FOCAL Initiative

ICEV TO EV WORKFORCE TRANSITION LABOUR MARKET FORECAST

CANADA REPORT

FEBRUARY 2024

About the FOCAL Initiative

The Future of Canadian Automotive Labourforce (FOCAL) Initiative, funded by the Government of Canada, is a collaboration of the Canadian Skills Training and Employment Coalition (CSTEC), the Automotive Policy Research Centre (APRC) and Prism Economics and Analysis.

The FOCAL Initiative has produced labour market information and data related to Canada's automotive manufacturing sector, examined key trends affecting the automotive labour market, and produced forecasts of supply and demand for key occupations in the broader automotive sector.

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Executive Summary

Canada is in early stages of a transition towards decarbonization that will have a significant impact on the automotive manufacturing sector. Production processes and supply chains have already begun to shift their focus from internal combustion engine vehicles (ICEVs) to electric vehicles (EVs).

Occupation impacts are influenced by the characteristics and timing of the transition. For some occupations (such as electronics assemblers), the number of needed workers and the tasks that they perform is very closely tied to the type of vehicle being produced. Those occupations will be significantly impacted by the ICEV-EV transition. Other occupations (such as computer network technicians) may experience relatively moderate or little impact if the tasks that they perform are not associated with the type of vehicle produced. Therefore, it is important to examine occupation-level impacts so that industries can ensure that they have the right number of workers with the right skills throughout the transition.

This report explores the labour market impact of the ICE-EV transition in Canada for 68 occupations in 49 industries, across a forecast horizon from 2025 to 2040. The term '*recruitment gap*' is the primary indicator of occupation-level impacts in this report. The recruitment gap is a measure that captures labour market supply and demand dynamics that evolve during the forecast period. Because occupational demand is contingent on the number and type of vehicles being produced, a specific base case production scenario was defined as the context for the analysis. Demographic trends (which influence the entrance of young workers and exit of older workers from the labour force) and immigration were also incorporated into the analysis. Results of the analysis indicate that several occupations are expected to experience significant impacts during the transition. The magnitude and timing of impacts are unique for each occupation. For example, at the national level a large recruitment gap is expected to occur *consistently* for occupations such as manufacturing managers, motor vehicle assemblers, and construction millwrights/industrial mechanics. Large recruitment gaps are expected to occur towards the *beginning* of the forecast horizon and gradually dissipate for occupations such as industrial electricians, electronics/electrical product manufacturing supervisors, and electrical/electronics engineering technologists and technicians. Recruitment gaps are expected to peak in the *middle* of the transition period for occupations such as mechanical engineering technologists and technicians, machining tool operators, and industrial painters. In other words, employers throughout the supply chain will face recruitment pressures that are occupationally specific and timed to different phases of the ICEV-EV transition.

This report describes national occupational impacts. However, results will be different at provincial and regional levels because of industrial characteristics and labour market supply-demand dynamics unique to those areas. Readers are encouraged to review provincial and regional occupational forecast reports, along with other related publications that have been produced as part of the FOCAL II initiative.

Introduction

FOCAL I reports (published in 2022) highlighted the crucial role of a broader automotive industry across Canada. As work concluded, it became clear that the emerging transition from internal combustion engine vehicles (ICEV) to electric vehicles (EV) was a new challenge facing the industry. The FOCAL II initiative is helping employers and job seekers manage the transition from (ICEV) to (EV). Assistance includes direct action through wage and training subsidies, and guidance in critical areas like skills transferability, diversity, immigration and apprenticeship. This support is augmented by FOCAL's analysis of the impact of new investments in EVs and the loss of ICEV-related production. The focus is on manufacturing industries, including vehicle assembly, parts production, battery supply and related changes across the supply chain. This process provides measures of changing labour market conditions for industries and occupations. FOCAL II assesses these impacts in three steps.

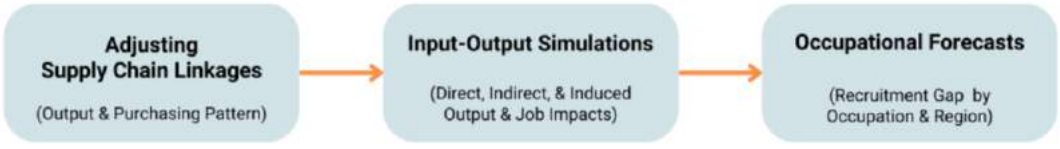
First, the EV Model estimates impacts of announced plans and expected investments and calculates new levels of production and related links across the supply chain. The analysis allocates these direct, initial impacts across;

- a transition horizon from 2025 to 2040
- 49 selected NAICS industries in
- Canada, Ontario, Quebec, Manitoba and seven regions.

Second, the direct impacts of new EV facilities are extended into the broader economy to estimate indirect impacts across all supplying industries and induced impacts related to changes in employment and incomes. This second step uses an expanded input-output capability that captures changes in the distribution of purchases across the supply chain and new patterns of local and external supply.

Third, the full range of impacts on employment are translated into labour market impacts that track changes in recruiting and job search conditions. This report describes these final, labour market impacts across 68 key occupations for Canada. Figure 1 illustrates this three-step process.

Figure 1. Impact analysis steps



Impacts of the transition are sensitive to changes in many factors. These include consumer acceptance of EVs, the timing and scale of investment in new production facilities, emerging economies of scale and technological advances that reduce vehicle and component costs, government policy, and success in Canada securing EV production mandates. Three scenarios have been created, with each reflecting a different set of outcomes for each of these factors. The

scenarios are described fully in the FOCAL II report titled '*The Shift to EV Production in Canada's Automotive Manufacturing Sector: Assessing the Economic and Labour Market Impacts*'. A variation of these scenarios is summarized in a base case scenario that is used for the labour market impact model.

The base case scenario describes an ICEV-EV transition that will comprise both job gains and losses, changes in employment conditions, and related labour market disruptions for selected industries and occupations. Direct impacts spread out from vehicle assembly, parts producers specialized in combustion engines and transmissions and electronic parts, battery assembly, related chemical and mineral processes and, under certain assumptions, mining. Impacts are most disruptive in regions experiencing either new investments in battery plant production or losses as internal combustion engines are phased out. These impacts create a variety of changes, with large and pronounced effects nationally in some occupations (examples are described in Section 4 of this report) and more limited impacts across other occupations (impacts for all selected occupations are described in detail in Appendix D)[1].

This introduction is followed by a national profile of employment that comprises the traditional automotive industry (including assembly and parts manufacturing) and extends it to emerging industries in the production and supply chain for EVs. Section 3 describes impacts across the ICEV-EV transition in key industries. Section 4 reports detailed impacts across selected occupations. Conclusions and implications are a reviewed in the final section. A description of the base case scenario, a list of the industries and occupations selected for the analysis, the methodology applied in the labour market models, and tables of detailed impacts for the occupations are located in Appendices.

[1] Occupation impacts vary by province and region, due to differences in industrial characteristics and other labour market supply/demand dynamics unique to those areas. See provincial and regional reports for details.

The ICEV-EV Transition in Canada – Background

The coming transition from ICEVs to EVs is a major change for the Canadian economy. In 2022, the national workforce of 18,438,400 included 1,594,800 working in manufacturing and 112,500 in the core automotive assembly and parts industries (NAICS 3361 and 3363, respectively)[2]. Motor vehicle assembly and related activity are critical to the overall well being of the Canadian economy. For example, assembled motor vehicles and parts are consistently among the top two or three exports from Canada; often second only to oil and gas extraction[3].

Relative to other industries, employers in manufacturing often identify human resources, skills shortages and recruiting as a major challenge in business development. According to Statistics Canada:

> "Businesses in manufacturing were the most likely to expect challenges recruiting staff and these levels have remained unchanged when compared to 2022. In the second quarter of 2023, nearly half (48.4%) of businesses in manufacturing expected recruiting skilled employees to be an obstacle, compared with 47.4% in the second quarter of 2022"[4].

Demographic change has contributed to recruitment challenges in recent years, as the population of Baby Boomers (born between 1946 and 1965) retires. The 2021 Census tracked an increase of 5.9% in the total population and 3.9% in the working age population between 15 and 69 compared to 2016. However, the composition of the workforce has been shifting. Baby Boomers now represent a decreasing proportion of the population and immigration, while younger generations increase in relative size. For example, between 2016 and 2021, the proportion of Millennials (born between 1981 and 1996) increased by 8.6% while the proportion of Baby Boomers decreased by 3.1%. Over half of the immigrants who arrived in Canada between 2016 and 2021 were Milennials. As shown in Figure 2, it is expected that Millenials will outnumber Baby Boomers by 2029 and Generation Z (born between 1997 and 2012) will outnumber Baby Boomers in 2032. [5]

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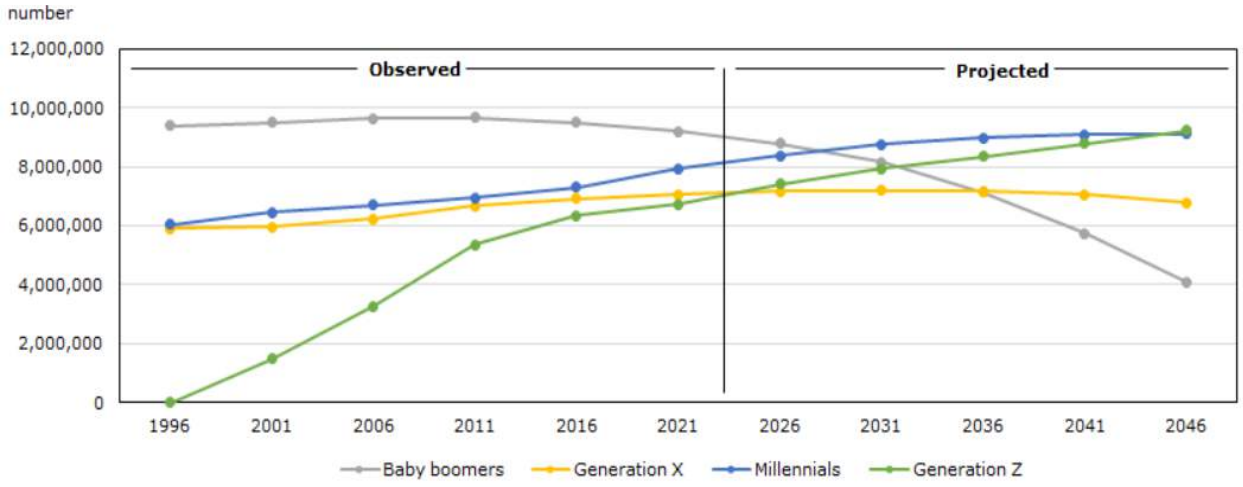
[2] Source: Statistics Canada. Table 36-10-0489-01 Labour statistics consistent with the System of National Accounts (SNA), by job category and industry

[3] Source: Government of Canada Trade Data Online (https://ised-isde.canada.ca/site/trade-data-online/en).

[4] Source: 'Analysis on labour challenges in Canada, second quarter of 2023' https://www150.statcan.gc.ca/n1/pub/11-621-m/11-621-m2023009-eng.htm

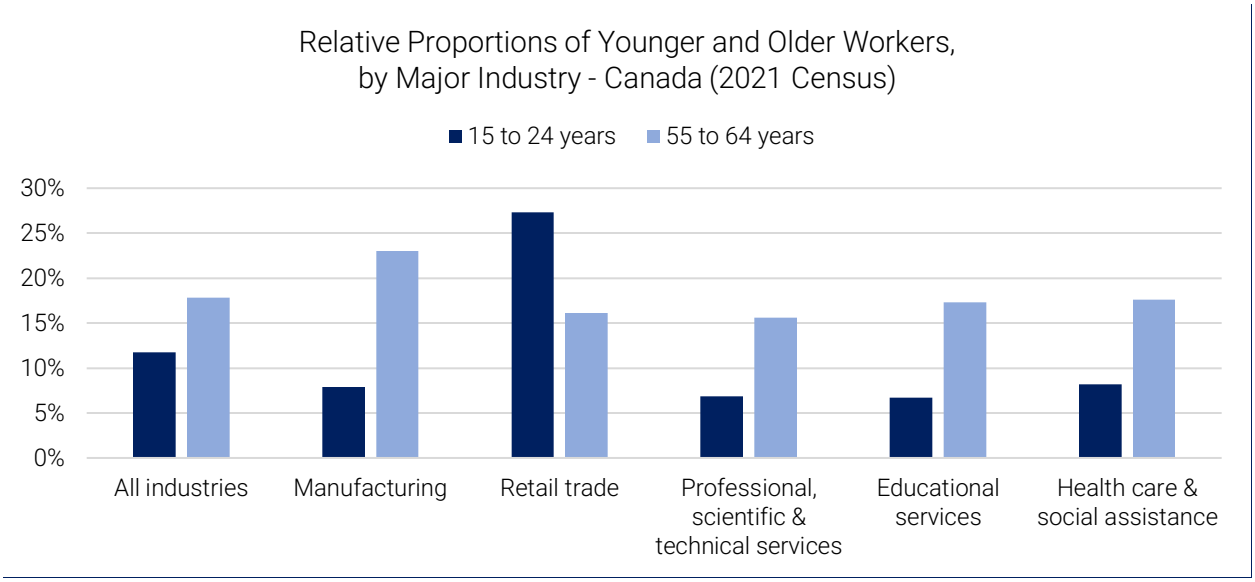
[5] Source: 'A generational portrait of Canada's aging population from the 2021 Census' (https://www12.statcan.gc.ca/census-recensement/2021/as-sa/98-200-X/2021003/98-200-X2021003-eng.cfm)

Figure 2. Changing Demographics in Canada (Source: Statistics Canada)



Demographic trends are not consistent across industries, however. In the manufacturing sector, there continues to be a higher proportion of older workers and a lower proportion of younger workers. As shown in Figure 3 (below), of the five largest industry sectors in Canada, the manufacturing sector has the highest proportion of employees in the 55 to 64 age group. Thus, while Baby Boomers have largely transitioned out of the labour force in other industries, the exodus is slower in the manufacturing sector and recruitment challenges related to the retirement of older workers persist.

