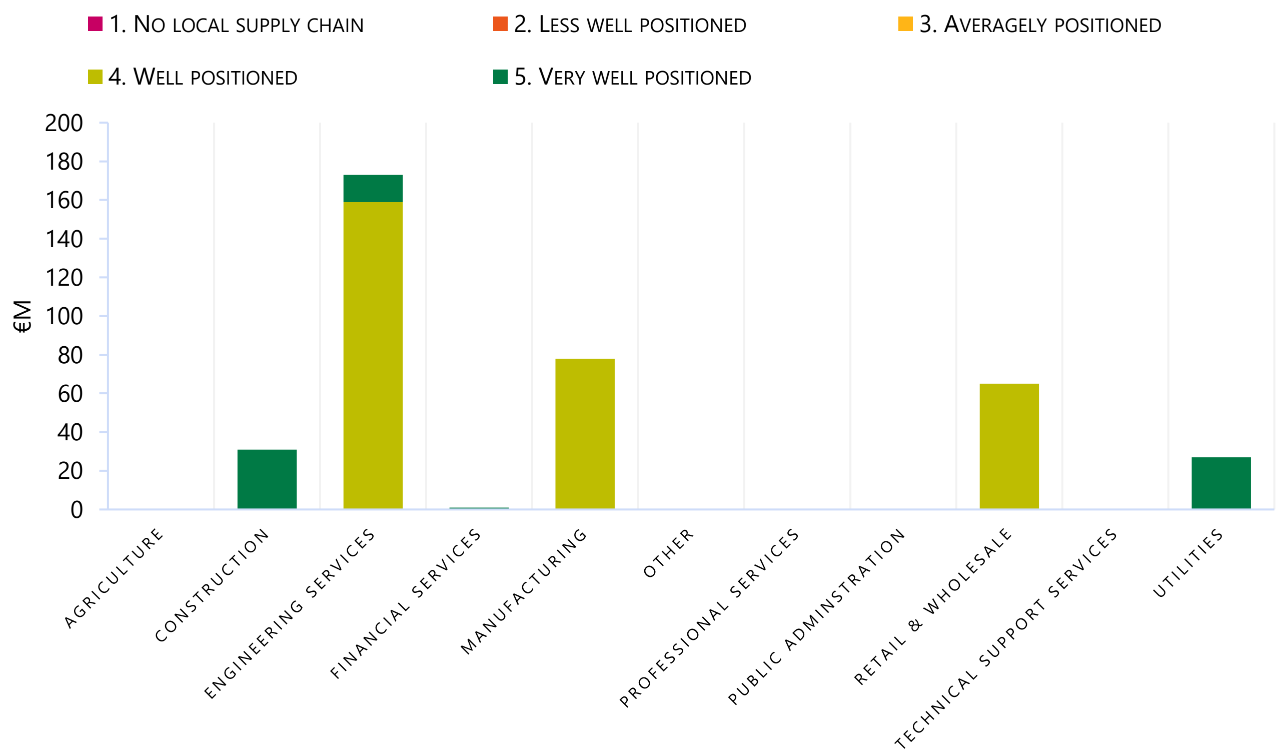
Summary of Findings: It is estimated that total value of the Irish smart buildings and homes market in 2030 is €374 million (Table 8)**.** Irish enterprise could potentially supply an estimated 73% of the total domestic market for smart buildings in 2030.

Table 8: Market size in 2030 and Irish Share for smart buildings and homes in Ireland and EU-27+UK

Capacity	***Irish Market***		***EU-27+UK Market***	
	Market Size (M€)	***Irish Share (M€)***	***Market Size (M€)***	***Irish Share (M€)***
1. No local supply chain	0	0	3,935	10
2. Less well positioned	0	0	11	0
3. Averagely positioned	0	0	0	0
4. Well positioned	302	211	0	0
5. Very well positioned	72	65	0	0
Total	**374**	**276**	**3,946**	**10**

Figure 19 breaks down the €374 million of estimated total value of smart buildings and homes market by sector. It further highlights how Irish enterprises are positioned to capture the domestic market for the technology in 2030.

Figure 19: Market size by sector in 2030 for smart buildings and homes for the Irish Market



Source: SEAI Supply Chain Analysis

The multidimensional nature of the smart buildings market makes determining a definitive value chain a complex task. Furthermore, different sectors will also tend to have quite different value chain shares. For example, retail will account for a larger share of the residential BACS market share than it will in the non-residential sector market. In Ireland, some companies are already doing well in this area and the ability of the Irish supply chain to capture future investment is considered to be high. Projections suggest that new jobs will be created for installers, design consultants, architects, contractors and energy experts. For these newly created jobs, it will be necessary to establish competence requirements supported by accreditation and certification.

A model supply chain for smart buildings and homes was created to break down costs along the supply chain and ascertain the equipment and services that are likely to be domestically sourced. This has been presented in Appendix 1 (Fig 35) and Appendix 2 (Fig 47).

5.2 Energy efficient construction

Energy efficient construction involves installing components in housing to increase the energy efficiency performance and reduce lost heat and energy. These retrofit installations come in two categories: deep and shallow. A shallow retrofit involves incremental improvements like insulation and lighting upgrades, resulting in modest savings. Deep retrofits, however, are comprehensive overhauls integrating multiple measures simultaneously to significantly enhance efficiency, such as extensive insulation, high-performance windows, and advanced heating systems. However, shallow and deep retrofits are distinguished not by the specific measures implemented but by the depth of the upgrade in energy performance. The distinction lies in the overall impact, with deep retrofits transforming buildings into nearly zero-energy or zero-emission structures through substantial reductions in energy use and emissions.

The Climate Action Plan includes targets to improve the energy performance of Irish homes. Homes are assessed against Building Energy Rates, which score homes on a scale from A-G. The Climate Action Plan has a key target of achieving the equivalent of 120,000 dwellings retrofitted to BER B2 or cost optimal equivalent by 2025, and 500,000 dwellings by 2030.[188] Stricter requirements will also be placed on new buildings. In April 2024, the CSO published data indicating that 1.2 million unique dwellings have received a BER assessment since 2009 and out of these circa 1 million homes are rated B3 or below.[189]

The Climate Action Plan also outlines goals for installing heat pumps in homes instead of boilers. 680,000 heat pumps are to be installed by 2030. This includes installations in both new and existing buildings.[190] The Build 2024 report states that the total investment in building and construction is €31.5 billion in 2023. Such investment along with continued collaboration between the public and private sectors is expected to support the growth of energy efficient construction initiatives in the Irish market.[191]

As part of the supply chain analysis, the market size for energy efficient construction in Ireland, the EU and globally was estimated to provide a total estimated range of annual investments for the technology in 2030. The potential Irish share, or the ability of Irish enterprises to capture the domestic and EU markets, was then calculated. The approach and methodology have been detailed in chapter 1.1 and a summary of findings has been presented below.

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[188] Construction Procurement Ireland (2024), '*Climate Action Plan 2024*,' https://constructionprocurement.gov.ie/sustainability/climate-action-plan-2024/

[189] Table 2 'BERs by Period of Construction (2009-2024)' was used to calculate the figure of circa 1 million homes with a BER of B3 or below, CSO (2024), *Domestic Building Energy Ratings Quarter 1 2024*, https://www.cso.ie/en/releasesandpublications/ep/p-dber/domesticbuildingenergyratingsquarter12024/

[190] Pg 20. Government of Ireland (2024), '*Climate Action Plan 2024*', DECC, https://assets.gov.ie/296414/7a06bae1-4c1c-4cdc-ac36-978e3119362e.pdf

[191] Pg 8, Government of Ireland (2024), *'Build 2024 - Construction Sector Performance and Capacity'*, Department of Public Expenditure, NDP Delivery and Reform, https://www.gov.ie/en/publication/ceb9d-build-2024-construction-sector-performance-and-capacity/

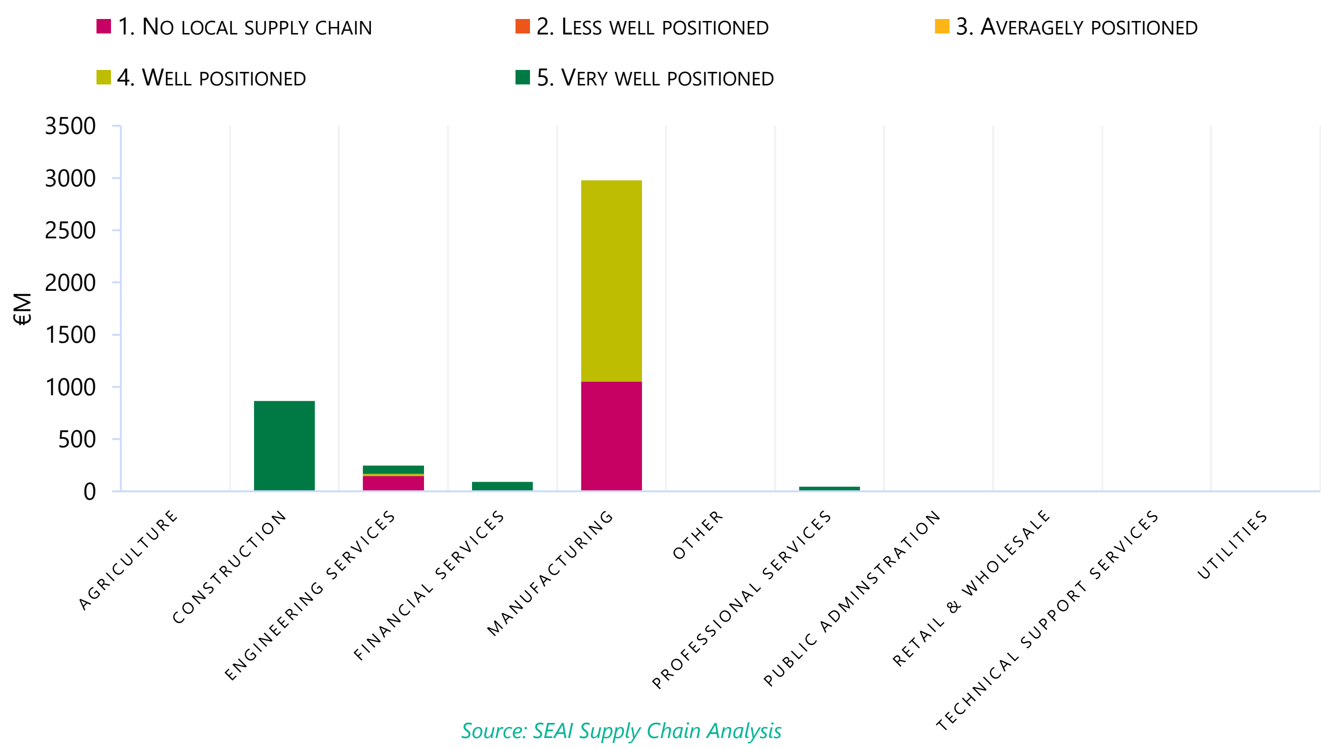
Summary of Findings: The average market size estimated in the supply chain analysis is €4.2bn (Table 9) for energy efficient construction. Irish enterprise could potentially supply an estimated 58% of the total domestic market for energy efficient construction in 2030.

Table 9: Market size in 2030 and Irish Share for energy efficient construction in Ireland and EU-27+UK

Capacity	Irish Market		EU-27+UK Market	
	Market Size (M€)	Irish Share (M€)	Market Size (M€)	Irish Share (M€)
1. No local supply chain	1,196	120	191,068	478
2. Less well positioned	0	0	2,702	20
3. Averagely positioned	0	0	0	0
4. Well positioned	1,950	1,365	0	0
5. Very well positioned	1,084	975	0	0
Total	**4,230**	**2,460**	**193,770**	**498**

Figure 20 breaks down the €4.2 billion of estimated total value of energy efficient construction market by sector. It further highlights how Irish enterprises are positioned to capture the domestic market for the technology in 2030.

Figure 20: Market size by sector in 2030 for energy efficient construction for the Irish Market



Source: SEAI Supply Chain Analysis

A model supply chain for energy efficient construction was created to break down costs along the supply chain and ascertain the equipment and services that are likely to be domestically sourced. This has been presented in Appendix 1 (Fig 36) and Appendix 2 (Fig 48) and the key findings about the technology have been summarised below.

The supply chain for energy efficient construction can be divided into three categories:
(1) the preliminary phase, involving the feasibility studies, planning and permitting and design stages,
(2) procurement and materials supply, and
(3) installation and quality assurance.

Ireland is very well positioned to capture the entirety of preliminary phase of the supply chain, which includes jobs for structural engineers, surveyors, design and build contractors and architectural technicians.

Procurement and materials supply represent over half of total energy efficient construction costs. Ireland is well positioned to supply the most expensive components, such as the cavity wall insulation, double/triple glazing, internal and external cladding, attic insulation, commercial and public sector heating controls and the heat pump. Installation and commissioning represent the next largest proportion of energy efficient construction costs at 22.6%. Irish mechanical, electrical, and construction contractors are well positioned to supply these services.

5.3 Sustainable biomass heating for buildings

Solid biomass, such as logs, wood chips and pellets, can be utilised in boilers to provide renewable heat in domestic and commercial buildings. Biomass boilers are much more expensive than natural gas equivalents, however the costs for operation and management tends to be lower due to the lower costs associated with the feedstock. Additionally, there is government support for biomass heating systems via the Support Scheme for Renewable Heat (SSRH)[192] which provides financial incentives for businesses to switch from fossil fuels to biomass heating.

Biomass feedstocks are typically sourced from forestry products such as pellets, chips, logs and sawmill residue but also include municipal, agricultural and horticultural waste. Pellets and logs tend to be used for smaller installations whilst chips are used for larger buildings.

The National Heat Study, a comprehensive analysis of Ireland's heating sector, highlights the significant potential for biomass to contribute to the country's renewable heat targets.[193] The study identifies key applications and sectors where biomass can be deployed most effectively, such as in energy-intensive industries and large commercial buildings. By aligning SSRH incentives with the insights from the National Heat Study, Ireland can strategically promote the adoption of biomass heating systems in the most impactful areas, accelerating the decarbonisation of the built environment and industry.

As part of the supply chain analysis, the market size for sustainable biomass heating for buildings in Ireland, the EU and globally was estimated to provide a total estimated range of annual investments for the technology in 2030. The potential Irish share, or the ability of Irish enterprises to capture the domestic and EU markets, was then calculated. The approach and methodology have been detailed in chapter 1.1 and a summary of findings has been presented in the following section.

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[192] SEAI (2024), '*Support Scheme for Renewable Heat*', https://www.seai.ie/business-and-public-sector/business-grants-and-supports/support-scheme-renewable-heat/
[193] SEAI (2022), '*National Heat Study Summary Report*', https://www.seai.ie/publications/National-Heat-Study-Summary-Report.pdf

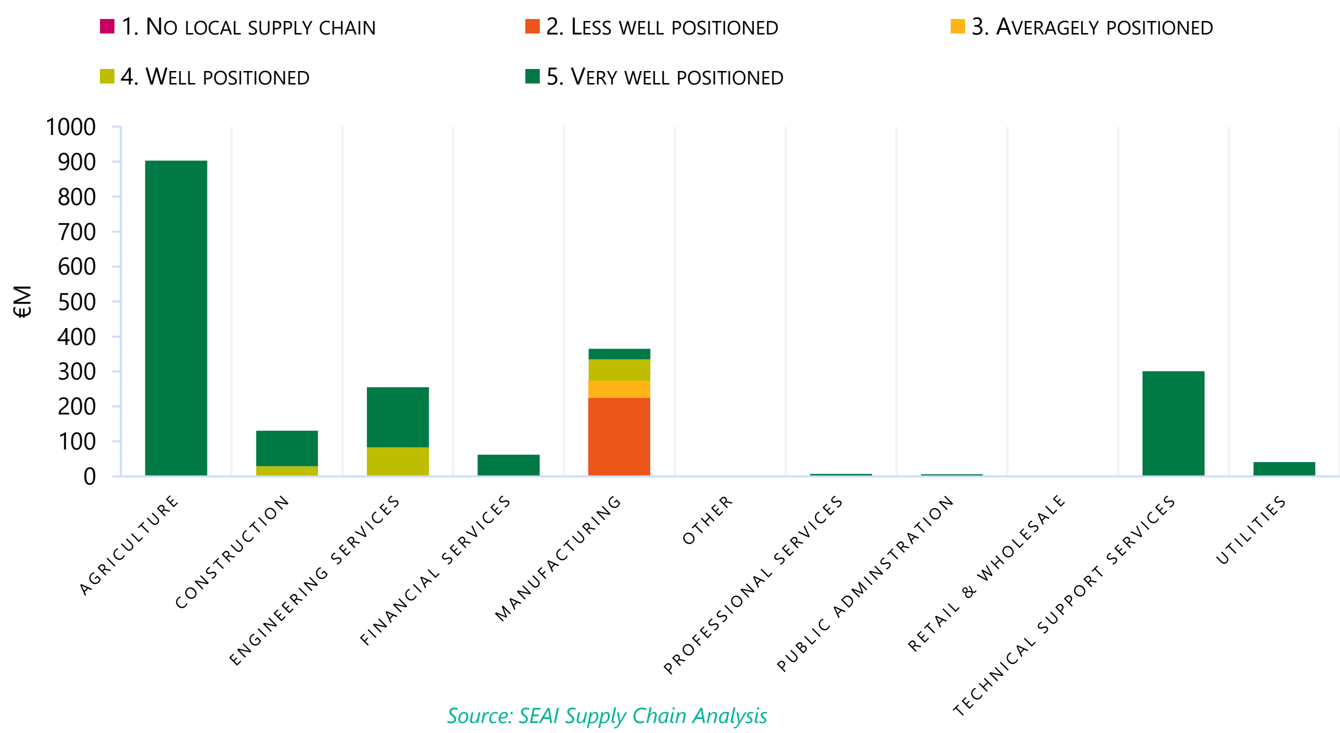
Summary of Findings: The average market size estimated in the supply chain analysis is €2 billion (Table 10). Irish enterprise could potentially supply an estimated 80% of the total domestic market for sustainable biomass heating for buildings in 2030.

Table 10: Market size in 2030 and Irish Share for sustainable biomass heating for buildings in Ireland and EU-27+UK

Capacity	Irish Market		EU-27+UK Market	
	Market Size (M€)	Irish Share (M€)	Market Size (M€)	Irish Share (M€)
1. No local supply chain	0	0	293,622	734
2. Less well positioned	224	67	59,176	444
3. Averagely positioned	49	24	0	0
4. Well positioned	175	123	0	0
5. Very well positioned	1,623	1,461	0	0
Total	**2,071**	**1,675**	**352,798**	**1,178**

Figure 21 breaks down the €2 billion of estimated total value of sustainable biomass heating for buildings market by sector. It further highlights how Irish enterprises are positioned to capture the domestic market for the technology in 2030.

Figure 21: Market size by sector in 2030 for sustainable biomass heating for the Irish Market



Source: SEAI Supply Chain Analysis

A model supply chain for sustainable biomass heating for buildings was created to break down costs along the supply chain and ascertain the equipment and services that are likely to be domestically sourced. This has been presented in Appendix 1 (Fig 37) and Appendix 2 (Fig 49) and the key findings about the technology have been summarised below.

The supply chain for sustainable biomass heating can be divided into three categories:
(1) the preliminary phase, involving the feasibility studies, planning and permitting and design stages,
(2) procurement and materials supply, and
(3) installation and quality assurance.

Ireland is very well positioned to capture the preliminary phase of the supply chain, which includes jobs for environmental and engineering consultants for the feasibility studies and project planners and financial, legal and technical advisers for planning and permitting. Ireland is also well positioned to provide the mechanical, electrical and civil engineering expertise for the design and procurement of biomass components.

Procurement and materials supply cover 71% of total biomass boiler costs. Ireland could provide the mechanical handling equipment as well as the feedstock store, equalling 13% of total costs. Installation and commissioning represent the second highest percentage of total capital costs at 18%. The Irish economy is mostly well positioned to capture the entirety of the process, including the groundworks, device assembly and control, mechanical, electrical and civil engineering. Irish mechanical, electrical, and construction contractors are well positioned to supply these services. Ireland is also well positioned to capture the annual operation and maintenance costs.

Finally, it is important to recognise the inter-relationship between biomass, bioenergy, and the bioeconomy; and the cascading use of biomass in our energy strategies.[194] By exploring the co-location of sustainable energy technologies alongside other innovations, biomass utilisation can be optimised in both regional and national contexts.

5.4 District heating

District heating (DH) systems deliver centrally generated heat for space heating and water heating needs to homes, businesses and public buildings through a network of underground insulated pipelines. Consumption is then metered at each building in much the same way as electricity. As heat rather than fuel is supplied to end-users, a district heating network is fuel agnostic. The heat can be recovered from a variety of sources including, for example, the 'waste' heat of thermal generation on industrial sites or recovered from rivers or the sea by large industrial heat pumps. It can also be produced from natural gas, biomass, and combined heat and power (CHP) plants. Depending on the supply of heat, district heating systems can be a highly cost-effective and low-carbon option.[195]

Smart controls are opening up several potential synergies between district heating and electricity systems that rely on variable renewable energy. Low-cost excess generation can be used to power large-scale heat pumps or stored in cheap thermal storage tanks. In contrast, when renewable electricity output is low, CHP plants can be used to simultaneously meet heat and electricity demands.

