ELECTRIFICATION AND EMPLOYMENT IN THE FRENCH CAR INDUSTRY

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>>1 INTROUDCTION

In 2020, the European automotive market began its shift towards electric vehicles while the coronavirus crisis hit the sector particularly hard. In France, its vulnerabilities are all the more visible: dependence on globalised supply chains, overcapacity of production, and low competitiveness in a context of increased competition. One year later, the difficulties of sector caused by (industrial) disinvestment – from which the sector has suffered for many years – and after many waves of massive relocation to low-cost countries stick out. This is bad news for employment with site closures and relocation piling up again. Moreover, France's delay in terms of transition to non-fossil fuel technologies from the historically dominant diesel engines is all the more glaring, as the other European players are accelerating.

For the first time, in 2020, electric and plug-in hybrid vehicles exceeded 10% of market share in both France and Europe. They will most likely dominate sales within a few years. While at the end of 2018, only around 60 electrified models (100% electric, plug-in hybrids or hybrids) were present in continental dealerships, this number should reach 176 by the end of 2020, 214 in 2021 and 333 in 2025. Regarding the evolution of battery prices, parity between the purchase price of electric and combustion engines can be expected within 5 to 7 years (Bloomberg and Transport & Environment, 2021) and reinforces the realism that combustion engines will come to an end sooner than expected. This parity has already been achieved if we consider the total cost of ownership (purchase + use - BEUC, 2021).

European standards on vehicle CO_2 emissions have been the driving force behind the shift towards electrified models. By setting an average emissions ceiling of 95g CO2/km, they have enabled a 40% reduction in emissions since 2007, according to the Climate Action Network. Nevertheless, the vehicles placed on the market still emit too much CO_2 with regard to climate objectives, especially as the European Union has raised its overall 2030 objective of reducing greenhouse gas emissions for cars to -55%. The forthcoming revision of these standards should enable the car industry to take the path to total decarbonisation by 2050.

The end of internal combustion engines is therefore coming much faster than the industry had expected, and it is bringing about an unprecedented change in the sector. Europe's current effort to catch up, through the "Alliance for Batteries", in order to avoid a possible lack of supply of battery cells, is a key step in order not to lose the battle of the electric vehicle and to keep the possibility of anchoring the car industry of tomorrow in Europe. To achieve this goal, the European car industry intends to spend almost €145 billion to convert its product portfolio by 2025 (Transport & Environment, 2019). It does not seem excessively optimistic to conclude that electrification might not only be a threat, but also an opportunity for the European industry. According to Transport & Environment, Germany, France, Spain, Italy and the UK will have around 85% of the production capacity by 2025.

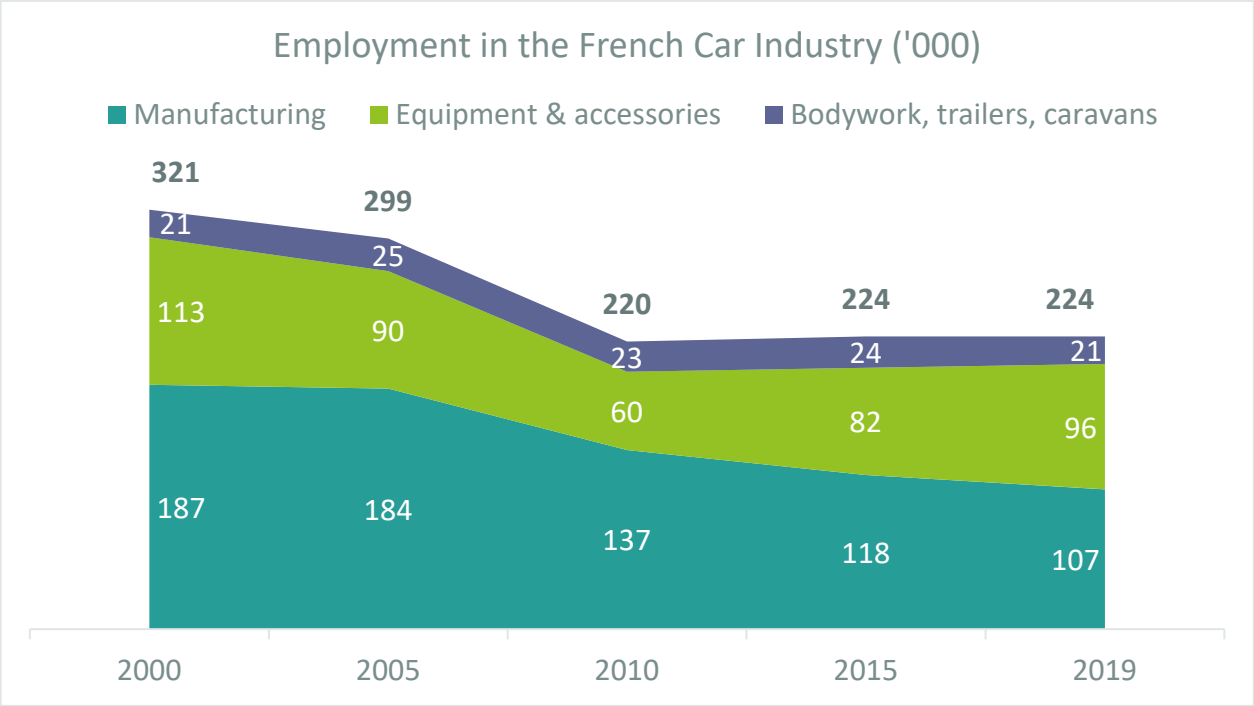
Nevertheless, the French industrial fabric is struggling to cope. This trend has been observed for some time now. The available data reveal the extent of the problem: the number of vehicles assembled in France has fallen from 3 million in the early 2000s to 2 million in 2019, and 1.3 million in 2020, at the height of the crisis.

Compiling reliable data on employment in the automotive sector is a challenging task. The definition of its scope varies significantly. The industry association CCFA (2021) includes a large range of services (such as driving schools insurance companies and road transport), and their annual analysis comes to the conclusion

that some 8-10% of private sector employment are linked to the car industry. Although these figures are often cited in the press and by politicians, most experts agree that greatly overestimate the importance of the sector.

Looking at their data in more detail, we observe a strong decline in automotive employment, especially in the first decade of the millennium. Jobs in manufacturing continue to decrease over the entire period. In the last 20 year, 42% of these jobs disappeared. In the equipment and accessories industries, the downward trend after the year 2000 turns around and the data record an increase. This trend is partly due to changes in the statistical definition of the scope of these activities from 2015 onwards, but might also be explained by increased outsourcing from tasks that were not considered "core business" by the OEMs.

Figure 1 – Employment in the French car industry



Source: CCFA, several years

Nevertheless, in light of the relatively poor quality of publicly available data, Syndex compiled its own database. Our data suggest that over the last five years alone, employment has fallen by 7 to 8% in the automotive industry. The fall has been greater among manufacturers (-12%), while suppliers have seen employment decline by -4% to -6% (see sections 2 and 3 below for a presentation and discussion of the data). Our findings contradict those from the CCFA figures regarding suppliers, which is most likely due to a narrower definition in our database (see also below). The overall trend, however, that employment in the car manufacturing industry shows a decreasing trend, is confirmed by both CCFA and Syndex data.

In contrast to other parts of the industry, economic recovery after the 2008 economic crisis was not accompanied by a recovery in employment in the automotive sector. Moreover, due to its importance in the economic structure, developments in the car industry have a major impact on other sectors. Therefore, the automobile sector has been the sector that has been a major driver for job reduction in recent years. These two factors contribute to the importance of any analysis of the future of employment in the automotive industry and make an active steering through public policy all the more necessary.

The outlook for the coming years, however, is no grounds for optimism. In its recent assessment, the Observatoire de la Métallurgie (2021) points out the risk of losing another 100,000 jobs by 2035 in the French automotive industry.

The switch to electric vehicles, and this is a central subject of this study, is the major factor in the transformation of business models, work and employment. The conversion to electric power, which is now underway, will have an impact on traditional activities, and in particular the production of engines, which will require fewer mechanical parts and less manual labour.

To date, however, electromobility has above all opened new opportunities for those companies that anticipate, diversify and position themselves in a world that has become ultra-competitive. With, in 2019, only 4% of vehicles produced being electrified, and two projects linked to the manufacture of batteries in France, the challenge today is to accelerate the first stage of the ecological transformation of mobility.

As of today, one of the main reasons for the drop in activity and employment are fundamental developments in the global supply chain. The automobile market, which is now entirely globalised, is no longer limited to the historical production zones, fully integrating China, Morocco or Turkey, or Eastern Europe. The players in the sector have seized the opportunity to source strategically from low-cost countries, exacerbating competition between countries and accelerating relocation.

In recent years, the production of city cars and compact cars has lost its last productive ties to France. The Renault Clio, until recently produced in Flins, has now moved to the production lines in Novo Mesto (Slovenia) and Bursa (Turkey) and the Peugeot 2008 has left Poissy and is now produced only in Trnava (Slovakia) and Kenitra (Morocco). France is the OECD country that has relocated most of its industrial production to third countries, which explains to a significant extent the current situation. As a result, if at the beginning of the 2000s, one out of every two cars sold on the market was manufactured in France, by 2020 it will be one in five.[1] Although the electric market is taking off, with some 10,000 registrations of 100% electric vehicles recorded in April 2021, only 18% are produced in France (data from the European Association for Electromobility, AVERE).

In addition to technological developments and changes in the global supply chain, the decline of the French automotive industry calls into question the economic policies that have been pursued over the past ten years in both France and Europe. At European level, in the absence of a coordinated industrial strategy, competition is increasing between countries to attract investment. Social dumping practices are fuelling relocations within the Union. Furthermore, the standards on CO_2 emissions from light vehicles are based on a set of rules, which may prove unproductive. Weight factoring is a case in point, which disadvantages the lightest vehicles and marks a lost battle for the French industry against its German neighbour.

At national level, the automotive industry has benefited from massive support from the State for many years, from scrappage bonuses to the recovery plan initiated in 2020. However, despite the stated ambitions to modernise the production system (“Digital Factory” or “Factory 4.0”) or to switch to electric vehicles, and in spite of the €8 billion put on the table in 2020, this plan does not alter the underlying trend of rationalisation and delocalisation and, therefore, job losses.

Therefore, it is crucial to analyse the technological changes fuelled by electrification in conjunction with other trends, such as European and national economic policy and globalised value chains.

The automobile industry is at a turning point in its history. The transition to electromobility is a key stage in maintaining and redeploying industrial activities and jobs in the long term, and in meeting the challenge of total decarbonisation of transport by 2050. This paper attempts to contribute to the debate how public policy and company strategies can be leveraged to contribute to electrified mobility while impeding further deindustrialisation of French and Western European regions.

We start our analysis by presenting our data and methodology. To assess the scope of the development, we have compiled a unique database of employment information at company level. The dataset focuses on car engines as one of the most impacted activities and contains some 140 sites with roughly 70,000 jobs,, which is about one quarter of total employment in French car manufacturing. In this study, we focus on engine plants that are likely to be strongly impacted by electrification (114 establishments). The data give a screenshot on the current situation of employment and allows to track some of the more recent trends. To

[1] The share of French brands in the registration of cars in France decreased very mildly over that period. In 2000, 59,1% of new light passenger vehicles registered were from a French brand. In 2019, it was 56,8% (CCFA, 2021).

model scenarios for future developments, we have conducted expert interviews to assess the impact of electrification on employment. The subsequent section 3 presents some insights from our database. Thereafter, we present the different scenarios for the future, ranging from "laissez faire" to ambitious goals for CO_2 reduction and strong industrial policy to protect local value chains and employment (section 4). Section 5 presents the results of our different models. To illustrate our hypothesis, we present a recent case study in chapter 6. The chapter finishes with some concluding remarks.

>>2 DATA AND METHODOLOGY

To conduct our analysis, we have compiled a unique and comprehensive database with company-level information. The analysis presented here focuses on engines as these are the ones that are expected to experience the strongest impact of electrification. Therefore, we have consolidated information on 114 sites and/or establishments in the French engine industry in France (see Figure 2). In total, our database consists of a starting sample of 121 establishments. (Three sites closed during the study period.)

Figure 2

Automotive sector

Powertrain industry

OEM
OES
Subcontractors

- **136 sites in the powertrain industry**
- **70 000 employees (2018) in production, R&D, and services**

For each establishment, in addition to its company name and the group to which it belongs, we have compiled some supplementary information.

- Its rank in the supply chain (OEM, OES, subcontractor),
- Its degree of exposure to the change in engine technology (from 1 to 4),
- Its family of activity,
- The professional categories employed at the site, and
- Its portfolio of activities and business lines (R&D, production, support functions)

Finally, we have assessed, to the extent that it was possible, whether the site is undergoing a diversification strategy.

The data collected by establishment are compiled from the social balance sheets (*bilan social*) produced by the companies at different dates (2014, 2016 and 2018). In addition, we conducted interviews when access to documents was not possible. In a few cases, we extrapolated data from previous years, used public data provided by the company or from other public sources.

The following data were collected:

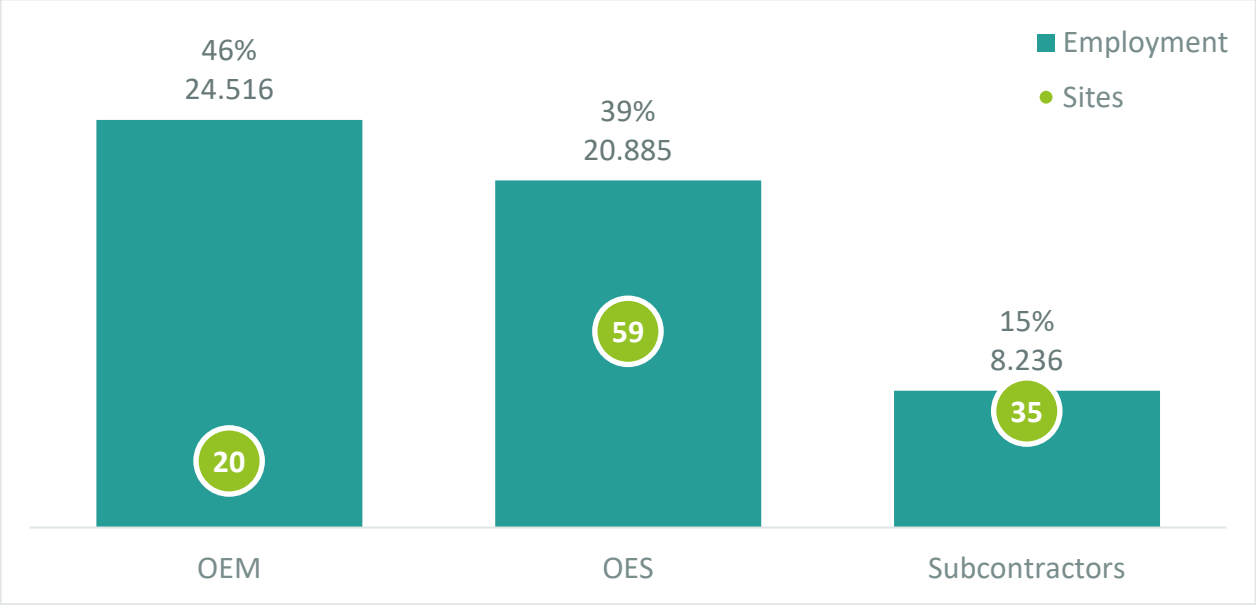
- Number of permanent employees,
- Employment categories,
- Average temporary work,
- Workforce older than 55 years,

- Employment forecasts or employment trends over 3 or 5 years.

A selection of the data is presented in section 3. Figure 3 shows that almost half of the jobs (46%) are with OEM followed by OES (Tier 1 and 2, 39%) and subcontractors (15%). OEM also show a tendency to concentrate employment on a few large sites whereas jobs with suppliers are spread across smaller establishments.

According to the analysis presented in Figure 4 three jobs out of four are with French-owned groups (74%). Employment in foreign-owned companies is concentrated in German businesses (11%). All other countries show lower rates of weight in the overall employment landscape.