Figure 3. Proportions of older and younger workers in major Canadian industries (Source: 2021 Census)



Research in FOCAL I made the case for defining a broader automotive sector that adds key industries in the manufacturing and technology supply chain to the traditional grouping of

assembly and parts manufacturing. Defined traditionally (i.e. NAICS 3361 Motor vehicle manufacturing and 3363 Motor vehicle parts manufacturing), automotive employment grew from 90,400 workers in 2009 to 118,000 workers in 2019. Employment decreased by 15% from 2019 to 2020, primarily due to COVID shutdowns in Canada and elsewhere[6]. The core automotive workforce continues to recover to pre-COVID levels.

Over 98% of national employment in vehicle and parts manufacturing is concentrated in three provinces: Ontario (representing 89% of total national employment in these two industries), Quebec (approximately 7% of national employment), and Manitoba (slightly more than 2% of national employment)[7].

Table 1 tracks the distribution of the selected industries included in the emerging automotive workforce. In this FOCAL II analysis, the broader automotive industry is defined to include specific new industries joining the automotive supply chain for EV production. This includes battery manufacturing, chemicals, material processing and mining. These numbers serve as a starting point for measuring employment impacts.

[6] Source: Statistics Canada. Table 36-10-0489-01 Labour statistics consistent with the System of National Accounts (SNA), by job category and industry

[7] Ibid. This estimate is calculated using the aggregation of NAICS 3361 (motor vehicle parts manufacturing) and 3363 (motor vehicle parts manufacturing).

Table 1. 2022 Employment in Canada's broader automotive sector (Source: Statistics Canada, Automotive Policy Research Centre (APRC))

Industry	Employment in 2022
Automobile and light-duty motor vehicle manufacturing	31,900
Heavy-duty truck manufacturing	5,400
Parts manufacturing	70,200
Mining	25,600
Basic chemical manufacturing	10,500
Other material processing	36,700
Battery manufacturing	14,800
Management, scientific and technical consulting services	149,200
Plastic product manufacturing	89,000
Other electronic product manufacturing	24,800
Semiconductor and other electronic component manufacturing	18,200
Iron and steel mills and ferro-alloy manufacturing	16,900
Foundries	8,900
Forging and stamping	4,300
Other automotive supply chain	1,328,500

The ICEV to EV transition will shift employment among the industries in the broader automative sector. The traditional leading economic role for these industries is clearly at risk as Canada must now compete for its place in the new world of EV production. Attention is focused on the crucial role of batteries in the new EVs and Canada has been active and successful in the global competition for battery production. FOCAL II research tracks the likely path of the transition across industries and occupations as supply chains are redefined for EVs.

Table 1 tracks employment across 49 selected industries. These comprise the core assembly and parts producers, and include additional upstream industries (e.g., relating to battery production) in the evolving supply chain. A list of the specified industries featured in the labour market impact analysis, identified as the most important players in the EV transition, are found in Appendix A.

The major investments driving the transition have been documented in the media. Vehicle assemblers, parts manufacturers and new battery plants have announced their plans for expansion in Canada. These investments include major facilities for;

- battery production,

- commitments to transform existing assembly plants to accommodate high volume EV assembly,
- new production facilities to supply battery production with specialized components including
    - anode, cathode, specialized metal processes,
    - mining and mineral processing for speciality rare metals.

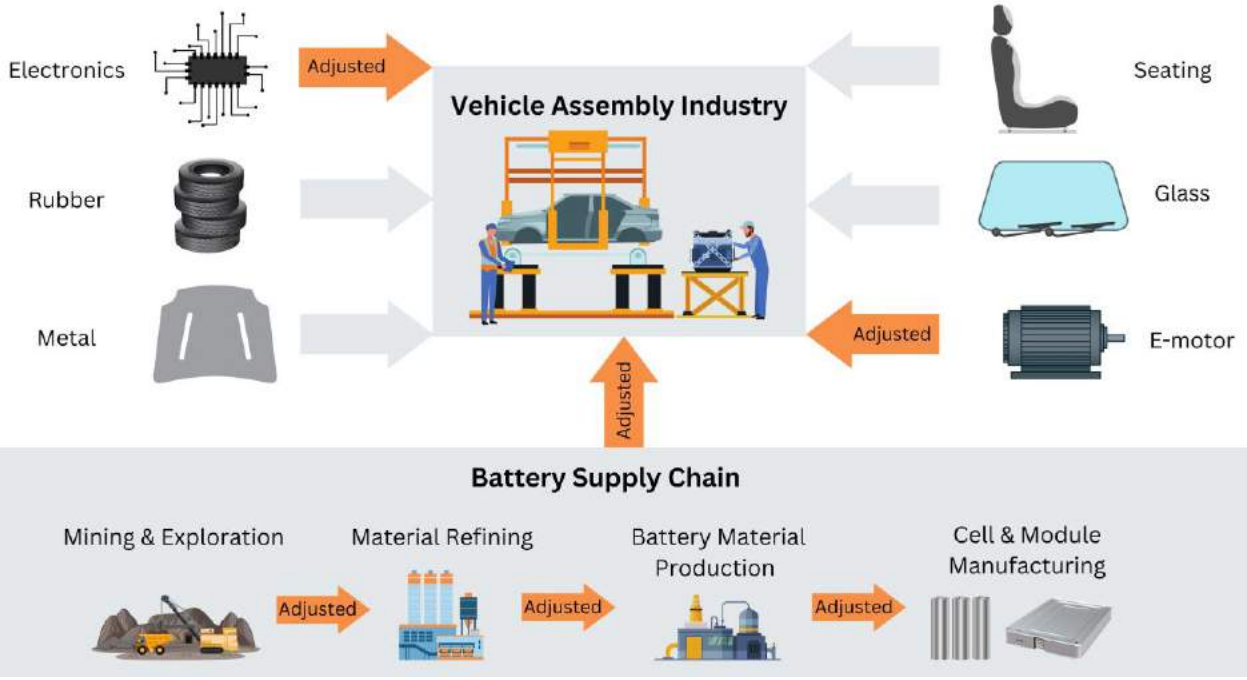
These investments are concentrated in regions across Ontario but also include new and expanded facilities in Quebec and Manitoba. FOCAL II research transforms these plans into specific changes to the current supply chain including the impact on production by industries and timing of the changes across a transition from 2025 to 2040.

Industry Impacts Across the ICEV - EV Transition

This section extends the initial analysis of announced investment and assembly plans to include the broader impact of these changes across the vehicle supply chain and then the overall Canadian economy.

Findings are calculated from the Statistics Canada Interprovincial Symmetric Input-Output table. Input Output tables are standard tools, for Canada and the Provinces, that track the transactions that connect industries and their customers over a fixed period of time. These tables are the best sources available to analyze the chain of transactions that link motor vehicle assembly to suppliers and to customers. The FOCAL II analysis customized the Statistics Canada tables by replacing ICE supply chains with estimates of new EV supply chains, including the addition of the new battery production facility and related investments in new chemical, mineral and mining production capabilities.[8] Figure 4 illustrates the changes introduced by FOCAL II at this stage of the analysis.

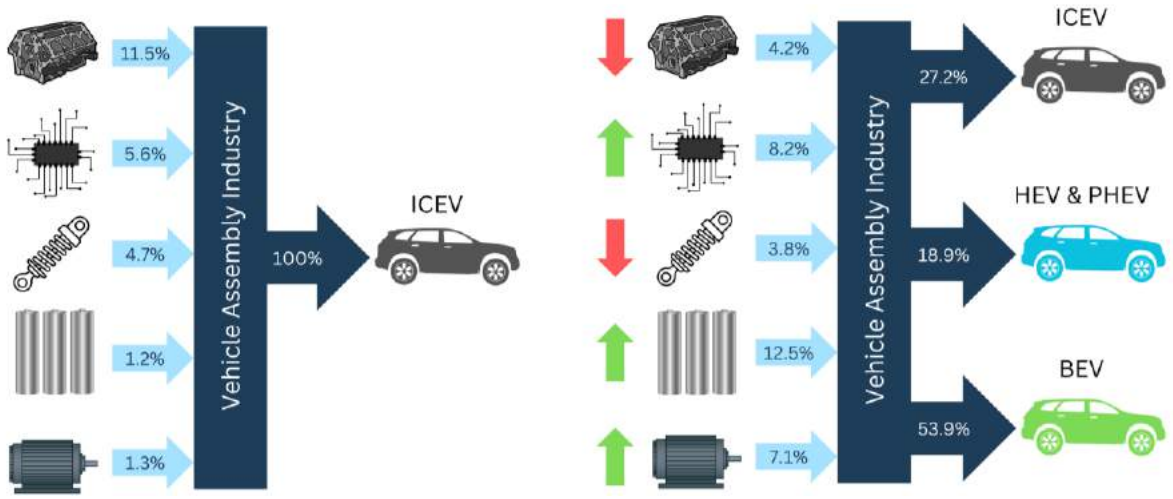
Figure 4. Adjusting automotive and battery manufacturing supply chain linkages for the impact analysis



[8] See Introduction section and Appendix C for more detailed information about the methodology used in the FOCAL II analysis.

Figure 5 provides an example of the changes that are imposed based on analysis of the core industry links from parts manufacturers to assembly. Changes in the distribution of inputs into vehicle assembly, seen in the diagram, capture changes between 2019 and 2030 from the base case scenario.

Figure 5. Vehicle assembly industry supply inputs



Results are reported at three levels of impact. First, d*irect impacts* are the initial change introduced by new levels of vehicle assembly by type (i.e. internal combustion engine ICEV, hybrid HEV, plug in hybrid PHEV and battery electric BEV) new battery plants and related outputs. Second, the IO system calculates *indirect impacts* that reflect changes in output and sales in response to direct impacts. For example, many chemical and mineral processing suppliers will alter sales to meet the requirements of battery production. Third, *induced impacts* reflect how changing employment and incomes alter consumer purchases. Total impacts are the sum of direct, indirect and induced impacts.

Base Case Scenario

Direct impacts, which will determine the overall employment impacts, are introduced in the analysis across the transition period from 2025 to 2040 and in specific categories;
Vehicle assembly, by type;

- Internal combustion
- Hybrid
- Plug in hybrid
- Battery electric

New battery plants operating, by;

- Plant capacity and suppliers;

The battery supply chain, consisting of;

- Cathode and anode suppliers
- Material filtering and processing
- Mining

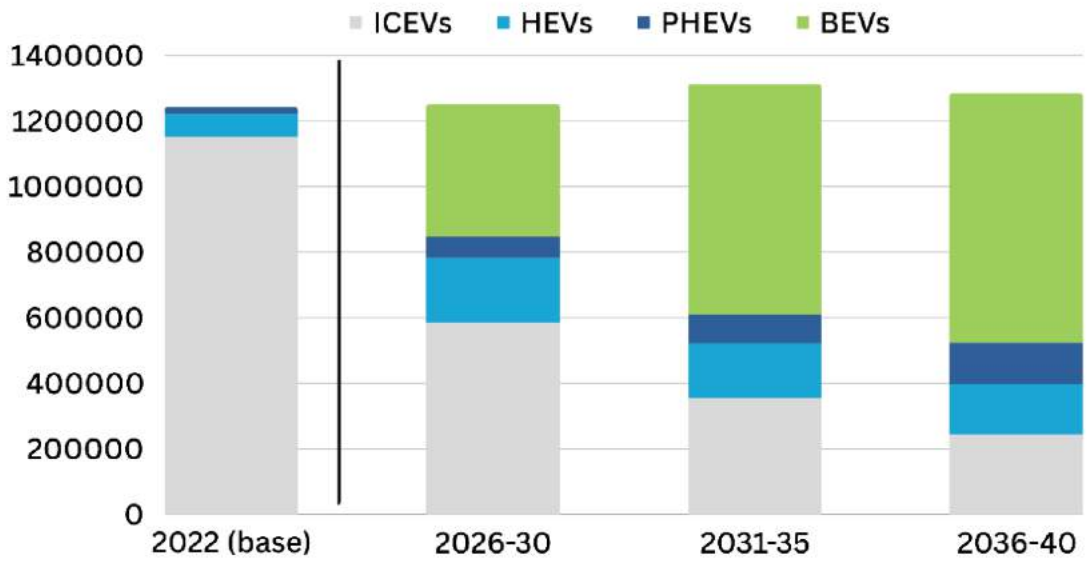
A base case scenario has been developed that combines key assumptions across these categories. The magnitude and timing of these assumptions are expressed in terms of total employment impacts by industry, which are then transformed into detailed occupational impacts.

