MENON ECONOMICS

Outlook for jobs creation in European battery industry

Content

Summary

Introduction

Development and production of batteries will play a crucial role in Europe's decarbonisation efforts. Through cutting fossil fuel usage in transportation and electricity production, batteries will help bring down emissions from two sectors which contribute heavily to global emissions. Currently, large-scale political and commercial capital is being mobilised to establish European battery production capabilities as well as a specialised supply chain. Both on a regional, municipal and national level this is one of the most ambitious industrial endeavours in decades.

To prepare for the coming battery revolution, policy makers rely on good quality data. Although the future size of the market is inherently uncertain, not all estimates are created equally. Currently, we believe that there is little trustworthy data available, and estimates of the size of the total battery market and the expected employment effects seem to be mostly guesswork. This is also confirmed by interviews with industrial participants, analysts, and policy makers.

Without an understanding of the magnitude of the possible employment effects, it is hard for policy makers to design and implement smart policies. For national politicians, this data is needed in the consideration of whether battery production is worth their while as a strategic sector and what policy instruments should be used to support it. For local politicians and public servants who are faced with large-scale investments in battery facilities in their communities, good estimates are crucial for establishing policies in areas as diverse as housing, infrastructure, provision of welfare services and others.

In this note we present our estimates for the European battery cell market in 2030, price development, as well as production and value added. The main focus, however, will be jobs creation and economic impact (indirect job creation) in the European battery market. Finally, we take a brief look at the effect factories can have for small and mid-sized cities.

Results

Based on a total production of 1,150 GWh annually in 2030 and a price of roughly 70 USD/kWh, we estimate that the **European market for batteries will grow to USD 81 bn**, measured in annual production value. This only covers the production of battery cells and not the rest of the supply chain. The European production corresponds to an annual contribution to GDP (value added) of roughly USD 27 bn. This is a large market, though significantly smaller than Europe's current automotive market which is 20 times bigger.

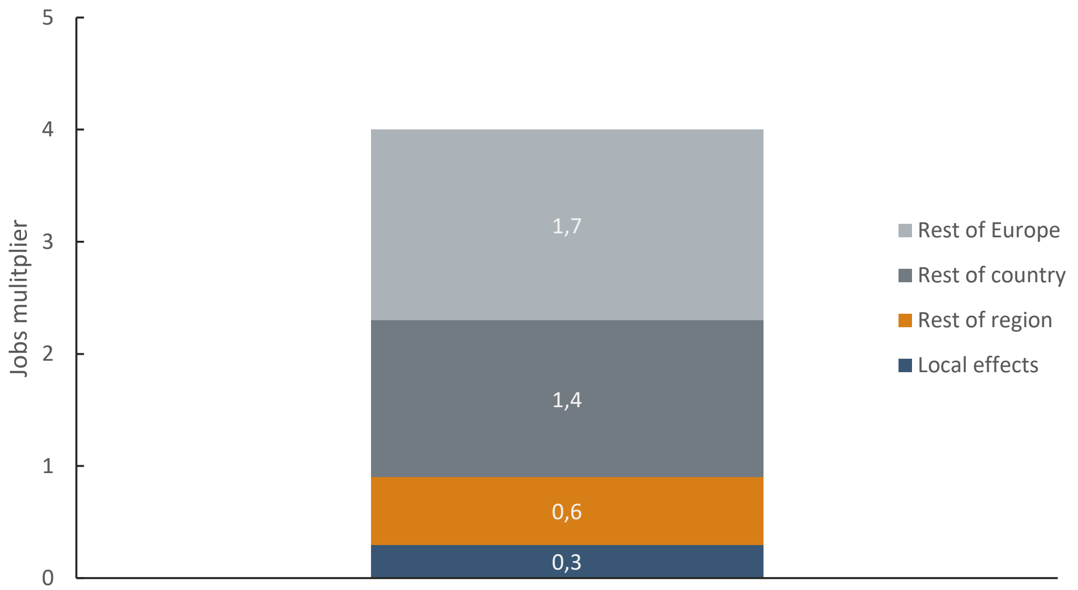
For many policymakers, the jobs associated with the emerging battery industry are even more important than market size. In this note, we employ two different methods to estimate the numbers of jobs in the industry in 2030. We estimate that **the number of direct jobs in European battery cell production in 2030 will be 150,000.**

If Europe is to succeed in the battery sphere, it is necessary to develop a more or less complete supply chain. This means that in addition to the direct jobs, a wide range of specialised and generic jobs will be created on the continent. In this note, we calibrate Menon's economic impact model to battery cell production and estimate that **the total European jobs multiplier will be somewhere around 3.9.** That means that for every job in battery cell production, 3.9 other jobs are created in the upstream value chain. Economic impact analyses only include upstream effects (from suppliers) and thus do not include recycling. However, they include *all* suppliers. That is, both specialised suppliers (of, say, active materials and electrolytes), but also generic suppliers, including everything from financial to janitorial services.

With roughly 150,000 direct jobs, a multiplier of 3.9 gives a total of 735,000 new jobs in Europe by 2030. If Europe succeeds in establishing a larger part of the supply chain on the continent, the multiplier could be as high as 6.5. On the other hand, if the producers will keep importing most active materials, we expect a multiplier closer to 2.