Figure 3 - Employment in the French Car Engine Industry in 2018



Source: Syndex database

In addition to the employment database, we have conducted expert interviews to establish how employment might develop with progressing electrification. Based on these interviews, we have established employment indices that capture the need for labour according to the type of engine employed (diesel, petrol, light hybrid, rechargeable hybrid, electric vehicle, fuel cell vehicle, gas vehicle).

These indices were constructed by cross-referencing employment data with the volumes produced in seven segments of the engine industry:

- Production of traction battery cells,
- Engine components (machined parts of the engine block, including the injection system),
- Electronics (ECUs and sensors),
- Engine assembly (final assembly of the engine),
- Transmission and gearboxes (production and assembly of transmission and gearbox components),
- Exhaust systems (production and assembly of exhaust system components, including pollution control),
- Foundry.

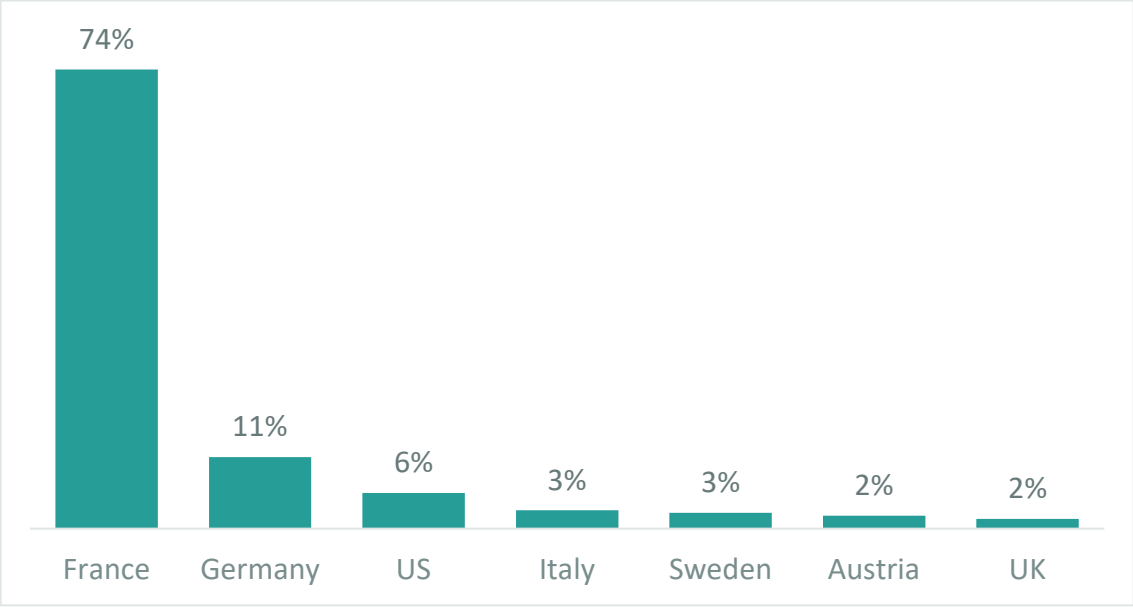
The indices take into account the reality of employment in the motor industry in France for each of these segments of activity, except for the production of traction battery cells. When compiling the dataset, battery cell production did not yet exist in France. Regarding battery cells, the employment index is based on the

assumption that the entire value chain for the assembly of electrified Global Modular Platform (GMP) packs is located in France.

The indices for fuel cell engines were estimated on the basis of technical considerations from other engine technologies. A significant part of the powertrain is similar to that of an electric vehicle. The difference between the two technologies is concentrated on the different substitution of a traction battery by a fuel cell.

The results of our estimates are presented in Figure 5 and Figure 6. Comparing electric engines to diesel, the most common ICE produced in France, the overall need for a labour for an electric engine is about 60%. In terms of segments, the strongest negative impact is expected from assembly and components (especially mechanical pieces) followed by exhaust systems, transmission, and gearboxes as well as foundry activities. New jobs in battery production do not compensate the losses elsewhere.

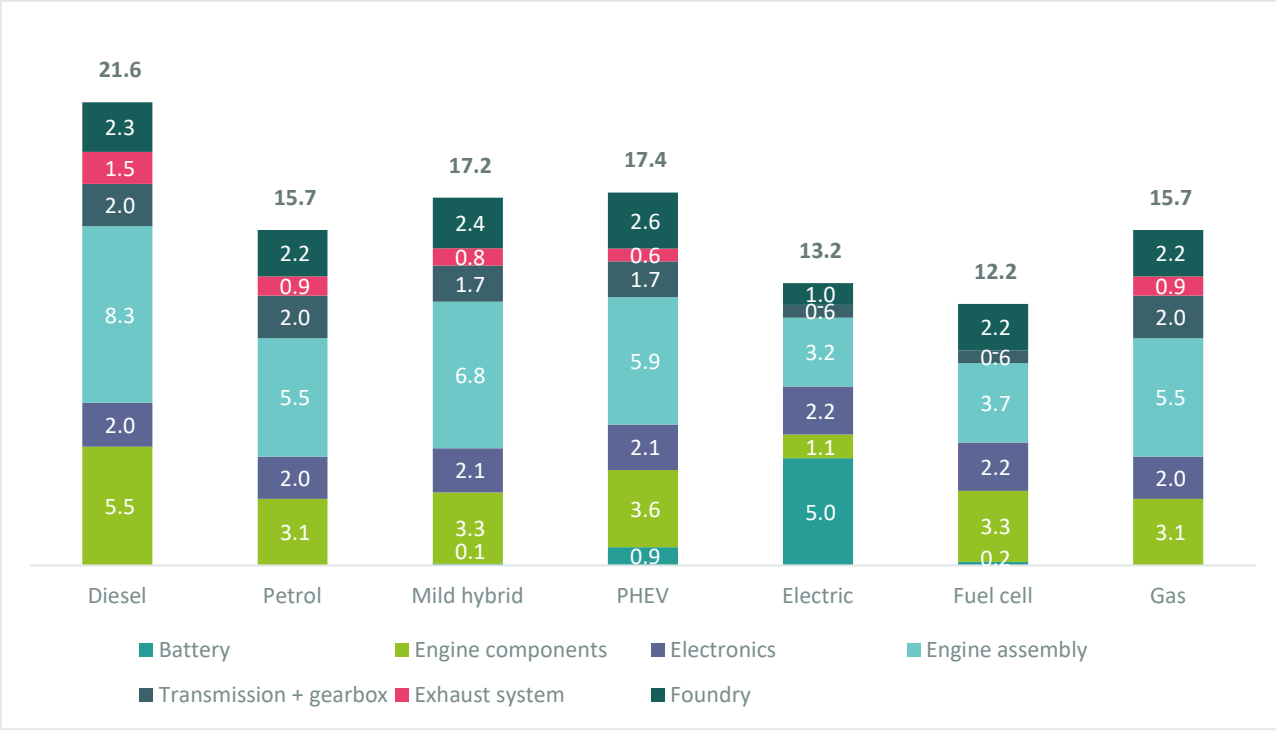
Figure 4 – Employment in the Car Engine Industry by Company Country of Origin



Source: Syndex database

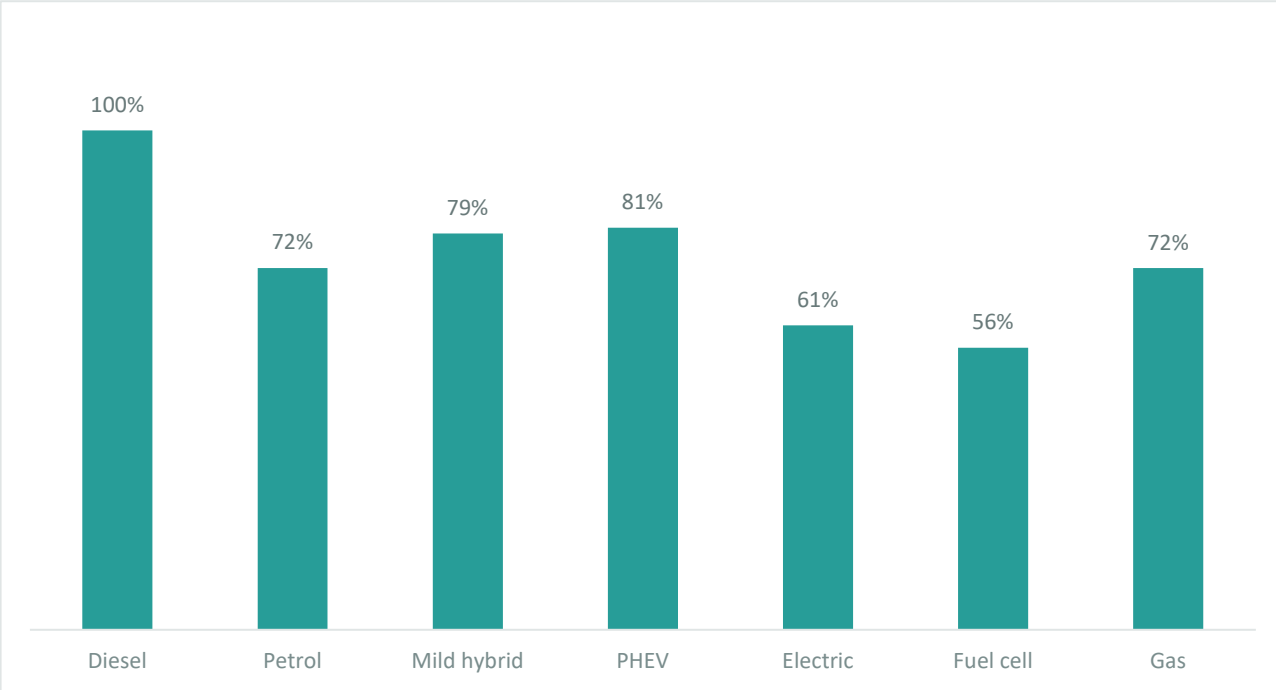
For our employment forecasts, we apply these indices to the motor production database according to the mix and volume defined in each scenario (see Section 4 below). The result is a calculation of employment that we can break down by segment.

Figure 5 – Employment indices by propulsion technology (FTE needs for 1,000 vehicles)



Source: Syndex database

Figure 6 – Employment indices by propulsion technology (Diesel = 100%)



Source: Syndex database

>>3 INSIGHTS INTO THE FRENCH AUTOMOTIVE INDUSTRY

Our database records almost 54,200 permanent jobs (excluding temporary workers) on 121 sites (450 people on average) in 2018.

To this volume must be added 8,500 temporary jobs on the 70+ sites for which we have information. Extrapolated to the entire panel, we estimate that there are around 15,000 temporary workers, which amounts to a total employment of 70,000 people in 2018.

Car manufacturers and equipment suppliers dominate this panel.

- 23 OEM sites account for half of the workforce,
- half of the sites are from 'Tier 1' suppliers, representing almost 40% of jobs.

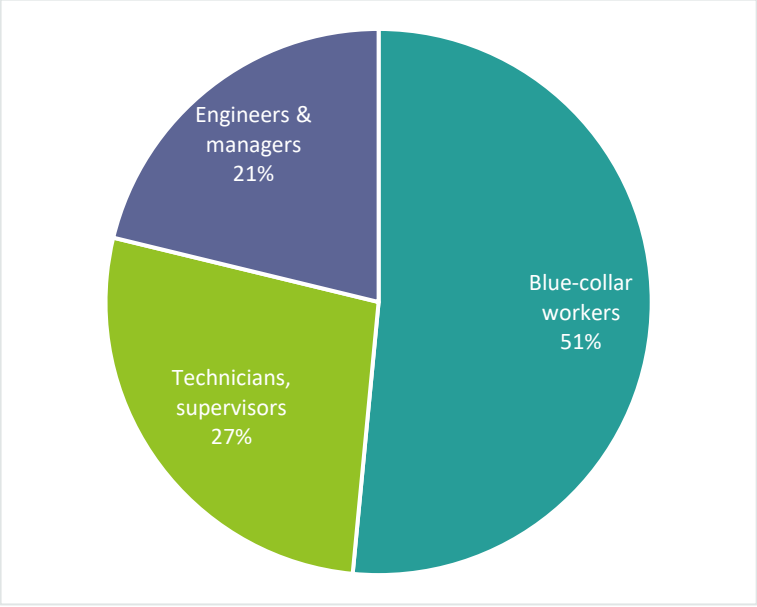
The database covers an estimated quarter of employment in the car industry in France. Although our information is not comprehensive, we assume that our sample is a reliable indicator to produce representative results for the entire powertrain industry of the automotive sector.

The thirty-five subcontractor sites in our panel record nearly 8,500 jobs, probably underestimate the reality of the activity in the powertrain sector. Most of these companies, however, have a diversified product and customer portfolio within and outside the automotive sector. Therefore, it seems difficult to link all the establishments of these players to the powertrain sector alone.

3.1. JOB PROFILES AND AGE STRUCTURE

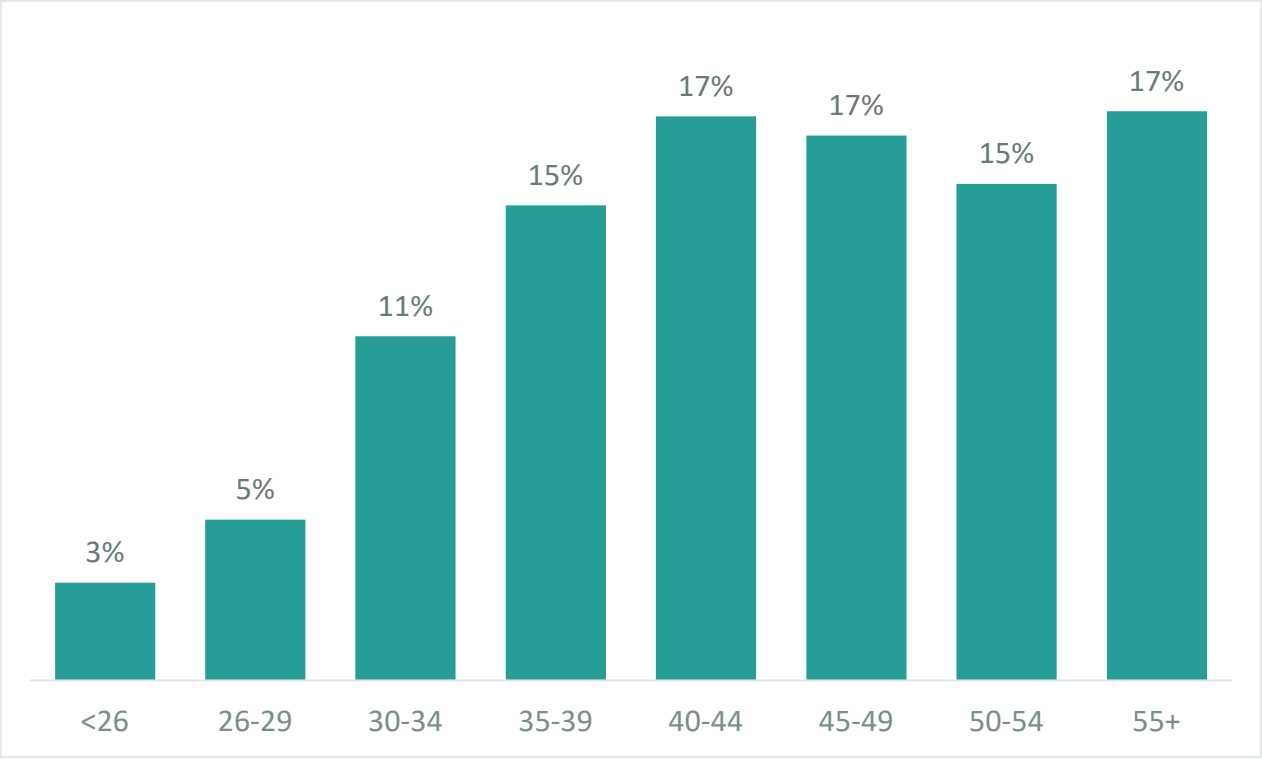
Blue-collar workers represent 51% of employment in the motor sector (see Figure 7), that is just over 50%. Service activities (support functions, administration, trade) and R&D contribute to the employment levels in the categories of Employees, Technicians and Administrative staff (27%) and Engineers and Executives (22%). The workforce in the sector is relatively old, as shown in the age pyramid in Figure 8. The 55+ age group represents the largest category of employees (17%), and half of the workforce is over 45 years old.

