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#ENERGY TRANSITION

#MOBILITY

ELECTRIC VEHICLES

EUROPEAN MOBILITY AND INDUSTRIAL LEADERSHIP AT STAKE

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Introduction

While European elections are coming, climate change is a rising topic of concern for many Europeans[1]. A quarter of greenhouse gas emissions in Europe comes from transport while to achieve the objectives of the Paris Agreement, Europe should become a carbon-neutral economy by 2050, thus needing to **bring to near-zero the emissions of its transport system**[2]. The European Union (EU) has been actively creating the framework to make our mobility cleaner but still faces many challenges to put these regulations into acts and to achieve a transition that is socially fair.

The soon-to-be elected EU policy-makers, i.e. new Members of the European Parliament, and newly elected Commissioners will make key decisions to shape this new mobility landscape. Through their vote on May 26th, EU citizens have the opportunity to send them a clear message.

To realise a transition from today's dirty mobility system to tomorrow's clean mobility system, there is no silver bullet, but there is the **opportunity to articulate several solutions**. Future mobility needs to be based on energy-efficient and low-emission modes that rely on clean energy. The solution will not be only technological. The way we think mobility needs to change towards a more sustainable approach, starting with reducing the need to move. A comprehensive solution can build on several dimensions: reduction and optimisation of our mobility needs, digitalisation, shared economy and behavioural changes[3].

One of the solutions emerging worldwide is electrification. Nonetheless, many questions remain over the CO2 emissions of electric vehicles (EV) compared to diesel and gasoline vehicles, the charging infrastructure, the cost of owning and using an electric car, the environmental impact of EV production (especially the battery), and the impact of this transformation on the European car industry and its millions of jobs.

This brief focuses on the question of electric mobility and concludes **that electric vehicles alone will not make our mobility clean, but they are a key part of the solution.**

1. Based on Eurobarometer 90.1 data and forthcoming Jacques Delors Institute policy brief by Thomas Pellerin-Carlin and Thierry Chopin
2. European Commission, 'A clean planet for all', November 2018
3. For a more developed perspective of changes needed in mobility, see Emilie Magdalinski, "Clean mobility: the European Way", Policy Paper, Jacques Delors Institute, January 2019

1 ▪ Electric vehicles are a much cleaner alternative to diesel and gasoline cars but are no silver bullet to replace them

Diesel and gasoline cars emit CO2 on the road through the combustion of hydrocarbons. Electric vehicles rely on electricity to power an electric motor, hence emitting no CO2 on the road. However, the production of the battery and the generation of electricity used by the EV can emit CO2 if relying on "dirty" electricity[4]. In this regard, to be consistent when comparing the impact of different vehicles, one should use the emissions of the whole lifecycle of both EVs and internal combustion engine (ICE) cars. Electric cars are cleaner than ICE cars, as illustrated by figure 1 showing the comparison between two small cars used in France. Furthermore, several studies provide lifecycle assessments and find that even with a "dirty" electricity mix, EVs emit less CO2 than ICE cars over their lifetime[5].

Deploying EVs will lead to an increase in electricity consumption. But predictions for the massive increase in electricity demand and in peak hour demand should be nuanced. Not all Europeans are going to charge their EV at the exact same moment, just like they do not launch their washing machine at the exact same moment. Smart charging helps optimise electricity demand and reduce peak load demand on the network. With vehicle-to-grid charging, EVs can even charge and store electricity produced in off-peak hours and send electricity back to the grid during peak hours. The deployment of electric vehicles is a promising option to store the abundance of cheap renewable electricity at specific moments (e.g. sunny midday, windy nights)[6].

Today, most of the EU electricity is generated without emitting greenhouse gases[7]. EU electricity generation is becoming even cleaner over time as coal is being phased-out[8], EU objectives for renewables are being increased (to 32% by 2030) and EU policy moves towards an objective of climate neutrality. It is thus key to adopt a comprehensive approach to the energy transition: the more we develop electric vehicles, the more we need renewable electricity production to produce more and cleaner electricity; and the more renewables we have, the more we need electric vehicles to provide batteries that are useful to balance the electricity system. In this sense, EVs are a crucial ingredient to reach net zero emissions by 2050[9].

On top of CO2 emissions, conventional cars strongly contribute to air pollution, which causes 400,000 premature deaths each year in the EU[10]. While significant technological improvements have been made to reduce pollutants' emissions, measurements between 2011 and 2017 still indicate that

4. The carbon intensity of electricity used to charge the car in Europe depends on the energy sources used to produce electricity and on the time of day when charging the car. For instance, coal-fired electricity generation emits high amounts of CO2 as opposed to power generation from renewables and nuclear. Additionally, if the car is charged at consumption peak hour, it will rely more on dirty fuels that are used to top up high demand.