We have also split the multiplier into its geographic components. That is, we estimate how many indirect jobs will be sustained by battery cell production in the local region (at municipality level), the county/region, nationally and in the rest of Europe. The exact distribution for say a region will depend heavily on the presence of specialised battery suppliers, among other factors. Nevertheless, in the figure below we show what could be a typical split between the four geographical levels.

Figure 0-1: Geographic job multipliers for a representative region and country. Source: Menon Economics



In the last part of hte note, we look at the broader societal effects for small or mid-sized cities of attracting large production facilities. The majority of planned European battery production facilities are located in relatively small cities (often between 10,000 and 50,000 inhabitants), and frequently in industrial brownfields. Examples of this include Northvolt in Skellefteå in Sweden, Freyr in Mo i Rana in Norway, Samsung's factory in Göd in Hungary, Britishvolt in Blyth in the United Kingdom, Italvolt in the Milano area and Svolt in Überherrn in Germany.

Since the cities are relatively small, the establishment of battery production facilities will substantially increase employment in the respective locations. For instance, Freyr is expected to increase the labour force in their region by around 3,000 people, an increase of almost 25 percent from the 13,000 people today. Furthermore, many of these cities have experienced population decline or stagnation, and thus such large increases in the demand for labour necessitate a large influx of new inhabitants. In previous analyses by Menon Economics, we have calculated a population multiplier of between 2 and 4. That is, for each new direct job in battery creation the local region will see an increase in population of between 2 and 4. These types of increases have substantial societal effects and can often change the development of a small or mid-sized city dramatically.

What can Menon Economics offer?

Menon analyses economic issues and provides advice to companies, organisations, and authorities. We combine economic and commercial expertise in fields such as industrial organization and competitive economy, strategy, finance, organizational design, and social profitability. We use research-based methods in our analyses and work closely with leading academics in most disciplines.

In the last two years, Menon has carried out several extensive economic analyses of new battery production facilities. Besides a traditional economic impact analysis (jobs in the supply chain) we calculate the effect on the local community in terms of new jobs, population growth, pressure in the housing market, electricity demand, transport bottlenecks and several other important aspects. In addition, Menon has a in-depth understanding of the skills needed in battery production, and how that intersects with tight European labour markets.

1. The global and European battery market

Developing and producing batteries will play a crucial role in Europe's decarbonisation. Through cutting fossil fuel usage in transportation and electricity production, batteries will help bring down emissions from two of the sectors which contribute heavily to total global emissions.

Today, three countries – China, South Korea, and Japan – make up between 80 and 90 percent of global production capacity. Based on data from major companies (the main ones being CATL, LG Energy Solution, BYD, Panasonic), we estimate that today's market is somewhere in the region of 700 GWh. Europe currently lags far behind these countries when it comes to innovation, skills, and technology. This, however, looks like it is about to change with many so-called gigafactories about to be opened on the continent.

The battery value chain

The most important parts of the value chain are illustrated in the figure below.

Figure 1-1: Illustration of the battery value chain

- **Materials and Mining:** Mining and preparation of key materials including cobalt, nickel, lithium, manganese, and several others. These are mainly mined in countries outside of the EU.
- **Active and other processed materials**: Manufacture of active materials for anodes and cathodes, electrolytes, and binders.
- **Cell manufacturing:** Production of battery cells. This is what is mostly meant when talking of "battery production".
- **Packaging and OEMs:** The process of putting cells into smaller or larger modules, which are used for storage or integrated into batteries for vehicles.
- **Recycling:** Deconstruction, disassembly, cleaning, and recycling of batteries.

In this brief note, we will mostly focus on cell production. However, some of the factories currently planned in Europe will include both some processing of materials as well as some packaging, making the scope less clean cut.

1.1 The value of the European market in 2030

In 2019, the IEA and the European Commission estimated that total global battery production was expected to reach nearly 1,000 GWh per year by 2025 and exceed 2,600 GWh by 2030. Current estimates, however, are much higher and global production in 2030 is now estimated to be as high as 5,500 GWh[1]. This is still far lower than the expected demand for batteries. Rystad Energy[2] estimates that total demand in 2030 will be close to 8,800 GWh annually.

Most analysts estimate that Europe's market share of battery cell production will rise from around 8 percent in 2020 to between 15 and 20 percent in 2030[3]. Depending on the estimate for the global market, this corresponds to between 800 and 1,200 GWh of annual European capacity. To put this number into context, assuming an average EV battery pack of 80 kWh, this corresponds to enough batteries for around 11 million EVs per year. On a global scale it is assumed that EV batteries will make up 55 percent of total battery demand, although we believe this share will be somewhat higher in Europe. Including other purposes (batteries for storage, maritime transport, heavier vehicles, etc.) European demand will almost certainly exceed 1,000 GWh in 2030.[4] With such a large gap between projected European demand and supply, it is not inconceivable that European production will grow faster and exceed our estimate in 2030.

