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SOUTH AFRICAN NEW ENERGY VEHICLE RESEARCH REPORT

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For the Department of Trade, Industry and Competition

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EXECUTIVE SUMMARY

The findings in this report suggest that the transition to New Energy Vehicle (NEV) consumption and production in South Africa is inevitable. However, driving an earlier and more meaningful NEV transition in South Africa will require a careful balance between incentivising a sustained shift in domestic market demand to NEVs; establishing an appropriately aligned, renewable energy-based charging infrastructure; and supporting a shift in South African vehicle production, away from Internal Combustion Engine (ICE) vehicles to a mix of Hybrid Electric Vehicles (HEVs), Plug-in Hybrid Electric Vehicles (PHEVs), and Battery Electric Vehicles (BEVs). Balancing these factors is key to successfully transitioning the South African vehicle industry to an ultra-low carbon future, while simultaneously ensuring it remains a major contributor to the industrial development of the domestic economy, as per the objectives of the South African Automotive Masterplan (SAAM), which runs until 2035.

How the South African government supports the industry and its complex value chain to make this transition is replete with challenges, the most notable being the major cost associated with transitioning to the consumption and production of more expensive vehicles – at least for a period, and until battery technologies advance to levels that secure their price parity with equivalent ICE products. The South African market is highly price sensitive, especially in the two lowest quintiles of market consumption (price elasticities of -1.795 and -1.95 respectively) (Barnes and Grant, 2019), hence the almost non-existent sales of NEVs in the domestic market, except in the apex quintile.[1] This creates a major misalignment in the development trajectory of the South African market relative to the local automotive industry's most important export markets, the European Union (EU) and United Kingdom (UK). These markets, which jointly consume a similar number of South African assembled vehicles as supplied into the domestic market, will likely be BEV-only by 2035. This raises a striking challenge for the multinational vehicle assemblers operating in South Africa. Their domestic business case is essentially a balanced one, with vehicles needing to be supplied into the South African and major export markets to achieve sufficient scale economies to operate at internationally competitive levels. To maintain this balance in future, it is critical that domestic and international market demand shifts are broadly aligned.

This does not mean consumption in the South African and EU/UK markets needs to be fully aligned in the timing and profile of NEV consumption. As per other developing economies explored in this report, South Africa is starting its NEV transition slightly later; and has distinctive geographical and operating parameters (road conditions, vehicle use factors, income distribution, consumption patterns) that will impact the nature of its NEV transition. For example, while the NEV transition for passenger vehicles is likely to be slightly longer in South Africa than in the EU/UK, there is a strong likelihood that Light Commercial Vehicle (LCV) demand in South Africa will remain hybrid-based for the period to 2035, with LCV-HEVs being replaced primarily with PHEVs, as opposed to a full transition to BEVs.

Recommending to **the dtic** how to support the transition to domestic NEV consumption and associated domestic NEV production constitutes the next phase of this project. The project team is confident that it has learned enough from the international competitor economy analysis, international NEV market analysis, and the Original Equipment Manufacturer (OEM) consultation process to engage meaningfully with the industry's key stakeholders on the transition to NEV consumption and production in South Africa, and looks forward to engaging with **naamsa** I The Automotive Business Council, National Association of Automotive Component and Allied Manufacturers (NAACAM) and the National Union of Metalworkers of South Africa (NUMSA) on potential interventions to support the successful transition of the South African automotive industry from an ICE to NEV base.

[1] Light vehicles that sold for more than R613 201 in 2018 (Barnes and Grant, 2019).

CONTENTS

ABBREVIATIONS

AC	Alternating Current
ACC	Advance Chemistry Cell
ACEA	European Automobile Manufacturers' Association
ADF	Automotive Development Fund
AFSTP	Alternate Fuels for Surface Transportation Programme (India)
AIS	Automotive Investment Scheme
ANEEL	National Electric Energy Agency
APDP	Automotive Production Development Programme
ASEAN	Association of Southeast Asian Nations
B&M Analysts	Benchmarking and Manufacturing Analysts
BCD	Basic Customs Duty
BEV	Battery Electric Vehicle
BOI	Board of Investment (Thailand)
BRT	Bus Rapid Transit System
BSF	Battery Separator Film
CBU	Completely Built Unit
CEFTA	Central European Free Trade Agreement
CFE	Comisión Federal de Electricidad (Mexico)
CNG	Compressed Natural Gas
CIT	Corporate Income Tax
CKD	Completely Knocked Down
DC	Direct Current
dtic (the)	Department of Trade, Industry and Competition
EEV	Energy Efficient Vehicles
EFTA	European Free Trade Association
ENME	National Strategy for Electric-mobility
EOL	End-of-Life
EPA	Economic Partnership Agreement
EU	European Union
EV	Electric Vehicle
FAME	Faster Adoption and Manufacturing of Electric Vehicles (India)
FCEV	Fuel Cell Electric Vehicle
FTA	Free Trade Agreement
GST	Goods and Services Tax
GWh	Gigawatt hours
HEV	Hybrid Electric Vehicle (non-plug in, self-generating)
HFCEV	Hydrogen Fuel Cell Electric Vehicle
ICE	Internal Combustion Engine
IFC	International Finance Corporation
IPI	Imposto Sobre Produtos Industrialisados (tax on industrialised goods in Brazil)
ISAN	Impuesto Sobre Automóviles Nuevo (Mexican tax)
ISS	Imposto Sobre Serviços (Brazilian municipal services tax)
IT	Income tax
km	Kilometres
kW	Kilowatt
LCV	Light Commercial Vehicle
Li-on	Lithium-Ion
LNG	Liquefied Natural Gas

LPG	Liquefied Petroleum Gas
M&HCV	Medium and Heavy Commercial Vehicle
MFN	Most Favoured Nation
MGTC	Malaysian Green Technology and Climate Change Centre
MoMP	Ministry of Military Production
MoU	Memorandum of Understanding
MVA	Manufacturing Value Added
MVT	Motor Vehicle Tax (Turkey)
NAACAM	National Association of Automotive Component and Allied Manufacturers
naamsa	The Automotive Business Council
NAP	National Automotive Policy (Malaysia)
NCECP	National Energy and Climate Plan
NEMMP	National Electric Mobility Mission Plan (India)
NEV	New Energy Vehicle
NLCCMP	National Low Carbon Cities Master Plan
NOMP	National Organisation for Military Production
NTP	National Transport Policy (Malaysia)
NUMSA	National Union of Metalworkers of South Africa
OEM	Original Equipment Manufacturer
OICA	Organisation Internationale des Constructeurs d'Automobiles
PBNEV	Vehicle Labelling Programme (Brazil)
PEA	Provincial Electricity Authority (Thailand)
PHEV	Plug-in Hybrid Electric Vehicle
PI	Production Incentive
PLI	Production-Linked Incentive (India)
PMP	Phased Manufacturing Programme (India)
PS	Pioneer Status
R&D	Research and Development
REDII	Renewable Energy Directive (EU)
RRP	Recommended Retail Price
SA	South Africa
SAAM	South African Automotive Masterplan
SCT	Special Consumption Tax (Turkey)
SKD	Semi Knocked Down
SKI	SK Innovation (Hungary)
SMME	Small, Micro and Medium-sized Enterprise
SSA	Sub Saharan Africa
SSE	Scottish and Southern Energy
SUV	Sport Utility Vehicle
TCO	Total Cost of Ownership
TIPS	Trade & Industrial Policy Studies
TOGG	Turkish Automobile Joint Venture Group
UK	United Kingdom
USMCA	United States-Mexico-Canada Agreement
US	United States
VALA	Volume Assembly Localisation Allowance
VAT	Value Added Tax
VW	Volkswagen
ZEV	Zero-emission Vehicle

1. INTRODUCTION

1.1. Report context

This research report is submitted to the Department of Trade, Industry and Competition (**the dtic**), Republic of South Africa (SA), as the second deliverable of the New Energy Vehicle Project being co-funded by Trade & Industrial Policy Strategies (TIPS)[2] and **naamsa** I The Automotive Business Council. The report has been compiled by a team of consultants based at Benchmarking and Manufacturing Analysts (B&M Analysts) and TIPS. The report details the key research findings from the first four months of project work completed as part of the NEV project to develop an electric vehicle (EV) roadmap and automotive sector policy paper for **the dtic** that aligns with the South African Automotive Masterplan (SAAM), which runs until 2035. The report is based on extensive international and domestic research undertaken from July to October 2021.

The importance of the project is underpinned by the fact that almost all vehicle production and consumption in South Africa is Internal Combustion Engine (ICE) based. According to **naamsa**'s sales figures, only 324 NEVs were sold in the COVID-19 impacted South African market in 2020, with this representing less than 0.1% of the total domestic market. Yet, the majority of South African vehicle and related automotive component production is exported, with the primary export markets being the EU and the United Kingdom (UK). Combined, these two markets consume the majority of South African vehicle and component exports; and yet governments in the EU and the UK have both announced timeframes within which they will phase out ICE consumption in their markets, and shift to NEVs.

These shifts in South Africa's major export markets represent a potentially major threat to the South Africa automotive industry, and the aspirational targets that have been set in the SAAM for 2035. These targets are:

- Local production of 1.4 million units, or 1% of global production;
- 60% local content in South African vehicles;
- Doubling of employment off 2016 levels;
- Transformation of Tier 2 component manufacturing and dealership operations; and
- Deeper technical capabilities, and more advanced infrastructure and skills in the South Africa automotive industry.

As South Africa's most successful and important manufacturing sector, it is deemed critical to the domestic economy that the automotive industry achieve its potential through to 2035, as scoped within the SAAM. At the same time, it is also recognised that the South Africa vehicle market and broader transportation industry needs to become substantially more environmentally sustainable over the period of the SAAM, and that growth in domestic NEV consumption is as important an objective as the development of the industry. This is recognised in South Africa's Green Transport Strategy of 2018.

Previous research undertaken by TIPS, in collaboration with **the dtic** and **naamsa** I The Automotive Business Council,[3] the national vehicle industry's representative body, have articulated potential government strategies to support the realisation of the SAAM, and support a transition to NEV

[2] On behalf of **the dtic.**

[3] Montmasson-Clair, G., Dane, A. and Moshikaro, L. (2020). Harnessing Electrical Vehicles for Industrial Development in South Africa. TIPS. Pretoria. June 2020.

production and consumption in South Africa. More recently, the South African government published a Green Paper, exploring the advancement of NEVs in South Africa. The document, The South African Road to Zero (The Roadmap), which was released for public consultation on 18 May 2021, advocates for the acceleration of NEV consumption and production in South Africa in a manner that aligns with the global NEV trajectory.

The Green Paper identifies two major strategic imperatives for the South African automotive industry in its summary:

1. Securing South Africa as a global manufacturing base (for NEVs and ICE vehicles); and
2. Supporting NEV component localisation in the next 10-15 years.

These reports and preliminary policy documents have identified the need for immediate change within the South African automotive industry. However, their concepts and proposals need to be tested empirically, against international comparator evidence, the individual strategies of the country's light vehicle producers, and in relation to the complex suite of incentives that make up the Automotive Production Development Programme Phase 2 (APDP 2) that presently underpins the SAAM and the overall development of the South African automotive industry. Importantly, while the national government's Green Paper identifies an extensive range of potential interventions to support the realisation of the two strategic imperatives, they are not costed, nor analysed holistically. While the intention of the Green Paper is clear, and its overarching objectives supported by industry stakeholders, the policies, regulations, and programmes required to give effect to a successful NEV transition in South Africa still need to be developed and tested, hence the importance of this study.

1.2. Project objectives

The overarching objective of the project is the development of a comprehensive set of policy recommendations for **the dtic** in respect of:

1. Optimally increasing NEV consumption and production in South Africa, with NEVs to comprise 15%-20% of the domestic market by 2025 and 30%-40% by 2030. This set of targets broadly aligns with transition objectives set in the world's major vehicle markets.
2. Supporting the achievement of the SAAM's key objectives through to 2035. These encompass local production growth, local content development, employment growth, industry transformation and the advancement of technical capabilities, infrastructure, and skills.

The five key areas to be focused on over the duration of the project encompass the following:

1. Mapping the price differentials of selected ICE vehicles being manufactured in South Africa at present, and imported into the domestic market, relative to their NEV model equivalents/counterparts, including hybrids, Plug-in Hybrid Electric Vehicles (PHEVs), and Battery Electric Vehicles (BEVs).
2. Engaging with **naamsa**'s light vehicle and medium and heavy commercial vehicle (M&HCV) members to explore their potential future NEV models in the South African market and the appropriate price premiums between ICE vehicles and the various NEVs to stimulate local market consumption of NEVs (to obtain 15%-20% domestic market share by 2025 and 30%-40% of sales by 2030).
3. Determining an appropriate incentive or suite of incentives to close the identified price gap between ICE and NEV vehicles. Potential considerations to include Ad Valorem duty adjustments, EV import tariff reductions, and APDP incentive adjustments.

4. Analysing the cost to the South African fiscus should 15% designated procurement be implemented for the conversion of public transport buses to NEV equivalents.
5. Identifying BEV components which could be localised in support of the SAAM's 60% future local content objective; and the associated identification of an optimum incentive regime under the APDP to support NEV localisation opportunities.

The project is broadly structured into two parts, with the first part (July to mid-October) concentrating on primary and secondary research activities, and the second part (mid-October to end-December), which follows from this report, concentrating on the development of policy, regulatory and programmatic recommendations that emerge from the findings and that are intended to give effect to the objectives framing the project. The second part entails substantial modelling work and engagements with industry stakeholders, to ensure that the draft recommendations developed are robustly tested and that stakeholder perspectives are secured prior to the submission of the final recommendations to **the dtic**.

1.3. Methodology

The methodology followed to complete this Key Research Findings report encompassed the completion of six primary activities.

- First, the team reviewed NEV, vehicle carbon emission, and green transportation reports completed in South Africa and internationally, and also interrogated NEV developments in the key export markets of the EU and UK. These reports are referenced at the end of this report.
- Second, the team completed a desktop-based review of NEV production and consumption support being provided by governments in selected competitor economies to South Africa. These included Turkey, Thailand, Malaysia, Brazil, Mexico, Hungary, Poland, India, Egypt, and Morocco. These are the same economies that were included in SAAM's review of South African competitor economies.
- Third, and again on a desktop-basis, the project team explored the price differentials of comparable NEV and ICE vehicles in the South African and selected international markets. These markets included the UK, France, Australia, Thailand, and Turkey, with the analysis encompassing the full range of NEVs: HEVs, PHEVs, and BEVs.
- Fourth, the project team surveyed and/or interviewed a selection of **naamsa**'s light vehicle and M&HCV members (including bus assemblers).[4] The research instrument focused on potential future NEV models in the South African market, potentially appropriate price premiums between ICE and NEVs to stimulate local market NEV consumption, OEM recommendations (and supporting information) on NEV government policy support required for domestic market consumption and local production, and insights into NEV component localisation opportunities and challenges. A total of 10 surveys and/or interviews were completed, with responses depicted in Table 1.
- Fifth, the team reviewed previous local and international research on NEV component opportunities, and then analysed these findings in relation to the OEM survey/interview inputs on NEV component opportunities and challenges.
- Finally, the project team explored bus procurement developments in South Africa, in preparation for the modelling of the fiscal consequences of designating 15% NEV bus procurement.

[4] The survey instrument used is included as Appendix A.

Table 1: OEM surveys and/or interviews completed

OEM	SURVEY	INTERVIEW	OTHER
BMW	X	X	
Busmark		X	
Jaguar Land Rover	X	X	
Hino	X	X	
Hyundai	X		
MAN			X
Mercedes Benz		X	
Nissan	X		
Toyota	X	X	
Volkswagen	X	X	

- Fifth, the team reviewed previous local and international research on NEV component opportunities, and then analysed these findings in relation to the OEM survey/interview inputs on NEV component opportunities and challenges.
- Finally, the project team explored bus procurement developments in South Africa, in preparation for the modelling of the fiscal consequences of designating 15% NEV bus procurement.

1.4. Report structure

In addition to this introduction, the report comprises six sections and four appendices. Section 2 explores the NEV price comparison findings and position South Africa's NEV affordability challenge – in relation to local ICE pricing and in respect of global NEV prices relative to their ICE counterparts. In Section 3, we analyse NEV market and production developments across a range of second tier automotive economies that represent important benchmarks for South Africa. Valuable lessons can be gleaned from this section, with competitor economies following a similar trajectory to South Africa in respect to the slow transition to NEV consumption in their domestic markets.

Section 4 returns to a focus on South Africa, exploring the findings from the OEM strategy surveys and interviews. This section is particularly important to the study as it articulates the strategic position of South African OEMs and vehicle importers in respect of domestic NEV developments. It frames the critical need for a NEV transition in South Africa. Section 5 then introduces the NEV component localisation opportunities that will be analysed in more detail in the project's next report, while Section 6 concludes the report by summarising the major findings and outlining the balance of activities required to complete the project.

Appendix A outlines the key questions posed to the South African OEMs included in the study, while Appendices B and C provide additional detail on NEV policies in Thailand and India's states respectively. Appendix D is critical to the overall project as it comprises a briefing note compiled for **the dtic** on the 12th of October as an additional output of the project. Prepared for COP-26, it outlines the parameters of a potentially rapid transition to NEV consumption and production in South Africa. It has been included in this report to initiate engagement with industry stakeholders in preparation for the next phase of the project. It is essential that the Briefing Note is read in preparation for stakeholder discussions that will commence post the completion of this report.

2. NEV AND ICE PRICING ANALYSIS

The battery technology used in NEVs is relatively more expensive than established ICE technology. Consequently, NEVs typically have a price premium compared to ICE equivalent models. An effective demand incentive for South African NEVs would essentially need to compensate for this price premium. The market for NEVs in South Africa is therefore very small. In addition, OEMs reported selling NEV models at below cost in the South African market to stimulate demand for these vehicles. To establish an accurate assessment of the price premium between NEVs and their respective ICE equivalent models, the research team conducted an analysis of price differentials between NEVs and their respective ICE equivalent models in the South African market and in six other competitor markets, namely the UK, France, Australia, United States (US), Netherlands, and Germany.[5] The pricing is based on information obtained from OEM websites through desktop research conducted between July and October 2021. Prices reported are recommended retail price (RRPs) and thus exclude taxes or incentives.

2.1. South Africa

NEV price premiums

The NEV price differential analysis for the South African market focused on NEV vehicle models[6] priced at below R1 million. Three NEV models were sold below this pricing threshold in South Africa in 2021. These NEVs included the BMWi3 (BEV), the Lexus ES 300h EX (soft hybrid) and the Toyota Prius (PHEV). The ICE equivalent models for these vehicles are the BMW 1 series 118i, the Lexus ES250 EX, and the Toyota Corolla 1.8XS CVT, respectively. All these models are imported into the South African market. The pricing differentials are shown in Table 2.

Table 2: South African NEVs and ICE equivalents sold in 2021

NEV MODEL	MAKE	NEV SA PRICE	ICE EQUIVALENT	ICE SOUTH AFRICAN PRICE	% DIFFERENCE (NEV VS ICE)
BMWI3 EDRIVE I3	BEV	US$51 218	**BMW 1 series 118i**	US$37 569	36%
LEXUS ES 300H EX	Hybrid	US$56 494	**Lexus ES250 EX**	US$46 844	21%
TOYOTA PRIUS HYBRID	PHEV	US$38 464	**Toyota Corolla 1.8XS CVT**	US$26 865	43%

Note: Data was obtained in June 2021 with currency conversions applied at US$0.07 per Rand.

The analysis is severely compromised by the small number of models identified and the equally small number of vehicles sold. The data suggests that the typical price differential between NEVs and their respective ICE equivalent models in South Africa is 33%. The highest price differential is for the PHEV, priced 43% higher than its ICE equivalent model. This is followed by the BEV, priced 36% higher than its ICE equivalent. Last, the hybrid is priced 21% higher than its ICE equivalent. The price differential for the BEV is expected to be understated given that several OEMs reported selling their NEV models at below cost in the South African market to stimulate new demand for these vehicles. In addition, other markets have a much wider NEV market distribution, with a larger proportion of BEVs, followed by PHEVs, and hybrids as the smallest market segment. South Africa's NEV market is smaller and atypical in its distribution, hence the need to evaluate the price differential of NEVs and their respective ICE equivalents in other competitor markets which have more established NEV markets.

[5] Turkey and Thailand were initially included in the research but were ultimately excluded from the report as comparative NEV and ICE equivalent pricing information was difficult to find.
[6] Affordable NEVs were considered those priced at below R1million (or below US$67 910) per vehicle.

2.2. Netherlands

NEV price premiums

Following the same price limit as for the South African NEV market, nine NEV models were analysed in the Netherlands in 2021, including the BMWi3 eDrive i3 (BEV), Toyota Yaris Hybrid, Nissan Leaf (BEV), VW ID.3 (BEV), VW e-Up (BEV), Ford Focus (hybrid), Hyundai Kona Electric (BEV), Hyundai Kona Hybrid, and the Kia Xceed Plug-in Hybrid (PHEV). The pricing differential between these NEVs and their respective ICE equivalent models, is shown in Table 3.

Table 3: Netherlands NEVs and ICE equivalents sold in 2021

NEV MODEL	MAKE	NEV RRP	ICE EQUIVALENT	ICE RRP	% DIFFERENCE
BMWI3 EDRIVE I3	BEV	US$46 246	**BMW 1 series 118i**	US$41 170	12%
TOYOTA YARIS HYBRID	Hybrid	US$25 086	**Toyota Yaris**	US$21 964	14%
NISSAN LEAF	BEV	US$35 834	**Nissan Micra**	US$21 669	65%
VW ID.3	BEV	US$38 724	**VW Golf**	US$32 018	21%
VW E-UP	BEV	US$30 630	**VW Up**	US$19 773	55%
FORD FOCUS	Hybrid	US$32 255	**Ford Focus**	US$31 665	2%
HYUNDAI KONA ELECTRIC	BEV	US$37 921	**Hyundai Kona**	US$29 873	27%
HYUNDAI KONA HYBRID	Hybrid	US$29 688	**Hyundai Kona**	US$29 873	-1%
KIA XCEED PLUG-IN HYBRID	PHEV	US$41 043	**Kia Xceed**	US$32 371	27%

Note: Data was obtained in September 2021 with a currency conversion of US$1.16 per Euro.

The analysis suggests that the typical price difference between NEVs and their ICE equivalents in the Netherlands is 23%. The highest differential is for BEVs, priced 36% higher than ICE equivalent models, followed by PHEVs, 27% higher, and lastly HEVs, priced only 5% higher. The Netherlands has a high market concentration of BEVs and PHEVs and a lower concentration of HEVs, relative to South Africa, which may explain the lower price differential between NEVs and ICE equivalent models overall.

2.3. United Kingdom

NEV price premiums

The same suite of NEV vehicles were analysed for the UK market, with the findings in Table 4. This suggests that the typical price differential between NEVs and their ICE equivalent models is 30%. The highest differential is for BEVs, priced 42% higher than their ICE equivalents, followed by PHEVs, priced 39% higher, and HEVs, priced only 8% higher than their respective ICE equivalent models.

Table 4: UK NEVs and ICE equivalents sold in 2021

NEV MODEL	MAKE	NEV RRP	ICE EQUIVALENT	ICE RRP	% DIFFERENCE
BMWI3 EDRIVE I3	BEV	US$46 090	**BMW 1 series 118i**	US$32 565	42%
NISSAN LEAF	BEV	US$35 442	**Nissan Micra**	US$19 551	81%
VW ID.3	BEV	US$40 404	**VW Golf**	US$32 531	24%
VW E-UP!	BEV	US$32 115	**VW up!**	US$18 624	72%
FORD FOCUS 1.0L HYBRID	Hybrid	US$30 915	**Ford Focus 1.0L**	US$29 933	3%
HYUNDAI KONA ELECTRIC	BEV	US$38 107	**Hyundai Kona**	US$28 993	31%
HYUNDAI KONA HYBRID	Hybrid	US$32 660	**Hyundai Kona**	US$28 994	13%
MITSUBISHI OUTLANDER PHEV	PHEV	US$48 755	**Mitsubishi Outlander**	US$38 243	27%
KIA XCEED PLUG-IN HYBRID	Hybrid	US$43 363	**Kia Xceed**	US$28 911	50%

Note: Data was obtained in September 2021 with a currency conversion of US$1.36 per British Pound.

2.4. France

NEV price premiums

Six NEV models were analysed in the French market, with their comparative prices presented in Table 4. The analysis suggests that the typical price differential between NEVs and their respective ICE equivalent models in France is 31%. As per the other markets, the highest differential is attributed to BEVs, which are typically priced 41% higher than ICE equivalents, followed by PHEVs which are typically priced 39% higher than ICE equivalents, and lastly followed by hybrids which are typically priced 12% higher than their respective ICE equivalent models.

