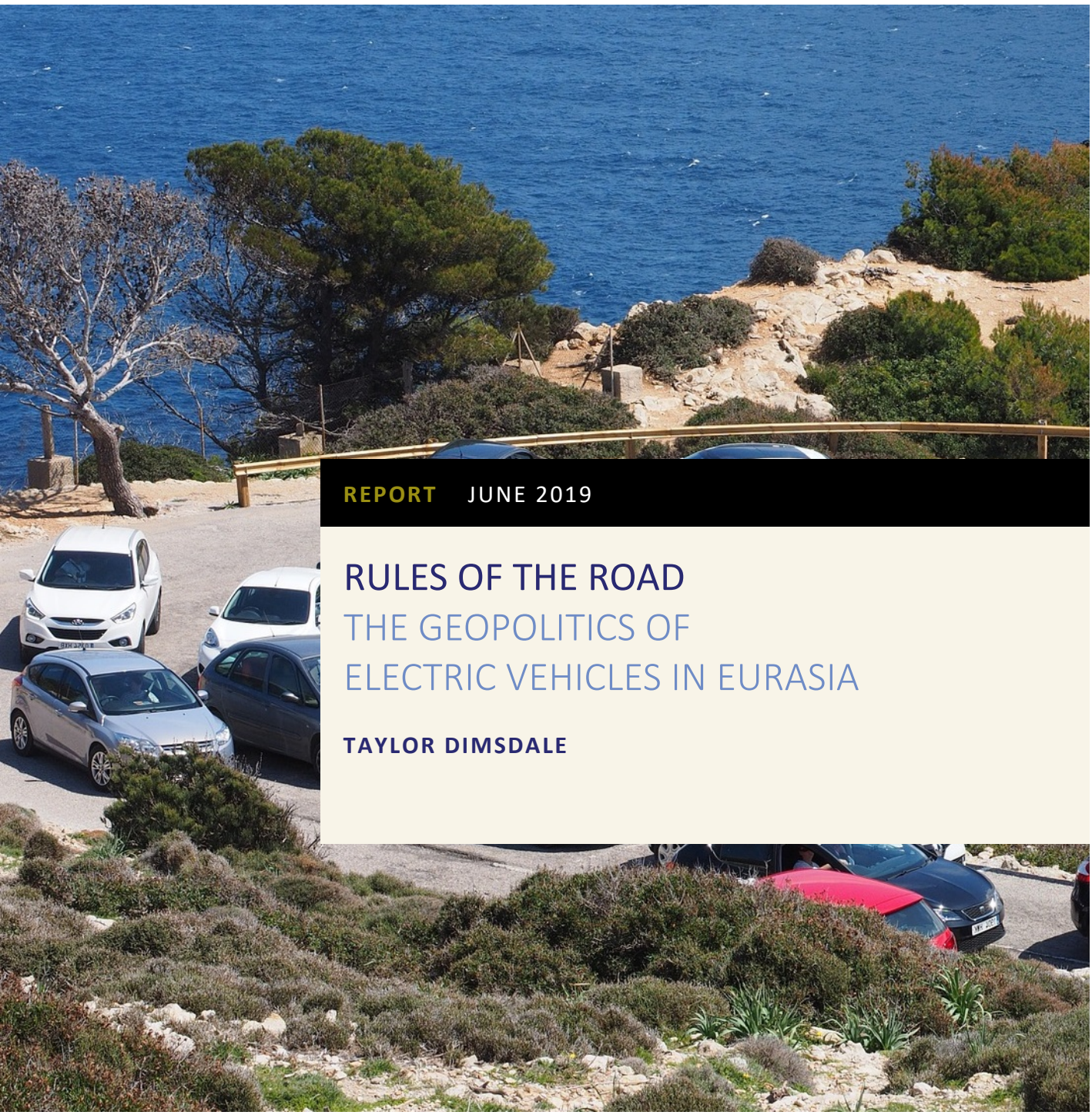
E3G



REPORT JUNE 2019

RULES OF THE ROAD

THE GEOPOLITICS OF ELECTRIC VEHICLES IN EURASIA

TAYLOR DIMSDALE

Acknowledgements

This publication is a deliverable of MISTRA GEOPOLITICS, which is funded by the MISTRA – The Swedish Foundation For Strategic Environmental Research.

The author wishes to thank several colleagues at E3G for their contributions to this report, including Nick Mabey, Tom Burke, Claire Healy, Camilla Born, Luca Bergamaschi, Anna Glasser, Jennifer Tollmann, Pelin Zorlu, Danny Scull and Iskander Erzini Vernoit. Karl Hallding from the Stockholm Environment Institute and Malin Mobjörk from the Stockholm International Peace Research Institute provided early input to the concept. The report also draws on inputs from a discussion held at a joint workshop between E3G and Stiftung Wissenschaft und Politik (SWP), which was chaired by Dr. Kirsten Westphal. Thanks are also due to the following individuals and organizations for their time and input: Jonathan Miller (Japan Institute of International Affairs); André Månberger (Lund University); Caspar Rawles (Benchmark Mineral Intelligence); Rod Schoonover, PhD (Bureau of Intelligence and Research, US Department of State); Philipp Wendel and Jochen Künzel, (Auswärtiges Amt); David Sandalow (Center on Global Energy Policy); Aiko Shimizu (Daimler AG); and Justin Swarbrick (What Communications). The individuals acknowledged here do not necessarily endorse the report or its recommendations. The report also benefited from several other interviewees who have requested to remain anonymous.

About E3G

E3G is an independent climate change think tank accelerating the transition to a climate safe world. E3G builds cross-sectoral coalitions to achieve carefully defined outcomes, chosen for their capacity to leverage change. E3G works closely with like-minded partners in government, politics, business, civil society, science, the media, public interest foundations and elsewhere. In 2018, for the third year running, E3G was ranked the fifth most globally influential environmental think tank.

Berlin office
Neue Promenade 6
Berlin, 10178 – Germany
Tel: +49 (0) 30 2887 3405

Brussels office
Rue du Commerce 124
Brussels, 1000 Belgium
Tel: +32 (0) 2 5800 737

London office
47 Great Guildford Street
London SE1 0ES, UK
Tel: +44 (0)20 7593 2020

Washington DC office
2101 L St NW
Suite 400
Washington, DC 20037
United States
Tel: +1 202 466 0573

Copyright

REPORT JUNE 2019

RULES OF THE ROAD
THE GEOPOLITICS OF ELECTRIC VEHICLES IN EURASIA

TAYLOR DIMSDALE

CONTENTS

EXECUTIVE SUMMARY

This paper envisions how countries might respond to rapid market penetration of electric vehicles (EVs). It focuses on Eurasia which as a region encompasses several key geopolitical actors and most of the world's largest automobile producers. The objective of this report is to increase awareness of the geopolitical risks and identify ways to strengthen rules-based international cooperation.

Even conservative forecasts show significant growth in EV adoption over the next several decades. Declining battery costs, which have fallen by 79% since 2010, and stronger fuel efficiency standards are occurring alongside ambitious EV targets and investment from governments and the private sector. EVs are likely to be cost competitive with Internal Combustion Engines (ICEs) without subsidies within the next five years, and to account for most car sales by 2035. Significant barriers remain, including limited charging infrastructure, long re-charge times and cyber risks. However, rising concerns about climate impacts, changing consumer preferences and interest in new market opportunities are catalyzing infrastructure initiatives and research and development into next generation battery technologies. Demand for ICEs is already falling in some countries – including in China where sales in November 2018 were 20% lower than the previous year. Concerns about public backlash to urban air pollution, which cost $225bn in lost labor income in 2013, is also driving interest in EVs in many countries.

Under most scenarios the trend towards electrification of the transport sector will continue and could happen much faster than mid-range forecasts predict. Most forecasts have consistently underestimated EV deployment and other clean energy technology adoption rates. There are many historical examples of new technologies growing exponentially. A rapid transition to EVs would increase the risk of disruption, especially against the current backdrop of rising trade barriers and resource nationalism. The German government's minister for education and research has referred to battery technology as an "existential" concern given the reliance of the German economy on the auto industry for jobs and growth.

EV adoption is likely to influence geopolitics through several interrelated mechanisms, including international trade, energy security and competition over strategic resources. EVs will also have second and third order effects with geopolitical or human security implications, in large part as a result of a declining tax base in oil producing countries. In each case EVs have the potential to be a catalyst for greater cooperation, or a source of conflict.

Depending on how governments respond to current trends, EVs could reinforce or hinder **international trade**. EV costs must decline rapidly to meet their full growth potential in a way that delivers a transport sector that is compliant with the Paris Agreement. This implies a deepening of global supply chains as well as regulatory and market integration which could prompt a rise in 'green' free trade agreements. However, the integration of international EV markets brings with it potential for trade tensions given the disruption of existing industries particularly in EU, US and Japan. In Germany, for example, cars account for over €400bn in domestic revenue and 13% of the country's exports. Significant job losses are possible absent investment in retraining programs, which could prompt governments to protect incumbent industries. Wider developments in trade could also influence EVs. The rise of populism and protectionism and resulting threats to the WTO increases the risk that the largest auto producing countries take a 'go-it-alone' approach whereby they invest in EVs less to lead a new market and more to gain a strategic advantage. This scenario could result in fragmentation of domestic industries each with different technologies and standards, leading to lower global growth.

With respect to **energy security**, if electrification reduces oil demand public revenues from oil could decline in producing countries, many of which are in regions already at risk of instability. It could also result in the rebalancing of a key geopolitical dynamic between energy producers and consumers, particularly the US and China. For decades the US Navy has controlled oil supply chains and sea lanes of communication – subsidized by $81bn per year in spending by the US Department of Defense. This is considered an economic and security vulnerability by large oil importers, including China. China's largescale investment in EVs combined with its push for energy infrastructure and trade including through the Belt and Road Initiative (BRI) stems in part from a desire to reduce its reliance on the US for protection of oil supply. In both the International Energy Agency's (IEA) New Policy and EV30 scenarios, China and the EU have the highest EV market share in 2030, despite the United States' historical leadership in battery innovation. A world where oil declines while batteries rise as geopolitical drivers would look very different to the world of today.

While extreme resource scarcity is not a high probability scenario, the need for cobalt, nickel, lithium and other minerals could lead to increased **competition for access to strategic resources** with at least two knock-on effects. First, it is possible that access to these elements will be used, as oil has been, for energy 'statecraft'. If US control of oil supply choke points has long been recognized as a vulnerability for oil importers including China, China has in turn identified the growing demand for minerals needed for clean energy technology as a geostrategic opportunity. Second, there is the potential interaction of demand for minerals with state or regional instability. The largest reserves of metals and minerals required for battery production are found in fragile states with poor governance records. Centuries of experience shows that investment in resource extraction can lead to civil unrest and instability.

EVs could also have **second and third order** effects with geopolitical and possibly human security implications. The adoption of electric cars could wipe out US$19 trillion in revenue for the oil industry by 2040. The world's largest independent energy trader, for example, has predicted peak oil demand in 15 years and signaled it intends to focus on clean fuels and power trading. A loss of revenue on this scale would mean lower tax revenues for governments reliant on the oil industry including Russia and the Commonwealth of Independent States (CIS). But it also carries risks for institutional investors and pension funds with high exposure to the oil and gas sector. Forecasts of significant revenue losses, or stranded assets risk, have been dismissed by some security and energy policy experts; but these concerns are supported by the growing recognition from central bankers and other financial actors that the transition risks from climate change policy represent material risks to the financial system.

A review of publicly available national security and intelligence documents and other grey literature, complemented by expert interviews, demonstrates that only very limited attention has been paid to the geopolitical or security implications of a high EV scenario. Most commentary that addresses EV adoption does so from a techno-economic perspective. The national security strategies reviewed address topics of relevance to this issue, such as the security risks of climate change, risks to resource supply chains and the opportunity of new energy technologies. But none of the government documents examined deal directly with the implications of EVs or the electrification of transport more generally. **The lack of preparedness for a high EV scenario could increase the risk of geopolitical tensions in the future.** Based on the analysis undertaken for this study several recommendations are proposed with the aim of strengthening rules-based international cooperation to help mitigate the risk of geopolitical tensions and a disorderly energy transition.

