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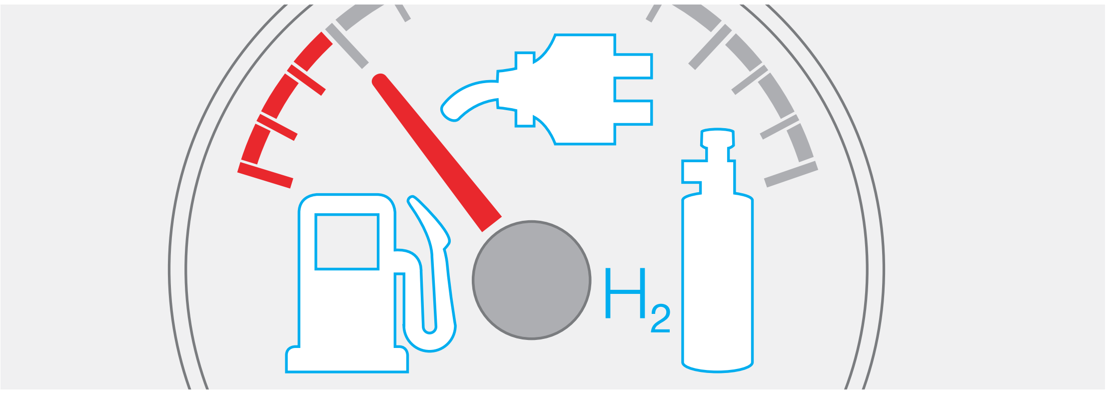
Automotive & Assembly



Boost!

Transforming the powertrain value chain – a portfolio challenge

Content

Introduction

The global market for automotive powertrains will more than double by 2030 to EUR 460 billion, creating 420,000 new jobs worldwide. Globalization and electro-mobility are the key drivers. The internal combustion engine (ICE) will be standard for the foreseeable future, but the electric car is on its way. Numerous technologies like optimized, low-emission ICE (e.g., 3-cylinder), hybrid, and electric vehicle will coexist. This is turning the automotive powertrain industry into a portfolio game and exposing it to high uncertainty, as major shifts will transform the value chain. Now, the race is on to capture attractive growth opportunities and manage rising challenges in the transforming powertrain industry.

Once the stable backbone of the automotive industry, powertrains will become a business area composed of a variety of technologies and business models, triggered by forthcoming regulations restricting vehicle carbon emissions and changes in customer behavior. Although at least 90 percent of cars will still run on an ICE ten years from now, it is very uncertain which technologies will prevail. At the same time, the automotive industry is gaining momentum: automotive powertrain market revenue – driven by electro-mobility and globalization – will more than double from EUR 190 billion to EUR 460 billion by 2030, and new players will enter the market. This transformation will be accompanied by dramatic shifts in the value chain. Carmakers, suppliers, and potential new entrants need to orient themselves now in order to leverage their strengths in this portfolio game to create opportunities and manage potential risk and challenges.

To help companies gain perspective in this changing market, McKinsey has developed a detailed value chain model to project the effects that such shifts will have on powertrain components and technologies. From these market developments, future competences that will be required of the powertrain industry can be derived, e.g., raw materials management and "me-chem-tronic" skills (mechanical, chemical, and electronics) for employees.

Automotive powertrains will become a different industry – a portfolio game

The automotive industry is currently dealing with a number of discontinuities, which will turn the powertrain into a portfolio of technologies. One of the major discontinuities is stricter CO_2 regulation. This results in optimization of current ICE technology with a trend toward smaller, highly-charged engines, turbochargers, compressors, and sophisticated direct injection. The trajectory also points to the electrification of the powertrain in either pure electric or hybrid vehicles.

Another trend affecting the industry is very strong growth in emerging markets, mostly in BRIC countries (Brazil, Russia, India, and China). Car and powertrain production is shifting to these markets. As customer needs and regulation requirements vary, technology differences across regions are large. Furthermore, local governments try to leverage alternative powertrains and prepare their carmakers and suppliers to build up competences. China, for example, is providing well-directed funding to build up an electric powertrain industry – in order to simply leapfrog the era of ICEs. As a result, there is still a persistent production undercapacity in these markets, while there is some overcapacity in established markets.

Additionally, discontinuity in customer preferences creates ultra-low-price segment outperformance. On the other hand, the premium market is showing above-average growth rates resulting in a mid-market squeeze. This evolution will accelerate technologies that massively reduce CO_2 emissions for larger premium cars as well as push highly cost-competitive technologies, e.g., 3- or even 2-cylinder engines for small cars.