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[194] National Resources Institute Finland, (2023), *'Cascade vision: Regionally adaptive circular bioeconomy – added value, wellbeing and resource wisdom with cascade processing'*, https://jukuri.luke.fi/bitstream/handle/10024/553376/luke-luobio_52_2023.pdf?sequence=4
[195] IEA (2023), '*District Heating - Energy System*', https://www.iea.org/energy-system/buildings/district-heating

Currently, approximately 60 million EU citizens are served by district heating. According to reports by the EU and the IEA, DH currently meets around 11-12% of the EU's heat demand via 6,000 District Heating and Cooling (DHC) networks.[196] The proportion of district heating varies significantly across different regions in Europe. In traditionally colder countries in Northern and Eastern Europe, such as the Nordic and Baltic regions and Poland, district heating is the predominant urban heating solution. In contrast, district heating has historically played a minimal role in Southern Europe and certain Western European nations, including Ireland, the Netherlands, and the United Kingdom. This is attributed to milder climates and different energy strategies in these regions. There is substantial potential to scale up this contribution. The Heat Roadmap Europe estimates that the waste heat from power generation in Europe could play a crucial role in meeting its heat demands.[197]

In Ireland, district heating supplies less than 1% of the total heat consumption, one of the lowest shares in Europe.[198] The barriers to district heating tend to be non-technical, as the technologies involved are not new. There are often barriers around stakeholder awareness when there is a lack of history of district heating as a utility. There are also barriers on the demand side, relating to population density. In order for district heating to be economically feasible, there needs to be a sufficient heat demand within a given area. This is because the denser the heat demand, the shorter the pipelines required, which means lower investment costs, and lower operational costs through lower losses and lower pumping requirements.

In much of Ireland, where there is low population density, district heating is economically unsuitable. Nevertheless, Ireland has significant potential for district heating, with estimates from the National Heat study indicating that up to 50% of the building heating demand in Ireland could be met by district heating systems. [199] The Irish government has set ambitious targets for district heating, aiming to deliver 2.7 TWh of heat annually through district networks by 2030 as part of its Climate Action Plan.[200]

The launch of the Tallaght District Heating Scheme, which utilises waste heat from a local data centre to provide low-carbon heating to public buildings in the area, marked a significant milestone in demonstrating the viability and potential of district heating in Ireland.[201] Additionally, other large-scale projects, such as the Dublin District Heating Scheme, are expected to enhance the role of district heating in meeting the country's heating needs.[202] Local-level planning, including energy mapping, will be essential for identifying suitable areas for district heating networks, thereby maximising their contribution to Ireland's energy landscape in the coming years.[203]

As part of the supply chain analysis, the market size for district heating in Ireland, the EU and globally was estimated to provide a total estimated range of annual investments for the technology in 2030. The potential Irish share, or the ability of Irish enterprises to capture the domestic and EU markets, was then calculated. The approach and methodology have been detailed in chapter 1.1 and a summary of findings has been presented in the following section.

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[196] Mordor Intelligence (2024), '*Europe district heating market size & share analysis – growth trends & forecasts (2025 – 2030)*' https://www.mordorintelligence.com/industry-reports/europe-district-heating-market
[197] Heat Roadmap Europe (2018), '*Heat Roadmap Europe: Low-carbon heating & cooling strategies for Europe*', https://heatroadmap.eu/#
[198] Pg 1, SEAI (2022), '*National Heat Study: District Heating and Cooling*', https://www.seai.ie/sites/default/files/publications/District-Heating-and-Cooling.pdf
[199] Ibid
[200] Pg 39, Government of Ireland (2024*), 'Climate Action Plan 2024'*, DECC, https://assets.gov.ie/296414/7a06bae1-4c1c-4cdc-ac36-978e3119362e.pdf
[201] Codema (2024), *'Tallaght District Heating Scheme'*, https://www.codema.ie/our-work/tallaght-district-heating-scheme/
[202] Dublin City Council (2021), '*Report on Dublin District Heating Project*', https://www.dublincity.ie/sites/default/files/2021-05/spc-update-05-may-2021.pdf
[203] SEAI (2024), '*District Heating Map*', https://www.seai.ie/data-and-insights/district-heating-map

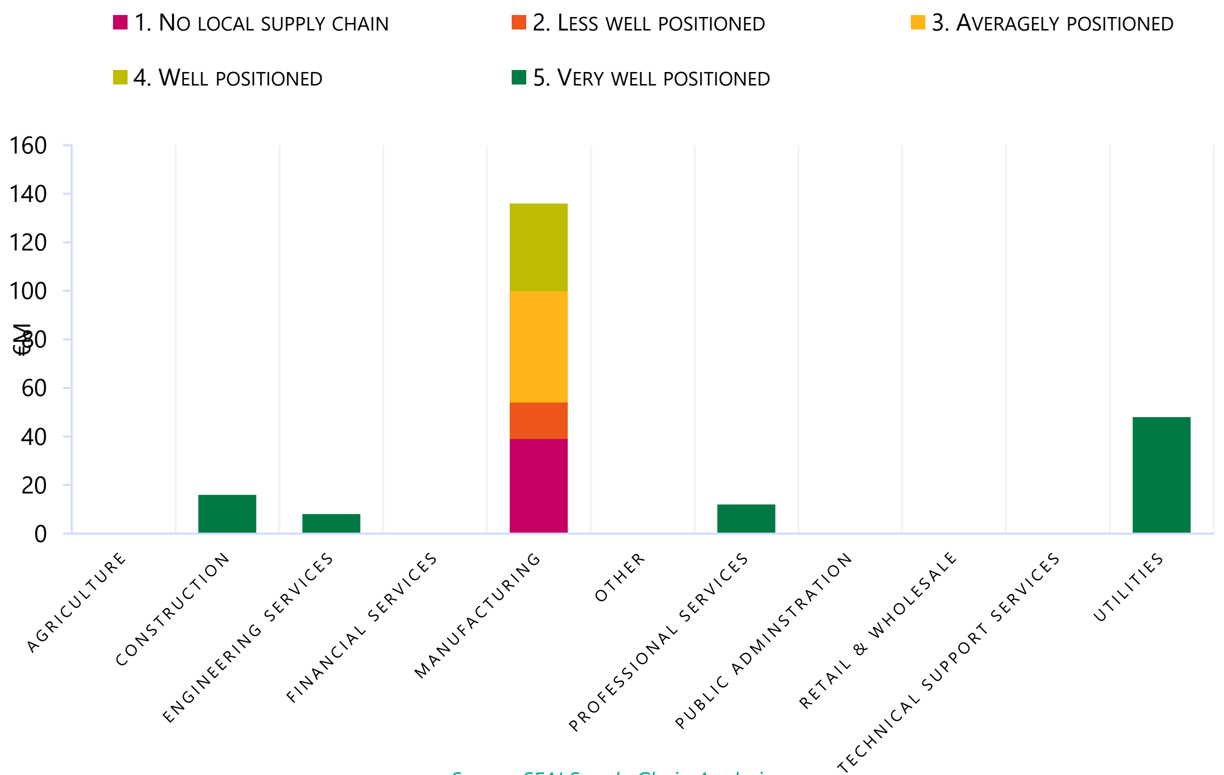
Summary of Findings: The average market size estimated in the supply chain analysis is €221 million (Table 11). Irish enterprise could potentially supply an estimated 60% of the total domestic market for district heating in 2030.

Table 11: Market size in 2030 and Irish Share for district heating in Ireland and EU-27+UK

Capacity	Irish Market		EU-27+UK Market	
	Market Size (M€)	Irish Share (M€)	Market Size (M€)	Irish Share (M€)
1. No local supply chain	39	4	65,180	163
2. Less well positioned	15	4	0	0
3. Averagely positioned	46	23	0	0
4. Well positioned	37	26	0	0
5. Very well positioned	84	76	0	0
Total	**221**	**132**	**65,180**	**163**

Figure 22 breaks down the €221 million of estimated total value of district heating market by sector. It further highlights how Irish enterprises are positioned to capture the domestic market for the technology in 2030.

Figure 22: Market size by sector in 2030 for district heating for the Irish Market



Source: SEAI Supply Chain Analysis

A model supply chain for district heating was created to break down costs along the supply chain and ascertain the equipment and services that are likely to be domestically sourced. This has been presented in Appendix 1 (Fig 38) and Appendix 2 (Fig 50) the key findings for this technology have been summarised below.

The largest share of the upfront investment for district heating is for pipework, which represents 27% of capital costs. Ireland is averagely positioned to capture this investment. Depending on the heat supply, a significant portion of investment is also required for the prime mover and ancillary plants, which respectively account for an estimated 26% and 9% of the capital costs in the supply chain. Ireland has no domestic market for CHP units and is less well positioned for most ancillary plants. However, there are other heat generation technologies that could be adopted, for example, the Tallaght District Heating Scheme utilises waste heat and innovative heat pump technology.[204]

However, Ireland is very well positioned to capture investment in installation and commissioning of district heating systems, which equates to roughly 10.5% of costs in the supply chain. Significant work could be created for electrical, mechanical, and civil engineering firms. Ireland is also strongly positioned to capture all of the services associated with operations, maintenance and fuel feedstock for district heating systems. As Ireland has no significant manufacturing base in this area, the export opportunities associated with District Heating is likely to be limited.

[204] Pg 15, SEAI (2020), '*Heat Pump technology Guide*', https://www.seai.ie/publications/Heat-Pump-Technology-Guide.pdf

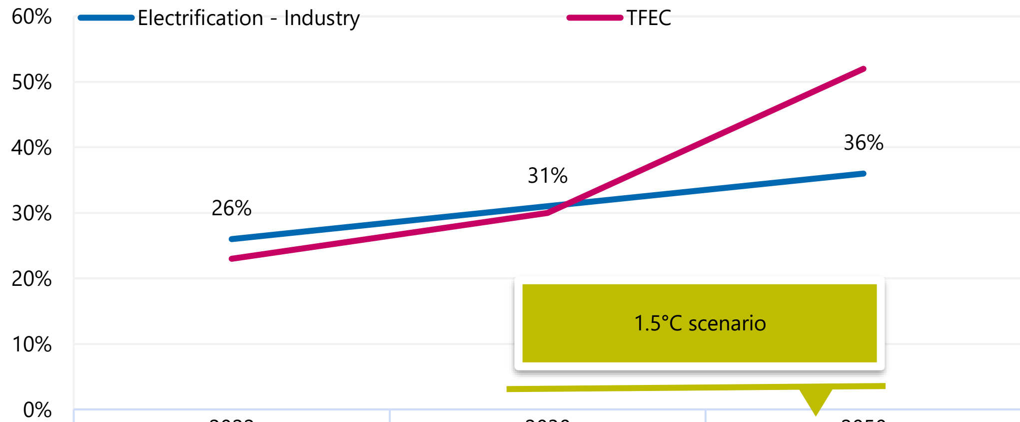
6 Energy in industry

The industry sector is responsible for about one-quarter of energy-related CO_2 emissions globally[205] **and 10% in Ireland**.[206] Industry's lower share of energy-related CO_2 emissions in Ireland is primarily due to the country's relatively limited activity in the heavy industrial sectors that are responsible for the most energy consumption, including iron, steel, aluminium, chemicals and petrochemicals and cement. The decarbonisation of industry is particularly challenging and technologies such as renewable hydrogen and carbon capture and storage may be required to achieve net zero emissions in the sector over the longer term.

Several technologies are available that can lead to significant emissions reductions prior to 2030. Improved energy efficiency measures can be a first step to reducing emissions. Electrification of certain industrial processes currently powered by fossil fuels can also lead to reduced emissions. For example, electric heat pumps can be used in several industrial processes including, channelling industrial waste heat to process water, central heating systems, blanchers and dryers. Additionally, electric boilers are widely available while electric furnaces for industrial heat demand up to 1,000 ^{0}C are technologically feasible but not yet commercially available for all applications.[207] Sustainable biomass, waste and anaerobic digestion plants that convert organic matter into biogas can be used to provide renewable process heat. Renewable hydrogen and carbon capture and storage are also expected to contribute towards the decarbonisation of industry over the longer term, and there is ongoing work in Ireland to assess their feasibility.

IRENA's recent analysis outlines that to align with the 1.5°C by 2050 target, substantial efforts would be required in the industry sector. As seen in figure 23 by 2030, the electrification rate in the industry sector is expected to reach 31%. And looking further ahead to 2050, industry sector's electrification rate will need to rise to 36%.[208]

Figure 23: Global electrification in industry sector and Total final energy consumption (TFEC) under the 1.5°C Scenario in 2022, 2030 and 2050



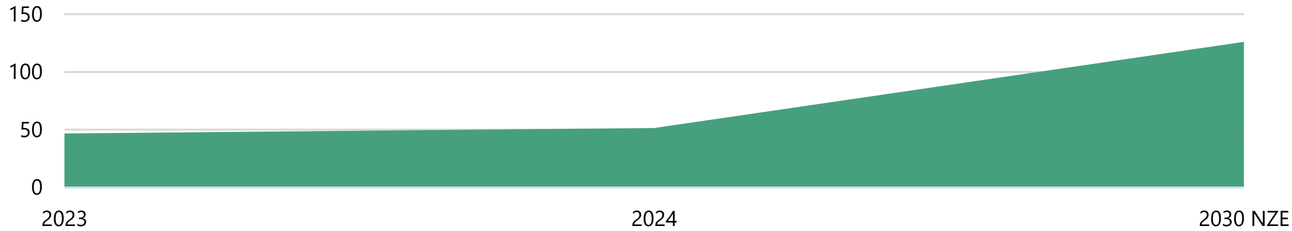
	2022	2030	2050
Electrification - Industry	26%	31%	36%
TFEC	23%	30%	52%

Source: IRENA (2024), World Energy Transitions Outlook 202: 1.5° C Pathway

[205] IEA (2024), '*Industry – Energy System*' https://www.iea.org/energy-system/industry
[206] Table 7.1, SEAI (2024), '*Energy in Ireland*' https://www.seai.ie/sites/default/files/publications/energy-in-ireland-2024.pdf
[207] Pg 4, McKinsey & Company (2020), '*Plugging in: What electrification can do for industry*', https://www.mckinsey.com/~/media/McKinsey/Industries/Electric%20Power%20and%20Natural%20Gas/Our%20Insights/Plugging%20in%20What%20electrification%20can%20do%20for%20industry/Plugging-in-What-electrification-can-do-for-industry-vF.pdf
[208] Based on Fig 1.5, Pg 37, IRENA (2024), '*World Energy Transitions Outlook 2024: 1.5°C Pathway*', https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Nov/IRENA_World_energy_transitions_outlook_2024.pdf

The IEA's World Energy Investment 2024 report highlights that the global investments in energy efficiency in the industrial sector declined in 2023, reversing the gains from the preceding two years. [209] It further suggests that achieving 2050 decarbonisation targets will require nearly tripling of investments in end use sectors by 2030.[210] Figure 24 presents the global energy efficiency-related industry investment required in the Net Zero Scenario leading up to 2030.[211]

Figure 24: Global energy efficiency-related industry investment in the Net Zero Scenario, 2023-2030 ($ billion)



Source: IEA (2023), Data and statistics - Global energy efficiency-related end-use investment in the Net Zero Scenario

Ireland has several policies aimed at promoting energy efficiency. The Finance Act of 2010 introduced a carbon tax to mineral oils, natural gas and solid fuels supplied for combustion, which promotes more efficient consumption. It also adopted the Energy Efficiency Obligation Scheme (EEOS) in 2014 in compliance with EU 2012 Energy Efficiency Directive. The scheme was designed to promote energy efficiency in homes, businesses and communities in Ireland.[212] The redesigned EEOS, which commenced on January 1, 2023, builds on the previous scheme established in 2014. This new legislation requires larger energy companies to assist energy users in achieving energy savings, thereby contributing significantly to Ireland's energy-saving targets under the revised EU Energy Efficiency Directive (EED).[213]

Ireland has substantial room for improvement when it comes to using renewable energy to meet heating needs. It has been observed that an increased use of renewable wastes in industry has contributed to a recent growth in Ireland's renewable energy use for heat. [214] Despite the indicated growth, Ireland has substantial room for improvement as it has the lowest share of renewable sources for heating and cooling, compared to the rest of EU.[215]

Several support measures are in place to encourage renewable heat and the electrification of industry. SEAI's SSRH encourages the adoption of biomass, heat pumps and anaerobic digestion systems by commercial, industrial, agricultural, district heating, public sector and other non-domestic heat users. The scheme provides installation grants to bridge the gap between the installation and operating costs of renewable heating systems and the conventional fossil fuel alternatives.[216]

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[209] Pg 151, IEA (2024), '*World Energy Investment 2024*', https://iea.blob.core.windows.net/assets/60fcd1dd-d112-469b-87de-20d39227df3d/WorldEnergyInvestment2024.pdf
[210] Pg 153, Ibid.
[211] Figure 24 is based on the IEA graph on Global energy efficiency-related end-use investment in the Net Zero Scenario, 2019-2030, https://www.iea.org/data-and-statistics/charts/global-energy-efficiency-related-end-use-investment-in-the-net-zero-scenario-2019-2030
[212] SEAI (2023), *'Energy Efficiency Obligation Scheme (EEOS)'*, https://www.seai.ie/business-and-public-sector/business-grants-and-supports/energy-efficiency-obligation-scheme/
[213] Government of Ireland (2023), '*New legislation introduced for the Energy Efficiency Obligation Scheme*',DECC https://www.gov.ie/en/press-release/e5331-new-legislation-introduced-for-the-energy-efficiency-obligation-scheme/
[214] Pg 133, SEAI (2024), '*Energy in Ireland*' https://www.seai.ie/sites/default/files/publications/energy-in-ireland-2024.pdf
[215] Eurostat (2024), '*Renewable energy for heating & cooling up to 25% in 2022*', https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20240227-2
[216] SEAI (2024), '*Support Scheme for Renewable Heat (SSRH)*', https://www.seai.ie/business-and-public-sector/business-grants-and-supports/support-scheme-renewable-heat/

Ireland's Climate Action Plan 2024 emphasises the development and stabilisation of the indigenous supply of biomass for renewable heat. The plan outlines several key strategies and actions to enhance the use of biomass as a sustainable energy source. One major initiative is the introduction of a Renewable Heat Obligation (RHO),[217] which will require a certain proportion of energy supplied in the heat sector to come from renewable sources, including biomass. This obligation aims to incentivise suppliers to integrate renewable heat into their offerings, thereby increasing the share of renewable energy in the heating sector.

6.1 Electrification of industry (heat pumps)

The requirements for heating in industry are highly specific. As described above, electrification of industry can be achieved using a variety of different technologies such as boilers and furnaces. This section focuses specifically on industrial heat pumps.

The diversity of the industrial heat pump makes it attractive for many applications where both heating and cooling are required. For instance, a heat pump can use the waste heat from the refrigeration system to provide heat for drying processes, while also meeting cooling demands. Heat pumps are typically used for processes that operate in the low-temperature range (up to 160 °C) including distillation, dehumidification, evaporation processes, and water heating or cooling. Food and beverage, chemicals and petroleum are the major end-use sectors. Electrification using highly efficient heat pumps in countries with a low carbon electricity grid can lead to a very deep level of decarbonisation.

The global market for industrial heat pumps was valued at $ 9.5 billion in 2023.[218] The size of the industrial heat pump market in Europe has been valued at approximately $ 460 million in 2023 and is expected to grow at a CAGR of over 5.7% from 2024 to 2032.[219] Ongoing regulatory measures pertaining to energy optimisation across various industries will significantly raise the product demand. Moreover, growing consumer awareness around clean energy technologies will support market trends for industrial heat pumps, resulting in a rise in their installation.

Although the market for industrial heat pumps in Ireland is currently limited, continuous improvements in heat pump technology and increasing demand for low-temperature heating solutions will contribute to the anticipated growth of the industrial heat pump market in Ireland. Further, SSRH's financial incentives, targeted support and alignment with climate goals is collectively expected to drive the growth of the industrial heat pump market in Ireland.

As part of the supply chain analysis, the market size for industrial heat pumps in Ireland, the EU and globally was estimated to provide a total estimated range of annual investments for the technology in 2030. The potential Irish share, or the ability of Irish enterprises to capture the domestic and EU markets, was then calculated. The approach and methodology have been detailed in chapter 1.1 and a summary of findings has been presented in the section below.

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[217] Government of Ireland (2023), '*Renewable Heat Obligation*', DECC, https://www.gov.ie/en/publication/7a1f1-renewable-heat-obligation/#introduction-of-a-renewable-heat-obligation

[218] Business Wire (2024), '*Industrial Heat Pump Industry Research 2024: $9.5 Billion Market Trends, Opportunities and Forecasts 2020-2024 & 2025-2030 - Expansion Driven by Increasing Energy Efficiency Requirements - ResearchAndMarkets.com*', https://www.businesswire.com/news/home/20241111035981/en/Industrial-Heat-Pump-Industry-Research-2024-9.5-Billion-Market-Trends-Opportunities-and-Forecasts-2020-2024-2025-2030---Expansion-Driven-by-Increasing-Energy-Efficiency-Requirements---ResearchAndMarkets.com#:~:text=Global%20Industrial%20Heat%20Pump%20Market,applications%20across%20various%20industrial%20sectors.