To estimate the value of future European battery cell production we need to estimate the price of battery cells and packs (or "modules") going forward. The decrease in the price of lithium-ion batteries has been rapid in recent years. Pack prices per kWh were above USD 1,200 in 2010. With the most recent price being reported by Bloomberg NEF[5] at around USD 135 per kWh, this constitutes a fall of almost 90 percent.[6]

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[1] *Wood Mackenzie, https://www.woodmac.com/press-releases/global-lithium-ion-battery-capacity-to-rise-five-fold-by-2030/ and https://www.rystadenergy.com/newsevents/news/press-releases/powering-up-global-battery-demand-to-surge-by-2030-supply-headaches-on-the-horizon/*

[2] *Ibid.*

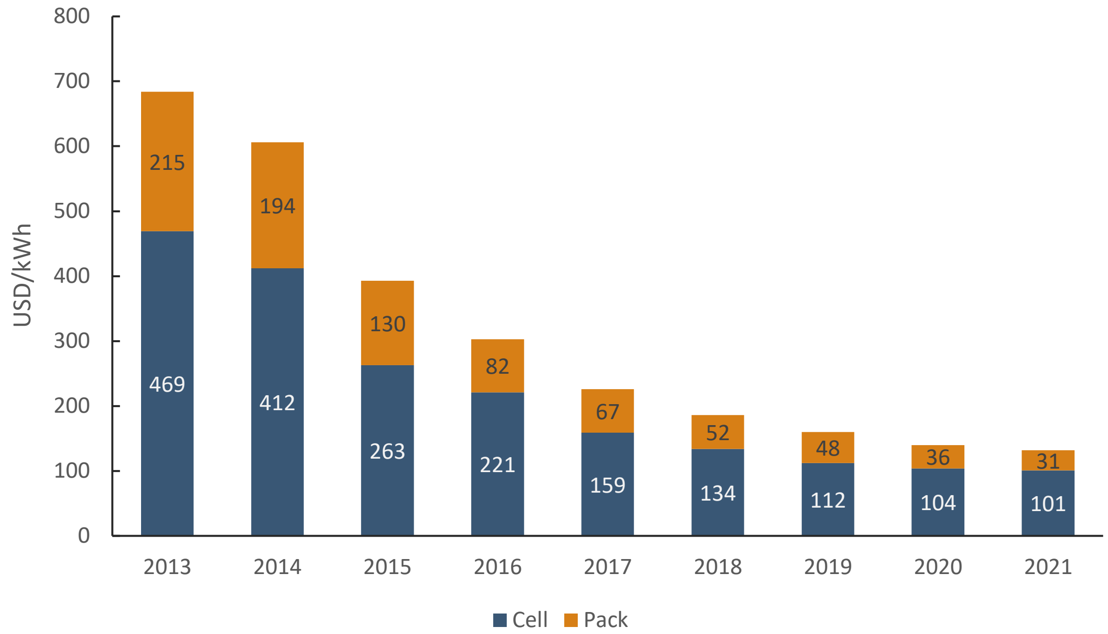
[3] *See for example https://www.energy-storage.news/europe-and-us-will-shave-c-10-off-chinas-li-ion-production-capacity-market-share-by-2030/ and https://www.woodmac.com/press-releases/global-lithium-ion-battery-capacity-to-rise-five-fold-by-2030/*

[4] *See e.g. https://bnef.turtl.co/story/evo-2022/page/6/2?teaser=yes*

[5] *https://about.bnef.com/blog/battery-pack-prices-fall-to-an-average-of-132-kwh-but-rising-commodity-prices-start-to-bite/#_ftn1*

[6] *Many point to a pack price of around USD 100 per kWh as the price level where EVs become cost-competitive with internal combustion car engines.*

Figure 1-1: Price development of battery cells. Source: BloombergNEF



Although high commodity prices in 2021 and 2022 will put upward pressure on the battery price development in the short term, in the medium to long term it is expected that prices will continue to fall markedly. Car makers such as Volkswagen, Renault and Ford have estimated that costs will reach somewhere between USD 60 and 75 per kWh in 2030.[7] **Taken together, this suggests a European market size of USD 81 bn annually in 2030**. Although this is a considerable market, it is still far off the total European automotive market whose production value in 2019 was around EUR 1,250 bn.

For policymakers, production value in itself is less important than value added (GDP) which is fundamental for economic welfare. Although the relationship between production value and value added varies significantly across sectors, similar sectors tend to have similar "value added margins". A comparable sector could be automotive production, where the composition of the work force and the use of technology will broadly resemble that of battery cell production. In 2019, European car manufacturers had value added of roughly EUR 33 for every EUR 100 of production. Projecting similar margins, the contribution to GDP of European battery production will be USD 26.6 bn in 2030.

These estimates are of course highly uncertain, and we therefore model the total market size with different assumptions[8] to see how this affects the value added. According to our simulations, the revenue from European battery cell production in 2030 ranges from USD 42 bn to 105 bn and value added from USD 11 bn to 42 bn.

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[7] These estimates are in line with the US Energy Department's Office of Vehicle Technologies, which funds battery research.