Recommendation 1: G20 Energy Ministers should establish a task force on trade and electric vehicles. EVs have the potential to amplify existing threats to the open global trade regime if subsidized industries abroad result in, or are perceived to result in, domestic job losses. This could follow a similar pattern as the recent tit-for-tat reprisals around solar subsidies. Such a political backlash could stall the transition to electrification of transport and risk overshooting climate targets. Negotiations have been underway on an Environmental Goods Agreement for the elimination of tariffs on green goods in the WTO since 2014. Every country included in this study is also represented in the EGA. However, this process has stalled since 2016. The G20 Energy Ministers could revive the discussions as a steppingstone for a multilateral free trade agreement on EVs. One of the key outputs of this task force should be a set of guidelines establishing what type of government support counts as fair trade based on a detailed consideration of just transition issues. If the G20 decides not to address these issues, then as major markets the EU and China should make these issues a priority for their bilateral High-Level Economic and Trade Dialogue.

Recommendation 2: G20 trade task force should launch a working group on harmonizing regulatory approaches on EV standards. The low carbon transition, including electrification of the transport sector, will mean that battery supply and storage capacity become more important relative to liquid fuel access. The most economically efficient approach would be the regulatory harmonization of EV standards – including standards for "e-highways" for electric trucks. This can build on previous dialogue including through the Asia Pacific Economic Cooperation (APEC) roadmap for international electric vehicle standards. It could also be used to strengthen the evidence base on smart grid interoperability standards, the capability of electricity grids to accommodate EVs and of EV batteries to act as reliable grid storage capacity.

Recommendation 3: The US, EU, China, Japan and Korea should pledge to increase support to international R&D initiatives such as the Electric Vehicle Initiative, including more funding for next generation battery technologies. Overcoming the largest barriers to EV adoption will likely require advances in battery technology. This challenge is also an opportunity for international cooperation. Most countries reviewed here have domestic R&D programs, for example solid state batteries, and bilateral initiatives already exist for example between France and Germany, and Japan and China. Multilateral R&D support on next generation of battery technologies should be increased through the Clean Energy Ministerial (CEM). The Electric Vehicle Initiative (EVI), which was launched under the CEM, should receive greater attention and support.

Recommendation 4: The EU and China should stress test their security and economic strategies against a high EV scenario. Any significant changes in the price of oil or increased risk of instability in regions such as the Middle East North Africa (MENA), Southeast or Central Asia would have implications for the EU and China, which already share concerns about vulnerability to resource shocks and to instability to their neighbourhoods and investments. Existing economic and security strategies recognize these risks but do not account for the impacts of rapid adoption of EVs.

Recommendation 5: The EU should work more strongly with countries with deposits of EV metals and minerals to improve resource governance including through capacity building and technical assistance. Growing demand for minerals used in EVs including lithium and cobalt have economic benefits for developing countries; but the costs can also be considerable, as decades of evidence on the 'resource curse' has shown. Studies have shown that mining can drive social conflict in Africa particularly when commodity prices are high. Recent research has also shown increases in environmental contamination from mining and other related economic activity which increases the risk of social unrest or conflict. Considering the security risks of regional instability, it is in every country's interest to ensure benefits of resource extraction are shared with the wider population and strong institutions lead to good governance of resource extraction. The countries included in this study can facilitate dialogue between different stakeholders at the national level including government, private sector and civil society. There are many existing initiatives to draw upon, for example an initiative in West Africa run by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH or resources like *Managing Mining for Sustainable Development* from UNDP and UNEP.

Recommendation 6: The EU should work with the International Monetary Fund (IMF) to assess the risk that EVs pose to the macroeconomic stability of oil producers. Falling oil demand resulting from EV deployment could lead to a significant drop in public revenue for large and small oil producers. There is limited understanding of the full scope of these impacts on the wider economy. The EU has a stated interest in maintaining regional and global stability during the low carbon transition. The IMF has the capabilities necessary to conduct a systemic analysis of the risk EVs pose to macroeconomic stability in oil producing states. The EU should request that the IMF conduct an analysis and release the results publicly.

Recommendation 7: The EU should commit to supporting the preparation of transition strategies and policies for high cost oil producers. In a world of declining oil demand the lowest cost producers will have a significant advantage. Countries with relatively high production costs include Algeria, Angola, Chad, Colombia, Ecuador, Gabon, Iraq, Kazakhstan, Libya, Nigeria, Oman, Turkmenistan, Venezuela and Yemen. Countries with relatively low GDP and high production costs will need credible strategies to manage the risks in transition away from oil dependency but often lack the capacity to develop and implement them. They should be supported by partners with technical expertise and experience in developing long term climate strategies.

THE GEO-POLITICAL IMPLICATIONS OF ELECTRIC VEHICLES

INTERNATIONAL TRADE

THE RISE OF 'GREEN' FREE TRADE AGREEMENTS

$120bn
The approximate value of the global EV market in 2017

$567bn
The projected value of the global EV market in 2025

EV costs must fall rapidly if sales are to grow to deliver a transport sector compliant with the Paris Agreement. > Fast growth requires an expansion of global supply chains, regulatory cohesion and market integration which could prompt a rise in 'green' free trade agreements.

UNFAIR SOCIAL TRANSITION AND STRATEGIC TRADE TENSIONS

Countries struggling to compete with new EV technology will lose market share and car-making jobs. > To protect domestic industries they raise import tariffs on EVs and stifle global trade and take up of EVs.

ENERGY SECURITY

INSTABILITY IN OIL STATES

Electrification could spell reduced public revenues from oil in producing countries, many of which are in regions already at risk of instability. > If oil declines while batteries rise as geopolitical drivers the world will look very different.

TRANSNATIONAL ENERGY INFRASTRUCTURE AND THE BELT AND ROAD INITIATIVE

China is investing in EVs and the Belt and Road Initiative to reduce its reliance on the US for protection of oil supply chains. It is also a way to bring Chinese EVs and clean energy to the global market. The EU, China and Japan want to avoid impact of volatile oil markets on economic growth. This could all lead to faster phase out of combustion engines.

ACCESS TO STRATEGIC RESOURCES

ENERGY STATECRAFT

80% *of the world's mined supply of rare earths is controlled by China*

Since 2011, China has recognised the rare-earth elements required for clean energy technology as a strategic resource. > The need for cobalt, nickel, lithium and other minerals could lead to increased competition for access to them. > It is possible that access to these elements will be used, as oil has been, for energy 'statecraft'.

REGIONAL OR STATE INSTABILITY

The largest reserves of metals and minerals required for battery production are found in weak states with poor governance records. > Investment in resource extraction can lead to environmental degradation, civil unrest and instability.

SECOND AND THIRD ORDER EFFECTS

ECONOMIC SHOCKS AND FINANCIAL INSTABILITY

US$19 trillion *The estimated revenue for the oil industry that will be wiped out by 2040, by the adoption of electric cars*

Large scale loss of oil industry revenue would mean lower tax revenues for governments reliant on the oil industry. > This is particularly concerning for Russia, and the Commonwealth of Independent States. > Lower oil industry revenues leads to poor returns for institutional investors including pension funds. > This is followed by a decline in institutional investment in oil and the industry less able to raise capital.

SCOPE AND DEFINITIONS

The primary objective of this analysis is to raise awareness, particularly amongst policymakers, of the potential of a rapid shift towards electric vehicle ownership to impact the decision-making of major global powers, and in turn international relations. The paper therefore takes an expansive view the term **geopolitics**. We use the Penguin Dictionary definition as 'a method of foreign policy analysis which seeks to understand, explain and predict international political behavior primarily in terms of geographical variables, such as location, size, climate, topography, demography, natural resources and technological development and potential.' Oil or other resources like rare earth minerals as drivers of political behavior clearly fall under this definition, as would technological capacity for battery production or growth in urban populations and the impact on air pollution, for example.

Electric Vehicles (EVs) are defined here as any vehicle that derives all or part of its power from electricity – not necessarily from the grid. This includes battery-electric vehicles, plug-in hybrids, conventional hybrids and hydrogen fuel cell vehicles (HFCVs), the latter of which powers an electric motor by converting hydrogen gas into electricity. Objections might be raised to the inclusion of hydrogen cars which are viewed by many to be in competition with battery technology. We include hydrogen fuel cell vehicles here because a largescale shift towards hydrogen would have similar geopolitical implications as a largescale shift towards battery powered vehicles in areas like international trade, oil demand and employment impacts in auto markets and supply chains.

The analysis takes a similarly expansive view of **Eurasia** as a geographical focus, which in this analysis refers to the combined continental landmass of Europe and Asia. The analysis focuses on China, France, Germany, Japan, South Korea, and the United Kingdom. We also include the United States given its extensive economic and security interests in the region. These countries were chosen due to the combination of their significant geopolitical influence and the size and reach of their auto markets. Many other countries in Eurasia could be included in this kind of analysis; notable gaps would include Russia given its dependence on oil rents, and India as rapidly growing auto market, to offer just two examples. Such an extensive analysis was beyond the scope of this study but would be useful as a future project.

CHAPTER 1: INTRODUCTION

Electrification of the transport sector is underway. Most forecasts predict significant growth in the market penetration of electric vehicles (EVs) in the coming decades. While they are starting from a low base, global sales for plug-in electric vehicles were 2.1 million in 2018 – a growth of 64% compared to the previous year[1].

EVs are likely to be cost competitive with internal combustion engine (ICE) vehicles within the next five years[2]. At the high end of available forecasts, EVs make up a third of the road transport market by 2035 and more than two thirds of market share by 2050, leaving oil demand flat from 2020 to 2030 and falling steadily thereafter. Such a scenario translates to 2 million barrels of oil per day (mbd) displaced by 2025 and 25mbd by 2050. By one estimate, EVs could wipe-out of $19 trillion in revenue from the oil industry by 2040[3].

There is an emerging literature on the geopolitics of the energy transition but the role of electric vehicles in this space is relatively under-developed. **There is a need for better understanding of the key drivers and possible scenarios to help mitigate the risk of geopolitical tensions and a disorderly energy transition as well as to identify avenues for dialogue and stronger rules-based international cooperation.**

The objective of this research was to explore how nation states might respond to rapid and potentially disruptive market penetration of electric vehicles (EVs). The report examines how key economic, foreign policy and security actors are envisioning the future of electric vehicles and to assess the geopolitical implications of these scenarios for the Eurasia region. The approach is based on extensive desk-based research supported by interviews with economic, foreign policy, intelligence and security experts from multiple countries.

Chapter 2 provides an overview of core drivers and regional trends, with a focus on the transport sector, as well as a review of the available forecasts and various governmental policies and private sector initiatives. Chapter 3 presents a forecast of medium term (10-15 year) geopolitical impacts spanning a range of security and economic dimensions. Chapter 4 reviews foreign policy and security futures including a review of government documents and grey literature as well as expert and stakeholder interviews. Chapter 5 concludes with recommendations for future analysis and for aligning public officials and other influencers around a common agenda aimed at mitigating the risk of geopolitical tensions and a avoiding a disorderly energy transition.

[1] Roland Irle (2019) **Global EV Sales for 2018 – Final Results**

[2] Bloomberg New Energy Finance (2019) **Electric Vehicle Outlook**

[3] Aurora Energy Research (2018) **Rapid Technological Shifts Could Wipe $21 Trillion of fossil fuel company revenues by 2040**

CHAPTER 2: TRENDS, DRIVERS AND FORECASTS

Trends

According to the International Energy Agency (IEA), EV sales surpassed 1 million in 2017 and a 3% share of the global car stock[4]. Figures for 2018 from the Electric Vehicle World Sales Database show a doubling in overall sales from the previous year and even higher year-on-year growth[5].

EV sales have been growing at 40-50% per annum[6]. Growth is concentrated in a handful of countries with China accounting for more than half of global sales, more than double that of the US which is the second largest market. EV sales in China increased 72% in 2017. The largest market share is in Norway where EVs accounted for 50% of sales in 2018, followed by Iceland and Sweden. While EVs accounted for 2.5% of new car sales overall in the United States in 2018, this varies by state; in California for example that figure was 8%[7]. There has also been significant growth in electric buses and two-wheel vehicles in several countries, including China.

EV infrastructure is also increasing rapidly but a significant amount of additional investment will be required to meet some of the higher-end EV forecasts. Most EV chargers are privately-owned but would require public infrastructure to help manage the increase in demand from the electricity grid[8].

Three of the top four trends in the most recent Global Automotive Executive Survey are related to electric mobility – including fuel cell electric mobility, battery electric mobility, and hybrid electric mobility. These are followed by issues of connectivity and digitalization[9]. Consumer preferences are also shifting. Recent surveys suggest that a significant number of drivers and even higher share of millennials either expect to own, or would consider purchasing, an EV[10].