Table 5: France NEVs and ICE equivalents sold in 2021

NEV MODEL	MAKE	NEV RRP	ICE EQUIVALENT	ICE RRP	% DIFFERENCE
BMWI3 EDRIVE I3	BEV	US$46 194	**BMW 1 series 118i**	US$34 689	33%
NISSAN LEAF	BEV	US$31 104	**Nissan Micra**	US$19 646	58%
VW ID.3	BEV	US$40 181	**VW Golf**	US$32 162	25%
HYUNDAI KONA ELECTRIC	BEV	US$36 423	**Hyundai Kona**	US$24 571	48%
HYUNDAI KONA HYBRID	Hybrid	US$27 636	**Hyundai Kona**	US$24 571	12%
KIA XCEED	PHEV	US$41 153	**Kia Xceed**	US$29 590	39%

Note: Data was obtained in September 2021 with a currency conversion of US$1.16 per Euro.

2.5. Australia

NEV price premiums

Only four NEV models were analysed for the Australian market. These models included the BMWi3 eDrive i3 (BEV), Toyota Yaris SX 1.5L Hybrid, Ford Escape ST-Line PHEV, and the Hyundai Kona Electric (BEV). The pricing differential between these NEVs and their respective ICE equivalent models is shown in Table 6.

Table 6: Australia NEVs and ICE equivalents sold in 2021

NEV MODEL	MAKE	NEV RRP	ICE EQUIVALENT	ICE RRP	% DIFFERENCE
BMWI3 EDRIVE I3	BEV	US$57 195	**BMW 1 series 118i**	US$38 622	48%
TOYOTA YARIS SX 1.5L HYBRID	Hybrid	US$24 095	**Toyota Yaris SX 1.5L petrol**	US$22 580	7%
FORD ESCAPE ST-LINE PHEV	PHEV	US$42 516	**Ford Escape**	US$29 529	44%
HYUNDAI KONA ELECTRIC	BEV	US$43 636	**Hyundai Kona**	US$21 319	105%

Notes: Data was obtained in September 2021 with currency conversion applied of US$0.74 per Australian Dollar.

The analysis suggests that the price differential between NEVs and their respective ICE equivalent models in Australia is 42%. The highest differential is again for BEVs, which are priced 76% higher than ICE equivalents, followed by PHEVs which are 44% higher, and HEVs which are priced 7% higher.

2.6. United States

NEV price premiums

Nine NEV models were analysed in the US, including the Toyota Corolla 1.8L Hybrid LE, Nissan Leaf (BEV), VW ID.4, (BEV), Ford Escape SE Hybrid, Ford Escape SE Plug-in Hybrid, Hyundai Kona Electric (BEV), Mitsubishi Outlander PHEV, Kia Sorento Hybrid, and Kia Sorento Plug-in Hybrid (PHEV).

The pricing differential between these NEVs and their respective ICE equivalent models is shown in Table 7.

Table 7: US NEVs and ICE equivalents sold in 2021

NEV MODEL	MODEL	NEV RRP	ICE EQUIVALENT	ICE RRP	% DIFFERENCE
TOYOTA COROLLA 1.8L HYBRID LE	Hybrid	US$23 650	**Toyota Corolla**	US$20 075	18%
NISSAN LEAF	BEV	US$27 400	**Nissan Versa**	US$14 980	83%
VW ID.4	BEV	US$39 995	**VW Taos**	US$22 995	74%
FORD ESCAPE SE HYBRID	Hybrid	US$28 030	**Ford Escape S**	US$25 555	10%
FORD ESCAPE SE PLUG-IN HYBRID	PHEV	US$33 075	**Ford Escape S**	US$25 555	29%
HYUNDAI KONA ELECTRIC*	BEV	US$35 225	**Hyundai Kona**	US$22 375	57%
MITSUBISHI OUTLANDER PHEV	PHEV	US$36 695	**Mitsubishi Outlander**	US$25 795	42%
KIA SORENTO HYBRID	Hybrid	US$33 990	**Kia Sorento**	US$29 490	15%
KIA SORENTO PLUG-IN HYBRID	PHEV	US$44 990	**Kia Sorento**	US$29 490	53%

Notes: Data was obtained in September 2021.

The analysis suggests that the typical price differential between NEVs and their respective ICE equivalent models in the US is 42%. The highest differential is attributed to BEVs, which are typically priced 71% higher than ICE equivalents, followed by PHEVs which are priced 41% higher than ICE equivalents, and hybrids which are priced 14% higher than their respective ICE equivalent models.

2.7. Germany

NEV price premiums

Ten NEV models were analysed in the German market. The pricing differential between these NEVs and their respective ICE equivalent models is shown in Table 8.

Table 8: Germany NEVs and ICE equivalents sold in 2021

NEV MODEL	MAKE	NEV RRP	ICE EQUIVALENT	ICE RRP	% DIFFERENCE
BMWI3 EDRIVE I3	BEV	US$45 096	**BMW 1 series 118i**	US$32 203	40%
TOYOTA YARIS HYBRID	Hybrid	US$27 115	**Toyota Yaris**	US$21 958	23%
TOYOTA COROLLA	Hybrid	US$32 122	**Toyota Corolla**	US$29 220	10%
NISSAN LEAF	BEV	US$34 677	**Nissan Micra**	US$16 177	114%
VW ID.3	BEV	US$41 002	**VW Golf**	US$31 931	28%
VW E-UP	BEV	US$24 769	**VW Up**	US$15 957	55%
FORD FOCUS	Hybrid	US$27 057	**Ford Focus**	US$24 514	10%
HYUNDAI KONA ELECTRIC	BEV	US$41 222	**Hyundai Kona**	US$23 114	78%
HYUNDAI KONA HYBRID	Hybrid	US$25 785	**Hyundai Kona**	US$23 114	12%
KIA XCEED PLUG-IN HYBRID	PHEV	US$41 615	**Kia Xceed**	US$25 080	66%

Notes: Data was obtained in September 2021 with currency conversion applied of US$1.16 per Euro.

The analysis suggests that the typical price differential between NEVs and their respective ICE equivalent models in Germany is 48%. The BEV differential is 63% higher, the PHEV differential 66%, and the hybrid only 14% higher than ICE equivalent models.

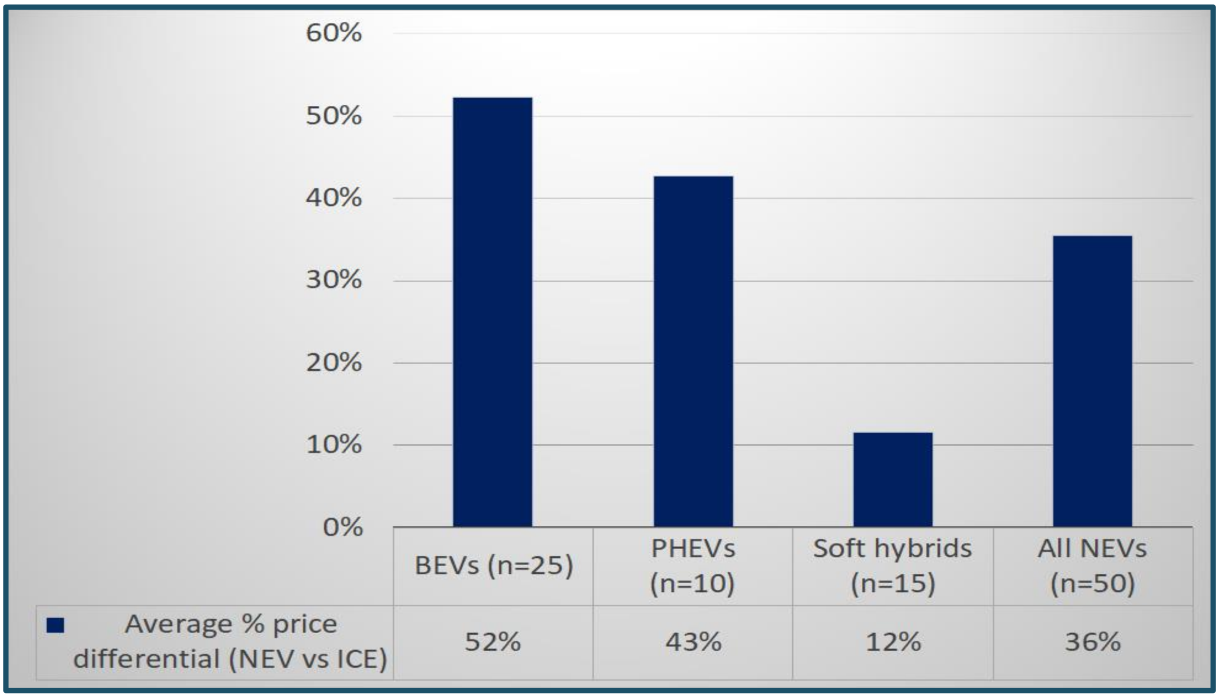
2.8. Conclusion

This section analysed the pricing differentials between NEVs and their respective ICE equivalent models in South Africa and six other competitor markets, namely the UK, France, Australia, US, Netherlands, and Germany.

The South African market analysis is compromised by the small number of models identified and the equally small number of vehicles sold. Nonetheless, the analysis suggests that the typical price differential between NEVs and ICE equivalents in South Africa is 33%. The highest differential is for PHEVs, at 43%, and the lowest price differential is for hybrids which are typically priced 21% higher than their respective ICE equivalent models. However, it was noted that the price differential for BEVs is understated in South African given that OEMs reported selling NEV models at below cost to stimulate new demand for these vehicles.

In the six other markets analysed, the typical price differential between NEVs and their respective ICE equivalent models is 36%. The average price differential by NEV type make is shown in Figure 1. It shows that the highest average price differential is attributed to BEVs, which are typically priced 52% higher than their ICE equivalent models, followed by PHEVs, which are typically priced 43% higher than their ICE equivalent models, and lastly followed by hybrids which are typically priced 12% higher than their respective ICE equivalent models. These findings are important, as they suggest the base price differentials that exist between NEVs and their ICE equivalents.

Figure 1: NEVs and ICE equivalent price differential (across six comparator markets) in 2021



Source: Authors

3. INTERNATIONAL COMPARATOR ECONOMY DESKTOP REVIEW

There has been a concerted policy push for countries to promote e-mobility, especially with the ratification of the Paris Agreement in 2015. Policymakers in various countries have since introduced new environmental standards and regulations that seek to compel industries to reduce their carbon emissions output and act sustainably.

This has led to a technology paradigm shift, as industries shift to more sustainable energy solutions and clean technologies. Many countries have drafted goals, strategies, and guidelines to address environmental sustainability, particularly within the transport sector. The transport sector plays a critical role in reducing carbon emissions and the transition to e-mobility.

To position South Africa relative to other countries regarding NEV opportunities, this section of the report reviews NEV market developments and manufacturing support provided in 10 selected competitor economies: Brazil, Egypt, Hungary, India, Malaysia, Mexico, Morocco, Poland, Thailand, and Turkey. These countries were reviewed as part of the development of the SAAM, as key automotive competitors to South Africa. This section narrowly focuses on their NEV incentives.

Countries use both demand and supply-side measures to incentivise support for NEV demand and to provide incentives to encourage NEV manufacturing. Demand-side measures include vehicle subsidies, tax differentials, vehicle use fees, corporate tax adjustments, and fee rebates, whereas supply-side support measures include investment-based tax incentives, infrastructure provision, production support, and subsidies for developing green skills. Furthermore, countries have invested in NEV transport infrastructure, in particular charging stations to support the transition to e-mobility.

Table 9 summarises NEV policies and incentives across the 10 countries selected for this study. They include an assessment of demand and supply-side fiscal and non-fiscal incentives, in addition to regulatory frameworks for the rollout of charging infrastructure.

As evident from the data presented in Table 9, Hungary, India, Poland, and Thailand are the four economies with the largest number of NEV-specific automotive incentives, whereas Brazil, Egypt, and Malaysia have less developed NEV-specific incentives. Higher shares of NEV sales are typically found in countries offering substantial fiscal incentives and a comprehensive charging infrastructure. While there has been visible growth in NEV sales globally with NEVs accounting for 2.6% of total vehicle sales, on average NEVs only constitute 1.1% total vehicle sales among the selected countries,[7] signalling lower NEV market penetration levels in developing economies.

However, of the selected countries, Hungary, Poland, and Thailand have established manufacturing sites for NEVs and components. These countries have introduced policies targeting NEV manufacturing and supporting the localisation of NEV-related components and parts.

[7] Selected countries include Thailand (1%), India (0.5%), Hungary (2%), Malaysia (0.04%) and Poland (1.89%).

Table 9: Matrix of NEV specific incentives

	DEMAND-SIDE INCENTIVES								SUPPLY-SIDE INCENTIVES		
Country	Import duty rebate	Tax break	Direct Subsidy	Vehicle financing support	First time buyers' incentive	Government purchases	Scrappage allowance	Non-financial support	Investment tax incentive	Plant and machinery allowance	Raw material and parts incentive
Brazil	X			X				X			X
Egypt	X	X	X					X			
Hungary			X	X		X		X			
India	X	X					X	X			
Malaysia											
Mexico	X					X		X			
Morocco	X	X									
Poland	X	X	X	X	X						
Thailand	X	X						X	X	X	X
Turkey		X						X			

Source: Authors.

Note: Non-financial support includes free parking, toll road fee waivers and preferential bus-lane travel, for example.

3.1. Brazil

NEV policy and programme review

Brief overview: Brazil's automotive strategy

The Brazilian automotive industry has a significant ethanol-base. Brazil is the seventh largest market for vehicles and ninth largest automotive producer in the world. The country produced two million vehicles and sold 2.1 million vehicles in 2020, down from 2.8 million in 2019 (OICA , 2021b). Brazil's major OEM investments include General Motors, Fiat, and Volkswagen. The country forms part of the Mercosur[8]-Mexico free trade area (FTA). Currently, NEVs represent 2% of Brazil's fleet, while BEVs represent less than 0.1% of total vehicles in the market (Henry, 2021; Vargas et al., 2020). Most NEVs in the country are used by government, corporate services, or in public transportation (Vargas et al., 2020). Factors influencing the slow deployment of NEVs in Brazil relate to the country's dependence on ethanol, a lack of government support, and the limited availability of charging infrastructure.

NEV policy strategy

Brazil does not face challenges in energy security or extreme air pollution compared to other countries. Despite this, Brazil has committed to implementing measures to reduce carbon emissions. According to Costa et al. (2017), Brazil is committed to reducing carbon emissions by 37% by 2025 and by 43% by 2030 – relative to 2005 levels. Ethanol fuel is a key source of clean fuel in Brazil and is primarily responsible for decreasing the growth of transport emissions (Bordonal et at., 2018). It accounts for around 50% of the fuel consumption of road transport in Brazil (Costa et al*.,* 2017). Costa (2020) notes that, in 2019, more than 92% of vehicles sold in Brazil were flex-fuel vehicles that operate on a blend of gasoline and ethanol. However, increased biofuel production has led to several environmental problems, such as deforestation, soil contamination, and water and air pollution.

One of the main obstacles to the introduction of NEVs in Brazil is that NEVs are in competition with biofuels, particularly ethanol. As a result, transport electrification in Brazil does not have the same push as other countries. Through various policy measures and initiatives, however, the government has outlined its plan to decarbonise the transport sector. Among the initiatives launched are the Brazilian automotive industry policy, ROTA 2030, Brazil's emission control programme, also known as the PROCONVE – Vehicle Air Pollution Control programme, and the RenovaBio Programme designed to promote the expansion of biofuels into Brazil's energy mix (Vargas et al., 2020).

The Brazilian government launched the Rota Program 2030 programme in 2018 with the aim of stimulating automotive industry investment and competitiveness. The programme's objectives are to increase fuel efficiency and reduce carbon emissions, encourage research and development (R&D) investment through tax incentives, and to ensure vehicle safety (Bland, 2017). In its commitment to achieving energy efficiency, Rota 2030 introduced a reduction in the industrialised products (IPI) tax[9] of between 1%-2%[10] for vehicles that comply with Brazil's energy efficiency standards (Bland, 2017).

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[8] Mercosur, also known as the Common Market of the South, is a trade bloc agreement that exists between Argentina, Brazil, Paraguay and Uruguay.

[9] The IPI is an excise or luxury tax applicable to domestically produced and imported products into Brazil (Transport Policy, 2020).

[10] Hybrid vehicles with flex-fuel technology receive an additional 2% IPI tax reduction.

This reduction in the IPI tax will be applicable from 2022. ROTA 2030 also established mandatory requirements for vehicle manufacturers to increase the energy efficiency of their fleets by 11% by 2022 through the Vehicle Tagging and the Motor Vehicle Air Pollution Control Programmes (BNAmericas, 2021). In addition to achieving minimum energy efficiency levels, vehicle manufacturers also need to comply with Brazil's Vehicle Labelling Programme (PBNEV) and commit to reaching minimum levels of structural performance and driver assistance technologies (Amir, 2020).

Although Rota 2030 seeks to improve vehicle energy efficiencies, the policy is criticised for not providing a clear direction for the automotive industry NEV transition (Wolffenbuttel, 2020). Furthermore, Rota 2030 does not include a specific policy for NEVs, but it does incentivise flex-fuel hybrids. It therefore remains difficult to ascertain whether the programme will ultimately promote NEVs in Brazil.

Demand-side and supply-side NEV incentives

Brazil announced two NEV incentives geared towards reducing the price offering of NEVs in the local market. Brazil's Senate Bill 174/2014 exempts NEVs manufactured in Brazil from the IPI tax (Trentini and Colin, 2015). In additional, import taxes for NEVs were reduced from 30% to 0%, making NEVs exempt from import taxes (Trentini and Colin, 2015). NEV-related components and parts are also exempted from import taxes; however, this is on condition that there is no domestic equivalent of the imported component (Trentini and Colin, 2015).

There are two types of taxes in Brazil applicable to vehicles. The Brazilian tax system comprises the IPI excise tax and the ICMS (Imposto sobre Circulação de Mercadorias e Serviços) tax on the circulation of goods, transportation, and communication services (KPMG, 2016). There are additional taxes on vehicles including the ISS – Imposto Sobre Serviços (municipal services tax) and the Social Contribution for Social Security Financing (COFINS) tax. These taxes can increase the final price of a vehicle in the Brazilian market by more than 70% (Quatro Rodas, 2021).

For domestically produced vehicles, the IPI is added on the sales price of vehicles, while for imports, the tax is based on the sales price plus additional import taxes and other fees, including shipping costs and insurance costs (Transport Policy, n.a.). As illustrated in Table 10, the IPI tax rates for locally produced vehicles ranges from 7% to 25%, depending on the vehicle type, fuel type, and engine displacement (Transport Policy, n.a.).

Table 10: IPI rates for vehicles in Brazil

ENGINE CAPACITY (CM^3) AND FUEL TYPE	IPI RATE FOR DOMESTICALLY MANUFACTURED VEHICLES	IPI RATE FOR IMPORTED VEHICLES[11]
NEVs	0%	0%
Less than 1000 cc	7%	37%
1000 cc-2000 cc Flex/Ethanol	11%	41%
1000 cc-2000 cc Gasoline	13%	43%
Above 2000 cc Flex/Ethanol	18%	-
Utility vehicles	4%	31%

Source: Andrade et al, 2019:4

[11] This rate is not applicable for vehicles imported from Mexico and Mercosur.

Public transportation and procurement

Brazil is a major bus exporter. However, the country lags in the electrification of public transport because of its lack of adequate NEV policies. According to P&S Market Research (2018), Brazil's first electric bus was launched in Sao Paulo in 2014. The electric bus was manufactured in Brazil, while its batteries were imported from Japan (P&S Market Research, 2018).

The high cost of electric buses and the lack of infrastructure in Brazil remain barriers to electric bus adoption. In addition, procurement costs on electric buses in Brazil are high. Depending on the state, Brazilian taxes on imported electric buses can add up to about 120% of the base vehicle price, resulting in a significantly higher final price (P&S Market Research, 2018). To promote electric buses and to stimulate investment in innovation in the local bus industry, the government announced vehicle financing support, imposed an import tax exemption on electric buses, and reduced the import tax on parts and equipment used in the manufacturing of electric buses (P&S Market Research, 2018). Electric and ethanol-powered buses in Brazil are eligible for both vehicle financing with lower rates and longer repayment terms than those available for traditional ICE buses (P&S Market Research, 2018).

In 2020, BYD completed its first locally produced chassis for electric buses in Sao Jose dos Campos, in the state of Sao Paulo (Sustainable Bus, 2020). The electric bus model covers 250km with a full charge and is intended for Brazil's Green Line[12] bus rapid transit (BRT) market. According to Sustainable Bus (2020) and Seetao (2020), the BYD plant has an annual production capacity of 720 buses, however, only 12 buses were scheduled to be assembled in 2021. All electric buses will be locally produced by BYD in cooperation with its local partner, Marco Polo (Seetao, 2020). BYD has an electric bus footprint that covers Brazil, Chile, Colombia, Ecuador, Costa Rica, Uruguay and Argentina.

The large consumers of NEVs in Brazil are private and public companies. Sao Jose dos Campos leased 30 NEVs, including the e5 and the e6 models from BYD in 2018. The vehicles were for use by the police department and other government agencies). Brazilian brewery Ambev has a fleet of 1 000 NEVs from local Brazilian manufacturers Fábrica Nacional de Motores (FNM) and Agrale (Hampel, 2021). The NEVs are for Ambev to deliver beverages throughout South America (Hampel, 2021). Hampel states that the brewery company also plans to convert at least half of 7 000 trucks to clean energy alternatives by 2023.

NEV charging infrastructure

A consortium of private and public companies in Brazil[13] created the e-mobility programme to support the development of charging infrastructure across Brazil. The programme includes plans to install free-to-use charging stations in Brazilian cities. The charging stations will allow free charging of NEVs, although users will be required to register with the programme to access free charging (Vargas et al., 2020). The free charge benefit will remain in place until the National Electric Energy Agency (ANEEL) develops standards that regulate the country's charging infrastructure (Vargas et al., 2020).

[12] The Green Line is the first pure electric BRT route in Brazil.

[13] Private and public companies including Volvo, BMW, and Portugal-based energy company, EDP, along with Volkswagen, Audi, Porsche, Siemens, ABB, and Electric Mobility Brasil are the key players supporting the roll out of charging infrastructure in Brazil.

3.2. Egypt

NEV policy and programme review

Brief overview: Egypt's automotive strategy

The Egyptian automotive industry is dominated by Completely Knocked Down (CKD) and Semi Knocked Down (SKD) assemblers and hundreds of components and parts suppliers (Friedrich-Ebert-Stiftung, 2020). Egypt was ranked 43rd globally in vehicle production in 2020, producing 23 754 vehicles (OICA, 2020a). The country sold 219 732 vehicles in 2020, which is substantially more than the 170 568 vehicles sold in 2019 (OICA, 2021b). The market share of NEVs is small and according to The Africa Report (Onyango, 2021), Egypt has an estimated 1 500 registered NEVs in the country.

NEV policy strategy

The government of Egypt has a vision to develop an efficient domestic automotive industry. Its Vision 2030 national plan targets a reduction in air pollution by 2023, with further plans to increase Egypt's renewable energy mix to 22% of total energy supply in 2030 (ABB, 2019; IRENA, 2018). The adoption of an e-mobility strategy in Egypt would play a key role in helping the country succeed in its goals of reducing carbon emissions, improving air quality, and reducing the country's dependency on fuel imports and subsidies (MOF, 2018). Although Egypt does not have a strategic plan targeting NEV growth, several steps have been taken by the government to promote NEV adoption.

NEV incentives include a 100% exemption from custom duties (excluding public transport, electric buses, which are subject to a 40% import tariff) (Friedrich-Ebert-Stiftung, 2020). Custom duty exemptions for NEVs have been in place since 2013 and were maintained in the government's 2018 provisions (Friedrich-Ebert-Stiftung, 2020). The import of used vehicles is banned in Egypt, but a recent exception was made for NEVs. To encourage the use of NEVs and enhance future market opportunities, the government issued a decree in 2018 permitting the import of pre-owned NEVs into Egypt, provided the vehicles are no more than three years old (Egypt Today, 2018; Zawya, 2021; Friedrich-Ebert-Stiftung, 2020). Although the public transport sector is a leading source of emissions, there are currently no incentives for vehicles used in public transportation. Electric buses are subject to a 40% custom duty. The lack of recycling facilities and co-ordination to plan for handling of batteries will pose a challenge of how to deal with the batteries in the country when they reach their end-of-life (EOL) (Friedrich-Ebert-Stiftung, 2020).