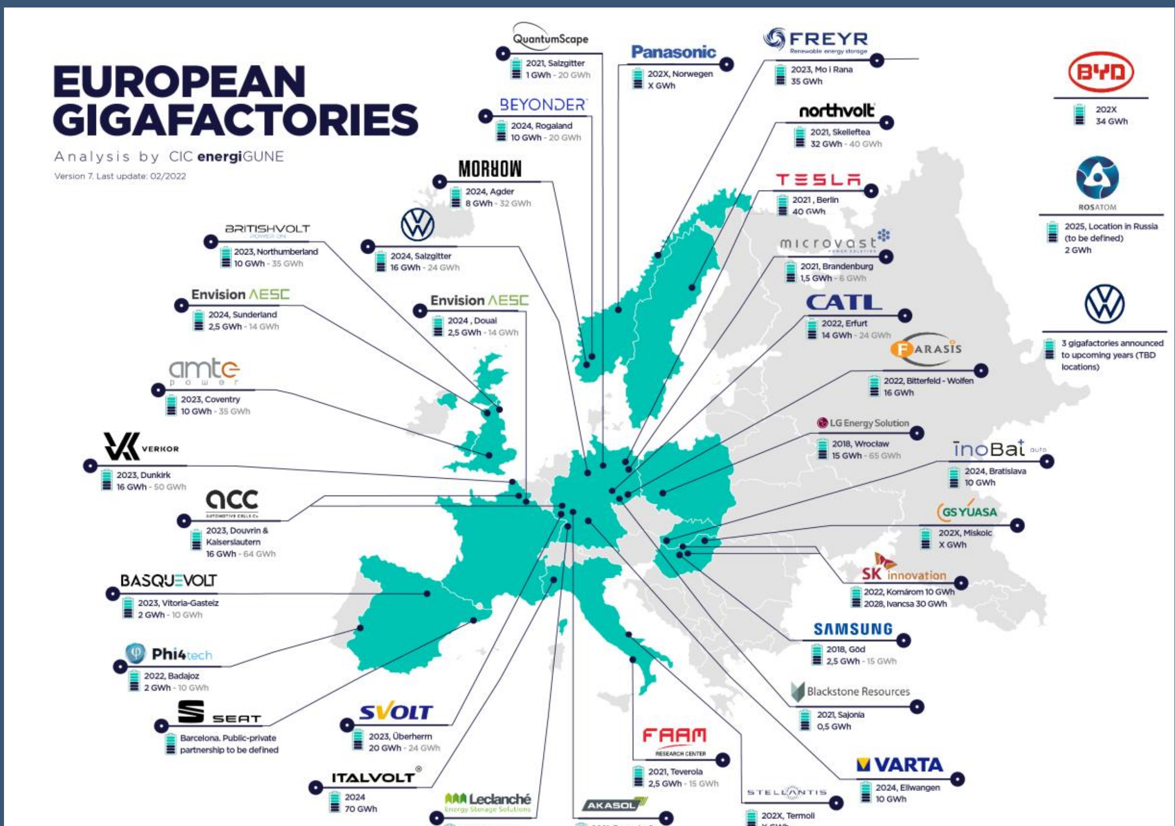
[8] To create the range, we adjust the market size (600-1,500 GWh), battery prices and value-added margins.

European Gigafactories

As already stated, the majority of battery production today is located in Asia. However, there are large-scale plans in both Europe and US to catch-up to the Asian producers. In recent years in Europe, a number of gigafactories for batteries have been built or are under construction, and even more gigafactories are in the planning stages.

The reason for the Europe's increased ambition in the space are manyfold, and both commercial, political, and geopolitical factors play a part. However, there are two of the main reasons for the increased focus on growing a battery supply chain. The first is that Europe and its car industries are reluctant to become too dependent on Chinese and Asian batteries. Secondly, the batteries produced in Asia are less sustainable in terms of their climate footprint that what is compatible with the Paris goals. As a consequence, we have seen a number of battery factories being built and starting to produce in recent years. Examples include Tesla's factory in Germany (expected to be fully operational in 2023, capacity of 40 GWh), Northvolt in Sweden (fully operational in 2024, capacity of 32 GWh), LG Energy Solution in Poland (operational in 2018, maximum capacity of 35 GWh) and Samsung in Hungary (operational in 2018, maximum capacity of 30 GWh). This, however, only seems to be the start and factories are popping up all over the continent, such as Freyr battery factory in Norway, Britishvolt and Italvolt. The map below shows the most important of the gigafactories currently operating or being planned in Europe.

Figur 2. Overview of planned and existing European gigafactories. Source: CIC Energigune