5. See for example Messagie, M. (2017) "Life Cycle Analysis of the Climate Impact of Electric Vehicles"; EEA (2018) "Electric vehicles from life cycle and circular economy perspectives"; JRC, 2018, Electricity carbon intensity in European Member States; Fondation pour la Nature et l'Homme, European Climate Foundation and Carbone 4, « Quelle contribution du véhicule électrique à la transition écologique en France ? », December 2017. Also according to car makers' data: Rob Hull, "Electric cars better for the environment than traditional cars, says VW study", driven.co.nz, 29/04/2019

6. See Element Energy and Cambridge Econometrics, «Towards Fossil-Free Energy in 2050", March 2019

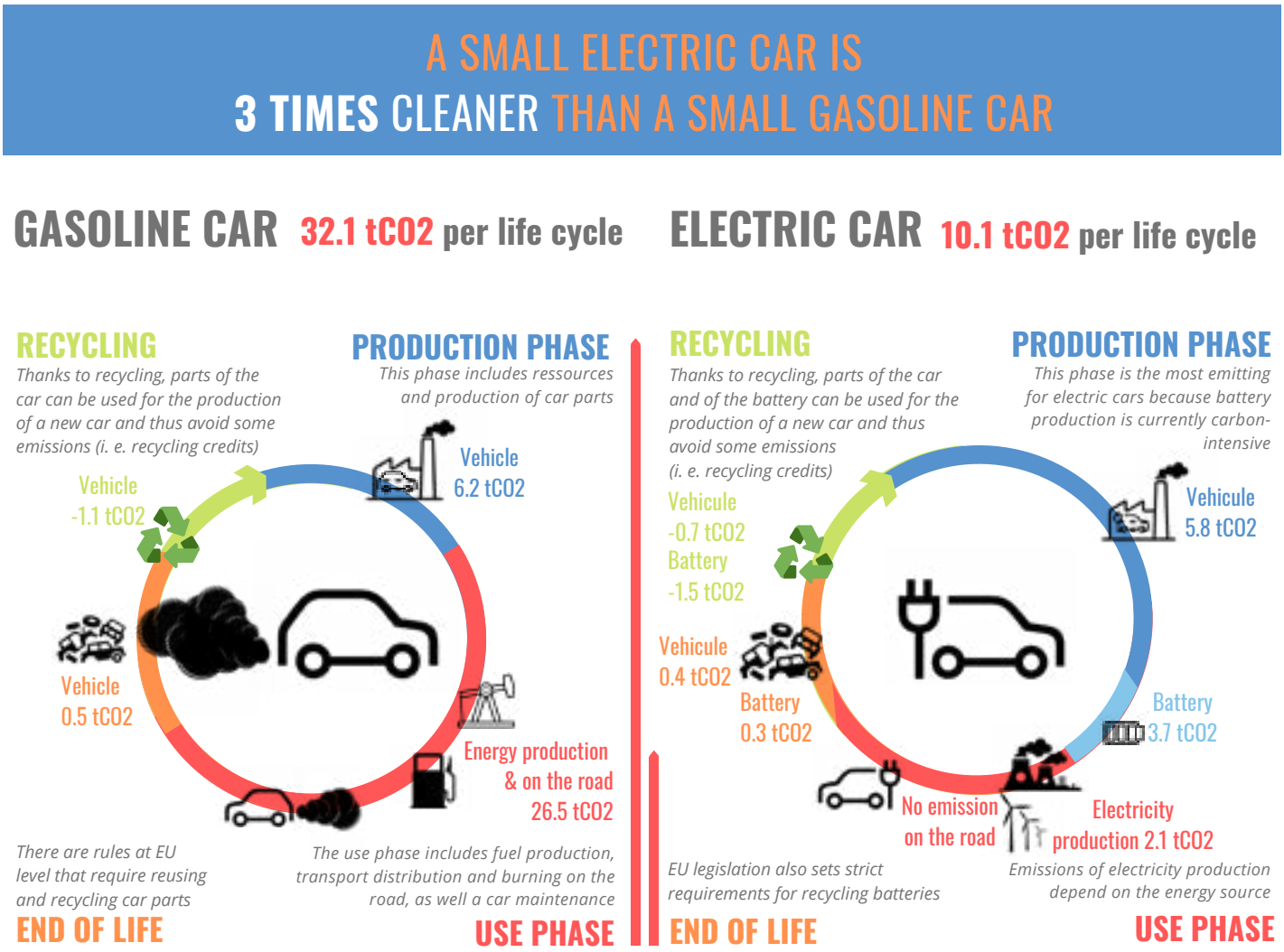
7. According to Eurostat data, 55% of EU electricity is generated through renewables (30%) and nuclear (25%).