To lower the cost of NEVs, the government offers purchase subsidies and incentives for NEV consumers. Egypt launched a financing programme in 2018 for the private purchase of NEVs as well as a separate financing programme to provide vehicle finance for the purchase of electric taxis (LYNX Strategic Business Advisors, 2019). No further details are available on the programme. In addition, to stimulate NEV demand in the market, the government pledged to offer subsidies of approximately E£50 000 (US$3,185) per NEV for the first 100,000 locally assembled vehicles, on condition that the vehicle can cover over 400km per single charge (LYNX Strategic Business Advisors, 2019).

Public transportation and procurement

In support of electric-powered public transportation, the government of Egypt mandates that publicly listed companies are to replace 5% of their fleets with NEVs annually (LYNX Strategic Business Advisors, 2019). In addition to encouraging procurement, the Egyptian Passenger Transportation Authority signed an agreement in 2018 with Chinese manufacturer BYD for the purchase of 15 electric buses. The electric buses will be part of the Alexandria's public transport fleet (Centre for Transport Excellence, 2020). The US$40 million partnership includes installing 18 charging stations, as well as their servicing and maintenance (Centre for Transport Excellence, 2020).

The prospect for local assembly of electric buses includes collaboration by Chinese manufacturer Foton Motor in agreement with the Ministry of Military Production (MoMP) to produce 500 electric buses a year. The company intends producing 2 000 buses over a four-year period, using 45% local components provided by Egypt's Military Factory (Afrik21, 2020). Under the agreement, Egypt seeks to create a local market for electric buses together with building technical capacity in manufacturing NEVs (Egypt Today, 2020a; Sustainable Bus, 2020).

Other initiatives to develop electric buses in Egypt include plans by German companies ZF Friedrichshafen AG and start-up e-troFit. The partnership aims to explore the potential to retrofit existing diesel buses to fully electric in collaboration with Egyptian public transport authorities (Friedrich- Ebert-Stiftung, 2020).

NEV and component manufacturing

No NEVs are locally assembled in Egypt, but Egypt Today (2020a) reported that the country will begin producing NEVs from 2021. The Egyptian government has signed MoUs with various players in the segment, but most of Egypt's NEV plans, including the signed agreements with foreign companies, have been delayed as a result of the COVID-19 pandemic.

- Drshal, an Egyptian company signed agreements with two Chinese companies Dongfeng Motor Corporation and Vasworld Power Corporation Limited for SKD assembly of the DFLZ M5 NEV model (Daily News Egypt, 2018). According to Daily News Egypt (2018), Dongfeng and Vasworld Power plan to export NEV SKD kits and batteries to Egypt, while Drshal will be responsible for the local assembly of SKD and CKD. In addition, Drshal announced plans to aid and develop local component supplier industries that support the manufacturing of vehicles. Overall, Drshal will invest US$53 million in the the NEV programme (Daily News Egypt, 2018).
- In another partnership with Chinese manufacturers, El Nasr Automotive Manufacturing Company partnered with Dongfeng in a joint venture to assemble the Nasr E70 NEV model. The E70 model is scheduled to begin production in 2022. According to the agreement, El Nasr will produce 25 000 NEVs annually (Egypt Today, 2021b). BMW announced plans to export NEVs into the Egyptian market, while Daimler has offered its expertise in developing concepts of e-mobility, including autonomous driving (LYNX Strategic Business Advisors, 2019).
- Chinese automotive company Geely and the National Organisation for Military Production (NOMP) signed a MoU in 2019 to build a NEV assembly plant (Friedrich-Ebert-Stiftung, 2020). According to Friedrich-Ebert-Stiftung (2020:18), the MoU "aims to initiate cooperation to enhance technology transfer and the local production of NEVs using the available capacity of NOMP's plants, in line with Egypt's national strategy for NEV production".

Although Egypt does not have a specific NEV policy, auto-manufacturing and component companies operating in Egypt benefit from government incentives. These incentives aim to enhance production capabilities in the country and to enable local assemblers to compete with imported vehicles in the domestic market. Companies located in the Suez Canal Economic Zone (SCZone) receive the following benefits (Werr, 2020):

- 100% foreign ownership;
- 100% foreign control of import/export activities;
- Imports are exempt from customs duties and sales tax;
- Customs duties on exports into Egypt are imposed on imported components only, and not on the final product; and
- Fast-track visa services.

NEV changing infrastructure

The charging infrastructure in Egypt is still in the initial phase of development and huge investments are needed for this. The Egyptian government has no plan to implement financial support for public charging stations, so establishing charging points mainly depends on investment by the private sector.

To support NEV demand, the rollout of charging infrastructure was first introduced into Egypt in 2018 by local start-ups ReVolta Egypt and Infinity-Energy. ReVolta has since installed 200 charging stations in 18 of Egypt's governorates[14] (Africanews, 2018; LYNX Strategic Business Advisors, 2019). The European Bank for Reconstruction and Development plans to invest $60 million towards Infinity-Energy to advance NEV charging infrastructure across gas stations in Egypt as well as in selected residential communities (Shumkov, 2019). Infinity-Energy has since set up over 30 NEV charging stations, mostly in Cairo and Giza, with further plans to bring the total number of charging stations to 100 by the end of 2020 (Enterprise, 2020). Another manufacturing company, ABB supplied 20 Terra 53 multi-standard DC charging stations to numerous gas stations and major cities across the country. Other plans for rolling out infrastructure include the manufacturing of NEV charging infrastructure by Scottish and Southern Energy (SSE) company and Electric Marathon International (LYNX Strategic Business Advisors, 2019). A local factory built by SSE and Electric Marathon International will produce NEV charging stations (LYNX Strategic Business Advisors, 2019).

To assure the safety of consumers and regulate charging infrastructure, the Egyptian Electricity Utility and Consumer Protection Regulatory Agency approved regulations that will be applied to companies interested in investing in NEV charging infrastructure (Daily News Egypt, 2020). The agency also approved proposed tariffs for charging NEVs, however these are yet to be standardised (Daily News Egypt, 2020).

3.3. Hungary

NEV policy and programme review

Brief overview: Hungarian automotive strategy

The automotive industry is important for the Hungarian economy. Vehicle manufacturing accounts for at least a third of the country's exports (Than and Hovet 2020). During 2020, Hungary produced 406 497 vehicles, including light commercial vehicles (OICA, 2020). The country was ranked as the world's 25th vehicle producer in 2020 and 24th in 2019. There are four leading OEMs in Hungary, namely Audi, Suzuki, Mercedes and Opel (Swiss Global Enterprise, 2020). Hungary forms part of the European Free Trade Association (EFTA) and the Central European Free Trade Agreement (CEFTA). NEVs represented 2% of Hungary's total vehicle sales in 2020, with 11 810 NEVs registrations made up of about 5 655 PHEVs and 8 214 HEVs (Netherlands Enterprise Agency, 2021).

NEV policy strategy

Hungary is a member of the EU. The EU has developed a long-term strategy – the European Green Deal for reducing greenhouse gas emissions and achieving "climate neutrality" by 2050 (European Commission, n.d.). Hungary's NEV policy strategy includes initiatives from the EU Green Deal and its own national strategic plans. As part of the EU Green Deal, the EU introduced its Fit for 55 plan in 2021. According to the European Automobile Manufacturers' Association (ACEA, 2020), under this

[14] Egypt is divided into 27 official governorates which are administrative divisions in the country administered by governors (2020).

plan, all sectors including energy, agriculture, transport, and buildings are required to reduce their carbon emissions by 55% by 2030 (from 1990 levels), in alignment with the 2030 Climate Target Plan and the European Green Deal to mitigate against climate change.

Fit for 55 is crucial for the transition to sustainable mobility solutions in Europe. A key proposal towards decarbonising the transport industry includes a ban on the sale of carbon emitting passenger vehicles and light commercial vehicles from 2035, including HEVs (ACEA, 2020). The EU requires its member states to steer away from fossil fuel-based transport through “the structural transformation of the automotive value chain to producing completely different powertrain components for NEVs, and to develop the required supporting charging and refuelling infrastructure” (Harrisson, 2021: 19).

In alignment with targets set in the EU’s Renewable Energy Directive (REDII), by 2030 the EU targets a 32% share of renewable energy in total final energy consumption for the transport sector (European Commission, n.d.). Hungary targets at least 20% renewable energy by 2030. EU member states are required to reduce carbon emissions through their National Energy and Climate Plans (NECPs). The NECP, effective from 2021-2030, is a comprehensive policy outlining the role of the transport sector among EU member states in promoting energy efficiency, reducing emissions, and increasing the bloc’s share of renewable energy in its energy mix (Netherlands Enterprise Agency, 2021). Moreover, the NECP seeks to facilitate the spread of NEVs as well as their supporting charging infrastructure, while also promoting support for the use of biofuels in the transport sector. For Hungarian transportation, the NECP points to the country’s intention to integrate hydrogen technology in its transportation systems and industrial applications (Netherlands Enterprise Agency, 2021).

In other efforts to increase the share of biofuels and significantly enhance the role of e-mobility in Hungary, the government approved the Climate and Nature Protection Action Plan in 2020 with funding of HUF 32 billion (US$2 billion) allocated towards the support of renewable energy production and Ft 36 billion (US$2.7 billion) towards the procurement of low and zero-emission vehicles (ZEV) Szőke, 2020).

Under the Climate and Nature Protection Action Plan, the Hungarian government allocated Ft 5 billion (about US$16 million) in the form of a progressive subsidy to incentivise the spread of small and affordable NEVs and electric-scooters (for non-private usage) (Netherlands Enterprise Agency, 2021). The subsidy scheme aims to cover 21% of the purchase price of new NEVs, but is capped at Ft 1.5 million (US$4 806) per vehicle (Netherlands Enterprise Agency, 2021; Hungary Today, 2020). The amount of subsidy scheme for NEVs in Hungary is categorised as follows:

- The support for the purchase of a vehicle for up to five people is a maximum of Ft 2.5 million (US$8 011) for vehicles with a price between Ft 11 million (US$35 234) and Ft 12 million (US$38 437).
- For vehicles that cost between Ft 12 million (US$38 437) and Ft 15 million (US$48 046), consumers can receive support of a maximum of Ft 1.5 million ($4 806). Vehicles priced above the ceiling would not be eligible for support.
- The scheme also provides for micro-mobility vehicles and taxis that meet the eligibility criteria to receive support of up to 55% of the total purchase price of NEVs.

In 2020, with an additional Ft 882 million (US$2.8 million), the Hungarian government expanded the subsidy scheme to extend support to the purchase of over 2 000 NEVs.

Vehicles with a green license plate in Hungary are exempted from vehicle tax, registration tax, the vehicle release fee, and from the corporate vehicle tax. Additional support from the government for ZEVs and NEVs includes non-financial incentives in the form of preferential bus lane use and free parking in Budapest and other major cities of Hungary.

NEV and component manufacturing

There is strong support for NEV production in Hungary. In 2018, Audi Hungaria began production of the Audi e-tron in its factory located in Győr (Audi, n.d.). Audi Hungaria also produces NEV models such as the Audi Q3 MHEV, Audi Q3 Sportback MHEV, Audi Q3 PHEV, and the Audi Q3 Sportback PHEV (Audi, 2020). Since 2018, it is estimated that 187 163 electric drivetrains were produced in the Győr plant (Audi, n.d.). Another top vehicle manufacturer in Hungary, Mercedes, announced that it would add a Ft 50 billion (US$16 billion) investment to its Hungarian plant to include NEVs in its production line (Mercedes-Benz, n.d.). Mercedes locally produced the CLA Coupe and CLA Shooting Brake PHEV models in Hungary and will begin manufacturing the EQB BNEV from its plant in Kecskemét. The A-Class PHEV is also scheduled for production at the Kecskemét plant in future, although no dates have been announced yet for its production (Automotive World, 2021).

In component and parts manufacturing, Hungary has capacity to manufacture a variety of NEV components, specifically the battery. Hungary is positioned as a prominent hub for battery production outside of Asia. There are currently no specific incentives for NEV or battery manufacturing in Hungary, however, manufacturers benefit from different types of government support offered to investors including cash subsidies for investments, training, job creation, R&D, tax incentives, and the reduction of corporate tax (Swiss Global Enterprise, 2020). According to Reuters (2018), three of the five largest Asian battery manufacturers for electric vehicles, namely Samsung SDI, SK Innovation, and GS Yuasa, produce batteries in Hungary. Moreover, other battery producers including AVL, Bosch, and Thyssenkrupp have made significant investment into the Hungarian battery manufacturing industry. Following these decisions, more suppliers of large battery manufacturers are expected to invest in Hungary with support from the government. Hungary announcing that it plans to support Toray's €397 million (US$461 million) investment in a new production plant for LIB separator films (BSF)[15] in the Közép-Dunántúl region of Hungary (European Commission, 2020). The project started in 2019 and is planned to be completed by 2023, creating almost 200 direct local jobs (European Commission, 2020).

The EU approved a subsidy by Hungary worth €90 million (US$104 million) for SK Innovation (SKI) to build its second battery manufacturing plant in Hungary with an estimated annual capacity of 10GWh. The plan is for commercial battery production to begin in 2022 (Korea Herald, 2021). According to various reports (Randall, 2021; Simon, 2021; Szőke, 2021), SKI also announced its plans to build a third battery cell factory in Iváncsa. In total, Hungary will have an annual production capacity of about 30 GWh from these battery investments. Meanwhile, Hungary had planned to grant aid support of €108 million (US$125 million) to Samsung SDI in Göd for battery production, but in 2019 a probe was made into the subsidy by the EU to assess whether the subsidy was in line with EU rules on regional State aid (European Commission, 2019; Reuters, 2021a).

Public transportation and procurement

With the support of the Climate and Environmental Protection Action Plan, Hungary launched its Green Bus Programme in 2020 with the objective of replacing every second bus in public transportation with low or zero-emission buses (Ministry for innovation and Technology, 2020). Part of the programme requires that from 2022 all new buses put into operation in towns with a population over 25 000 must be electric (Hungary Today, 2021). The programme is designed to be implemented in two phases with Phase 1, also known as the pilot phase, including the operation of one electric bus that passengers in Debrecen (Hungary's second largest city) can take for free for period of a month;

[15] Battery Separator Film (BSF) is a key component of lithium-ion batteries, used in consumer electronics, energy storage systems, and electric vehicles.

and Phase 2 when the government will support the purchase of electric buses for Debrecen's bus fleet. At least 1 300 electric buses will be operational by 2030, supported by the programme. The budget allocation for programme is Ft 36 billion (US$115 million) over 10 years.

Chinese manufacturer BYD received a non-refundable subsidy of Ft 925 billion (US$3 billion) by the Hungarian government for its investment in Komárom (Portfolio, 2017). BYD supplies electric buses to public transport operator Tuke Busz in Pecs. These BYD electric buses are manufactured in a local plant in Komárom. Other electric bus manufacturing activities in Hungry include the assembly of the Modulo Medio Electric bus, developed in Hungary by EVopro Ltd and assembled by MABI-BUS Ltd (Interreg Central Europe, 2019).

NEV charging infrastructure

Hungarian local governments receive full funding from the national government for installing new charging stations for NEVs. Expansion of the charging infrastructure is expected to receive funding of around €362 million (US$420 million) from the government (Hungary Today, 2021).

A charging initiative in a strategic partnership between the Hungarian NKM National Utilities and Fortum Charge & Drive was established to develop an extensive NEV charging service network across Hungary. Sixty-six EVBox charging points were installed by the National Utilities, while Fortum Charge & Drive will provide the cloud-based SaaS (software as a service) solution[16] to administer and operate the charging network.

3.4. India

NEV policy and programme review

Brief overview: Indian automotive strategy

India's automotive industry is dominated by two-wheelers and passenger vehicles. In 2020, India ranked as the world's sixth-largest automotive market in production volume, producing 3.4 million units (OICA, 2020a). Sales in the Indian automotive industry reached 2.9 million in 2020, down from 3.8 million in 2019 (OICA, 2020b).

India has around 15 leading OEMs with Maruti Suzuki as the top vehicle manufacturer in the country, accounting for at least 48.5% of India's passenger vehicle market (Singh, 2020). Other notable OEMs in the Indian market are Hyundai India, Tata Motors, Mahindra & Mahindra, Honda, and Toyota.

The government of India has taken various steps to create a favourable environment for the adoption of NEVs in the country. Displaying similar trends to the ICE market, India's NEV market is also dominated by two-wheelers and three-wheelers including electric scooters and rickshaws (Moerenhout, 2021). Although the local market is at a nascent stage, the share of NEVs for passenger vehicles was 0.5% in 2019 (Moerenhout, 2021).

NEV policy strategy and policy support

The Indian government introduced support policies to encourage the adoption of NEVs across various vehicle segments. India's goal is to reach 30% of NEVs by 2030 (Brodie, 2017, 2019; IEA, 2021).

The development of India's NEV policy frameworks began in 2010 with the launch of the Alternate Fuels for Surface Transportation Programme (AFSTP) from 2010 to 2021. The AFSTP had a total budget

16 Instead of downloading software with SaaS, consumers can instead access applications via an internet browser.

of ₹95 crore (US$12.6 million) with the goal to support the spread of NEVs and to support R&D for NEV components and parts (DHI, 2019). The AFSTP offered a 20% subsidy for electric two-wheelers, three-wheelers, four-wheelers, and electric buses (EY, 2019; Pavaskar, 2016). Post the implementation of the programme, NEV sales increased sharply, particularly in the two-wheeler segment. However, the early growth in sales was followed by a decline as the scheme had limited scope and did not provide adequate incentives for increasing the uptake of NEVs and promoting NEV component manufacturing (Gupta, 2021).

In 2013, the National Electric Mobility Mission Plan (NEMMP) 2020 was introduced. The NEMMP aimed to develop a NEV roadmap and promote the electrification of transport in India and NEV domestic manufacturing. Moreover, NEMMP is expected to afford India the opportunity to position its auto-industry as a leading manufacturer of NEVs, while also expanding the domestic market for electrified vehicles. The NEMMP targeted between six and seven million NEV sales by 2020 (DHI, 2019). In total, ₹14 000 crore (US$1.9 billion) of funding was allocated towards e-mobility, including towards the creation of charging infrastructure (DHI, 2019). No incentives were given under the NEMMP till the FAME scheme was introduced.

- The Faster Adoption and Manufacturing of Electric Vehicles in India (FAME) scheme was launched in 2015 under the NEMMP. To implement the vision of the NEMMP, the FAME scheme would be implemented in a phased manner comprised of FAME Phase I, Phase II, and amended Phase II (Chaliawala, 2021; Talwar, 2021; AutoNews, 2021). The government of India implemented FAME Phase I to support the transition towards NEVs. FAME Phase I (2015-2019) was aimed at promoting e-mobility through government support in the form of incentives and subsidies to boost NEV demand, NEV manufacturing and to establish charging infrastructure locally (PIB Delhi, 2019). Under FAME Phase I, funding of ₹795 crore was allocated to the scheme targeted towards creating demand for NEVs through financial incentives aimed at reducing the NEV purchase price, establishing a technology platform, establishing R&D for pilot projects as well as support for developing charging infrastructure (PIB Delhi, 2019; Business Standard, 2019).
- FAME Phase II (2019-2022) focused on charging infrastructure and demand-side incentives for NEV consumers, including two-wheelers and electric buses (Gupta, 2021). Under the scheme, 2 700 charging stations for NEVs were planned to be set up across different cities classified in the Tier 1 category.[17]According to the Times of India (2021), as of July 2021, only 350 charging stations had been installed as part of the FAME scheme. At the state level, energy department agencies, including electricity regulatory commissions, electricity transmission and distribution companies, renewable energy development corporations, and urban development authorities are responsible for regulating charging infrastructure and are responsible for planning regulations that govern where to locate charging stations. The government earmarked ₹10 000 crore (US$1.4 billion) to support the implementation of FAME II with demand-side incentives accounting for around 86% of total funds (Gupta, 2021).
- FAME Phase II was extended to 2024.The extension of FAME II scheme will see an increase of 50% in benefits offered to electric two-wheelers (Chaliawala, 2021). Under the revised FAME Phase II policy scheme, the subsidy for electric two-wheelers was increased to ₹15 000 (US$204) per kWh of battery capacity from ₹10 000 (US$136) per kWh. Furthermore, the limit on two-wheelers was increased to 40% of the ex-showroom price, previously capped at 20%. The eligibility criteria for

[17] Cities in India are grouped into Tier 1, 2 and 3 classifications. The most developed cities are Tier 1 and the underdeveloped cities either fall under Tier 2 or Tier 3 cities (Tandon, 2021).

electric two-wheelers to qualify for subsidy under the FAME II scheme include a minimum range of 80km on single charge and a minimum speed of 40km. Yet, according to Chaliawala (2021), a recent CRISIL report[18] showed that 95% of the electric motorcycles in India are not eligible for the incentive scheme, as they failed to meet the eligibility criteria.

The FAME policy scheme targets subsidies for up to 7 000 electric buses, 500 000 electric three-wheelers, 55 000 electric passenger vehicles (including hybrids), and one million electric two-wheelers (Chaliawala, 2021).

From the FAME II incentive structure, there is a clear focus by the Indian government to push for NEV adoption for electric two-wheelers, three-wheelers, and electric buses, and less on electric passenger vehicles and other electric four-wheelers. According to Innovation Norway (2018), in the current Indian market, 23 electric buses (0.01%), 103 685 four-wheelers (66.26%), 145 (0.09%) three-wheelers, and approximately only 52 662 (33.63%) electric two-wheelers were sold under the FAME scheme, falling below the policy target of one million sales of electric two-wheelers by 2022.

In addition to the NEMMP and FAME schemes, the government of India has also introduced other noteworthy initiatives, such as the Smart Cities programme (launched in 2015), National Mission on Transformative Mobility and Battery Storage (approved in 2019), and the Production-Linked Incentive (PLI) Scheme (launched in 2020).

Demand-side incentives

In addition to benefits provided under the FAME scheme, the goods and services tax (GST) for BEVs was reduced from 12% to 5%, while hybrids and ICE vehicles pay a GST rate of 28% plus an additional tax – cess (Jain, 2021). Several Indian states[19] have formulated their own NEV policy frameworks that offer favourable terms for vehicle financing, subsidies, and scrapping incentives to encourage NEV adoption. Centre for Energy Finance (2021) outlines below the incentives available across various states in India.

- **Coupons:** Financial incentives in the form of government coupons can be provided to NEV consumers. The coupons would be reimbursed by the government at a later stage. Coupon amounts may vary according to the vehicle category or the price of the vehicle. An example of this is the Haryana state government's financial coupon on the purchase of a NEV within the first six months of the policy term. The amount of the coupon ranges between ₹50 000 (US$680) to ₹100 000 (US$1 360).
- **Interest subventions**: Interest subventions are discounts offered on the interest rate applicable on getting a loan. These subventions are borne by the government when proposed through a policy. The consumer would receive a waiver on the interest rate paid by them. In Delhi's NEV policy, an interest subvention of 5% is offered on all loans taken to finance NEVs.
- **Road tax exemption:** All vehicle owners in India need to pay a road tax at the time of purchase to the state government. This tax is dependent on multiple factors, such as vehicle cost and fuel type,

[18] Credit Rating Information Services of India Limited

[19] States with EV policies include Karnataka, Delhi, Kerala, Maharashtra, Uttarakhand, Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, and Telangana. Besides, Bihar, Chandigarh, Punjab, Haryana, Gujarat, Assam, and Himachal Pradesh have draft EV policies awaiting state cabinet approvals. Karnataka was the first State in India to introduce a NEV policy for transforming mobility to provide clean transport options for its citizens. NEV policies among different states have varying aims and objectives, with some common themes emerging among them.

and varies across Indian states. In most Indian states with NEV policies, NEVs are exempt from paying the road tax.

- **Registration fee exemption:** Most Indian states exempt NEVs from paying registration fees.
- **Income tax benefit**: Income tax (IT) benefits are commonly used to incentivise NEV purchases. This is provided as a deduction on the tax amount payable by an individual to the government. In 2019, the central government announced an IT benefit of ₹150 000 (US$1 996) on interest paid on loans taken to finance NEVs.
- **GST reimbursement**: States may offer GST reimbursements on the purchase of NEVs. States like Andhra Pradesh offer this benefit, which is a 100% reimbursement of the GST paid by NEV consumers.
- **Scrapping incentives**: Scrapping incentives are used to disincentivise the use and ownership of old ICE vehicles. In India, these are provided on deregistering old ICE vehicles. A scrap value is provided – which may be a fixed amount, a share of the ex-showroom price, or a rebate on the road tax and registration fee of a new vehicle.