Base Case Scenario Assumptions

The base case scenario assumes a specific path in the transition from ICEVs to EVs. At the start of the transition, vehicle production is overwhelmingly ICEVs with a relatively small number of EVs. By the end of the transition, the production mix inverts so that the vast majority of vehicles produced are EVs. For the impact analysis, the overall transition is divided into intervals. The relative mix of ICEVs and EVs change from one interval to the next. Occupational impacts evolve accordingly.

Figure 6 illustrates the transition in vehicle production, expressed in units produced. The chart distinguishes between production of ICEV (internal combustion engine), HEV (hybrid electric), PHEV (plug-in electric), and BEV (battery electric) vehicles. The first column illustrates the production mix at the start of the transition.

Figure 6. Base case scenario – estimated vehicle production, by type of vehicle



Note that the number of vehicles assembled across the transition to 2040 stays roughly constant between 1.2 and 1.3 million. Further, the base case scenario reflects a slow pace of adoption of EVs in the market, with BEV production increasing from less than 1% of total vehicle production in 2022 to nearly 60% by 2040. This relatively low assembly level and slow acceptance of BEVs limits employment impacts relative to the 2022 base.

The base case scenario assumes that four new battery production facilities will be operating in Canada by 2040. For the purpose of the employment impact analysis, it is assumed that these plants will be operating at less than full capacity and accessing one third of needed cathode, anode, mineral and other battery supply chain inputs from Canadian suppliers (see Table 2).

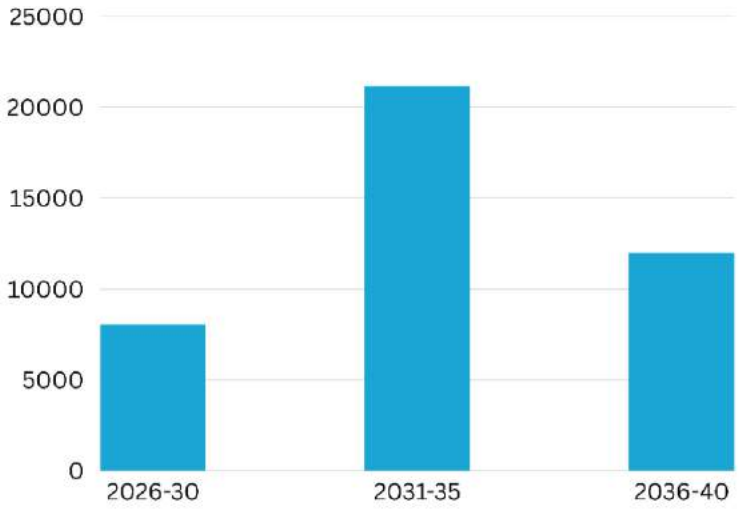
Table 2. Base case scenario - battery supply chain assumptions

Battery Production & Supply Chain	Assumptions
Battery manufacturing (4 plants)	100 GWh
Cathode & anode manufacturing	32.5 %
Material filtering & processing	32.5 %
Mining	32.5 %

National Impacts Across Industries

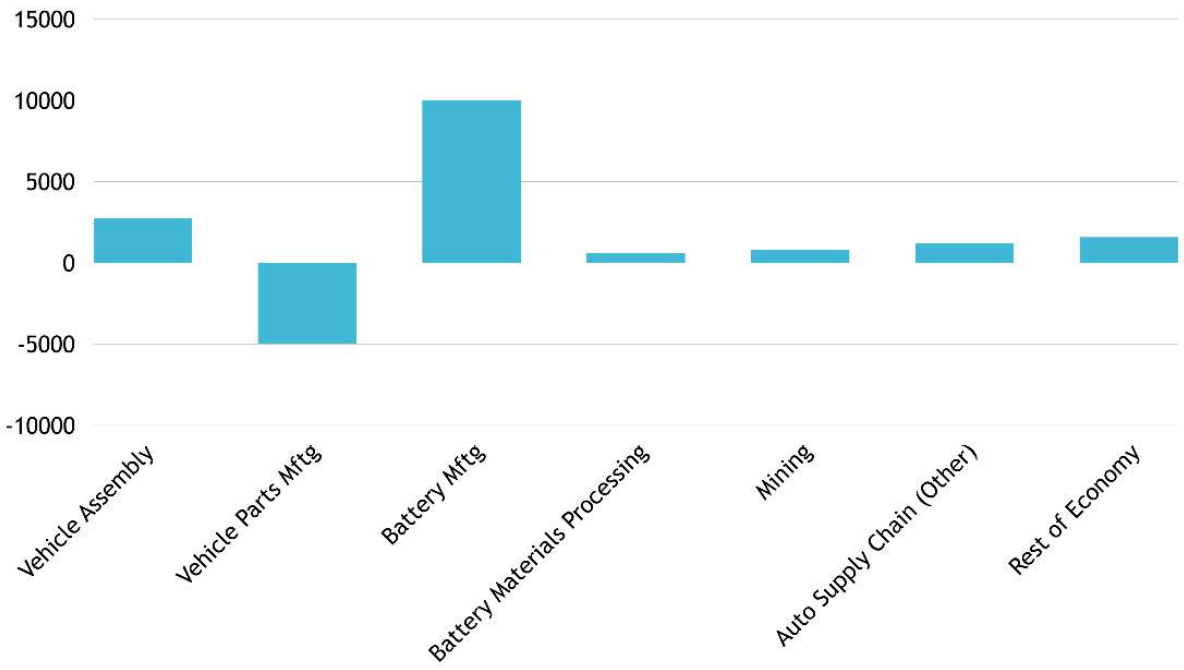
Figure 7 summarizes the total employment impacts in the base case Scenario in the three intervals of the transition. The total impact is positive, with gains in each of the three five-year intervals, as new activity in battery production and its supply are large enough to offset employment losses related to declining activity in gasoline engine and related production. Initial job losses are due to declining assembly and a lag in new battery startups. Impacts peak at 21,000 jobs in the 2031 to 2035 period as battery operations ramp up.

Figure 7. Total impact of ICEV-EV transition on employment - all industries, Canada



A summary of total employment impacts across the transition from 2025 to 2040 by industry is shown in Figure 8. Note that the biggest and consistently positive gains are in the battery cell and module manufacturing where new investment is concentrated. Limited gains in assembly reflect the base scenario assumptions (i.e., the production mix changes through the transition period but the total number of vehicles assembled is generally constant). The decline in parts industry production reflects a shift in activity out of the traditional parts production, e.g. internal combustion engines and related areas like transitions. Electric vehicles will source a much smaller part of inputs from the traditional parts manufacturers. Activity across the supply chain shifts to battery module, cells and their related suppliers.

Figure 8. Total impact of ICEV-EV transition (2025 to 2040) on employment by industry category, Canada



These industry changes are allocated to occupations in the next section. Labour market impacts are then calculated.

Labour Market Impacts by Occupations

This section of the report describes the impacts of the ICE – EV transition on national labour markets for fifteen occupations. FOCAL II findings signal difficulties for recruiters and job seekers during the peak and trough periods as the transition unfolds from 2025 to 2040. Changing employment and market conditions, driven by change in the broader vehicle industry, are set against other key trends affecting the labour force available to meet demands. The largest, supply-side trends are in Canada's demographics and immigration.

Occupations that are concentrated in the broader automotive sector and in key regions participating in the transition face the biggest changes. Labour markets more distant from the investments, assembly plants, and key occupations engaged in other industries face more limited impacts. Fifteen occupations that are concentrated in the selected industries (listed in Appendix A) are included in this section as the focus of the discussion.

Recruitment Gaps

FOCAL has created a "recruitment gap" measure for each occupation and regional market. Recruitment gaps are calculated annually for each occupation and region and summed across the transition intervals. High and rising recruitment gaps signal tight markets with skill and general labour shortages and lower gaps signal broader labour availability and more job search challenges. The recruitment gap (pictured below in Figure 9) is defined as expansion demand plus replacement demand less new entrants.

Figure 9. Recruitment gap components

Expansion demand is measured by the annual change in employment and these changes are determined by the impacts reported above. Change in expansion demand is primarily due to start up and growth in EV assembly activity, new battery production and related impacts across the supply chains. Expansion demand would be reduced by elimination of internal combustion engines and related supply chains. Economies of scale and evolving technology in EV assembly and battery technology will have a long-term impact lowering employment. In these and other ways, attributes and assumptions included in the base case scenario will effect impacts across occupations.

Replacement demand is the sum of exits from the workforce due to retirements and mortality. Trends in Canada's population have created challenges for recruiting, especially related to Baby Boomers (born between 1946 and 1965) who have been retiring in increasing numbers for more than a decade. These changes have focused human resource management on issues like succession planning and skills training. The last of the Baby Boomers turn 65 in 2030, so the wave of retirements will fade across the last ten years of the transition. This suggests lower recruitment gaps in occupations as they shift to younger age profiles.

New entrants are youth entering the workforce for the first time. This includes young graduates from education and training programs, and immigrants. Lower birth rates over many years have limited growth in the youth population from age 15 to 30 and this has limited the number of new entrants. It is important to note that these demographic effects are changing at the same time as the ICEV-EV transition.

The recruitment gap measure has been constructed to signal the overall effect of these changes across the transition as employment impacts are distributed among occupations and then set against the trends in populations and labour force availability. Future immigration patterns will play a large role in market conditions.

Impacts on Occupations

FOCAL II results identify fifteen occupations that experience notably large recruitment gaps at some point across the transition period. Results are summarized in three separate intervals with the initial period from 2026 to 2030. Results for each interval sum the recruitment gap for each year within the interval. The total recruitment gap is expressed in two ways. In the left panel of Figures 10 to 24, the recruitment gap for each time interval is displayed as the number of additional workers needed, above and beyond the 2022 base year employment. In the left panel of Figures 10 to 24, the recruitment gap for each time interval is expressed as the percentage change in employment relative to the starting level of employment in 2022. In other words, the recruitment gap is not a forecast of total employment for each occupation - it is an estimate of *incremental* workers needed for an occupation, in addition to the current employment in that occupation in 2022.

Large recruitment gaps for an occupation (expressed as a headcount, or the number of additional workers needed) indicate the magnitude of the recruiting effort that will be needed. Recruitment gap percentages that approach 100%, for example, imply that the impact in an occupation may need to essentially double in size to meet operational demands. Large recruitment gaps suggest more acute recruiting pressures and potential skill shortages because the supply of workers will likely be insufficient to meet demand.

For occupations with older age profiles, recruitment gaps may be exacerbated by both expansion demand and replacement demand. For occupations with younger age profiles (implying low replacement demand), recruitment gaps may nevertheless appear if expansion demand is high. In

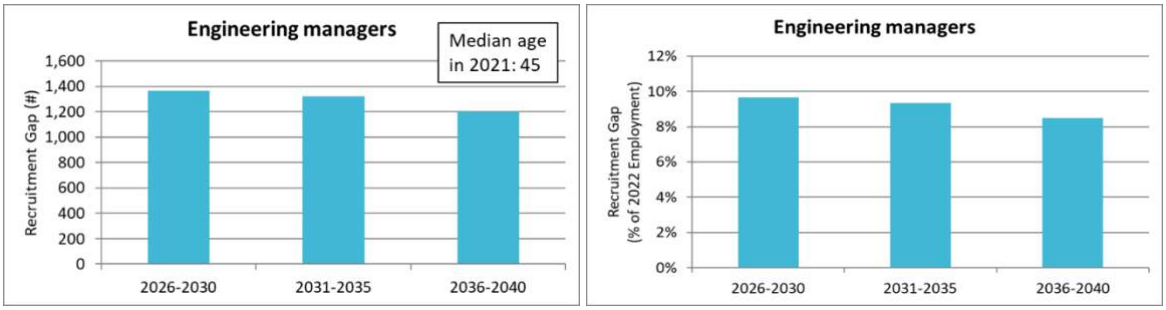
other words, recruiting pressures may result from *high expansion demand* (for occupations that are in demand due to increased operational activites), *high replacement demand* (for occupations skewing heavily towards older workers), and/or *low numbers of new entrants* into the occupation. Detailed results for each selected occupation are found in Appendix D.

These components of the recruitment gap manifest differently for each occupation and for each regional market. Components of the recruitment gap likely change during different stages of the transition period (e.g., as the Baby Boomers finish exiting the labour force, as battery plants are built and assembly plants re-tooled for EV production, and so on). It is potentially misleading to express the ICEV-EV transition as a single number of jobs that are needed fifteen years into the future, as that ignores specific recruiting pressures that appear (and possibly disappear) for different occupations in different geographic markets at different points during the transition period.