[219] Global Market Insights Inc. (2024), '*Europe Industrial Heat Pump Market Share, 2024-2032 | Statistics Report*', https://www.gminsights.com/industry-analysis/europe-industrial-heat-pump-market

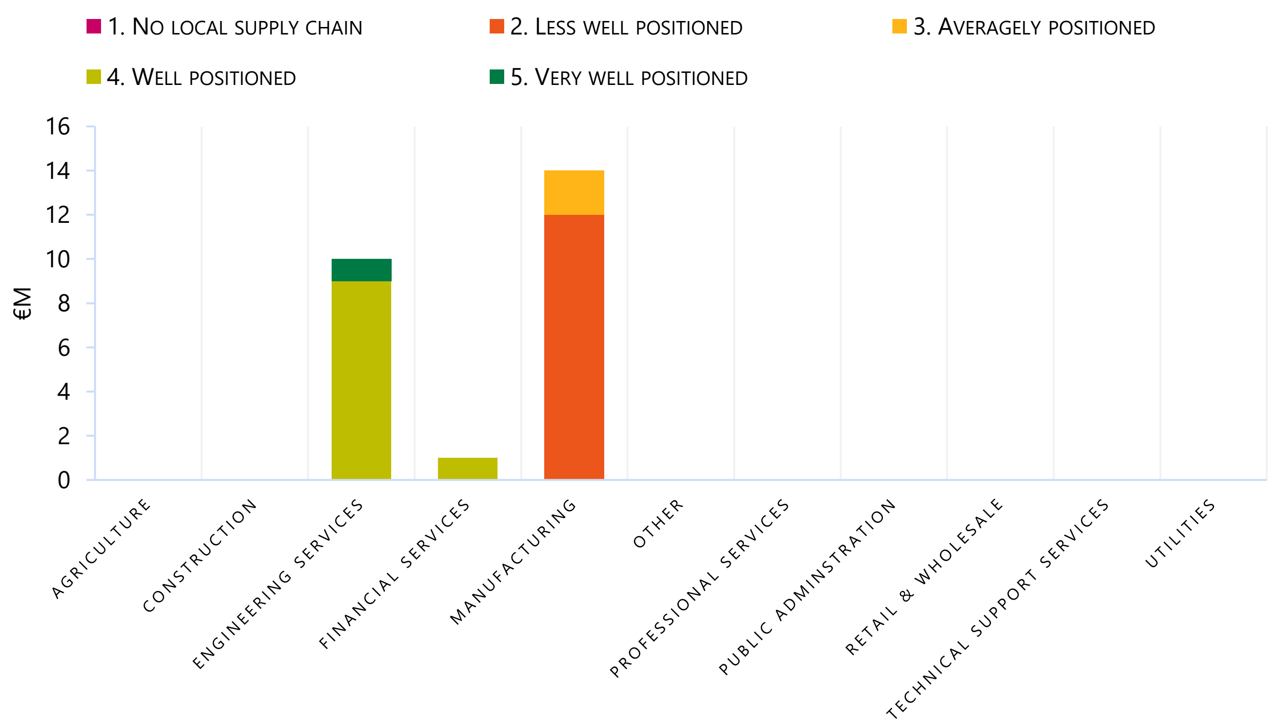
Summary of Findings: The average market size estimated in the supply chain analysis is €25 million (Table 12). Irish enterprise could potentially supply an estimated 52% of the total domestic market for industrial heat pumps in 2030.

***Table 12:* Market size in 2030 and Irish Share for industrial heat pumps in the Ireland and EU-27+UK**

Capacity	Irish Market		EU-27+UK Market	
	Market Size (M€)	Irish Share (M€)	Market Size (M€)	Irish Share (M€)
1. No local supply chain	0	0	588	1
2. Less well positioned	12	4	0	0
3. Averagely positioned	2	1	0	0
4. Well positioned	10	7	0	0
5. Very well positioned	1	1	0	0
Total	**25**	**13**	**588**	**1**

Figure 25 breaks down the €25 million of estimated total value of industrial heat pump market by sector. It further highlights how Irish enterprises are positioned to capture the domestic market for the technology in 2030.

Figure 25: Market size in 2030 and Irish Share for industrial heat pumps in the Irish market



Source: SEAI Supply Chain Analysis

A model supply chain for industrial heat pumps was created to break down costs along the supply chain and ascertain the equipment and services that are likely to be domestically sourced. This has been presented in Appendix 1 (Fig 39) and Appendix 2 (Fig 51) and the key findings for the technology have been summarised below.

The supply chain includes costs associated with air source and ground source heat pumps, which were scaled according to their projected deployments within the industry. The costs are split between preliminary activities, the procurement and material supply required for the technology components, installation and quality assurance and the operation and maintenance costs. Ireland is very well positioned to supply the permitting and the legal, financial and commercial advisers for the planning and permitting of industrial electrification projects, equating to 2.7% of total costs.

The manufacturing structure in the supply chain map has been split to show the components required for ground source (left column) and air source heat pumps (right column). Overall, Ireland is not well positioned to capture the costs for either variation of the technology.

However, Irish enterprises could provide the expertise required for installing the heat pumps which total 38.2% of project costs and include the administration, labour, distribution, mobilisation, drilling, groundwork and the ground loop installation.

Operational costs assume no decommissioning of heat pumps up to 2030 as a result of the assumed long lifetimes of heat pumps (in excess of 15 years).[220] Resultingly, the operation and maintenance costs are then split between the required electricity and maintenance of the heat pump at 69% and 31% of annual costs respectively. Ireland is well positioned to capture the costs for O&M services.

6.2 Biomass anaerobic digestion

Anaerobic Digestion (AD) is a natural process where plant and animal materials (biomass) are broken down by micro-organisms in the absence of air. The AD process begins when biomass is put inside a sealed tank or digester.

Naturally occurring micro-organisms digest the biomass, which releases a methane-rich gas (biogas) that can be used to generate renewable heat and power for industrial use. Biogas can be cleaned to produce biomethane, which can then be injected into the grid. Many forms of feedstock are suitable for AD, including food waste, slurry and manure, as well as crops and crop residues. Following the AD process, the remaining material (digestate) is rich in nutrients and can be used as a fertiliser.

AD is a well-established technology in Europe, with around 20,000 plants in operation, each averaging a size of 35 GWh.[221] In 2023, the combined production of biogas and biomethane reached 22 billion cubic meters (bcm), as reported by the European Biogas Association (EBA). This volume exceeds the total inland natural gas demand of Belgium, Denmark, and Ireland combined, and accounts for 7% of the European Union's natural gas consumption for the year.[222]

[220] Pg 66, IEA (2022), '*The Future of Heat Pumps*', https://iea.blob.core.windows.net/assets/4713780d-c0ae-4686-8c9b-29e782452695/TheFutureofHeatPumps.pdf

[221] Pg 33, Pg 9, Government of Ireland (2024), '*National Biomethane Strategy*', DECC, DAFM, https://www.gov.ie/en/publication/d115e-national-biomethane-strategy/

[222] European Biogas Association (2024), '*The EBA Statistical Report*' https://www.europeanbiogas.eu/22-bcm-of-biogases-were-produced-in-europe-in-2023according-to-a-new-report-released-today/

Among the measures being supported within the REPowerEU Plan, the EU Commission has set a target for 35 billion cubic metres (bcm) per annum of biomethane production capacity to be available across the EU by 2030.[223] It is observed that the EU has been successfully meeting most of the REPowerEU Plan's ambitious targets, so far. It is further estimated to be on track to achieve the medium to longer-term objectives.[224]

AD is is a relatively new technology in Ireland, but it has the potential to benefit greatly from the success and advancements seen across Europe. The current installed capacity is hard to assess, particularly in Ireland due to private ownership, however it is estimated that there are 43 facilities in Ireland producing 580 GWh of biogas, in addition to the two biomethane facilities.[225]

Ireland's National Biomethane Strategy highlights 25 key actions necessary to achieve the Climate Action Plan target of 5.7 TWh sustainable biomethane production by 2030; mainly focusing on the potential of the agricultural sector. [226] Furthermore, to support the need to decarbonise the heat sector, the Government of Ireland has agreed to the introduction of a Renewable Heat Obligation (RHO).

The RHO will support an increased use of renewable energy in the heat sector and contribute to a reduction in emissions in line with Ireland's climate ambitions. The RHO (under development by DECC and SEAI), will play a crucial role in guaranteeing a progressively increasing market demand for biomethane well beyond 2030.[227] In order to be eligible for support or obligation schemes, and to be counted towards national renewable energy shares, AD plants will need to be certified by an independent certification body operating according to an EU approved voluntary sustainability scheme.

As part of the supply chain analysis, the market size for biomass AD in Ireland, the EU and globally was estimated to provide a total estimated range of annual investments for the technology in 2030. The potential Irish share, or the ability of Irish enterprises to capture the domestic and EU markets, was then calculated. The approach and methodology have been detailed in, chapter 1.1 and a summary of findings has been presented in the following section.

[223] Pg 3, European Commission (2022), '*REPowerEU Plan*' https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022SC0230&from=EN
[224] European Commission (2024), '*REPowerEU – 2 years on*', https://energy.ec.europa.eu/topics/markets-and-consumers/actions-and-measures-energy-prices/repowereu-2-years_en
[225] Pg 9, Government of Ireland (2024), *'National Biomethane Strategy'*, DECC, DAFM, https://www.gov.ie/en/publication/d115e-national-biomethane-strategy/
[226] Pg 5, Ibid.
[227] Government of Ireland (2024), '*Renewable Heat Obligation*', DECC, https://www.gov.ie/en/publication/7a1f1-renewable-heat-obligation/

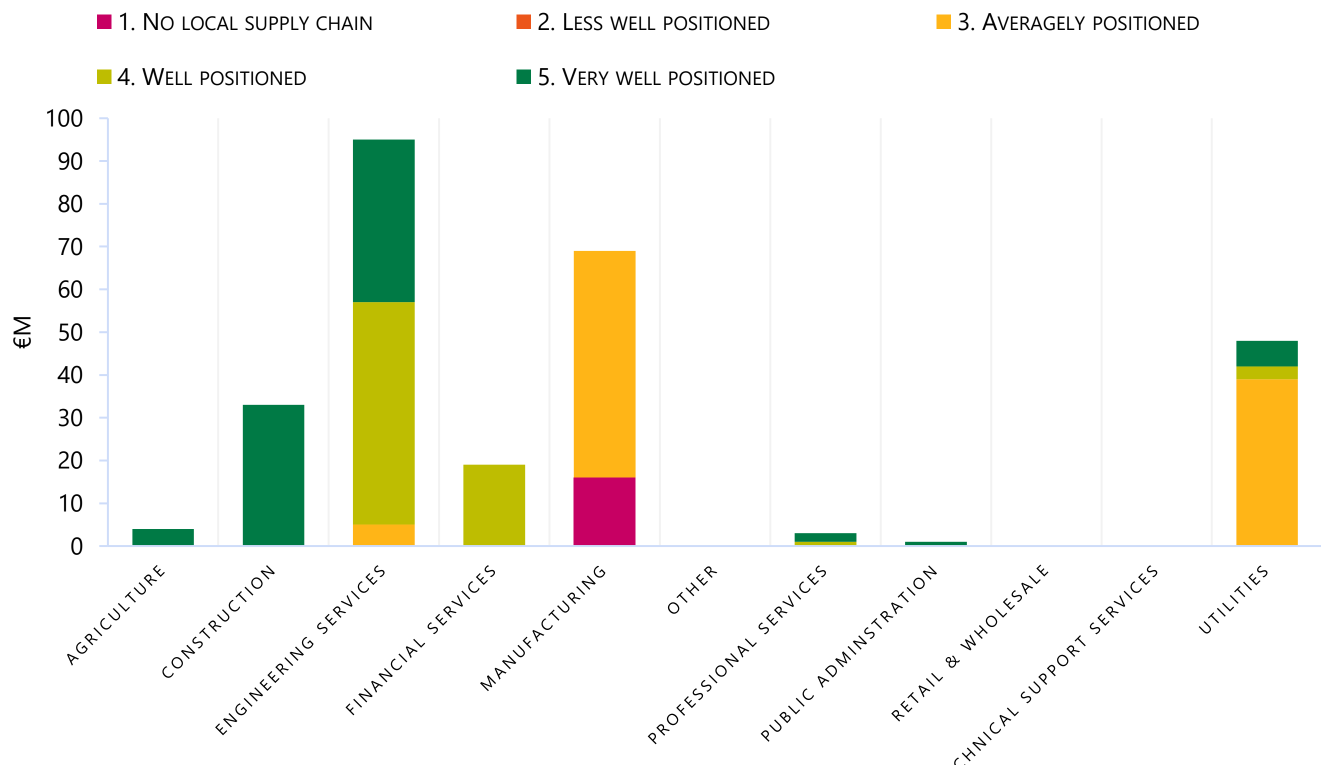
Summary of Findings The average market size estimated in the supply chain analysis is €273 million (Table 13). Irish enterprise could potentially supply an estimated 65% of the total domestic market for biomass anaerobic digestion in 2030.

Table 13: Market size in 2030 and Irish Share for biomass anaerobic digestion in Ireland and EU-27+UK

Capacity	***Irish Market***		***EU-27+UK Market***	
	Market Size (M€)	***Irish Share (M€)***	***Market Size (M€)***	***Irish Share (M€)***
1. No local supply chain	16	2	10,287	26
2. Less well positioned	0	0	606	5
3. Averagely positioned	97	49	0	0
4. Well positioned	75	52	0	0
5. Very well positioned	84	76	0	0
Total	**273**	**178**	**10,893**	**30**

Figure 26 breaks down the €273 million of estimated total value of biomass AD market by sector. It further highlights how Irish enterprises are positioned to capture the domestic market for the technology in 2030.

Figure 26: **Market size in 2030 and Irish Share for biomass AD in the Irish market**



Source: SEAI Supply Chain Analysis

A model supply chain for biomass AD was created to break down costs along the supply chain and ascertain the equipment and services that are likely to be domestically sourced. This has been presented in Appendix 1 (Fig 40) and Appendix 2 (Fig 52) and the key findings for the technology have been summarised below.

According to the analysis, Ireland is well positioned across the entire AD supply chain to capture the high installation costs. The preliminary phase accounts for 11% of a project which is split between feasibility studies, and planning and permitting. The Irish economy is very well positioned to capture the activities for environmental and engineering consultants, project planners and managers, legal and technical advisers and the local authority permits, which account for 10% of the project. Ireland is well positioned to capture the remaining 1% attributed to insurance.

The procurement and material supply phase accounts for just over two thirds of the total capital costs. Ireland is very well positioned for the design lifecycle stage, encompassing the project management and mechanical, electrical and civil engineering costs at approximately 11% of total project costs. Ireland is mostly well positioned to capture the manufacture and materials supply lifecycle stage, which accounts for over half of the capital costs.

Installation and quality assurance is the second most expensive phase, predominantly made expensive by the installation and commissioning. Ireland has different degrees of capture potential for the different engineering needs related to installing AD. Ireland is very well positioned to capture the mechanical engineering costs alongside the groundworks and device assembly.

As part of operation and maintenance, residue disposal and the electrical and mechanical engineering are well positioned in the Irish economy and account for over a third of the annual costs. The insurance and licenses required account for 16.6% and are well positioned in the Irish economy, but the operators which account for 37.8% and are less well positioned in the Irish economy. To enhance the effectiveness of operators in the biomethane sector, they are likely to be trained by technology suppliers.

The agriculture and horticulture waste, required as feedstocks and the necessary laboratory testing are all well positioned to be provided by Irish businesses and total approximately 9.7%.

The current installed capacity is relatively low, and scaling up to meet the ambitious targets will require significant investment and development of skills. In the near term, training courses will be essential to address the skills gap identified in the National Biomethane Strategy, which calls for a skills gap assessment to build capacity and skills required for an indigenous biomethane sector.[228]

[228] Pg 43, Government of Ireland (2024), *'National Biomethane Strategy'*, DECC, DAFM, https://www.gov.ie/en/publication/d115e-national-biomethane-strategy/

7 Key findings

The following details the key findings from the report:

1. **Market Share Potential**: The Irish supply chain has considerable potential to capture a share of the investment in sustainable energy technologies, particularly in construction, engineering services, and financial services.
2. **High-Value Markets**: The largest potential markets for Irish enterprises are in smart grids, electric vehicles, sustainable biomass heating and energy efficient construction. Irish companies could capture a share of these expanding markets.
3. **Domestic Focus**: The Irish supply chain is primarily tailored to serve the domestic market, with more limited capabilities to effectively engage with the EU and global markets.
4. **Strategic Opportunities**: There are strategic opportunities for Irish R&D teams to contribute to the development and testing of next-generation sustainable energy technologies.
5. **Enhance Local Manufacturing**: Although Ireland is unlikely to manufacture the key components of the technologies studied, local enterprises could still capture a share of the market by providing some services and equipment. Directing sufficient funding towards enhancing local manufacturing facilities and service businesses could support the growth of the domestic supply chain and further strengthen Ireland's position in the sustainable energy market.

The below section highlights how well the Irish supply chain is positioned to capture new business as a result of the anticipated investment across each of the sustainable energy related products and services studied within this report.

Onshore Wind

Ireland generates a higher proportion of its electricity from onshore wind than most countries in Europe. Irish companies are well positioned or very well positioned to provide services including environmental consulting, electrical engineering, civil engineering, legal and financial advisory services. While the domestic onshore wind market indicates an opportunity for Ireland, Irish enterprises are not as competitively positioned to compete in the EU and global markets. Although there are examples of considerable investment in onshore wind energy in Ireland, there is a need to strengthen investment to develop the onshore wind market and help increase the levels of energy generated from wind. While there are ambitious targets, supportive policies, and opportunities for Irish enterprises in the onshore wind market; there are also challenges related to decommissioning costs, planning and grid infrastructure, community acceptance, economic impact, and technological innovation. Addressing these challenges will be crucial to fully harness the potential of onshore wind energy in Ireland.

Solar PV

Ireland's solar PV market has undergone a transformation in recent years with rapid growth being driven by the government's ambitious targets, such as the CAP 2024's goal of 8 GW of solar capacity by 2030 as part of the country's broader 80% renewable electricity generation target. As of 2024, the total solar capacity in Ireland reached 1,185 MW, a substantial increase from 680 MW in 2023. This growth offers an opportunity for Irish enterprise in the domestic market. Given the strong growth trajectory and future potential of Ireland's solar PV market, the industry would benefit from prioritising efforts to address the key challenges including grid integration, planning/permitting delays, and supply chain issues, which need to be addressed to support continued solar growth. Irish companies could gain domestic market share in areas related to planning and permitting for ground mounted solar.

Microgeneration

Ireland has had limited development of rooftop solar to date. However, it is now recognised that solar could contribute to Ireland's future energy mix and small-scale wind deployment is expected to increase in the coming years. Irish companies are very well positioned to deliver the services associated with the planning and design of microgeneration installations. The biggest opportunity for Irish enterprise is in installation and commissioning of microgeneration units.

Offshore renewable energy

Offshore wind is a rapidly growing market, benefitting from continued innovation and higher and more consistent wind speeds than onshore locations. Ireland's CAP 2024 includes an ambitious target of 5 GW installed offshore wind capacity by 2030. As a result, the domestic market for new deployment of offshore wind is expected to grow by 2030. The Offshore Renewable Energy Technology roadmap has assessed the potential for fixed offshore wind, floating offshore wind and wave energy to play a role in Ireland's decarbonised electricity system. The development of the offshore wind market represents a considerable sustainable energy opportunity for Irish enterprises. Furthermore, Ireland could capture inward investment, and therefore jobs and economic benefit in areas including construction and marshalling ports (both fixed and floating), tower manufacturing, and synthetic cable manufacturing. Ireland's strong research and development capabilities make it an attractive location for advancing wave energy technology. Despite the early stage of wave electricity generation, there remains significant uncertainty about the future market potential. However, Ireland's strategic location, technical expertise, and supportive infrastructure suggest that the country could make contributions to the growth and commercialisation of the wave energy sector.

Smart grid

Smart grid technology will play a central role in decarbonising Ireland's energy system, given its expected reliance on variable wind resources. Smart grids represent a large economic opportunity for Irish enterprise. The Irish market for new deployment of smart grids is expected to grow considerably this decade and Ireland could potentially capture a large portion of this market. Irish companies are well positioned to capture a share of the market for installation and quality assurance. Notable opportunities for job creation exist in safety and accommodation, civil engineering, and tower erection based on Ireland's ability to capture market share in these areas. Ireland could capture investment during the feasibility studies, planning and permitting, and design and procurement phases of smart grid development.