Table 11: India's basic custom duty structure

KEY COMPONENTS	OLD BCD	NEW BCD
Lithium-ion cells	5%	10%
Battery packs	5%	15%
Other components: charger, motor, motor controller, power control unit, energy monitor, contactor, brake, system for recovering, electric compressor	0%	15%

Source: AdvantEdge Founders, 2020

According to Insights on India (2020), although the Phased Manufacturing Programme (PMP) policy increased the domestic production volumes, the improvement in local value addition is slow to take off.

The Production-Linked Incentive (PLI) follows through after the PMP. The central government introduced the PLI scheme to improve manufacturing in the automotive industry.

The PLI scheme was launched in March 2020 to incentivise and scale-up the local manufacturing of specified products accompanied by import substitution policies (PIB, 2021). The scheme aims to encourage investors and domestic companies to set up or expand existing manufacturing in India (PIB, 2021). In November 2020, a second edition of the PLI scheme was introduced for a wide range of sectors including the automotive industry, advance chemistry cell (ACC) battery, food, pharmaceuticals, and textile industries (Mint, 2020). The PLI for ACC manufacturing incentivises domestic battery manufacturing. The PLI seeks to set up giga-factories for battery manufacturing with a capacity of 50 GWh of ACC and with the intention to reduce the dependence on imported batteries, as current demand for ACC in India is met by imports (Mint, 2021).

Additional outcomes of the scheme are to facilitate demand creation for battery energy storage in India, promote new cell technologies, and to ensure 60% localisation, among other expected results (EV Reporter, 2021; Mint, 2021). A total of ₹18 100 crore (US$2.4 million) was allocated to the scheme.

India auto-producers Mahindra & Mahindra (Mahindra Electric) and Tata Motors both produce NEVs locally. Mahindra produced the e2o (BEV) in 2013, however sales were discontinued in India in 2016 because of poor sales and the new safety regulations (Sameer, 2019). Mahindra Electric expanded its electric vehicle portfolio with the launch of the e-Verito sedan (BEV), to be followed by the launch of the Mahindra eKUV100 SUV in 2022 (Mahindra Electric, 2020; Autocar India, 2021a).

It was reported by Firstpost (2021) that Tata Motors has four NEVs models: the Tigor EV, the Nexon EV, as well as the recently launched Tigor EV Ziptron (launched in 2020) and the Xpres-T EV sedan. To further strengthen its efforts in supporting the development of e-mobility in India, Tata has also set up over 700 charging stations in 120 cities and is leveraging on other Tata Group companies including Tata Power, Tata Chemicals, and Tata AutoComp (Firstpost, 2021).

Tata Motors reportedly had sold more than over 10 000 NEVs in the local market by 2021 (Firstpost, 2021). The Firstpost (2021) notes that Tata's NEV models are eligible for FAME II subsidies.

3.5. Malaysia

NEV policy and programme review

Brief overview: Malaysia's automotive strategy

Malaysia has the third largest automotive industry in Southeast Asia and is the 21st largest vehicle producer globally with annual production of 485 186 units in 2020 (OICA, 2020a). Vehicle sales in 2020 were hit by the COVID-19 pandemic. Sales were down by 12.4% from 604 287 units in 2019 to 529 434 in 2020 (OICA, 2020b). Malaysian OEMs Proton and Perodua own the largest share with more than 60% in the local vehicle market (The Star, 2021). According to the Malaysia Automotive Association industry report (2021), NEVs accounted for 0.04% of total vehicle sales in 2020, a lower percentage compared to other ASEAN[20] countries. Challenges that hamper the growth of NEV adoption in Malaysia include the lack of consumer awareness about NEVs, the availability of charging infrastructure, and the affordability of NEVs (Paultan, 2021).

NEV policy strategy

The transport sector in Malaysia is dominated by fossil fuels, making it one of the biggest sources of air pollution and rising carbon emissions (Susskind et al., 2020). The focus on introducing NEVs is primarily to reduce its reliance on fossil fuels, minimise pollution, and reduce carbon emissions. Improving the transport sector requires a shift towards fuel efficient and zero-emission vehicles. Malaysia's transport policy, with a particular focus on the automotive industry, outlines plans to accelerate the introduction of NEVs and boost their adoption in Malaysia. According to Schröder and Iwasaki (2021), NEV support by the government is part of the country's vision towards sustainability and decarbonising transport.

The government of Malaysia introduced its National Automotive Policy (NAP) in 2006 aimed at facilitating the transformation of the local automotive industry and encouraging its integration into global value chains (MAA, 2014). The NAP was amended in 2009 and 2014 to strengthen its objectives for the creation of a competitive local automotive industry (MAA, 2014). In 2020, the NAP 2020 was launched with the objective of developing Malaysia into a production hub for energy efficient vehicles, thereby encouraging sustainability and supporting industrial policy development in the country (Slocat, 2020). The NAP 2020 outlined specific measures aimed at supporting e-mobility in Malaysia, including the promotion of battery production and the development of smart grids.

To ensure efficiency and sustainability while also minimising pollution, Malaysia launched the National Transport Policy (NTP) 2019-2030. The NTP is Malaysia's roadmap for developing energy efficient vehicles and for formulating incentives to encourage their use (GTALCC, 2021).

[20] The Association of Southeast Asian Nations (ASEAN) comprises 10 states – Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam.

In 2021, Malaysia implemented its low-carbon initiatives targeted at significantly reducing carbon emissions and supporting growth of e-mobility in the country through National Low Carbon Cities Master Plan (NLCCMP) and the National Low Carbon Mobility Blueprint 2021-2030. The NLCCMP targets 33 local cities for low-carbon urban development and urban planning (GTALCC, 2021). The National Low Carbon Mobility Blueprint[21] outlines Malaysia's key proposals in transport aimed at increasing electrification across several vehicle segments to include motorcycles, passenger vehicles, and buses (Sooi, 2021). The Blueprint will also increase the use of alternative fuels through the introduction of a fuel levy and the shift to a carbon emission-based vehicle tax structure. The Blueprint also includes import and excise duty exemptions for BEVs and PHEVs. The tax exemption is targeted at 100 000 units, comprised of 10 000 BEVs and 90 000 PHEVs. The exemption is applicable until the end of 2022, then from 2023 to 2025. NEV units will receive a 75% import and excise duty exemption, with this reduced to a 50% exemption from 2026-2030 (Paultan, 2021; The Star, 2021). In addition, the proposed benefit includes a road tax exemption for imported Completely Built Unit (CBU) NEVs. The Blueprint also targets 125 000 charging stations by 2030, however, Malaysia is currently said to only have about 500 stations installed (Kaur, 2021).

Demand side and side supply NEV incentives

Malaysia may not have a dedicated NEV policy, but under the Low Carbon Mobility Blueprint, one of the key benefits of NEVs is their exemption from import and excise duties till the end of 2022. Generally, excise duties vary for vehicles depending on value price and engine capacity – the ad valorem rates range between 2% and 60% (Schroder and Iwasaki, 2021).

NEV and NEV component manufacturing

The NAP 2020 provides several incentives to the automotive industry for activities related to NEV manufacturing. Benefits for energy-efficient vehicles (inclusive of fuel-efficient ICE vehicles, biodiesel and Compressed Natural Gas (CNG)/ Liquefied Petroleum GasLPG and NEVs) under the NAP 2020 are grouped together with no clear goals for NEV implementation (Schroder and Iwasaki, 2021). According to Schroder and Iwasaki (2021), the NAP 2020 provides economic incentives for manufacturers to promote the production of energy efficient vehicles for local and foreign investors. A comprehensive mix of fiscal incentives, duty exemptions, customised training, and R&D grants are included in the NAP. The following are benefits outlined in the NAP 2020, but investors must adhere to the qualifying criteria (PWC, 2021):

- Granting companies pioneer status, which is an income tax exemption ranging from 70% to 100% for five to 10 years;
- Investment tax allowance of 60% or 100% on qualifying capital expenditure for five years;
- Reinvestment allowance of 60% on qualifying capital expenditure for 15 consecutive years; and
- Grants for R&D and training.

It was announced in 2019 that the Automotive Development Fund and Industrial Adjustment Fund, set to improve competitiveness in component and parts manufacturing, will continue. Some automotive manufacturers took advantage of the provided incentives in the NAP and have since embarked on local CKD assembly. In 2012 following the launch of the NAP 2009 and 2014, Honda began assembly of the Jazz Hybrid (HEV), and Nissan followed with manufacturing the Serena S Hybrid (HEV) in 2014, Toyota began manufacturing the Camry Hybrid (HEV), and Daimler began assembly of

[21] According to the Malaysia Industrial Development Finance Corporation Research, Sooi (2021) reports that the Low Carbon Mobility Blueprint 2021-2030 is subject to final cabinet approval and there is no certainty that all proposals will be implemented.

the Mercedes-Benz S400 L Hybrid (HEV) in 2014. Later in 2016, Mercedes-Benz added the C350e (PHEV) to its production range in 2016 and the E350e (PHEV) in 2017 (Kobayashi, 2021).

NEV charging infrastructure

The Malaysian Green Technology and Climate Change Centre (MGTC) is mandated to drive Green Growth, Climate Change Mitigation, and Green Lifestyle in the country. The MGTC built a charging network – chargEV to support NEVs and increase the availability of charging infrastructure in the country (Tan, 2021). Additional private investment in charging points was undertaken by BMW in partnership with MGTC for the installation of BMW's ChargeNow network in Bangsar Shopping Centre in Kuala Lumpur, Ramada Plaza, and at the Iconic Hotel in Penang, to name a few (ChargeNow, 2019; BMW, 2019). Other investors include Shell who through a partnership with Porsche installed six charging points at various Shell stations. The charging stations are set to be equipped with DC chargers (180kW) (AutoFutures, 2021; Newsroom, 2021). Although Malaysia has made progress in infrastructure installations for charging, Malaysia's charging infrastructure is still insufficient to meet the growing demand for NEVs in the county.

3.6. Mexico

NEV policy and programme review

Brief overview: Mexico's automotive strategy

Mexico's automotive industry produced nearly 3.2 million vehicles in 2020, making Mexico the sixth largest producer of vehicles. In vehicle sales, Mexico sold 976 373 vehicles in 202, and 1.4 million in 2019 (OICA, 2020b). Fuelling this growth of Mexico's automotive industry are the world's largest OEMs, including Nissan, Ford, General Motors, Volkswagen, and Chrysler. Nissan was the leading producer of vehicles in Mexico, accounting for nearly 21% of all units sold in the country, followed by General Motors in second place, with a share of 14% (International Trade Administration, 2021).

Mexico has 13 FTAs with 50 countries, including its agreement between the US, Mexico, and Canada (USMCA) and FTAs with the EU and EFTA. Mexico has long been a crucial manufacturing hub for the USMCA region and for US auto-manufactures in particular. The Mexican NEV market is at an early stage of development, but commercialisation of NEVs in the country began in 2014 (CMS Law, 2020a). NEV sales reached 14 235 in quarter two of 2019 (largely consisting of hybrids) (AMIA, 2019; CMS Law, 2020a). Local NEV models include the Renault Twizy, Zacua M2, Nissan Leaf, Chevrolet Spark and Bolt, BMW i3, Ford Fusion, Honda Civic and CR-Z, and Tesla models.

NEV policy strategy

In its commitment towards achieving e-mobility, Mexico introduced its National Strategy for Electric-mobility (ENME) in 2018. The policy is aimed at identifying objectives and incentives for the widespread rollout of NEVs in Mexico and the promotion of smart mobility (Low Carbon Business Action, n.d.). States in Mexico, including Mexico City, Guadalajara, Puebla, and Playa del Carmen, have implemented laws and regulations on e-mobility for electric bikes, electric scooters, and NEVs (Low Carbon Business Action, 2020). Mexico aspires to increase NEV sales to 50% of new vehicle sales by 2040, and then to 100% by 2050 (Netherlands Enterprise Agency, 2019). Mexico plans to replace its transport fleet with NEVs. Under the ENME, Mexico expects that by 2030, 500 000 light vehicles and 7 000 trucks will be electric (Low Carbon Business Action, n.d.).

Demand side and supply side NEV incentives in Mexico

Making NEVs more affordable for consumers is a key priority for the Mexican government. Thus, Mexico's federal legislation provides varying levels of fiscal incentives and support to encourage the use of NEVs in the local market. Both financial and non-financial incentives are on offer. NEV consumers are eligible to receive benefits ranging from import duty exemptions to income deductions. NEVs do not pay import tariffs. This is applicable for imported passenger vehicles and light and heavy commercial vehicles. The exemption on import tariffs is valid from 2020[22] until September 2024 (Mexico Now, 2020b). Mexico's Income Tax Law grants permissible deductions to NEV consumers. The Income Tax Law allows a deduction of up to Mex$250 000 (US$12 290) for NEVs, while ICE vehicles are allowed deductions of up to Mex$175 000 (US$8 600) (Montemayor, 2019). Under the Income Tax, the leasing of NEVs attracts a daily deduction of Mex$285 (US$14), while Mex$200 (US$10) a day can be deducted for ICE vehicles (Montemayor, 2019). A further fiscal incentive in the form of a tax credit of 30% is granted for investment made towards public power supply facilities for NEVs (CMS Law, 2020).

New vehicles in Mexico are subject to value-added tax (VAT), the Impuesto Sobre Automóviles Nuevo (ISAN) tax, and the vehicle ownership tax (Angloinfo, n.d.). The ISAN tax rates vary according to the value of a vehicle. For vehicles produced in Mexico, the ISAN tax rate is calculated on the sales price of the vehicle to the final consumer. For imported vehicles, the tax is calculated on the basis of the customs value plus import duty and other related duties (Art. 2 ISAN Law, 2019). There is no ISAN tax on NEVs.

Non-financial incentives in Mexico include incentives such as preferential parking with a charging station, the exclusion of NEVs from the Hoy No Circula[23] restrictions in Mexico City, an exemption from emission control verifications for NEVs, and road toll fee waivers. NEVs in Mexico City are granted a 20% discount through the EcoTag on regular road toll fees (MexInsurance, 2019). In addition, there are no fee escalations for NEV consumers recharging their vehicles at stations owned by Mexico's largest electricity supply company Comisión Federal de Electricidad's (CFE) (Montemayor, 2019). The CFE installed independent meters for NEV consumers to give consumers a differentiated rate for charging that is relatively cheaper (Montemayor, 2019).

NEV and component manufacturing

Mexico has no domestic manufacturing incentives for NEVs at present, but under the IMMEX Program,[24] which incentivises manufacturers to export goods, and investors and manufacturers in the automotive industry are eligible for a 25% income tax deduction for investment in the automotive industry and a 30% credit towards R&D projects (Tecma, 2021). According to the IMMEX programme, automotive manufacturers operating in Mexico can import raw materials and equipment into Mexico import duty free (Tecma, 2021).

Despite the lack of specific NEV incentives, Mexico's tax incentives afford the country an advantage in vehicle production relative to its Latin American competitors. Producing a vehicle in Mexico is 30% cheaper compared to producing one in Brazil, while it is 60% much more expensive to produce a

[22] The Mexican General Import and Export Duties Law was recently modified through a couple of decrees (effective September 4 2020 and October 23, 2020) to include tariff exemptions for NEVs.

[23] Under the No Hay Circula programme, NEVs can drive daily without limitation, unlike other ICE vehicles subjected to "no-circulation" restrictions.

[24] The IMMEX Program incentivises manufacturers to export goods. IMMEX provides a tax incentive that allows Mexican companies to temporarily import goods that will then be used in the manufacture or repair of products, without having to pay general import tax or VAT of 16% on those imported goods (Tecma, 2021).

vehicle in Argentina than in Mexico (ProMéxico, 2016; Moreton, 2017). Incentives granted to automotive companies in Mexico make the country an attractive investment for auto-manufacturing, including for NEV manufacturing. US OEMs Ford and General Motors have announced plans to invest in NEV manufacturing in Mexico. Ford has invested US$420 million in Mexico's Cuautitlán plant to begin manufacturing of its new Mustang Mach E electric pickup truck, while General Motors announced that it would invest US$1 billion in the country to manufacture NEVs between 2020 and 2025 (Mexico Now, 2020a; Naughton, 2020; SWFI, 2021).

Public transportation and procurement

Mexico City has devoted strategies and plans to improve the city's sustainability though reducing emissions and pollution. Mexico City's Green Plan launched in 2007 was designed to lead the city towards eco-mobility. The plan resulted in number of initiatives such as the Hoy No Circula (No drive days) and Muvete en Bici (Get on your bike) dedicated towards improving and expanding public transportation systems and through offering cycling and walking options in the city.

Mexico City is one of the C40 Cities Climate Leadership Group, which consists of 97 cities representing one in 12 people of the world's population (C40 cities, 2011). The focus of the C40 cities is on combating climate change and reducing carbon emissions at a city level. In 2011, Mexico City introduced the Government of Mexico City's Taxi Substitution Programme, which sought to replace the city's 103 000 taxi fleet with 10 000 new taxi models through a subsidy of Mex$15 000 for each new taxi (C40 cities, 2011). The public transportation programme offered Mexico City an opportunity to introduce NEVs into its fleet, but this took place only in 2017 when the municipal government of Mexico City procured 100 hybrid taxis (C40 cities, 2011). In 2017, Mexico City and three C40 cities (Paris, Madrid, Athens) pledged that their cities would ban the sale of diesel vehicles by 2025 to limit pollution (McGrath, 2016). Public and private operators of electric public transportation in Mexico City are exempt from renewing their vehicle fleets every 10 years (CMS Law, 2018a).

In 2020, Chinese ride-sharing company DiDi[25] announced plans to roll out smart and sustainable urban mobility initiatives in Mexico. As the first new energy initiative for ride-hailing in Latin America, DiDi will introduce a fleet of NEVs to its platform in Mexico (Green Car Congress, 2020). In phase one of the initiative, more than 700 units of NEVs including model offers from BYD and Renault will be available through co-operation with local leasing partners and drivers (Green Car Congress, 2020).

NEV charging infrastructure

A few companies have invested in NEV charging infrastructure in Mexico. Initiatives for charging infrastructure include installing more than 1 000 charging points across various states in the country (Chino, 2021). The charging infrastructure project is financed through a trust for Energy Transition and Sustainable Energy Use (Chino, 2021). A joint venture by BMW and Nissan established the ChargeNow initiative. The initiative cost US$4.95 million for about 700 charging stations throughout the country (Zwanziger, 2021). To make public charging easier for Tesla models, the NEV manufacturer invested in developing a charging infrastructure network in Mexico with plans to install 136 super chargers (Zwanziger, 2021). Mexico has the most charging stations in Latin America (Chino, 2021).

[25] DiDi already operates the world's largest EV fleet, with nearly one million NEVs available on its platform in China.

3.7. Morocco

NEV policy and programme review

Morocco's automotive strategy

Morocco is the second largest producer of vehicles in Africa and the leading vehicle producer in North Africa (Business Wire, 2020). Morocco accounted for 83.4% of all vehicles produced in the region in 2019 (Business Wire, 2020). The country has an annual production capacity of 700 000 vehicles. In 2020, Morocco produced 248 430 vehicles, down from 38.4% in 2019 (OICA, 2020a). Sales of vehicles reached 133 308 units in 2020 (OICA, 2020b). The Moroccan automotive industry is led by European OEMs Renault and PSA Group. NEV manufacturer BYD announced in 2017 that it plans to enter the Moroccan vehicle production market (Bolduc, 2017). NEVs are yet to take off in Morocco.

NEV policy strategy

Morocco, through its Green Energy programme, aims to increase its share of renewable energy sources to 52% of the country's energy mix by 2030 (Shahan, 2021; ITA, 2020). The programme emphasises the importance of improving energy efficiency, particularly in the transport, construction, and manufacturing sectors (Diab, 2018). To support this goal, Morocco targets carbon emission reductions in transportation by promoting the use of low fuel consumption vehicles, including NEVs.

Demand-side and supply-side NEV incentives

The government of Morocco has adopted various demand-side incentives to promote the deployment of NEVs in the country. According to Diab (2018) and Jabrane (2016), Morocco's Finance Act exempts NEVs from custom duties, while importers and distributors of NEVs in the local automotive market are exempted from the 10% value-added tax (VAT) rate levied on specifically designated operations. The government also aims to broaden consumer awareness of NEVs and its advantages through the spread of public information and local awareness campaigns (Diab, 2018).

NEV and component manufacturing

Morocco signed multiple MoUs with Chinese and European OEMs to develop local NEV production in line with Morocco's goal to produce one million vehicles by 2025 (North Africa Post, 2021). Morocco does not have a NEV policy, but manufacturers in the industry can benefit from investment incentives and several other advantages. Automotive investments in Morocco's industrial zones receive up to a five-year corporate tax exemption (extendable to promote export of production), VAT exemptions, exemption from withholding tax of dividends originating from activities carried out in the industrial zones, access to modern infrastructure and skilled workforce, and training support (UNCTAD, 2019). Companies and investors benefit from FTAs with the US and EU.

- BYD signed a MoU in 2017 to build a manufacturing plant for electric buses and electric trucks in the Mohamed VI Tangier Tech City. There are no further details on when production for the vehicles is planned to commence.
- In an agreement with Renault, the OEM stated that it would integrate the Group's e-mobility technologies into vehicles produced in Morocco. No further details were provided on Renault's strategy for the integration.
- In 2020, the PSA Group and the Moroccan postal service signed an agreement to produce an adapted version of the Citroën Ami BEV specifically for Barid Al-Maghrib's mail deliveries across Morocco (Randall, 2020). A total of 225 BEVs were commissioned for mail delivery, while

manufacturing is planned to take place at the PSA Peugeot Citroën plant in Kenitra (Randall, 2020). A date for the manufacturing of the Ami has not been confirmed.

- European company STMicroelectronics, based in Bouskoura, was awarded a contract by Tesla Motors to manufacture electronic components for Tesla in 2021 (Attaq, 2021). STMicroelctronics manufactures and supplies semiconductors for Tesla's NEV models. According to Clarke (2021), STMicroelectronics began production for Tesla in June 2021. The production of components will provide investment opportunities for Morocco and will allow the country to be part of the NEV global production value chain.

NEV charging infrastructure

Private companies and research institutions are some of the key stakeholders in Morocco involved in setting up charging infrastructure in the country. According to data from ElectroMaps (n.d.), a total of 92 charging stations are available in Morocco. Below is a list of charging initiatives by various players:

- Vivo Energy Morocco,[26] in partnership with charging port supplier NEV-Box, installed Morocco's first charging station in 2016. The charging point was installed at a Shell Exit station between Casablanca and Marrakesh (Diab, 2018; Koeller, 2016).
- Another initiative by the Green Energy Park research platform[27] built a factory to produce charging infrastructure for NEVs. The factory has a monthly production capacity of about 300 iSmart[28] charging stations (Takouleu, 2021). By 2022, the Green Energy Park aims to produce at least 5 000 stations for the Moroccan market and broader African region (Takouleu, 2021; Attaq, 2021; North Africa Post, 2020). The platform will also develop a fast-charging terminal that will allow charging capacity between 20kW and 60kW (Attaq, 2021).
- Oil and gas company Total installed at least 15 charging points across 10 stations in Agadir, Marrakech, Casablanca, Rabat, and Tangier (Takouleu, 2021). In October 2021, Tesla installed its first charging stations in Morocco, also the first Tesla charging station by Tesla in Africa. The NEV company installed four supercharger stations capable of delivering 150kW at the Onomo Hotel in Casablanca and near the Tangier Al Houara Hilton Resort (Morocco Embassy, 2021). The emergence of Tesla charging stations in Morocco is likely to see a rapid growth in interest for NEVs in the local market.

3.8. Poland

NEV policy and programme review

Polish automotive strategy

Poland is one of the leading automotive markets in Europe, ranking sixth in the European Union. The Polish automotive industry produced 451 382 vehicles in 2020 (OICA, 2020a) making it the 23rd largest vehicle manufacturer globally. Poland recorded 510 153 vehicle sales in 2020, down from 656 258 vehicles in 2019 (OICA, 2020b). The Polish NEV market is growing, and there are at least 53 NEV models

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[26] Vivo Energy Morocco supplies and distributes Shell and Engen branded fuels and lubricants to retail and commercial customers across Africa.
[27] The Green Park platform was set up jointly by the Institute for Research in Solar Energy and New Energies and the Mohammed VI Polytechnic University.
[28] iSmart charging stations are considered "intelligent charging stations", which will be connected to a monitoring platform that facilitates control and maintenance of the station and integrates CO_2 sensors, among other features.

available on the local market (Kubiczek and Hadasik, 2021). According to the ACEA progress report (2020), in 2020, 1.89% of new vehicles sold in Poland were BEVs and PHEVs.