8. Monika Oczkowska, Thomas Pellerin-Carlin, "Just energy transition: a reality test in Europe's coal regions", Jacques Delors Institute, May 2019.

9. Transport & Environment, «Roadmap to decarbonising European cars», November 2018

10. European Environment Agency, Air quality in Europe—2018 report, 2018

FIGURE 1 ▪ Comparing CO2 emissions over the lifecycle of an EV and a gasoline car



Comparison of the emissions over the life cycle of a small car in France in 2016 (in tCO2eq)

tCO2 eq. : tons of CO2 equivalent
1tCO2 corresponds to 1 round trip by air from Paris to New-York

This figure is a simplification of the stages of a vehicle life cycle for one specific type of car to provide an overview of the elements to take into account when assessing the impact of a car.

Source : Jacques Delors Institute based on Chéron, M., Gilbert-d'Halluin, A., Schuller, A. « Quelle contribution du véhicule électrique à la transition écologique en France ? », Fondation pour la Nature et l'Homme, Rapport technique, décembre 2017

many diesel cars largely exceed the European emission limits for nitrogen oxide (NOx)[11]. As EVs do not burn diesel or gasoline to power the car, they significantly contribute to decreasing air pollution in cities[12].

2 ▪ Charging infrastructure is developing but range anxiety persists

Many Europeans still fear that electric cars cannot drive long distances due to limited autonomy. This anxiety is decreasing thanks to improvements in the battery range and to

11. ICCT, "European Vehicle Market Statistics, Pocketbook 2017-2018", 2018
12. EVs are indeed 'zero tail-pipe emission'. They however still generate air pollution through road, tyre and brake wear, like ICE cars.

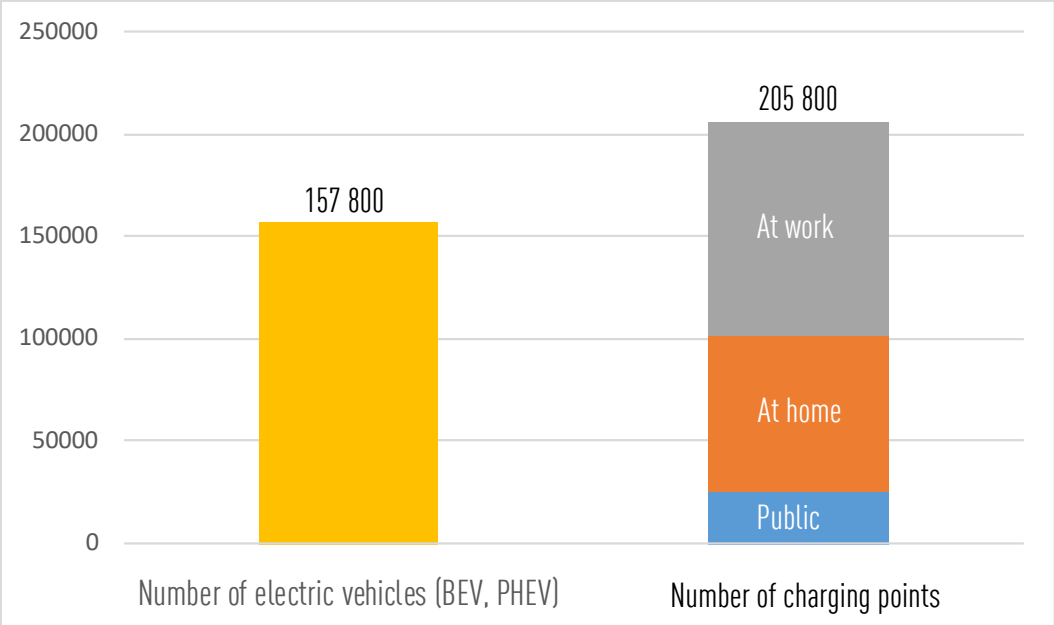
a growing network of charging points (e.g. see figure 2 for the French case, where the number of charging points is even higher than the number of electric vehicles that need charging in France).[13]

Electric cars now have an autonomy of 150 to 400km[14]. Most upcoming new electric vehicles have an autonomy of at least 400 km (e.g. Renault Zoe). This is more than enough for most daily trips (e.g. if one has an average daily driving distance of 50 km), and efforts should rather focus on developing new battery technologies and deploying charging points[15]. Currently, most people charge their EVs at home, by means of a standard electrical outlet or a dedicated wall box. It takes up to 4-10 hours to fully charge a depleted battery with a slow charger[16].