Selected Occupations

Engineering managers (Figure 10): This occupation has an older age profile, with a median age of 45 years in 2021[9]. A high recruitment gap is identified at the start of the ICEV-EV transition.

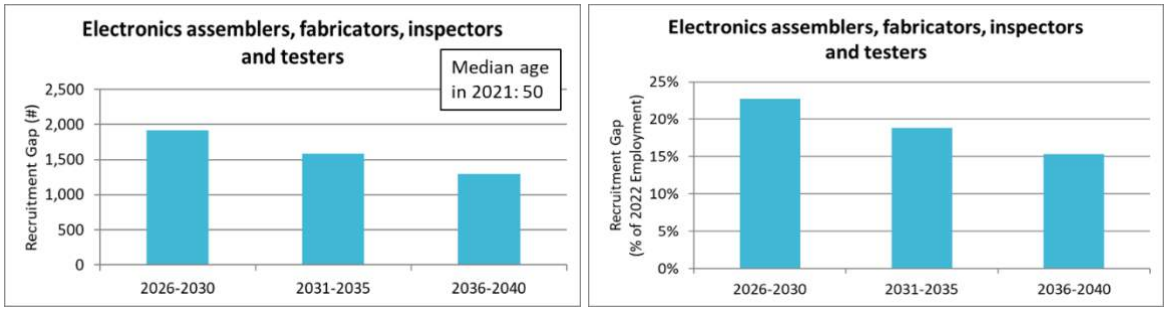
Figure 10. Recruitment gap - engineering managers



Electronics assemblers, fabricators, inspectors and testers (Figure 11): This occupation has a significantly older age profile, with a median age of 50 years. The recruitment gap peaks during the first interval of the ICEV-EV transition reflecting expansion demand as battery production comes online, as well as replacement demand from retirements. More than 20% of the 2022 base year employment will be needed to meet the increased demand during the 2026-2030 interval.

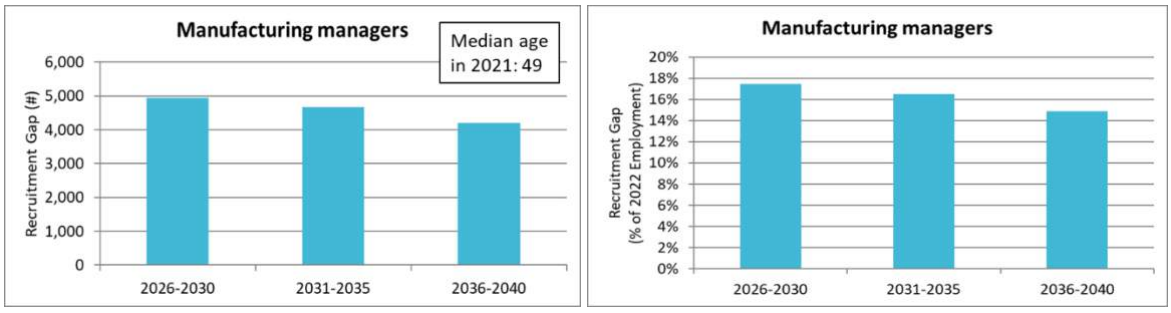
Figure 11. Recruitment gap – electronics assemblers, fabricators, inspectors and testers

[9] Median ages are calculated using 2021 Census data for each occupation in selected industries (see Appendix A for list of industries). The median age for all occupations in the selected industries is 42 years old in 2021.



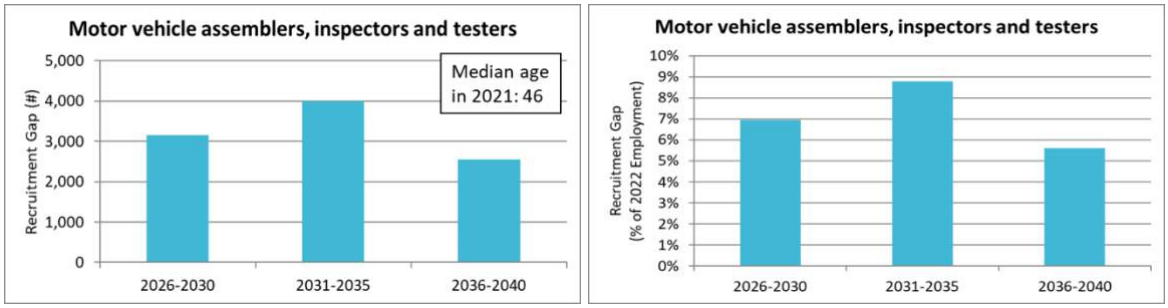
Manufacturing managers (Figure 12)*:* This occupation has a significantly older age profile, with a median age of 49 years. The recruitment gap peaks at the beginning of the ICEV-EV transition, reflecting increased expansion demand as well as increased replacement demand (as the higher-than-average number of older workers retire). The recruitment gap is among the largest for this occupation compared to other occupations. The impacts across the transition are a high proportion of the starting workforce, signalling added recruiting challenges.

Figure 12. Recruitment gap – manufacturing managers



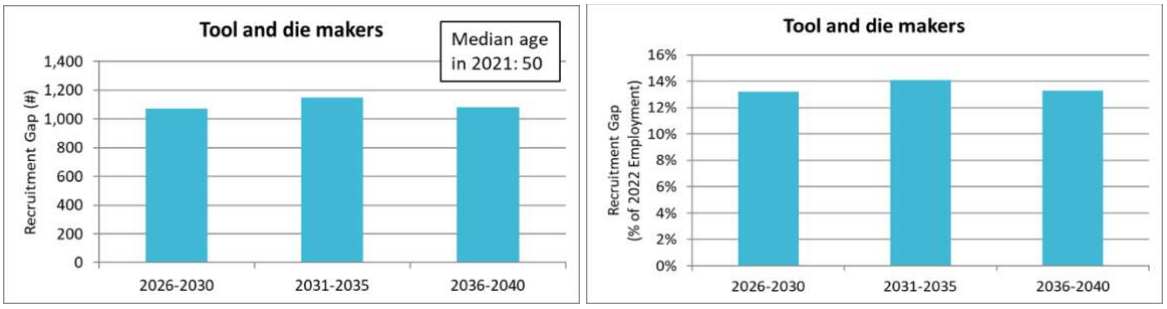
Motor vehicle assemblers, inspectors and testers (Figure 13)*:* This occupation has an older age profile, with a median age of 46 years. The recruitment gap is moderate at the beginning of the ICEV-EV transition, peaking during the 2031-2035 interval. The number of workers needed is quite high in absolute numbers, with the possibility for retraining ICE assemblers for EV assembly.

Figure 13. Recruitment gap – motor vehicle assemblers, inspectors and testers



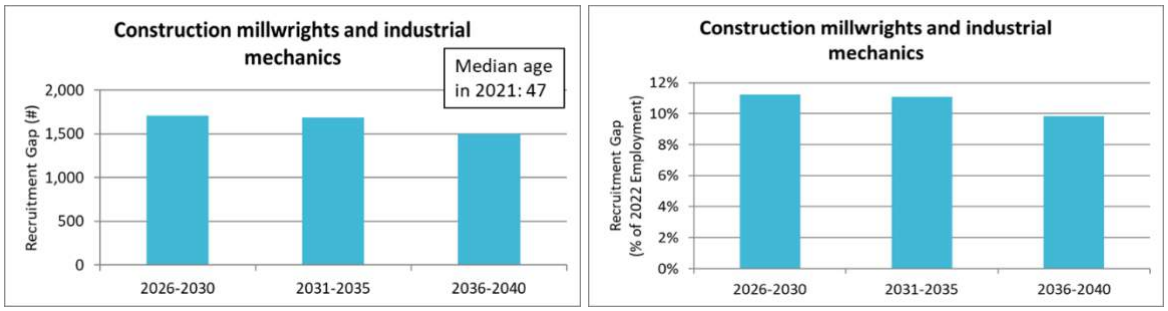
Tool and die makers (Figure 14)*:* This occupation has a significantly older age profile, with a median age of 50 years in 2021. Many of the oldest workers in this occupation will likely have retired in the earliest days of the ICEV-EV transition, possibly prior to 2025. The recruitment gap is high throughout the transition, peaking in the 2031-2035 interval. The impacts across the transition are a high proportion of the starting workforce, signalling added recruiting challenges

Figure 14. Recruitment gap – tool and die makers



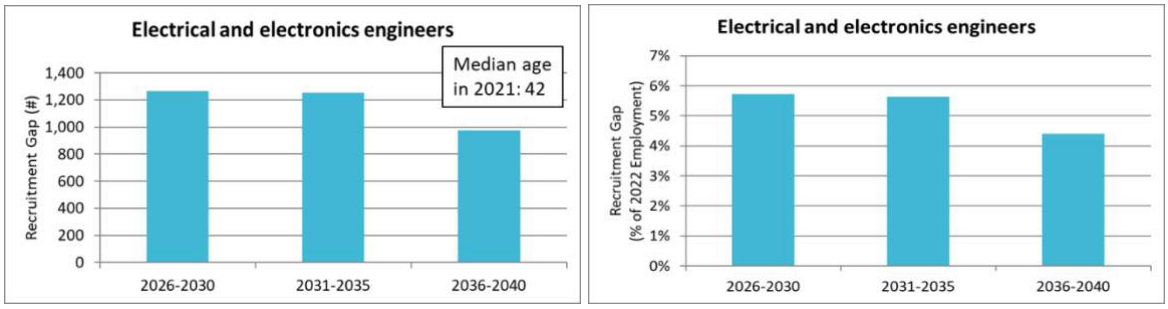
Construction millwrights and industrial mechanics (Figure 15)*:* This occupation has a much older age profile, with a median age of 47 years. The recruitment gap is high throughout most of the ICEV-EV transition, but abates during the final interval.

Figure 15. Recruitment gap – construction millwrights and industrial mechanics



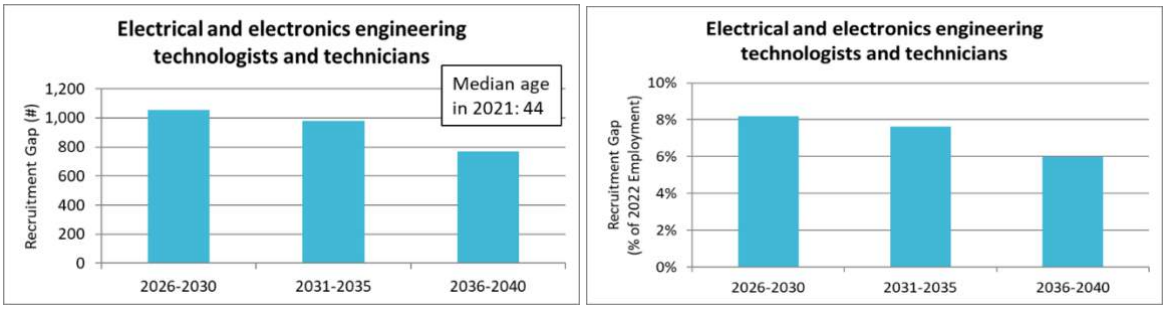
Electrical and electronics engineers (Figure 16)*:* This occupation has an age profile that is similar to the median age of all occupations in the industries that were selected for this occupational impact analysis, with a median age of 42 years. There is no peak in recruitment gap to indicate specific industry impacts at a particular time interval during the ICEV-EV transition.

Figure 16. Recruitment gap – electrical and electronics engineers



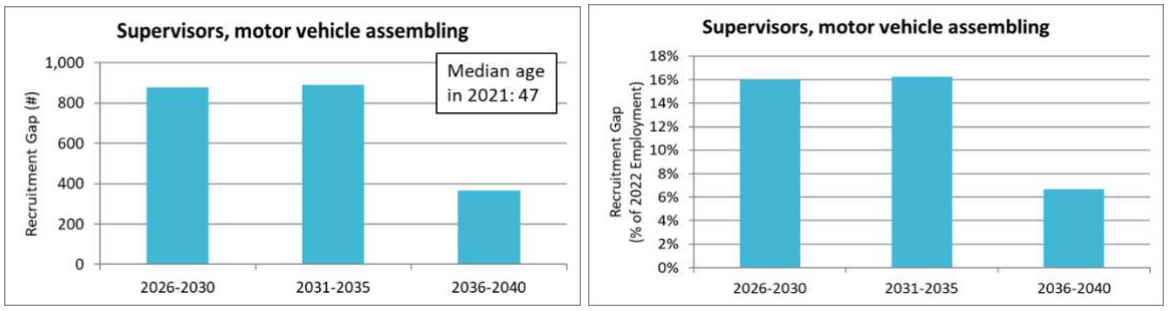
<u>*Electrical and electronics engineering technologists and technicians*</u> (Figure 17)*:* This occupation has a somewhat older age profile, with a median age of 44 years. There is a high recruitment gap at the start of the the ICEV-EV transition.