Electric vehicles

The domestic market size for new deployment of electric vehicles, including both BEV and PHEV, is expected to grow by 2030. Ireland's enterprises could capture a share of this market. There are market opportunities for Ireland associated with the O&M of EVs. Irish enterprises could potentially deliver the O&M services for EVs including insurance, and electrical and mechanical engineering for servicing / maintenance. Ireland has several research teams operating at the forefront of battery research and materials chemistry. While negligible in terms of market share, this R&D could yield longer-term opportunities as battery chemistry continues to develop and as other chemistries such as solid state and lithium silicon batteries are explored.

Electric vehicle charging stations

The rapid increase in deployment of EV vehicles expected in the next decade may mean there is space for new suppliers to enter the market, and there will be significant demand for installations at all types of charging infrastructure that require suitably qualified electricians and electrical engineers. Irish enterprise could benefit from making space for new suppliers in the market. There is a need for software for smart charging at both public and private charging facilities which Irish suppliers are well positioned to capture. In addition, software is required for payment systems and connectivity at all levels and Irish enterprises could capture some of this market.

Smart buildings and homes

The smart buildings market in Ireland is projected to experience growth, particularly in the energy infrastructure domain, which will create new job opportunities for installers and energy experts. As the market evolves, it presents opportunities for innovation and investment, making it a critical area for future development in Ireland. To capitalise on the growth potential in the smart buildings market, Ireland could focus on developing the necessary skills and certifications for installers and energy experts. This can be achieved through targeted training programs and the establishment of accreditation frameworks.

Energy efficient construction

The market for energy efficient construction in Ireland is projected to grow significantly. Procurement and materials supply represent over half of total energy efficient construction costs. Ireland could supply the most expensive components, such as the cavity wall insulation, double/triple glazing, internal and external cladding, attic insulation, commercial and public sector heating controls and the heat pump. Irish enterprises could prioritise capturing the market related to these components of energy efficient construction. By focusing on the supply and installation of high-cost materials and technologies, businesses could enhance their competitiveness and contribute to the national goals outlined in the Climate Action Plan. This strategic focus could in-turn support the growth of the energy efficient construction sector and the increased demand for retrofitting and energy efficient upgrades in residential and commercial buildings.

Sustainable biomass heating for buildings

The Irish economy is mostly well positioned to capture the preliminary phase of the supply chain for sustainable biomass heating, which includes jobs for environmental and engineering consultants for the feasibility studies and project planners and financial, legal and technical advisers for planning and permitting. It could also capture a share of the market by providing services including the groundworks, device assembly and control, mechanical, electrical and civil engineering. Finally, it is important to recognise the inter-relationship between biomass, bioenergy, and bioeconomy; and the cascading use of biomass in our energy strategies. By exploring the co-location of sustainable energy technologies alongside other innovations, biomass utilisation can be optimised in both regional and national contexts.

District heating

Ireland could attract investment in the installation and commissioning of district heating systems, which could in-turn create substantial opportunities for electrical, mechanical, and civil engineering firms. The country also has the potential to provide services related to the operation, maintenance, and fuel supply for these systems. Irish enterprises could benefit from securing investment in the installation and commissioning of district heating systems which could lead to significant work for engineering firms across various disciplines. Additionally, prioritising the development of services related to the operation, maintenance, and fuel feedstock for district heating systems could be a key area of focus for growth and innovation in the sector.

Industrial heat pumps

The market for industrial heat pumps in Ireland is currently limited. While Irish enterprises may not be well-positioned to capture the larger European market, they could still provide valuable services in permitting and legal, financial, and commercial advisory roles for industrial electrification projects, in Ireland. Irish enterprises could benefit from leveraging the opportunities presented by the Support Scheme for Renewable Heat to expand their offerings in permitting, advisory and O&M services for industrial electrification projects.

Anaerobic digestion

Ireland is well positioned across the entire AD supply chain to capture the high installation costs. Irish enterprises could capture a share of the preliminary phase of the supply chain for AD. In particular, Irish environmental and engineering consultants, project planners and managers, legal and technical advisers and the local authority permits have the potential to capture this market. As part of operation and maintenance, Ireland could provide services related to insurance, residue disposal and electrical and mechanical engineering. The current installed capacity of AD in Ireland is relatively low, and scaling up to meet the ambitious targets will require significant investment and development of skills. Irish enterprises could benefit from prioritising the development of all areas of the AD market.

Overall, as Ireland’s energy landscape evolves to meet its ambitious climate and renewable energy targets; there are opportunities for Irish enterprises to provide select services and equipment across the sustainable energy technologies studied. Ireland's energy policy and energy markets are undergoing rapid and continuous transformation as the country pursues decarbonisation across transport, buildings, and industry through measures like electric vehicle incentives, building energy efficiency upgrades, and support for industrial fuel switching. In addition to policy initiatives and support schemes, incentive instruments are in place to promote sustainable/net-zero technologies. Key instruments include (i) Disruptive Technologies Innovation Fund which extends support to the development of renewable energy equipment and other innovative technologies;[229] and (ii) a skills programme which provides vocational training in the renewable energy industries.[230] Despite these advancements, challenges remain especially around supply chain management and infrastructure to support the evolving supply chain dynamics in Ireland. To ensure a smooth transition towards a sustainable energy future there is a strong need for a strategic approach to build a more resilient, efficient, and sustainable supply chain ecosystem in Ireland.

[229] Government of Ireland (2024), ‘*Disruptive Technologies Innovation Fund*’ Enterprise Ireland, https://enterprise.gov.ie/en/what-we-do/innovation-research-development/disruptive-technologies-innovation-fund/

[230] Wind Energy Ireland (2024) ‘*Green Tech Skillnet*’ https://windenergyireland.com/training-development/green-tech-skillnet

8 Conclusion and recommendations

The supply chain analysis of the sustainable energy technologies studied indicates that there is considerable scope for Irish suppliers to capture a share of the investment in sustainable energy technologies in Ireland, particularly in relation to construction, engineering services and financial services. Although Ireland is unlikely to manufacture the key components of the technologies studied, local enterprises could still capture a share of the market by providing some services and equipment. A model supply chain was created for the sustainable energy technologies analysed as part of the study, with the exception of offshore renewable energy.[231] The supply chains for the Irish and EU-27+UK markets have been presented in Appendix 1 and Appendix 2, respectively. Key findings about the technologies have been summarised below.

Overall, the biggest potential internal markets for Irish enterprises are in smart grids, electric vehicles, energy efficient construction and sustainable biomass heating for buildings. Irish supply chain companies are well placed to capture a share of these markets. Table 14 summarises the total size of the market in Ireland and the potential for a share of each market to be supplied by Irish enterprises.

Table 14: Total size of the Irish market in 2030 and potential Irish share for each market

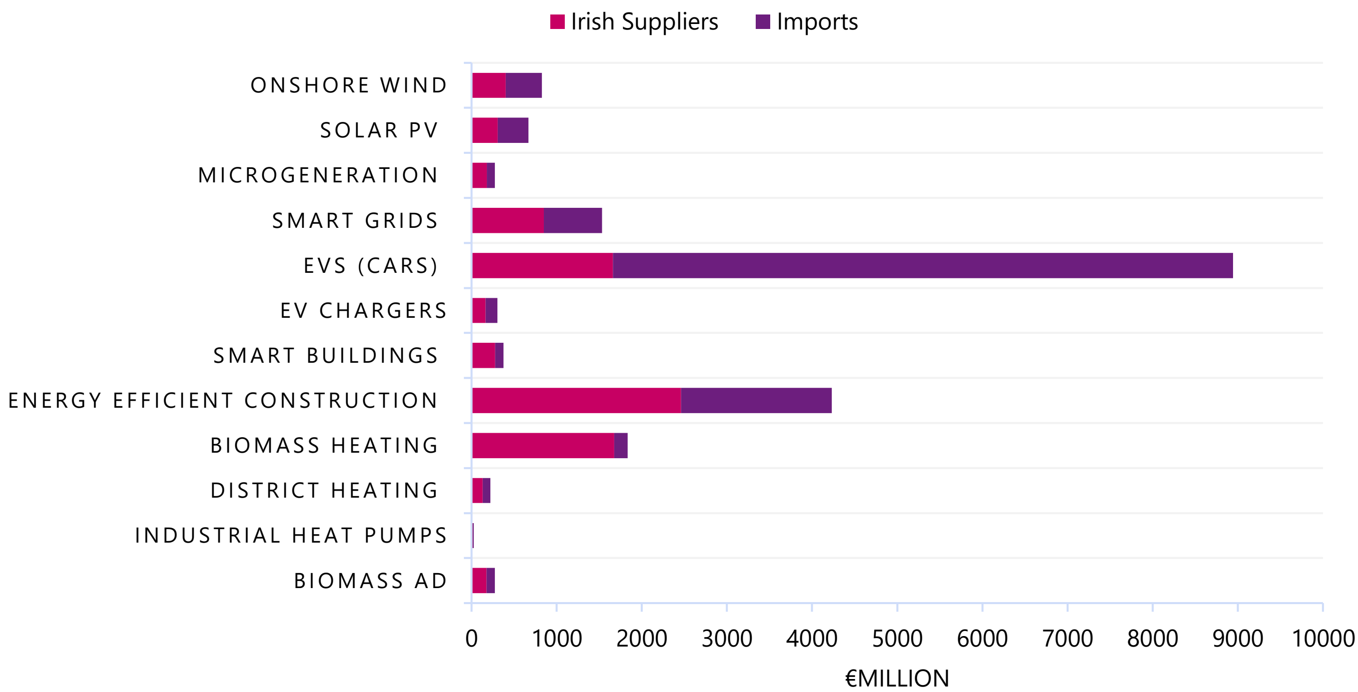
Capacity	Market Size (€ million)	Irish Share (€ million)	% Irish Supply chain utilisation
Onshore wind	827	400	48%
Solar PV	669	309	46%
Microgeneration	274	180	66%
Smart grids	1,535	847	55%
Electric vehicles	8,945	1,659	19%
Electric vehicle chargers	305	166	55%
Smart buildings and homes	374	276	74%
Energy efficient construction	4,230	2,460	58%
Sustainable biomass heating for buildings	2,071	1,675	81%
District heating	221	132	60%
Industrial heat pumps	25	13	52%
Biomass anaerobic digestion	273	178	65%
Total	**19,749**	**8,295**	**42%**

This report relates to analysis at a particular point in time. The analysis draws upon data and assumptions for a particular time period and there is a need to take into consideration Ireland's current cost competitive position compared to its EU and global counterparts. The key findings and recommendations in this report have resulted from a combination of the analysis completed and the outputs from the external stakeholder engagement that was undertaken after the analysis had been completed.

[231] Please refer to the offshore Renewable Energy Technology roadmap for a detailed assessment of the potential for fixed offshore wind, floating offshore wind and wave energy to play a role in Ireland's decarbonised electricity system.

Figure 27 illustrates the potential Irish share of each market for each of the 12 supply chains mapped.

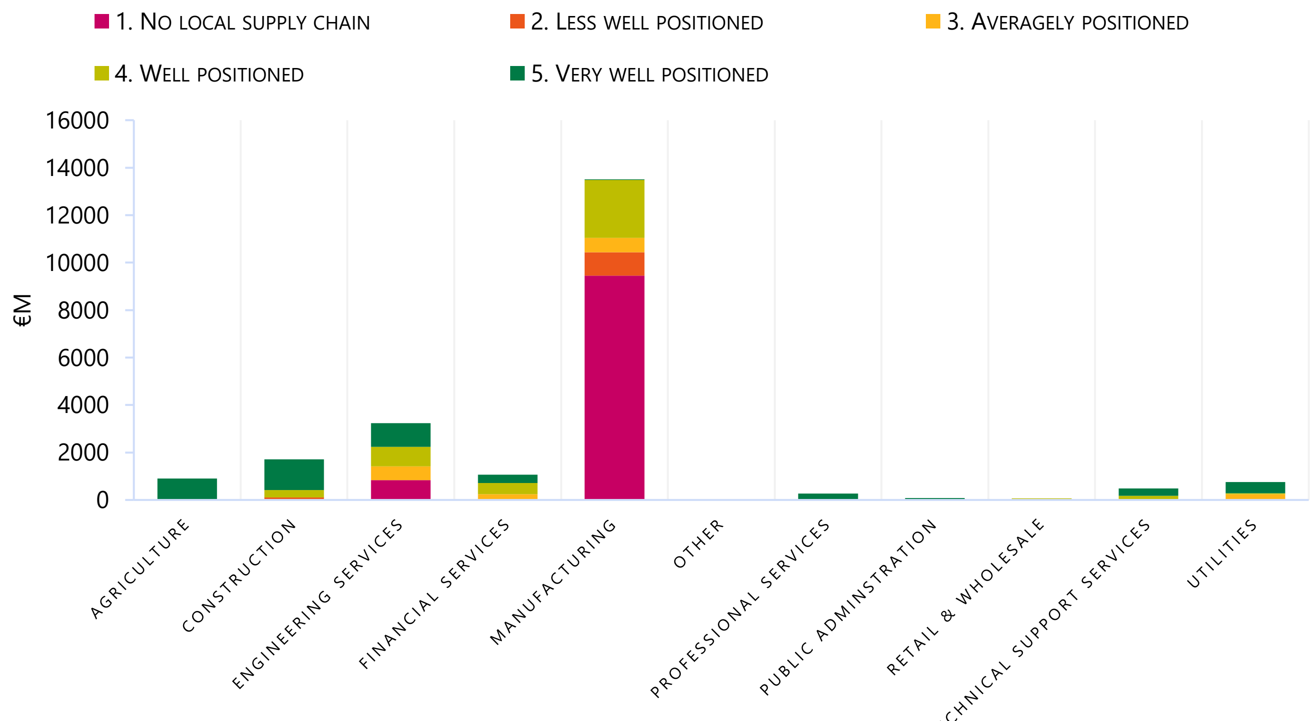
Figure 27: Irish market size and potential Irish Share in 2030



Source: SEAI Supply Chain Analysis

Figure 28 presents the overall breakdown of the market in Ireland across the supply chains by sector.

Figure 28: Irish market size by sector in 2030 across supply chains



Source: SEAI Supply Chain Analysis

Across the EU and UK markets, the main opportunities for Irish suppliers are likely to relate mainly to the provision of high value-added specialist products and services, where Ireland has a competitive advantage due to (i) on-going investment in research, development and innovation, (ii) skills base in advanced product engineering or (iii) its low tax environment. In most other areas of the EU and UK market, Irish supply chain companies are likely to struggle to gain market share, as there is a strong preference for the use of local service providers and distributors of manufactured goods.

Although manufacturing offers potential for Irish supply chain companies to gain market share, Irish suppliers are generally less competitive in this sector and the opportunities for exporting Irish manufactured products are somewhat limited. Most major items of machinery are imported, and the manufacture and assembly of products in Ireland is often undertaken by large multinational companies who have other manufacturing sites across the EU and UK that are located closer to potential export markets.

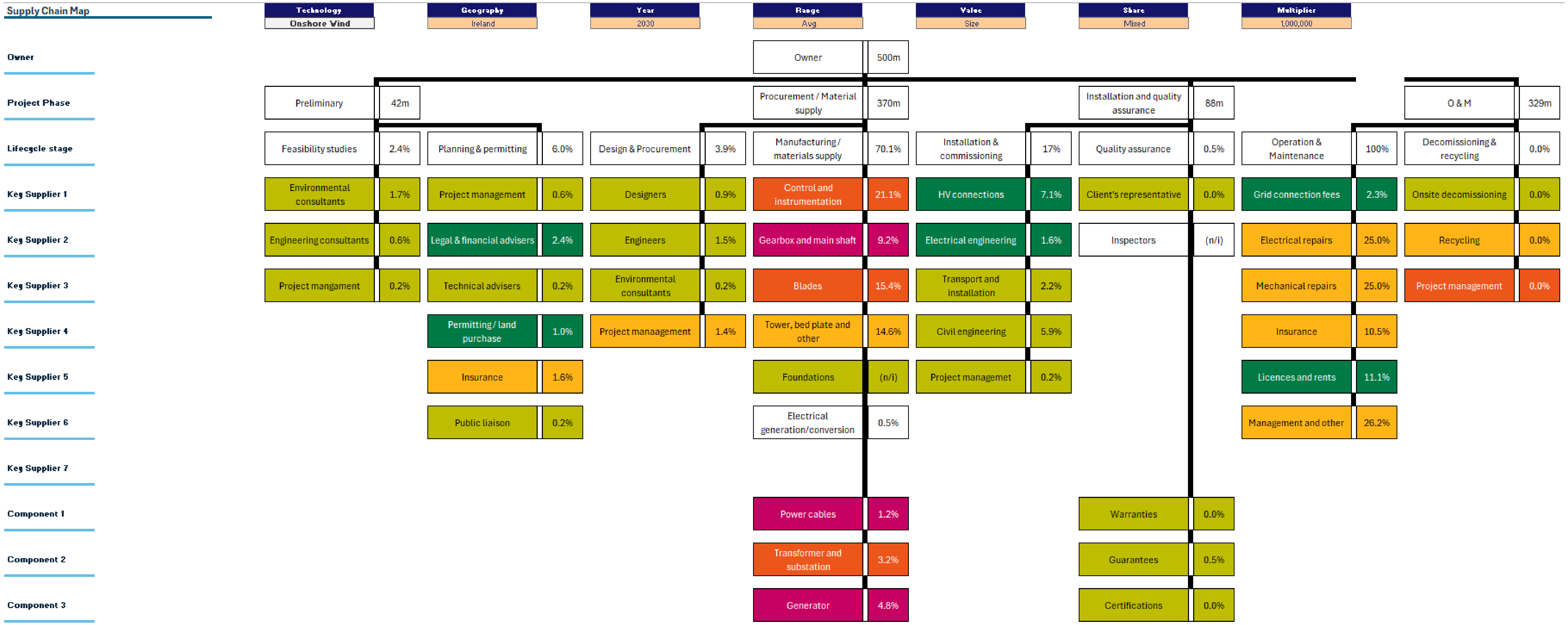
There are also strategic opportunities for Irish R&D teams to contribute to the development and testing of the next generation of sustainable energy technologies. Targeted interventions to build technical expertise, enterprises and markets will allow Ireland to continue to foster opportunities in the sustainable energy technologies of the future.

By implementing the following recommendations, Ireland can effectively harness the opportunities presented by the transition to sustainable energy systems, driving economic growth, job creation, and environmental sustainability:

1. **Develop skills and certifications:** Establish targeted training programs and accreditation frameworks to develop the necessary skills and certifications for installers and energy experts.
2. **Leverage R&D capabilities:** Utilise Ireland's strong R&D capabilities to advance emerging renewable technologies.
3. **Promote sustainable practices:** Encourage businesses to adopt sustainable practices such as green procurement and comply with EU directives and legislation for sustainable and responsible business.
4. **Focus on high-value markets**: Effectively harness the opportunities available by prioritising high-value markets such as energy efficient construction, sustainable biomass heating, electric vehicles, and smart grids.
5. **Capture the preliminary phase of the supply chain for key technologies:** Focus on capturing the market for planning, permitting and design of technologies such as onshore wind farms, utility solar PV, microgeneration units, smart grids, EV charging, smart buildings & homes, energy efficient construction, sustainable biomass heating, industrial heat pumps and AD. This includes feasibility studies, project planning, financial, legal, environmental, commercial and technical services and advisory roles.
6. **Capture the installation and commissioning markets:** Focus on capturing the market for the installation and commissioning of technologies such as onshore wind, utility solar PV, microgeneration, EV charging infrastructure, smart buildings & homes, energy efficient construction, district heating systems, and AD. This could create substantial opportunities for electrical, mechanical and civil engineers, engineering firms and qualified electricians.