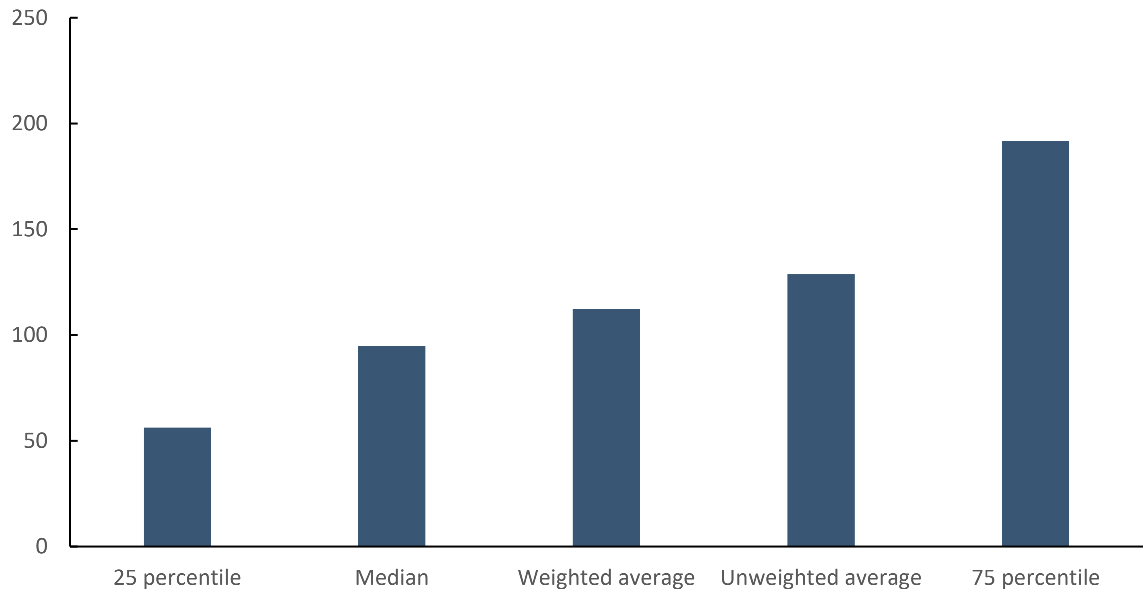
2 Employment effect of producing batteries in Europe

Given the large uncertainty with respect to almost all key variables, we employ two different methods of calculating the number of jobs in European battery cell production towards 2030. In the first method, we use estimates of value added per employee (for example by looking at comparable industries). In the other, we use an estimate of expected production (in GWh) per employee.[9]

For the **first method,** we use productivity in the automotive sector as a proxy for productivity in European battery production. Both sectors use high-tech manufacturing with relatively automated modes of production. In addition, it is likely that battery production, like the automotive sector, will consist of a handful of large players, indicating that the profitability margins will be similar. In 2019 – the last year not dominated by the covid pandemic and supply chain disruptions – German car manufacturers created gross value added of EUR 136 bn. This was done by employing 916,000 workers.[10] Dividing the two numbers gives us a GDP per employee of roughly EUR 150,000, significantly higher than the EU average productivity. If European battery production reaches similar productivity levels, one would expect the **European battery production to result in 170,000 jobs in the EU**. If we instead use the range of market size estimates calculated in the section above, we find that battery production could generate between 71,000 and 267,000 European jobs in 2030.

The **second method** takes as its input the number of expected GWh of production in Europe and the number of jobs per produced GWh. By comparing several sources of information from the different battery producers, we estimate this number in the figure below.

Figure 2-1: Observed or expected employees per GWh produced.



We use 24 existing and planned battery gigafactories in the estimation of these numbers. There are large differences in the reported number of jobs/GWh, and therefore we choose to present an interval between the

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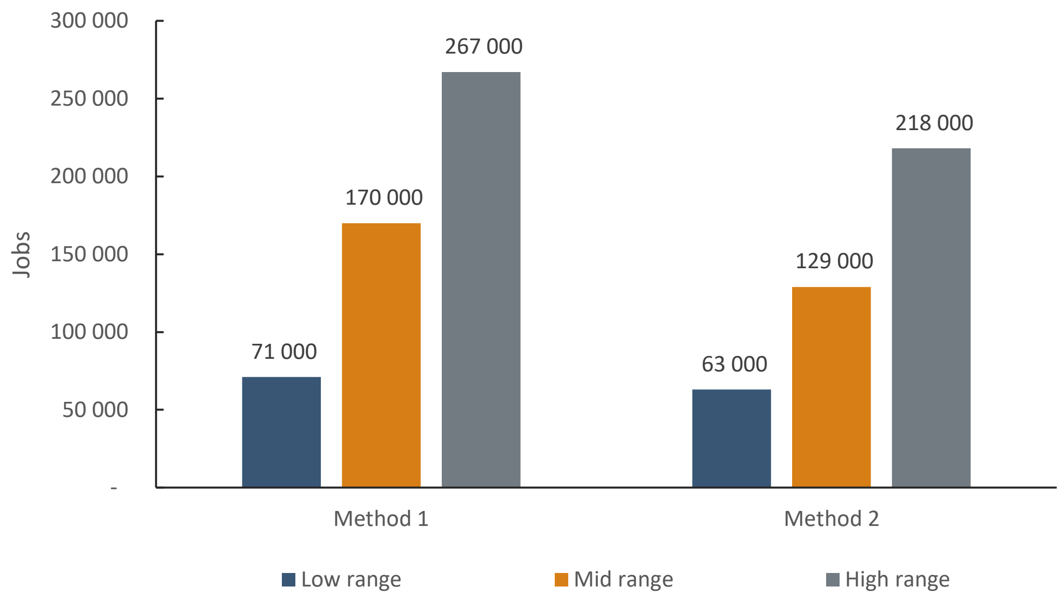
[9] *In this latter method people tend to express productivity as employees per GWh and not as production per employee and we follow that.*