Drivers

Technology push

The past decade has seen significant innovation in low carbon energy technologies and falling costs. This Includes the growing cost competitiveness of solar and wind

[4] IEA (2018) **Global EV Outlook**

[5] Roland Irle (2019) **Global EV Sales for 2018 – Final Results**

[6] McKinsey & Co. (2019) **Global Energy Perspective 2019**

[7] EVAdoption (2019) **California EV Sales Market Share Reaches 9.90% in August**

[8] ICCG (2017) **The Road Ahead for Electric Vehicles**

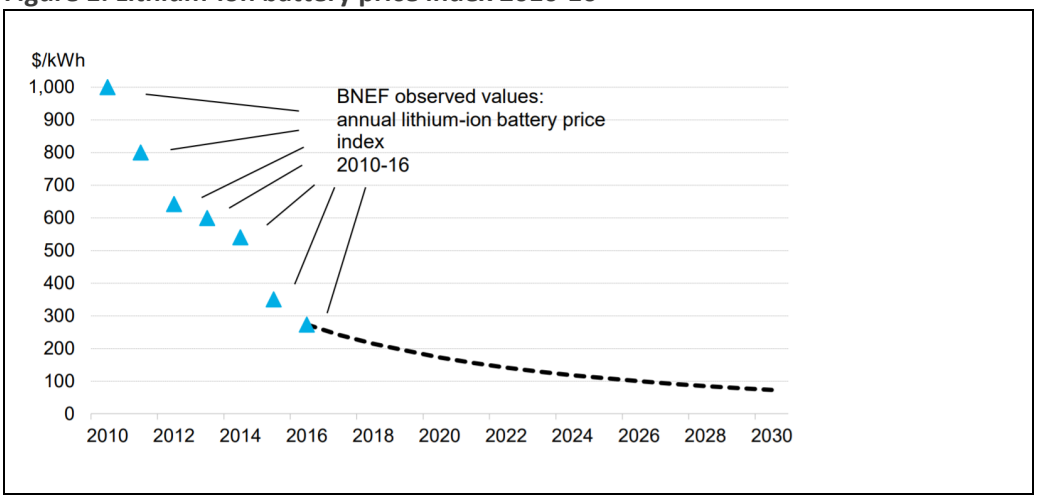
[9] KPMG (2018) **Global Automotive Executive Survey**

[10] McKinsey & Company (2018) **Three surprising resource implications from the rise of electric vehicles**

energy, deployment of smart grid technologies and systems and the falling costs of batteries and storage technology. For EVs this also includes lower costs of other components including power electronics, electric motors transmission and motor housing costs which could fall a further 10-25% by 2025[11]. EVs have fewer parts than ICEs which also reduces costs associated with labor or repair, and increased production of EVs and batteries will lead to economies of scale and efficiency. Taken together these would support a shift towards decentralized electricity systems that could lead to very rapid penetration of new technologies.

The cost of lithium-ion batteries accounts for most of the difference in cost between ICEs and EVs. Battery prices have dropped 79% since 2010 and cost parity between internal combustion engines and electric vehicles could arrive in the latter half of the 2020s[12]. Research is also underway on the next generation of battery technologies, including solid state batteries as an alternative to liquid electrolytes[13]. These batteries would, if successfully produced at scale, be lighter and maintain a charge longer, as well as being safer and charging faster and using less cobalt, which could address some of the major barriers to largescale penetration of EVs.

Figure 1. Lithium-ion battery price index 2010-16



Source: Bloomberg New Energy Finance, 2017

Decentralization and Digitalization

Falling technology costs, digitalization and innovation is fundamentally changing electricity networks. This includes a move away from large-scale centralised power plants sending a one-way, predictable supply of power to end-users who cannot respond to price signals or sell excess power back into the grid. Increasingly the instrumentation, communications and analytics are available that allows power network infrastructure to be operated in a dynamic and efficient manner – often

[11] Narayanan, A. (2018) **How To Make Electric Vehicles Profitable As Tesla, GM Look To Build Millions**. Investors Business Daily.

[12] Bloomberg New Energy Finance (2018) **McKerracher: BP's Energy Outlook and the Rising Consensus on EV Adoption**

[13] S&P Global (2018) **Electric Vehicle Solid State Battery Technology Likely a Decade Away**

referred to as the smart grid. These changes are increasing the capacity of countries to achieve a zero-carbon power sector rapidly and cost effectively. Heat pumps and electric vehicles have inherent storage capabilities that can contribute to system balancing and reduce the need for excess capacity. Electric vehicles are potentially one integrated component of a new power system that includes significant increases in decentralized renewables energy, energy storage (including EVs), and demand side management.

Climate change and air quality

Meeting the 1.5C target set under the Paris Agreement requires the decarbonization of the global energy system by mid-century. The transport sector accounts for roughly 15% of global emissions, mostly from the burning of petrol and diesel fuel. Greater efficiency for example from ramping up fuel economy standards or other technological improvements would be helpful but will not lead to complete decarbonization. Meeting even just the 2C target would require half of all passenger cars to be electrified by 2050; for 1.5C almost all cars would need to be zero emissions[14].

Air quality is also a major public health issue in many parts of the world and particularly in heavily populated cities in emerging economies. Rising pollution levels come with enormous costs: in 2013 air pollution caused 5.5 million premature deaths and $225bn in lost labor income[15]. Growing public concern about urban air quality and greater awareness of the issue – as seen for example in the highly popular Chinese documentary "Under the Dome" – is leading to action by many governments. Political Economy Mapping undertaken recently by E3G also found high levels of concern within several major emerging economy governments about potential public backlash against urban smog, as well as a high level of interest amongst government officials in EVs as a potential solution as private cars are responsible for almost three-quarters of urban air pollutants[16]. EVs have been found, on average, to produce lower emissions over their lifetime than combustion engine vehicles, although comparisons differ depending on the country and vehicle studied, and EV benefits are smaller in countries that are heavily reliant on coal[17].

Consumer preferences

According to surveys a rising share of the public want or expect to buy EVs[18]. In addition, demand for ICEs has been falling in the largest markets including China, the EU and United States. Some analysts are predicting a peak in ICE sales in 2018[19]. This

[14] **Climate Action Tracker 2018**

[15] World Bank (2016) **Air Pollution Deaths Cost Global Economy US$225 Billion**

[16] World Resources Institute (2015) **Transport Plays a Key Role in Urban Air Quality**

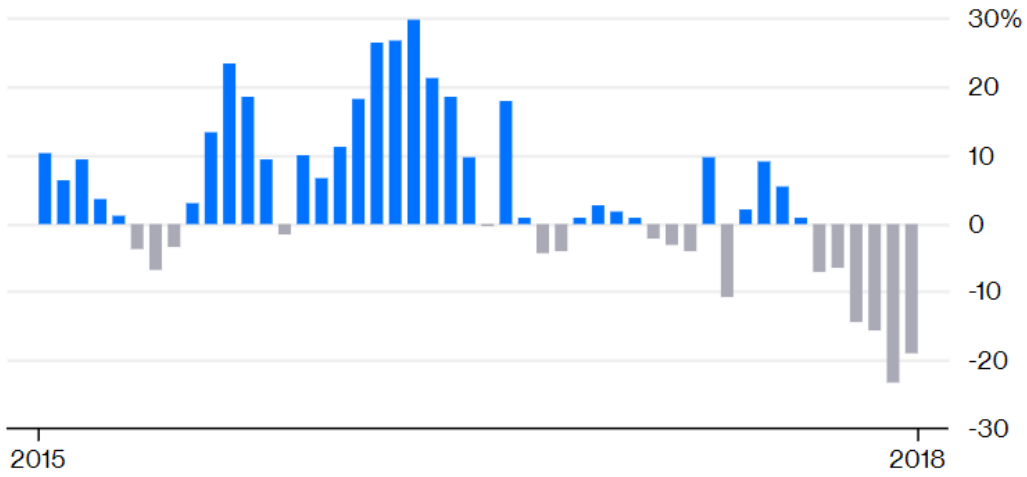
[17] Carbon brief (2019) **Factcheck: How electric vehicles help to tackle climate change**

[18] Transport & Environment (2018) **Forty percent of Europeans say the next car they buy is likely to be electric - poll**

[19] McGee, P. (2018) **Combustion engine car sales to hit peak demand in 2018, say analysts** Financial Times December 30 2018.

could result from a variety of factors including higher efficiency standards and the ongoing trade disputes between multiple major economies. Passenger vehicle sales in China have been falling as EV sales have been growing, as shown in Figure 2 below. Sales in November 2018 had fallen 20% from the previous year[20].

Figure 2. China internal-combustion-engine passenger vehicle sales growth, year on year



Source: Bloomberg New Energy Finance, 2019

National strategies and policies

EVs feature prominently in the national strategies of several of the world's largest economies, including China and India. Table 1 below provides an overview of national EV targets. China has arguably gone further than any other country in supporting EVs through government policies and subsidies – including approximately $58bn in government spending to support the supply and demand of new energy vehicles (NEVs)[21]. New Energy Vehicles (NEVs) are one of the 10 advanced industries in the "Made in China 2025" plan. Chinese credits and subsidies, and a possible ban on petrol and diesel engines, could make it account for roughly half of the EV market by 2025. China also has two of the world's top five lithium battery makers[22]. There is also a security imperative for China as a large oil importer in reducing dependence and on the US for protecting supply chains, as discussed further in Chapter 3.

[20] Nathaniel Bullard & Colin McKerracher (2019) **Dispelling the Myths of China's EV Market** Bloomberg February 8, 2019

[21] Scott Kennedy (2018) **China's Risky Drive into New Energy Vehicles** CSIS

[22] Kana Inagaki, Henry Sanderson & Charles Clover (2018) **Global carmakers race to lock in lithium for electric vehicles**

China's EV strategy and supporting policies

The Chinese government classified New Energy Vehicles (NEVs) as a "strategic emerging industry" in 2010. This followed roughly a decade of NEV development through China's five-year development plans. The government plans for annual NEV production and sales to reach 4.6m by 2020 and eventually ban ICEs entirely. China finalized its NEV mandate in September 2017. Automakers that sell 30,000 cars or more annually in China to produce fleets with a Corporate Average Fuel Economy of 42 miles per gallon (5.6 liters per 100 kilometers) by 2020, and 54.5 mpg (4.32 l/km) by 2025. The policy establishes NEV credit targets of 10% of the conventional passenger car market in 2019 and 12% in 2020. China supplies incentives to manufacturers of EVs but also subsidies to consumers of $3,000 to $6,600 per vehicle with local governments adding 15% to 50%[23]. Cities also offers other incentives such as exemptions from certain regulations. Subsidies increase for vehicles with a higher range per charge and for higher battery pack densities.

The economic and strategic importance of EVs has also been recognized by developed countries including the EU, Japan and Korea, as well as the United States, at least at the subnational level.The German Ministry for Economic and Energy Affairs and the French Economy and Finance ministries have published a joint manifesto for a European industrial policy "fit for the 21st century which includes a commitment to disruptive innovation in health, energy, climate security and digital technology. This focuses on investment in breakthrough and cutting-edge technologies, specifically on a new generation of batteries. France and Germany both have plans to boost production of battery cells for electric cars largely in response to the market dominance of battery companies in Asia[24]. The German government's minister for education and research has referred to battery technology as an "existential" matter given the reliance of the German economy on the auto industry for jobs and growth. Cars account for one-fifth of German exports and one-third of its spending on research and development[25].

In South Korea, EV demand has increased in response to a package of policies aimed at addressing air pollution, enacted in 2017[26]. The government also has plans to double the number of rapid charging stations available in the next few years. Japan has set a target that all Japanese vehicles sold must be at least partly electric by 2050. The Japanese plan includes subsidies for battery manufacturers and support to car companies to ensure a stable supply of metals[27]. The US does not have a national target for EV deployment. Under the Trump Administration, US energy policy has

[23] Jack Perkowski (2018) **What China's Shifting Subsidies Could Mean For Its Electric Vehicle Industry** Forbes July 13 2018 3

[24] ClimateWire (2019) **France to boost investment in battery cells**

[25] Akshat Rathi (2019) **The complete guide to the battery revolution** Quartz April 1 2019

[26] Argus (2018) **South Korean EV sales rise amid air quality push** 5 November 2018

[27] The Asahi Shimbun (2018) **Japan sets goal of selling only 'electric' vehicles globally by 2050**

focused on promoting and scaling up investment in fossil resources including oil and attempting to roll back fuel efficiency standards[28]. There is a federal EV tax credit, however, and most US states have supportive policies. Several of the largest US states have set penetration targets including California's policy of 5 million zero-emission vehicles on the road by 2030[29].

Fuel efficiency and emission targets for cars are another driver of EVs. The EU for example has mandated new carmakers cut the average fleet emissions to 95 grams per kilometer of CO2 by 2021. Average emissions in 2018 were 121g suggesting that meeting the efficiency target could be very expensive for the industry – in the order of tens of billions of euros[30]. Credits received by carmakers for EV production can be used towards meeting the emission target.