NEV policy strategy

Poland's government has introduced its National Energy and Climate Plan,[29] which has a target of achieving 23% of gross final energy consumption being sourced from renewable sources by 2030. As an EU member state, Poland has a NEV strategy that includes initiatives from the EU Green Deal and its own national initiatives. In 2017, Poland adopted the Electro-mobility Development Plan which provides a strategy for NEVs and charging infrastructure deployment (Interreg Central Europe, 2019). One of the strategic frameworks from the Electro-mobility Development Plan is the Act on Electro-mobility and Alternative Fuels Infrastructure Development Policy of January 2018, which includes an EU directive[30] on the deployment of NEVs (procurement and fleet targets for NEVs) and alternative fuels infrastructure (including electric energy, LNG, CNG and hydrogen) (Sobczyk and Sobczyk, 2021; CMS Law, 2018b; IEA, 2017). The Act sets rules and regulations for the promotion of e-mobility and alternative fuel vehicles in the local market. The Act also defines requirements for developing charging stations "including the technical requirements for NEV stations, obligations of public entities, developing of the alternative fuel infrastructure and vital implementation requirements of such infrastructure" (Wappelhorst and Pniewska, 2020).

The Polish government provides significant support for NEV charging infrastructure through the Act. The Act includes specific incentives to drive the deployment of charging infrastructure. Under the Act, municipalities are required to introduce an appropriate number of publicly accessible charging points in their areas. In addition, building permits are not a requirement for the installation of charging stations or charging points.

Demand-side and supply-side NEV incentives

The Act on Electro-mobility and Alternative Fuels also detailed incentives for NEV promotion and manufacturing. In 2020, the Polish government, through the National Fund for Environmental Protection and Water Management launched three incentive schemes – the Green Car subsidy, the e-VAN programme, and the Koliber scheme (Wappelhorst and Pniewska, 2020; Kowalczyk, 2020). The details of these incentives include the following:

1) Green Car subsidy covers at least 15% in aid for the purchase price of NEVs. The subsidy offers vehicles maximum aid ranging between zł18 750 (US$4 717) and zł70 000 (US$17 612); however, the purchase price of the vehicle should not exceed zł125 000 (US$31 450). NEVs that exceed zł125 000 (US$31 450) do not qualify for the subsidy. As part of the incentive scheme, the government also offers subsidies for the construction and installation of charging infrastructure, with maximum support ranging between zł5 000 (US$1 258) and zł25 000 (US$6 293) for a charging point of up to 22kW (Wappelhorst and Pniewska, 2020).
2) The e-VAN programme offers once-off incentives of up to zł70 000 (US$17 612) for companies that purchase or lease a NEV van.

[29] To meet the EU's energy and climate targets for 2030, EU member states are required to develop a 10-year integrated national energy and climate plan (NECP) for 2021 to 2030.
[30] The government also adopted the National Framework for Alternative Fuels Infrastructure Development Policy to implement EU Directive 2014/94 of the European Parliament and of the Council of 22 October 2014) on the deployment of alternative fuels infrastructure.

3) Koliber's main target is small, micro, and medium-sized enterprises (SMMEs) and zero-emission taxis. According to Wappelhorst and Pniewska (2020), the Koliber incentive scheme offers support for the purchase or lease of NEVs capped at PLN 25,000 (US$6 293).

These three schemes are designed as rebate schemes. All programmes are aimed specifically at the purchase of BEVs. In addition to the benefits received from the incentive schemes, the Act exempts BEVs[31] and Fuel Cell Electric Vehicles (FCEVs) from excise duties, while ICE vehicles pay excise rates between 3.1% and 18.6% of a vehicle's net value depending on the engine capacity (Wappelhorst and Pniewska, 2020). Non-financial support in the Act includes preferential bus-lane access, free parking facilities in all public areas and in paid public parking zones, and free access to charging infrastructure.

NEV and component manufacturing

Electro-Mobility Poland revealed two prototype vehicles – the Izera, one an SUV and the other a hatchback, both BEVs that are expected to enter production in 2023 (Grzegorczyk, 2020). Both Izera models offer a driving range of up to 400kms. Poland is also a member of the European Battery Alliance – an EU initiative working to develop a battery production value chain in the bloc from 2025 (IFRI, 2019). Currently, Poland assembles battery packs, however with very limited output. To expand capacity in battery manufacturing, the government is expected to grant state aid to battery manufacturers looking to invest in new factories for battery manufacturing.

LGChem invested €1 billion (US$1.2 billion) to expand its plant in Kobierzyce, which is estimated to have an annual capacity production of 100 000 battery packs a year (LGCorp, 2017; Kane, 2017). In 2019, Poland had planned to grant €95 million (US$110 million) of public support to LGChem to finance its expansion of the battery plant.[32] Other battery initiatives in Poland include the investment by Belgian Umicore to produce cathode material in the country, with production expected to have begun in 2020. Chinese battery component producer Guotai-Huarong is expected to build a lithium-ion electrolyte factory near Oława, with an estimated annual capacity of up to a million batteries (Bolesta et al*.,* 2020).

Public transport and procurement

On average, vehicle ownership for private-use in Poland is low, only one-third of new cars in the country are for private use (Kołsut and Stryjakiewicz, 2021). As a result, promoting NEVs for private use is not significant in the Polish car market, instead fleet purchases are of much greater importance. The Electromobility Act set fleet and procurement targets for NEVs. The Act covers incentives for companies that introduce NEVs in their commercial vehicle fleet. Companies that purchase NEVs receive a maximum deduction amount of zł225,000 (US$56 748) for BEVs versus the zł150 000 (US$37 814) received for procuring ICE and hybrid vehicles (Wappelhorst and Pniewska, 2020). The central government pledged that NEVs will make up at least 10% of its fleet from 2022 and increase to at least 20% NEVs from 2023 (Wappelhorst and Pniewska, 2020). The target for the share of NEVs in the fleet of local administrations with a population of more than 50 000 is 10%, achieved by at least 2022 (Wappelhorst and Pniewska, 2020).

Local company Impact Clean Power Technology is a key player in electric bus battery production, and supplies batteries to Solaris for its electric buses. Poland is the largest exporter of electric buses in the EU. The Polish government introduced subsidies of PLN zł 60 million (US$15.1 million) to support the purchase of electric school buses and e-mobility infrastructure in rural communities (NFP, 2020). According to data by the Notes from Poland (NFP, 2020), Poland's share of e-bus exports in the EU

[31] PHEVs were previously exempt from excise duty until 2021 January

[32] In 2020, the European Commission launched an in-depth investigation into the €95 million support for LGChem.

increased from 10% in 2017 to 46% in 2020, and it is estimated that about a third of all electric buses in Europe are manufactured in Poland, led by Solaris Bus & Coach,[33] Volvo, and MAN Truck & Bus.

Green hydrogen is a significant building block for Poland to reduce emissions. As part of the country's hydrogen strategy, the Urbani 12 hydrogen bus model, produced by Solaris Bus with an estimated reach of 350km, will be introduced in Konin, Poland (The First News, 2021). Although Solaris Bus has been making them since 2014, this is the first time the buses will operate in Poland (The First News, 2021). Konin is also building a new hydrogen service station which will be completed by the end of 2021 and will have two refuelling points, one for private vehicles and one for buses. The hydrogen fuel will be supplied by a local power station (The First News, 2021).

3.9. Thailand

NEV policy and programme review

Brief overview: Thai automotive strategy

Thailand is the largest vehicle producer in the ASEAN bloc. According to OICA (2020a), Thailand produced 1.4 million vehicles in 2020, down from two million in 2019. About half of the vehicles produced in Thailand are exported to Southeast Asia to Philippines, Indonesia and Malaysia (ITC, 2020). Major OEMs including Toyota, Mitsubishi, Honda, and Nissan produce vehicles in Thailand. In 2020, Toyota held the largest share with 20.8% of the market (Global Data, 2020). Vehicle sales in Thailand decreased by 21.4% from 2019 to 792 146 units in 2020 (OICA, 2020b). The Thai NEV market is small and less than 1% of vehicles in the market are BEVs (Kudun & Partners, 2021). According to Schröder and Iwasaki (2021), most NEVs in Thailand are hybrids and the NEV market in the country is mainly made up of motorcycles, not passenger vehicles.

NEV policy strategy

Thailand is pursuing NEVs as it looks to transform the country into a NEV manufacturing hub, especially in the ASEAN region. Thailand is also interested in securing the country's current position in regional and global automotive value chains. A new NEV roadmap was approved by the Thai government in 2020 (Bangkok Post, 2021). The NEV roadmap seeks to integrate with other policies into a broader Thai NEV plan on e-mobility and sustainability that will create linkages with Thailand's Industry 4.0: the Smart Grid Project,[34] and other relevant sectors (Paultan, 2021). Thailand aims to sell ZEVs only from 2035 (Paultan, 2021). The proportion of electric vehicles and hybrid cars combined is only 1% of all vehicle registrations, but Thailand expects to increase NEV market share to 50%, revised up from a previous target of 30% of all new vehicle registrations by the end of the decade. (Bangkok Post, 2021; Paultan, 2021).

Although HEVs have had their place in the Thai market since 2009, the popularity of NEVs in Thailand is still low. Most OEMs in the country also largely focus on producing HEV models, hence demand is strongly skewed towards hybrid manufacturing, and BEVs remain a marginal niche market that mainly consists of electric motorcycles.

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[33] In 2019, Solaris Bus & Coach was bought by Spain's Grupo CAF.

[34] Smart City is part of the Thai government's 4.0 initiative to change big cities like Phuket, Chiang Mai, Khon Kaen, and Bangkok into technology hubs.

Demand side NEV incentives

The Thailand government has increasingly favoured a policy focused on ensuring the country becoming a significant NEV market and producer. NEV consumers are eligible to receive various types of tax reductions and exemptions. In 2018, Thailand introduced a new excise tax scheme that shifted taxation away from being based on engine capacity alone towards one based on a combination of engine capacity and CO_2 emissions (Schröder and Iwasaki, 2021) (see Table 12). The Thai government revised the excise tax, effective through to 31 December 2025, to promote investment for companies that produce HEVs, PHEVs and BEVs. Under the current excise structure, BEVs are exempt from excise duties. The excise tax for HEVs and PHEVs is higher, with rates depending on engine size and CO_2 emissions. For example, the excise tax rate for HEVs and PHEVs with higher CO_2 emissions and an engine size over 3 000 cc is set at 50%.

Table 12: Excise tax scheme 2018

VEHICLE TYPE	ENGINE CAPACITY	CO2G/KM			
		<100	100-150	150-200	>200
ICE	<3000 cc		30%	35%	40%
	E85/CNG		25%	30%	35%
	>3000 cc				50%
Hybrid (PHEV and HEV)	<3000 cc	5%	20%	25%	30%
	>3000 cc				50%
BEV	-	2%* (Reduced to 0% 2020-2022, then 2% from 2023)			
Eco-car	1300-1400 cc	14%			17%
	E85 (Fuel of 85% ethanol, 15% gasoline)	12%			

Source: LMC Automotive, 2018

Besides this new tax structure, other measures to stimulate the domestic market and achieve Thailand's 2030 goal include NEV parking discounts for consumers, investment incentives for companies, and developing charging infrastructure across the country.

NEV and component manufacturing

The Government of Thailand considers NEVs key for industrial development and has, through the Board of Investment (BOI), formulated its NEV roadmap and associated incentives that promote investment in NEV manufacturing. The BOI offers benefits for six types of NEV production: (1) equipment used in HEVs and PHEVs; (2) HEVs and parts; (3) PHEVs and parts; (4) BEVs and parts; (5) electric buses; and (6) charging infrastructure.

Thai's NEV roadmap is divided into three phases (Nation Thailand, 2021):

- Phase I (2021-2022) covers the promotion of electric motorcycles and the support of infrastructure for motorcycles.
- Phase II (2023-2025) seeks to incentivise the development of a NEV industry in the Thai market. Phase II targets production of 225 000 vehicles and pick-up trucks, 360 000 motorcycles and 18 000 buses and trucks by 2025, as well as the production of batteries.
- Phase III (2026-2030) is driven by the "30/30 policy" to produce 725 000 NEV vehicles and pick-ups, plus 675 000 electric motorcycles.

In November 2020, the BOI issued its latest tax incentives for NEVs. For qualifying PHEV and BEV projects valued at less than five billion baht (US$164 million), the tax holiday is limited to three years. However, BEV projects valued at five billion baht (US$164 million) or more will be eligible for an extension if they meet one of the following requirements: produce a minimum of 10 000 units within three years; produce additional parts for production; invest in R&D; or start in 2022.

Motorcycles, three-wheelers, buses and trucks, and electric-powered ship production projects are among NEV vehicle segments eligible for a three-year Corporate Income Tax (CIT) exemption, which can be extended under certain conditions. OEMs that locally produce NEVs along with at least one of the 17 components[35] eligible for benefits will receive an import tax exemption for machinery and CIT for eight years (Thailand Board of Investment, 2018). In addition, OEMs using locally produced batteries will also benefit from a special excise tax rate. To incentivise local production for NEV batteries, the BOI approved additional incentives to produce both battery modules and battery cells for the local market by granting a 90% reduction of import duties for two years on raw or essential materials not available locally (LMC Automotive, 2018).

Many OEMs manufacture NEVs in Thailand, although mostly PHEVs and HEVs. OEMs began NEV production before the government announced its strategic policy framework for NEVs. Subsequently, the announced fiscal incentives for manufacturing spurred investment and underpinned the scale-up in NEV production and the manufacturing of NEV-related components. The NEV programme so far has resulted in the increase in local NEV production capacity as well as in promoting the local assembly of a limited number of HEV and PHEV models (LMC Automotive, 2018).

Thailand's BOI approved applications from FOMM, Mine Mobility, Mercedes-Benz, SAIC Motor, Skywell, and Toyota for BEV production; from Honda, Mazda, Nissan, and Toyota for hybrid vehicle production; and from Audi, BMW, Mercedes-Benz, Mitsubishi, SAIC Motor, and Toyota for PHEV production Amir, 2020). A list of NEV manufacturing projects in Thailand by OEM is provided in Appendix B.

NEV charging infrastructure

There are 1 200 charging stations in Thailand operated by various companies. For example, BMW operates 141 charging stations across 63 locations throughout Thailand, while the Thai Provincial Electricity Authority (PEA) partnered with Bangchak Corporation, a leading Thai energy company, to install 124 of ABB's Terra 54 fast chargers at 62 sites across Bangchak's petrol stations and PEA offices. All these chargers were planned to be installed by the end of 2021. In 2021, US owned e-mobility company EVlomo, in co-operation with Australian charging infrastructure manufacturer Tritium and the EAST Group, invested US$50 million to build a DC charging network across Thailand (EVlomo, 2021).

3.10. Turkey

NEV policy and programme review

Brief overview: Turkey's automotive strategy

Turkey is one of Europe's leading vehicle manufacturers. In 2020, approximately 1.2 million vehicles were produced in Turkey, making the country the fifth largest vehicle manufacturer in the region behind Germany, Spain, France, and Russia (OICA, 2020a). The total vehicle sales in 2020 were 796 200 in 2020, up by 61.8% from 491 947 units in 2019 (OICA, 2020b). NEV incentives are lacking in the local market. Despite this, the share of BEVs in total vehicle sales increased from 0.1% in 2020 to 0.3% in

[35] The 17 components include batteries, traction motors, battery management systems, DC/DC converters, inverters, electric circuit breakers, portable EV chargers, EV smart charging systems, high voltage harness, reduction gear, battery cooling system, and regenerative braking system.

2021, and the share of hybrid vehicles increased from 3.2% to 8.4% in the same period (Daily Sabah, 2021). The sale of HEVs in Turkey dominates the NEV market due to their relatively lower cost compared to BEVs.

NEV policy strategy

The Turkish government relies on vehicle tax reductions to encourage consumers to purchase efficient vehicles. Vehicle consumption taxes in Turkey comprise of VAT, the Special Consumption Tax (SCT), and the Motor Vehicle Tax (MVT). VAT is levied at 18%. The MVT tax amount ranges between TL 1 769 (US$197) and TL 50 107 (US$5 592), depending on engine capacity (Carscoops, 2020). The SCT rate is imposed on vehicles taking into consideration multiple factors, such as the engine capacity, vehicle type, and vehicle pre-tax price (Manning, 2019; Reuters, 2021b).

In 2011, Turkey introduced its first NEV incentive in the form of tax breaks. The SCT was reduced for BEVs and hybrid vehicles. The SCT rates for HEVs varied between 45% and 110%, while BEVs were subject to lower rates between 3%-15% (see Table 13). Another benefit for BEVs under the tax regime was that BEVs received exemption from the MVT (Manning, 2019; Bianet, 2021). In 2020, however, Turkey implemented a new policy raising taxes levied on BEVs to discourage their imports, and to support the local manufacturing industry. With the updated SCT, rates increased for BEVs from between 3%-15% to between 10%-60%. As shown in Table 13, BEVs with an electric motor of up to 85kW are taxed 10% from 3%, while for vehicles with a motor of 85kW and 120kW, the rate is 25% from 7% and for vehicles with an electric motor exceeding 120kW, their SCT rate increased by 45 percentage points from 15% to 60%.

Table 13: SCT taxes on NEVs in Turkey

		OLD SCT	AMENDED SCT
Vehicle Type	Pre-tax Price		
Hybrid Vehicles			
Hybrid with > 50kW electric motor and ≤ 1800 cm3	≤50 000	45%	
	50 000>≤ 80 000	50%	
	> 80 000	110%	
Hybrid with > 100kW electric motor and 2000 < ≤2500cm3	≤100 000	100%	
Hybrid with > 100kW electric motor and >2500cm3		110%	
Battery Electric Vehicles			
Electric motor <85kW		3%	10%
Electric motor between 85kW & 120kW		7%	25%
Electric motor > 120kW		15%	60%
Other vehicles > 2000 cm3		160%	220%

Source: Authors (data from Manning, 2019: Reuters, 2021b)

To accommodate the increasing number of NEVs in Turkey, the government also introduced non-financial incentives that include mandatory parking requirements under the Regulation on Parking Areas Act (CMS Law, 2018c). The regulation states that at least one of every 50 parking spaces must have charging stations for NEVs at both mall parking and offside parking (CMS Law, 2018c). Similarly, under the Planned Landscape Regulation, NEV charging stations will be installed at the parking bays, petrol stations, and other appropriate locations across the country (CMS Law, 2018c).

NEV and component manufacturing

NEV vehicle manufacturing in Turkey is led by the Turkish Automobile Joint Venture Group (TOGG), a consortium made of Turkish companies including the Anadolu Group, BMC, Kok Group, Turkcell, and Zorlu Holding as well as an umbrella organisation, the Union of Chambers and Commodity Exchanges of Turkey. TOGG designed and manufactured a BEV prototype in 2020. According to various reports, TOGG plans to produce five different NEV models that include a SUV, a sedan, a c-hatchback, a b-SUV, and a b-MPV with an annual production capacity of 175 000 units (Daily Sabah, 2020). The consortium will begin mass production of its SUV in 2022 with 51% of the parts sourced locally. Under the Group's production plans, TOGG is expected to manufacture more than one million vehicles by 2035 (Daily Sabah, 2020). The government has since pledged to purchase 30 000 units (3%) of the fleet for the public sector by 2035 (Daily Sabah, 2020).

Ford Otomotiv Sanayi A.S. (Ford Otosan), a joint venture between Koc Holding and Ford Motor, will invest €2 billion (US$2.3 billion) to establish a battery assembly facility and a NEV production plant (Daily Sabah, 2020). As part of a strategic alliance between Ford Otomotive and Volkswagen, the plant will manufacture the Transit Custom van PHEV model (in 2023)[36] and Volkswagen's electric-Transporter (Daily Sabah, 2020). The TOGG consortium and Ford Otomotiv will benefit from incentives provided by Turkey for manufacturing companies and investors, such as VAT and customs duty exemption, VAT refund, corporate tax deduction, income tax withholding support, and allocation of investment site (Deloitte, 2018).

Public transportation and procurement

Turkish bus and coach manufacturer TEMSA and Turkey's defense company ASELSAN developed electric buses for public transportation, namely the MD9 electriCity and the Avenue Electron buses (Daily Sabah, 2021). So far, TEMSA has exported its bus models to Sweden and Romania. In 2021, the company started assembling battery packs for its electric buses at the company's Adana plant (Daily Sabah, 2021). Aras Kargo, a private cargo company, owns the largest NEV fleet of commercial vehicles in Turkey (Aras Kargo, n.d.). In 2014, Aras Kargo's fleet was made up of 39 BEVs (Aras Kargo, n.d.). Unfortunately, there are no recent reports on the company's activities.

NEV transport infrastructure

There are no incentives for charging infrastructure in Turkey but charging infrastructure does exist. Data by Gönül et al (2021) shows that 582 charging points (excluding home chargers) are installed in Turkey. Multiple companies including Eşarj, G-Charge (Gersan), Voltrun, Yeşil Güç (Greenway), Zorlu Energy Solutions, and ABB have installed charging stations across Turkey (Shura, 2019).

3.11. Rwanda and Mauritius

NEV policy review in Africa

Outside of Africa's main auto-producing countries (South Africa, Egypt, and Morocco), Rwanda and Mauritius lead the promotion of e-mobility through recent policy measures that seek to incentivise NEVs. NEV incentives offered in Rwanda and Mauritius include reduced electricity tariffs for NEVs, exemption from import and excise duties, and rent-free land for charging stations.

Rwanda NEV policy

According to a 2018 Inventory of Sources of Air Pollution in Rwanda, transport emissions are the leading cause of air pollution in Kigali and other urban areas in the country. Part of Rwanda Environment Management Authority's long-term goal is to contribute towards carbon neutrality as outlined in Rwanda's Vision 2050 (UNFCCC, 2020). In the short term, Rwanda aims to reduce emissions by 38% by 2030 with NEVs estimated to represent 9% of potential energy-related emissions

[36] This is in line with Ford's strategy to produce two-thirds of its vehicle sales in Europe to be BEVs and HEVs by 2030.

(NDC, 2018). The government plans to promote NEVs and electric motorcycles through various policy incentives to encourage their use. Although Rwanda has a limited automotive market, the country's NEV incentives are comprehensive and seek to catalyse the transition from fossil fuel dependent transportation to e-mobility. According to the Global Green Growth Institute (GGGI, 2021), transitioning to e-mobility in Rwanda would cost approximately US$900 million.

To support the market development of NEVs, Rwanda offers the following advantages for NEVs (Nkurunziza, 2021; Kuhudzai, 2021):

- Vehicle imports in Rwanda attract a 25% import duty, 18% VAT, and an excise tax ranging from 5% to 15%. The excise duty is dependent on the vehicle engine capacity. NEVs, NEV-related components and parts, charging station equipment, and batteries are all exempted from import and excise duties.
- Components and parts, batteries, and other related NEV equipment are exempted from the 5% withholding tax.
- Reduced electricity tariff at the industrial level. At this level, NEV consumers will be charged US10cents/kWh instead of the normal rate of 20 cents/kWh. NEVs also benefit from reduced electricity tariffs during off peak periods.

Rwanda also offers a wide range of non-financial incentives such as rent-free land[37] for installing public charging stations, the introduction of green license plates that allow NEVs to receive preferential access to bus lanes, free parking and free license, and authorisation for commercial NEVs (Kuhudzai, 2021). The government has announced that preference would be granted to NEVs for transport fleets hired by the government (Kuhudzai, 2021; Bajpai and Bower, 2020). Companies involved in the manufacturing and assembly of NEVs in Rwanda are entitled to receive a 15% Corporate Income Tax (CIT) and a tax holiday incentive, regardless of the investment amount (Bajpai and Bower, 2020).

NEV initiatives in Rwanda

A number of initiatives in e-mobility are undertaken by different stakeholders (Bajpai and Bower, 2020), however, so far the focus has mainly been on electric motorcycles.