[10] *All data on German car manufacturing are sourced from Statistisches Bundesamt*

25th percentile and the 75th percentile. It is important to notice that these numbers are based on existing factories producing at full capacity, existing factories that have started producing, but are not producing their full planned capacity, and planned gigafactories that are not producing anything yet. There is, in other words, large uncertainty associated with these numbers. However, they give us some pointers about how many employees should be expected per GWh produced. **The numbers imply that about 100 employees/FTEs are needed per GWh produced**. The most efficient factories expect to use as few as 50 employees per GWh, while the least efficient factories may possibly use as many as 200 employees per GWh. [11] The average employee-to-GWh ratio in the sample is about 130 employees. This number is driven upwards by some outliers, as the median is about 95 employees per GWh produced. The weighted average is about 112 employees/GWh.

Above, we estimated the size of the European market for battery cell production to be around 1,150 GWh annually in 2030. With a "labour intensity" of roughly 112 employees per GWh, this results in a **total estimated number of 129,000 European jobs**. This is lower than the estimate from the first method, but well within the range given above. If we instead use the 25th and the 75th percentile of labour intensity of 55 and 190 employees per GWh, respectively, we find an estimate of total jobs in Europe of 63,000 and 218,000. Thus, the two methods overlap relatively closely, as shown in the graph below.

Figure 2-2: Estimates of jobs in European battery cell production in 2030. Source: Calculations by Menon Economics



The average of the two mid-point estimates is **150 000 employees**, which we consider as our base-case estimate for the direct employment effect of battery cell production in Europe in 2030.

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[11] *There are notable differences between the factories which may explain some of the variation in the number of employees per GWh. While some factories, such as Tesla, will keep the full production in-house, other battery factories, such as Freyr, will be part of the value chain in car manufacturing, without producing cars. This will naturally affect the number of employees related to the battery factory. While Tesla's operating factories on average have around 130 employees per GWh produced, factories that only produce batteries and ship these to car manufacturers have around 90 employees per GWh produced. It is also worth noticing that there seem to be some economies of scale, as gigafactories planning to produce more than 20 GWh have an unweighted average of roughly 100 employees per GWh produced.*

3 Total economic impacts from battery production

We now move on to try and quantify the total number of jobs created in the supply chain of the battery producer. This includes both the direct employment in battery cell production as well as in the supply chain. Economic impact analyses only include upstream effects (from suppliers) and thus does not include recycling. However, it includes *all* suppliers. That is, both specialised suppliers (of, say, active materials and of electrolytes), but also generic suppliers, including everything from financial to janitorial services.

Broadly speaking we can think of four relevant regional areas for analysis. These are:

- Local effects
- Regional[12] effects
- National effects
- European effects

While the first and the last will be approximately the same for most European battery factories, the second and the third will vary considerably depending on the size of the region/country where the factory is located, the availability of local suppliers and several other factors.

At the **local level,** effects will be relatively small. This is because modern battery production is advanced, high-tech manufacturing requiring complex inputs which are seldom available in the local area. Depending on the size and the use of local suppliers for generic services (janitorial services, electrical, cleaning, or similar services) we estimate that the indirect impact of European battery production will be between 0.1 and 0.4 jobs created per job in the factory. This means that a factory of roughly 2,000 employees will create between 200 and 800 jobs locally (in addition to the 2,000 jobs in the factory). This, however, does not mean that the effects on the local community will be equally small. We deal with the total societal effect in the section below. However, in some cases specialised suppliers will probably open facilities in near proximity to the factory. In that case, the effects will be somewhat larger.

At the **regional level,** the economic effects will vary significantly. For regions with no specialised battery value chain, the effect will be roughly the same as the local effects. That is in addition to the 0.1-0.4 indirect local effects, we estimate that roughly 0.25 jobs will be created or sustained in the surrounding region. Again, this number comes on top of the direct employment in the factory. This will include some of the same type of jobs as the local jobs, but also jobs in transport and logistics, some professional services and several others. However, this changes if and when the region develops a supply chain of material suppliers. The cost structure of battery production is such that active materials (the cathode and anode materials) make up the majority of the total cost. If such suppliers are present in the region, one can imagine significantly higher indirect effect on jobs creation, and we estimate that the job multiplier in that case could be in the range of 0.8-1.3.[13]

In many ways the **national level** is similar to the regional level, in that the size of the multiplier is highly dependent on the size of the country and the presence of a national battery supply chain. In previous analyses by Menon Economics[14], we calculated a national job multiplier of around 1. This is to be considered a minimum,

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[12] Here we think of local as being municipalities and regional being larger counties or regions

[13] The job multiplier here is cumulative. So, the 0.8 – 1.3 number is the cumulative size for both the local and regional level

[14] https://www.menon.no/wp-content/uploads/2021-111-Ringvirkninger-og-samfunnseffekter-av-Freyrs-etablering-i-Mo-i-Rana.pdf (in Norwegian)

as we calibrated the model to reflect a small country with almost no specialised suppliers. In that analysis, we assumed that almost all non-specialised suppliers were to be located in Norway. Thus, this multiplier will not increase with the size of the country as long as there are no specialised suppliers. The situation could be very different if a larger country (say France or Germany) develops a group of domestic suppliers. In that case, the job multiplier could be as high as 2.5-3.