Table 1. Overview of governmental EV targets

Country	Target
China	• Share of alternative fuel vehicles of at least 20% by 2025 = 7 million cars • 4.6 million EV car sales by 2020 • End production of ICE vehicles by 2040
European Union	• EV chargers at parking spaces in 10% of buildings by 2023 • Emission reduction target for new cars of 95 gCO2 per km by 2021
France	• Ban on petrol and diesel sales by 2040
Germany	• 1 million EVs by 2022
India	• 30% of all vehicles electric by 2030
Israel	• No new ICE sales after 2030
Japan	• All vehicles at least part electric by 2050
Netherlands	• 100% emission free new cars by 2030
Norway	• Ban on petrol and diesel car sales by 2025
South Korea	• EVs account for 30% of auto sales by 2020
UK	• Ban on petrol and diesel car sales by 2040
California	• 5 million zero-emission vehicles by 2030
New York	• $250 million electric vehicle expansion initiative 10,000 Vcharging stations by the end of 2021

[28] Steven Mufson & Brady Dennis (2019) **Trump administration quits fuel efficiency talks with California** 9

[29] Office of Governor (2018) **Governor Brown Takes Action to Increase Zero-Emission Vehicles, Fund New Climate Investments**

[30] Peter Campbell & Patrick McGee (2019**) Europe car groups face huge profit hit to cut CO2**. Financial Times April 15, 2019.

Financial sector risks and incentives

Alongside national and subnational policies, central banks are also beginning to take the risk of climate seriously and are warning of sharp and sudden drops in asset prices and negative effects on productivity and growth[31]. Along with physical risks are transition risks whereby policies to mitigate climate could impact asset values. Central banks and supervisors have come together to form the Network for Greening the Financial System (NGFS) to address these challenges. What was initially seen as a long-term threat to financial stability has quickly become a more immediate concern. Financial institutions representing $100tr in assets including 23 global systemic banks, 8 of the top 10 global asset managers, the world's leading pension funds and insurers, and the two dominant shareholder advisory service companies publicly supported the Task Force on Climate Related Financial Disclosures (TCFD) recommendations[32]. Shareholders have increasingly been pressuring oil companies to disclose their climate-related risks and take measures to mitigate emissions[33].

Market pull

In response to changing demand and regulatory pressures, most of the major automobile companies have announced EV targets or investments. Tesla has been a dominant player and leads the world in overall sales[34]. But other major companies have entered the market for batteries or EVs with overall investment totaling roughly $100 billion. These include Daimler ($11.7 billion to introduce 10 pure electric and 40 hybrid models) and Ford ($11bn) as well as Nissan which produces the top selling Leaf. Volkswagen AG has announced it will spend $40 billion by 2030 to build electrified versions of its 300-plus global models and has awarded $48 billion in contracts to purchase batteries. Volkswagen plans to build up to 22 million electric cars and 70 new models over the next decade[35] and claims to have designed a new model that can go about 370 miles on a single charge[36]. General Motors plans to launch 20 new battery and fuel cell electric vehicles by 2023. Most private sector EV investment has been in Germany, followed by China and the United States[37]. However, most of the investment in EVs from European carmakers has gone towards producing EVs in China due to China's ambitious EV mandate, the size and potential of the market and the requirement that carmakers set up joint ventures with Chinese manufacturers[38].

[31] Jana Randow and Piotr Skolimowski (2019) **Central Banks Are Thinking Greener as Climate Change Hits Policy** Bloomberg April 2 2019

[32] Bank of England (2018) **Transition in thinking: The impact of climate change on the UK banking sector** f

[33] Susan Moran (2019) **Most Oil Giants Still Fighting Shareholder Pressure to Address Climate**. Climate Liability News April 11, 2019 /

[34] Bridie Schmidt (2019) **Tesla Model 3 outsold all other EVs in 2018, while China charged ahead** The Driven march 14, 2019 /

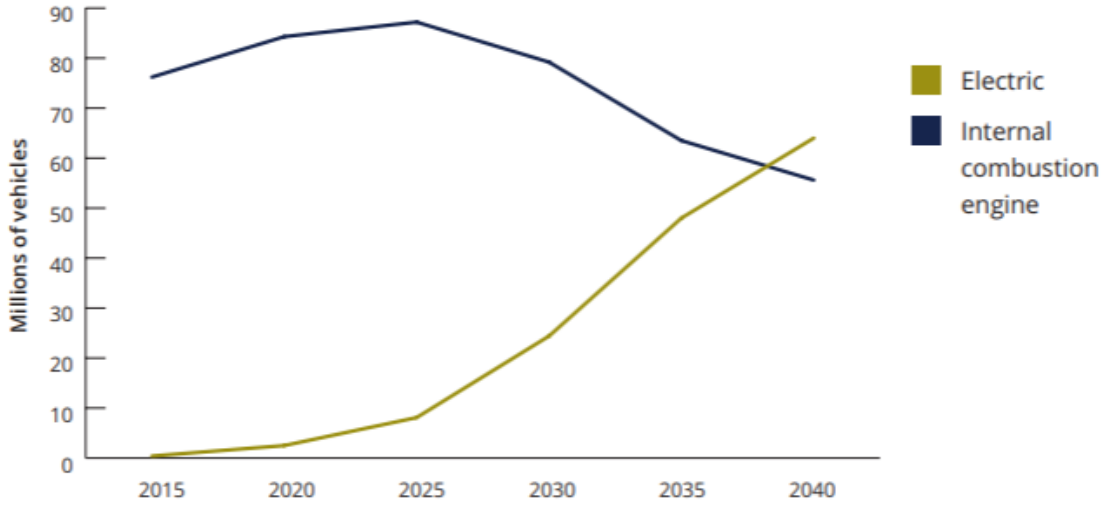
[35] Domenick Yoney (2019) **Volkswagen Plans 22 Million Electric Cars in 10 Years** Inside EVs March 12 2019 /

[36] Geoffrey Fowler (2018) **Tech predictions for 2019: It gets worse before it gets better** Washington Post December 27, 2018

[37] Paul Lienert (2018) **Global carmakers to invest at least $90 billion in electric vehicles** Reuters January 15, 2018. W

[38] Frédéric Simon (2018) **China dwarfs Europe on EV investments, figures show** Euractiv June 22, 2018 /

Figure 3. Sales of EVs and ICEs



Source: Bloomberg New Energy Finance, 2017

In addition to carmakers, most of the international oil companies (IOCs) now have some level of exposure to EV markets or supply chains. This includes supporting R&D into next generation electric storage technologies, direct investments in battery companies or charging infrastructure[39]. BP has purchased a vehicle charging station company, as well as investing in mobile charging station battery technology firm. Shell has recently purchased NewMotion, a charging station company with more than 30,000 installations across 25 European countries[40]. Equinor has an investment in ChargePoint which sells charging equipment for electric vehicles[41]. These investments are partly a response to calls from shareholders for better climate risk disclosure, as well as concerns about declining oil demand. The world's largest independent energy trader has predicted peak oil demand in 15 years and signaled it intends to focus on clean fuels and power trading[42].

[39] John Fialka (2019) **Oil majors see a climate threat – to their bottom line** ClimateWire January 5 2019

[40] Karolin Schaps (2017) **Shell buys NewMotion charging network in first electric vehicle deal** Reuters October 12 2017 V

[41] Equinor (2018) **Equinor towards 2030** l

[42] Ed Crooks and Anjli Raval (2019) **Oil majors and utilities begin to battle for power** Financial Times March 25, 2019

Barriers

Bullish forecasts and excitement about EVs as a new market must be weighed against existing technological and economic realities. Every scenario reviewed as part of this research shows significant EV growth. But to reach a scale that would have significant impact on oil demand, for example, EVs will need to overcome several barriers that do not have easy solutions. It is also worth noting that demand for freight transport, aviation and petrochemicals are all likely to increase which will also affect oil demand. Barriers to higher EV adoption include:

- **Charging infrastructure**: Charging times vary depending on the electrical current and the battery, but in all cases EV charging takes significantly longer than it does to refuel an ICE. Research is underway to improve fast-charging technology, but this raises the risk of batteries overheating. Additionally, there are not enough charge points to meet projected future demand and standardization is also a challenge, although legislation has been introduced in some countries to address this issue[43]. It will be difficult to integrate charging infrastructure into urban areas where most people don't own private driveways and charge points, although this varies by geography – for example while three quarters of US EV owners have access to private charging points, the number is only 40% for Europe and 30% for China[44]. Goldman Sachs has estimated $6 trillion of investment could be required for EV infrastructure[45].

- **Range anxiety**: Average EV range is a difficult metric to capture but a review of available estimates suggests it currently stands at roughly 100 miles per charge, with top ranges above 300. However, range is still a concern for consumers and is also related to the infrastructure challenge – on longer trips drivers need to plan a route with known charge points. Lower temperatures can also significantly reduce battery range[46].

- **Cyber risk**: EVs and associated charging infrastructure could be vulnerable to cyberattacks. This is especially true when thinking about EVs as themselves being distributed energy resources that are part of a wider innovations in the electricity ecosystem including smart grid components such as sensors or demand side technologies. While some cyber risks are manageable with existing IT solutions, it is possible that innovation will be required to build resilience to unexpected threats to an increasingly interconnected transport architecture[47].

[43] Andy Miles (2019) **Standardization of EV Charging in the EU** CleanTechnica February 16, 2019 /

[44] McKinsey & Co (2018) **The surprising resource implications from the rise of electric vehicles**

[45] Anjani Trivedi (2018) **The $6 Trillion Barrier Holding Electric Cars Back** Bloomberg November 4 2018 n

[46] Tom Krisher (2019) AAA: **Cold weather can cut electric car range over 40 percent** AP February 7, 2019

[47] Nihan Karali (2017) **Cyber-security of PEVs** Lawrence Berkeley National Laboratory f

From a decarbonization perspective, EVs on their own are not a panacea. If the electricity on the grid is being supplied primarily by coal or gas the impact on climate risk could be either negligible or potentially even worse than the status quo. However, with wind and solar reaching grid parity in many countries leading to a shift from coal to gas and renewables there are reasons to believe that electricity grids are likely to become lower carbon as opposed to more fossil-heavy.

Importantly, research has shown that Battery Electric Vehicles (BEVs) expend fewer GHGs over their lifecycle than ICEs[48]. Electric cars generate half the emissions of the average comparable gasoline car, even when pollution from battery manufacturing is accounted for. This ratio is likely to improve as batteries become even more efficient.

Forecasts

EV forecasts should be considered critically, as each have their own biases and assumptions. They vary with respect to definitions of what counts as an EV, battery costs, time period assessed and other assumptions making direct comparison difficult. There are also differences in how temperature scenarios and climate policy is treated. A more detailed breakdown of these assumptions has been done by Columbia University's Center for Global Energy[49]. One of the key findings of that study, notably, was a consensus of low or zero oil demand growth over the next two decades.

While recognizing these caveats, it is notable that even very conservative forecasts show significant growth in EV market penetration to 2050 due to a combination of falling battery and technology costs, regulatory reform and supportive policy.
At the lower end of the forecasts, BP sees the total number of EVs rising from 3m to more than 300m by 2040. At the high end, the Carbon Tracker Initiative predicts that EVs could make up a third of the road transport market by 2035 and more than two thirds of market share by 2050. That would leave oil demand flat from 2020 to 2030 and then falling steadily to 2050. Such a scenario translates to 2 million barrels per day (mbd) displaced by 2025 and 25mbd by 2050.