- Local manufacturer of electric motorcycles Ampersand raised US$3.5 million in its Series A funding which will go toward increasing its electric motorcycle fleet size and related charging stations. Ampersand has 35 operational electric motorcycles assembled locally with four stations.
- Rwandan e-solutions company Safi Universal Links has 30 electric-motorcycles in operation (some operating as taxis) with seven charging stations. The company installed Rwanda's first charging station in Kigali (Ministry of Infrastructure, 2021). Although currently focused on replacing old ICE motorcycles with electric motorcycles, both Ampersand and Safi Universal Links look to enhance Rwanda's shift to e-mobility and to increase infrastructure.
- Rwanda Electric Motorcycle Company started the assembly of electric motorcycles and plans to retrofit existing ICE motorcycles into electric motorcycles (Ministry of Infrastructure, 2021).
- In the passenger vehicle segment, Mitsubishi Motors Corporation and Victoria Motors Rwanda launched the PHEV SUV in 2018. As of 2020, 20 PHEVs had been sold (Ministry of Infrastructure, 2021).
- Rwanda became the first African country to introduce a Volkswagen (VW) electric car. VW has 20 e-Golfs and two charging stations operated by Siemens, in a joint agreement with VW. One charging station is located in the Kigali Special Economic Zone while another one is located at Kigali

[37] For land owned by the government.

Convention Centre. The pilot e-Golf project will be added into the Volkswagen Mobility Solutions Rwanda fleet. The plan by VW is to increase the number of NEVs to 50 units and charging stations to 15 installations, depending on the outcomes of the pilot project (Uwiringiyimana, 2019; Venter, 2021).

- Rwanda aims to have 20% of buses electric by 2030. The International Finance Corporation (IFC) conducted a feasibility study on launching electric buses in Kigali. The IFC will partner with Rwanda to introduce electric buses in the city, however, no further details were available as of October 2021 (Daliah, 2020; Ministry of Infrastructure, 2021).

Mauritius NEV policy

The Government of Mauritius is committed to diversifying the country's energy supply, improving energy efficiency, and addressing the country's environmental challenges. Mauritius implemented an e-mobility policy support as part of the country's shift to a low-carbon, efficient and sustainable transport sector (EV Consult, 2020).

Mauritius pursues a shift to ZEVs and efficient vehicles by offering lower import taxes to NEVs compared to ICE vehicles. In 2016, the government of Mauritius exempted BEVs from the import duty, while also reducing the road tax and registration duty for BEVs. Mauritius also introduced a reduced excise duty of between 5%-15% for NEVs, depending on the drivetrain and size of the electric motor. These benefits for NEV consumers resulted in 14 266 NEV sales in 2020, comprised of 14 060 HEVs and 206 BEVs (Mukeredzi, 2021). Mauritius has at least two public charging stations installed in the country (Mukeredzi, 2021).

Conclusion

Transport sector in most countries is dependent on fossil fuels at present. For environmental sustainability as well as to enhance industrial policy, developing a NEV market is crucial to decarbonise transport and to transform the sector through the application of emerging technologies. All countries included in this study have implemented policy measures and strategies to help reduce transport-related carbon emissions, improve air quality, and increase the share of renewable energy sources.

E-mobility can help countries achieve sustainable development objectives and decarbonisation goals. The uptake of NEVs is, however, comparably slow to date. The high purchase price of NEVs and the availability of charging infrastructure remain major barriers to the spread of NEVs. To grow the market, however, a mix of strong and enabling policy measures and incentives addressing the cost, charging infrastructure, and information gap could help to increase the share of NEVs, as leading markets show.

A key policy in the initial phase is the offering of significant purchase and tax incentives to make NEVs economically attractive compared to ICE vehicles. To disincentivise the purchase of ICE vehicles, India introduced scrappage incentives, while Turkey, Brazi and Thailand introduced tax incentives for NEVs to lower their purchase price. In Thailand, Mexico and Brazil, the excise duty is levied on vehicles based on CO_2 emissions and engine capacity, levying higher rates for high emitting and large vehicles. In parallel, countries extended the public charging infrastructure network, which remains important to increase visibility and reduce range anxiety. In addition, NEVs are exempt from import duty in Morocco, Egypt and Malaysia, while India allows for duty reductions on imported NEVs and parts used in NEV production. To further develop the NEV market, Poland, Thailand, Mexico and Brazil set fleet targets for the procurement of NEVs by both government agencies and private companies to reduce emissions and switch to zero emitting vehicles. Non-financial incentives are also catalysts for the adoption of NEVs. These range from free parking, preferential access to bus lanes, and road toll fee waivers. The Thai, Hungarian, Polish and Indian governments have all implemented policies to address manufacturing opportunities for NEVs and components through relevant funding and incentives.

4. OEM STRATEGY SURVEYS AND INTERVIEWS

The surveys and interviews completed in September and October 2021 highlighted numerous critical issues framing the importance of the NEV market and manufacturing growth in South Africa, and the challenges associated with this. The key findings from the research are presented in the following five sub-sections. In 4.1, the demand-side findings from the light vehicle interviews are considered. The strategic insights shared on domestic market demand challenges are considered, as well as views on potential incentives to drive increased NEV consumption in alignment with the targets set for this project. Sub-section 4.2 interrogates NEV light vehicle assembly challenges in South Africa, and OEM views on how to stimulate the domestic production of NEV light vehicles. M&HCV OEM perspectives are shared in 4.3, with this sub-section including insights into NEV bus market challenges and opportunities. Sub-section 4.4 then considers NEV developments in the broader African market, while sub-section 4.5 summarises Section 4 by considering the key strategic findings to have emerged from the surveys and interviews.

4.1. NEV light vehicle demand growth

4.1.1. Market demand challenges

The OEM interviews highlighted that South African market demand is a general problem for the industry and that existing market trajectories create limited space for organic NEV market growth. Individual OEMs have different growth models for the South African market, but the consensus is that the domestic market will only grow to around 700 000 vehicles by 2035, as opposed to the SAAM's objective of 1.2 million units. Rather than representing new organic growth opportunities, NEV sales are therefore likely to be replacements for previous ICE sales. Furthermore, the lack of growth closes off many NEV opportunities, as most NEV products are still niche based; and as emphasised in one of the interviews "…market niches within market niches do not create volume opportunities".

The primary factors underpinning very limited current domestic market demand for NEVs are:

1. Pricing: This is undoubtedly the most important factor, as attested to in every interview. According to the findings presented in Section 1, NEVs are considerably more expensive than their ICE equivalents, even after vehicle assemblers reduce their margins and negotiate preferential deals with their dealerships to promote and sell more NEVs.
2. Availability of charging infrastructure: Customers remain nervous of NEV infrastructure limitations, making BEVs particularly unattractive as a NEV option.
3. Energy supply: Customers are nervous of grid-based energy availability, and associated reliability. Interestingly, many BEV customers have home-based renewable energy supplies for their vehicle charging, with one OEM surveying their BEV buyers and discovering that 50% of them charged their vehicles using photovoltaic-sourced energy. Given that the cost for this type of infrastructure is high, demand needs to extend beyond customers who can afford renewable energy supply solutions at their homes.
4. Risk: Most vehicle customers are risk averse, and do not respond well to unfamiliar products and/or technology. It was emphasised that many customers have residual value concerns relating to NEVs, and that until there are a larger number on the road, risk averse customers are unlikely to be persuaded to purchase NEVs.

Interviews stressed that comparative pricing with ICE products remained the single biggest issue with NEVs, and remained the root cause for the other major market challenges. Essentially, customers will not shift to NEVs if they are priced well above their ICE equivalents, and that this limited demand then resulted in a lack of infrastructure availability and NEV visibility on South African roads, which reduced demand further, resulting in a negative consumption cycle.

Critically, in the context of this study, it was noted that NEVs would not achieve a 15%-20% market share in 2025 or 30%-40% in 2030 unless low-cost NEV options were available in the domestic market. It was emphasised that two thirds of the South African passenger vehicle market comprised small vehicles, and that having a NEV product range in this market category was key to NEV market growth. It was also emphasised that the maximum estimated pricing gap between an ICE and a NEV equivalent could only be around 10% before demand for the NEV product plummeted. It was noted that a Total Cost of Ownership (TCO) argument was only convincing to an average private buyer to around this level, with interest in NEVs declining substantially above this threshold; and yet it was noted that the pricing gap in South Africa and globally ranges from 20% (HEV) to over 100% (BEV) – and as confirmed in Section 1.

4.1.2. Ad valorem amplified price differentials

One of the major factors driving NEV and ICE pricing differentials in the South African market is the structure of the excise tax (ad valorem) system. This was emphasised as being severely damaging to NEV consumption across all the OEM surveys and interviews. The consensus is that the ad valorem excise tax structure in South Africa makes a difficult business case for NEV consumption an almost impossible one (hence the lack of NEV consumption presently). This is because the ad valorem "gradient" for light vehicles becomes increasingly punitive for light vehicles as pricing increases, with the maximum 30% excise tax being in place for vehicles with a base wholesale price of around R650 000. This is around the price point of cheap NEVs, especially PHEVs and BEVs, contributing to making NEVs substantially more expensive than their ICE equivalents, which attract significantly lower ad valorem taxes. One OEM provided compelling evidence showing how the differential in the ad valorem amplified a R119 000 wholesale pricing disadvantage on an ICE-NEV equivalent – to a full R225 000 disadvantage.

4.1.3. CBU duty amplified price differentials

The large-scale pricing differentials caused by base price differences and the ad valorem tax structure is further amplified for vehicle importers, which do not have assembly operations in South Africa. These importers are faced with higher CBU duties because of the higher costs of the NEVs. In addition, if sourced from the EU, BEV importers are also exposed to South Africa's 25% Most Favoured Nation (MFN) duty rate, as opposed to the 18% duty rate for ICE vehicles, as per the SADC-EU-EPA. While these importers can reduce their import duty exposure (and by implication the amount of ad valorem tax paid) by purchasing residual Production Incentive (PI) and Volume Assembly Localisation Allowance (VALA) credits from local OEMs or component manufacturers, these purchases still result in a higher cost burden on NEVs relative to their imported ICE equivalents.

This issue does not appear to be as significant for local OEMs as they have sufficient PI and VALA credits at present to offset their duty exposure on any NEVs they are importing into the country. However, the present EU duty dispensation for NEVs limits the sale of imported NEVs and reduces competition in key South African NEV market segments.

4.1.4. Incentivising domestic NEV demand

OEM interviews were explicit about the need for a range of incentives to make NEVs competitive in the domestic market. A plethora of ideas were tabled in the interviews, with many OEMs repeating the extensive list of suggestions presented in the government's Green Paper. Essentially, the ideas put forward can be placed in one of two categories.

The first category covers private vehicle consumption, and the second corporate vehicle ownership.

For the first category, opportunities put forward ranged from reducing or even fully removing the ad valorem excise tax on NEVs, to providing vehicle consumers or suppliers (OEMs or dealers) with cash grants (or an equivalent) that reduces the comparative purchase price of NEVs, to subsidising electricity or home-based renewable energy infrastructure, to reducing in-use NEV costs (for example, introducing "green number plates" that reduce operating costs, such as annual vehicle registration fees) – or enabling easier use, such as permits to drive in special driving lanes.

For the second category, opportunities covered the same as those for private consumers, but with additional opportunities relating to providing companies with corporate income tax breaks for converting their vehicle fleets to NEVs. It was emphasised that corporate fleet vehicles generally travel significantly more kilometres annually and so encouraging fleet conversion would have a much larger impact on carbon emission reduction than the conversion of privately owned vehicles. Several OEMs emphasised that this was the strategy followed by the governments in their home countries, and that the positive impact on carbon dioxide emissions had been significant.

4.1.5. Other demand-side issues highlighted

A couple of the OEMs expressed the view that increasing NEV consumption without increasing comparative ICE costs was unlikely to yield a rapid NEV transition in the domestic market. As per the EU and UK government approaches, it was emphasised that national government needed to either announce the banning of pure ICE vehicles sometime in the future (beyond existing investment horizons, which in the automotive industry is approximately 10 years), or to signal progressively severe future taxes on ICE vehicles. It was noted that either of these two approaches would further encourage the NEV transition.

Contradicting this, another OEM provided compelling evidence that its PHEV and BEV products would produce more CO_2 emissions in South Africa than its ICE equivalents. It was emphasised that this is linked to South Africa's coal-based energy grid, and that without renewable energy supply for its BEV and PHEV products, forcing the NEV transition in South Africa was essentially futile from an environmental perspective.

4.2. NEV light vehicle production growth

4.2.1. Export sustainability

OEM surveys and interviews highlighted that large-scale exporting will remain crucial for the sustainability of OEM investments in South Africa. Furthermore, dependence on the EU and UK markets is expected to continue for the foreseeable future, partly because of poor domestic market performance (which is expected to continue) and partly because of ongoing stagnation within the broader Sub-Saharan African automotive market, which promised so much growth potential a few years ago.

The rapid transition to NEV consumption in the EU and UK markets consequently represents a medium- to longer-term existential threat to South African vehicle production. While local plants can potentially produce ICE vehicles for the domestic market and HEVs and PHEVs for developed economy markets (as these are essentially increasingly sophisticated ICE-based products) for a period, they will not be able to produce both ICE vehicles and BEVs over the long term. As the EU and UK markets shift from HEV to PHEV consumption and ultimately exclusively BEV consumption (from 2035), it is therefore critical for South African OEM facilities to shift their model ranges in alignment with major market trends.

This does not mean that South Africa needs to follow directly in-step, but that local production needs to align with the overall technology shift of the Global Value Chains in which the OEMs operate. It was further pointed out that as signatories to the United Nation's various environmental agreements, the local production of pure ICE vehicle would likely become untenable in future as global vehicle brand credibility becomes aligned with corporate green credentials. OEM perspectives varied on the end point, but BEV market dominance is anticipated in developed economy markets by 2035, with BEVs and PHEVs potentially competing in developing economy markets for a longer periods, especially in those markets where LCVs comprise an important part of light vehicle consumption. As per the EU and UK electrification roadmaps, the OEMs surveyed are clear that HEVs are an important, but transitory, technology that is unlikely to extend beyond the next two model lifecycles.

4.2.2. NEV strategies

Almost all of the OEMs that participated in the research have NEV transition plans in place. Where technology access is available, the majority of the NEV transition over the next five years will relate to HEVs, with PHEVs growing slightly more slowly, but coming to dominate NEV output from around 2026 to 2030 (for passenger vehicles) and potentially longer for LCVs (to 2035/2040). BEVs will remain niche imported products for the next few years, with wider supply in the domestic market and potential local production dependent on local legislation forcing BEV production, or BEV competitiveness improving significantly over the next few years. OEMs hold differing views on the length of this transition period, with some OEMs believing BEVs will be price competitive with ICE vehicles in the next five years, and others arguing that BEV competitiveness with ICE would still take more than another decade for PVs and potentially much longer for LCVs.

The OEMs indicated that investment requirements for HEVs are low. Battery packs are imported as "black box parts" and assembling the batteries on vehicles during the assembly process therefore does not require major investment, beyond the usual tools and fixtures required for their assembly on to vehicles. The downside of this low investment model is the lack of localisation opportunities and the significant increasing cost of CKD imported components, which raises the comparative duty burden on locally assembled vehicles being supplied into the domestic market relative to imported CBUs.

It was emphasised in the OEM surveys that this problem would be compounded with the introduction of local PHEV assembly. Multiple black box parts were likely to be imported, raising the comparative cost of CKD imports, rendering the domestic assembly of PHEVs for the domestic market potentially less attractive than importing CBU PHEVs. The local assembly challenge for HEVs and PHEVs (when supplying the domestic market)[38] is demonstrated in Table 14. As highlighted, the local assembly of a R400 000 ICE vehicle with 50% local content has an 8% pricing advantage over an equivalent EU/UK import. Holding this local content constant in value, the advantage reduces to 6.9% for an equivalent HEV, and only 6% for an equivalent PHEV. These percentage shifts are not dramatic, but the duty advantage for PHEV assembly in South Africa is essentially 25% lower than for ICE vehicles, a not insignificant shift.

[38] The challenge does not exist for exported vehicles as there are no CKD duties payable on re-exported components.

Table 14: NEV "black box" import impact on the competitiveness of local assembly for South African market supply

INDICATORS	ICE VEHICLE	HEV	PHEV
Vehicle price	R 400,000	R 450,000	R 500,000
Local content	R 200,000 (50%)	R 200,000 (44.4%)	R 200,000 (40%)
Imported content	R 200,000 (50%)	R 250,000 (55.6%)	R 300,000 (60%)
CKD duty payable	R 40,000	R 50,000	R 60,000
EU sourced CBU @ same price (18%)	R 72,000	R 81,000	R 90,000
SA OEM duty advantage	R 32,000	R 31,000	R 30,000
SA OEM pricing advantage %[39]	8.0%	6.9%	6.0%

Source: Authors

One of the major concerns raised by OEMs is the challenge of localising transitory technologies. If the South African government follows the EU/UK government roadmap and is determined to have the domestic industry transition to BEV assembly quickly, there is likely to be no business case for the localisation of HEV and PHEV components. In transitionary environments, securing reasonable returns on investment requires large volumes of production over a short period, neither of which is likely in South Africa. Locally assembled HEVs and PHEVs are therefore likely to have similar Rand values of local content as their ICE equivalents, but lower levels of local content on a percentage basis, and a higher duty burden rendering them less competitive in the highly competitive South African market.

Given the specific NEV technology trajectories of the OEMs' parent companies, it was further emphasised that local content would be built from assembling NEVs in South Africa and then linking opportunities to the assembly process, as opposed to building local content from South Africa's materials base and then trying to force a link to South African assembled NEVs. This is a key finding, as it emphasises that NEV lead source arrangements[40] at a parent OEM level are key to identifying and driving localisation opportunities.

4.2.3. AIS support

OEMs noted that the Automotive Investment Scheme (AIS) in its present form was largely sufficient for HEV investments, but that the position was unclear for PHEVs, and most definitely insufficient for BEV investments. This is because BEV assembly requires a significant reconfiguration of existing ICE assembly plants (many of which have dated infrastructure), and the infusion of a range of new technologies. It was emphasised that the change from ICE to BEV assembly represented more of a greenfield-type investment than a standard brownfield adjustment for a new model. It is in this context that the OEMs noted that the existing level of AIS support was insufficient, and that the AIS's BBBEE and headcount requirements were also misaligned with BEV opportunities. This is because many new BEV technologies are owned by multinational corporation suppliers to the global OEMs, which are unlikely to invest in South Africa when the country is demanding equity transfers to domestic partners; and because BEV assembly is sufficiently different to ICE assembly to make it impossible to maintain headcount on a direct volume replacement basis. OEMs are firmly of the view

[39] This calculation excludes the benefits secured from VALA and PI.

[40] Lead source arrangements relate to global supply contracts entered into between OEMs and their key Tier 1 suppliers. In return for the Tier 1 suppliers undertaking R&D for the OEM on the development of a specific new model, the Tier 1 supplier secures a global supply contact for the component or sub-assembly. Securing production of the component or sub-assembly in South Africa requires negotiations with both the OEM parent company and the Tier 1 supplier.

that an augmented AIS is key to developing a viable NEV business case in South Africa, and that the qualifying requirements of the AIS need to be aligned with global NEV developments (and new potential lead source arrangements) to secure NEV investments, especially at a component manufacturing level.

4.3. NEV M&HCV and bus considerations

Engagements with M&HCV OEMs revealed that while ad valorem taxes are not an issue in this market segment, NEV demand in the domestic market is limited for several other reasons. These range from the additional cost of NEVs (that cannot be fully compensated by TCO calculations), to risk perceptions of using unknown technologies in established and commercially successful vehicle fleets, to major concerns with the expensive infrastructure required to support NEV fleets. This was highlighted as a key issue in respect of TCO calculations. If firms are measuring only comparative energy costs over a timeframe and holding all other costs constant, then NEVs may have a chance of being competitive relative to their ICE counterparts, but when charging infrastructure costs are included in the TCO calculation, ICE vehicles remain significantly more competitive.

M&HCV engagements emphasised that a lack of NEV take -up in the domestic market was not because of a lack of information relating to NEV opportunities, but rather the inverse. The sophisticated calculations used by fleet owners demonstrated the lack of competitiveness of NEV products in most domestic market segments. The OEMs indicated that unless the underlying reasons for the lack of NEV competitiveness are dealt with there is unlikely to be a rapid transition to wider NEV use.

Several NEV opportunities were, however, identified. First, Hydrogen Fuel Cell Electric Vehicles (HFCEVs) may soon be competitive in the fixed route large bus and extra-HCV truck market,[41] while it was noted that under specific circumstances fixed route, BEV medium commercial vehicles and buses were already competitive relative to their ICE equivalents. This was because of the opportunity to optimise the use of charging infrastructure around the fixed routes, and the low daily distance and limited weights carried by these vehicles. An example provided was the bus fleet supplying the Gautrain. Conversely, it was noted that the larger commuter bus market in South Africa would likely remain HEV or PHEV for the foreseeable future.

As commercial vehicles are intermediate capital inputs used by businesses, it was emphasised that the best way to incentive the transition to NEVs was likely to be in the form of CIT benefits. One potential opportunity identified is the extension of Section 12L of the Income Tax Act to include NEVs. Section 12L is at present an incentive to rapidly depreciate renewable energy investments, and so the link to carbon dioxide reduction is already firmly established. Unlike the major challenges facing the light vehicle industry, NEV developments in the domestic market are unlikely to create much of an investment or operating challenge for local M&HCV vehicle assemblers. Bus assembly in South Africa is largely agnostic of the underlying propulsion technology (as it is primarily a body building activity), while the balance of M&HCV assembly in the country is SKD-based. As powertrains, drivetrains, and cabins are imported, limiting local operations to basic assembly and domestic homologation activities, the transition to NEVs is likely to be easily accommodated within existing local SKD-based operations.

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[41] Again, the fixed routing is critical to short term competitiveness, as hydrogen infrastructure investment costs are extremely high.

4.4. African NEV opportunities

The transition to NEV consumption in the South African market is unlikely to be supported by regional market developments. Sub-Saharan African market consumption is primarily of pre-owned vehicle imports, and these are projected to remain ICE-based for at least another decade or two. This projection is based on the ICE vehicle population in developed economies slowly aging and then being supplied into SSA markets at the end of their useful life in those economies.

As NEVs will only fully displace ICE vehicles in these developed economies between 2030 and 2035, it is likely that SSA markets will continue to be offered cheap, pre-owned ICE vehicles for the full period of the SAAM. This is limiting to South Africa, as it means any stimulation of local NEV demand is unlikely to be augmented by regional demand shifts toward NEVs.

The regional situation could change if pre-owned vehicle imports into SSA markets were either stopped or more aggressively taxed, but this is unlikely. Only Rwanda and Mauritius appear to have innovative NEV incentives in place (see Section 3), and both these markets are very small. Mauritius, for example, uses significant excise tax differentials to incentivise NEV consumption relative to ICE equivalents (see Table 15), while Rwanda offers an even wider range of incentives for NEVs. These range from reduced electricity tariffs for NEV charging, to zero-rated excise taxes and VAT, to rent-free government land for the establishment of fast charging stations.

Table 15: Mauritius' differential excise taxes for NEVs

VEHICLE TYPE	LOWEST EXCISE TAX	HIGHEST EXCISE TAX
ICE	45%	100%
HEV	25%	70%
PHEV	10%	65%
BEV	0%	15%

Source: OEM interviews/surveys

Projecting forward, South African OEMs clearly see very little volume opportunity for BEVs in SSA. The expectation is that HEVs and PHEVs opportunities may emerge over the next few years (although this will require major fuel quality improvements in most SSA markets), but that the large-scale consumption of BEVs is highly unlikely for the foreseeable future.

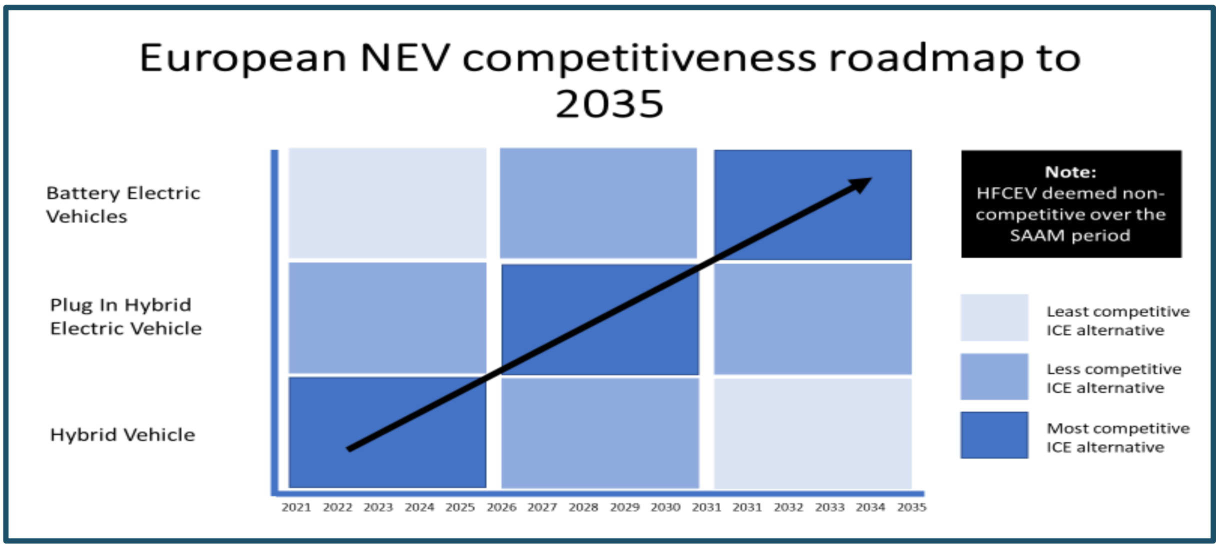
4.5. Strategic overview of OEM perspectives

The various strategic perspectives shared by the OEMs interviewed and/or surveyed are summarised in Figures 2 and 3.