A final trend affecting the automotive value chain also comes from the consumer perspective. Cars are losing their importance as status symbols, and eco-friendly, green technologies are gaining importance – especially among young people. New mobility concepts are needed to satisfy their demand for individual, but more flexible mobility, e.g., car sharing. Often these new concepts are embedded in eco-friendly mobility systems that connect different modes of mobility (e.g., trains and cars).

Overall, we will see a variety of powertrain technologies and business models operating in the same space. In addition, significant activities to reduce vehicle weight will be required to ensure electrification success. While ICEs have held the pole position in the powertrain industry for over 125 years, a portfolio of different powertrain concepts needs to be explored now, including

- Internal combustion engine (ICE): normal and optimized engines, like micro hybrids
- Hybrid electric vehicle (HEV; with and without plug-in): optimized combustion engine and electric motor
- Range extended electric vehicle (REEV; with and without plug-in): electric motor only, but combustion engine to generate energy for range extension
- Battery electric vehicle (BEV): electric motor and battery as energy storage
- Fuel cell electric vehicle (FCEV): electric motor and fuel cell as energy storage.

Electric cars on the horizon, but the optimized combustion engine will be key to the portfolio game for decades

Depending on the evolution of CO_2 regulatory policy, several powertrain mix scenarios are conceivable. If strict CO_2 emission targets are achieved by 2050, battery-powered vehicles (for short journeys) and fuel cell vehicles (for long journeys) will dominate the landscape in the long term. If regulation is more moderate, ICEs will be built into nearly half of all vehicles – still in 2050 – especially as secondary, less complex motors in range extended electric vehicles.

Next to CO_2 regulation, the electrification trend is advanced by the increasing competitiveness of all electric powertrain technologies ("xEVs": BEV, REEV, FCEV) with ICEs due to a convergence of total ownership costs. This is not only driven by an increase in oil price and the rising supply of renewable energy, but especially by the high speed of cost reduction expected for new technologies. Battery cells for example cost EUR 400 to 600 per kWh today. Advances in chemistry and automation along with a fine-tuning of systems design will massively reduce those costs to EUR 250 to 350 per kWh in the next ten years.

To reflect this uncertainty in regulation, McKinsey's powertrain study defined three scenarios to assess future development. All scenarios consider CO_2 emissions from well to wheel, whereas today often only the emissions from tank to wheel are considered.

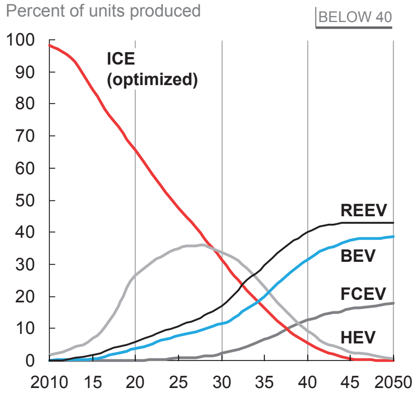
- "Below 100": moderate CO_2 emission reduction to 95 g CO_2/km in 2050. This would imply that regulation as of 2020 will not get much tighter. Only the tank-to-wheel standard will shift to a well-to-wheel standard

- "Below 40": strong CO_2 emission reduction to 40 g/km in 2050 – a scenario that foresees a continuation of increasingly restrictive emission standards

- "Below 10": very strict CO_2 emission reduction to 10 g/km in 2050, representing the global warming goal of a maximum increase of 2 degrees Celsius transferred to the transportation industry.

Reaching the Below 40 and Below 10 scenario emission reduction targets is not feasible with pure ICE; electrification will be needed.

Global market shares by powertrain technology
Percent of units produced



Global market shares by powertrain technology
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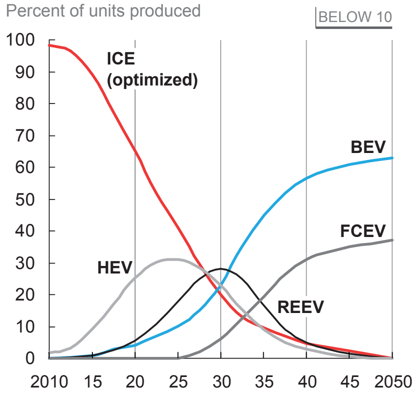

Global market shares by powertrain technology
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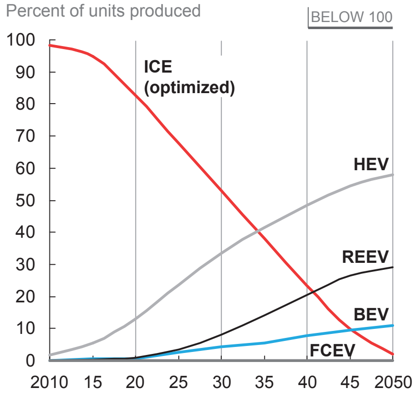