Figure 7 – Job Profiles



Source: Syndex database

Figure 8 – Age Structure



Source: Syndex database

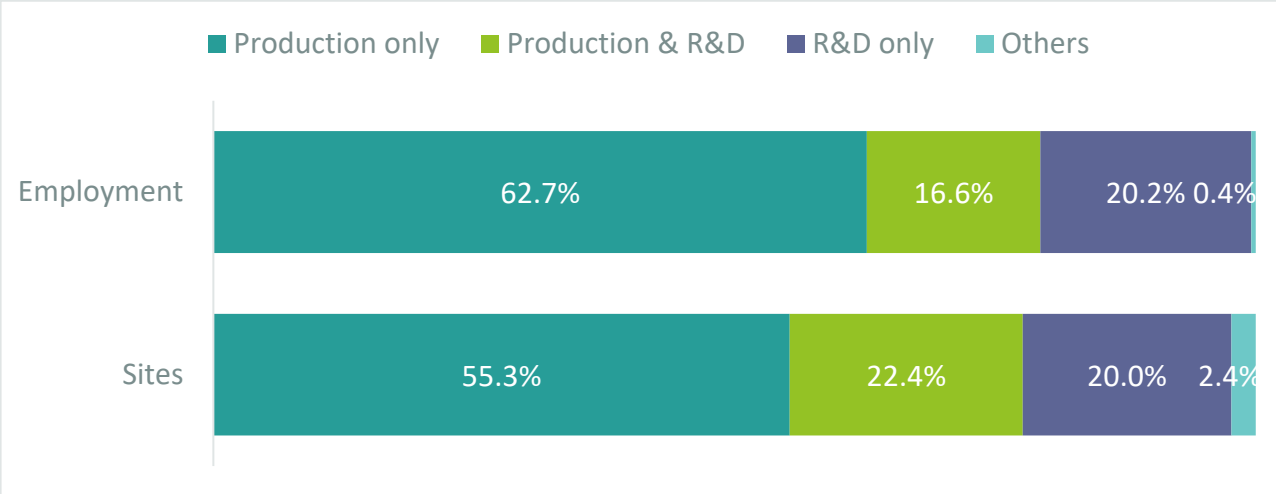
3.2. THE VALUE-CHAIN

Our panel consists of various parts of the supply-chain of powertrain and drive train (transmission) activities, with activities related to exhaust / pollution control, or electronics and engine control.

Figure 9 shows the number of sites and employment by site profile. Some 20% of all sites are pure research and development sites (20% of employment) and another 22% have both R&D and production capabilities (17% of employment). However, more than half (55%) of all establishments representing close to two thirds of employment (63%) are exclusively dedicated to production.

We argue that pure production sites are more exposed to European or international competition, and that it is more challenging to reorientate their mode of production to new product lines. Therefore, we assume that these sites are more at risks than R&D centres or mixed establishments.

Figure 9 – Site profiles



Source: Syndex database

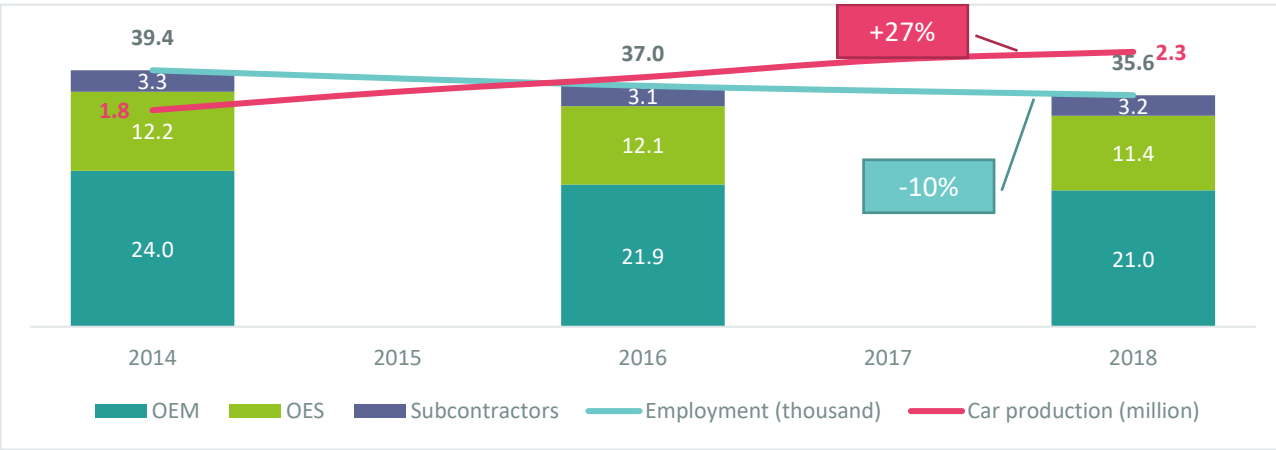
3.3. THE WORKFORCE IN THE MOTOR INDUSTRY RECORDS A DOWNWARD TREND

For more than half of the sites (and workforce), we can follow the employment trend over the period 2014-2018. It is worth noting that the period under study recorded a significant rebound in economics activity and growth in volume, but a drop in employment.

While car production in France increased by 27%, employment in the automotive sector fell by 10% between 2014 and 2018, according to our data (Figure 10).

- the decline was stronger amongst OEM (-12%),
- for suppliers, the downward trend was not as strong as for manufacturers (-6% for OES and -4% for subcontractors).

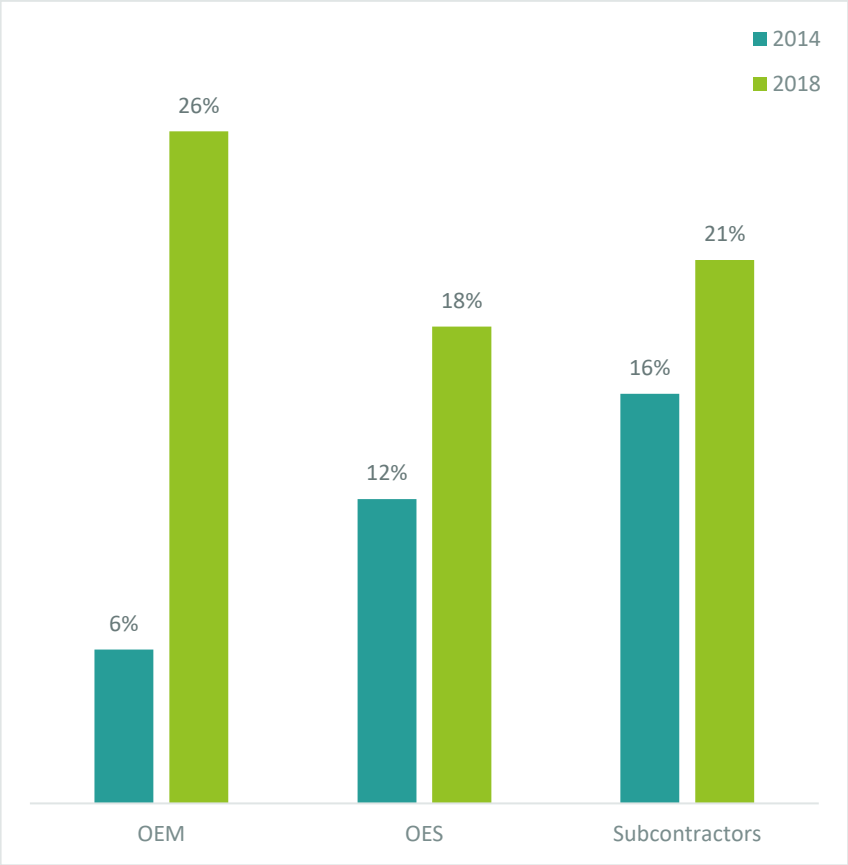
Figure 10 – Car production and permanent employment*



** Passenger cars + vans + trucks*
Source: Syndex database

At the same time, data show a high and rising level of agency work. According to Figure 11, the proportion of agency workers in the overall workforce increased significantly. Whereas in 2014 some 6% of employees were employed with an agency, this proportion rose to 26% by 2018. For OES and subcontractors, the increase is less pronounced, but remains substantial (from 12% to 18% and from 16% to 21%, respectively).

Figure 11 – Proportion of agency workers



Source: Syndex database

In conjunction with figures on production and permanent employment, these data suggest that companies in the car industry used temporary workers to gradually replace permanent employment during the recent upswing. We might thus conclude that a rationale behind this strategic choice was the perspective of electrification and the anticipation of a drop in the need for labour.

3.4. INDUSTRIAL SITES EXPOSED TO THE SHIFT TOWARDS ELECTRIFICATION

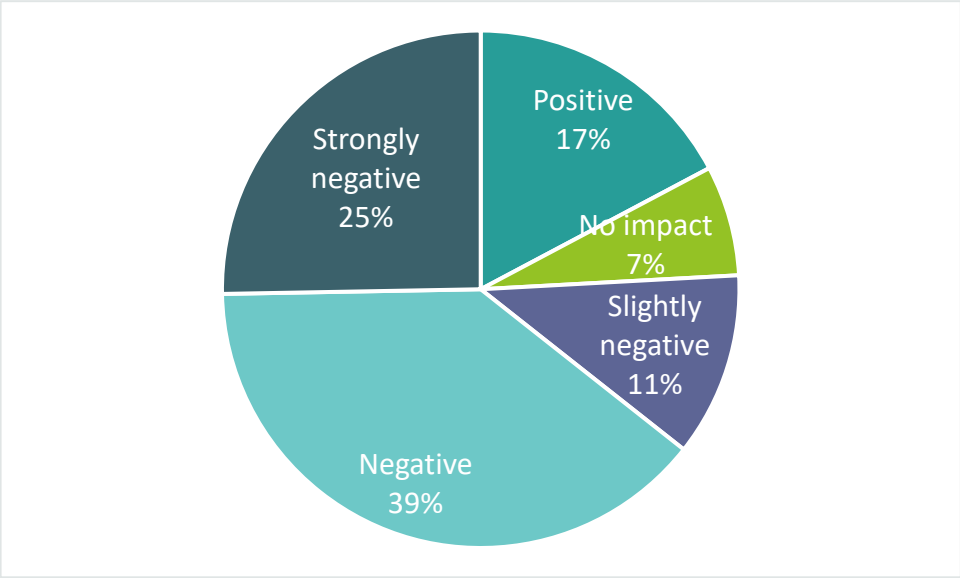
As argued above, the decline in diesel electrification and the gradual shift towards electrification will most likely have a different impact on employment depending on the activity of the establishment. We note that 20% of sites and employees are diesel-oriented and almost half sites and jobs are within the field of thermal combustion. Nearly 20% of sites (30% of jobs) also make parts for EVs. 14% of sites (but only 5% of jobs) work primarily for electric vehicles.

We estimate (see Figure 12) that more than a quarter of sites in scope of our study are likely to be strongly impacted by changes in the mix (mainly working for combustion engines). Half of these sites are beginning to diversify, particularly towards hybridisation or electric vehicles, but these are mainly manufacturer sites or large equipment suppliers.

The sites that are expected to be affected (strongly, moderately or weakly) focus on thermal combustion. We find that these are slightly more involved in diversification.

About fifteen sites (including those focused on EVs) view electrification as an opportunity. Many of these sites are manufacturers or equipment suppliers.

Figure 12 – Expected impact of electrification



Source: Syndex database

3.5. TH THREE-YEAR OUTLOOK SHOWS A CONTINUATION OF THE DOWNWARD TRAJECTORY

Employment trends over a three-year horizon were provided for more than 80 sites in our database, with the outlook for an expected increase, decrease or stability in the workforce.

These trends are rarely specified by the management of the establishments (only one-third of them produce a quantified evaluation of employment) and 8 sites declare that they have no visibility.

We have very little data on a 4 to 5-year period, as most of the strategies are formulated for 3 years only. In a majority of cases, the trends (even in the short term, excluding the Covid effect) tend to be downwards, probably significantly so for a third of the sites (and jobs).

These trends are negative for half of the sites for which data are available, and positive for a quarter of them (Figure 13).

In spite of these trends, more than twenty sites representing more than 11,000 jobs see opportunities. While these sites include those already positioned on the electric vehicle, they represent the different families of activities (and some are currently focused on diesel). The vast majority of them are diversifying, taking into account the evolution of the engine mix to come.

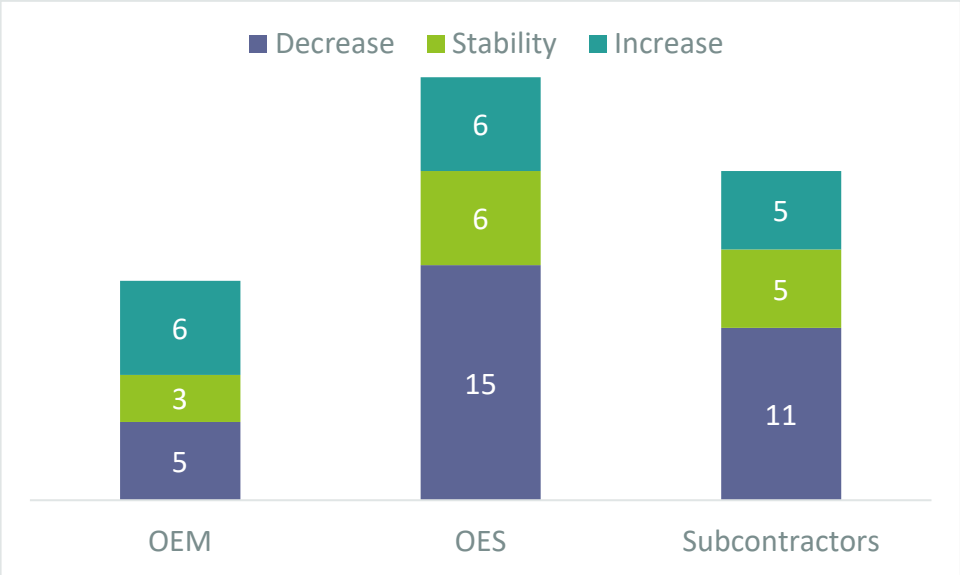
Out of the sixty sites for which a qualitative assessment of employment trends is possible, some conclusions may be drawn.

- The evolution of the technological changes of the engine is the major factor, having a strong negative impact.
- On the other hand, the evolution of the product is perceived as an opportunity for roughly a quarter of the sites (for instance, diversification towards niche products for electric vehicles).
- Productivity effects are certainly a factor, but they are rarely considered as the primary driver for the evolution of employment, whether it is the usual productivity (3 sites with a downward trend) or

productivity gains as a result of the introduction of Industry 4.0 and automation (4 sites with expectations of a decrease, stability or increase in employment).

- Other factors are sometimes mentioned, such as the financial situation, which already gave rise to fears of negative developments for several sites.

Figure 13 – Expected employment developments



Source: Syndex database

3.6. THE STRATEGIES OF THE PLAYERS IN THE AUTOMOBILE INDUSTRY

The strategies adapted by the car companies in the context of the transition to electrification are often based on a re-internalisation[2] of the design and production of components (including, but not limited to batteries) and systems, or they are achieved through new partnerships. For instance, we note that Renault-Nissan-Mitsubishi (RNM or "The Alliance") or most German OEM table on internalisation whereas PSA (now Stellantis) focus on new partnerships (such as the JV with Saft to build two lithium-ion EV battery cell plants in Europe).

In terms of product strategies, our survey shows the following trends.

- A growing number of automotive contractors are diversifying into activities linked to electrified propulsion systems.
- For activities that have no or little link to the core business, such as batteries, partnerships are the option of choice.
- Our data show that diversification makes it generally possible to maintain employment, or at least to limit its decline.

However, the product strategy is not the only factor in the impact on employment. Companies leverage many other competitive angles, some of which are well-known, such as (de)location, (re)organisation or automation, which modifies both their presence in France and the productivity of production lines.