Figure 17. Recruitment gap – electrical and electronics engineering technologists and technicians



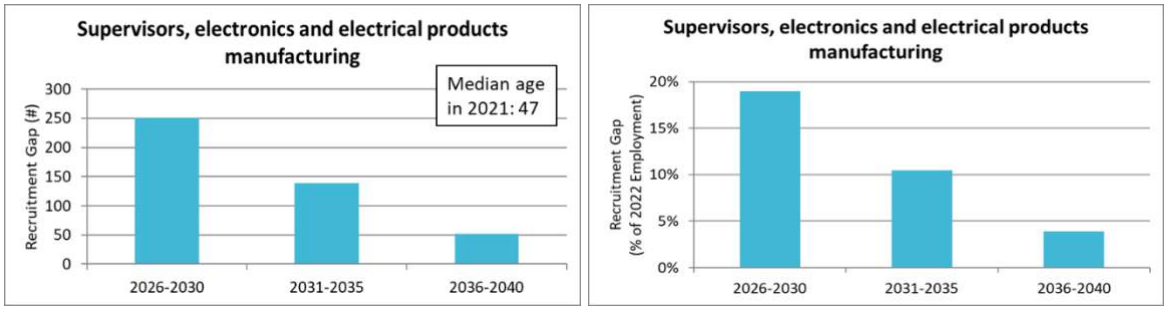
<u>*Supervisors, motor vehicle assembling*</u> (Figure 18)*:* This occupation has a noticably older age profile, with a median age of 47 years. The recruitment gap is high throughout much of the ICEV-EV transition, dissipating during the final interval. The impacts across the transition are a high proportion of the starting workforce, signalling added recruiting challenges.

Figure 18. Recruitment gap – supervisors, motor vehicle assembling



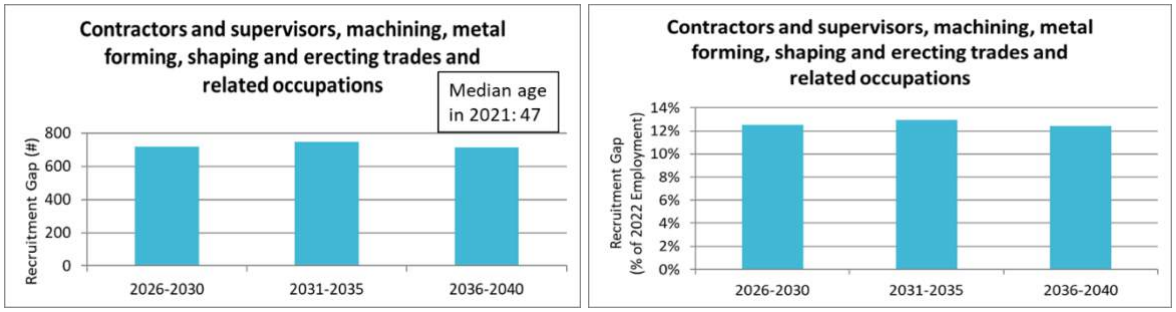
<u>*Supervisors, electronics and electrical products manufacturing*</u> (Figure 19)*:* This occupation has a noticably older age profile, with a median age of 47 years. The recruitment gap peaks during the first interval of the ICEV-EV transition and then tapers towards the end of the transition, reflecting early increased demand for this occupation.

Figure 19. Recruitment gap – supervisors, electronics and electrical products manufacturing



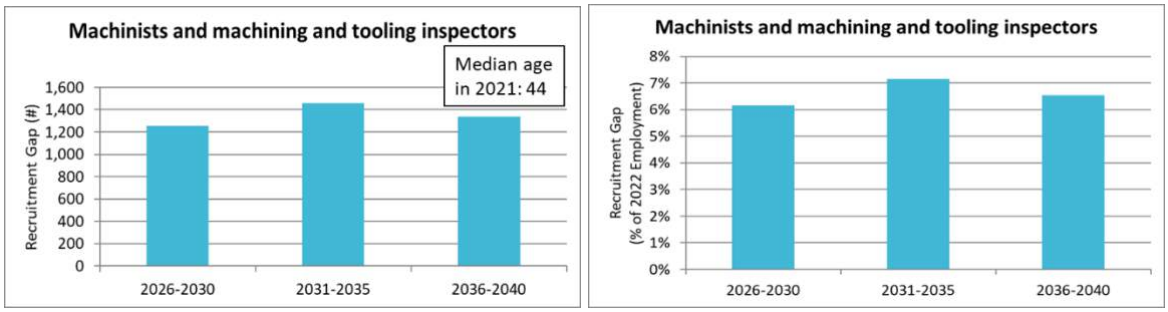
<u>*Contractors and supervisors, machining, metal forming, shaping and erecting trades and related occupations*</u> (Figure 20)*:* This occupation has a noticably older age profile, with a median age of 47 years. The recruitment gap is high throughout all intervals of the ICEV-EV transition. The impacts across the transition are a high proportion of the starting workforce, signalling added recruiting challenges.

Figure 20. Recruitment gap – contractors and supervisors, machining, metal forming, shaping and erecting trades and related occupations



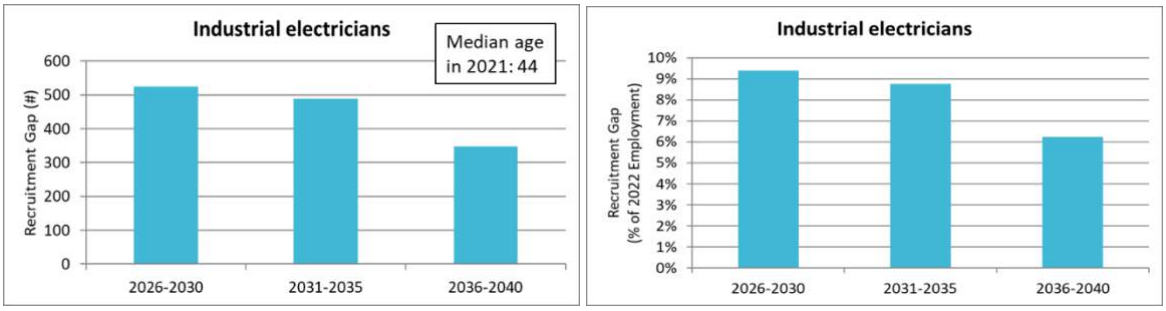
<u>*Machinists and machining and tooling inspectors*</u> (Figure 21)*:* This occupation has a slightly older age profile, with a median age of 44 years. The recruitment gap is high throughout all intervals of the ICEV-EV transition, peaking in the 2031-2035 interval.

Figure 21. Recruitment gap – machinists and machining and tooling inspectors



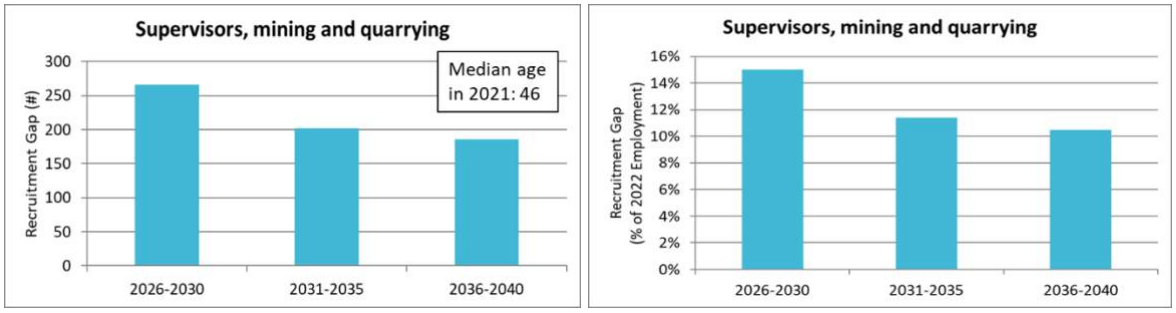
Industrial electricians (Figure 22)*:* This occupation has a older age profile, with a median age of 45 years. The recruitment gap is high throughout all intervals of the ICEV-EV transition, peaking in the 2026-2030 interval.

Figure 22. Recruitment gap – industrial electricians



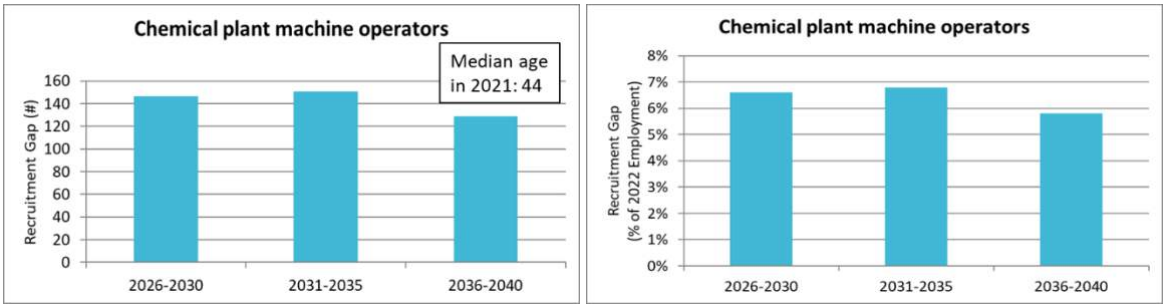
Supervisors, mining and quarrying (Figure 23)*:* This occupation has an older age profile, with a median age of 46 years. The recruitment gap is higher at the beginning of the ICEV-EV transition, reflecting increased expansion demand in the battery supply chain.

Figure 23. Recruitment gap – supervisors, mining and quarrying



Chemical plant machine operators (Figure 24)*:* This occupation has a somewhat older age profile, with a median age of 44 years. The recruitment gap is consistently high throughout the ICEV-EV transition.

Figure 24. Recruitment gap – chemical plant machine operators



Implications for Recruiting and Job Search

This section draws out some implications and trends in the findings. Results indicate that hiring challenges will be concentrated in engineering, skilled trades and assemblers. Results for these occupations, at the national level, certainly reflect the ICE to EV transition but skills shortages are also, in part, inherited from the past. This implies that recruitment gaps were high prior to transition intervals. The transition will aggravate an existing skills shortage situation and concentrate it in electrical related occupations.

Results also distribute the rising recruitment gap roughly equally across the three main transition intervals. Direct impacts, taken from the pattern of announced changes, signal a peak in employment, during the 2031 – 2035 interval, as this is the period of the largest gains in battery related production. The modest spike in national recruitment gaps in the 2031 – 2035 interval reflect only a muted peak but the impact of the battery plants is more apparent as the findings are reported on each region. These impacts will be set out in more detail in regional reports.

The impacts anticipated here reflect very different changes to employment and work conditions across industries and occupations. For most the fifteen occupations listed here, the impacts will include added new jobs, lost jobs in the ICEV supply chain and adding new skills as the workforce moves on to the EV related production. For managers, supervisors and assemblers in the assembly industry these impacts may be part of changing work conditions where existing assemblers will be able to transfer staff to new assembly lines. For managers, supervisors and assemblers in electronics assembly the impacts will be in new jobs and skills, often in new plants. For a relatively small workforce, mostly on the ICEV supply chain related to gasoline engines, transmissions, exhaust systems and a few other areas, the impacts will be lost employment.

A final, general observation about the results notes that recruitment gaps tend to be lower in the final 2036 - 2040 interval. This is related to two anticipated changes that span the transition. The first is the trend to higher productivity and lower vehicle and battery costs across the supply chain as the technologies and processes mature and global markets grow. These changes anticipate modest but long term declines in employment across the base case scenario. The second is the demographic trend to fewer retirements and lower age profiles in the later years of the transition as Baby Boomers leave the workforce.

Tracking these labour market changes invites further commentary on labour mobility that might result as variations in recruitment gaps emerge across regions, industries, and occupations. These opportunities for balancing markets are often not apparent at the national level where measures add regions and industries together. Reports on labour market impacts in specific regions highlight these possibilities. For example, quite distinct recruitment gaps are apparent across occupations and regions that signal the potential for mobility. FOCAL has prepared skills transferability matrices (STMs) that track the potential for filling openings in occupations with a

skills shortage with candidates from related occupations with similar skills profiles[10]. Readers are invited to review FOCAL finding for the matrices on the website: www.futureautolabourforce.ca. More specific examples of opportunities for recruiters and job seekers related to skills transferability are highlighted in the regional reports. The STMs will assist all stakeholders in engaging in the transitioning of workers to other occupations and sectors in the event of technological changes and economic disruptions.

Focal findings offer a similar insight into the potential for inter-regional labour mobility across occupations as differences in recruitment gaps emerge in the regional analysis.

[10] FOCAL has developed Skills Transferability Matrices (STMs) using artificial intelligence (AI) and complex algorithms for occupations in the sector to help identify transferable skills, tasks, technical knowledge and abilities across other occupations and sectors.

Conclusions and Implications

The ICEV – EV transition, in the base case scenario, will create disruptions in labour markets for at least fifteen occupations. Recruiting challenges will emerge in these labour markets, with the peak challenges concentrated between 2026 and 2035 as EV assembly builds to a peak and new battery and related supply production comes on stream. Recruiting for engineering, skilled trades and assembly occupations will face skills challenges and general shortages. In many cases, the ICE-EV transition demands arrive when markets are already challenged by, among other things, high levels of retirements.