Appendix 1: Supply chain maps for the Irish market

Figure 29: Onshore wind technology supply chain map for the Irish market



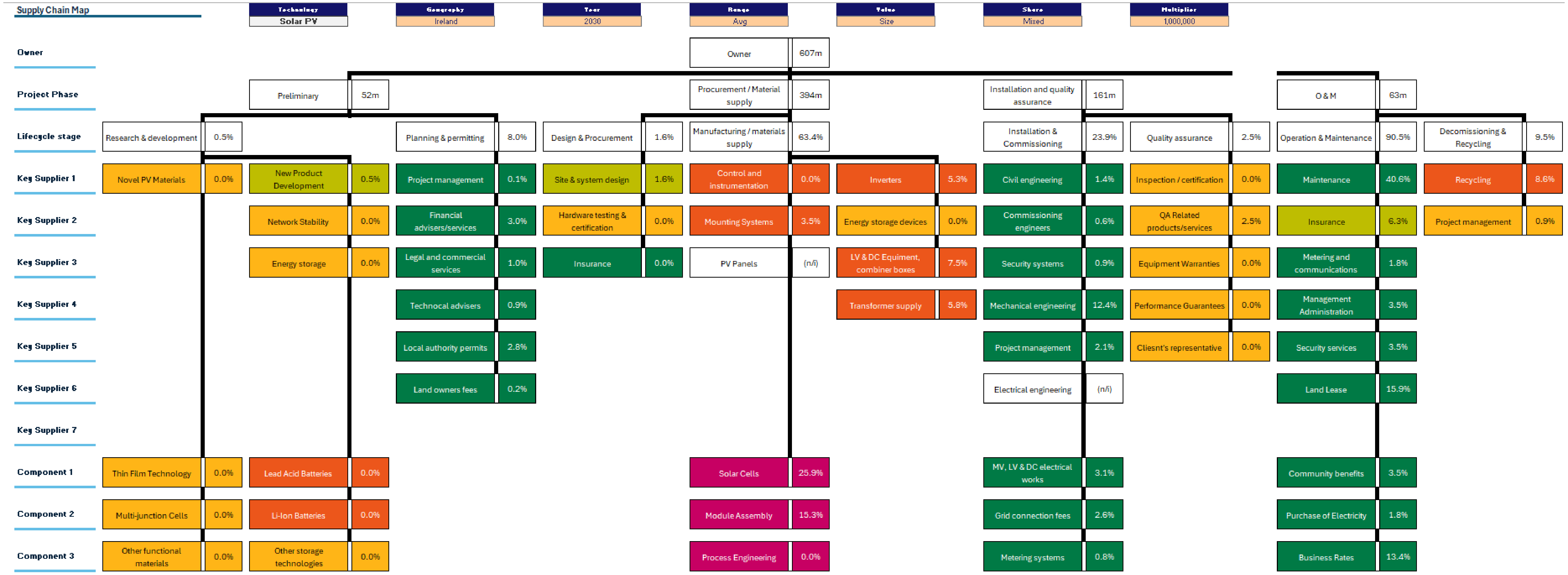
While Ireland has the potential to capture domestic market as outlined in the supply chain map above, there is a need to further study the cost competitiveness of Irish enterprises with its European counterparts.

Key:

1. No local supply chain	2. Less well positioned	3. Averagely positioned	4. Well positioned	5. Very well positioned

Note: (1) Unit of Figures = € million; (2) Owner = Preliminary + Procurement/material supply + Installation and quality assurance; (3) O&M is listed as a separate item;
(4) The published estimates did not include all supply chain divisions. These have been displayed as not included (n/i).

Figure 30: Utility scale solar PV supply chain map for the Irish market



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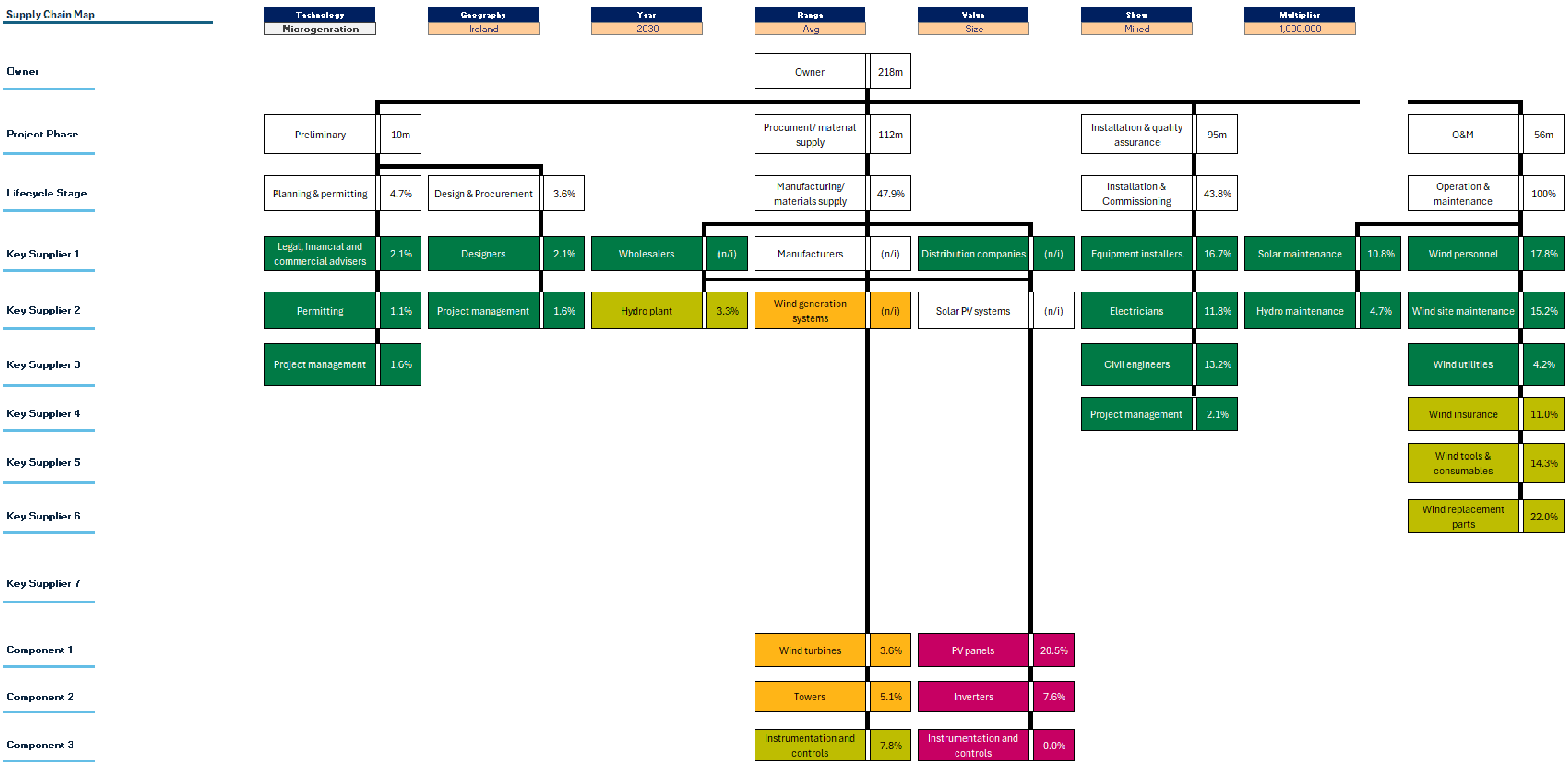
(4) The published estimates did not include all supply chain divisions. These have been displayed as not included (n/i).

Figure 31: Microgeneration supply chain map for the Irish market



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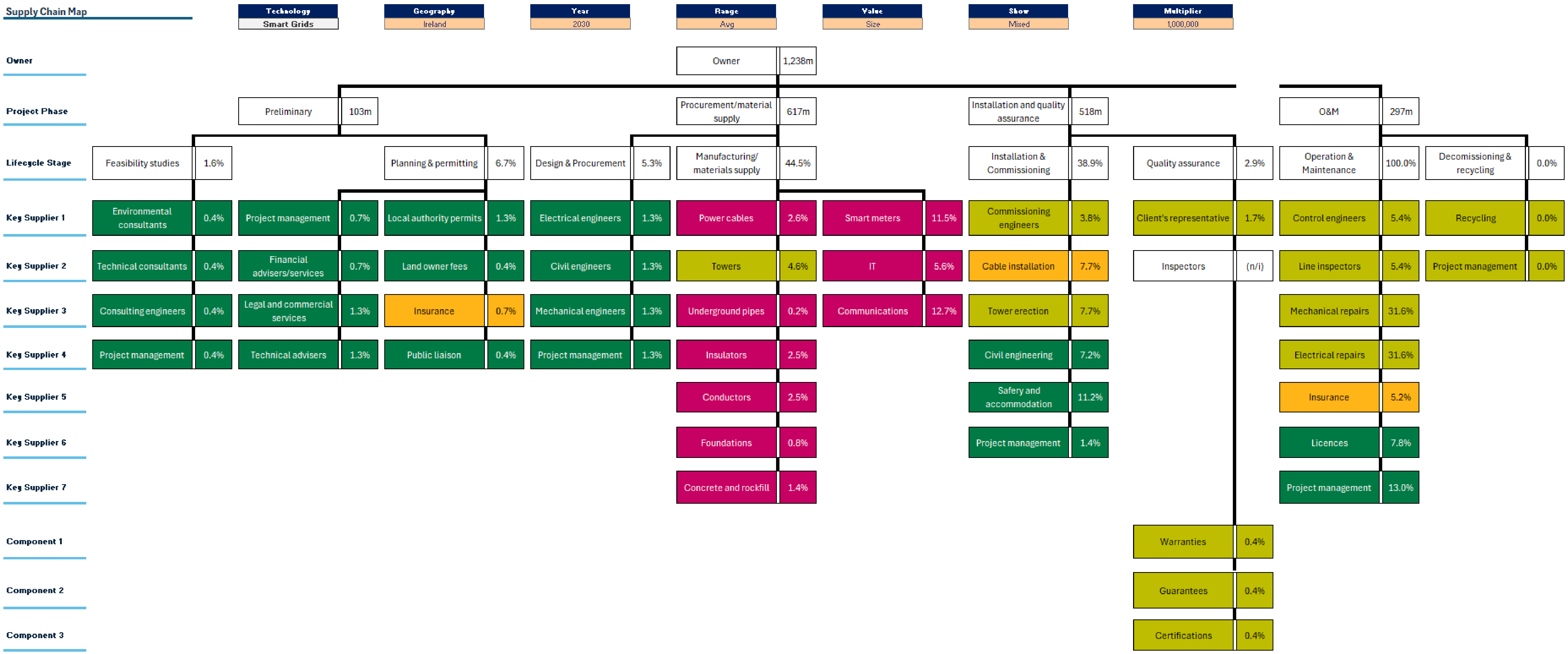
(4) The published estimates did not include all supply chain divisions. These have been displayed as not included (n/i).

Figure 32: Smart grid supply chain map for the Irish market



While Ireland has the potential to capture domestic market as outlined in the supply chain map above, there is a need to further study the cost competitiveness of Irish enterprises with its European counterparts.

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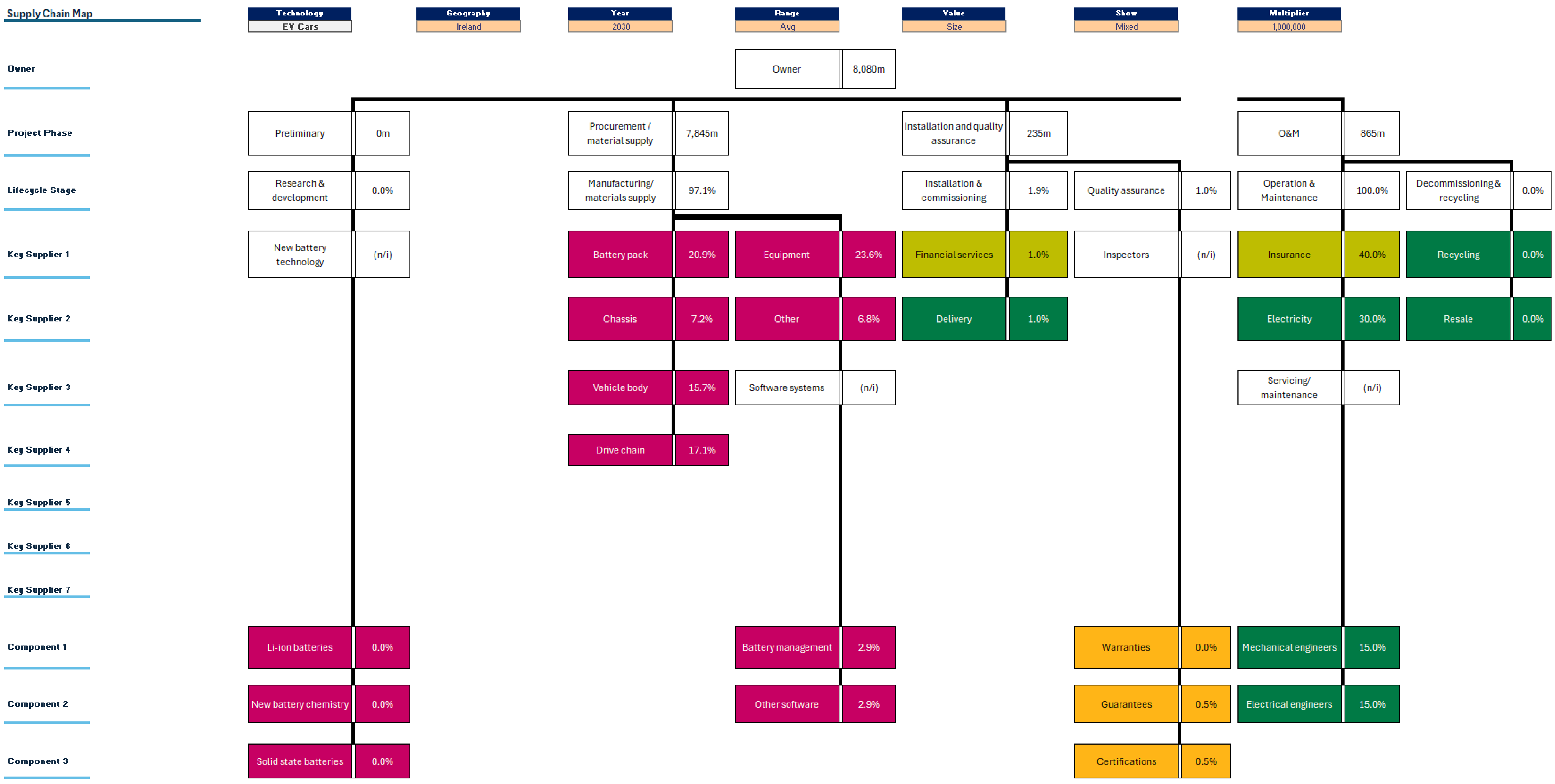
(4) The published estimates did not include all supply chain divisions. These have been displayed as not included (n/i).

Figure 33: Electric vehicle supply chain map for the Irish market



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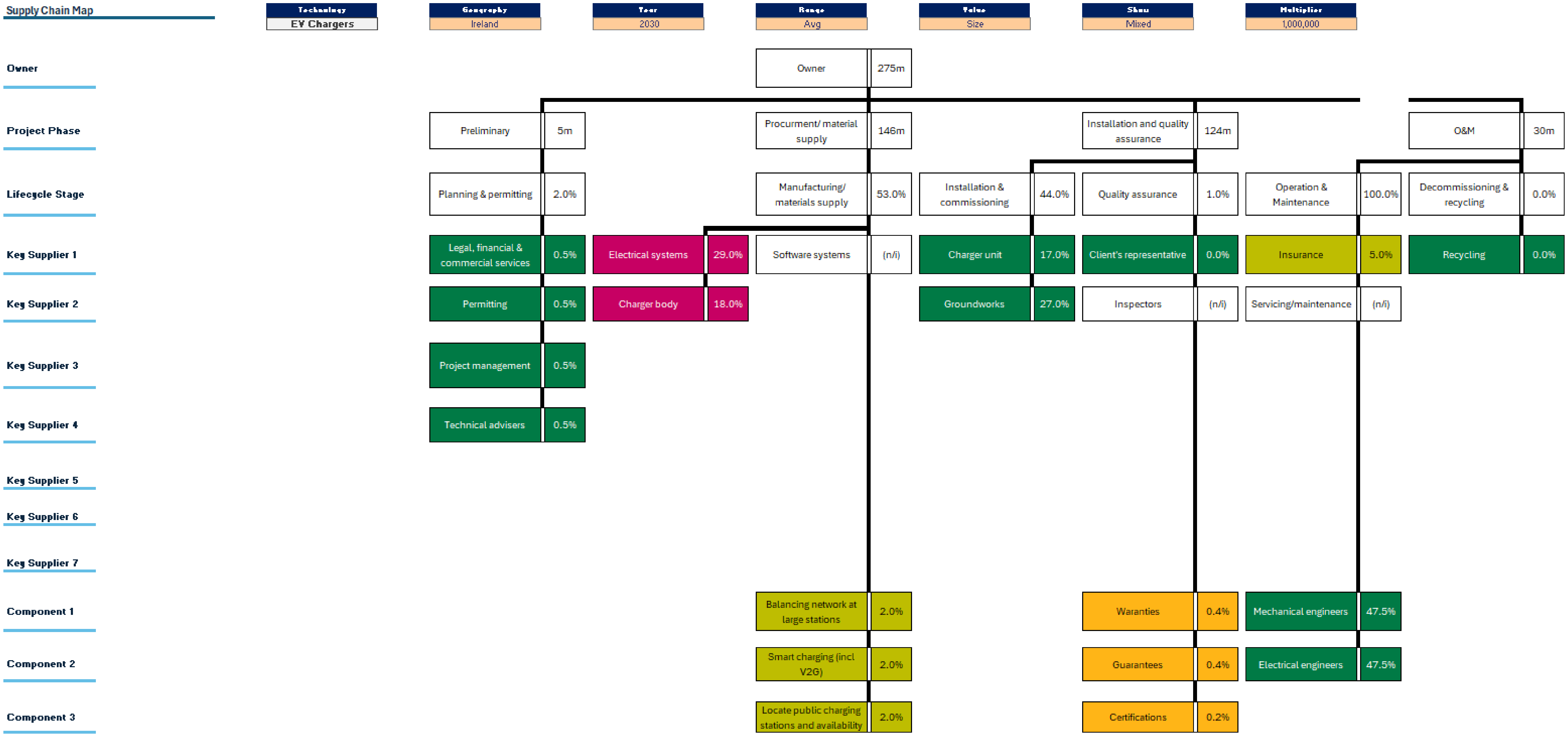
(4) The published estimates did not include all supply chain divisions. These have been displayed as not included (n/i).

Figure 34: Electric vehicle chargers supply chain map for the Irish market



While Ireland has the potential to capture domestic market as outlined in the supply chain map above, there is a need to further study the cost competitiveness of Irish enterprises with its European counterparts.

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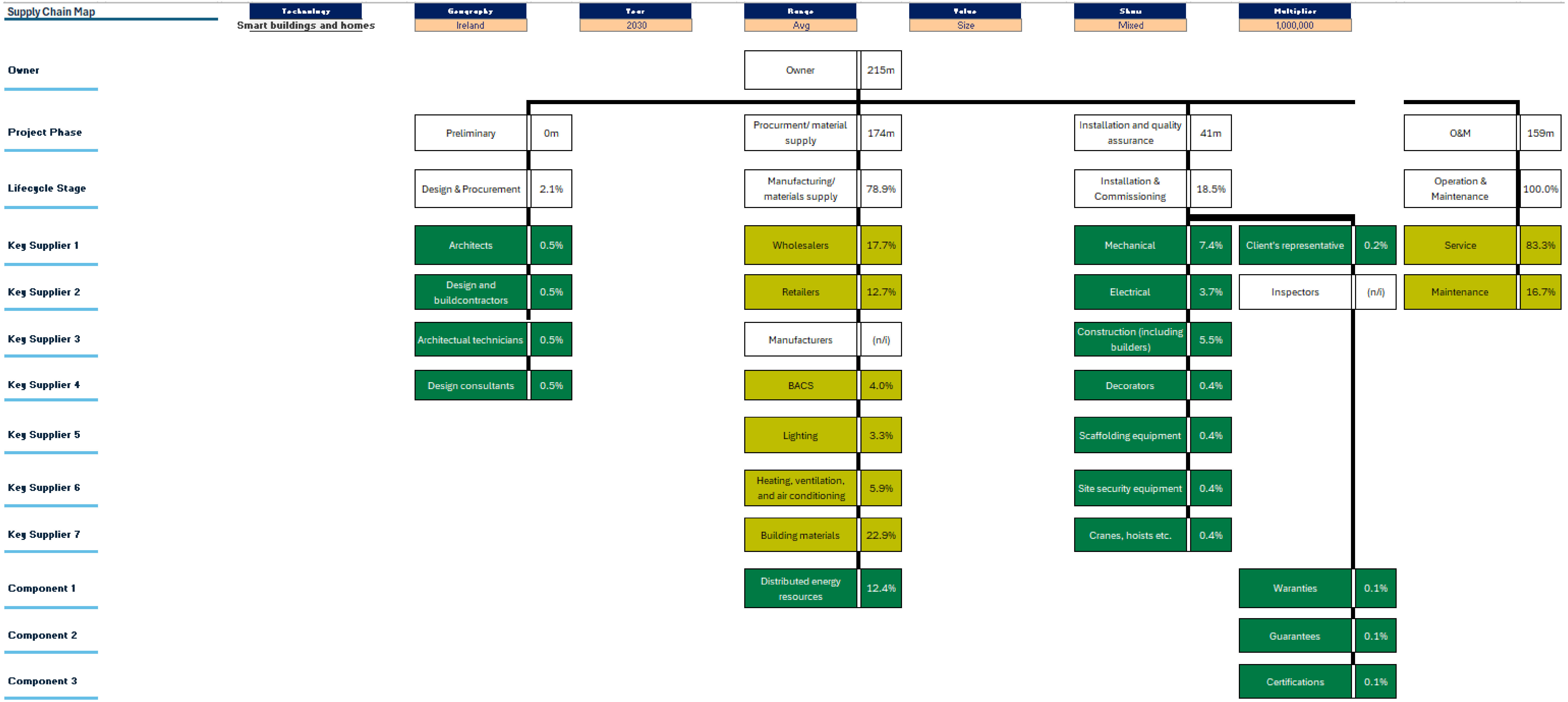
(4) The published estimates did not include all supply chain divisions. These have been displayed as not included (n/i).