[48] Union of Concerned Scientists (2015) **Cleaner Cars from Cradle to Grave**

[49] Marianne Kah (2018) **Electric Vehicles and Their Impact on Oil Demand: Why Forecasts Differ** Columbia Center on Global Energy Policy f

Table 2. EV forecasts

	# of EVs	Year	Oil demand	% of vehicle sales
IEA NPS	125m (light duty vehicles)	2030	2.57 mb/d	13%
IEA EV30	220m (light duty vehicles)	2030	4.74 mb/d	12%
BNEF	500m (passenger EVs)	2040	13.7 mb/d	57%
BP ET	320m	2040	2.5 mb/d	25%
Carbon Tracker	400m	2035	10.6 mb/d	35%

International Energy Agency (2018) Global EV Outlook

Bloomberg New Energy Finance (2019) Electric vehicle Outlook

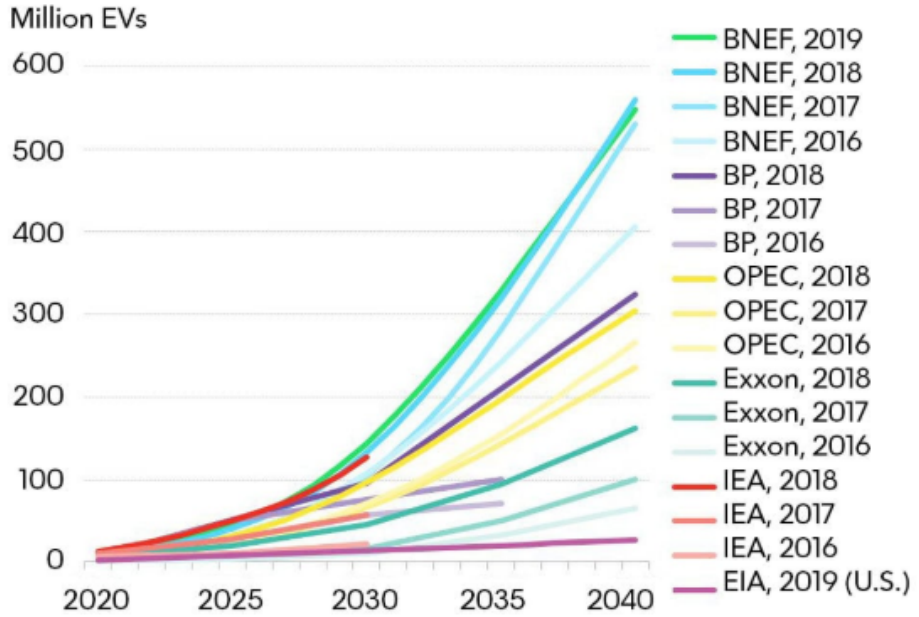
BP (2019) Energy Outlook

Carbon Tracker (2017) Expect the Unexpected: The Disruptive Power of Low-carbon Technology

Passenger vehicles make up approximately one quarter of oil demand, and many analysts are predicting significant growth in demand from the petrochemicals and aviation sectors. This could partially offset reduced demand from the penetration of EVs.

As shown in Figure 4, forecasts have consistently underestimated EV deployment and other clean energy technology adoption rates. There are many recent examples of new technologies being adopted at exponential rates, suggesting that the standard forecasting models are more likely to underestimate rather than overestimate future EV penetration.

Figure 4. Forecasts of global EV penetration



Source: BloombergNEF, organization websites. Note: BNEF's 2019 outlook includes passenger and commercial EVs. Some values for other outlooks are BNEF estimates based on organization charts, reports and/or data (estimates assume linear growth between known data points). Outlook assumptions and methodologies vary. See organization publications for more.

Source: BNEF EV Outlook 2019

CHAPTER 3: GEOPOLITICAL IMPLICATIONS

The review of relevant trends and available forecasts suggests that EVs are highly likely to make up a steadily increasing share of auto sales in the coming decades under almost any scenario. Factoring in technology drivers like digitalization, the growing awareness of governments of the need to manage the risks of climate change and air pollution, and changing consumer preferences, there are reasons to believe that electrification of the transport sector could happen faster than most mainstream forecasts are predicting. History shows that fast energy or technological transitions can be highly disruptive and the level of interconnectedness of the global economy today increases these risks.

The rapid adoption of EVs on a global scale would have far-reaching implications, spanning trade, security, economic and social spheres. There are implications for global supply chains, including in auto markets but also with respect to the availability of rare earth minerals and other resources. There are also second and third order impacts that would likely result from the decline in revenues and taxes in oil producing countries. With greater electrification comes interconnection and possibly interdependence. Control of electricity grids and storage capacity could become more important than control of fossil fuel resources but would also open new cyber risks.

This chapter provides a high-level overview of the potential impacts of widescale and rapid adoption of EVs for the Eurasia region.

International Trade

The automobile industry and its supply chains represent a significant share of many developed country economies. While most of the world's major car producers are in the Eurasia region, any disruption to the production of cars or auto supply chains will have global repercussions.

- **China**: China is the world's largest auto producer[50]. It accounts for 30% of worldwide vehicle production which is larger than the US, EU and Japan combined[51].

- **United States**: Automakers and their suppliers are responsible for 3% of America's GDP, and one of the largest sources of American manufacturing jobs[52]. Over the past five years, automakers have exported more than $692 billion in vehicles and parts.

[50] Anjani Trivedi (2018) **Uncover your eyes: There's no China car crash** Bloomberg October 14, 2018

[51] Statista **Automotive Industry in China: Manufacturing – Statistics & Facts**. Accessed in May 2019.

[52] AAPC (2018) **US Economic Contribution Report**

- **European Union**: According to the European Automobile Manufacturers Association (ACEA), the automotive sector provides direct and indirect jobs to 13.3 million Europeans, representing 6.1% of total EU employment; the 3.4 million high-skilled jobs in automotive manufacturing represent 11.3% of the EU's total manufacturing employment[53] generating a trade surplus of €90.3 billion for the European Union. Taxation on motor vehicles is worth €413 billion annually in the EU-15 Member States. In Germany alone, cars represent 13% of extra-EU exports and €70bn in revenue[54]. Domestic auto sales in Germany are over 400bn[55].

- **Japan**: 5.5 million people, or 8.7% of Japan's workforce are employed in automotive manufacturing and related industries. Auto parts manufacturing accounts for over 600,000 jobs in the sector, and another 390,000 jobs are allocated to the production of raw materials and basic equipment used in automotive manufacturing[56].

- **South Korea**: The auto industry accounts for 7% of South Korea's GDP and employs 7% of the manufacturing sector – roughly 235,000 people[57]. The country is home to two of the world's largest auto companies – Hyundai and Kia.

EVs could impact trade in at least two ways:

The rise of 'green' free trade agreements: EV costs must decline rapidly to meet their full market growth potential in a way that delivers a transport sector that is compatible with limiting global temperature rise to 2C. This implies an expansion of global supply chains as well as regulatory cohesion and market integration that would deliver economies of scale[58]. This inter-dependence is also a priority for delivering climate security objectives, including greater transnational cooperation and management of climate risk. Truly scaling up EVs implies a significant role for policy to support innovation and resource efficiency including through better recycling of EV materials. Growth in demand for EVs could therefore lead to an increase in trade of vehicles as well as for ultra-efficient batteries and other components. Achieving these outcomes would require countries taking steps to remove trade-related barriers of EVs and their components. The payoff of EV trade could be significant: **the global EV market was approximately $120bn in 2017 and is projected to reach $567bn by 2025 growing at Compound Annual Growth Rate (CAGR) of 22%[59].**

[53] ACEA (2018) **New Figures underline the importance of Europe's auto industry**

[54] Eurostat (2019) **International trade in cars**

[55] Statista (2019) **Automobile industry in Germany**

[56] Caylon Neely (2017) **The Japanese Automotive Industry** Japan Industry News December 19, 2017

[57] Song Jung-a & Edward White (2018) **South Korea throws struggling car parts suppliers a $3bn lifeline** Financial Times 1

[58] ICTSD (2018) **The Role of Trade Policy in Enabling the Global Diffusion of Electric Vehicles** f

[59] **Global Electric Vehicle Market 2018-2025: A $567.3 Billion Opportunity** BusinessWire August 27, 2018

Unfair social transition and strategic trade tensions: The integration of EV markets brings with it the potential for exacerbating trade tensions given the potential disruption of existing industries in EU, US and Japan in particular. Job losses of up to 3 million, or 25% in the major exporters (US, EU and Japan) in the absence of retraining programs are possible due to the extensive reach of the ICE supply chain[60]. Additionally, EVs could lead to tensions over the use of government subsidies to support domestic industries, as well as rules around access to technology and Intellectual Property Rights. If countries with deeply embedded interests in and legacy around the auto industry struggle to create and adopt the best EV technologies, it could prompt governments to raise rather than remove trade-related barriers. These kinds of developments fall against a backdrop of growing threats to multilateralism and the World Trade Organization (WTO).

It is also important to consider how recent dynamics in international trade more generally could in turn impact the level of integration of the EV market. While a rise in supply and demand for EVs would affect global trade, uncertainty around the future of several key bilateral trade relationships, particularly in the cases of the United States and China, and the United States and Europe, could also have significant implications for EV production and market penetration. The increase or decrease in global trade flows or imposition of tariffs or other barriers will determine which countries and companies are producing the batteries and other components as well as where those products are being manufactured[61]. Tariffs that are either currently in place, or that have been threatened on foreign cars or rare earth or other materials, could fundamentally alter plans of manufacturers and change the shape of global supply chains. Under a worst-case scenario this would significantly reduce trade in EVs leaving them concentrated it in the largest markets. It is notable that despite ongoing trade negotiations, some Chinese EV makers still have plans to sell new models in the United States[62]. Japan notably does not apply duties on either ICEs or EVs[63]. Some developing countries have pledged to limit tariffs on hybrid vehicles or EVs as part of their national contributions to the Paris Agreement[64].

The current geopolitical environment increases the risk that the largest auto producing countries decide to 'go-it-alone' on EVs. Under this scenario countries would not be investing in EVs to take a lead role in a growing global market but rather to gain a strategic advantage in terms of lower dependence on imported vehicles or energy. This scenario could result in the fragmentation of markets, all with different technologies and standards, leading to fewer total EVs, fewer jobs and a lower impact on emissions. This scenario could also result adversely impact cooperation on other issues, such as energy security or resource access.

[60] Michael Sheetz (2019) **Electric vehicles could cost the auto industry millions of jobs, a top analyst says** CNBC March 15, l

[61] Stratfor (2018) **Electric Vehicles Reach a Crossroads** https://worldview.stratfor.com/article/electric-vehicles-reach-crossroads

[62] Takeshi Shiraishi (2019) **Chinese electric cars prepare US blitz in 2020 despite trade war** Nikkei Asian Review February 27, 2019

[63] ICTSD (2018) **The Role of Trade Policy in Enabling the Global Diffusion of Electric Vehicles**

[64] Ibid

Energy security

Fossil fuels have been the cornerstone of energy security strategies, and oil has been a primary driver of geopolitics, for at least a century. A clear implication of EVs and the low carbon transition more broadly is the possibility of a of recalibration of many state-to-state relationships and regional dynamics. In Eurasia a contributing factor to these changing dynamics will be state investments in largescale energy infrastructure projects, including China's Belt and Road Initiative (BRI) and the EU's Connectivity Strategy.

One of the most influential factors in the response of governments to electrification of transport is the repositioning underway of many of the world's largest energy companies, both private and publicly owned. International Oil Companies (IOCs) are moving into the retail electricity space and in some cases investing in charging infrastructure for EVs. Several of the IOCs have recently acquired battery storage and EV charging companies in anticipation of faster growth in electricity than oil[65]. Many utility companies similarly see the growth in EVs as an opportunity to reverse falling revenues resulting from lower demand for energy and efficiency improvements. Enel, for example, by some accounts the largest energy company in the world, had installed close to 50,000 EV charging points by 2018. Several other large utilities have recently announced partnerships with auto companies to build out EV infrastructure[66].

In the very short term, any impact that EVs have on oil markets will likely fall within the normal range of market volatility. Looking beyond the next decade, however, a material impact on oil demand is possible. When EVs are considered in the wider context of a shift towards a low carbon energy system and taking account of revealed preferences and actions of major oil producers and oil companies as described above, it is clear the perception of lower demand is already affecting decision-making in ways that could have geopolitical implications.

Risk of instability in oil producing states*:* If the trend towards electrification continues or accelerates, countries with economies heavily reliant on rents from the oil industry are likely to see their global influence decline. Not only would their international ability to project power deteriorate but this could lead to instability domestically as these countries are often heavily dependent on revenue from the oil sector to invest in social programs and subsidies for food and fuel. In a world of declining oil demand countries with low production costs will have a significant advantage[67]. Countries with relatively high breakeven production costs will be exposed early and will need transition strategies and plans; these countries include Algeria, Angola, Chad, Colombia, Ecuador, Gabon, Iraq, Kazakhstan, Libya, Nigeria, Oman, Turkmenistan, Venezuela and Yemen[68].

[65] Ed Crooks & Anjli Raval (2019) **Oil majors and utilities begin battle for power** Financial Times March 25, 2019 2

[66] **Ibid**

[67] E3G (2018) **Crude Awakening: Making Oil Major Business Models Climate-Compatible**

[68] Matthew C Klein (2017) **Which oil exporters are most desperate for higher prices?** Financial Times July 11 2017

Several of the IOCs have struggled economically in recently years, largely funding their dividend payments to shareholders via borrowing from capital markets[69]. Some investors are already shifting away from fossil fuels to other opportunities, leading to oil and gas companies trading at low multiples relative to profits[70]. There is growing concern in oil and gas companies about the sustainability of their business models in the face of climate policy and physical impacts, partly in response to initiatives like the Task Force on Climate Related Financial Disclosures (TCFD). These concerns are leading some IOCs to shift investment towards the power sector including in renewables and electric vehicle supply chains. Given the exposure to the energy sector in large institutional investors and pension funds this could have cascading impacts throughout entire economies.