The actual nature of these impacts will vary. Occupations with older age profiles are almost certainly already candidates for HR programs that focus on retention, succession and training in new technologies and work supervision. One challenge will be filing new jobs created in the new battery cell, module and related supplier production where, in some cases, unique skills and training will define entirely new occupations. At the other extreme that will be lost jobs in gasoline engine, transmission and related manufacturing across the ICEV supply chain. This will create a small be important source of job seekers with important experience, but possible needs to upgrade training.

Another area will be occupations in vehicle assembly where jobs might be transferred across existing processes from ICE to new EV production perhaps even in the same company or facility. One example of change will be the addition of work assembling battery modules into battery packs – likely in or close to final assembly.

Labour market shifts in all these areas, industries and occupations will have skill, training qualification and geographic dimensions. Thus, recruiters and job seekers may find themselves in proximity to jobs and candidates in nearby regions or related occupations having transferable skills and experience. FOCAL II regional labour market reports for four provinces and seven regions will consider these possibilities as they dig deeper into these dimensions and reveal important variations across the ICE-EV transition.

This national report summarizes the scope and scale of the transition as we see a total addition of 21,000 jobs across the transition (see Figure 7 from earlier in this report). In this base case scenario, with cautious assumptions about the transition, the number of jobs created exceeds the number lost. Labour market challenges in this case will prompt recruitment gaps to emerge across the country as the transition from 2025 to 2040 unfolds.

These challenges are spread across many occupations and regions. Seeing this many specific HR challenges clarifies the critical impact of the ICE-EV transition. These changes are both a risk and a reward. HR risks are not new to Canadian manufacturing, but the scale of EV related changes may raise these risks to new, higher levels. But there is a major reward here as the transition, as represented in the base case scenario, will leave Canada in 2040 with a larger and almost completely adapted automotive vehicle industry. Other FOCAL II scenarios show more

dramatic success as Canadian assembly of EVs increases its share of markets and a larger and longer supply chain reaches back to new mining potential. This is, after all, Canada's second most important export industry and circumstances described here confirm its emergence as a new and global force.

Appendices

Appendix A – Industries Analyzed in the Labour Market Impact Model

Table 3. List of industries analyzed in the labour market impact model, with NAICS industry codes

Industry (NAICS Code)
2122 Metal ore mining
2123 Non-metallic mineral mining and quarrying
3132 Fabric Mills
3133 Textile and Fabric Finishing and Fabric Coating Mills
3251 Basic chemical manufacturing
3252 Resin, Synthetic Rubber, and Artificial and Synthetic Fibers and Filaments Manufacturing
3255 Paint, coating and adhesive manufacturing
3259 Other chemical product manufacturing
3261 Plastic product manufacturing
3262 Rubber product manufacturing
3272 Glass and glass product manufacturing
3279 Other non-metallic mineral product manufacturing
3311 Iron and steel mills and ferro-alloy manufacturing
3312 Steel product manufacturing from purchased steel
3313 Alumina and aluminum production and processing
3314 Non-ferrous metal (except aluminum) production and processing
3315 Foundries
3321 Forging and stamping
3322 Cutlery and hand tool manufacturing
3323 Architectural and structural metals manufacturing
3325 Hardware manufacturing
3326 Spring and Wire Product Manufacturing
3327 Machine shops, turned product, and screw, nut and bolt manufacturing
3328 Coating, engraving, cold and heat treating and allied activities
3329 Other fabricated metal product manufacturing
3335 Metalworking machinery manufacturing
3341 Computer and peripheral equipment manufacturing
3342 Communications equipment manufacturing
3344 Semiconductor and other electronic component manufacturing
3345 Navigational, measuring, medical and control instruments manufacturing
3351 Electric lighting equipment manufacturing
3353 Electrical equipment manufacturing
3359 Other electrical equipment and component manufacturing
3361 Motor vehicle manufacturing:
336110 - Automobile and light Duty Motor Vehicle Manufacturing
336120 - Heavy-duty truck manufacturing
3363 Motor vehicle parts manufacturing:

Industry (NAICS Code)
336310 - Motor vehicle gasoline engine and engine parts manufacturing
336320 - Motor vehicle electrical and electronic equipment manufacturing
336330 - Motor vehicle steering and suspension components (except spring) manufacturing
336340 - Motor vehicle brake system manufacturing
336350 - Motor vehicle transmission and power train parts manufacturing
336360 - Motor vehicle seating and interior trim manufacturing
336370 - Motor vehicle metal stamping
336390 - Other motor vehicle parts manufacturing
415 Motor vehicle and motor vehicle parts and accessories merchant wholesalers
4173 Computer and communications equipment and supplies merchant wholesalers
4931 Warehousing and storage
5413 Architectural, engineering and related services
5415 Computer systems design and related services
5416 Management, scientific and technical consulting services

Appendix B – Occupations Analyzed in the Labour Market Impact Model

Table 4. List of occupations analyzed in the labour market impact model (Canada)

NOC Code	Occupation
11200	Human resources professionals
13201	Production and transportation logistics coordinators
14400	Shippers and receivers
14402	Production logistics workers
20010	Engineering managers
20012	Computer and information systems managers
21101	Chemists
21211	Data scientists
21220	Cybersecurity specialists
21221	Business systems specialists
21222	Information systems specialists
21223	Database analysts and data administrators
21230	Computer systems developers and programmers
21231	Software engineers and designers
21232	Software developers and programmers
21233	Web designers
21234	Web developers and programmers
21301	Mechanical engineers
21310	Electrical and electronics engineers
21311	Computer engineers (except software engineers and designers)
21320	Chemical engineers
21321	Industrial and manufacturing engineers
21322	Metallurgical and materials engineers
21330	Mining Engineers
22100	Chemical technologists and technicians
22220	Computer network and web technicians
22222	Information systems testing technicians
22301	Mechanical engineering technologists and technicians
22302	Industrial engineering and manufacturing technologists and technicians
22310	Electrical and electronics engineering technologists and technicians
22312	Industrial instrument technicians and mechanics
72010	Contractors and supervisors, machining, metal forming, shaping and erecting trades and related occupations
72020	Contractors and supervisors, mechanic trades
72100	Machinists and machining and tooling inspectors
72101	Tool and die makers

NOC Code	Occupation
72106	Welders and related machine operators
72200	Electricians (except industrial and power system)
72201	Industrial electricians
72400	Construction millwrights and industrial mechanics
72410	Automotive service technicians, truck and bus mechanics and mechanical repairers
73300	Transport truck drivers
73400	Heavy equipment operators
75101	Material handlers
82020	Supervisors, mining and quarrying
83100	Underground production and development miners
84100	Underground mine service and support workers
90010	Manufacturing managers
92020	Supervisors, motor vehicle assembling
92021	Supervisors, electronics and electrical products manufacturing
92024	Supervisors, other products manufacturing and assembly
93100	Central control and process operators, mineral and metal processing
93101	Central control and process operators, petroleum, gas and chemical processing
94100	Machine operators, mineral and metal processing
94101	Foundry workers
94104	Inspectors and testers, mineral and metal processing
94105	Metalworking and forging machine operators
94106	Machining tool operators
94110	Chemical plant machine operators
94111	Plastics processing machine operators
94200	Motor vehicle assemblers, inspectors and testers
94201	Electronics assemblers, fabricators, inspectors and testers
94203	Assemblers, fabricators and inspectors, industrial electrical motors and transformers
94204	Mechanical assemblers and inspectors
94212	Plastic products assemblers, finishers and inspectors
94213	Industrial painters, coaters and metal finishing process operators
95100	Labourers in mineral and metal processing
95102	Labourers in chemical products processing and utilities
95109	Other labourers in processing, manufacturing and utilities

Appendix C– Methodology Notes

There are three distinct research steps needed to provide accurate and detailed impacts that span the supply chain, industries and occupations.

1. New EV production
2. Economic impacts across the supply chain
3. Labour market impacts by region and occupation

1. New EV production

The FOCAL II EV Transition report presents a detailed analysis of new EV production. This includes careful review of the supply chain for EV assembly, battery technology and of announced plans for new battery production facilities and related changes in the supply chain. The review spans the supply chain; reaching upstream to chemical manufacturing, mineral processing and mining potential. In addition, the analysis tracks the related decline in assembling ICEV. The timing and magnitude of new production and shifts in the supply chain have been set out with alternative scenarios that reflect possible future outcomes.

The new EV production analysis estimates specific changes expected in industries spanning four stages in the supply chain for assembled motor vehicles, as illustrated in Figure 25.

Figure 25. The EV supply chain

The second step in the research assesses how these specific and direct changes to industrial activity will impact the broader automotive industry, its supply chain and the overall economy.

2. Economic impacts across the supply chain

At this stage the analysis calculates broader estimates of impacts on industry output and employment across the entire economy with detail set out for 55 selected industries in 10 regions and three provinces. Results in this second stage are impacts on industry employment – the key driver for labour market impacts.

Specific changes, estimated for the four stages and ten industries established in the EV Production analysis, are translated into broader economic measures using the system of Input-Output Tables. These tables are an economy wide accounting system that measures transactions connecting industries and customers. These are produced annually for Canada and the provinces/territories covering over 250 industries and 180 types of final customers.
Input-output (IO) tables are prepared by Statistics Canada as part of the system of national accounts. Calculations draw on surveys and economic statistics each year to update the detailed pattern of purchases and sales that link activity and spread the impact of changes across the economy. Annual measures track the pattern of each industry's purchases from suppliers and sales to both other "downstream" industries and final purchasers (e.g. exports, investments, government spending, and household consumption).

The tables are converted into an IO model that can be used to calculate the impacts of changes across the economy. The FOCAL II research creates new versions of these national and provincial IO models to estimate the impacts of the new EV production changes described in the first research stage. Specific changes are taken from the new EV production analysis and applied in the IO models. For example, the IO model analysis is based on;

1. new production levels for EVs and ICEVs in the assembly industry
2. new production levels for internal combustion engines
3. a new pattern of suppliers to the assembly industry
4. new production levels announced for battery plants
5. a new pattern of suppliers to battery production
6. new production levels announced for chemical, mineral and mining production

These changes are described as "direct" impacts that will be introduced into the economy at a specific time and place in the transition from ICEV to Evs. The magnitude and timing of direct impacts are different in each scenario.

Each direct impact prompts a series of indirect impacts across the economy as the pattern of purchases and sales changes according to the structure of the economy set out in the IO tables. A final round of induced impacts are included as the IO model tracks the changes in household income and the associated change in expenditures.

Finally, the IO model totals the direct, indirect and induced impacts on employment in each industry. These employment impacts are the key drivers for labour market analysis.
It is important to note some features of IO models that need to be reflected in the interpretation of findings. First, given the complexity of these models, there is a time lag in the release of tables such that, at the time of FOCAL II research, the most up to date IO data for Canada and the provinces was from 2019. Advanced features in our system allowed for the addition of base year data for 2022. Also, IO models do not contain measures of the production capacity of individual industries and calculated impacts are not constrained. This is important in, for example, the analysis of the impacts of the transition across Canada's mining and mineral processing industries. Finally, IO impacts calculated in the models are not time specific. Thus, the EV

production analysis, at the first research stage, sets out specific assumptions of the scheduling of the start and completion of new activity across the transition from 2025 to 2040.

3. *Labour market impacts by occupation and region*

Regional Labour Market reports provide analysis of the labour market impacts, including measures of market conditions for approximately 70 occupations[11]. These results are linked to further labour market and human resource management implications and related conditions in training, immigration, apprenticeship, diversity and other areas. This analysis assesses the likelihood of skill and labour shortages and other market imbalances in specific occupations and regions as the transition from ICEV to EV progresses.

Labour market models track both patterns of hiring and labour demand as well as elements of labour supply. Three broad components of employment and hiring are identified; expansion demand, replacement demand and recruitment gaps.

Expansion Demand

Expansion demand is defined by the employment impacts generated by the IO model analysis described above. These impacts are linked to the direct industry changes associated with the transitions from ICEV to EV in the selected industries and the broader economy. Employment changes by industry are spread across the transition interval from 2025 to 2040 and are specific to each transition scenario. These impacts are intended to highlight labour market disruptions. Expansion demand for each occupation was determined by taking the overall employment forecast by industry and transforming that forecast from the industry level to the occupation level within each industry.

The transformation from industry impacts to occupation impacts was accomplished by using industry (NAICS) and occupation (NOC) data from the 2021 Census.

Replacement Demand

Labour market conditions for each occupation and region will depend on other factors. The most critical of these are the demographic trends that are working their way through the economy. This includes the aging of the population, immigration and other factors. To capture these effects, a measure is added for replacement demand or estimates of retirement and mortality by occupation and region.

Final replacement demand changes were based on summing occupational estimates of labour force exits due to retirements and deaths across every age-year between 15 and 69 years.

[11] Findings for occupations with base year employment of less than one thousand (for national results) or less than one hundred (for provincial and regional results) are suppressed due to data reliability concerns.