[2] The terms re-integration and re-internalisation are used interchangeably and refer to the strategic decision to allocate development and production to internal capacities that have previously been sub-contracted to an external supplier. Diversification describes the process of looking for new business opportunities.

3.7. THE SEARCH FOR DIVERSIFICATION AS AN ALTERNATIVE TO THE DECLINE OF THE INTERNAL COMBUSTION ENGINE

According to the responses recorded in our database for 75 sites, only a quarter are not diversifying at all. Even those companies that have launched significant diversification, it is unlikely that diversification will transform the face of the company overnight. Therefore, we see that diversification is often partial and only touches upon a fraction of the site's activities.

For about thirty sites, we could clearly identify the nature of their diversification projects. Most of the initiatives concern hybridisation (including 48V) and electrics. Whenever an estimate was possible, half of the sites would only diversify up to a quarter of their activity, and less than 25% of all establishments would launch new activities for more than half of their previous endeavours.

3.8. HOW TO PREPARE FOR CHANGE?

The evolution of the engine mix and its probable negative impact on employment in the sector is not new. As a matter of fact, the present study is the fruit of the ongoing debate.

The efforts made by the French legislator focus on aim at forging a broad alliance to be involved in the transformation, and social partners are certainly a key stakeholder. According to French labour law, employee representatives have extensive access to so-called forward-looking employment and skills management (GPEC) strategies, and the legislator stipulates the negotiation of agreements – particularly at company level – on that matter. Moreover, French works councils are entitled to receive access to comprehensive information on company strategy, social and economic information (through, among other things, the right to name their own experts and consultants and the provision of a so-called socio-economic database, or BDES, by the employer).

In terms of measures, all evidence available suggests that training will play a key role in preparing for electrification. The remainder of this section presents the main findings from our research.

- In general terms, training efforts are difficult to measure (especially since the reforms of recent years). It is difficult to say whether the training is technical (rather than just compulsory and safety-related), and whether it is fit to prepare employees for a change in job requirements.
- Only six of the thirty sites have a multi-year training plan (in the majority of cases, we do not have any information on training strategy).
- Moreover, we know that the challenges of changing jobs and skills are significant, in a context where 20% of the workforce (at around thirty sites representing one third of jobs) is over 55 years old.

Therefore, it remains to be seen to what extent the efforts made by employers today will be sufficient to meet all skill requirements of the electrification. Anecdotal evidence suggests that some skill sets are already in shortage on the labour market (mostly related to electronic and/or mechatronic skills). Making sure that the present and future workforce is properly trained will be a key success factor for maintaining employment in the car industry, in France and beyond.

3.9. NEW ACTIVITIES

In the landscape of the French automotive industry, which has been well-established for decades and relies on century-old technology that it has never stopped developing, new activities are emerging, supported by the electric transition of vehicles. The most prominent examples are discussed in the remainder of this section.

- Traction batteries will be the heart of future electric powertrains. Traction batteries concentrate most of the challenges of this technology, and they capture most of the value. To date, in France, only a few industrial prototype units are active and large-scale industrial projects have yet to

materialise. Two projects have been the subject of company communication since the start of our study: that of PSA with Saft in Douvrin, and that of Renault with Envision in Douais. The company Verkor has also communicated its intention to set up a factory in the short term.

- Recycling of traction batteries is an activity that has yet to be developed, but the sector has significant potential, as the number of electric vehicles grows. For the time being, there are only a very limited number of players, including SNAM, Recupyl, Véolia and Umicor. We will present an example of the Renault “Re-Factory” below, which has integrated battery recycling in its business model.
- Retrofitting of combustion vehicles to electric vehicles is a niche and probably a transitory activity that involves the conversion of internal combustion vehicles to electric vehicles. There are some recent initiatives in France, one of which is also discussed below. This activity could contribute to accelerating the electrification of the fleet by producing a modest but real benefit on employment in automotive services.
- The development of mobility solutions based on hydrogen has been vigorously relaunched thanks to the hydrogen plans of the French government and the European Union. This technological vision is expected to deliver tangible results in a second phase (beyond 2030) and prerequires significant advancements in research and development as well as in the provision of infrastructure in the energy sector. The production criteria for hydrogen must consider that the process is green and carbon neutral. However, to date, the majority of examples that use hydrogen have been identified in the transport sector: freight transport, public transport, road, sea and rail. The hydrogen distribution network needs to be set up and the limited resources available should be reserved for efficient use. This technological solution does not seem to be suitable for individual mobility in the medium term, but there might be spill-over effects with the automotive industry, with a possible impact on employment.
- Recharging infrastructure: the development of electric mobility implies the development of a network of recharging stations. The construction of this network of recharging points should involve the construction companies responsible for building these points as well as electrical installers. However, these are modest projects in relation to the sector's current activity, and employment potential seems limited.

This non comprehensive list of alternative projects and diversification initiatives shows that an assessment if the full impact of the transition is challenging. It remains to be seen to what extent current industrial infrastructure can be dedicated to such new tasks. An overall assessment of the employment impact of such initiatives goes beyond the scope of our study. For illustrative purposes, we will present a case study from the automotive sector in section 6.

>>4 SCENENARIOS FUR FUTURE DEVELOPMENTS

To build our predictive models, we have constructed four scenarios around five variables that capture both market developments and strategic political choices until the year 2050.

- Volume (number of new cars and thus engines produced per year)
- End of internal combustion engines (year)
- Energy mix in newly registered cars
- Battery production in France
- Local supply chains

The five variables are modelled according to two dimensions – volume development and strategic political choices. As a result, we have derived four base scenarios for 2050. Scenarios 3 and 4 are presented in two

different variants so that there are six scenarios in total. The specifications of the models are detailed in Table 1.

The different assumptions of the models are subsequently applied to our database on engine production in France to predict future volumes. The employment indices presented above is used to estimate the employment effect of the predicted volume levels and composition. Excluding parts of the data that are not relevant for our analysis, The base figure for all simulations is derived from our employment database and represents 57,815 direct or temporary employees in production functions (excluding R&D and support functions).

>>5 RESULTS

In this section, we will provide the results from the scenarios discussed in section 4 above. We have constructed four models and two sub-models, i.e. 6 scenarios in total. For each scenario, we will first present the predicted engine mix and volumes that result from our simulations. Thereafter, the figures show the anticipated employment development using our employment indices. At the end of each section, a summary figure depicts the main factors driving the development.

5.1. SCENARIOS

Scenario 1: Further deindustrialisation

The evolution of the motor mix in this scenario is based on the following assumptions:

- electrification evolving at a relatively slow pace reaching 80% in 2040,
- combustion engines exiting the market by 2040

The evolution of production volumes in France would follow the path of deindustrialisation, with engine production reaching 1.36 million engines in 2050 (-55%, see Figure 15).

By applying our employment indices to these forecast volumes, the employment forecast suggests that the decrease in employment continues and would lead to a loss of approximatively 40,000 jobs by 2050 (-70%). The creation of jobs related to the production of cells for traction batteries is limited to the equivalent of 51.4 GW per year in 2050 (an estimated 5,500 jobs by 2050).

In Scenario 1, employment trends are driven by two factors.

- a strong deindustrialisation effect, linked to the significant drop in the volumes of engines produced in France,
- an electrification effect caused by the lower need for labour of electric vehicles.

It is worth reminding that this scenario is based on a “laissez faire” approach with no significant changes in public policies towards green mobility or company strategies on local value chains.

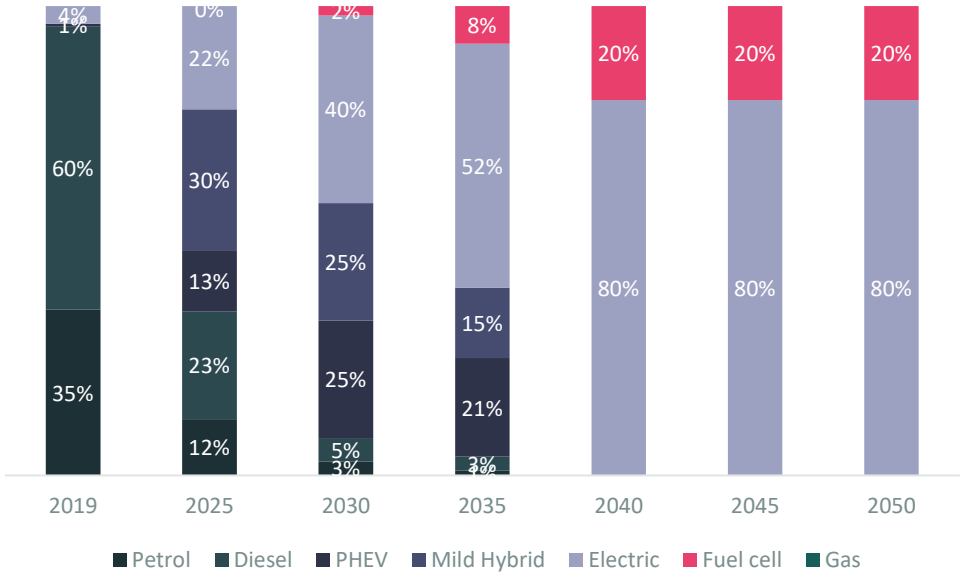
Scenario 2: Economic upturn

The evolution of the motor mix in this scenario is based on the following assumptions:

- electrification evolving at a moderately sustained rate and reaching 100% in 2040,
- an end date for the sale of combustion engines in 2035 and in 2040 for hybrid engines, whether rechargeable or not.

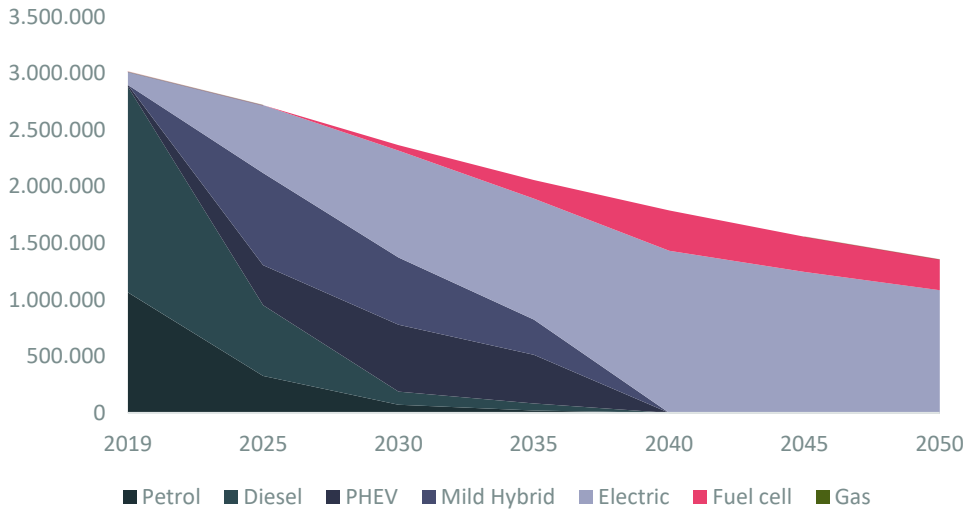
With production volumes in France set to reach 2.26 million engines in 2050 (-25%), French engine production would be at the same level as in the past. The energy mix is shown in Figure 18.

Figure 14 – Scenario 1: Forecast development of engine mix



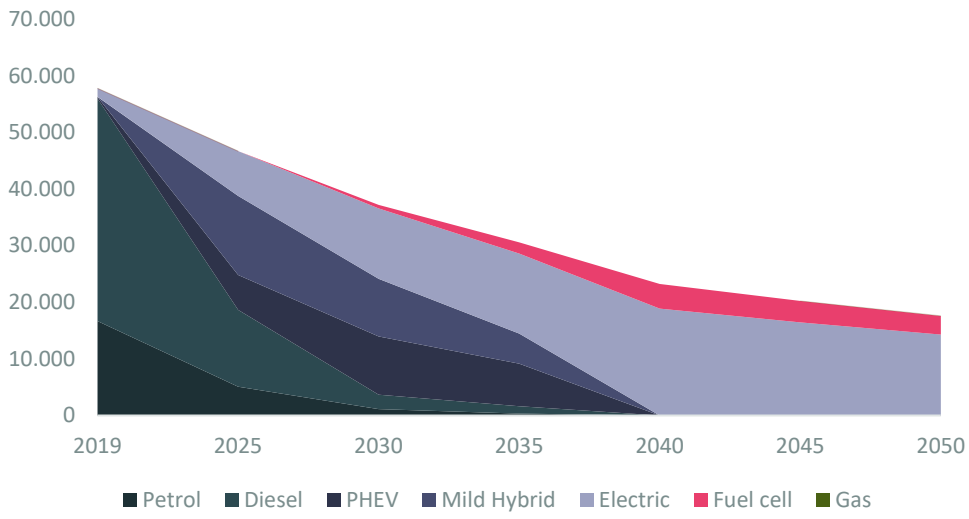
Source: Syndex database

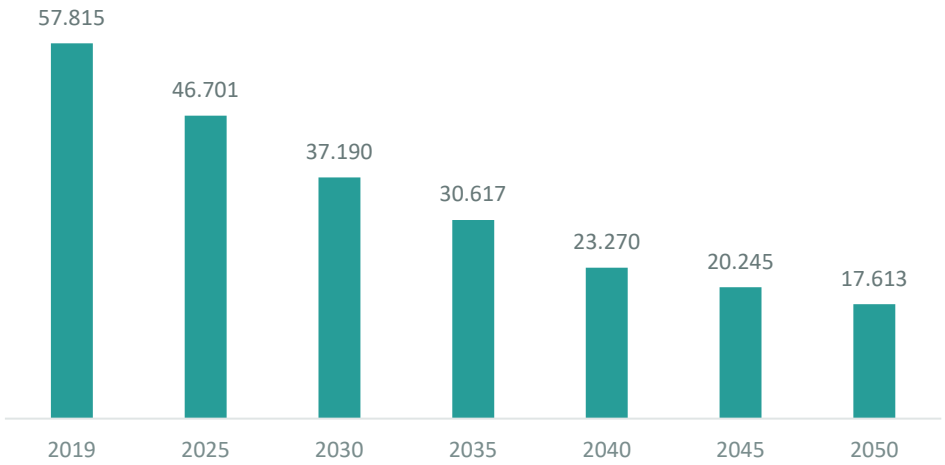
Figure 15 – Scenario 1: Forecast development of engine volume