Employers are also making charging infrastructure available in the workplace.

Public charging stations are used for only 5% of recharges today[17]. They are thus mainly needed for long trips and should provide reliable fast charging to make electric mobility attractive to drivers. Over the last years, EU legislation has been supporting the deployment of new charging points, both at home, in car parks and public areas[18]. Now the EU should enable easy access to charging points for all EVs throughout Europe and improve price and charging information as currently many drivers struggle to find their way in a wide landscape of charging operators.

FIGURE 2 ▪ Comparison of the number of charging points and EVs in France in 2018



Source : Jacques Delors Institute, based on AFP and Connaissance des Energies data as of November 2018

13. Connaissance des Energies, «Véhicules électriques: près de 25 000 points de recharge publics en France à fin novembre 2018», 8 January 2019
14. « Quelles sont les voitures électriques réellement vendues en France ? Quels sont leurs tarifs ? Quelle est leur autonomie ? Auto-Moto fait le point sur l'offre des véhicules électriques. », 12 april 2019
15. Attempts to significantly raise the autonomy with current technologies can be counterproductive as it would lead to heavier batteries and hence lower energy efficiency of the EV. See for more detailed explanation: Pellissier, S. « Autonomie des voitures électriques, quand le mieux devient l'ennemi du bien » in The Conversation, 1 November 2018
16. It takes 8-10 hours on a standard electrical socket. Owners can install home charging infrastructure ("wall box") to accelerate charging to an average 4-6 hours and to optimise the charging (e.g. at night).
17. Transport & Environment "Electric vehicles: The truth", September 2018
18. EU Directive 2018/844 (EPBD) and Directive 2014/94/EU (AFID)

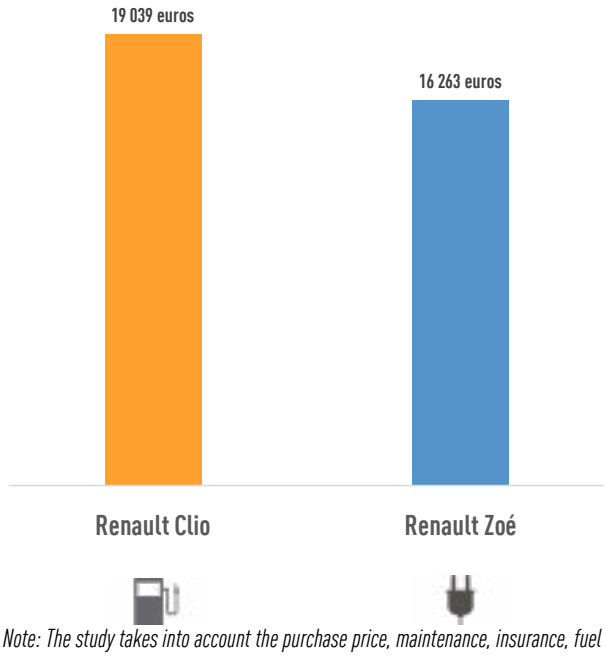
3 ▪ Electric vehicles are becoming more affordable to own than conventional cars

Buying, owning and using EVs is already cheaper than ICE cars, in some instances, especially when buying an EV is subsidised[19]. According to the European Consumer Organisation (BEUC), owning an electric car is already more affordable over a period of 4 to 7 years than owning a diesel car in Bulgaria, France, Portugal and Spain[20]. In France for instance, a study by French consumer organisation *UFC Que Choisir* found that over 4 years, the electric Renault Zoé is 3.000€ cheaper than the comparable gasoline car Renault Clio when driving 15,000km/year (see figure 3). Based on 2018 data, they estimate that Renault Zoé can drive 100km for about 3€ of electricity as compared to the Clio which requires about 8€ of gasoline for the same distance[21].

And EVs are becoming cheaper as the cost of batteries -which represents 40% of the cost of an electric vehicle- is falling. For instance, battery cost was divided by two in the last three years (from 350-400€/kWh in 2015 to less than 200€/kWh in 2018)[22].