Mortality and exit rates were available from Statistics Canada at the national and provincial level. Regional estimates incorporate provincial mortality and exit rate data, based on availability of data. Mortality and exit rates were applied to the existing single-year demographic profile by occupation by industry.

Labour market conditions were summarized by these measures to provide signals of possible skill and labour shortages across the transition in each occupation and region.

New Entrants

A similar demographic trend is captured with a measure of new entrants. Also linked to demographics and participation, this measure captures the effect of young entrants and the more volatile effects of immigration.

Total new entrants by province were based on historic data and projections of total population and labour force participation rates. Population projections were taken from Statistics Canada population projection data. Labour force participation rates were assumed to remain equal to 2022 levels for the transition period.

Recruitment Gaps

The recruitment gap comprises the interaction of three different labour market supply and demand components: expansion demand, replacement demand, and new entrant dynamics.

The recruitment gap is defined as;

Recruitment Gap = Expansion Demand plus Replacement Demand less New Entrants

The recruitment gap was calculated for 68 selected occupations in 49 industries in the national analysis (see Appendix A and B, respectively). As noted in the report, it represents expansion demand plus replacement demand less new entrants.

Other Methodology Notes

2022 Base Year Employment

The base year for the forecast was 2022. Although problematic due to COVID-related labour market adjustments from 2020 to 2023, it was the most recent year in which complete data on employment by industry was available. Base year employment was determined using multiple data sources, including Statistics Canada, APRC, Metro Economics, and Prism Economics and Analysis.

Occupation Age Profiles

Single-year age profiles (by occupation and by industry) were produced from 2021 Census data. Census data was collected during May 2021, in the midst of COVID-related labour market disruptions.

Appendix D – Detailed Results

This Appendix contains detailed tables of occupational impacts for each component of the recruitment gap: expansion demand (Table 5), replacement demand (Table 6), and new entrants (Table 7). These are followed by tables that show recruitment gaps expressed as headcounts (Table 8) and as a percentage of 2022 base year employment (Table 9).

Expansion Demand

Expansion demand impacts reflect the direct industry changes associated with the transitions from ICEV to EV in the selected industries and the broader economy. Values for each column in Table 7 are expressed as expansion demand relative to 2022 base year employment.

Table 5. Expansion demand – detailed results

Expansion Demand	2026-30	2031-35	2036-40	2025-40
11200 Human resources professionals	60	30	-20	60
13201 Production & transportation logistics coordinators	140	50	-50	120
14400 Shippers & receivers	290	110	-110	250
14402 Production logistics workers	40	10	-10	30
20010 Engineering managers	200	60	-60	190
20012 Computer & information systems managers	90	30	-30	80
21101 Chemists	50	10	-20	40
21211 Data scientists	10	0	0	10
21220 Cybersecurity specialists	0	0	0	10
21221 Business systems specialists	10	10	0	0
21222 Information systems specialists	80	40	-20	80
21223 Database analysts & data administrators	10	0	0	10
21230 Computer systems developers & programmers	40	20	-10	40
21231 Software engineers & designers	110	70	-30	130
21232 Software developers & programmers	120	50	-30	130
21233 Web designers	0	0	0	0
21234 Web developers & programmers	30	10	-10	30
21301 Mechanical engineers	500	200	-160	480
21310 Electrical & electronics engineers	470	140	-130	490
21311 Computer engineers (except software engineers & designers)	40	10	-10	40
21320 Chemical engineers	130	20	-40	100
21321 Industrial & manufacturing engineers	160	70	-60	150
21322 Metallurgical & materials engineers	10	0	-10	10

Expansion Demand	2026-30	2031-35	2036-40	2025-40
21330 Mining Engineers	20	0	-10	10
22100 Chemical technologists & technicians	50	10	-20	40
22220 Computer network & web technicians	60	20	-20	50
22222 Information systems testing technicians	0	0	0	0
22301 Mechanical engineering technologists & technicians	170	70	-60	140
22302 Industrial engineering & manufacturing technologists & technicians	150	50	-60	110
22310 Electrical & electronics engineering technologists & technicians	380	100	-110	380
22312 Industrial instrument technicians & mechanics	20	0	0	20
72010 Contractors & supervisors, machining, metal forming, shaping & erecting trades & related occupations	40	20	-10	30
72020 Contractors & supervisors, mechanic trades	20	10	-10	20
72100 Machinists & machining & tooling inspectors	120	60	-60	90
72101 Tool & die makers	40	30	-40	-10
72106 Welders & related machine operators	240	120	-90	220
72200 Electricians (except industrial & power system)	50	20	-10	50
72201 Industrial electricians	190	80	-60	180
72400 Construction millwrights & industrial mechanics	270	80	-110	200
72410 Automotive service technicians, truck & bus mechanics & mechanical repairers	90	90	-30	100
73300 Transport truck drivers	110	40	-40	90
73400 Heavy equipment operators	120	0	-40	90
75101 Material handlers	520	230	-190	470
82020 Supervisors, mining & quarrying	70	0	-20	50
83100 Underground production & development miners	140	-10	-40	90
84100 Underground mine service & support workers	40	0	-10	30
90010 Manufacturing managers	650	230	-220	590
92020 Supervisors, motor vehicle assembling	500	440	-90	680
92021 Supervisors, electronics & electrical products manufacturing	170	40	-50	170
92024 Supervisors, other products manufacturing & assembly	20	10	-10	20
93100 Central control & process operators, mineral & metal processing	10	0	0	10

Expansion Demand	2026-30	2031-35	2036-40	2025-40
93101 Central control & process operators, petroleum, gas & chemical processing	140	20	-50	120
94100 Machine operators, mineral & metal processing	100	10	-40	70
94101 Foundry workers	-30	-30	-20	-80
94104 Inspectors & testers, mineral & metal processing	20	0	-10	10
94105 Metalworking & forging machine operators	60	20	-30	40
94106 Machining tool operators	50	20	-30	20
94110 Chemical plant machine operators	40	10	-10	30
94111 Plastics processing machine operators	60	50	-30	50
94200 Motor vehicle assemblers, inspectors & testers	890	1,040	-420	800
94201 Electronics assemblers, fabricators, inspectors & testers	570	110	-180	520
94203 Assemblers, fabricators & inspectors, industrial electrical motors & transformers	160	80	-10	240
94204 Mechanical assemblers & inspectors	120	90	-30	140
94212 Plastic products assemblers, finishers & inspectors	10	10	-10	10
94213 Industrial painters, coaters & metal finishing process operators	100	70	-30	120
95100 Labourers in mineral & metal processing	40	0	-20	20
95102 Labourers in chemical products processing & utilities	60	20	-20	60
95109 Other labourers in processing, manufacturing & utilities	480	150	-170	430

Replacement Demand

Replacement demand represents occupational estimates of labour force exits due to retirements and deaths across every age-year between 15 and 69 years. Values for each column in Table 8 are expressed as replacement demand relative to 2022 base year employment.

Table 6. Replacement demand – detailed results

Replacement Demand	2026-30	2031-35	2036-40	2025-40
11200 Human resources professionals	1,480	1,490	1,490	4,460
13201 Production & transportation logistics coordinators	810	820	820	2,460
14400 Shippers & receivers	3,470	3,500	3,500	10,470
14402 Production logistics workers	160	160	160	490
20010 Engineering managers	1,780	1,800	1,800	5,380
20012 Computer & information systems managers	2,760	2,770	2,770	8,290
21101 Chemists	400	400	400	1,210
21211 Data scientists	120	120	120	350
21220 Cybersecurity specialists	310	310	310	920
21221 Business systems specialists	780	780	780	2,350
21222 Information systems specialists	5,520	5,530	5,530	16,580
21223 Database analysts & data administrators	580	580	580	1,740
21230 Computer systems developers & programmers	1,230	1,230	1,230	3,680
21231 Software engineers & designers	2,340	2,340	2,340	7,030
21232 Software developers & programmers	2,220	2,230	2,230	6,680
21233 Web designers	300	300	300	910
21234 Web developers & programmers	990	990	990	2,980
21301 Mechanical engineers	2,830	2,860	2,860	8,540
21310 Electrical & electronics engineers	2,960	3,000	3,000	8,960
21311 Computer engineers (except software engineers & designers)	1,000	1,010	1,010	3,010
21320 Chemical engineers	490	490	490	1,470
21321 Industrial & manufacturing engineers	760	770	770	2,300
21322 Metallurgical & materials engineers	150	150	150	460
21330 Mining Engineers	150	150	150	460
22100 Chemical technologists & technicians	440	450	450	1,340
22220 Computer network & web technicians	1,260	1,260	1,260	3,780
22222 Information systems testing technicians	240	240	240	730
22301 Mechanical engineering technologists & technicians	1,540	1,550	1,550	4,630
22302 Industrial engineering & manufacturing technologists & technicians	940	960	960	2,860
22310 Electrical & electronics engineering technologists & technicians	2,050	2,080	2,080	6,210
22312 Industrial instrument technicians & mechanics	240	240	240	730

Replacement Demand	2026-30	2031-35	2036-40	2025-40
72010 Contractors & supervisors, machining, metal forming, shaping & erecting trades & related occupations	1,010	1,010	1,010	3,030
72020 Contractors & supervisors, mechanic trades	310	310	310	940
72100 Machinists & machining & tooling inspectors	3,000	3,020	3,020	9,040
72101 Tool & die makers	1,600	1,600	1,600	4,800
72106 Welders & related machine operators	3,130	3,150	3,150	9,430
72200 Electricians (except industrial & power system)	170	170	170	520
72201 Industrial electricians	780	790	790	2,360
72400 Construction millwrights & industrial mechanics	2,540	2,570	2,570	7,680
72410 Automotive service technicians, truck & bus mechanics & mechanical repairers	910	920	930	2,770
73300 Transport truck drivers	2,170	2,180	2,180	6,530
73400 Heavy equipment operators	640	650	650	1,940
75101 Material handlers	6,940	6,980	6,980	20,890
82020 Supervisors, mining & quarrying	260	260	260	780
83100 Underground production & development miners	380	390	380	1,150
84100 Underground mine service & support workers	120	120	120	370
90010 Manufacturing managers	5,010	5,070	5,070	15,160
92020 Supervisors, motor vehicle assembling	620	680	700	2,000
92021 Supervisors, electronics & electrical products manufacturing	210	220	220	660
92024 Supervisors, other products manufacturing & assembly	120	120	120	350
93100 Central control & process operators, mineral & metal processing	140	140	140	410
93101 Central control & process operators, petroleum, gas & chemical processing	360	370	370	1,100
94100 Machine operators, mineral & metal processing	670	680	680	2,030
94101 Foundry workers	240	240	240	730
94104 Inspectors & testers, mineral & metal processing	180	180	180	550
94105 Metalworking & forging machine operators	1,110	1,120	1,110	3,340
94106 Machining tool operators	860	870	860	2,590
94110 Chemical plant machine operators	330	330	330	990
94111 Plastics processing machine operators	2,020	2,030	2,030	6,080
94200 Motor vehicle assemblers, inspectors & testers	6,930	7,050	7,080	21,060

Replacement Demand	2026-30	2031-35	2036-40	2025-40
94201 Electronics assemblers, fabricators, inspectors & testers	1,970	2,030	2,030	6,030
94203 Assemblers, fabricators & inspectors, industrial electrical motors & transformers	250	270	270	790
94204 Mechanical assemblers & inspectors	340	350	350	1,040
94212 Plastic products assemblers, finishers & inspectors	620	620	620	1,860
94213 Industrial painters, coaters & metal finishing process operators	820	830	830	2,490
95100 Labourers in mineral & metal processing	620	620	620	1,870
95102 Labourers in chemical products processing & utilities	550	550	550	1,650
95109 Other labourers in processing, manufacturing & utilities	3,190	3,220	3,220	9,630

New Entrants

This measure captures the movement of young people into the labour force as well as immigration.