Figure 35: Smart buildings and homes supply chain map for the Irish market



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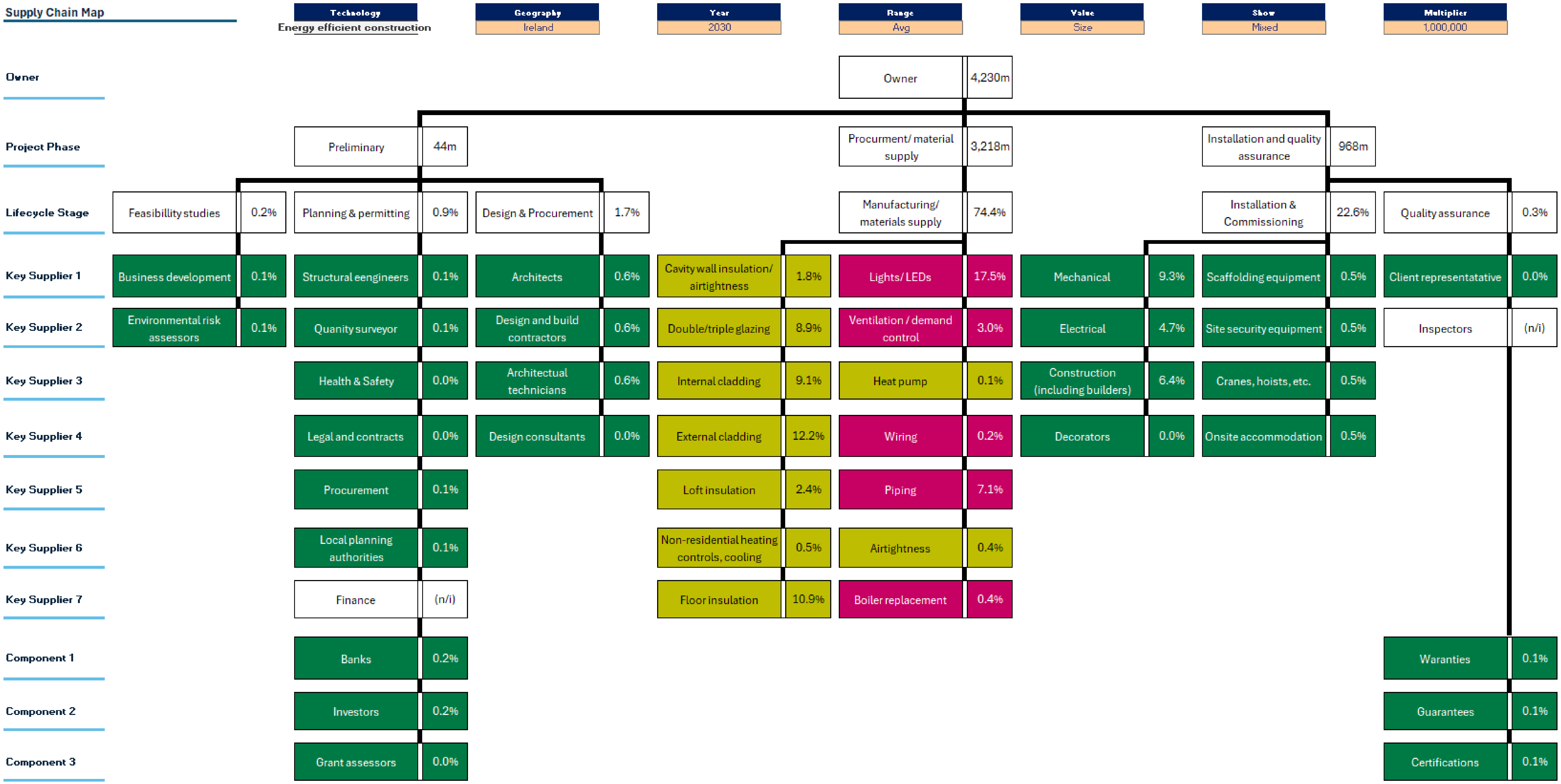
(4) The published estimates did not include all supply chain divisions. These have been displayed as not included (n/i).

Figure 36: Energy efficient construction supply chain map for the Irish market



While Ireland has the potential to capture domestic market as outlined in the supply chain map above, there is a need to further study the cost competitiveness of Irish enterprises with its European counterparts.

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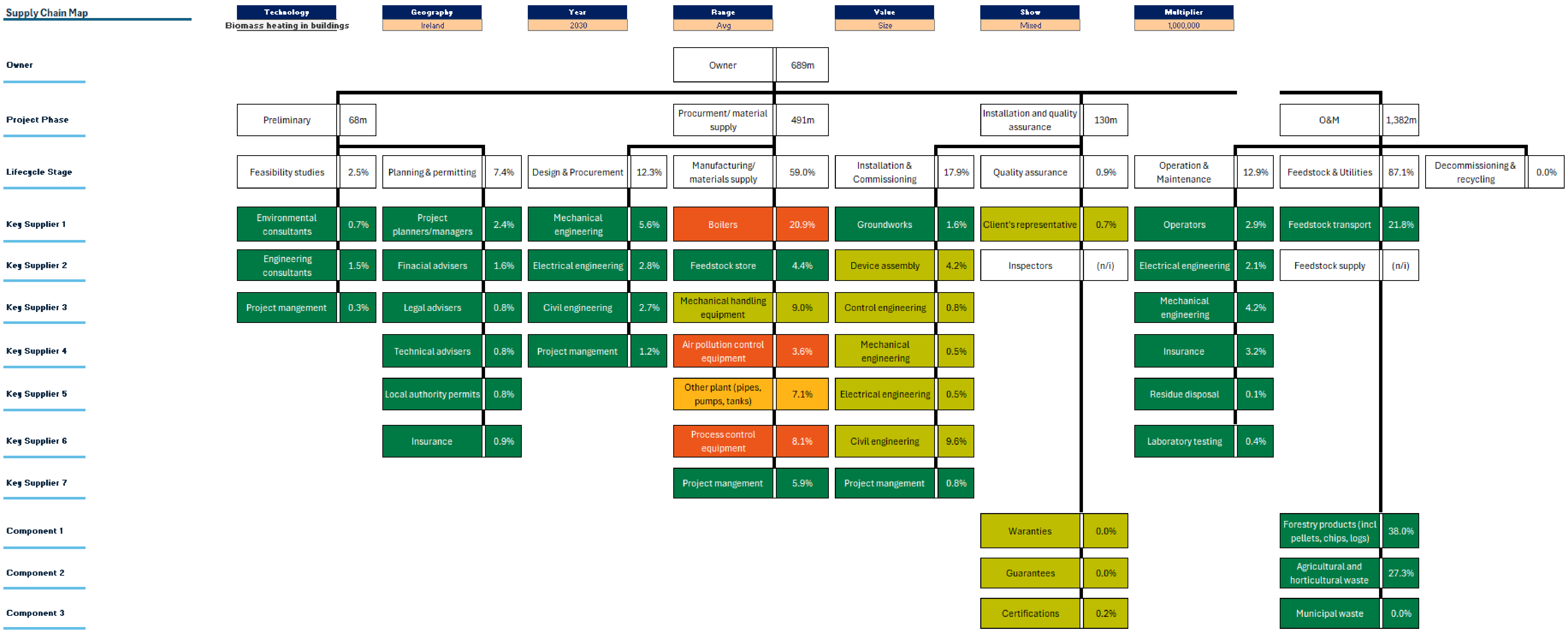
(4) The published estimates did not include all supply chain divisions. These have been displayed as not included (n/i).

Figure 37: Sustainable biomass heating supply chain map for the Irish market



While Ireland has the potential to capture domestic market as outlined in the supply chain map above, there is a need to further study the cost competitiveness of Irish enterprises with its European counterparts.

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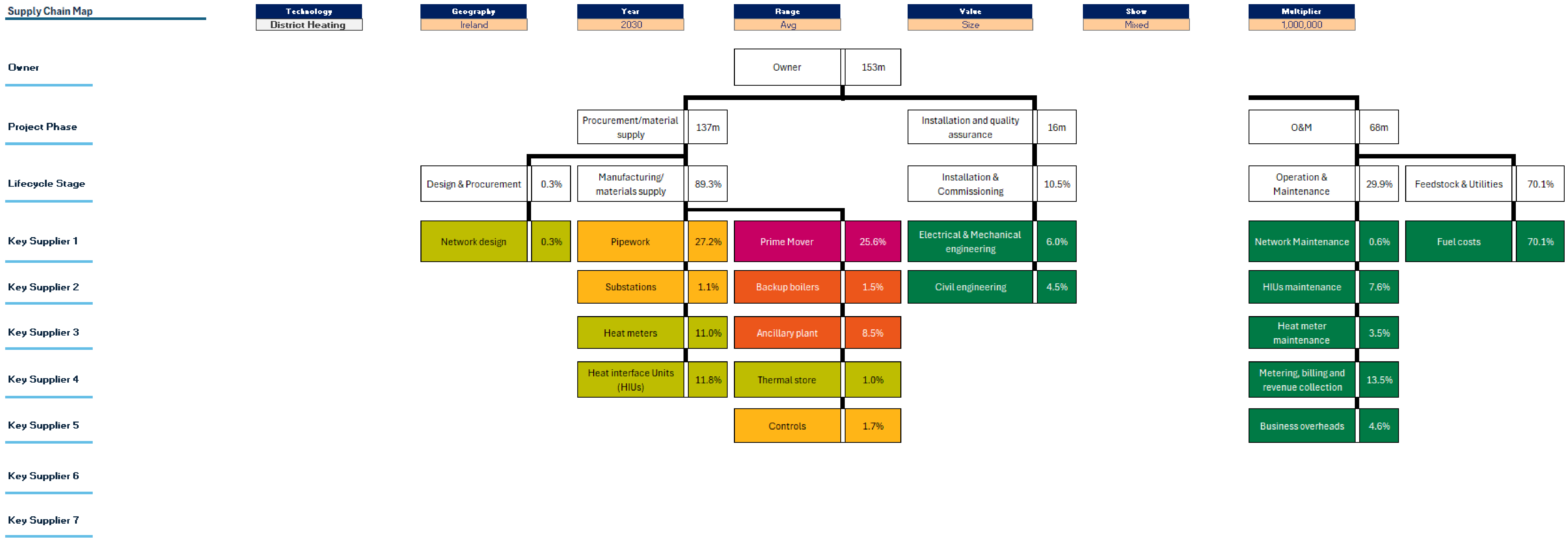
Note: (1) Unit of Figures = Million Euros; (2) Owner = Preliminary + Procurement/material supply + Installation and quality assurance; (3) O&M is listed as a separate item.
(4) The published estimates did not include all supply chain divisions. These have been displayed as not included (n/i).

Figure 38: District heating supply chain map for the Irish market



While Ireland has the potential to capture domestic market as outlined in the supply chain map above, there is a need to further study the cost competitiveness of Irish enterprises with its European counterparts.

Key:

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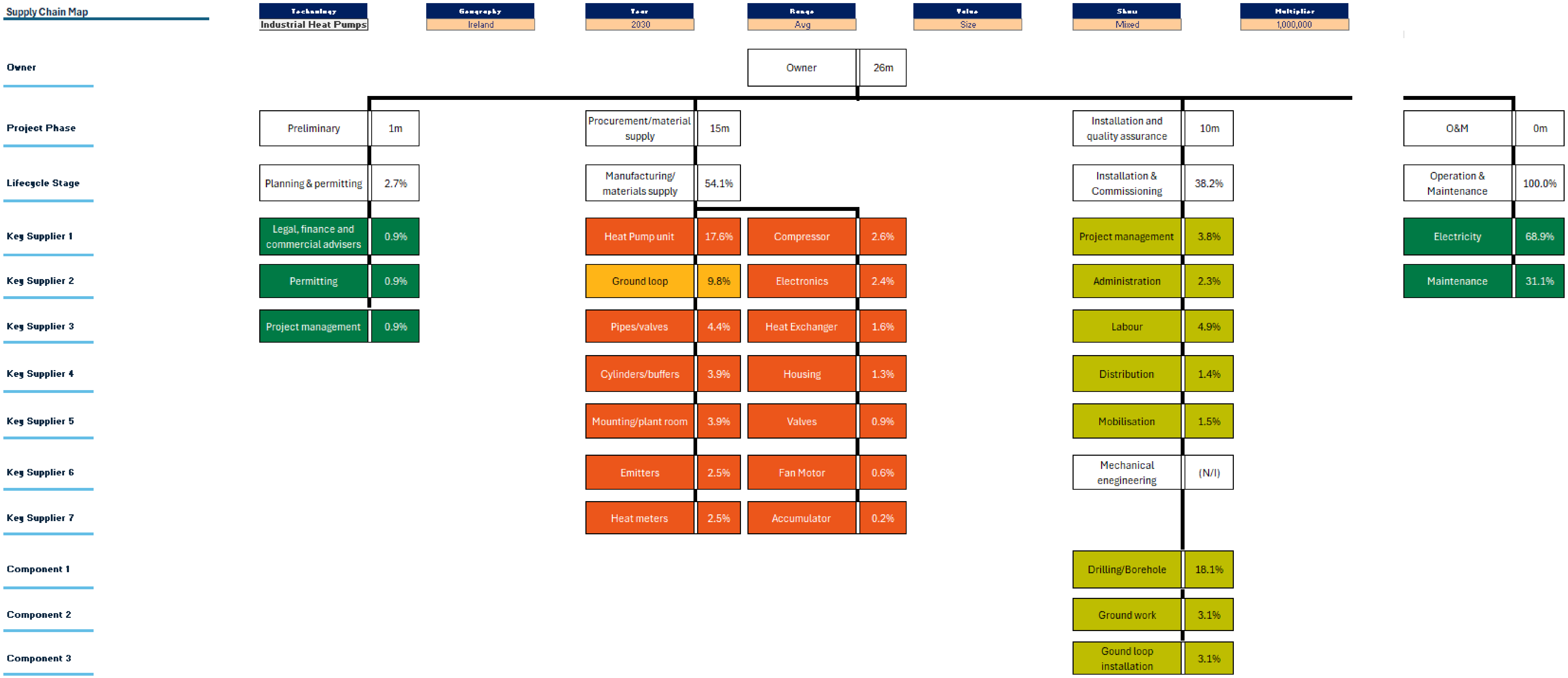
Note: (1) Unit of Figures = Million Euros; (2) Owner = Preliminary + Procurement/material supply + Installation and quality assurance; (3) O&M is listed as a separate item.

Figure 39: Industrial heat pumps supply chain map for the Irish market



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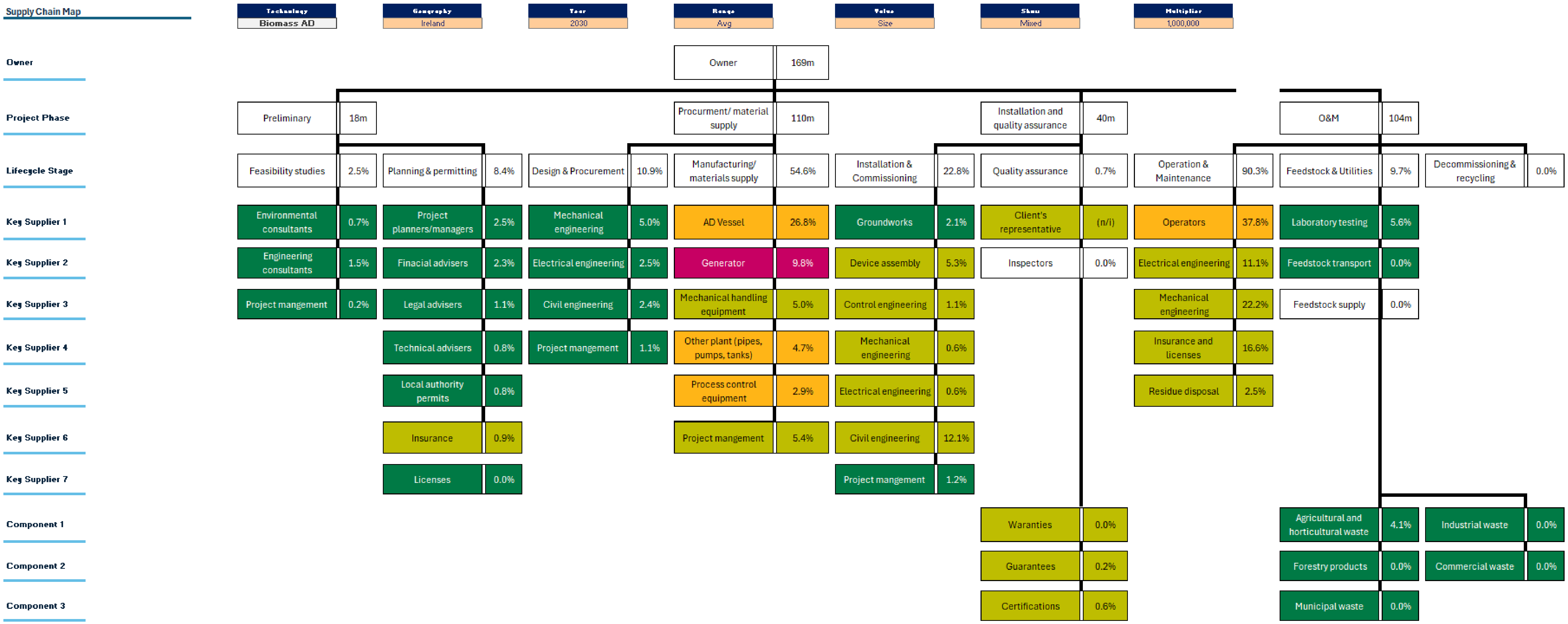
Note: (1) Unit of Figures = Million Euros; (2) Owner = Preliminary + Procurement/material supply + Installation and quality assurance; (3) O&M is listed as a separate item.
(4) The published estimates did not include all supply chain divisions. These have been displayed as not included (n/i).

Figure 40: Biomass (anaerobic digestion) supply chain map for the Irish market



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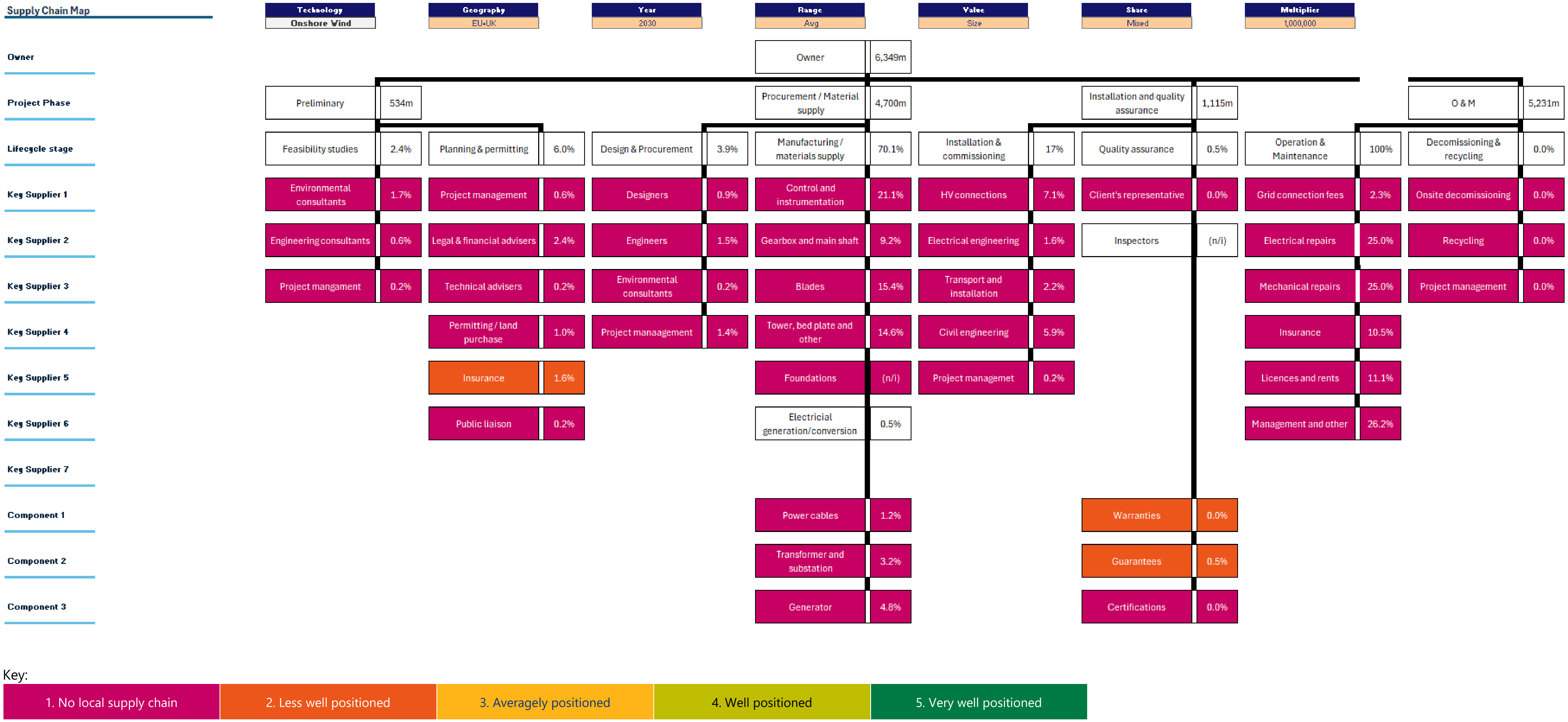
Note: (1) Unit of Figures = Million Euros; (2) Owner = Preliminary + Procurement/material supply + Installation and quality assurance; (3) O&M is listed as a separate item.
(4) The published estimates did not include all supply chain divisions. These have been displayed as not included (n/i).