Figure 2 depicts the likely trajectory of the EU and UK markets through to 2035. It illustrates that these light vehicle markets will transition to BEVs by 2035, with HEVs holding the most competitive NEV position relative to ICE vehicles until 2030, but with PHEVs then taking the lead competitive position (to 2035) and BEVs then taking over (from 2035) as the most competitive light vehicle powertrain technology. The boxes in Figure 2 reveal this shift over time.

The suggested light vehicle position of the South African market is portrayed in Figure 3 using the same framework.

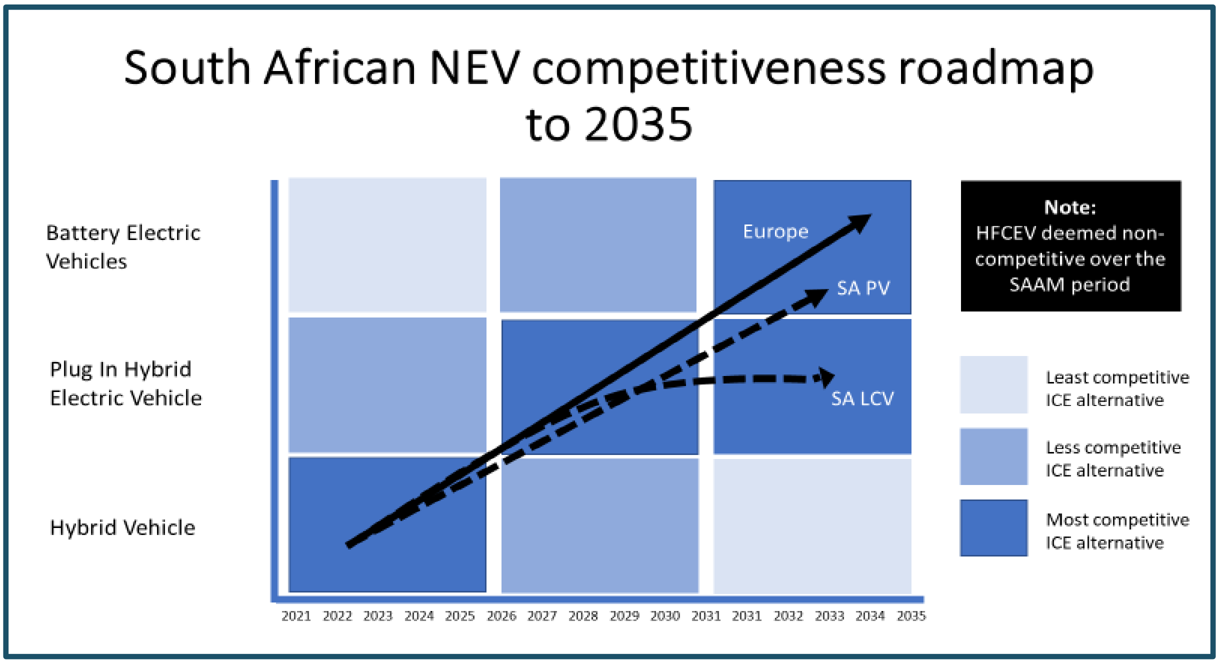
Figure 2: European NEV competiveness roadmap to 2035



Source: Derived from OEM engagements.

As highlighted, it is not entirely dissimilar to the EU/UK trajectory, with the passenger vehicle market following the same trend, but with a slight delay. There is, however, an important distinction in respect of the LCV market. PHEVs are expected to hold a competitive position for a potentially significantly longer period in the South African market.

Figure 3: South African NEV competiveness roadmap to 2035



Source: Derived from OEM engagements.

There are two significant implications for South Africa if the trend depicted in Figure 3 is correct. First, it means South Africa will follow a slightly different NEV transition to that of the EU/UK. While there will be broad alignment with passenger vehicles, LCV sales will remain hybrid-based for a longer period. Second, it means that the country's ICE-based legacy production base will remain in place for longer than evident in the EU/UK. This may only be for one or two model lifecycles, but given the seven to eight year average model lifecycle of a typical new vehicle model, this means that South Africa's full light vehicle shift to BEVs may only be in 2040-2050.

5. NEV COMPONENT LOCALISATION

The NEV transition has a clear distinction in respect of component localisation opportunities. For HEVs and PHEVs, there is fundamentally no threat to existing levels of local content, other than to reduce the percentage of local content in South African assembled vehicles. This is because HEVs and PHEVs only add content to ICE vehicles; they do not remove any content. However, this is not the case for BEVs. As seen in Table 16, the OEM interviews highlighted the loss of several major components when BEVs are introduced. Unless these lost components are compensated by the localisation of new BEV technologies (some of which are also present in HEVs and most of which are present in PHEVs), South African local content could significantly decrease. One OEM indicated that only 55% of the value of their existing ICE components would carry over to BEV assembly, with 45% representing entirely new components. The importance of localising at least some of the identified BEV components in Table 16 is, therefore, critical to the realisation of the SAAM.

Table 16: Component and system losses and gains as BEVs replace ICE vehicles

ICE COMPONENTS LOST	BEV COMPONENTS GAINED
Engine	Battery pack and management system
Transmission	Electric traction motor and controller
Engine Control Unit	Thermal cooling system
Fuel tank, line, pump, filler	Electromechanical brakes (vacuum pumps)
Airconditioning system	High voltage harnesses
Mechanical brakes	Charging point
Exhaust system (including catalytic converter)	
Radiator	

Source: Authors

While the transition to BEV assembly will challenge the value basket of vehicle manufacturing in South Africa, a further challenge is the extent to which PHEV technology has longevity. Certain OEMs are adamant that PHEVs are the best NEV technology for the South African and broader African LCV market, and that this opens the opportunity for domestic small ICE production in support of this strategy.

The production of LCV PHEVs may represent a potentially attractive value proposition for the country, given that four of the seven light vehicle OEMs produce LCVs, and that PHEVs represent a major progression in green technology, while still aligning with South Africa and the continent's broader market requirements. The potential shift of LCVs from ladder-chassis to monocoque-based products may alter this outcome, as such a shift would ease the transition of LCVs to BEVs. However, whether this is possible in the context of SSA's road and broader environmental conditions is unclear, especially if the 2035 timeframe is being considered.

Finally, while Table 16 highlights the list of affected components likely to be displaced and introduced as the industry transitions to BEVs, this does not mean that the balance of vehicle components will remain unaffected. Several of the OEM interviews emphasised that the shift to BEVs will generate huge challenges for the entire spectrum of component manufacturing, as there will be unrelenting pressure for components to become ever lighter. Combined with advances in nanotechnology and materials science, it was emphasised that even commodity components may undergo major change in respect of their materials base and functional form; and that this may open or close localisation opportunities in unexpected areas.

Notwithstanding these limitations, as well as ongoing rapid changes in the cost of BEV components, the following table, which is derived from engagements with OEMs provides an indication of the potential benefits to localise BEV components. Table 17 also highlights the PI and VALA incentives that would be generated from the localisation of these components. The incentives are based on a notional local content level of 30%, which may be too high, especially for the battery pack. Interviews highlighted that while battery pack assembly was possible in South Africa, the manufacturing of the high value battery cells would only take place in nodal automotive economies.

Table 17: Indicative BEV component prices, and potential APDP incentives*

BEV COMPONENTS	UNIT PRICE	LOCAL CONTENT @30%	VALA	PI	OEM INCENTIVE PER UNIT
Battery pack	R200 000	R60 000	R4 800	R7 500	R12 300
Battery management system	R6 000	R1 800	R144	R225	R369
Power controller	R20 000	R6 000	R480	R750	R1230
Charger	R24 000	R7 200	R576	R900	R1 476
Total: Selected components	**R250 000**	**R75,000**	**R6 000**	**R9,375**	**R15,375**

Source: Derived from OEM engagements * Based on 2021 APDP benefits

The indicative data presented in Table 17 suggests that the APDP would provide substantial operational support for BEV components, whether for exports or local aftermarket supply (PI only), or when assembled in local vehicles (PI and VALA). The PI provides support equivalent to 12.5% of the manufacturing value added (MVA) of BEV component, while VALA adds a further 8% of MVA (taking the total localisation benefit to a very substantial 20.5%). While this will reduce through to 2026, the reduction is marginal (to 19.5%), with the PI remaining unchanged and the VALA declining from 8% of MVA to 7%.

The major localisation challenge is unlikely to lie with APDP operational support, but rather the extent of the investment required for BEV components (and sub-systems) relative to the BEV volumes produced locally. This is the perennial problem of the South African automotive industry, highlighting the importance of AIS support for BEV investments (whether for vehicle assembly or BEV components).

6. CONCLUSION

The findings presented in this report suggest that the transition to NEV consumption and production in South Africa is inevitable. However, driving the NEV transition in South Africa will require a careful balance between incentivising a sustained shift in domestic market demand to NEVs; establishing an appropriately aligned, renewable energy-based charging infrastructure; and supporting a shift in South African vehicle production, away from ICE vehicles to a mix of HEVs, PHEVs, and BEVs. Balancing these factors is key to successfully transitioning the South African vehicle industry to an ultra-low carbon future, while simultaneously ensuring it remains a major contributor to the industrial development of the domestic economy, as per the objectives of the SAAM, which runs until 2035.

How the South African government supports the industry and its complex value chain to make this transition is replete with challenges, the most notable being the major cost associated with transitioning to the consumption and production of more expensive vehicles – at least for a period, and until battery technologies advance to levels that secure their price parity with equivalent ICE products.

The South African market is highly price sensitive, especially in the two lowest quintiles of market consumption (price elasticities of -1.795 and -1.95 respectively) (Barnes and Grant, 2019), hence the almost non-existent sales of NEVs in the domestic market, except in the apex quintile.[42] This creates a major misalignment in the development trajectory of the South African market relative to the local automotive industry's most important export markets, the EU and UK. These markets, which jointly consume a similar number of South African assembled vehicles as supplied into the domestic market, will likely be BEV-only by 2035.[43] This raises a striking challenge for the multinational vehicle assemblers operating in South Africa. Their domestic business case is essentially a balanced one, with vehicles supplied into the South African and major export markets to achieve sufficient scale economies to operate at internationally competitive levels. To maintain this balance in future, it is critical that domestic and international market demand shifts are broadly aligned.

This does not mean that consumption in the South African and EU/UK markets need to be fully aligned in the timing and the profile of NEV consumption. South Africa is starting its NEV transition slightly later and has distinctive geographical and operating parameters (road conditions, vehicle use factors, income distribution, consumption patterns) that will impact the nature of its NEV transition. For example, while the NEV transition for passenger vehicles is likely to simply be slightly longer in South Africa than in the EU/UK, there is a strong likelihood that LCV demand in South Africa will remain hybrid-based for the period to 2035, with LCV-HEVs being replaced primarily with PHEVs, as opposed to a full transition to BEVs.

Recommending to **the dtic** how to support the transition to domestic NEV consumption and associated domestic NEV production constitutes the next phase of this project. The project team is confident that it has learned enough from the international competitor economy analysis, international NEV market analysis, and OEM consultation process to engage meaningfully with the industry's key stakeholders on the transition to NEV consumption and production in South Africa, and looks forward to engaging with **naamsa**, NAACAM, and NUMSA on potential interventions to support the successful transition of the South African automotive industry from an ICE to NEV base.

A preliminary briefing note was completed for **the dtic** on the potential opportunity to fully transition the South African automotive industry to NEV consumption and production by 2035. Prepared for COP26, the briefing note represents one potential roadmap for the industry. Attached as Appendix D, it covers some high-level numbers and potential incentives to support the NEV transition within the timeframe of the SAAM. The note does not represent the definitive position of the project team, as this will emerge only after extensive consultation with industry stakeholders. It does, however, represent a useful starting point for discussion with industry stakeholders, hence its inclusion.

The NEV project is due to be completed by the end of 2021. Following the completion of this report, the next phase of the project involves the following key steps:

1. Engagement with key industry stakeholders on the country's potential NEV transition roadmap, using Appendix D as an important reference point;
2. Development of NEV policy recommendations (including potential APDP changes) for presentation to the project's Project Steering Committee in late November;
3. Modelling of NEV bus procurement impacts on the South African fiscus, and development of associated recommendations; and
4. Compilation of a NEV component list for potential localisation.

Once these steps have been completed, the project team will be able to finalise its recommendations to the Executive Oversight Committee of the SAAM and **the dtic** and complete the project.

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[42] Light vehicles that sold for more than R613,201 in 2018 (Barnes and Grant, 2019).

[43] For example, the UK plans to ban the sale of new ICE vehicles in 2030 and hybrids (HEVs and PHEVs) by 2035.

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APPENDIX A: OEM SURVEY INSTRUMENT

OEM New Energy Vehicle (NEV) survey

1. Has the company recently explored the introduction of any NEV models (soft hybrid, PHEV, BEV, HFCEV) in the South African market?
    a. If so, what was the decision on the introduction of the model(s)?
    b. Why? Please indicate (a) factors for introduction and (b) factors against.
    c. Do you have any information that you are willing to share on price differentials between potential NEV models and their ICE model equivalents?

2. Looking forward five years, what NEV opportunities do you see in the SA market?
    a. Type of NEV (Passenger versus Light Commercial, market segment)?
    b. Volume expectations?

3. Again, looking forward five years, what NEV opportunities do you see in the broader African market?
    a. Type of NEV (Passenger versus Light Commercial, market segment)?
    b. Volume expectations?

4. What do you believe is required from government for NEVs to secure 15-20% of your company's present domestic market share by 2025 and 30-40% of your domestic share by 2030?

5. When do you plan to replace your existing locally produced range of vehicle models?

6. Is there a plan to have NEV options for some or all your replacement model ranges? If so…
    a. What is the timing of the NEV introductions?
    b. What types of NEVs are you considering?
    c. What percentage of your total production do you envisage will be from NEVs?
    d. What major changes would need to be made to your production facility to accommodate your planned NEV assembly?
    e. What major changes would need to be made to your supply chain to accommodate your planned NEV assembly (and by what date)?
    f. Have you identified any specific NEV component localisation opportunities?
    g. Have you calculated the APDP benefits (PI, VALA, AIS) that would be secured from NEV assembly? How do these compare against your ICE assembly equivalents? If so, why are they different?

7. What immediate and potentially medium-term policy changes do you believe are critical to the APDP (and potentially outside of the APDP, but aligned with the SAAM) to secure substantially greater NEV production in South Africa (15-20% of your total assembly volume by 2025 and 30-40% by 2030)?

APPENDIX B: THAILAND NEV POLICY

The Thailand BOI has previously approved 26 projects producing NEVs of various types, including electric buses. So far, only seven of the projects have started commercial operations, namely Nissan, Honda, and Toyota producing HNEVs; Mercedes Benz and BMW producing PHEVs; and new comers FOMM and Takano producing BNEVs. BOI also approved 14 projects for manufacturing critical components and parts for NEVs, including 10 battery production projects.

Below is a list of NEV manufacturing projects in Thailand by OEM (all Schröder and Iwasaki, 2021):

- Toyota has produced the Camry Hybrid (HNEV) since 2009 and has produced the Prius (HEV) from 2010 to 2015 using imported battery packs from Japan. Under the NEV incentive scheme, Toyota applied to produce 7 000 HNEVs a year plus 70 000 NEV batteries as well as other non-NEV specific components, such as bumpers, doors, front and rear axles. Toyota commenced production of NiMH batteries at its plant in Chachoengsao Province in May 2019. The batteries produced are currently used in HEV models of the Camry sedan and the CHR SUV (Toyota, 2019; Marklines, 2020).
- Nissan began manufacturing the X-trail Hybrid (HEV) in 2015.
- Honda assembled its Jazz HEV in 2012 followed by the Accord HEV in 2014. From 2013 to 2015, Honda produced the Civic HEV in Thailand, but due to low sales discontinued its production globally. Following Thailand's NEV policy, Honda pledged to invest in HEV and HEV battery production.
- Mazda applied to the BOI to extend its production to BEVs. The OEM also plans to produce an undisclosed hybrid model and several components in Thailand.
- BMW started to produce PHEV models of its 3-series (330e) and X5 models in 2017. After the introduction of the NEV incentive scheme, BMW extended production to PHEV versions of the 5-series and 7-series (530e and 740Le, respectively).
- As part of the localisation effort, German supplier Dräxlmaier started to produce Lithium-ion traction batteries for BMW in Thailand in September 2019. Dräxlmaier assembles battery modules and subsequently packs from procured cells and other components, such as aluminium housing and electronic components. The company claims that it is the only plant that produces Li-ion batteries starting from the module stage in Southeast Asia.
- Mercedes started to assemble CKD kits of HEV versions of its C-class and E-Class models (C300 and E300 BlueTEC Hybrid) in 2013 and 2014. In 2016, the OEM updated its model line-up by starting assembly of PHEV versions of the Mercedes-Benz C-class and S-class (C350e and S500e). After Thailand offered incentives, the firm deepened its production capacity by applying for PHEV battery production and production of the EQC BEV.
- The joint venture between SAIC and local conglomerate Charoen Pokphand (SAIC-CP) pledged to produce PHEV and BEV versions of the MG ZS SUV under the BOI scheme.
- Mitsubishi also received approval for its plan to produce an undisclosed PHEV model in Thailand.
- First One Mile Mobility (FOMM), a Japanese start-up, entered the Thai market with an investment of roughly US$30 million to build its first factory with annual production capacity of 10,000 units in Chonburi Province.
- Energy Absolute, a Thai corporation mainly active in renewable energy and bio fuel production, will produce Li-ion batteries suitable for PHEV and BEV use in a joint venture with the Taiwanese Amita Technologies. The plant will initially have the annual capacity to produce batteries able to

store 1 GWh of electrical energy and be expanded to 50 GWh by 2021. Further, it will install a network of 3 000 charging stations under its EA Anywhere brand, and ally with an unidentified vehicle assembler to produce three different NEV models – one city car, one multi-purpose vehicle, and a sports car – all developed in-house.

- Auto Alliance (Thailand) Company Limited received approval for a plug-in hybrid electric vehicle (PHEV) and battery electric vehicles (BEV) production project to be located at the Eastern Seaboard Industrial Estate in Rayong Province. The project, with an investment value of 3.2 billion baht, will have an output of 5,000 PHEVs and 1,000 BEVs per year for distribution in the domestic market.
- In a signed a cooperation agreement with the local Ministry of Industry and the Thailand Automotive Institute, TÜV SÜD announced in 2019 that it would participate in the establishment of a battery test centre near Bangkok.
- In 2018, vehicle development service provider FEV founded a Thai subsidiary to support the regional mobility sector in the development of vehicles, engines, transmissions, and electric drives – including batteries and hydrogen fuel cells.

APPENDIX C: INDIAN STATE NEV POLICIES

STATE	KEY POLICY TARGETS AND INCENTIVES
Andhra Pradesh, Electric Mobility Policy (2018-23)	One million EVs by 2023. Goal of 100 000 slow and fast EV charging stations by 2024. All government vehicles including corporation boards and ambulances to be electric by 2024.
Delhi, EV Policy, 2020	Incentive of ₹30 000 (US$409) per vehicle. Incentive to scrap old polluting two-wheelers. Purchase incentive of INR 10,000 per kWh of battery capacity provided for electric four-wheelers (to ₹150 000 or US$2 039 per vehicle) for the first 1 000 e-cars registered In New Delhi. 100% of three and four-wheelers moving goods to transition to electric by 2030.
Karnataka, EV and Energy Storage Policy, 2017	Public fleet to Introduce 1 000 EV buses and set up 112 EV charging stations in Bengaluru. Focus on venture capital fund for e-mobility start-ups and creation of secondary market for batteries. Incentives: Interest free loans on net SGST for EV manufacturing enterprises.
Kerala, EV Policy, 2019	Viability gap funding for e-buses and government fleet. Incentives include tax breaks, road tax and toll charge exemption, free permits for fleet drivers and parking. Priority to EV component manufacturing.
Maharashtra, EV and Related Infrastructure Policy, 2018	Target to increase number of EV registrations to 500 000 over five-years. Secure investment of US$3.4 million for the EV manufacture. Exempt EVs from road tax and registration fees over policy period. Supporting fuel stations to set up charging stations.
Telangana, EV and Energy Storage Solution Policy, 2020	EV sales target by 2025: 80% two- and three-wheelers, 70% commercial cars (ride-haling companies such as Ola and Uber), 40% buses, 30% private car. Creation of 20 000 jobs by 2025 through shared mobility, EV manufacturing, and charging Infrastructure development. Incentives include registration fee and road tax waivers.
Uttar Pradesh, EV Manufacturing and Mobility Policy, 2019	Goal of 1 000 electric buses deployed in the state by 2030. Target of achieving 70% electrification of public transportation by 2030 on identified green routes (10 cities). Incentives include registration fee waivers on two-wheelers and four-wheelers. Road tax waiver: 100% for two-wheelers and 75% for four-wheelers.
Bihar, Draft Bihar EV Policy, 2019	To electrify all rickshaws by 2022 and promote e-rickshaw manufacture. Set up fast-charging stations at intervals of 50km on highways and commercial and residential locations. Registration waiver for EVs. Road tax waiver: 100% for two-wheelers and 75% for four-wheelers.
Gujarat, EV policy, 2019	Make Gujarat a manufacturing hub for EVs and ancillary equipment. Aim of having 100 000 EVs on the road by 2022, including two-wheelers or scooters, 14 000 three-wheelers, 4 500 cars, and buses. 100% exemption from registration fee and 50% exemption from motor vehicle tax, 100% exemption from electricity duty for e-charging stations.
Himachal Pradesh Draft EV Policy, 2019	Aims for 100% transition to EVs by 2030. Draft promotes creation of dedicated charging infrastructure and includes a provision for charging points in commercial buildings. Rapid EV adoption and contribution to 25% of all new public transport vehicle registrations by 2026. Some cities will stop registering new ICE vehicles.
Madhya Pradesh EV Policy, 2019	Enable faster adoption by providing affordable, and accessible charging infrastructure. Shared e-rickshaws and electric auto-rickshaws. Incentives: free permits, exemption/reimbursement from road tax/vehicle registration fees for five years, and 100% wavier on parking chargers at municipal parking facilities for five years. Electrify 5% of buses annually to 2030 and convert shared mobility fleets. All e-commerce logistics vehicles to EVs by 2030.
Tamil Nadu, EV Vehicle Policy, 2019	Convert all auto rickshaws in six major cities to EVs over 10 years. Establish venture capital and business incubation service hubs to encourage EV start-ups. EV and charging infrastructure manufacturing units will receive 100% exemption on electricity tax till 2025.
Uttarakhand (2018), EV Promotion and Infrastructure Policy	Aimed at 100% electrification of public transport, including e-buses; shared mobility.

APPENDIX D: BRIEFING NOTE

Transitioning the South African automotive industry to NEV consumption and production by 2035

Compiled by Justin Barnes and Gaylor Montmasson-Clair
For the South African Minister of Trade, Industry and Competition
12 October 2021

Problem statement

Driving the New Energy Vehicle (NEV) transition in South Africa will require a careful balance between incentivising a sustained shift in domestic market demand to NEVs; establishing an appropriately aligned, renewable energy-based charging infrastructure; and supporting a shift in South African vehicle production, away from Internal Combustion Engine (ICE) vehicles to a mix of Hybrid Electric Vehicles (HEVs), Plug in Hybrid Electric Vehicles (PHEVs), and Battery Electric Vehicles (BEVs).[44] Balancing these factors is key to successfully transitioning the South African vehicle industry to an ultra-low carbon future, while simultaneously ensuring it remains a major contributor to the industrial development of the domestic economy, as per the objectives of the South African Automotive Masterplan (SAAM), which runs until 2035.