Source: Syndex database

Figure 16 – Scenario 1: Employment forecast



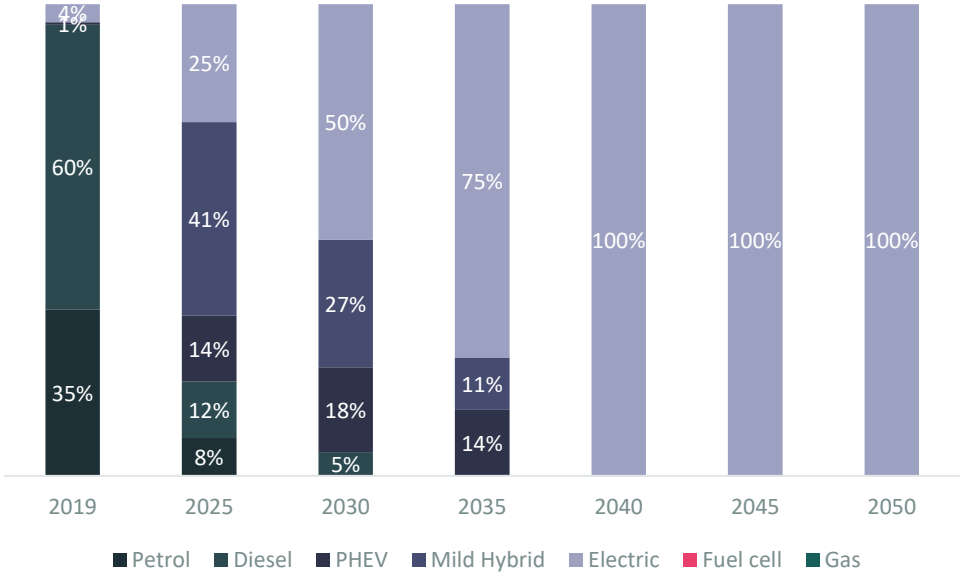


Source: Syndex database

Figure 17 – Scenario 1: Employment effect summary

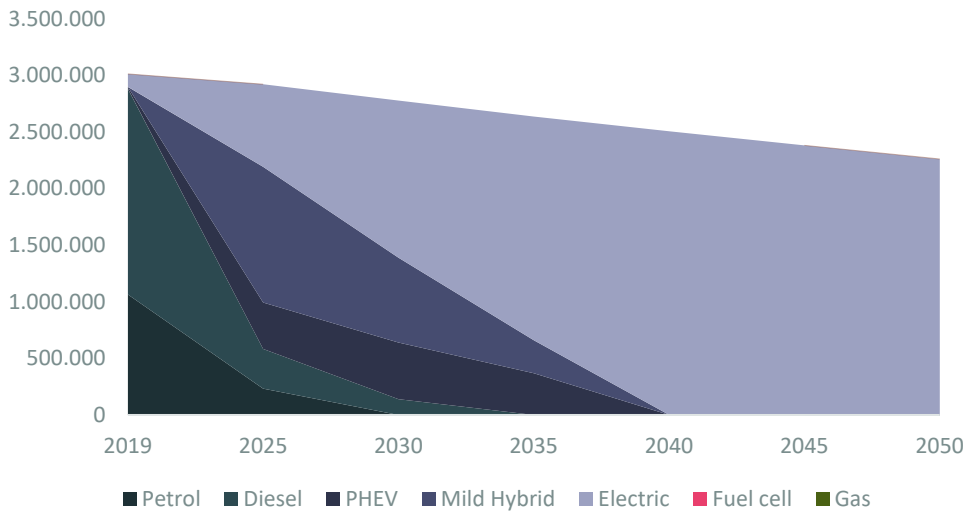
Source: Syndex database

Figure 18 – Scenario 2: Forecast development of engine mix



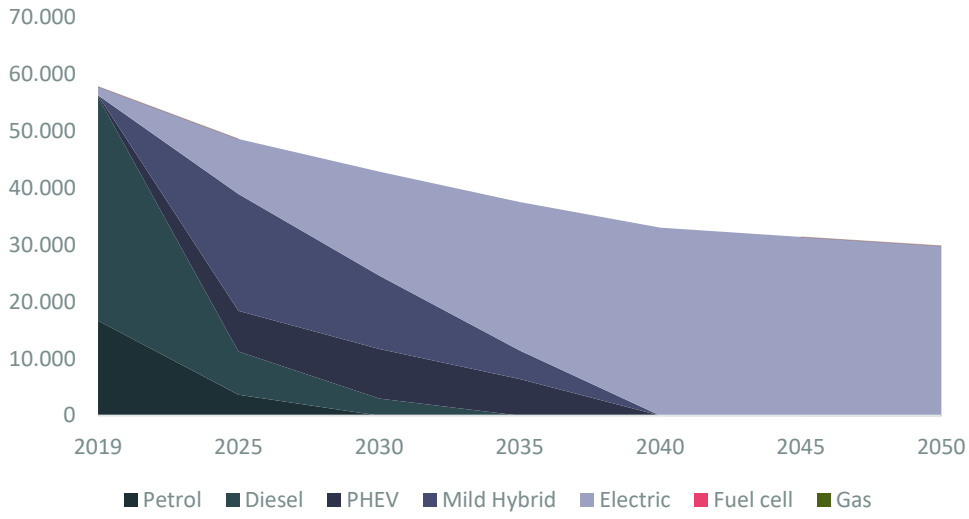
Source: Syndex database

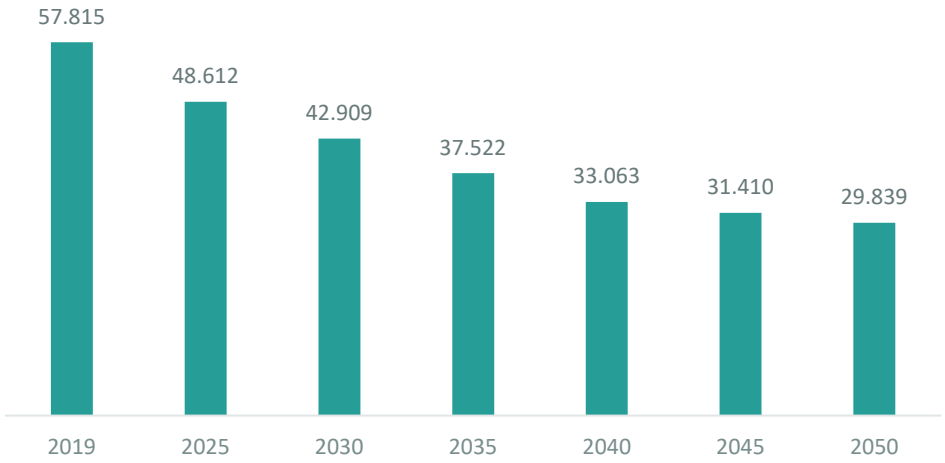
Figure 19 – Scenario 2: Forecast development of engine volume



Source: Syndex database

Figure 20 – Scenario 2: Employment forecast





Source: Syndex database

Figure 21 – Scenario 2: Employment effect summary

Source: Syndex database

By applying our employment indices to these forecast volumes, our data suggest that the decline in employment would also be significant, leading to a loss of roughly 28,000 jobs by 2050 (-48%). However, the development would be less severe than the one predicted in scenario 1.

The creation of jobs related to the production of battery cells is limited to a need equivalent to 113 GW per year from 2040 onwards (11,300 jobs).

The overall dynamic is similar to the one in scenario 1, although with a lesser impact (deindustrialisation and drop in volumes).

Scenario 3.1: Industrial relaunch

The evolution of the motor mix in this scenario is based on the following assumptions:

- Electrification evolving at a steady pace and reaching 100% in 2035,
- An exit date for combustion engines and non-rechargeable hybrids in 2030 and 2035 for rechargeable hybrids,
- The development of production volumes in France is maintained, i.e. an annual production of 3 million engines in 2050.

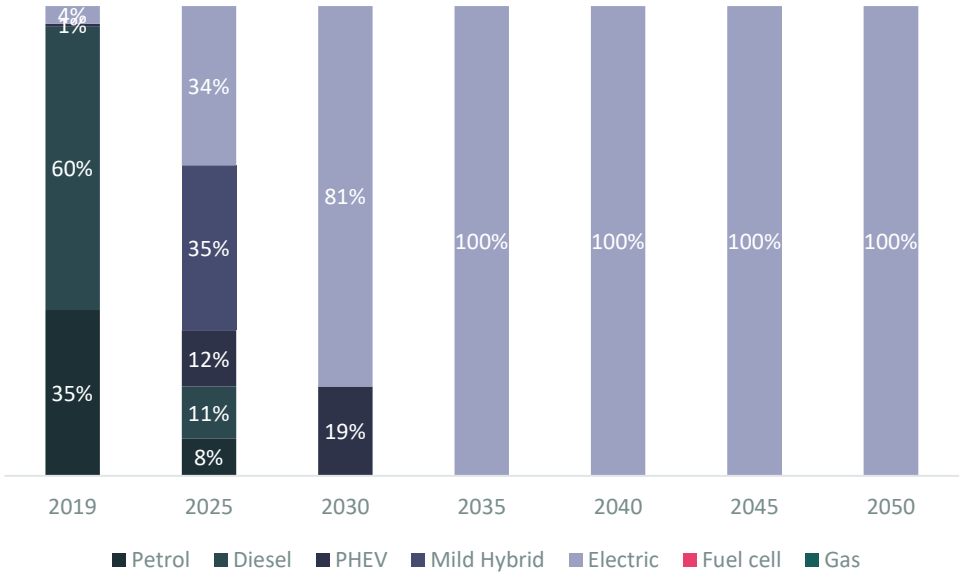
The French motor production is predicted to develop as depicted in Figure 23.

According to our forecasts, there would be a sharp decline in employment between 2019 and 2030, leading to a loss of 15,000 jobs (-27%) over the decade. The need for labour is then stable and stands at approximatively 40,000 by 2050, a reduction of 18,000 compared to 2019.

The creation of jobs related to the production of battery cells reaches its maximum, based on a need equivalent to 150 GW per year from 2035 (15,000 jobs).

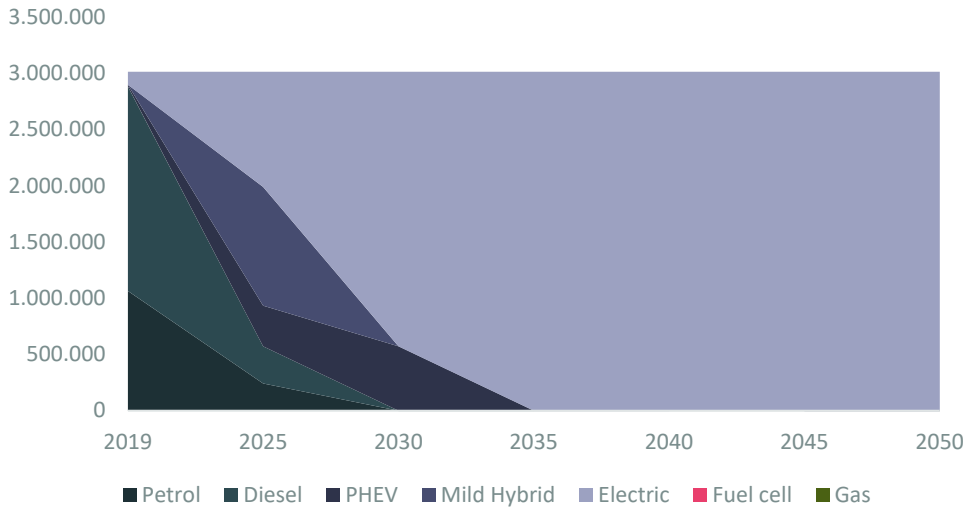
With French motor production being stable over the entire period under study, only technological changes have an impact on employment.

Figure 22 – Scenario 3.1: Forecast development of engine mix



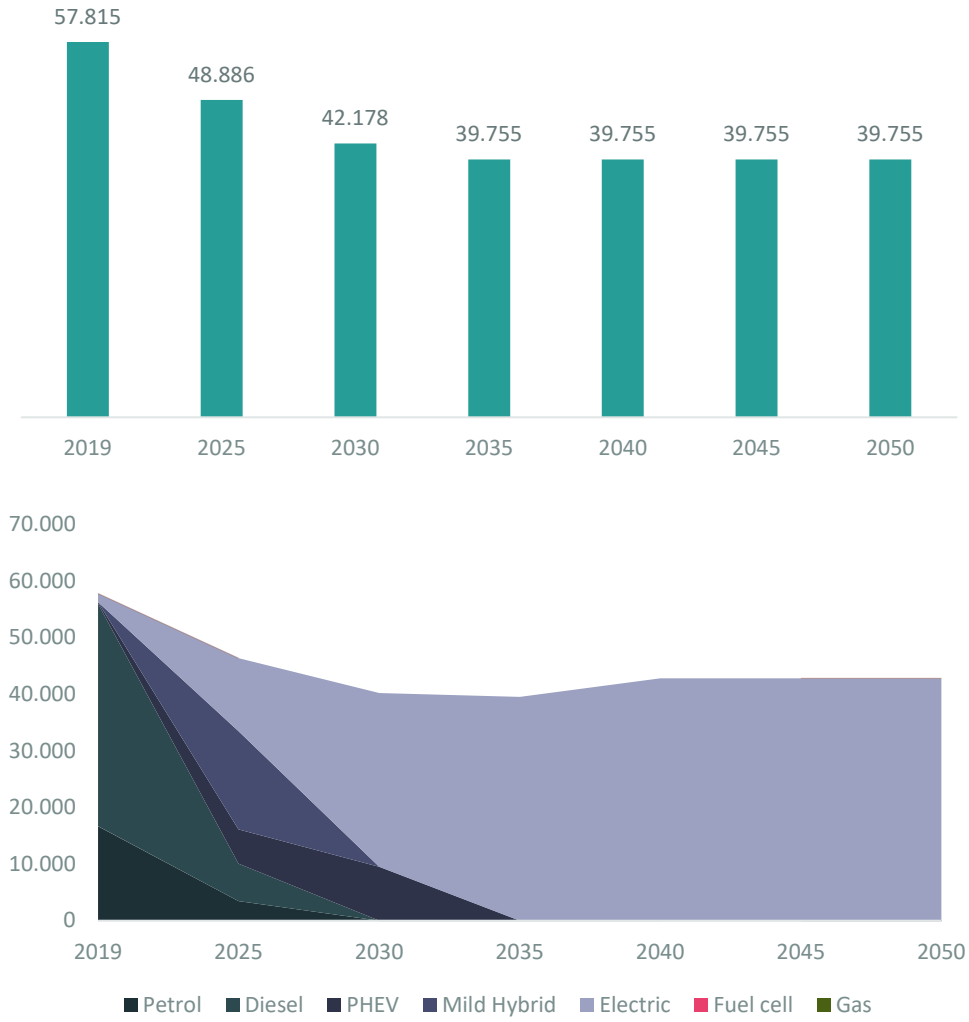
Source: Syndex database

Figure 23 – Scenario 3.1: Forecast development of engine volume



Source: Syndex database

Figure 24 – Scenario 3.1: Employment forecast



Source: Syndex database

Figure 25 – Scenario 3.1: Employment effect summary

Source: Syndex database

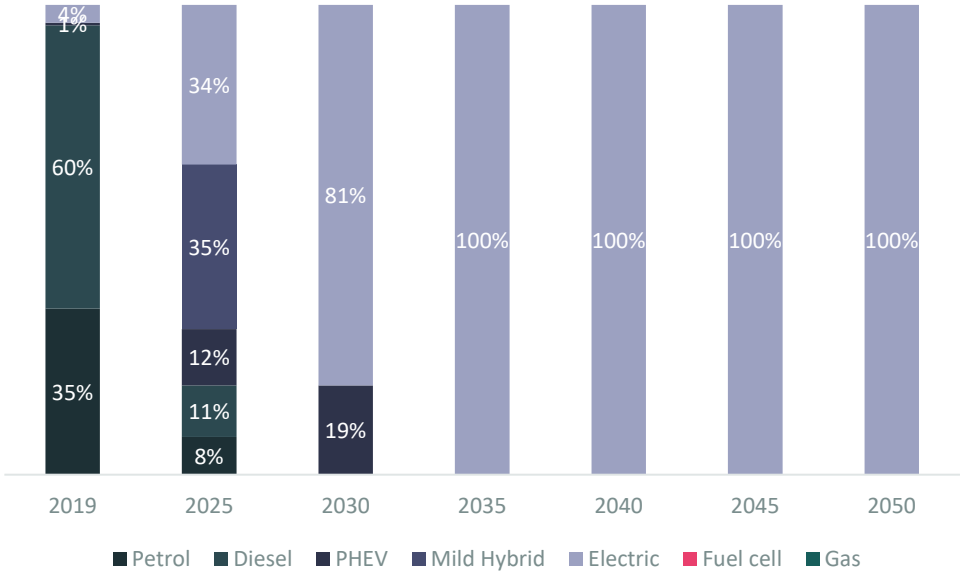
Scenario 3.2: Industrial relaunch with local value chains

The evolution of the motor mix in this scenario is based on the same assumptions as in scenario 3 described above, namely

- Electrification evolving at a steady pace and reaching 100% in 2035,
- An exit date for combustion engines and non-rechargeable hybrids in 2030 and 2035 for rechargeable hybrids,

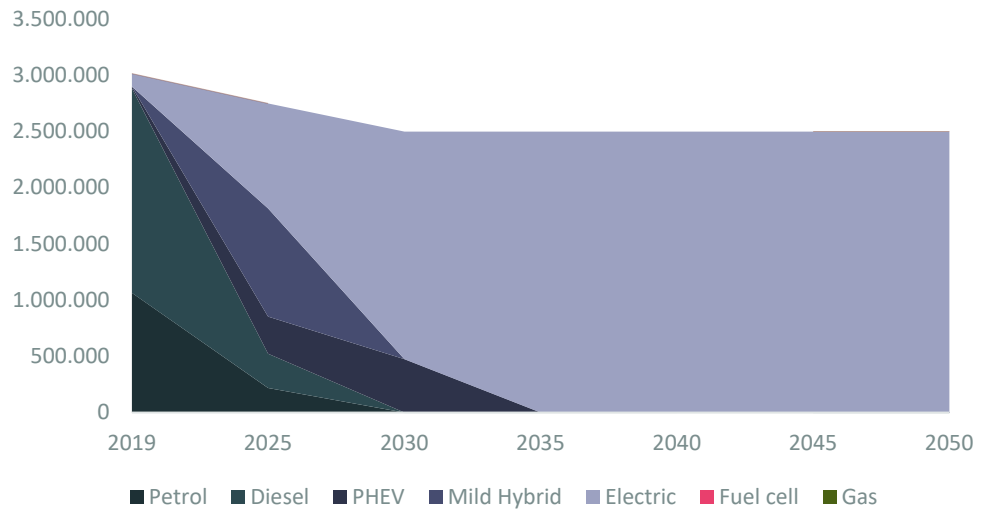
The main differences of scenario 3.2 is a drop in engine volumes to 2.5 million by 2030 (-17%), and stable levels thereafter. Moreover, we assume an additional 30% of volumes as a result of backshoring to promote local value chains (Figure 27).