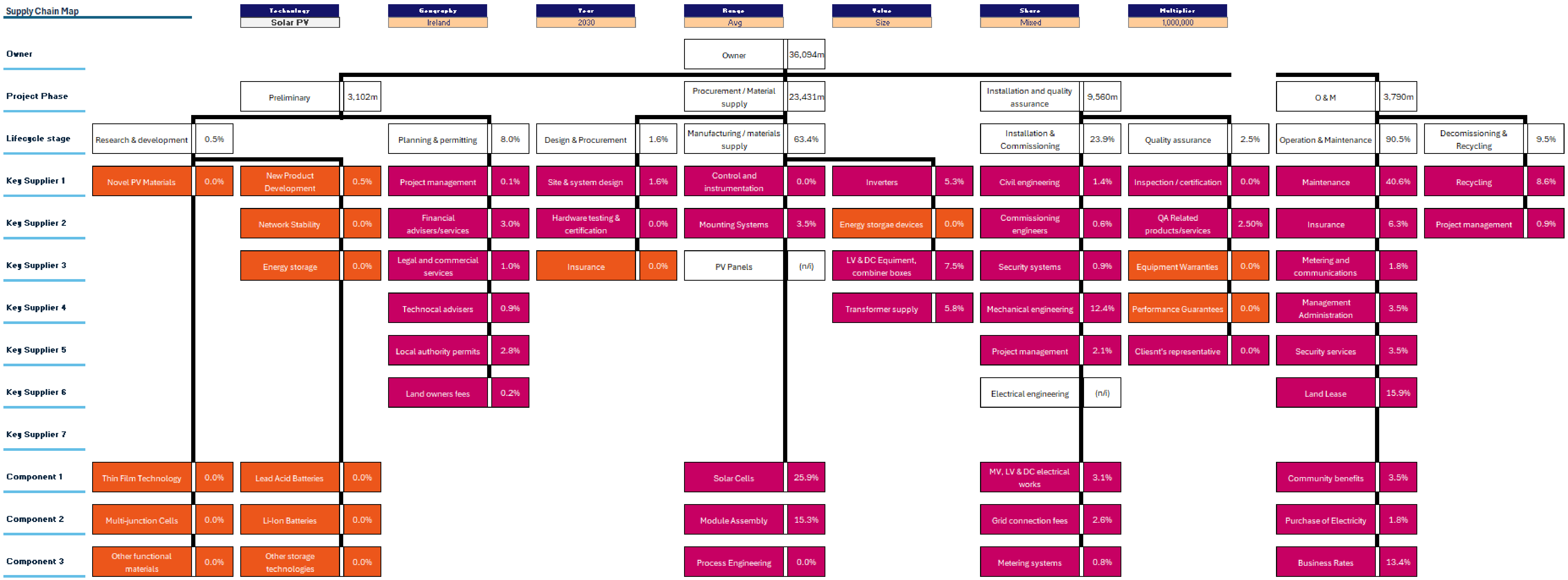
Appendix 2: Supply chain maps for the EU-27+UK market

Figure 41: Onshore wind technology supply chain map for the EU-27 + UK market



Note: (1) Unit of Figures = € million; (2) Owner = Preliminary + Procurement/material supply + Installation and quality assurance; (3) O&M is listed as a separate item; (4) The published estimates did not include all supply chain divisions. These have been displayed as not included (n/i).

Figure 42: Utility scale solar PV supply chain map for the EU-27 + UK market

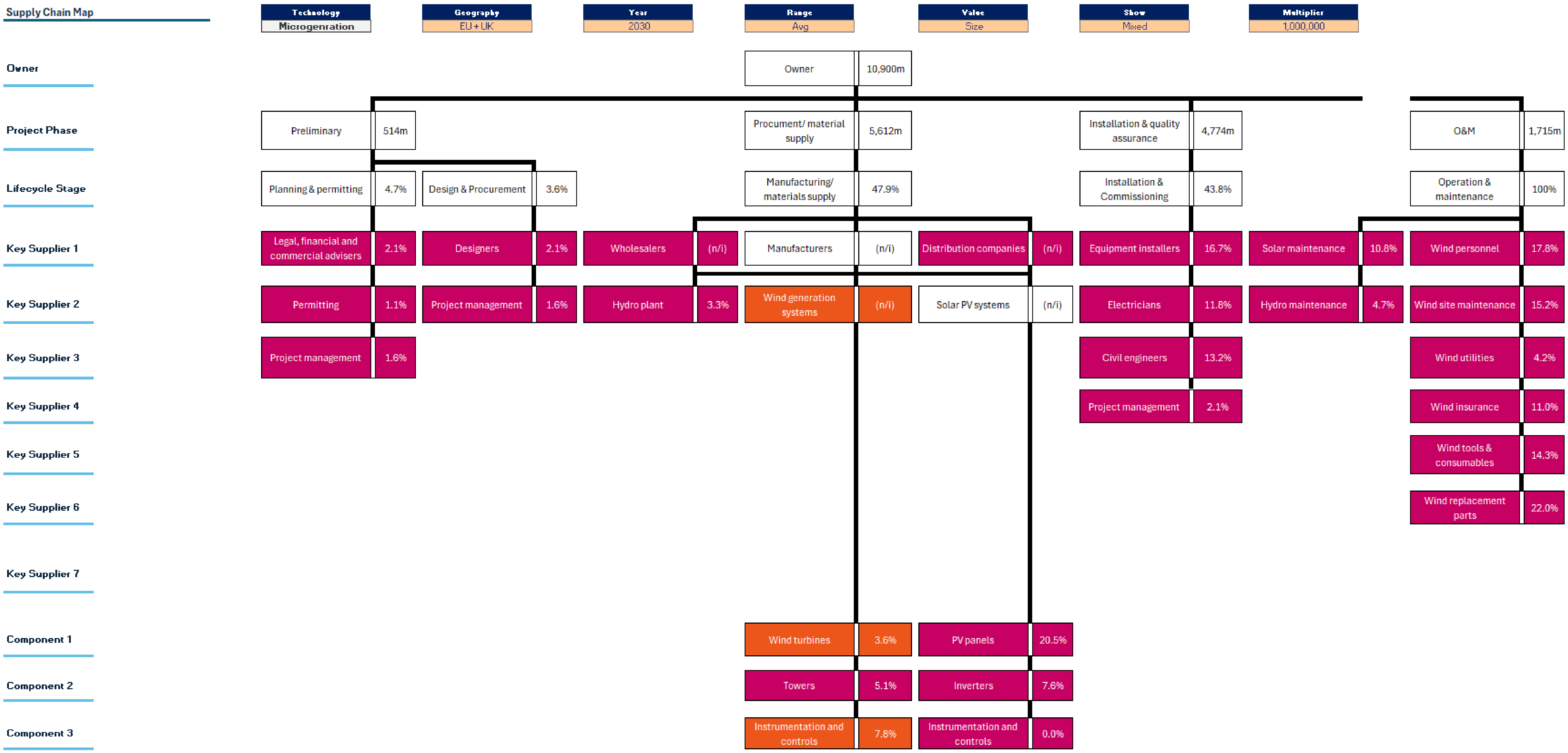


Key:

1. No local supply chain	2. Less well positioned	3. Averagely positioned	4. Well positioned	5. Very well positioned

Note: (1) Unit of Figures = € million; (2) Owner = Preliminary + Procurement/material supply + Installation and quality assurance; (3) O&M is listed as a separate item; (4) The published estimates did not include all supply chain divisions. These have been displayed as not included (n/i).

Figure 43: Microgeneration supply chain map for the EU-27 + UK market



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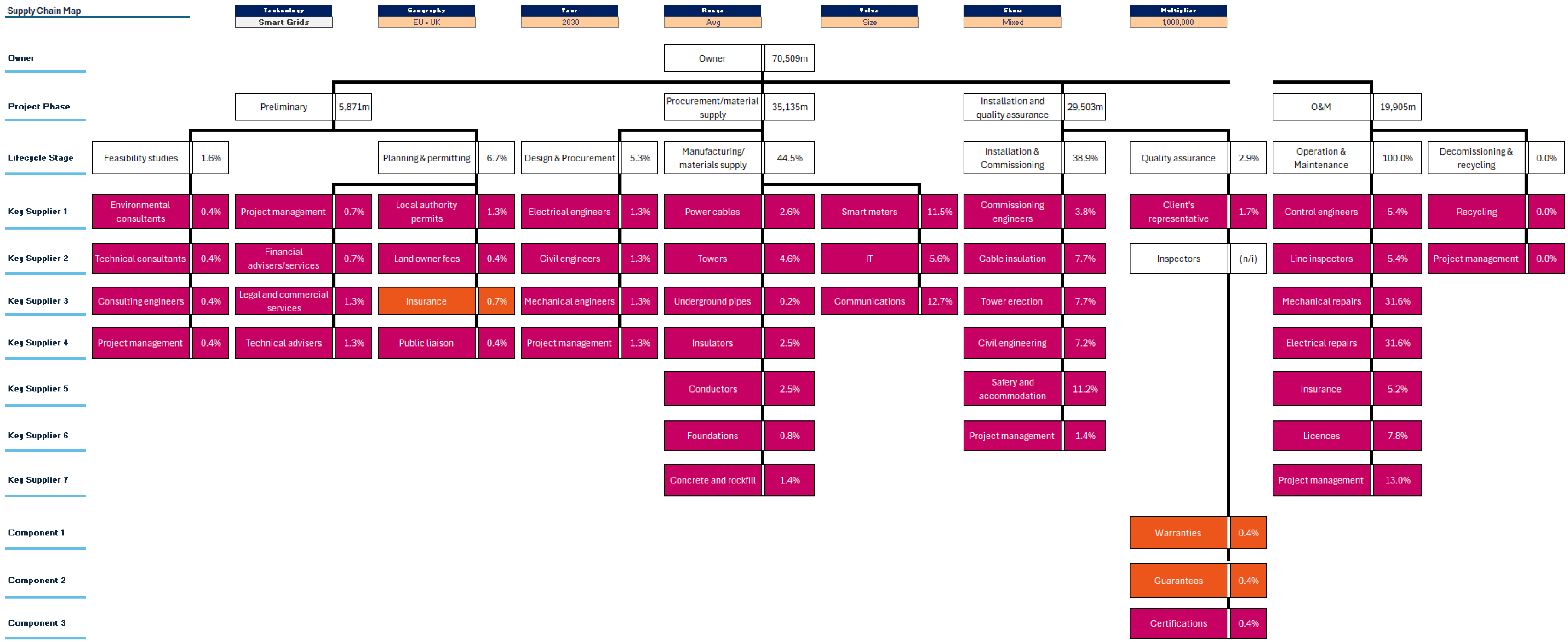
Note: (1) Unit of Figures = € million; (2) Owner = Preliminary + Procurement/material supply + Installation and quality assurance; (3) O&M is listed as a separate item; (4) The published estimates did not include all supply chain divisions. These have been displayed as not included (n/i).

Figure 44: Smart grid supply chain map for the EU-27 + UK market



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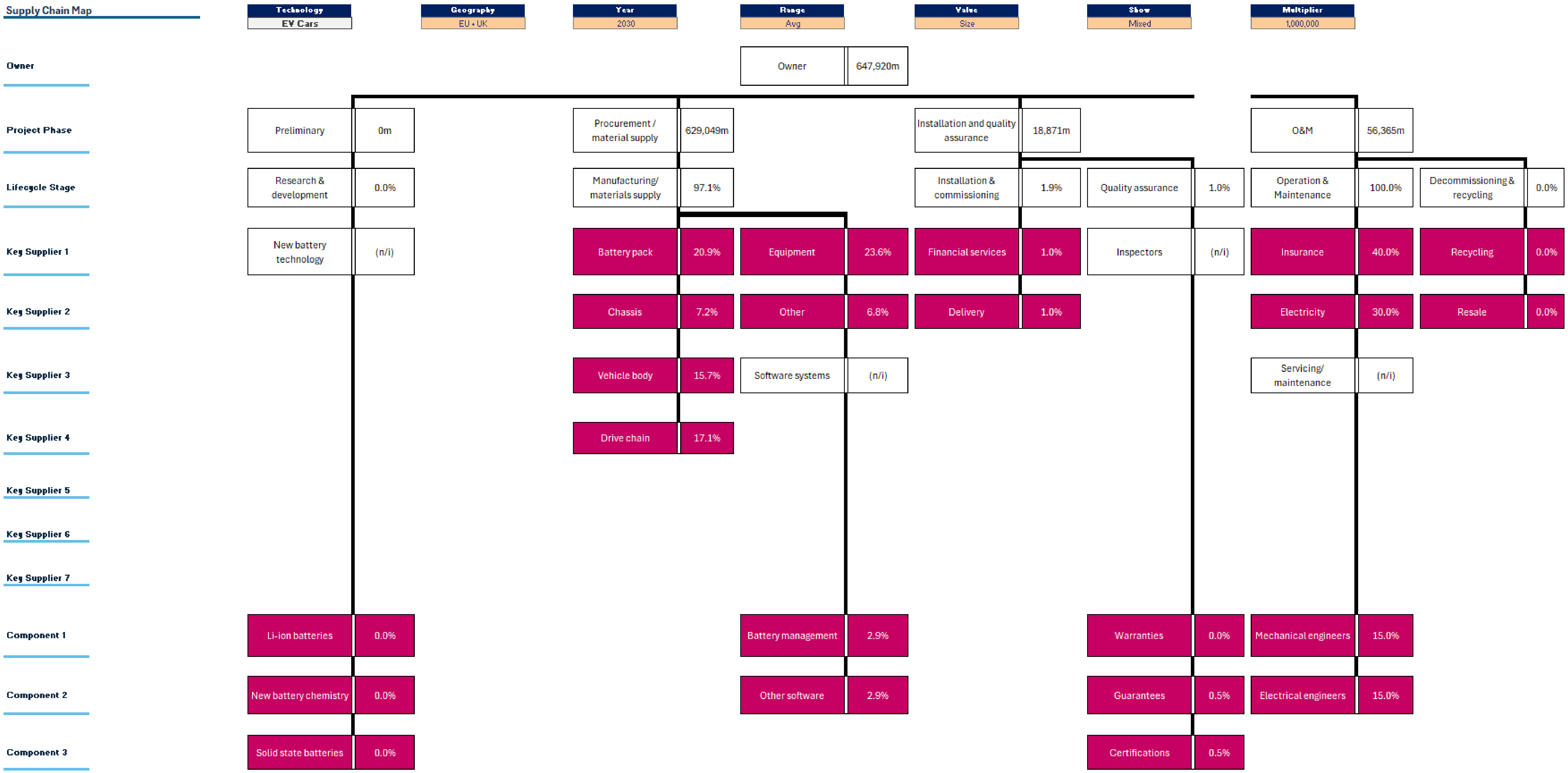
Note: (1) Unit of Figures = € million; (2) Owner = Preliminary + Procurement/material supply + Installation and quality assurance; (3) O&M is listed as a separate item; (4) The published estimates did not include all supply chain divisions. These have been displayed as not included (n/i).

Figure 45: Electric vehicle supply chain map for the EU-27 + UK market



Key:

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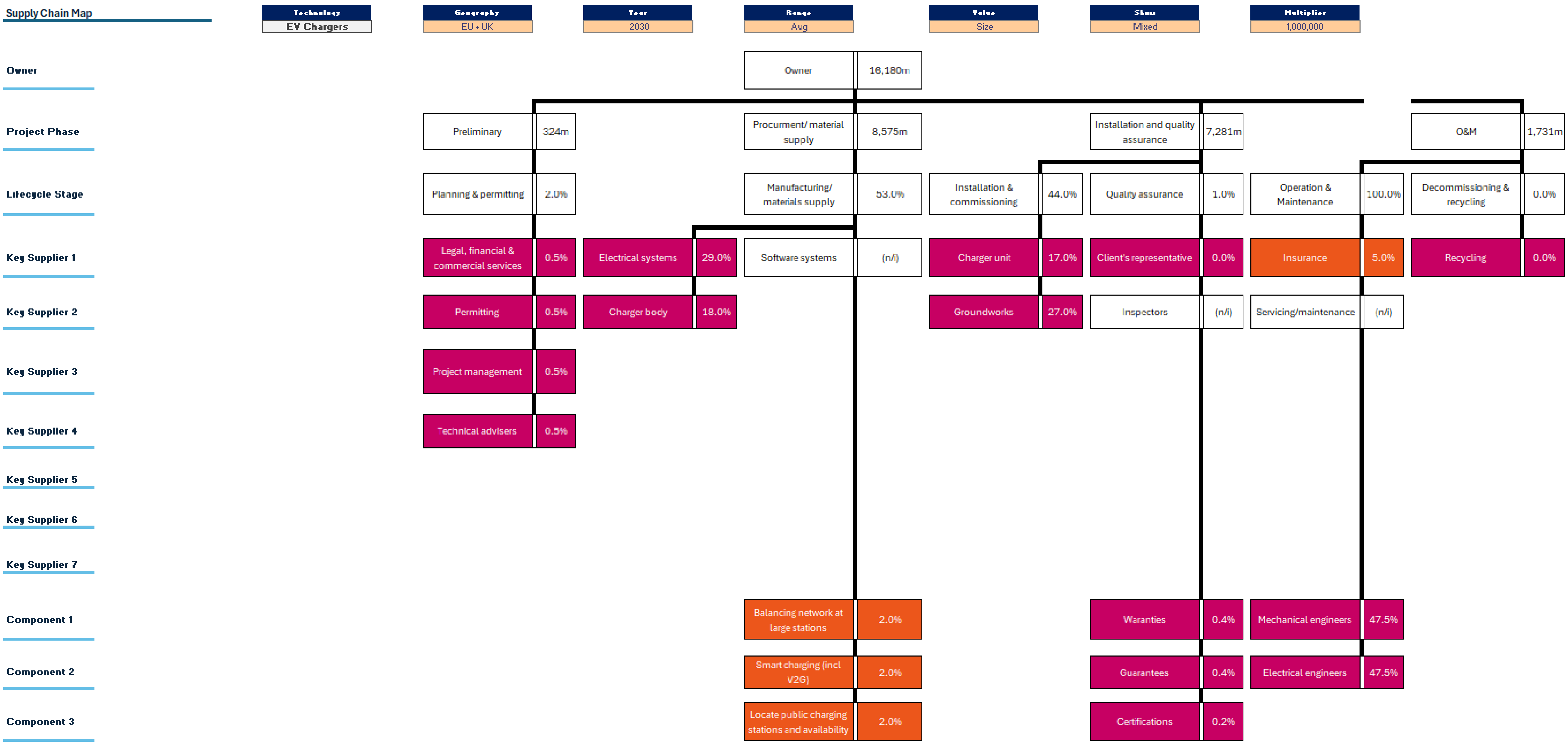
Note: (1) Unit of Figures = € million; (2) Owner = Preliminary + Procurement/material supply + Installation and quality assurance; (3) O&M is listed as a separate item;
(4) The published estimates did not include all supply chain divisions. These have been displayed as not included (n/i).