Additionally, the market for second-hand EVs is emerging and will be attractive as the high upfront cost of the car is reduced through depreciation. It will offer an alternative that is cheaper in both investment and use. Most widespread batteries rely on lithium-ion technology (like a smartphone). They gradually lose capacity with every charge so that the EV's autonomy slowly decreases. Currently, most carmakers estimate the battery lifetime to be of 8-10 years and provide similar guarantees. But according to Eindhoven Technical University Professor Auke Hoekstra, old Tesla batteries can still run at 80% capacity after 600.000km[23].

FIGURE 3 ▪ Total Cost of Ownership of a small car (B-segment) over 4 years, in France, 15 000km/year



Note: The study takes into account the purchase price, maintenance, insurance, fuel and financing costs and registration tax.
Source: Jacques Delors Institute, based on UFC Que Choisir, 2018

19. See for instance research led by Palmer, K., Tate, J. E., Wadud, Z., & Nellthorp, J. (2018). Total cost of ownership and market share for hybrid and electric vehicles in the UK, US and Japan. Applied energy, 209, 108-119
20. BEUC, "When will electric cars be an affordable option or European consumers?", 2018
21. UFC Que Choisir, « Budget auto : L'électrique, c'est du bonus ! », 10 October 2018
22. France Stratégie, « L'avenir de la voiture électrique se joue-t-il en Chine ? », 2018
23. https://twitter.com/AukeHoekstra/status/1120327774433173504

Some car manufacturers like Renault also propose to lease the battery to provide peace of mind to consumers and to facilitate battery change[24].

4 ▪ Battery production: towards a European production of sustainable batteries

Battery production requires a lot of energy and raw materials such as lithium, cobalt, graphite and nickel. Demand for these materials is growing but their extraction outside of the EU can be polluting and some ethical and social concerns have been raised[25]. To overcome these issues and create jobs in Europe, we need sustainable domestic battery cell manufacturing, which is currently missing.

This is why the European Commission launched in 2017 the European Battery Alliance (EBA). The EU wants to reassert European leadership in sustainable development through the creation of a battery value chain based on local production and decarbonised electricity[26]. This implies exploiting raw materials in the most sustainable manner by mapping deposits in Europe (esp. in central Europe, Finland, Sweden and Portugal)[27], securing a sustainable supply with trade partners, developing a recycling chain for batteries and leading research to reduce the reliance on raw materials in future battery technologies[28] (Figure 4). Setting sustainability criteria for batteries is essential to make EVs cleaner and to ensure a new model that avoids to merely replace our oil dependence by a raw materials dependence.

FIGURE 4 ▪ An example of the circular battery value chain developed by EIT RawMaterials

Source : EIT RawMaterials industry partners role in the Battery Value Chain

24. See for instance: « Renault Zoe : la batterie enfin proposée à l'achat », 23 March 2018
25. Cobalt in particular is mainly mined in the Democratic Republic of Congo, a country where political instability and use of child labour for cobalt mining raises ethical concerns.
26. Carole Mathieu, "The EU Battery Alliance: Can Europe avoid technological dependence?" Ifri, Edito Energie, 20 February 2018
27. European Commission's Report on Raw Materials for Battery Application (SWD(2018) 245/2), 22.November.2019
28. European Commission's Report on the Implementation of the Strategic Action Plan on Batteries: Building a Strategic Battery Value Chain in Europe, 09.April.2019

5 ▪ Electric vehicles are an industrial opportunity for Europe and for its automotive industry to remain worldwide leaders

If well planned, the clean mobility transition can benefit the European economy and industry. The EU is the second largest producer of cars so EV and battery production are a key industrial challenge for the European automotive industry. Additionally, the transition to electric mobility can be an economic boost in Europe as it will reduce dependency on imported oil and replace it with domestically-produced energy[29].