How the South African government supports the industry and its complex value chain to make this transition is replete with challenges, the most notable of which is the major cost associated with transitioning to the consumption and production of more expensive vehicles – at least for a period, and until battery technologies advance to levels that secure their price parity with equivalent ICE products. The South African market is highly price sensitive, especially in the two lowest quintiles of market consumption (price elasticities of -1.795 and -1.95 respectively), hence the almost non-existent sales of NEVs in the domestic market, except in the apex quintile.[45] This creates a major misalignment in the development trajectory of the South African market relative to the local automotive industry's most important export markets, which are the European Union (EU) and the United Kingdom (UK). These markets, which jointly consume a similar number of South African assembled vehicles as supplied into the domestic market, will likely be BEV-only by 2035.[46] This raises a striking challenge for the multinational vehicle assemblers operating in South Africa. Their domestic business case is essentially a balanced one, with vehicles supplied into the South African and major export markets to achieve sufficient scale economies to operate at internationally competitive levels. To maintain this balance in future, it is critical that domestic and international market demand shifts are broadly aligned.

This does not mean that consumption in the South African and EU/UK markets need to be fully aligned in respect of timing and the profile of NEV consumption. South Africa is starting its NEV transition slightly later and has distinctive geographical and operating parameters (road conditions, vehicle use factors, income distribution, consumption patterns, etc.) that will impact the nature of its NEV transition. For example, while the NEV transition for passenger vehicles is likely to simply be slightly

[44] Hydrogen Fuel Cell Electric Vehicles (HFCEVs) are unlikely to be competitive with other NEVs within the 2035 timeframe covered by this briefing note, hence the focus on the balance of NEV technologies. However, if HFCEVs were to become competitive within the period of the SAAM, it is recommended that they be treated in the same manner as BEVs.
[45] Light vehicles that sold for more than R613,201 in 2018.
[46] For example, the UK plans to ban the sale of new ICE vehicles in 2030 and hybrids (HEVs and PHEVs) by 2035.

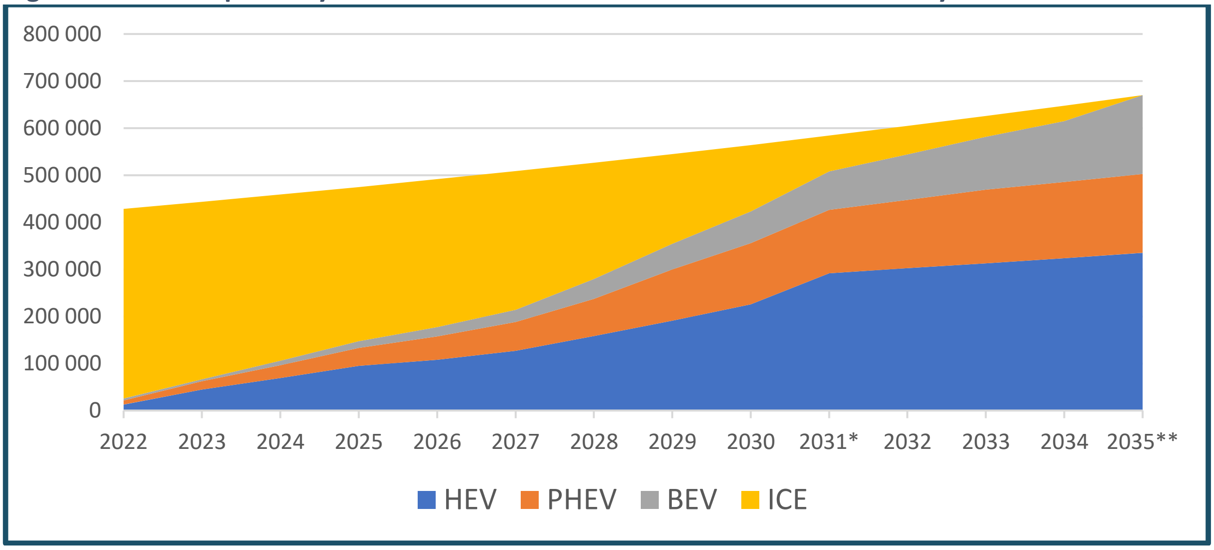
longer in South Africa than in the EU/UK, there is a strong likelihood that Light Commercial Vehicle (LCV) demand in South Africa will remain hybrid-based for the period to 2035, with LCV-HEVs being replaced primarily with PHEVs, as opposed to a full transition to BEVs.

This briefing note consequently considers an ideal NEV transition trajectory for South Africa for the period of the SAAM – in the context of major developed economy changes, and the country's own domestic market and production requirements. The note comprises three parts. The first part considers an ideal market transition plan, including a recommended set of costed incentives to drive the NEV transition. The second part considers charging infrastructure investments to support the NEV transition. The third part then considers the investment support required to transition local vehicle and associated component production in alignment with the market transition.

Transitioning the domestic market to NEV only consumption

Fully eliminating ICE sales in South Africa by 2035 appears possible, provided the South African market is heavily incentivised to purchase NEVs over the period. A possible profile of the transition is presented in Figure 4. As highlighted, the market is expected to trend from a completely ICE dominated one currently[47] to one where HEVs comprise 50% of the market in 2035, and PHEVs and BEVs 25% each. The modelling completed to support the transition projects the removal of incentives for HEVs at the end of 2030 and the banning of new ICE vehicle sales in South Africa at the end of 2034. Consequently, the NEV transition is dominated by HEV sales until 2030, but with some growth of PHEVs and BEVs to 2030 and then a rapid rebalancing of the NEV market to 2035, as PHEVs (for LCVs) and BEVs (for passenger vehicles) become increasingly competitive, and as domestic vehicle production transitions to NEV production (see Section 3). As highlighted in Figure 4, the projected the domestic market growth to 2035 is no longer to reach 1.2 million units annually, as projected in the SAAM. It is now 670 140 units per annum. This is based on **naamsa's** projected market sales for 2021, and then an expected 3.5% annualised growth rate for the period through to 2035.[48]

Figure 4: Possible pathway to reach 100% NEV market sales in South Africa by 2035



Notes: * Remove incentives for HEVs at end of 2030; ** Ban new ICE vehicle sales in South Africa at end of 2034

[47] Only 324 NEVs were sold in the COVID-19 impacted South African market in 2020, with this representing less than 0.1% of the total domestic market.

[48] The average annual 3.5% growth rate takes into account the industry's distressed starting position, and hence likely strong post Covid-19 recovery.

Securing the transition outlined in Figure 4 will require substantial incentivisation to equilibrate the cost differential between ICE vehicles and their HEV, PHEV and BEV counterparts. We have calculated the existing base[49] pricing differential to be up to R37,500 for HEVs, R75,000 for PHEVs and R150,000 for BEVs (present Rand values).[50] To secure ICE-equivalent levels of sales to 2035, but per the NEV mix change outlined in Figure 4, we have computed that the provision of required subsidies would be up to R259.5 billion (in 2021 Rand values). Most of the incentive would be directed to BEVs (R124.5 billion), followed by PHEVs (R96.4 billion), and then HEVs (R38.7 billion). The subsidy for individual NEVs, irrespective of their selling price, would therefore be up to R37 500 for HEVs (to be withdrawn at the end of 2030), up to R75 000 for PHEVs and up to R150,000 for BEVs (both to 2035). The Rand levels of support that have been determined should remain unchanged for the period, as inflation will slowly reduce their proportional value (relative to vehicle selling prices). This gradual decline in real support will be offset by the anticipated improvement in comparative battery costs over the period.

It is further recommended that the maximum support threshold for each NEV-type be set at a kWh-level for the leading technologies of the time, and for a period of seven years (in alignment with a typical model lifecycle). As an example, the maximum HEV support level of R37 500 could be set for a 2-kWh battery, with a gradient of support provided for smaller batteries. As such, an HEV with a 1-kWh battery would receive an incentive of R18 750, as opposed to the full R37 500. Key is ensuring that the threshold is set on the basis of NEVs available in the EU and/or UK markets and that the NEVs qualifying for support meet the EU and/or UK's NEV homologation requirements.

Critically, 50% of new vehicle sales would be BEVs and PHEVs by 2035, with the balance of the 50% highly fuel efficient HEVs. All ICE vehicle sales would terminate at the end of 2034, and South Africa would then be well positioned to transition to a zero-carbon light vehicle fleet over the next two decades.

Table 18: Maximum market subsidisation required to transition the domestic market to NEV only consumption by 2035 (all figures R millions)

YEAR	HEV	PHEV	BEV	ANNUAL SUBSIDY
2022	R 482	R 643	R 643	R 1 768
2023	R 1 663	R 1 330	R 665	R 3 659
2024	R 2 582	R 2 066	R 1 377	R 6 024
2025	R 3 563	R 2 850	R 2 138	R 8 551
2026	R 4 057	R 3 688	R 2 950	R 10 695
2027	R 4 771	R 4 580	R 3 817	R 13 168
2028	R 5 926	R 5 926	R 6 321	R 18 172
2029	R 7 155	R 8 177	R 8 177	R 23 510
2030	R 8 464	R 9 733	R 10 156	R 28 353
2031	R 0	R 10 074	R 12 264	R 22 338
2032	R 0	R 10 880	R 14 506	R 25 386

[49] This base price differential is for opening price point HEVs, PHEVs and BEVs, as opposed to luxury NEVs (where the pricing gap is larger); and assumes that vehicle assemblers will reduce margins where the price gap is higher.
[50] Based on the market's price elasticities, and assuming that no incentives are made available, we estimate that the projected South African light vehicle market of 670,140 vehicles in 2035, would decline to 458,523 units (a market decline of 31.6%). Even more importantly than the overall decline, sales in market quintiles 1 (vehicles to R214,200) and 2 (vehicles to R303,283) would reduce by 63.4% and 53.0% respectively, essentially decimating the bottom end of the South African market. These market declines would not only impact the South African vehicle industry; they would also significantly reduce the government's fiscal intake from the industry. In 2018, the South African government secured an average of R85,694 in taxes and levies from each vehicle sold in the country. Based on this figure, a decline of the 2035 market from 670,140 to 458,523 vehicles would cost the fiscus R18.1 billion in that year alone.

2033	R 0	R 11 730	R 16 891	R 28 620
2034	R 0	R 12 140	R 19 424	R 31 565
2035	R 0	R 12 565	R 25 130	R 37 695
TOTAL	**R 38 662**	**R 96 382**	**R 124 460**	**R 259 503**

NEV infrastructure provision

In addition to directly supporting NEV demand growth through a grant programme (per Section 1), the availability of public charging infrastructure (for BEVs and PHEVs) is a crucial factor underpinning the transition to NEVs.[51] This is critical to address range anxiety concerns in prospective buyers[52] but also to enable the effective use of BEVs on all roads.

A public network of both fast and slow chargers is required to complement private charging infrastructure. While most of the charging of PHEVs and BEVs would occur through private, slow chargers at home (80%),[53] the availability of fast chargers (which can fully recharge a passenger car in less than 20-30 minutes) is critical on long-distance routes, such as highways, as well as high traffic areas, such as city centres, business districts, shopping malls, and large office parks. Overall, despite the prevalence of private charging, the availability of public chargers (both slow and fast) is critical to enable the use of BEVs and to support ubiquitous market development.

While charging BEVs based on South Africa's largely coal-based electricity grid does potentially bring some benefit in terms of greenhouse gas emissions (depending on models), BEVs are only truly low-carbon when charged from renewable energy sources. The use of renewable energy-based systems to power charging stations would furthermore contribute to allay prospective consumers' concerns related to grid power supply.[54]

At the end of 2020, South Africa had 305 public EV charging stations, spilt between 163 fast-charging stations (53%) and 142 slow-charging stations (47%).[55] Given the very low number of BEVs and PHEVs on South African roads (637 and 653 respectively at the end of 2020), the country currently has a charging station for about every five vehicles. This is above the global standard, which is eight vehicles (BEVs and PHEVs) per charging station. As it stands, South Africa, therefore, has an arguably high number of charging stations relative to the number of BEVs and PHEVs in the market. However, as shown in Figure 5, the coverage within the country is highly imperfect. The visibility and availability of such charging stations also remain much too low to support the development of the market. In addition, an aggressive increase in NEV sales would have to be matched by an ambitious rollout of charging stations in the country.

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[51] The rollout of HFCEVs would require a dedicated infrastructure network for hydrogen; and is not covered in this brief.

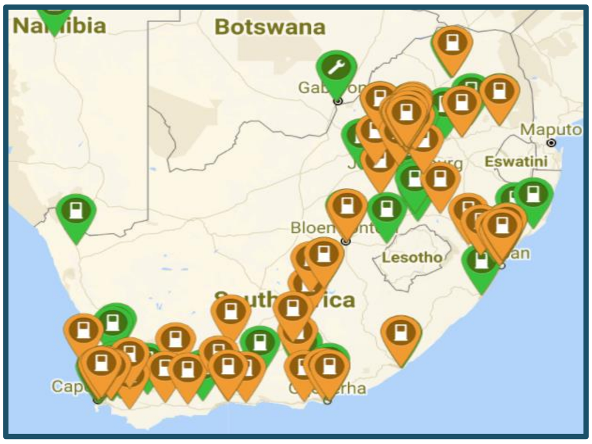
[52] Studies have found a statistically significant link between NEV uptake and charging infrastructure. Public chargers, in the early stages of market development, are more important as mechanisms to curb range anxiety rather than to deliver actual charging services. Indeed, range anxiety is only a factor for new prospective buyers and disappears entirely in active NEV drivers.

[53] Including office charging, the share of slow charging would extend to over 95%.

[54] Interestingly, interviews with OEMs have indicated that South African buyers of BEVs often have their own solar-based systems at home (up to 50% in the case of one OEM).

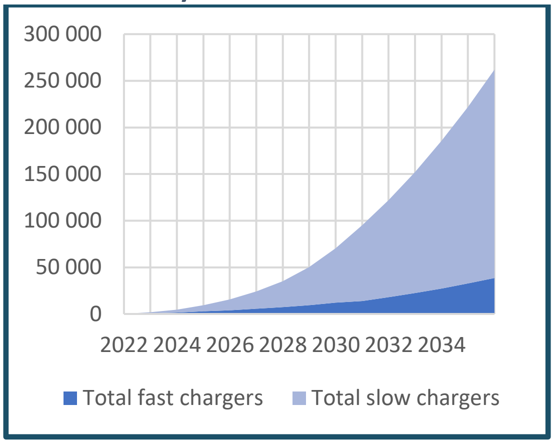
[55] Countries tend to have a relatively high share of fast chargers at an early stage of their NEV transition, essentially to build market awareness and confidence. As the market matures, fast chargers only account for 15% of the charging infrastructure.

Figure 5: South Africa's network of public charging stations in 2021



Legend: green denotes slow chargers; orange depicts fast chargers

Figure 6: Number of charging stations required to reach 100% NEV market sales in South Africa by 2035



Note: based on one charging station for eight vehicles (BEVs and PHEVs)

To keep up with a fast growth in EV sales (as detailed in Section 1), South Africa would require close to 262,000 public charging stations by 2035. In line with global trends, 85% of such stations, or about 223,000, would be slow charging by 2035, while 15% or 38,500 stations would be fast charging. Achieving such a coverage demands an ambitious rollout programme, progressively ramping up new installations from about 1 500 in 2022, to above 6,000 in 2025, to about 25 000 in 2030 and above 40 000 in 2035.

The capital cost of such a rollout would depend heavily on whether it is associated with the installation of solar-based systems along charging stations. In 2021, in South Africa, the installation (without a connected renewable energy-based system) of a slow charging station (AC 22kW charger) and a fast-charging station (DC 50kW charger) cost R45 000 and R540 000 respectively. As detailed in Table 19, on its own, we estimate the installation of required charging stations (to match an ambitious rollout of NEVs) to cost R30.8 billion in 2021 Rand terms (or an average of R2.2 billion per annum). Adding a renewable energy-based system to each charging station would materially increase the cost of this rollout to R95.5 billion in total (in 2021 Rand terms).

Table 19: Capital cost for the rollout of charging stations required to reach 100% NEV market sales in South Africa by 2035, with and without renewable energy-based systems (in 2021 Rand terms)

Year	Vehicle stock BEV+PHEV)	New fast chargers required	New slow chargers required	Without renewable energy		With renewable energy	
				Cost of fast chargers	Cost of slow chargers	Cost of fast chargers	Cost of slow chargers
2022	14 316	593	917	R0.3 billion	<R0.1 billion	R1.0 billion	R0.4 billion
2023	36 490	914	1 960	R0.5 billion	R0.1 billion	R1.5 billion	R0.8 billion
2024	73 211	1 167	3 680	R0.6 billion	R0.2 billion	R1.9 billion	R1.5 billion
2025	125 469	1 145	5 002	R0.6 billion	R0.2 billion	R1.7 billion	R1.9 billion
2026	194 273	1 603	6 997	R0.9 billion	R0.3 billion	R2.2 billion	R2.4 billion
2027	280 740	1 784	9 024	R1.0 billion	R0.4 billion	R2.3 billion	R2.9 billion
2028	401 598	2 169	12 939	R1.2 billion	R0.6 billion	R2.6 billion	R3.9 billion
2029	564 588	2 460	17 914	R1.3 billion	R0.8 billion	R2.8 billion	R5.1 billion
2030	761 326	2 010	22 582	R1.1 billion	R1.0 billion	R2.1 billion	R6.0 billion
2031	976 509	3 959	22 939	R2.1 billion	R1.0 billion	R4.0 billion	R5.7 billion
2032	1 217 161	4 428	25 654	R2.4 billion	R1.2 billion	R4.1 billion	R6.0 billion
2033	1 484 871	4 926	28 538	R2.7 billion	R1.3 billion	R4.3 billion	R6.3 billion
2034	1 774 775	5 334	30 904	R2.9 billion	R1.4 billion	R4.4 billion	R6.3 billion
2035	2 095 529	5 902	34 193	R3.2 billion	R1.5 billion	R4.5 billion	R6.6 billion
TOTAL		38 392	223 244	R20.7 billion	R10.0 billion	R39.6 billion	R 55.9 billion

Note: An annual cost reduction of 6% is factored in for solar-based systems.

Transitioning SA vehicle production to NEV only sales

As per the local market, South African vehicle production remains almost exclusively ICE-based. From November 2021, two locally produced models will have HEV options available, but the balance of domestic demand for NEVs will be met through imported products. While this is not in itself a problem in the short term given the way the Automotive Production Development Programme (APDP) incentives local production,[56] it will become a major problem within three to five years. As domestic and export demand for NEVs increases over time, ICE demand will decline, and the business case for ICE-dominated local production will be challenged. Essentially, OEMs will be required to replace their existing South African ICE platforms with NEV replacements; or risk the chance of having their operations made redundant.[57] Given that there will be a maximum of only two model replacements between now and 2035, OEMs will either introduce a NEV replacement at their next model change (to 2029), or, at the latest, the next (from 2030).

Investing in the assembly of HEVs will not necessarily result in major additional investment costs for South African OEMs, as the assembly of batteries can be easily assimilated into existing plant assembly operations. However, this does not apply to PHEV assembly, which requires more significant assembly changes and, most certainly not for BEV assembly, which requires major additional investment – potentially akin to a Greenfield operation. Beyond assembly changes, the shift to NEV technologies will also fundamentally challenge existing manufacturing operations within the domestic component value chain. This is the biggest threat facing the South African automotive industry, as well as the broader economy. On average, almost three component manufacturing jobs are created for every vehicle assembly job in South Africa, and at least one of these three jobs is likely to be threatened by the transition to NEVs.[58]

The transition to assembling NEVs must be accompanied by the local components industry acquiring a range of NEV technological capabilities that permit continued growth of local content in domestically assembled vehicles. This is presently only around 40% and, yet, as per the SAAM, it is essential that local content levels increase to 60% by 2035 to ensure the automotive industry supports the South African economy's industrial development, and associated employment growth. Reaching such local content targets is contingent on developing the NEV supply chain, particularly around batteries.

Increasing local content, while simultaneously transitioning to NEV technologies, will require a substantial increase in investment across the automotive value chain. To ensure this occurs, the existing Automotive Investment Scheme (AIS) will need to be significantly augmented.[59] As a small vehicle producing economy with limited scale economies by global standards, limited local technological capabilities, and high comparative operating costs relative to leading global

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[56] The entire APDP is predicated on an OEM export/import complementation model, hence the use of import rebates to incentive local production.

[57] Multinational OEMs have all committed to the United Nations' sustainability goals. It is therefore unlikely that ICE vehicles will continue to be sold in South Africa, or Africa more broadly, when the balance of the world's markets shift to NEVs. The OEMs will be obligated to shift their entire production base to NEVs.

[58] This estimate is based on two-thirds of the South African components industry manufacturing powertrain agnostic components, such as interior and exterior trim, glass, tyres, and metal pressings/fabrications, etc. The one third at risk would relate to the manufacture of catalytic converters, exhaust systems, certain heat transfer products, and a wide array of drivetrain and powertrain components.

[59] There are also major issues with the existing AIS. OEM interviews revealed a high level of dissatisfaction with the qualifying requirements of the AIS, including its Level 4 BEE requirement, and its requirement that OEMs and component manufacturers receiving support maintain or grow their headcount. It was noted that both elements would place substantial restrictions on the transfer of NEV technology to South Africa. These elements need to be considered in respect of the regulations framing the proposed NEV Investment Fund.

competitors, the business case for NEV investment in South Africa is likely to be highly challenging, unless substantial investment support is provided. It is, therefore, recommended that the existing AIS is supplemented with a NEV Investment Scheme (NEV-IS) that provides an additional 20% investment support for all NEV related investments in vehicle assembly and automotive component manufacturing operations, inclusive of tooling, machinery, and associated technical skills development linked to these investments.

Based on the recent investment profile of the South African automotive industry,[60] and the need to increase investment levels by an estimated 30% annually through to 2035, we estimate that the total vehicle assembly and component manufacturing investment required to successfully transition the South African automotive industry to a NEV production base in 2035 is R342 billion. Based on the additional 20% investment support required to support the transition (in addition to the present AIS), the NEV-AIS will need to disburse an additional R68.4 billion to support the industry through to 2035. Annual projected disbursements are presented in Table 20. The success of this strategy is also premised on the availability of performance and safety testing and certification capabilities in South Africa. It is currently not possible to certify domestically NEV lithium-ion batteries for exports to the EU, the UK or the United States.[61]

Table 20: Capital investment required to transition to NEV production 2035 in 2035 (R millions)

YEAR	ASSEMBLY	COMPONENTS	TOTAL INVESTMENT	NEV INCENTIVE*
2021	R 9 631	R 3 759	R 15 411	R 3 082
2022	R 10 208	R 3 985	R 16 215	R 3 243
2023	R 10 820	R 4 224	R 17 067	R 3 413
2024	R 11 469	R 4 477	R 17 970	R 3 594
2025	R 12 156	R 4 745	R 18 927	R 3 785
2026	R 12 885	R 5 030	R 19 941	R 3 988
2027	R 13 658	R 5 331	R 21 016	R 4 203
2028	R 14 476	R 5 651	R 22 155	R 4 431
2029	R 15 344	R 5 990	R 23 363	R 4 673
2030	R 16 264	R 6 349	R 24 643	R 4 929
2031	R 17 239	R 6 729	R 25 999	R 5 200
2032	R 18 273	R 7 133	R 27 437	R 5 487
2033	R 19 368	R 7 560	R 28 961	R 5 792
2034	R 20 529	R 8 013	R 30 576	R 6 115
2035	R 21 760	R 8 494	R 32 288	R 6 458
TOTAL	R 224 081	R 87 468	R 341 969	R 68 394

* This is in addition to the standard Automotive Incentive Scheme, which provides investment support of up to 35% for component manufacturers and 30% for vehicle assemblers.

Specific NEV localisation opportunities would include battery packs and associated management systems, electric traction motors and controllers, thermal cooling systems, electromechanical brakes (vacuum pumps), high voltage harnesses, and vehicle charge points. The balance of components supplied to vehicles would remain largely unchanged in respect of their form and function, but this will mask potentially major changes in respect to their materials used (durability and weight), their levels of digital connectivity (vehicle monitoring), and their associated homologation requirements.

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[60] We have estimated domestic automotive industry investment to be around R10.3 billion annually for the period 2014 to 2020, or an annual US$756.6 million (based on the average Rand/US$ exchange rate for the period). This is inclusive of OEM and automotive component manufacturer investments. Interestingly, annual investment has been consistent when measured in US dollars, with major increases relating to the depreciation of the Rand, as opposed to real investment increases (when measured in US dollars).

[61] Only testing and certification for stationary usages of lithium-ion batteries is currently available in South Africa.