Figure 46: Electric vehicle chargers supply chain map for the EU-27 + UK market



Key:

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Figure 47: Smart buildings and homes supply chain map for the EU-27 + UK market

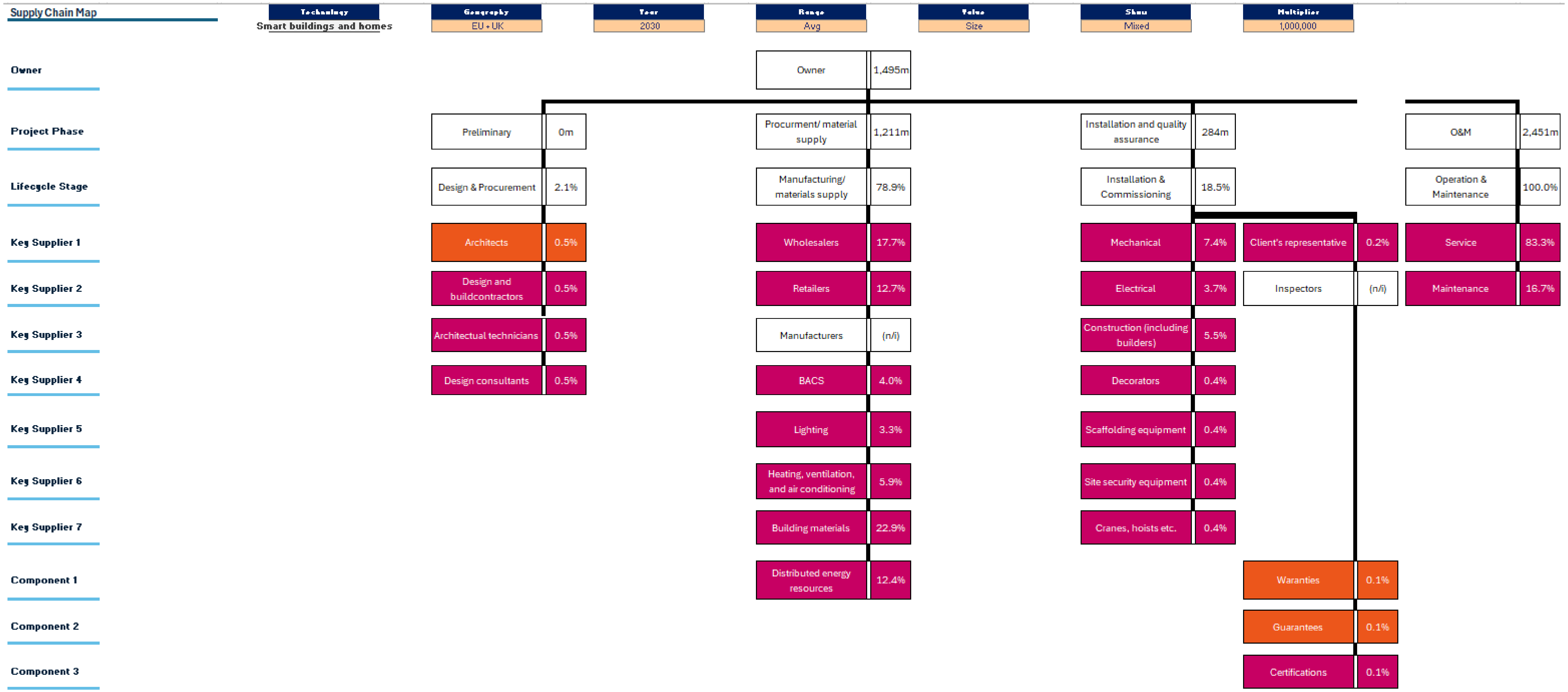

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Figure 48: Energy efficient construction supply chain map for the EU-27 + UK market

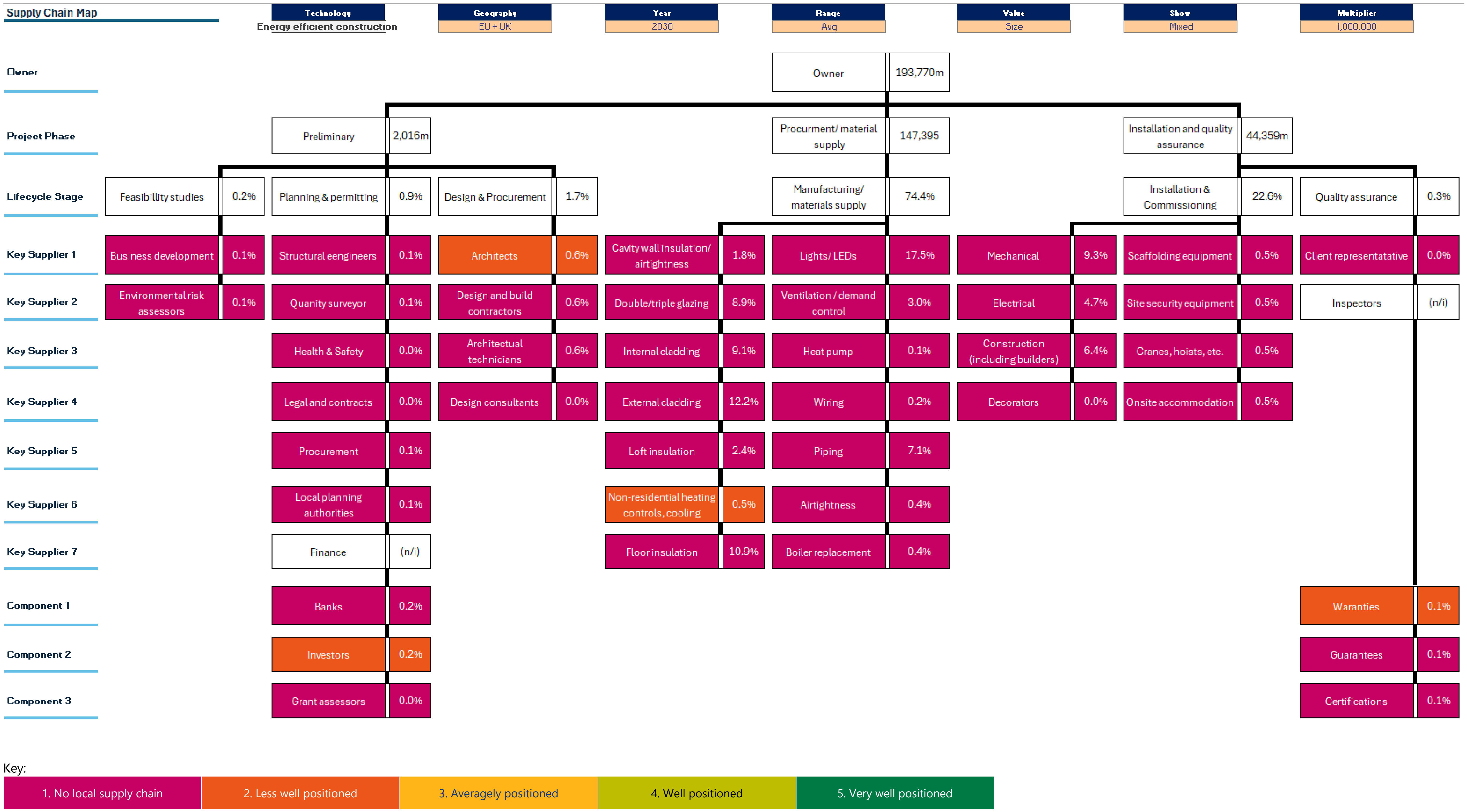

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Figure 49: Sustainable biomass heating supply chain map for the EU-27 + UK market

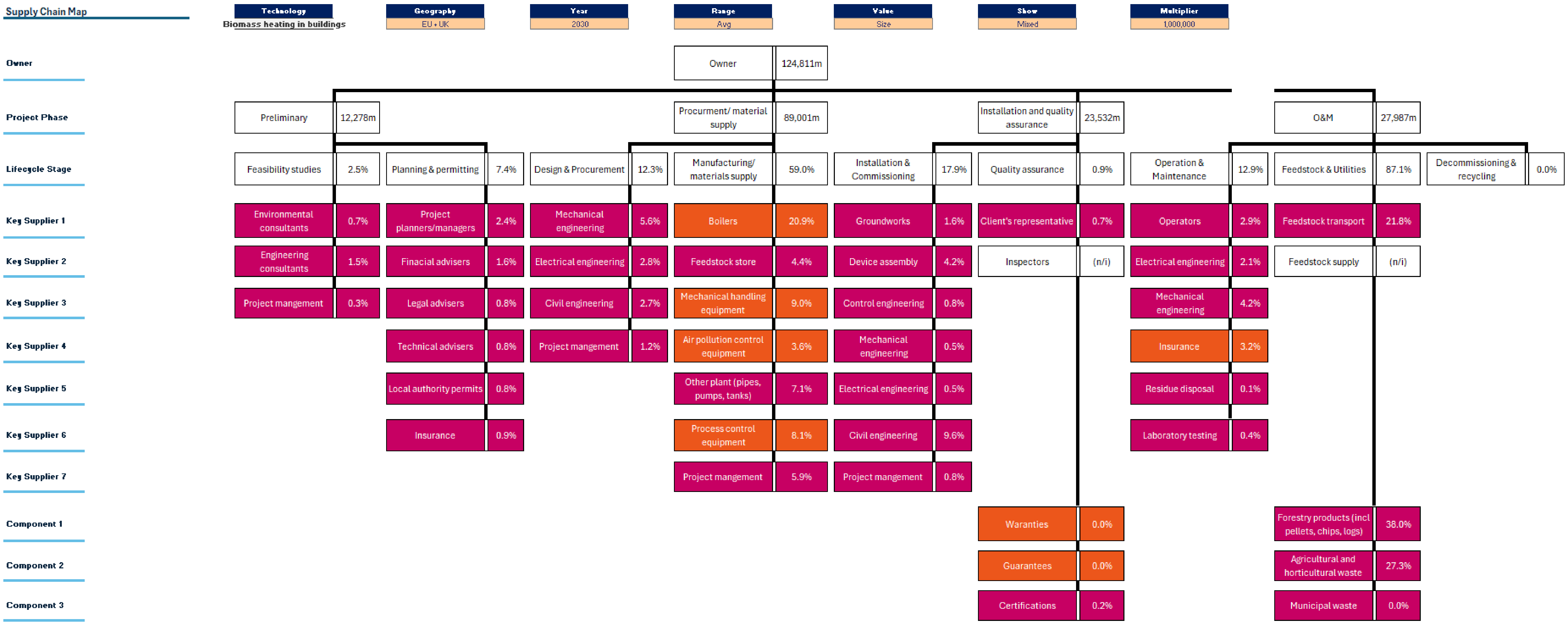

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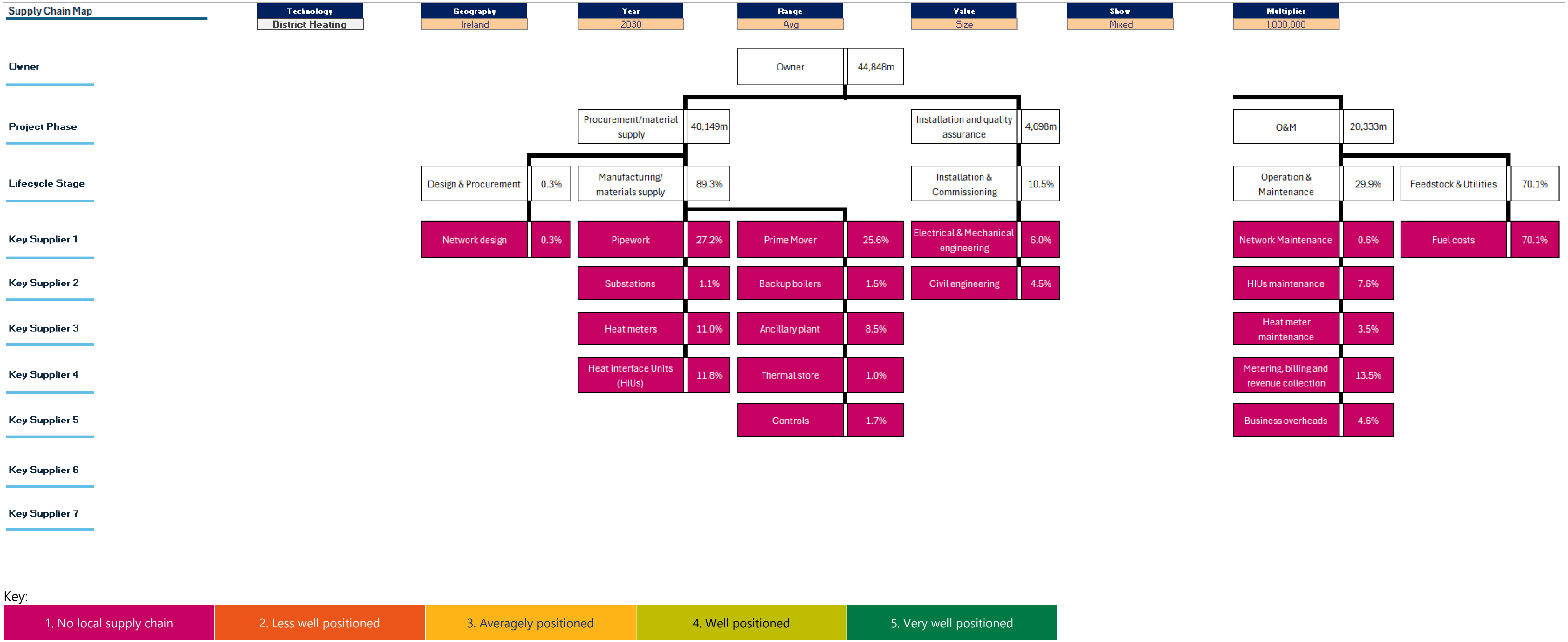
Figure 50: District heating supply chain map for the EU-27 + UK market



Note: (1) Unit of Figures = € million; (2) Owner = Preliminary + Procurement/material supply + Installation and quality assurance; (3) O&M is listed as a separate item

Figure 51: Industrial heat pumps supply chain map for the EU-27 + UK market

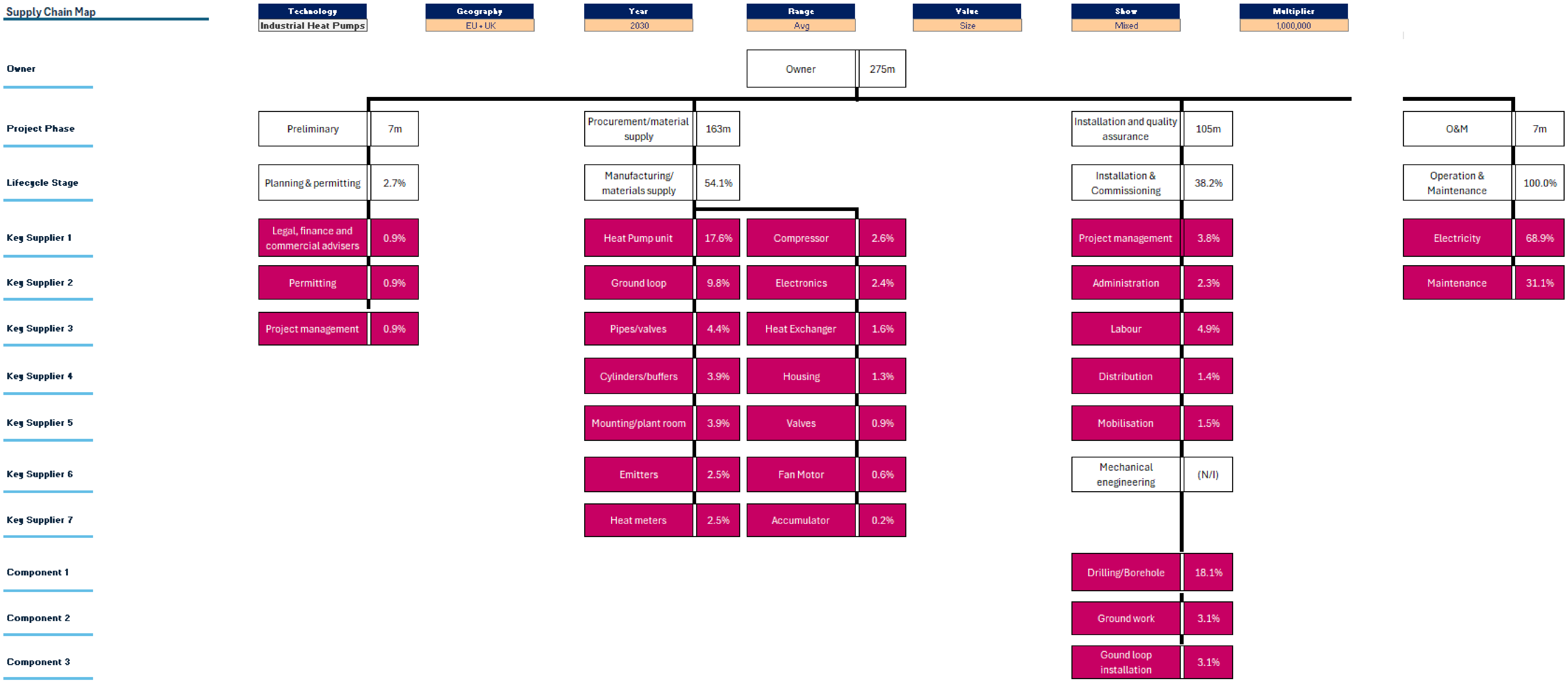


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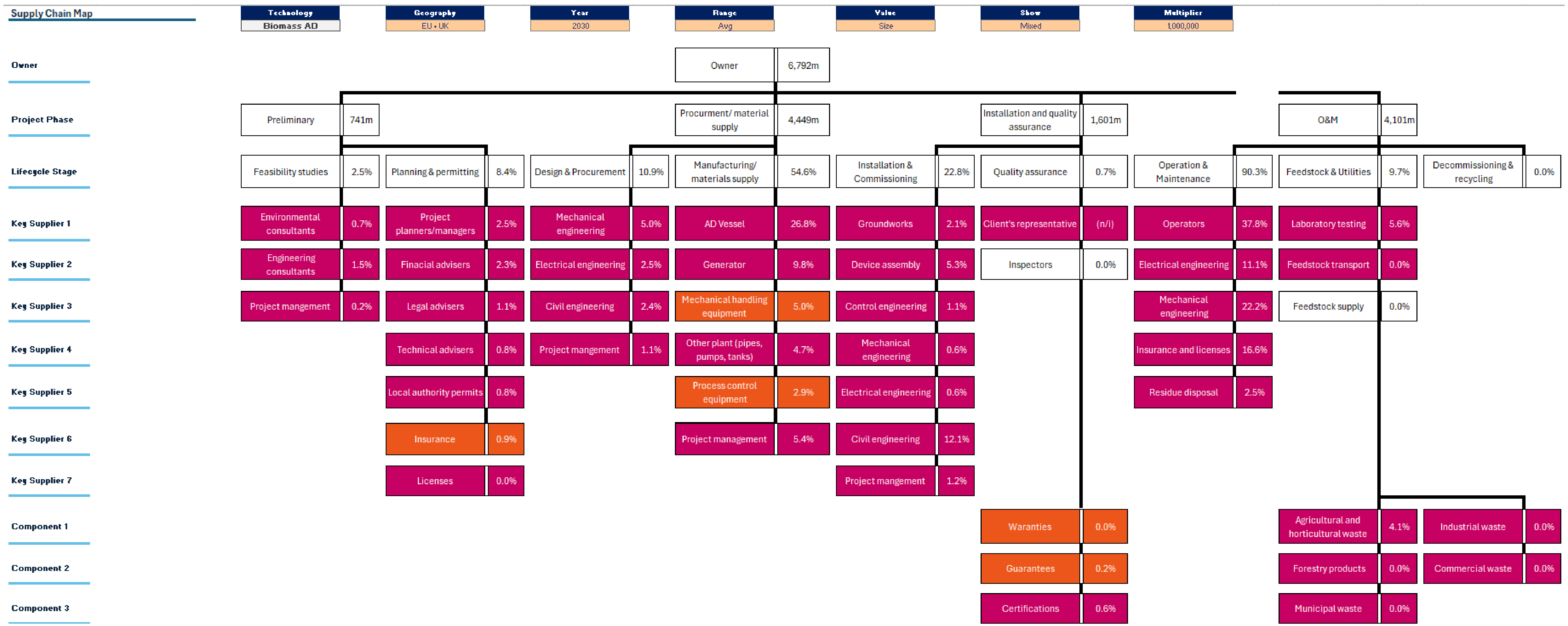
Figure 52: Biomass (anaerobic digestion) supply chain map for the EU-27 + UK market



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Appendix 3: List of Figures

Appendix 4: List of Tables

Appendix 5: Glossary of abbreviations

Abbreviations	Explanation
BER	Building Energy Rating
CAP	Climate Action Plan
CHP	Combined heat and power
CO2	Carbon dioxide
CO2eq	Carbon dioxide equivalent
CSO	Central Statistics Office
DAFM	Department of Agriculture, Food and the Marine
DECC	Department of Environment, Climate and Communications
DETE	Department of Enterprise, Trade and Employment
DoT	Department of Transport
EED	Energy Efficiency Directive
EEOS	Energy Efficiency Obligation Scheme
EPBD	Energy Performance of Buildings Directive
EV	Electric Vehicles
FDI	Foreign Direct Investment
GHG	Greenhouse gas
IDA	Industrial Development Agency
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
ISGAN	International Smart Grid Action Network
LCOE	Levelised cost of energy
MSS	Micro-generation Support Scheme
NDC	Nationally Determined Contributions
NECP	National Energy and Climate Plan
NZEB	Nearly zero energy buildings
NZIA	Net-Zero Industry Act
ORESS	Offshore Renewable Electricity Support Scheme
O&M	Operation & Maintenance
PV	Photovoltaic
R&D	Research and development
RD&I	Research, Development & Innovation

REFIT RESS	Renewable Energy Feed-in-Tariff Renewable Electricity Support Scheme
RHO	Renewable Heat Obligation
SRESS	Small-Scale Renewable Electricity Support Scheme
SRI	Smart Readiness Indicator
SSRH	Support Scheme for Renewable Heat
TRL	Technology Readiness Level
ZEVI	Zero Emission Vehicles Ireland

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