Changing national energy strategies, private sector investment and recognition of climate risk especially in the financial sector are already influencing the foreign policy of the world's major powers. The EU's Global Strategy and its growing focus on building resilience in the European neighborhood has been strongly influenced by the need to deal with multiple vulnerable states on its borders that are at risk of instability as oil revenues fall and volatility increases. China has similar concerns with respect to Russia, which relies on fossil fuels for half of its exports[71]. If oil declines in strategic importance it would likely correspond to a rise in the importance of battery technology. Countries are already hedging against this scenario. China is betting on EVs not just to address energy security but also to dominate technology markets and strengthen diplomatic relationships with countries that have clean energy targets[72] . As discussed in Chapter 2, France and Germany both have plans to boost production of battery cells for electric cars largely in response to the market dominance of battery companies in Asia[73]. It is notable that in both the IEA's New Policy and EV30by30 scenarios, China and the EU have the highest EV market share in 2030 despite the United States' historical leadership in battery innovation. Other forecasts show Europe overtaking the US as the number two EV market in the 2020s[74]. A world where batteries replace oil as a key geopolitical driver, but where the United States has fallen behind China and the EU in this market, would look very different.

Transnational energy infrastructure and The Belt and Road Initiative*:* China is the world's largest net oil importer and this dependence is expected to grow to 80% of oil demand by 2030 due to rising consumption alongside a large decline in domestic petroleum production. In 2017 alone oil imports cost China $162bn[75]. Chinese investment in EVs alongside the construction of pipelines in Central Asia as well as electricity grids through the Belt and Road Initiative (BRI) stems in part from a desire to reduce its reliance on the United States for protection of oil supply routes[76].

[69] E3G (2018) **Crude Awakening: Making Oil Major Business Models Climate-Compatible**

[70] David Sheppard (2019) **Investors risk losing faith in returns on offer from 'Big Oil'** Financial Times January 22, 2019

[71] Henry Foy (2017) **Russia struggles to unleash clean energy potential** Financial Times May 7 2017

[72] Amy M Jaffe (2018) **China's Coming Challenge to the US Petro-Economy** Council on Foreign Relations

[73] ClimateWire (2019) **France to boost investment in battery cells**

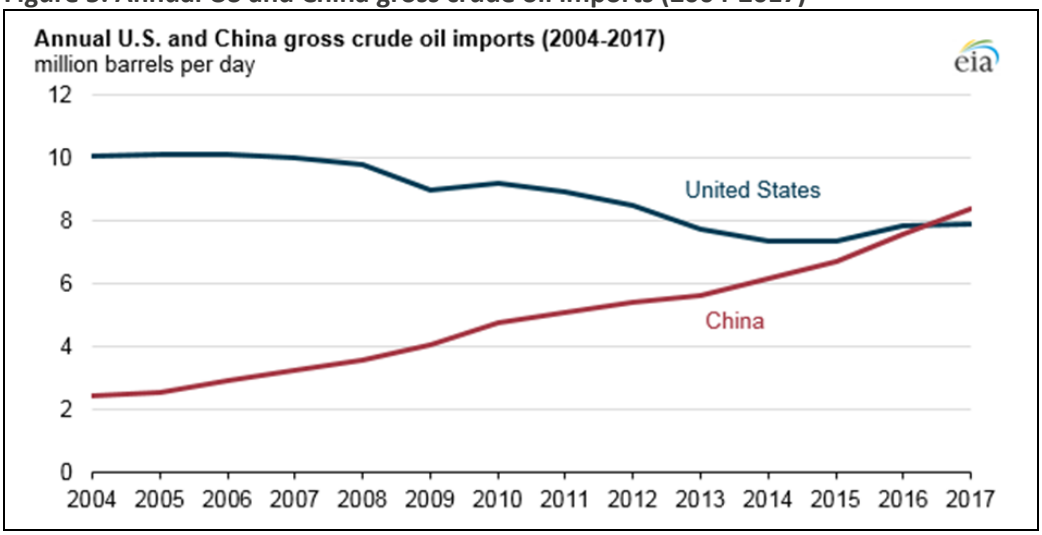
[74] Bloomberg New Energy Finance (2019) **Electric Vehicle Outlook 2019**

[75] Daniel Workman (2019) **Crude Oil Imports by Country** WREx

[76] Andrew Chatzky & James McBride (2019) **China's Massive Belt and Road Initiative** Council on Foreign Relations

Currently most oil and gas supply arrive via Sea Lanes of Communication (SLOC) choke points that are controlled by the US Navy – a fact that has not gone unnoticed by the Pentagon[77] or China[78]. The BRI and China's Made in 2025 strategy should be evaluated together – which suggest the BRI as a vehicle for bringing Chinese investment in clean energy technologies and EVs to the global market. The EU, China and Japan all want to avoid the impact of volatile oil prices on economic growth – especially as oil use declines and national oil companies (NOCs) become dominant. Japan also committed to spending $110 billion on infrastructure projects in Asia[79] and projects in central Europe, which some have referred to as Japan's own BRI[80]. Taken together, these drivers argue for a positive feedback loop precipitating faster phase out of ICEs.

Figure 5. Annual US and China gross crude oil imports (2004-2017)



Source: EIA 2018

While the gap between China's fossil fuel production and consumption has grown, it's largescale investment in renewable energy and EVs has moderated this increase. China's shift to low carbon sources moderated the growing fossil fuel gap by 20%, avoiding an extreme dependence on "geopolitical hotspots" for its fuel imports[81]. The founder and chairman of BYD, China's largest maker of battery-powered cars, has predicted that China's road transport will be 100% electric by 2030, due to the combination of concerns about air pollution but also oil security and particularly concerns about its lack of access[82].

While China and other major powers see overreliance on the United States for protecting oil supply chains as a risk, it is also a significant cost for the United States

[77] Samir Tata (2017) **Deconstructing China's Energy Security Strategy** The Diplomat January 14, 2017

[78] Amy M Jaffe (2018) **China's Coming Challenge to the US Petro-Economy** Council on Foreign Relations

[79] Andrew Chatzky & James McBride (2019) **China's Massive Belt and Road Initiative** Council on Foreign Relations

[80] Keith Johnson (2018) **Japan's Own Belt and Road Foreign Policy** February 9 2018

[81] John Mathews and Xin Huang (2018) **China's green energy revolution has saved the country from catastrophic dependence on fossil fuel imports** Energy Post March 21, 2018 /

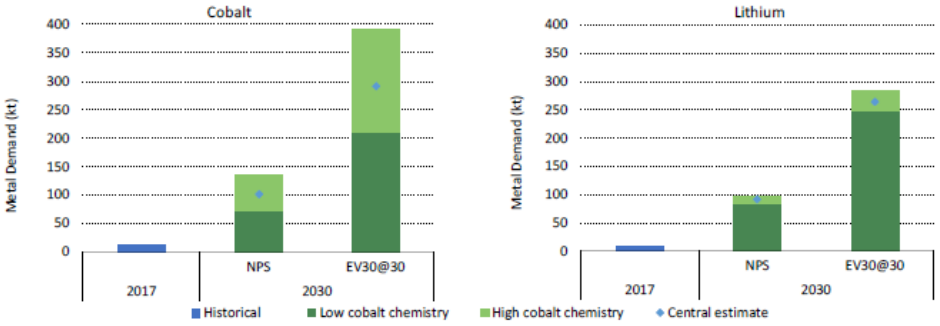
[82] Ed Crooks (2017) **The global importance of China's oil imports** Financial Times September 15, 2017 2

itself. Over half of US oil supply moves through one of seven major chokepoints that are largely found in unstable regions including the Middle East[83]. The US military spends approximately $81 billion per year protecting global oil supplies, or about 16% of recent Department of Defense (DoD) base budgets[84]. That implies a subsidy for all petroleum consumers of approximately $11.25 per barrel of crude oil. Former US intelligence officials have suggested that these subsidies are altering the behavior of the US military and are leaving other defense related priorities underfunded.[85] [86]

Competition for access to strategic metals and minerals

EV production, like clean energy technology more broadly, depends on the availability of various metals, minerals and rare earths elements (REEs). Most EVs use lithium-ion batteries, which have cathodes made of nickel, manganese and cobalt (NMC) but the list also includes copper, lithium, graphite and vanadium, among others. Demand for these commodities has already been rising. The costs of cobalt and lithium, for example, have doubled since 2015[87]. Analysts have pointed to the possibility that the supply of some of these metals could in fact slow the production of EVs[88].

Figure 6. Cobalt and Lithium demand, 2017 and 2030



Notes: NPS= New Policies Scenario. Projected battery capacities and sales figures are used to estimate material demand in 2030. Demand figures refer to pure metal contents. In the low cobalt scenario, NMC 811 makes up 90% of battery sales in 2030, with the rest being NCA. In the high cobalt scenario, NMC 622 makes up 90% of sales with NCA the rest. In all scenarios battery demand for HDVs is assumed to be 80% LFP and 20% NMC 622.

Source: IEA EV Outlook 2018

[83] Electrification Coalition (2018**) ZEV State Policy Rankings**

[84] SAFE (2018) **The Military Cost of Defending Global Oil Supplies**

[85] For example: "If we reduced our oil consumption by half, [the U.S. military] would act differently," said ESLC member Admiral Dennis C. Blair, the former Director of National Intelligence and Commander in Chief of the U.S. Pacific Command. General Duncan McNabb, the former commander of the U.S. Transportation Command and also a member of SAFE's ESLC stated: "If we can reduce our dependence on oil, we could reduce our presence in the Gulf and use the funds for other critical military priorities, like cybersecurity or hypersonic weapons. The same funds could support different security priorities. We would make different choices, that would make us safer and more secure

[86] Tim Daiss (2018) **How much does the US spend on defending global oil supplies** OilPrice.com September 24, 2018 l

[87] Russell Hensley, Stefan Knupfer and Dickon Pinner (2018) **Three surprising resource implications from the rise of electric vehicles** McKinsey & Company

[88] Claudia Assis (2018) **Metals shortfall to crimp electric-car battery supply, Moody's says** MarketWatch May 1 2018

If demand were to increase significantly under a high EV scenario two potential geopolitical implications are worth exploring:

Energy statecraft: First is the possibility that access to these elements will be used, as oil has been, for energy 'statecraft'. If US control of oil supply choke points has long been recognized as a vulnerability for oil importers, China has in turn identified the growing demand for metals and minerals needed for clean energy technology as a similar geostrategic opportunity. China controls roughly 80% of the world's mined supply of rare earth minerals[89] and China's National Development and Reform Commission (NDRC) has identified the development of the rare-earth elements as a strategic resource since 2011[90]. China plans to increase domestic production of rare earth elements while also limiting the export of raw materials, making it difficult for companies in other countries to manufacture products[91]. China is also investing in mines outside of China including in countries in southern and eastern Africa which have some of the largest reserves of REEs.

The world has already had a preview of the geopolitical consequences of increased competition for EV resources. In 2009 China reduced its exports of REEs significantly, and in 2010 the government blocked exports of these elements to Japan entirely following a territorial dispute. China also banned the export of rare earths to the United States. The US Defense Department subsequently conducted a review regarding the possible development of its own sources of supply for rare earths[92]. While investment flowed towards the development of rare earths following these actions, and some companies altered their production processes away from the use of REEs, there is still evidence that a new Chinese embargo of rare earths would damage US competitiveness[93]. Cobalt is on the list of retaliatory tariffs that the US has levied against the Chinese government – although the impacts to date have been limited[94]. Higher tariffs could mean Chinese cobalt shifting to EU markets and the US looking for alternative supply. Legislation has been introduced in the United States to increase production of minerals used in EV batteries and identify foreign sourced critical minerals that could increase US geopolitical vulnerability[95].

Regional or state instability: The largest reserves of metals and minerals required for renewable technologies are found in fragile states with poor governance records[96]. For example, the Democratic Republic of Congo (DRC) produces more than half of the world's cobalt and is one of the largest producers of copper. The interaction between

[89] Lucy Hornby & Henry Sanderson (2019) **Rare earths: Beijing threatens a new front in the trade war** Financial Times June 3 2019.