Lastly, we look at the **European level**. The total European multiplier will be mostly independent of what country the production is located in. However, whether the EU succeeds in establishing a supply chain in active materials will be crucial for the size of the total economic impact. In what we consider our base-case scenario, the economic job multiplier will be around 3.9. That means that for every job in battery cell production, 3.9 other jobs are created in the upstream value chain. In a case with a larger value chain on the continent, the multiplier will increase to over 6.5. One the other hand, if the producers will keep importing most active materials one would expect a multiplier of around 2.

There are three important points to keep in mind when it comes to the estimates above:

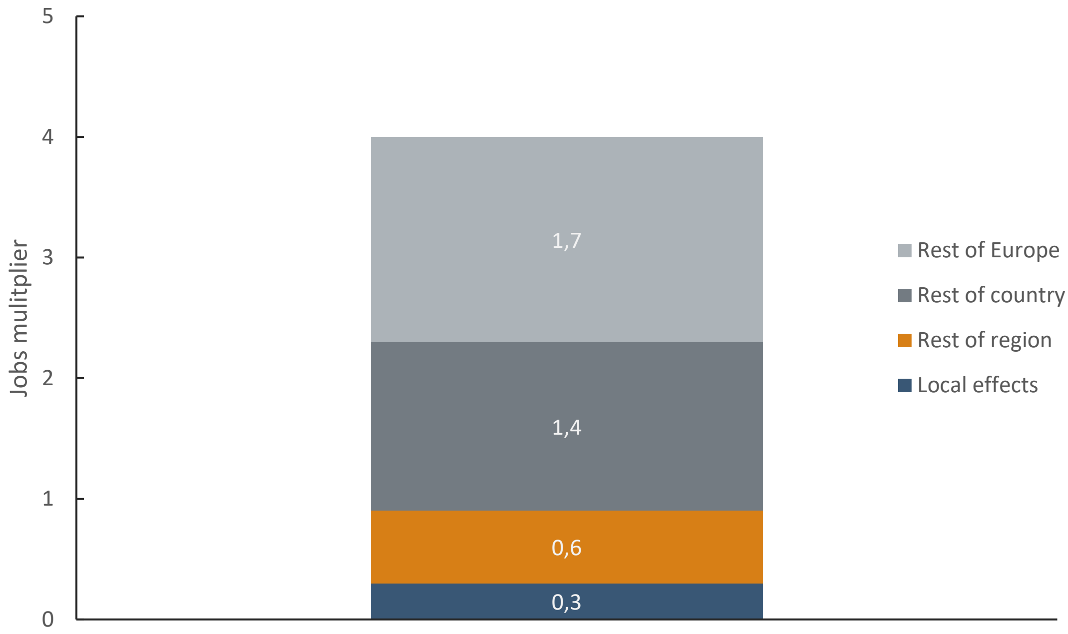
- Firstly, the estimates are characterised by large uncertainty. The model we use to estimate the multipliers is sensitive to input variables such as productivity, battery and commodity prices, supply chain development and many other factors that are hard to predict.

- Secondly, an economic impact analysis only looks at upstream effects. If European battery production is to be sustainable, it will have to develop ways to recycle large parts of the batteries. Research and innovation have already come a long way, and several commercial actors are looking to begin operating in 2022. These, however, are not included in the analysis.

- Lastly, the estimates for the different geographical levels are not independent. That is, if the regional multiplier is high, it is likely that most of the national multiplier (net of the regional effects) will be lower. The same is true across all levels.

Below we show what we consider a realistic estimate of the geographical split of the total European multiplier.

Figure 3-1: Geographic job multipliers for a representative region and country. Source: Menon Economics



We can now estimate the total number of jobs in battery cell production and the associated upstream supply chain. Thus, in addition to the roughly 150,000 jobs in European battery cell production in 2030, we estimate the creation of 585 000 new indirect European jobs. This constitutes a total of 735 000 new jobs.

4 Broader societal effects

The majority of planned European battery production facilities are placed in relatively small cities (often between 10,000 and 50,000 inhabitants), and frequently in industrial brownfields. Examples of this include Northvolt in Skellefteå in Sweden, Freyr in Mo i Rana in Norway, Samsung's factory in Göd in Hungary, Britishvolt in Blyth in the United Kingdom, Italvolt in the Milano area and Svolt in Überherrn in Germany.

There are two main reasons why battery production facilities choose to locate in brownfields in smaller cities. The first of these is infrastructure and electricity needs – battery production requires sufficient grid capacity, and ready logistics for shipping. The second is area requirements. Battery production factories are large, often requiring around 500,000 square meters of indoor space. The combination of these two factors makes small cities with existing industry a good choice – land is relatively affordable, and the necessary infrastructure already exists. We therefore consider it likely that future battery production facilities will continue to choose such locations.

Since most cities are relatively small, the establishment of battery production facilities substantially increases local employment. For instance, Freyr is expected to increase the number of employees by around 3,000 , an increase of almost 25 percent from the 13,000 people employed in the region today. These types of increases have substantial societal effects and can often change the development of a small or mid-sized city dramatically.