Figure 26 – Scenario 3.2: Forecast development of engine mix



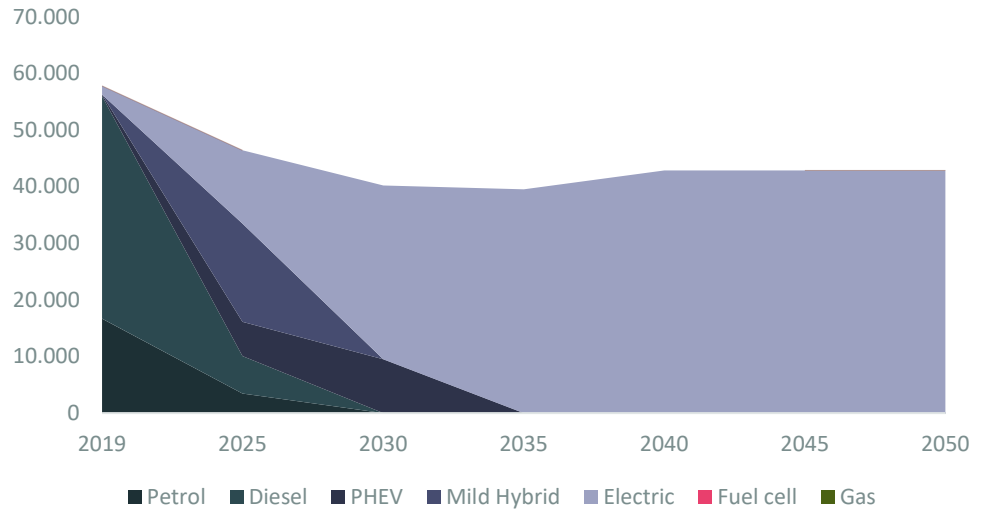
Source: Syndex database

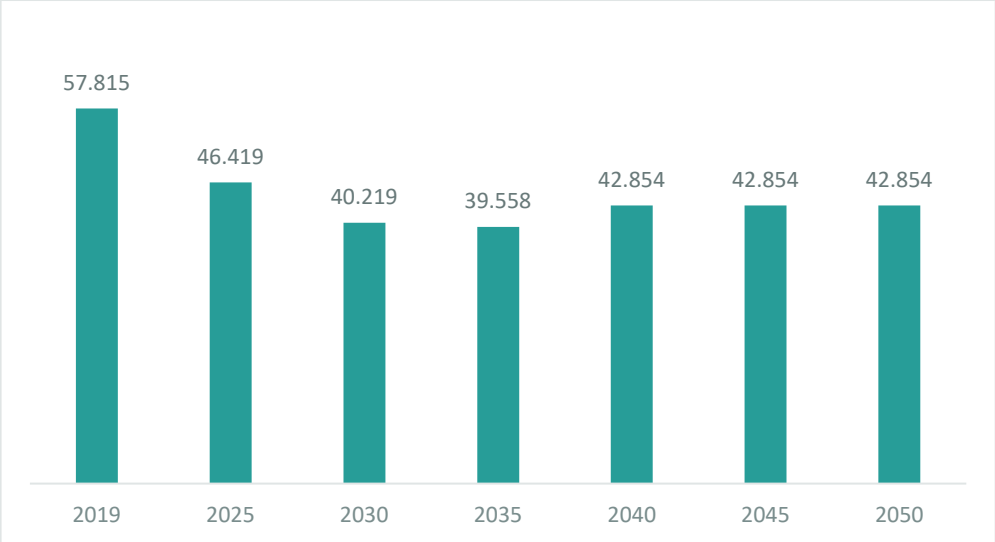
Figure 27 – Scenario 3.2: Forecast development of engine volume



Source: Syndex database

Figure 28 – Scenario 3.2: Employment forecast





Source: Syndex database

Figure 29 – Scenario 3.2: Employment effect summary

Source: Syndex database

Our estimations show that, as in Scenario 3.1, the decline in employment in would be strong between 2019 and 2030, leading to a loss of 17,000 employees (-30%) over the decade. In contrast to Scenario 3.1, the need for labour then recovers, supported by a movement to relocate part of the production (+30% in volume, excluding batteries) of the components in the value chain (all types of components).

The hypothesis adapted here is as follows:

- For electrical powertrain products, we assume that manufacturers/equipment suppliers will allocate a larger share of production to their French sites in their volume allocation decisions.
- This relocation of volumes applies to all component or equipment production activities (mechanical, electrical, electronic), but not to final assembly.
- Therefore, the aim would be to strengthen “local integration”, that is the local share of the production of components involved in the final assembly of the engine.
- The local integration rate of the automotive sector is estimated at between 30% (according to official sources) and 40% (according to OEM). There are no reliable estimates for engine production.
- In order to simulate an increase at this rate, we apply a growth rate to the volumes of components produced in France. This growth rate only applies to electrified engines.
- For the purpose of our computations, this rate is +5% in 2025, +15% in 2030, +20% in 2035 and +30% beyond.

The creation of jobs as a result of the production of battery cells would be equivalent to a need of 125 GW per year from 2045 onwards (12,500 jobs). The retrofit of thermal vehicles might increase the need for cells beyond this capacity between 2035 and 2045.

The increase in the local integration rate of the engine supply chain more than compensates for the decrease in the volume of engines assembled in France over the first decade.

Scenario 4.1: Industrial relaunch with local value chains and end of internal combustion engines by 2035

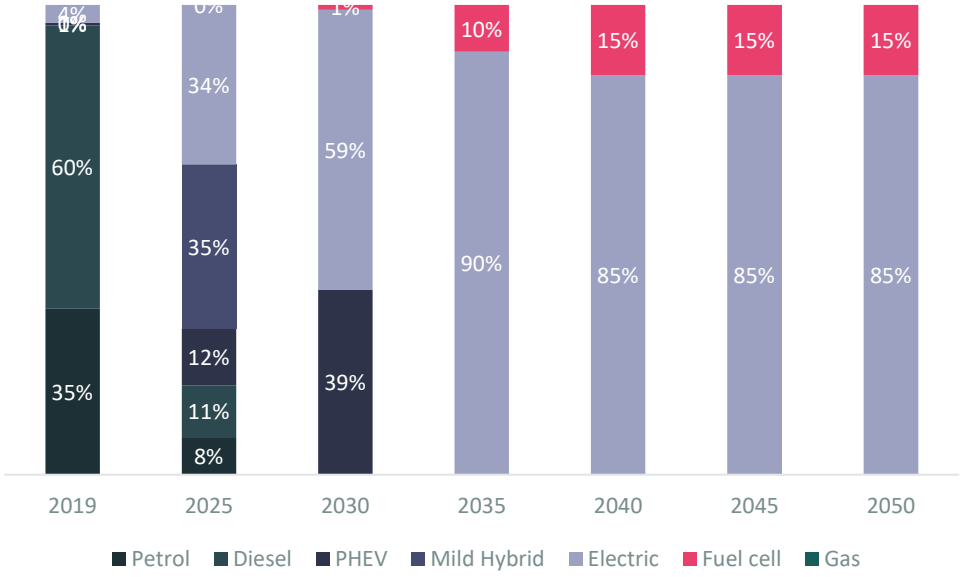
To calculate Scenario 4.1, we have made the following assumptions.

- Electrification evolving at a steady pace and reaching 90% EVs and 10% PHEVs in 2035,
- An end date for sales of combustion engines and non-plug-in hybrids in 2030, and 2035 for plug-in hybrids.

According to the assumed production level of 2.33 million engines per year for the period 2030-2050 (-23% compared to 2019), the estimated French engine production mix is presented in Figure 31.

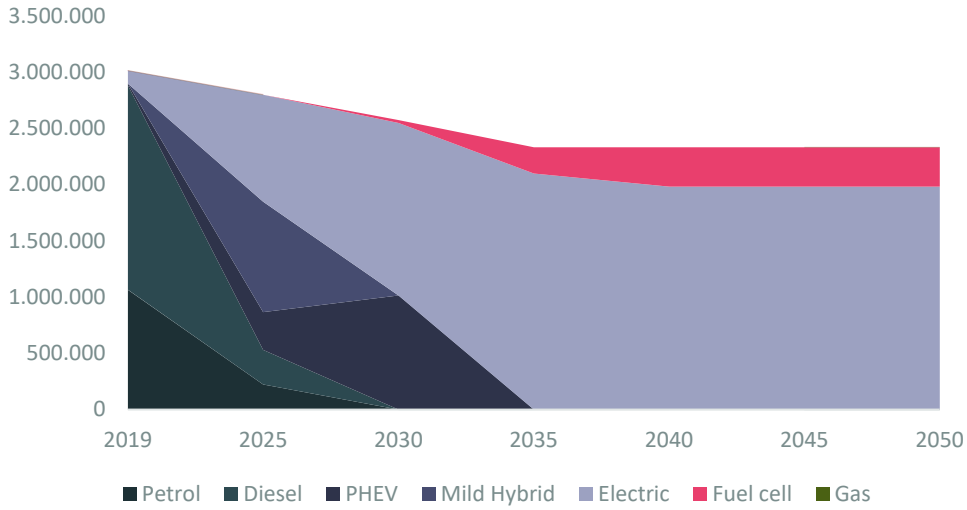
The employment simulation shows a decline in employment, which would be most pronounced between 2019 and 2030, leading to a loss of 14,000 jobs (-24%) over the decade. Hence, the decline is weaker in this scenario than in all the other ones, some of the drop is deferred to 2035 and beyond, after the end of sales of thermal vehicles.

Figure 30 – Scenario 4.1: Forecast development of engine mix



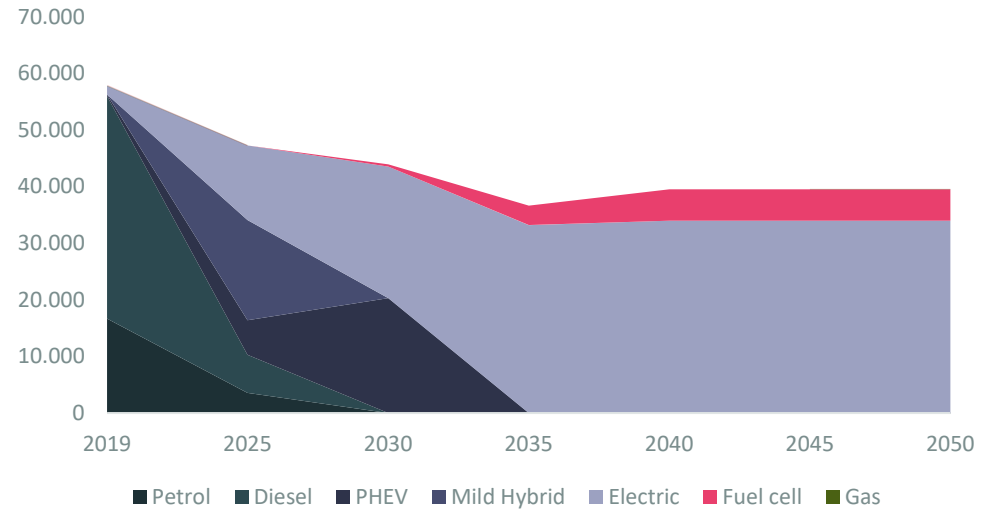
Source: Syndex database

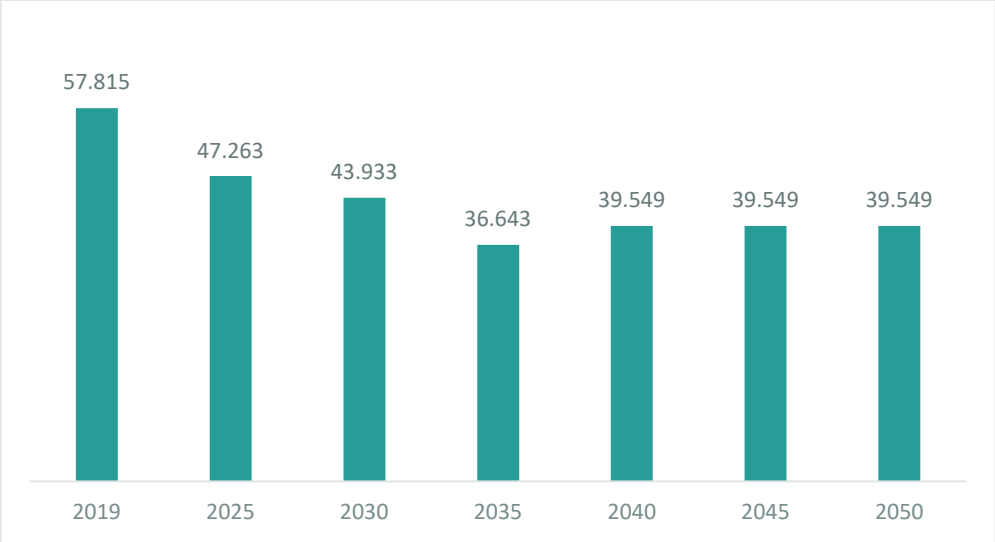
Figure 31 – Scenario 4.1: Forecast development of engine volume



Source: Syndex database

Figure 32 – Scenario 4.1 Employment forecast





Source: Syndex database

Figure 33 – Scenario 4.1: Employment effect summary

The need for labour then picks up, fuelled by a movement to relocate part of the production (+30% in volume, excluding batteries) of the components of the powertrain value chain (all types of components).

The creation of jobs linked to the production of cells for batteries is based on an annual production in France of cells for a total of 94 GW per year from 2035 onwards (10,000 jobs).

The retrofit of thermal vehicles constitutes a complementary outlet for battery cells, requiring additional capacity between 2035 and 2045.

The increase in the rate of local integration of the supply chain helps to compensate for part of the drop in the volume of engines assembled in France observed over the first decade.

Scenario 4.2: Industrial relaunch with local value chains and end of internal combustion engines by 2030

The evolution of the motor mix in this scenario is based on the following parameters.

- Electrification evolving at a steady pace and reaching 80% EVs in 2030,
- A market exit for combustion engines and non-rechargeable hybrids by 2030, and 2035 for rechargeable hybrids.