Powertrain future between two extreme scenarios, Below 40 being the basis for further analysis

The Below 40 scenario envisions increasingly restrictive standards, favoring a fully electric powertrain world dominated by REEVs. Here, the ICE would be the preeminent technology up to 2030. Thereafter – with tighter regulation – REEV/BEV penetration greatly increases and replaces ICE/HEV technology. In the long run, BEV is the prevailing technology in smaller vehicles, REEVs become dominant in medium-sized vehicles, and FCEVs are the powertrain of choice in larger vehicles. The powertrain portfolio game starts today and peaks in 2030. BEV, REEV, and FCEV dominance by 2050 leads to an electric-powertrain-only scenario.

In the very strict Below 10 scenario, electrification is even more prevalent, leading to a BEV and FCEV world. The ICE will dominate until 2025, but then lose market share to xEVs. In the long run, BEVs become dominant in smaller vehicles and FCEVs in larger ones. HEV/REEV will serve as bridging technology.

And even regulation in the modest Below 100 scenario will encourage electrification and result in a world of hybrids and BEVs. ICE remains dominant until 2030+, but BEV will become economically competitive after 2030. In this modest scenario no infrastructure for FCEV is going to be built. In the long run, HEV and REEV/BEV existence leads to a dual (electric/mechanical) powertrain scenario.

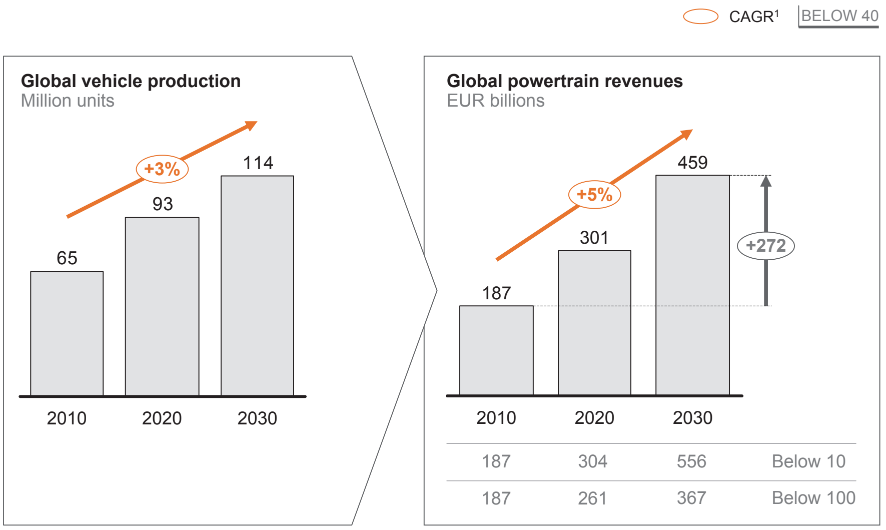
All scenarios show that technologies are about to change radically. While the long-term dominant powertrain technology cannot yet be predicted, some cornerstones can be derived. The first reality is that all technologies have to be engineered today. Research and development of electric powertrains are a significant share of R&D budgets, and the competition for technological leadership and definition of quasi standards is already on. But from a sales perspective, in the next ten years ICEs will be dominant – in 90+ percent of cars. Electrification will become a reality even in the short term – 20 to 35 percent of cars will have an electric motor by 2020. In the medium term, combinations of ICE and electric motors (especially HEVs) will capture market shares of 40 to 60 percent. Finally by 2050, the electric powertrain either as a sole solution or as a hybrid will dominate in all scenarios.

Players in the industry need to prepare to control bundles of technologies over the next several car generations that differ by region. Due to the striking differences in technologies between scenarios, truly robust options can only be found on the component level.

Powertrain revenues will more than double by 2030

With the changes in technology, a lot of business opportunities will be created. Worldwide, automotive powertrain revenues will more than double from EUR 190 billion to EUR 460 billion by 2030 (Exhibit 1).

Powertrain revenues will grow by EUR 270 billion until 2030



[1] Compound annual growth rate

SOURCE: Global Insight; McKinsey

Exhibit 1

While vehicle production will grow 3 percent per year until 2030, powertrain revenues will increase at a rate of 5 percent – 2.5 times the size of today's market as technologies become more complex.