How the establishment of a production facility changes the city depends on many factors, but the most important one is where the employees will come from. In general, employees can come from three sources:

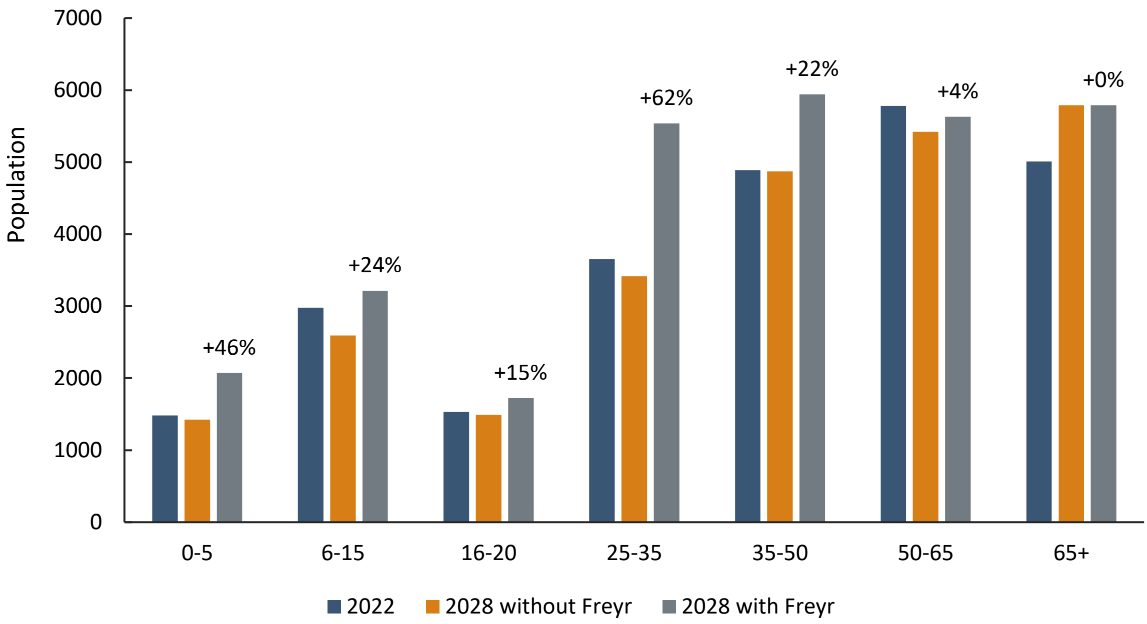
- Increased commuting from other cities and reduced commuting to other cities
- Unemployed people and people outside the workforce returning to work
- People moving to the city and/or fewer people moving out of it

In most cases, the employees at the battery production facilities will come from a combination of these sources, but in certain cases they will come almost exclusively from one of these sources. In the case of small cities located near a large city, increased commuting will likely absorb the majority of the employment needs – especially in the short term.

In the case of small cities located outside commuting distance from the nearest large city, the employees will either have to come from unemployed people returning to work, or from more people moving to the city. In the case of Freyr in Northern Norway, and Northvolt in Northern Sweden, there is almost full employment both on a municipality level and regionally. The employees there almost exclusively have to come from people moving to these areas. This can cause the population to increase substantially. In an analysis of Freyr that Menon carried out for Rana (the municipality where Freyr is located), we predict that the city will experience the largest relative population increase a municipality has seen in Norway for decades.[15] Since the majority of people moving will be young, this will also change the demographics of the city substantially, as shown in the figure below.

[15] *https://www.menon.no/wp-content/uploads/2021-111-Ringvirkninger-og-samfunnseffekter-av-Freyrs-etablering-i-Mo-i-Rana.pdf (in Norwegian)*

Figure 4-1: Forecast growth rates for different age groups in Rana municipality. Percentage shows growth due to Freyr. Source: Menon Economics



Without the establishment of Freyr, Rana would have had an aging, decreasing population, but the influx of new inhabitants due to Freyr will revitalise the city. This effect is likely to be even larger in other European cities, particularly in "left-behind" industrial cities, where unemployment, low employment/population ratios and aging populations are an even larger problem. In these cities, the employment could come from unemployed persons returning to work, those outside the workforce returning to work, or former industry workers returning to relevant work matching their education and experience. Combined with more people moving to the city, this can rejuvenate left-behind industrial cities.

However, for such rejuvenation to take place, the battery production facility and local government must work closely together since the city must move quickly if it is to attract new inhabitants and succeed in creating industrial growth. For most of the cities, the number of people moving in following the establishment of the factory will be multiple times larger than the number in the years before. The net number of people moving in will for most of the left-behind cities go from being negative before the establishment to substantially positive after. This may put severe strain on public infrastructure. This includes the need for roads, public transport and other public utilities, but the largest and most immediate need is usually for housing. It will be necessary to construct housing at a rapidly increased pace, and often also to build a different type of housing – one more oriented towards apartments and with a more active rental market. The trickiest part of this is that infrastructure and housing need to be in place *before* the factory starts producing to full capacity, or this will severely hamper both the battery producer and the societal effects for the city.