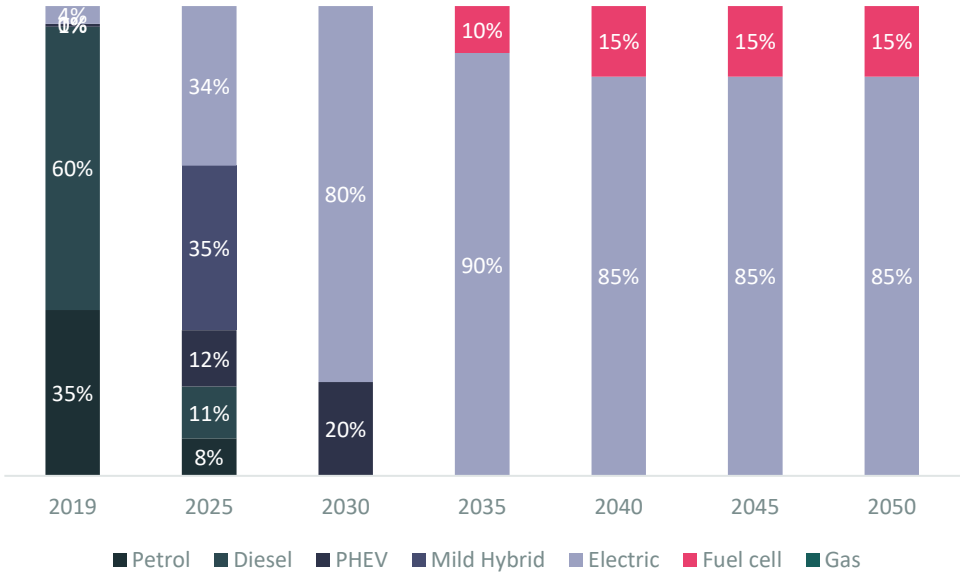
As in the previous scenario, production volumes in France are expected to record 2.33 million engines over the 2030-2050 period. The composition of powertrain technologies is expected to evolve as depicted in Figure 35.

As a consequence, employment would drop sharply between 2019 and 2030, leading to a loss of 20,000 roles (-34%). Thereafter, the need for labour would level and later recover, driven by a movement to relocate part of the production (+30% in volume, excluding batteries) of components in the drivetrain value chain (all types of components).

As for battery cells, we would expect the equivalent of 94 GW per year from 2035. The retrofit of thermal vehicles increases the need for cells beyond this capacity between 2035 and 2045.

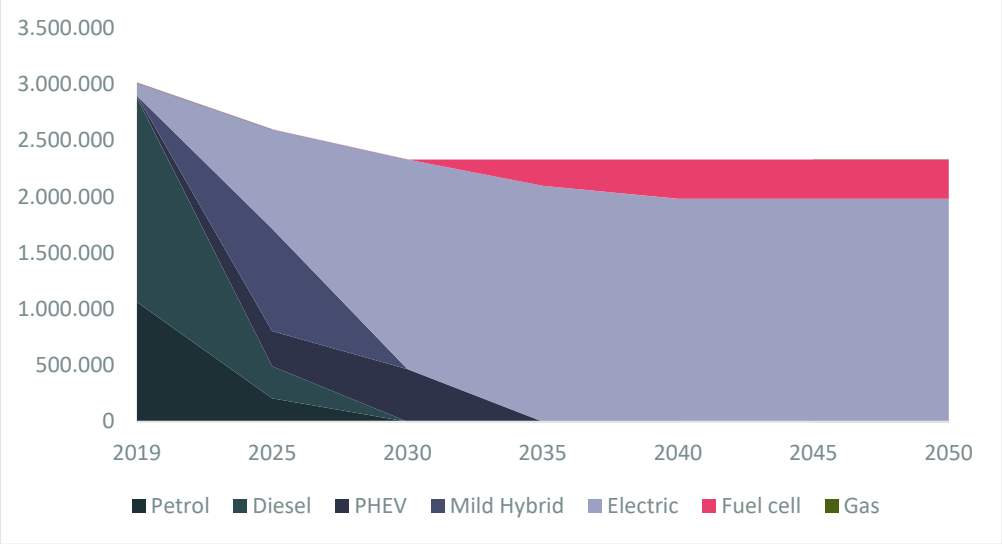
The increase in the rate of local integration of the supply chain helps to compensate for part of the drop in the volume of engines assembled in France observed over the first decade.

Figure 34 – Scenario 4.2: Forecast development of engine mix



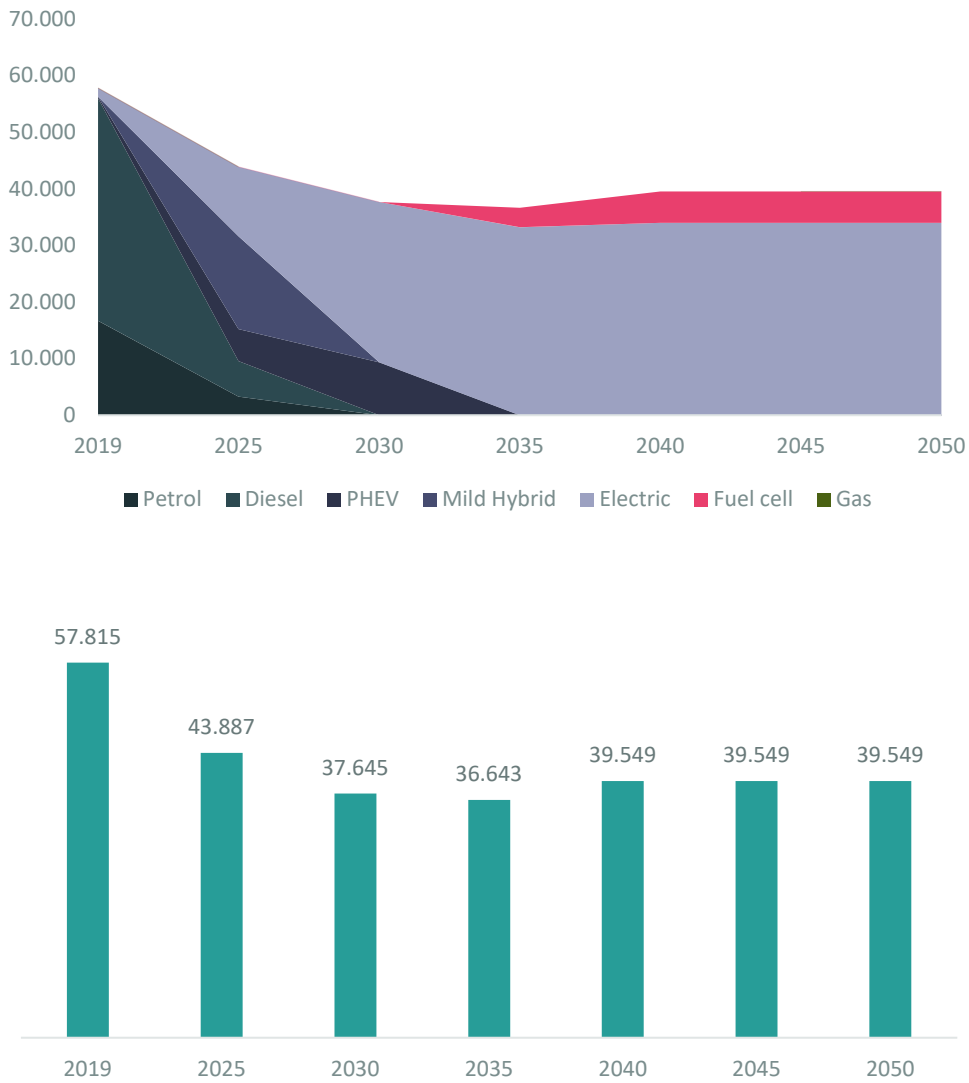
Source: Syndex database

Figure 35 – Scenario 4.2: Forecast development of engine volume



Source: Syndex database

Figure 36 – Scenario 4.2: Employment forecast



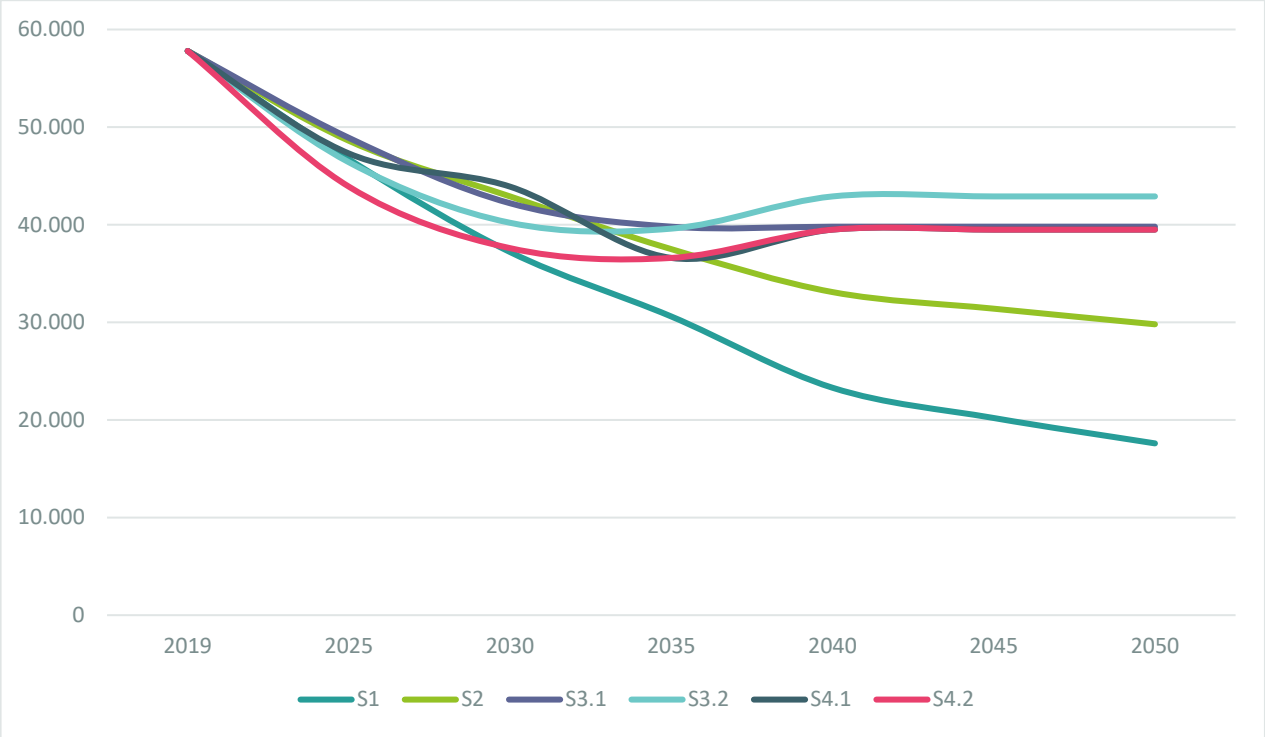
Source: Syndex database

Figure 37 – Scenario 4.2: Employment effect summary

5.2. SUMMARY OF THE SCENARIOS

Our analysis shows that all of the scenarios lead to a relatively steep decline in employment between 2019 and 2030. Scenarios 1 and 2 entail the most pessimistic assumptions and would deliver the most negative outcomes (see Figure 38).

Figure 38 – Employment developments according to the different scenarios



Source: Syndex database

On the other hand, we have identified two factors that contribute to preserving employment beyond 2030: maintaining engine production and/or relocating part of the upstream value chain. These factors would produce more optimistic results for employment, as shown in scenarios 3 and 4.

A comparative analysis also shows, however, that job reduction as a result of electrification is not a fatality. Ambitious public policy measure can offset, to a certain extent, the negative impact of electrification on employment. In our models, the strongest job losses are predicted in those models that assume an absence of policy response (scenarios 1 and 2), and not those that are based on rapid electrification and/or substantial drops in volume.

Moreover, it worth noting that we have only analysed the subsector of car engines, but new jobs could be created outside the scope of our data in annexed industries. The next section will briefly discuss that issue.

5.3. RECYCLING OF BATTERIES

The industrial sector for the recycling and recovery of batteries at the end of their life constitutes a potential source of new jobs that is difficult to assess at present.

The increase in the number of traction batteries in circulation on the market will lead to the development of activities to give them a second life: a traction battery that leaves a vehicle can be reused in stationary applications, as a complement to a sustainable energy source, for example.

Car manufacturers and most battery players have identified this opportunity and are communicating on battery reuse projects. This is the case in France with Renault, where one of the building blocks of its "Re-Factory" project in Flins consists of structuring an activity of deconstruction and reconditioning of traction batteries after they have been dismantled from an out-of-use electric vehicle (see section 6 below).

When it is not possible to recondition traction batteries, it is necessary to destroy and recycle them. Such processes require a specific treatment that only a few actors can currently provide on the French market.

The cost of the raw materials used in batteries (mainly cobalt, but also nickel, manganese and lithium), as well as the obligation imposed by the European directive on batteries to achieve a minimum recycling rate of 50%, should foster the development of industrial processing capacities for used batteries.

The French Strategic Committee for the Mining and Metallurgy Sector estimates that 50,000 tonnes of traction batteries will need to be recycled from 2027 onwards in France, a figure that should increase as electric vehicles become more widespread in the French car fleet.

The environmental impact of battery recycling can be measured at various levels:

- A reduction in local pollution at the raw material extraction sites: soil and groundwater pollution.
- A reduced carbon footprint in the battery production phase
- A traceability of batteries limiting the risks that they end up abandoned in the natural environment.

It has not been possible to establish an employment index based on the number of tonnes of batteries to be recycled, as there is no homogeneous and detailed data available to date. It is still quite a new activity that is currently being developed.

We estimate that the jobs created in a French traction battery recycling industry could amount up to between 2,000 and 9,000 jobs from 2035 onwards, provided that this activity is not relocated to countries with lower labour costs or fewer environmental constraints.

However, a more profound analysis would be necessary taking into consideration data from the industrial projects that are bound to develop in the coming years. Further research is needed in that domain.

5.4. CO_2 EMISSIONS BY SCENARIO

Although the core focus of our study is employment, we have also analysed the CO_2 impact of our models. Rough estimates show that the average CO_2 emission rate of engines assembled in France should significantly drop from 2025 onwards: from -25% of grams of CO_2 per kilometre in scenario 1 to -37% in scenarios 3 to 4bis. The differences between these two figures can be explained by the choices made in our scenarios concerning the speed of electrification of production.

With the assumed market exit of thermal combustion engines, CO_2 emissions should fall close to zero by 2035 (scenarios 3 and 4) or by 2040 (scenarios 1 and 2) at the latest.

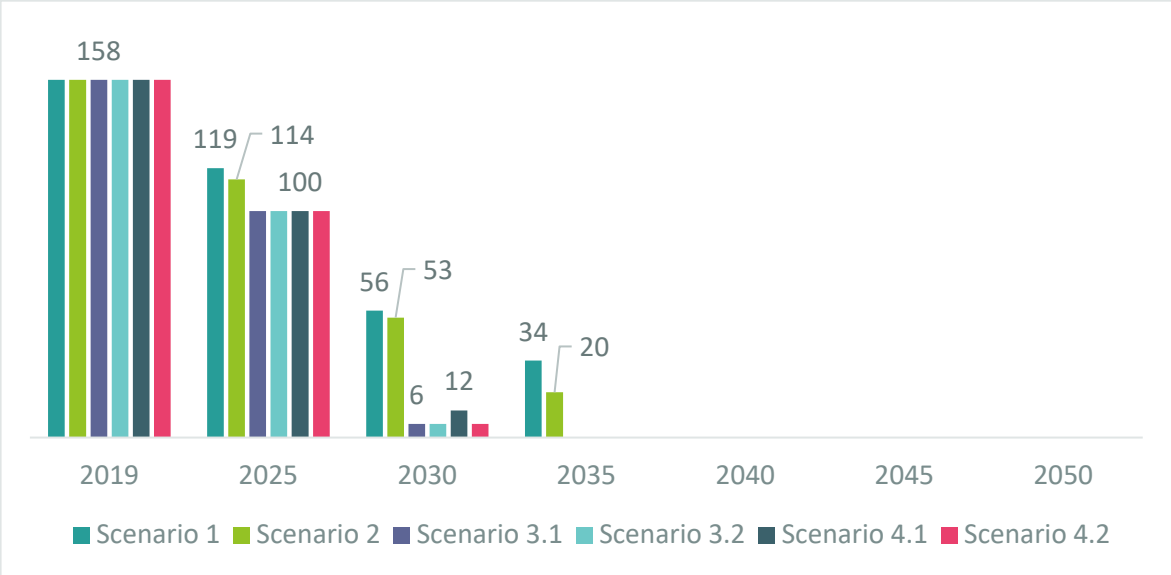
Figure 39 shows the number of cumulative grams of CO_2 emitted on average per engine from French production, based on our different assumptions.