[90] Ashley Feng & Sagatom Saha (2018) **Chinese Heavy Metal: How Beijing Could Use Rare Earths to Outplay America** Scientific American August 3, 2018

[91] Ashley Feng & Sagatom Saha (2018) **Chinese Heavy Metal: How Beijing Could Use Rare Earths to Outplay America** Scientific American August 3, 2018

[92] Keith Bradsher (2010) **Amid tension, China blocks vital exports to Japan** New York Times September 22, 2010 l

[93] Robert Castellano (2018**) A New China Rare Earth Embargo Would Damage Several US Companies' Technology Competitiveness** Seeking Alpha June 28 2018

[94] Charlotte Radford & Susan Zou (2018) **Could a US tariff hike shift cobalt trade flows?** Metal Bulletin September 26, 2018

[95] David Iaconangelo (2019) **Murkowski, Manchin target lithium battery 'Achilles' heel'** Energywire May 3, 2019

[96] IRENA (2019) **A New World: The Geopolitics of the Energy Transformation**

higher demand for REEs and state or regional instability is another possible implication of a high EV scenario. Some analysts have pointed to a short-term risk of cobalt shortages in the early 2020s[97]. A Chinese mining company made the largest ever private investment in the DRC in 2016 of a large copper and cobalt mining firm. It is possible that increased competition for access to REEs in Eurasia will impact other regions, including African politics and stability. The 'resource curse' means that in many producing countries mineral wealth has not led to sustainable growth. Research has also shown mineral wealth has not led to a decrease in poverty levels[98]. Studies have shown that mining can drive social conflict in Africa particularly when commodity prices are high[99] and increases in environmental contamination from mining and other related economic activity which increases the risk of social unrest or conflict[100].

It remains to be seen whether REEs and other minerals will have the same level of geopolitical influence that oil has had for decades. Most rare earths and other elements used for clean technology are not actually rare, but rather difficult to produce. The market is cyclical – meaning that when demand rises so does investment and ultimately supply. Recent analysis of the geopolitics of the clean energy transition by the International Renewable Energy Agency (IRENA) highlights reasons to believe it will be more difficult to use minerals for statecraft – including ongoing efforts to produce cobalt-free batteries and the opportunity presented by recycling to increase the supply of these elements. Historical experience with resource competition and the vulnerabilities of producer countries would suggest a need to approach this issue with caution and invest in international cooperation around governance and institutions alongside mining and resource extraction.

Second and third order effects

According to Aurora Energy Research the adoption of electric cars could wipe out US$19 trillion from the oil industry by 2040[101]. A loss of revenue on this scale would also mean lower tax revenues for governments reliant on the oil industry. This would have ramifications for institutional investors and pension funds, and ultimately with human security implications if not managed. Only 5% of UK pension funds have a climate change policy despite these funds being exposed to climate-related physical and transition risks[102]. Further, these do not necessarily need to be direct impacts – even awareness of future risks could lead to economic shocks. One study has found that if no action is taken to limit temperature rise to 2C a typical pension fund could suffer losses of 25% within five years after a shock[103].

[97] Bloomberg New Energy Finance (2018) **E-Buses to Surge Even Faster Than EVs as Conventional Vehicles Fade**

[98] Mark Tran (2012) **Africa's mineral wealth hardly denting poverty levels, says World Bank** The Guardian October 5, 2012

[99] ESOC (2016) **Concession Stands: How Foreign Investment Incites Protest in Africa**

[100] Renard Sexton (2018) **A new 'resource curse' is fueling riots around the world** Washington Post April 25, 2018 b

[101] Aurora Energy Research (2018) **Rapid technological shifts could wipe $21 Trillion of fossil fuel company revenues by 2040**

[102] Attracta Mooney (2018) **Pension funds fail to insulate against climate change risks** Financial Times November 4, 2018

[103] Kelly, S. et al. (2015) **Unhedgeable risk: How climate change sentiment impacts investment** University of Cambridge

The stock market capitalization of oil and gas companies remains substantial at around US$4.65tr and is widely held by institutional and other investors[104]. However, there are signs this is changing: Norway's Sovereign Wealth Fund, the world's largest, announced recently it would stop investing in oil and gas exploration in order to reduce its exposure to oil prices[105]. This followed other pledges from Multilateral Development Banks to end upstream investment in oil and gas extraction[106]. Close to 1000 institutional investors worth $6tr have pledged to divest from fossil fuels more broadly. Shell's 2017 annual report stated that divestment "…could have a material adverse effect on the price of our securities and our ability to access equity capital markets."[107] These moves combined with other structural changes including growing competition from NOCs create potential for stranded asset risk for the oil companies and therefore significant value loss for private (and public) investors. This in turn raises public policy concerns about financial instability[108].

A comprehensive exploration of these potential second and third order impacts of a loss in revenue from the oil sector cascading through the real economy was beyond the scope of this paper but would be an interesting area of future research.

[104] The Economist Intelligence Unit (2015) **The cost of inaction: Recognising the value at risk from climate change**

[105] Rob Davies (2019) **Norway's $1tn wealth fund to divest from oil and gas exploration** The Guardian March 8, 2019

[106] Larry Elliott (2017) **World Bank to end financial support for oil and gas extraction** The Guardian December 12, 2017

[107] Shell (2017) **Annual report and Form 20-F**

[108] E3G (2018) **Crude Awakening: Making Oil Major Business Models Climate-Compatible**

CHAPTER 4: REVIEW OF NATIONAL SECURITY STRATEGIES AND GREY LITERATURE

In order to assess the level of preparedness of countries for high EV penetration we first undertook a literature review and series of expert interviews. The purpose of this exercise was to assess the extent to which security, intelligence or foreign policy actors, individuals or organizations, are considering the geopolitical implications of the electrification of transport. In addition to searching for references to EVs or electrification of transport we also included various other terms of relevance, including:

- Energy technology innovation
- Risk to supply chains for metals or minerals
- Trade concerns particularly in the automobile sector
- Climate change as security threat or the implications of decarbonization.

The documents reviewed included publicly available national security strategies, as well as reports on future geopolitical scenarios and foreign policy publications This review does not claim to be comprehensive. One notable gap in the material is China's national security strategy, which is not publicly available – although a review of secondary sources of China's national security strategy has been included. In addition to the literature review, interviews were conducted with several public and private sector stakeholders including acting or former intelligence and foreign policy officials. Table 3 provides an overview of the sources reviewed and a summary of the relevant themes.

Table 3. Overview of sources:

Source	Type	Summary of relevant themes
German Security Policy	White Paper	• Prosperity depends on the unhindered use of global information and communication systems, supply lines, transportation and trade routes as well as on a secure supply of raw materials and energy. • Climate change as a threat multiplier. Potential for instability.
UK National Security Strategy 2015	Security Strategy	• Importance of innovative energy technology including nuclear, shale and renewables as reliance on hydrocarbon imports increases in coming decades. • Resource insecurity due to disruption of international supplies of food or minerals. • Mentions that currently 40% of oil is imported rising to 73% by 2030. Solutions mentioned include the new Southern Corridor pipeline, US liquid natural gas (LNG) imports, supplies of Australian LNG, and increased supply from Norway and North Africa. • More likely to see conflict on economic than military terms. Countries trying to dominate new markets. • Climate change as driver of instability
France Defense and National Security Strategy Review	Security Strategy	• Climate change increasing risk in vulnerable regions • Need strategic advantage in digital and innovative technologies – in military, defense industry context
US National Intelligence Strategy 2019	Intelligence Strategy	• Climate changes as a pressure point for regions at risk of instability • Invest in anticipatory intelligence to identify new trends, developments and threats
US National Security Strategy 2017	Security Strategy	• Pursuit of an 'Energy dominance' agenda; removal of excessive environmental and infrastructure regulations • Economic strategy to preserve technological advantage – including in battery technologies • US to remain a global leader in address pollution and greenhouse gasses through innovation
EU Global Strategy	Strategy	• Climate change as a threat multiplier particularly in the Mediterranean and MENA region • EU plans to invest in resilience and encourage energy liberalization, development of renewables, better regulation and technology transfers alongside mitigation and adaptation • EU will deepen trade and investment with China and dialogue on climate action
South Korea National Security Strategy 2018	Security Strategy	• Depletion of natural resources and pollution as potential drivers of global economic instability • Energy and environment emerging as security issues including natural disasters • Actively participate in Paris implementation and contribute to the global green economy • Strengthen diplomacy around climate change and international development

Source	Type	Summary of relevant themes
		• Economic power and state of the art IT technology recognized as national strengths • Increased economic interdependence between US and China alongside risks from the trade dispute and possible regional instability • Political instability in North Africa and other regions likely to increase • Economic instability leading to rise in protectionism • Plan to cooperate through a "Northern Policy" with Eurasian partners through transport, logistics and energy infrastructure as new engine of growth and peace and prosperity on the Eurasian continent; including through building a northern Eurasian energy network
Japan National Security Strategy 2013	Security Strategy	• Dependence on natural resource imports. Address threats to sea lanes of communication and ensure maritime security cooperation • Rapid progress in technological innovation and shift in the balance of power (rise of China & India); complexity of global security environment • Climate as a threat to human security; priority to work with international community to resolve the issue • Technological advancement in the energy sector leading to resource nationalism and intensified competition for resources; risk of crunches to global supply and demand also enhanced by climate change • Key national security goal to create a stable and predictable international environment • Important role of Japan's energy-saving and environmental technologies in its diplomacy • Africa as a region with abundant strategic natural resources
National Intelligence Council Global Trends 2017	Intelligence Forecast	• Unconventional energy revolution – global energy system to become increasingly resilient to supply shocks from fossil fuels to the benefit of resource-poor developing countries
Eurasia Group Top Risks for 2019	Forecast	• Risk increasing of a global innovation "winter"—a politically driven reduction in the financial and human capital available to drive the next generation of emerging technologies
Wood Mackenzie[109]	Blog	• Demand for raw materials like cobalt, nickel and lithium means geopolitical risk related to transport will not end with lower oil demand

[109] Simon Flowers (2018) **Geopolitics and the transition from oil to electric vehicles** Wood Mackenzie

There was a consensus in the literature that world is becoming more complex and more uncertain. The national security and defense strategies as well as foreign policy analysis from think tanks or other institutions included references to instability and unpredictability as dominant features of current and future geopolitics.
Several other themes emerged from the literature review that are relevant for the EV debate, including:

- Growing **competition for resources**, **threats to international trade** and **vulnerability of supply chains.**

- In the current geopolitical environment **economic conflict is more likely than military conflict**.

- **Technological innovation** and advances and the digital revolution is moving rapidly and holds both great promise and **potential for huge disruption**.

- **There is an abundance of data** and countries are positioning themselves to dominate in technology fields.

- The strategic importance of **open and fair economic system** to keep trade and access to natural resources flowing.

- Recognition of the **importance of supply routes for natural resources** including major sea lanes for oil transport.

- **Climate change as a threat multiplier or driver of instability.**

The literature review, complemented by interviews with government officials and civil society experts, demonstrates that **very limited attention has been given to the geopolitical or security implications of a high EV scenario.** Most grey literature that addresses EV adoption does so from a techno-economic perspective. The national security strategies reviewed address topics of relevance to electrification of transport, such as the security risks of climate change, risks to resource supply chains and the opportunity of new energy technologies. **However, none of the government documents examined deal directly with the implications of EVs or the electrification of transport more generally.**

Expert interviews conducted as part of this research alongside the analysis of various EV forecasts offer several plausible explanations for the lack of attention. In some cases where EVs or electrification of transport has been evaluated, analysts have concluded that it is unlikely to have a material impact on oil demand in the near term. In other cases, there was recognition that the impact might be material but that transport is just one piece of a larger puzzle concerning innovation in energy systems more broadly; for EVs to have an impact will require not just charging infrastructure but improvements in grid technology such as the proliferation of smart grid technologies and wider use of demand side management. Third, governments and

analysts alike are mainly concerned with the technical aspects of EVs – or which technology will be the winner in the marketplace. Again, it is worth noting a gap in the research is limited information about the decision-making processes, for example in China, which has very clearly determined that electric vehicles could be used for geostrategic advantage.

Based on the literature review and expert analysis Table 4 provides a comparison of how different countries in Eurasia are prepared for a high EV scenario across five key indicators, including: energy risk exposure to a low EV scenario, national security strategy priorities, technology and innovation capacity, industrial and economic strategy, and EV policies and targets.