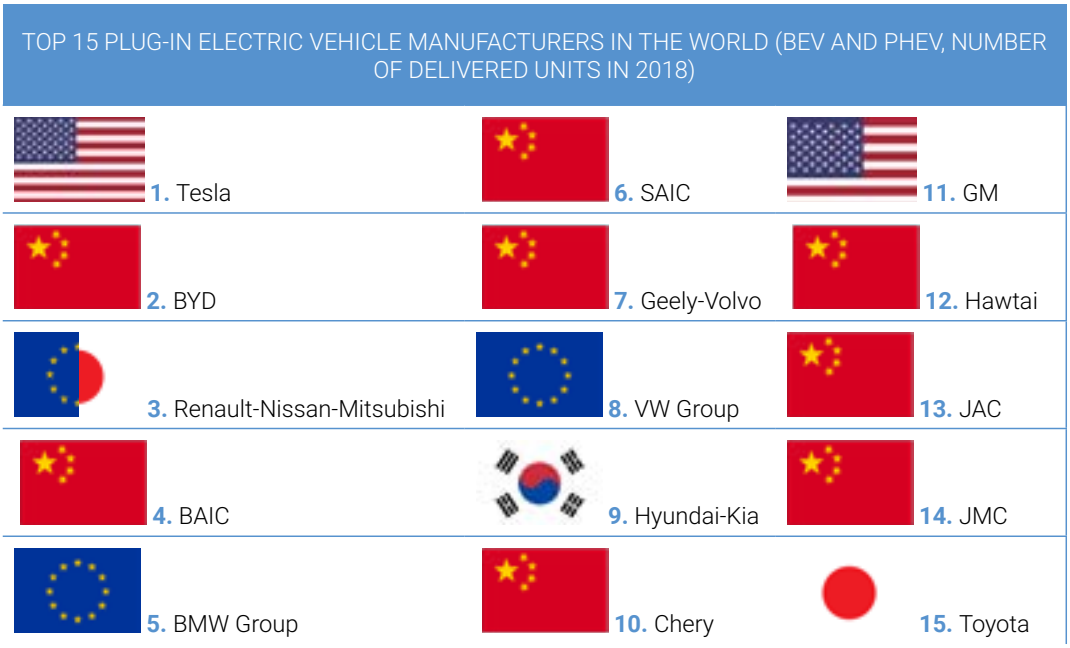
The race to become an electric mobility leader is already launched in China and in the US with domestic champions like BYD and Tesla (figure 5).

Many European manufacturers thus commit to developing and selling more EVs. A Franco-German initiative composed of the car-maker PSA-Opel and battery producer Saft is emerging to develop European battery cell production supported by national and European funding of almost €3bn[30].

The shift to electric vehicles impacts many companies and jobs along the value chain, with the creation of new jobs (e.g. battery production), the redefinition of existing jobs (e.g. garage workers) and scale-down of other jobs (e.g. fuel extraction). To support those companies, workers and their territories in the clean mobility transition, the European Union needs to co-create a Social Pact for the Energy Transition[31].

In total, this transition may lead to the net creation of 200,000 jobs in Europe[32]. These jobs will be the result of successful public and private endeavours, including the European Battery Alliance. Conversely, not engaging in this transition in Europe would have adverse effects as many European workers would lose their jobs to rising car manufacturing in competitive EV countries outside of the EU.

FIGURE 5 ▪ Worldwide leading manufacturers in EVs sales in 2018



Source: Jacques Delors Institute, based on EV-volumes.com data

29. Cambridge Econometrics, "Fuelling Europe's Future: How the transition from oil strengthens the economy", 2018
30. "PSA, Opel and Saft battery consortium ready to go", May 1st 2019
31. Jacques Delors, Sofia Fernandes, Thomas Pellerin-Carlin, 'European needs a Social Pact for the Energy Transition', Jacques Delors Institute policy brief, January 2018.
32. Mainly in the sectors of construction, services, electricity, hydrogen and manufacturing. Source: Cambridge Econometrics, "Fuelling Europe's Future: How the transition from oil strengthens the economy", February 2018; the European Association of Electrical Contractors estimates 200 000 new jobs by 2030 in the electricity sector alone.

Conclusion

Electric vehicles are a key component of our future clean mobility system. EVs already offer a cleaner alternative to diesel and gasoline cars and EU policy aims at improving their sustainability through the European Battery Alliance and a growing generation of renewable electricity in Europe. When it comes to the use of electric cars, the range and charging infrastructure offer an alternative that suits most of our daily journeys. Costs of owning an EV are falling and already competitive with conventional cars in many cases, without even accounting for the emerging second hand EV market. Finally, with numerous Chinese manufacturers in the electric mobility race, European car and battery manufacturers should catch the industrial opportunity to maintain the European leadership in car manufacturing, and develop new local jobs that are in line with our climate commitments and energy transition objectives.

The future of mobility will be what Europeans make of it. A first step for them would be to vote at the end of May 2019 for new European decision-makers who can raise the level of ambition towards cleaner mobility and work towards a mobility system that leaves no Europeans behind.

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