To estimate the development of CO_2 emissions, we have used data from different sources.

- Average emission rate per vehicle according to the HBEFA (Handbook of Emission Factors for Road Transport) as of Version 4.1 (August 2019).
- For plug-in hybrids, the assumptions used have been adapted from the HBEFA reference.

- Differences between diesel, petrol, plug-in hybrid, electric and fuel cells have been taken into accounts. Light hybrids are included in thermal combustion engines.
- The average rate for each of these technologies changes between 2020 and 2050. The average emissions are summarised in Table 2.

Figure 39 – Average emissions per engine produced in France (g/km)

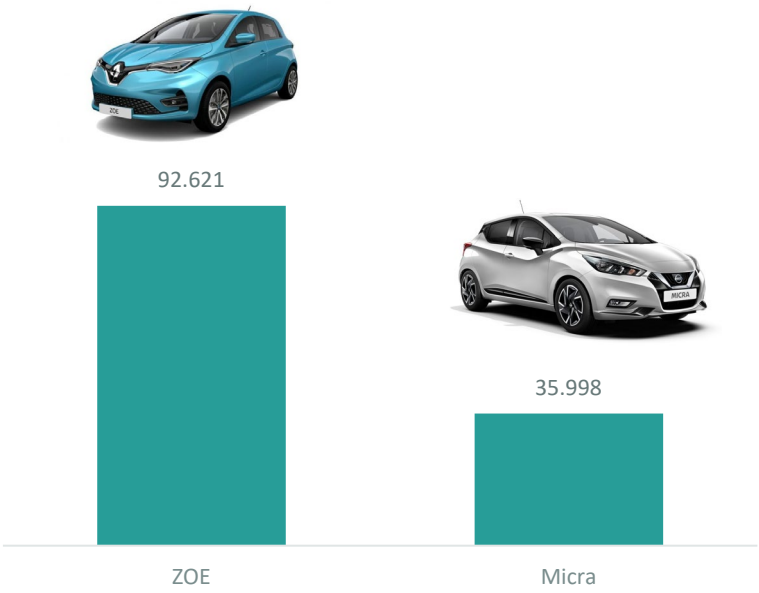


Source: Syndex database

>>6 CASE STUDY: THE RENAULT "RE-FACTORY" IN FLINS

The pace electrification of the car in France and elsewhere remains largely hypothetical, and so does the impact on employment. We can, however, observe some initiatives that might illustrate how plants that have been focused on thermal combustion engines in the past try to innovate their business model to prepare for changes to come. An interesting case in point is the Renault site in the town of Flins.

Figure 40 – Renault Flins production volume (2020)



Source: Renault Group – Universal Registration Document 2020

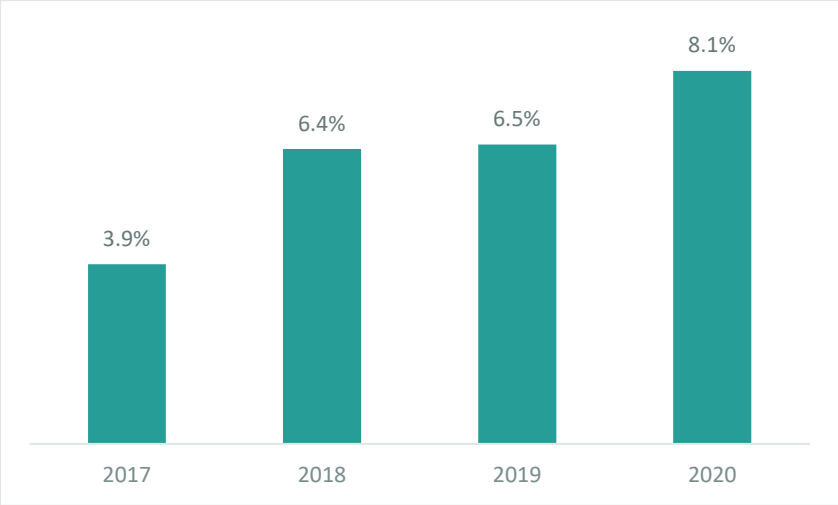
Established in 1952, the Flins site is located in the North-West of the Greater Paris region. Current production includes assembly, parts (metal sheets and deep drawing) and some remanufacturing and refurbishment. In 2020, the sites produced some 93,000 electric Renault Zoe and 36,000 Nissan Micra (see Figure 40). According to public data, the factory employs roughly 2,450 permanent staff and 1,500 agency workers.

To understand the rationale behind the transformation of the site to a "Re-Factory", it is worth reminding some general market trends that have inspired the project.

- Although the European car market grew up to 2019, it flatlined thereafter and is unlikely to continue its pre-Covid trajectory of constant growth. Recent IHS MarkIt data suggest that, after a recovery from the exceptional effects related to the pandemic, sales will level at around 18 million cars per year. Other factors, such as the current shortage of semiconductors and disruptions in supply and sales because of the war in Ukraine, will most likely slow down recovery.
- Moreover, the demand for cheaper segment A and segment B cars has dropped over the last decade. As XXX shows, there is a strong trend towards the higher price segments.
- At the same time, and related to the two beforementioned trends, the price for spare parts have recorded a significant spike over the last years (see Figure 41). In light of recent supply bottlenecks of new cars, the rise in prices is likely to continue.

In this context, Renault management has launched the transformation of the Flins plant into a "Re-Factory". All assembly activities are scheduled to stop by 2024. Instead, new capacities will be developed to offer a wide range of services throughout the car life cycle. Figure 42 summarises the concept.

Figure 41 – Price development for spare parts in France

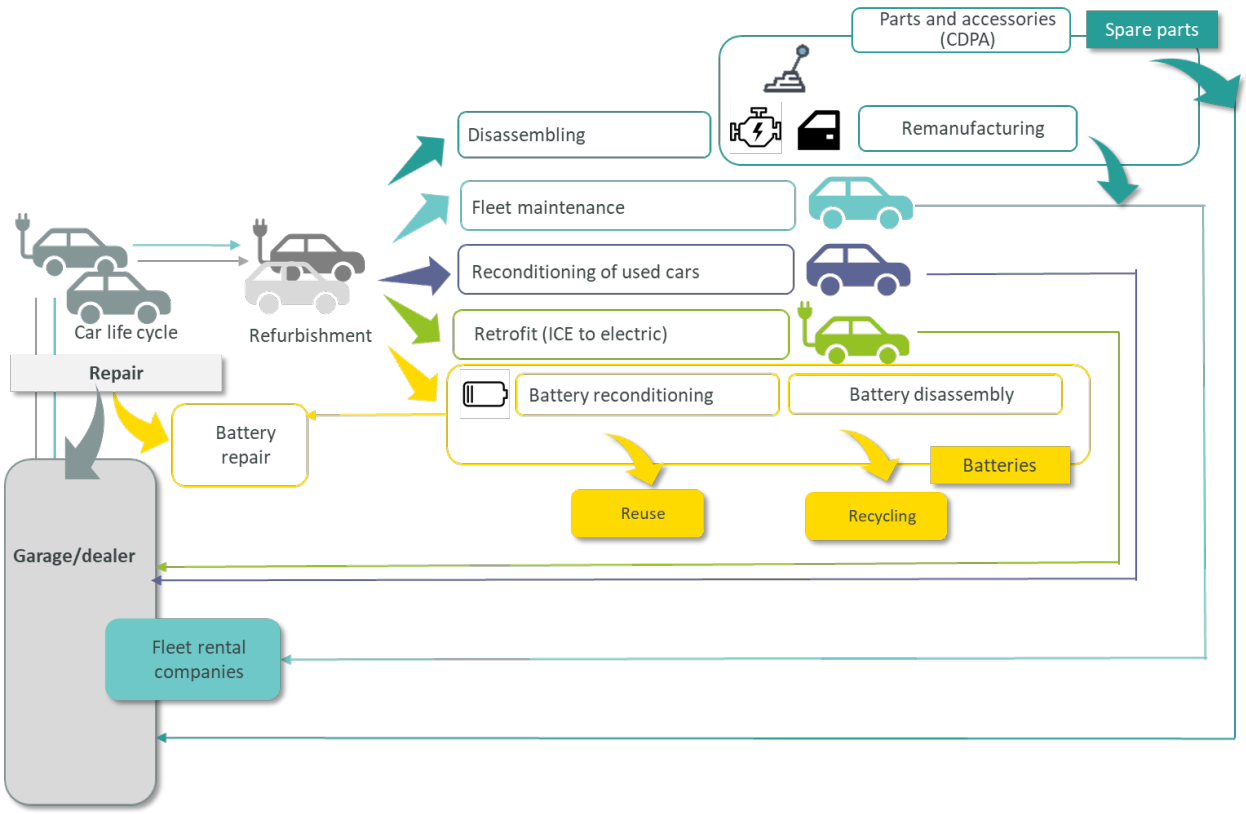


Source: Association Sécurité et Réparation Automobiles (SRA)

Repair

The site will offer repair services for used cars, both ICE and electric. This line of business includes life cycle management for batteries. According to their condition, used batteries are either reconditioned to be reused, or disassembled for recycling.

Figure 42 – Business activities of Renault's "Re-Factory" in Flins



Source: public company information, chart by Syndex

Refurbishment

Refurbishment includes a wide range of services.

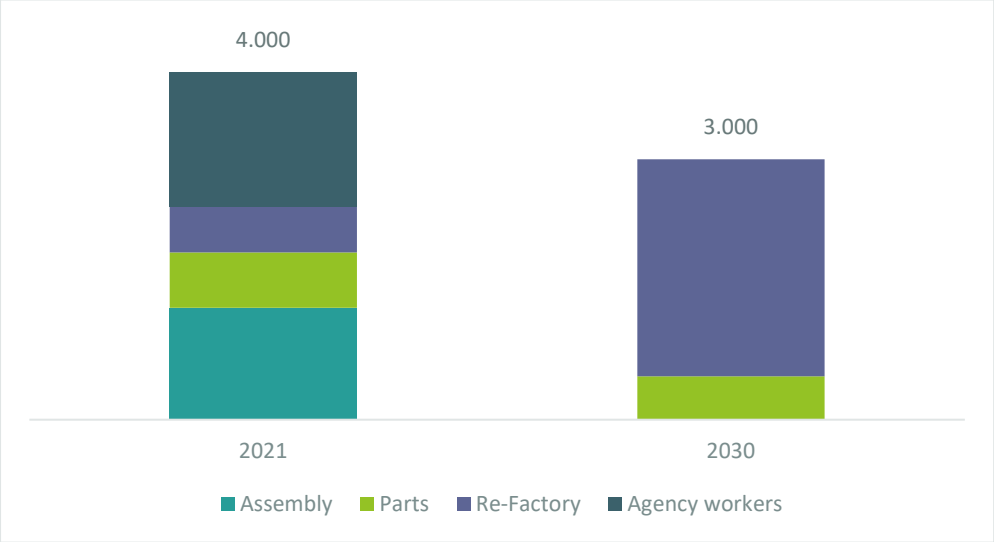
- Disassembling: According to their condition, used cars might be disassembled. Spare parts are to be reused either for resale or other refurbishment activities.
- Fleet maintenance: The offer includes fleet maintenance services, namely for car rental companies or other car fleet management services.
- Moreover, the site will offer to recondition or even retrofit (ICE to electric) used cars.

It is worth noting that the company considers the activities to be strongly complementary. For instance, spare parts from disassembling might be used for repair or fleet maintenance activities, reconditioned batteries for retrofitted cars, etc.

The new projects were launched in autumn 2021 with the declared goal to recondition 180 used cars per day, or 45,000 car each year. The company expects an annual turnover from new activities of €200 million from the new activities in 2025, and €1 billion in 2030.

Employment in the new Re-Factory activities is expected to partly compensate the stop of production. In 2021, the site employs some 4,000 people, more of one third are agency workers. By 2030, employment should stand at 3,000 workers, primarily in "Re-Factory" activities (see Figure 43). Renault management has recently announced that a similar model is contemplated for the Sevilla plant in Spain.

Figure 43 – Employment Outlook for Renault's "Re-Factory" in Flins



Source: public company information, estimates by Syndex

>>7 CONCLUSION

In this chapter, we used our unique database to assess the potential impact of electrification on employment in the French powertrain industry. Our scenarios have shown that we except a general decline of employment in that branch of the industry. The amount of job losses, however, varies according to the assumptions on which the models are based. Some conclusions can be drawn from the analysis.

First, our scenarios predict a reduction in employment of 15,000 to 40,000 jobs. It is worth reminding, however, that our data and the analysis is limited to the powertrain industries. Comparing our findings to the figures presented in Figure 1, 40,000 job losses would represent a decrease of 18% in overall employment in the car industry and a 38%-reduction in manufacturing, all other things being equal. For the mildest scenario (3.2), electrification would affect 7% and 14%, respectively.

Second. we have shown that a "laissez faire" approach of continuing recent pathways of industrial policies and company strategies deliver the worst possible outcome in terms of employment. We have made the deliberate choice to introduce a voluntarist component into our models and our assessment demonstrates that policy choices do matter. In fact, the scenarios with the weakest negative impact on employment are those that promote ambitious reduction targets, lower volumes and changes in industrial policies, notably in terms of a shift towards locally sources components. Volumes and the need for labour matter, but our data suggest that they are not the most decisive determinants. Policies makers and company leaders have a strategic choice to make if mobility is to become electric and sustainable without destroying many well-paid and often highly skilled jobs in France and in Europe.

As we have discussed above, our study provides detailed information on a clearly defined part of the industry. We have only briefly discussed, in section 3.9 and in section 6, some new activities related to electric mobility that might drive the creation of new jobs that are beyond the scope of our database. Studies with a broader focus have looked in more detail on the employment effects of such new activities. (The German ELAB studies are probably the most comprehensive analyses that have been published as of now.)

To successfully manage the transformation towards electric driving, it would be of utmost importance to foster significant investment in both research and development, and training of existing and future employees. Public policy initiatives at local and European level seem indispensable to make sure that employment remains in or returns to the customer base (which is, in our case, Europe). Adequate policy tools seem necessary to convince the internationally acting players in the field to adapt their sourcing and production strategies accordingly.

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>>9 TABLES

Table 1 – Scenarios and Key Assumption

	Scenario 1 Continued deindustrialisation ("*laissez faire*")	Scenario 2 Economic upturn	Scenario 3.1 Industrial relaunch	Scenario 3.2 Industrial relaunch with local value chains	Scenario 4.1 Industrial relaunch with local value chains and end of internal combustion engines by 2035	Scenario 4.2 Industrial relaunch with local value chains and end of internal combustion engines by 2030
Market development	Greater openness to imports	⅓ of LPV are sold in France	50% of the VP products are sold in France	50% of the VP products are sold in France	Production based on the national and regional market	Production based on the national and regional market
Strategic political choices	Continued deindustrialisation	Strengthening of France's position within the EU	Industrial relaunch	Industrial relaunch with local value chains	Industrial relaunch based on local value chains by 2035	Industrial relaunch based on local value chains by 2030
Volumes in 2050 (million engines)	1.35	2.26	3	2.5 (by 2030 and stability thereafter)	2.33 (by 2030 and stability thereafter)	2.33 (by 2030 and stability thereafter)
End of internal combustion engines (year)	2040	2040	ICE: 2030 PHEV: 2035	ICE: 2030 PHEV: 2035	2035	2030
Energy mix in newly registered cars	2040: 80% BEV 20% fuel cells	2040: 100% BEV	2035: 100% BEV	2035: 100% BEV	2035: 90% BEV	2030: 80% BEV
Battery production in France (GW)	51.4	113	150	125	94	94
Local supply chains	0%	0%	0%	+30%	+30%	+30%

Table 2 – Average emissions per engine produced in France (g/km) by technology

	2020	2030	2040	2050
Diesel	159	149	133	117
Petrol	168	148	133	117
PHEV	84	30	25	25
Mild hybrid	168	148	133	117
BEV	0	0	0	0
Fuel cell	0	0	0	0