Table 4. Comparison of preparedness for EV dominant future

	Energy risk exposure to low EV scenario	Security strategy[110]	Battery production & innovation capacity	Industrial / Economic Strategy and Policies	Targets
China	Largest oil importer – including from the US - and growing dependence (80% by 2030)[111]	Not available	Strength is in manufacturing, but innovation is improving. Home to 75% of lithium battery production; dominance in the supply chain of cobalt and other metals	Made in China 2025 strategy prioritizes dominance in high-tech manufacturing sectors including NEVs Cap-and-trade system	End production of ICEs by 2040 20% share of alternative fuel vehicles by 2025
France	Imports most oil and other fossil but nuclear supplies 75% of electricity	No recognition of relevant risk or geopolitical drivers for electrification	Ranked highly for new patents in automotive technology[112]	New industrial strategy launched with Germany; EUR700m investment to boost battery production for EVs	Ban on oil and gas production and sales of gas and diesel cars by 2040

[110] The most recent Chinese National Security Strategy has not been released publicly. This analysis is based on secondhand reports of the discussions surrounding adoption of the strategy including the RAND Corporation **https://www.rand.org/pubs/research_reports/RR1402.html**; and Finnish Institute of International Affairs **https://www.fiia.fi/en/publication/the-security-strategies-of-the-us-china-russia-and-the-eu**.

[111] Tsvetana Paraskova (2017) **China set to become more dependent on oil imports** OilPrice.com December 5, 2017

[112] Business France (2018) **France on the forefront of new mobility technologies**

	Energy risk exposure to low EV scenario	Security strategy[110]	Battery production & innovation capacity	Industrial / Economic Strategy and Policies	Targets
Germany	7th largest crude importer and 40% from Russia; but among fastest declining as well	Recognizes climate as driver of instability and importance of stable supply chains	Top 3 most innovative auto companies (Volkswagen, BMW and Daimler)	New industrial strategy launched with France. EUR1bn investment to boost battery production for EVs	1m EVs by 2022 after original target of 2020 delayed; EUR1bn EV incentive scheme & tax exemptions
Japan	3rd largest crude importer after China and US – cost $65.7bn. Almost 100% dependency	Identifies efficiency and environmental technologies as advantage; climate as a risk; dependence on resource imports	Several of the largest lithium battery producers. Toyota and Honda high on innovation ranking. High commitment and R&D investment in next generation / solid state battery technology	"All Japan" strategy and public-private committee on clean energy vehicles launched; JPY1.6bn R&D pledge to develop solid state batteries	Only EVs to be sold by 2050 (including gas-electric hybrids)
South Korea (2018)	Almost entirely dependent on imports; but also has 3 of 10 largest refineries so also high exports	Focus on denuclearization of the Korean peninsula; energy and environment as emerging security issues	Hyundai listed as one of the most innovative companies; Hyundai Motor Group announced a plan to introduce 44 electrified models by 2025 Won 2trillion of R&D funding for emerging technologies[113] Samsung SDI and LG Chem two of the largest battery manufacturers	Strategy includes infrastructure development, subsidies and R&D into advanced battery technologies[114]	Proportion of EV and Hydrogen cars 10% by 2020. 200,000 battery powered vehicles on the road by 2020 1,400 EV charging stations and 80 hydrogen fuel stations in place across South Korea by 2020

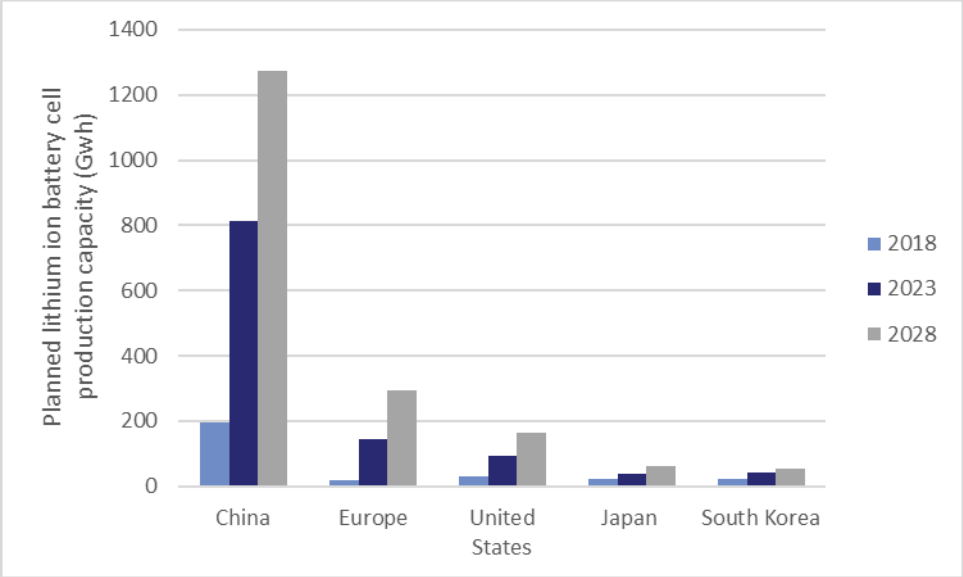
[113] Song Jung-a & Edward White (2018) **South Korea throws struggling car parts suppliers a $3bn lifeline** Financial Times December 18, 2018

[114] Bryan Harris (2017) **South Korea seeks to boost motorists' interest in electric cars** Financial Times February 12, 2017

	Energy risk exposure to low EV scenario	Security strategy[110]	Battery production & innovation capacity	Industrial / Economic Strategy and Policies	Targets
United Kingdom	Net importer of crude oil since 2005. Growing oil import dependence but is the second largest producer of petroleum in OECD Europe	Climate as driver of instability and importance of energy innovation	Only one auto company ranked on innovation list	"Road to Zero" strategy launched; Industrial strategy to make UK leader in zero emission vehicles GBP400m investment in charging infrastructure; GBP1.5bn investment in ultra-low emission vehicles by 2020	Every car and van sold to be effectively zero emission by 2040; 50% of new car sales low emission by 2030
United States	Growth in domestic oil production meant US became net crude and finished products exporter in 2018. But spends $81bn/year in oil subsidies protecting supply chains	Mentions battery technology but focus is on preserving fossil fuel dominance	Tesla and GM rank highly on global automotive index; Low manufacturing capacity but high innovation	Federal tax credits and R&D Other policies vary by state, but most states have policies in place; Multi-state 'ZEV Action Plan"	No Federal targets; Administration rolling back fuel efficiency standards. State level targets include 9 states setting 15.4% ZEVs by 2025; California has 5m EVs by 2030; New York has 1m by 2025 Maryland 300k by 2025

In the comparison above, China stands out in terms of its positioning of EVs as a strategic industry, its lead in manufacturing capacity and the extent of its policy support measures. Another indicator of country preparedness for a high EV future is expected lithium ion battery cell production capacity. Figure 7 below shows that China continues to dominate with continental Europe also rapidly increasing its capacity after 2018.

Figure 7. Lithium ion Megafactory Capacity[115]



Data source: Benchmark Mineral Intelligence 2019

[115] Data provided by Benchmark Mineral Intelligence (2019)

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

The future of the transport sector will emerge from a complex interaction of factors including technological change, geo-strategic maneuvering, climate policy, societal and cultural shifts and national and international politics. Rapidly falling battery costs, emission targets and other climate policies, concerns within governments about urban air pollution and industry desire to capture a new market are all compelling drivers of EV growth. Technological and economic realities should not be overlooked or underestimated. But if key barriers including charging infrastructure and battery range can be overcome, the transition to the electrification of the transport sector could happen very quickly.

Several credible studies forecast material impact on oil demand in the medium term (2030 to 2040) time frame. This would have obvious geopolitical implications given the role oil continues to play in international affairs. But even if EVs do not on their own dramatically alter oil markets they will almost certainly lead to increased demand for key resources and could disrupt the auto industry in many countries, leading to job losses and the risk of trade barriers in some countries as a means of protecting their industries.

The lack of preparedness for a scenario where EVs quickly overtake ICEs increases the risk of geopolitical tensions as this transition in the energy and transport sectors unfolds. The primary objective of this paper is to increase awareness of the potential geopolitical risks, highlight the importance of strengthening international rules-based cooperation and to start a dialogue on possible risk management approaches. Below are several emerging recommendations.

> **Recommendation 1: G20 Energy Ministers should establish a task force on trade and electric vehicles.** EVs have the potential to amplify existing threats to the open global trade regime if subsidized industries abroad result in, or are perceived to result in, domestic job losses. This could follow a similar pattern as the recent tit-for-tat reprisals around solar subsidies. Such a political backlash could stall the transition to electrification of transport and risk overshooting climate targets. Negotiations have been underway on an Environmental Goods Agreement for the elimination of tariffs on 'green' goods in the WTO since 2014. Every country included in this study is also represented in the EGA. However, this process has stalled since 2016. The G20 Energy Ministers could decide to revive the discussions as a steppingstone for a multilateral free trade agreement on EVs. One of the key outputs of this task force should be a set of guidelines establishing what type of government support counts as fair trade based on a detailed consideration of just transition issues. If the G20 decides not to address these issues, then as major markets the EU and China should make these issues a priority for their bilateral High-Level Economic and Trade Dialogue.

> **Recommendation 2: G20 trade task force should launch a working group on harmonizing regulatory approaches on EV standards.** The low carbon transition, including electrification of the transport sector, will mean that battery supply and storage capacity become more important relative to liquid fuel access. The most economically efficient approach would be the regulatory harmonization on EV standards – including standards for "e-highways" for electric trucks. This can build on previous dialogue including through the Asia Pacific Economic Cooperation (APEC) roadmap for international electric vehicle standards. It could also be used to strengthen the evidence base on smart grid interoperability standards, the capability of electricity grids to accommodate EVs and of EV batteries to act as reliable grid storage capacity.

> **Recommendation 3: The US, EU, China, Japan and Korea should pledge to increase support to international R&D initiatives such as the Electric Vehicle Initiative, including more funding for next generation battery technologies.** Overcoming the largest barriers to EV adoption will likely require advances in battery technology. This challenge is also an opportunity for international cooperation. Most countries reviewed here have domestic R&D programs, for example solid state batteries, and bilateral initiatives already exist for example between France and Germany, and Japan and China. Multilateral R&D support on next generation of battery technologies should be increased through the Clean Energy Ministerial (CEM). The Electric Vehicle Initiative (EVI), which was launched under the CEM, should receive greater attention and support.

> **Recommendation 4: The EU and China should stress test their security and economic strategies against a high EV scenario.** Any significant changes in the price of oil or increased risk of instability in regions such as MENA, Southeast or Central Asia would have implications for the EU and China, which already share concerns about vulnerability to resource shocks and to instability to their neighbourhoods and investments. Existing economic and security strategies recognize these risks but do not account for the impacts of rapid adoption of EVs.

> **Recommendation 5: The EU should work more strongly with countries with deposits of EV metals and minerals to improve resource governance including through capacity building and technical assistance.** Growing demand for minerals used in EVs including lithium and cobalt have economic benefits for developing countries; but the costs can also be considerable, as decades of evidence on the 'resource curse' has shown. Studies have shown that mining can drive social conflict in Africa particularly when commodity prices are high. Recent research has also shown increase in environmental contamination from mining and other related economic activity which increases the risk of social unrest or conflict. Considering the security risks of regional instability, it is in every country's interest to ensure benefits of resource extraction are shared with the wider population and strong institutions lead to good governance of resource extraction. The countries included in this study can facilitate dialogue between different stakeholders at the national level including government, private sector and civil society. There are many existing initiatives to draw upon, for example an initiative in West Africa run by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH or resources like *Managing Mining for Sustainable Development* from UNDP and UNEP.

> **Recommendation 6: The EU should work with the IMF to assess the risk that EVs pose to the macroeconomic stability of oil producers.** Falling oil demand resulting from EV deployment could lead to a significant drop in public revenue for large and small oil producers. There is limited understanding of the full scope of these impacts on the wider economy. The EU has a stated interest in maintaining regional and global stability during the low carbon transition. The IMF has the capabilities necessary to conduct a systemic analysis of the risk EVs pose to macroeconomic stability in oil producing states. The EU should request that the IMF conduct an analysis and release the results publicly.

> **Recommendation 7: The EU should commit to supporting the preparation of transition strategies and policies for high cost oil producers.** In a world of declining oil demand only the lowest cost producers will have a significant advantage. Countries with relatively high production costs include Algeria, Angola, Chad, Colombia, Ecuador, Gabon, Iraq, Kazakhstan, Libya, Nigeria, Oman, Turkmenistan, Venezuela and Yemen. Countries with relatively low GDP and high production costs will need credible strategies to manage the risks in transition away from oil dependency but often lack the capacity to develop and implement them. They should be supported by partners with technical expertise and experience in developing long term climate strategies.