Table 7. New entrants – detailed results

New Entrants	2026-30	2031-35	2036-40	2025-40
11200 Human resources professionals	1,230	1,070	1,070	3,630
13201 Production & transportation logistics coordinators	780	680	680	2,310
14400 Shippers & receivers	2,450	2,130	2,130	7,220
14402 Production logistics workers	220	190	190	650
20010 Engineering managers	610	530	540	1,820
20012 Computer & information systems managers	1,110	960	960	3,280
21101 Chemists	430	370	370	1,270
21211 Data scientists	790	690	690	2,340
21220 Cybersecurity specialists	440	380	380	1,290
21221 Business systems specialists	720	620	620	2,130
21222 Information systems specialists	3,140	2,720	2,720	9,250
21223 Database analysts & data administrators	420	360	370	1,240
21230 Computer systems developers & programmers	2,070	1,790	1,790	6,090
21231 Software engineers & designers	5,430	4,690	4,700	15,980
21232 Software developers & programmers	6,580	5,690	5,700	19,370

New Entrants	2026-30	2031-35	2036-40	2025-40
21233 Web designers	900	780	780	2,650
21234 Web developers & programmers	3,970	3,430	3,430	11,690
21301 Mechanical engineers	3,180	2,780	2,780	9,420
21310 Electrical & electronics engineers	2,160	1,890	1,900	6,410
21311 Computer engineers (except software engineers & designers)	770	670	670	2,270
21320 Chemical engineers	650	570	570	1,930
21321 Industrial & manufacturing engineers	950	830	830	2,800
21322 Metallurgical & materials engineers	210	180	180	610
21330 Mining Engineers	170	140	140	490
22100 Chemical technologists & technicians	380	330	330	1,130
22220 Computer network & web technicians	1,720	1,490	1,490	5,060
22222 Information systems testing technicians	810	700	700	2,390
22301 Mechanical engineering technologists & technicians	1,450	1,260	1,260	4,280
22302 Industrial engineering & manufacturing technologists & technicians	820	720	720	2,430
22310 Electrical & electronics engineering technologists & technicians	1,370	1,200	1,200	4,070
22312 Industrial instrument technicians & mechanics	210	180	180	620
72010 Contractors & supervisors, machining, metal forming, shaping & erecting trades & related occupations	320	280	280	950
72020 Contractors & supervisors, mechanic trades	260	230	230	770
72100 Machinists & machining & tooling inspectors	1,870	1,620	1,620	5,520
72101 Tool & die makers	560	480	480	1,650
72106 Welders & related machine operators	3,090	2,680	2,690	9,120
72200 Electricians (except industrial & power system)	290	250	250	850
72201 Industrial electricians	440	390	390	1,310
72400 Construction millwrights & industrial mechanics	1,110	960	960	3,270
72410 Automotive service technicians, truck & bus mechanics & mechanical repairers	860	750	760	2,550
73300 Transport truck drivers	710	620	620	2,100
73400 Heavy equipment operators	490	430	430	1,450
75101 Material handlers	7,720	6,700	6,710	22,780
82020 Supervisors, mining & quarrying	60	50	50	180

New Entrants	2026-30	2031-35	2036-40	2025-40
83100 Underground production & development miners	320	280	280	950
84100 Underground mine service & support workers	150	130	130	450
90010 Manufacturing managers	730	640	640	2,170
92020 Supervisors, motor vehicle assembling	250	230	240	780
92021 Supervisors, electronics & electrical products manufacturing	130	120	120	400
92024 Supervisors, other products manufacturing & assembly	140	120	120	400
93100 Central control & process operators, mineral & metal processing	150	130	130	430
93101 Central control & process operators, petroleum, gas & chemical processing	470	410	410	1,390
94100 Machine operators, mineral & metal processing	600	520	520	1,770
94101 Foundry workers	220	190	190	660
94104 Inspectors & testers, mineral & metal processing	180	160	160	530
94105 Metalworking & forging machine operators	840	730	730	2,470
94106 Machining tool operators	600	520	520	1,760
94110 Chemical plant machine operators	220	190	190	640
94111 Plastics processing machine operators	1,180	1,030	1,030	3,490
94200 Motor vehicle assemblers, inspectors & testers	4,670	4,090	4,120	13,880
94201 Electronics assemblers, fabricators, inspectors & testers	620	560	550	1,870
94203 Assemblers, fabricators & inspectors, industrial electrical motors & transformers	170	160	160	530
94204 Mechanical assemblers & inspectors	350	310	310	1,040
94212 Plastic products assemblers, finishers & inspectors	440	380	380	1,300
94213 Industrial painters, coaters & metal finishing process operators	720	630	630	2,140
95100 Labourers in mineral & metal processing	690	600	600	2,040
95102 Labourers in chemical products processing & utilities	570	500	500	1,700
95109 Other labourers in processing, manufacturing & utilities	2,710	2,370	2,370	8,020

Recruitment Gap (#)

The recruitment gap is defined as expansion demand plus replacement demand less new entrants. Values for each column in Table 10 are expressed as the recruitment gap relative to 2022 base year employment.

Table 8. Recruitment gap (#) – detailed results

Recruitment Gap (#)	2026-30	2031-35	2036-40
11200 Human resources professionals	310	450	400
13201 Production & transportation logistics coordinators	180	190	90
14400 Shippers & receivers	1,320	1,480	1,260
14402 Production logistics workers	<10	<10	<10
20010 Engineering managers	1,370	1,320	1,200
20012 Computer & information systems managers	1,730	1,830	1,770
21101 Chemists	20	40	10
21211 Data scientists	<10	<10	<10
21220 Cybersecurity specialists	<10	<10	<10
21221 Business systems specialists	70	170	160
21222 Information systems specialists	2,460	2,850	2,790
21223 Database analysts & data administrators	160	220	210
21230 Computer systems developers & programmers	<10	<10	<10
21231 Software engineers & designers	<10	<10	<10
21232 Software developers & programmers	<10	<10	<10
21233 Web designers	<10	<10	<10
21234 Web developers & programmers	<10	<10	<10
21301 Mechanical engineers	140	280	<10
21310 Electrical & electronics engineers	1,270	1,250	980
21311 Computer engineers (except software engineers & designers)	280	350	330
21320 Chemical engineers	<10	<10	<10
21321 Industrial & manufacturing engineers	<10	10	<10
21322 Metallurgical & materials engineers	<10	<10	<10
21330 Mining Engineers	10	10	<10
22100 Chemical technologists & technicians	110	130	100
22220 Computer network & web technicians	<10	<10	<10
22222 Information systems testing technicians	<10	<10	<10
22301 Mechanical engineering technologists & technicians	260	360	220
22302 Industrial engineering & manufacturing technologists & technicians	270	290	180

Recruitment Gap (#)	2026-30	2031-35	2036-40
22310 Electrical & electronics engineering technologists & technicians	1,050	980	770
22312 Industrial instrument technicians & mechanics	50	60	60
72010 Contractors & supervisors, machining, metal forming, shaping & erecting trades & related occupations	720	750	720
72020 Contractors & supervisors, mechanic trades	80	100	80
72100 Machinists & machining & tooling inspectors	1,260	1,450	1,330
72101 Tool & die makers	1,070	1,150	1,080
72106 Welders & related machine operators	290	590	370
72200 Electricians (except industrial & power system)	<10	<10	<10
72201 Industrial electricians	520	490	350
72400 Construction millwrights & industrial mechanics	1,710	1,690	1,500
72410 Automotive service technicians, truck & bus mechanics & mechanical repairers	140	260	140
73300 Transport truck drivers	1,570	1,600	1,520
73400 Heavy equipment operators	270	230	180
75101 Material handlers	<10	510	80
82020 Supervisors, mining & quarrying	270	200	190
83100 Underground production & development miners	200	90	70
84100 Underground mine service & support workers	10	<10	<10
90010 Manufacturing managers	4,930	4,670	4,210
92020 Supervisors, motor vehicle assembling	880	890	370
92021 Supervisors, electronics & electrical products manufacturing	250	140	50
92024 Supervisors, other products manufacturing & assembly	<10	10	<10
93100 Central control & process operators, mineral & metal processing	<10	10	10
93101 Central control & process operators, petroleum, gas & chemical processing	30	<10	<10
94100 Machine operators, mineral & metal processing	170	170	120
94101 Foundry workers	<10	20	30
94104 Inspectors & testers, mineral & metal processing	20	30	20
94105 Metalworking & forging machine operators	330	410	360
94106 Machining tool operators	310	370	320
94110 Chemical plant machine operators	150	150	130
94111 Plastics processing machine operators	900	1,050	970
94200 Motor vehicle assemblers, inspectors & testers	3,160	3,990	2,540
94201 Electronics assemblers, fabricators, inspectors & testers	1,920	1,590	1,290

Recruitment Gap (#)	2026-30	2031-35	2036-40
94203 Assemblers, fabricators & inspectors, industrial electrical motors & transformers	230	180	100
94204 Mechanical assemblers & inspectors	110	130	10
94212 Plastic products assemblers, finishers & inspectors	180	250	230
94213 Industrial painters, coaters & metal finishing process operators	200	280	170
95100 Labourers in mineral & metal processing	<10	30	<10
95102 Labourers in chemical products processing & utilities	40	70	30
95109 Other labourers in processing, manufacturing & utilities	960	1,010	680

Recruitment Gap (% of 2022 base year employment)

Recruitment gap values from the previous table are expressed in Table 11 as a percentage of 2022 base year employment.

For example: If the recruitment gap percentage is 100%, then employment in the occupation would have to double in size relative to 2022 employment levels (taking into consideration demographic and immigration supply-side transitions in the labour market) to meet increased demand associated with the ICEV-EV transition as defined by the base case scenario.

Table 9. Recruitment gap (% of 2022 base year employment) – detailed results

Recruitment Gap (% of 2022 Base Year Employment)	2026-30	2031-35	2036-40
11200 Human resources professionals	3%	4%	3%
13201 Production and transportation logistics coordinators	2%	2%	1%
14400 Shippers and receivers	6%	7%	6%
14402 Production logistics workers	<1%	<1%	<1%
20010 Engineering managers	10%	9%	8%
20012 Computer and information systems managers	6%	6%	6%
21101 Chemists	1%	1%	<1%
21211 Data scientists	<1%	<1%	<1%
21220 Cybersecurity specialists	<1%	<1%	<1%
21221 Business systems specialists	1%	2%	2%
21222 Information systems specialists	5%	6%	6%
21223 Database analysts and data administrators	3%	5%	5%
21230 Computer systems developers and programmers	<1%	<1%	<1%
21231 Software engineers and designers	<1%	<1%	<1%
21232 Software developers and programmers	<1%	<1%	<1%

Recruitment Gap (% of 2022 Base Year Employment)	2026-30	2031-35	2036-40
21233 Web designers	<1%	<1%	<1%
21234 Web developers and programmers	<1%	<1%	<1%
21301 Mechanical engineers	1%	1%	<1%
21310 Electrical and electronics engineers	6%	6%	4%
21311 Computer engineers (except software engineers and designers)	3%	3%	3%
21320 Chemical engineers	<1%	<1%	<1%
21321 Industrial and manufacturing engineers	<1%	<1%	<1%
21322 Metallurgical and materials engineers	<1%	<1%	<1%
21330 Mining Engineers	1%	1%	<1%
22100 Chemical technologists and technicians	4%	4%	3%
22220 Computer network and web technicians	<1%	<1%	<1%
22222 Information systems testing technicians	<1%	<1%	<1%
22301 Mechanical engineering technologists and technicians	2%	3%	2%
22302 Industrial engineering and manufacturing technologists and technicians	3%	4%	2%
22310 Electrical and electronics engineering technologists and technicians	8%	8%	6%
22312 Industrial instrument technicians and mechanics	3%	3%	3%
72010 Contractors and supervisors, machining, metal forming, shaping and erecting trades and related occupations	12%	13%	12%
72020 Contractors and supervisors, mechanic trades	3%	4%	3%
72100 Machinists and machining and tooling inspectors	6%	7%	7%
72101 Tool and die makers	13%	14%	13%
72106 Welders and related machine operators	1%	2%	2%
72200 Electricians (except industrial and power system)	<1%	<1%	<1%
72201 Industrial electricians	9%	9%	6%
72400 Construction millwrights and industrial mechanics	11%	11%	10%
72410 Automotive service technicians, truck and bus mechanics and mechanical repairers	2%	4%	2%
73300 Transport truck drivers	15%	16%	15%
73400 Heavy equipment operators	7%	6%	5%
75101 Material handlers	<1%	1%	<1%
82020 Supervisors, mining and quarrying	15%	11%	10%
83100 Underground production and development miners	6%	3%	2%
84100 Underground mine service and support workers	1%	<1%	<1%
90010 Manufacturing managers	17%	17%	15%
92020 Supervisors, motor vehicle assembling	16%	16%	7%

Recruitment Gap (% of 2022 Base Year Employment)	2026-30	2031-35	2036-40
92021 Supervisors, electronics and electrical products manufacturing	19%	10%	4%
92024 Supervisors, other products manufacturing and assembly	<1%	1%	<1%
93100 Central control and process operators, mineral and metal processing	<1%	1%	<1%
93101 Central control and process operators, petroleum, gas and chemical processing	1%	<1%	<1%
94100 Machine operators, mineral and metal processing	3%	3%	2%
94101 Foundry workers	<1%	1%	2%
94104 Inspectors and testers, mineral and metal processing	1%	2%	1%
94105 Metalworking and forging machine operators	5%	6%	5%
94106 Machining tool operators	6%	7%	6%
94110 Chemical plant machine operators	7%	7%	6%
94111 Plastics processing machine operators	7%	8%	8%
94200 Motor vehicle assemblers, inspectors and testers	7%	9%	6%
94201 Electronics assemblers, fabricators, inspectors and testers	23%	19%	15%
94203 Assemblers, fabricators and inspectors, industrial electrical motors and transformers	17%	13%	7%
94204 Mechanical assemblers and inspectors	4%	5%	<1%
94212 Plastic products assemblers, finishers and inspectors	5%	7%	6%
94213 Industrial painters, coaters and metal finishing process operators	3%	4%	3%
95100 Labourers in mineral and metal processing	<1%	1%	<1%
95102 Labourers in chemical products processing and utilities	1%	2%	1%
95109 Other labourers in processing, manufacturing and utilities	5%	5%	3%