The overall powertrain market growth of approximately EUR 270 billion will exceed global vehicle growth even though cost improvements are demanded by carmakers for components that are unchanged in performance. As higher performance and more features are needed to meet CO_2 regulations, ICE powertrain costs will increase by vehicle (e.g., because of turbocharger), and the cost for electrifying the powertrain will significantly increase due to the high cost of batteries. 80 percent of the growth will result from the gradual shift from ICE to xEV technology in the Below 40 scenario.

With stricter regulations, the growth of the powertrain industry will be even stronger. The market could exceed EUR 550 billion as in the Below 10 scenario. Fully-electric vehicles would penetrate the market by 2030, thus boosting sales for high-priced battery cells and battery systems.

This electro-mobility effect is intensified by a regional shift and the over-proportionate growth of the BRIC markets, which accounts for around 20 percent of the industry growth. The growth will be accompanied by dramatic shifts in the value chain, affecting market fundamentals and required competences.

Six major value chain shifts until 2030

Market shifts

Technology shifts from
ICE to xEV

“xEV market will be twice the size of ICE market”

Regional shifts from industrialized to emerging countries

“China’s and India’s markets will grow three times faster than triad markets”

Value-add shifts between players and business opportunities

“To keep carmakers’ value-add share stable, coverage of 50 percent of electric motor and all battery packaging and integration is required”

Competence shifts

Skill shifts from mechanics to “me-chem-tronics”

“44,000-FTE overcapacity in triad’s metal production, but 154,000 new FTEs in production of chemicals, plastics, and micro systems”

Employment shifts from industrialized to emerging countries

“420,000 additional FTEs in global powertrain, more than half of that in China/India”

Raw materials shifts from steel to copper and neodymium

“While demand for steel and alu almost doubles, demand for copper, neodymium, and lithium will grow up to 200 times of today”

Six major shifts that will change the automotive powertrain industry

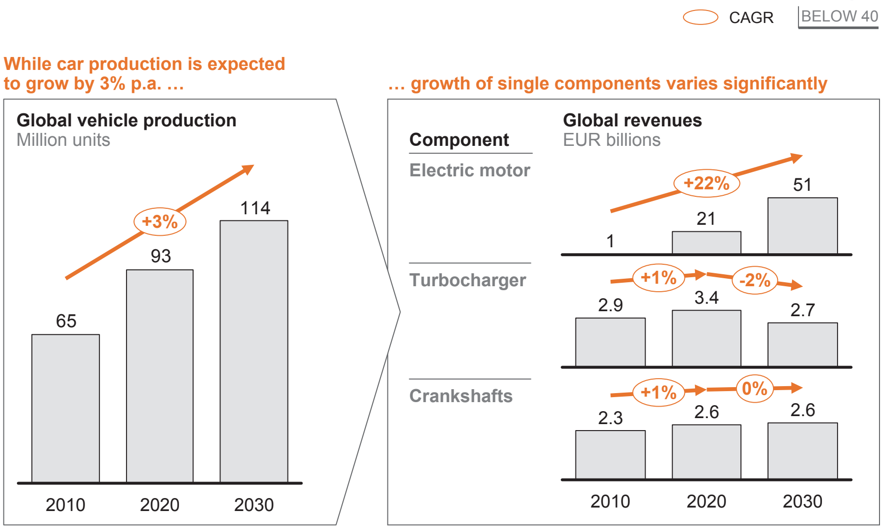
The tremendous growth in the powertrain industry is fostered by technology and regional shifts, resulting in major changes in the industry value chain, required skills and competences, employment trends, and the demand for raw materials.

Technology shifts

The major shift is primarily induced by the electrification already starting with micro hybrids today. By 2030, the market for xEV components – e.g., battery, electric motor – will be twice the size of the market for ICE components. By 2020, one in three cars (approximately 30 million) will be equipped with an (additional) electric engine. By 2030, two in three cars (approximately 70 million) will have an electric engine, but three in four cars (approximately 100 million) will still have an (additional) ICE.

The portfolio game will be played on the component level. Each component will have its own growth trajectory: electric engines and batteries are undoubtedly booming segments. Components that will profit from the increasing complexity (e.g., transmission and turbocharger) will continue growing in revenue through 2020. At that point, however, demand will significantly decline (Exhibit 2). The increase in vehicle production will temporarily conceal the decline in pure ICE components, but it will be evident in the medium term. For suppliers this will require an assessment of how their portfolios are exposed to different market growth rates and which strategies are needed to either capture the market growth or to handle a potential market decline. Also, growth opportunities outside the traditional product portfolio – leveraging core competence to enter new products – should be considered.

Different growth patterns expected for each type of component



SOURCE: Global Insight; McKinsey

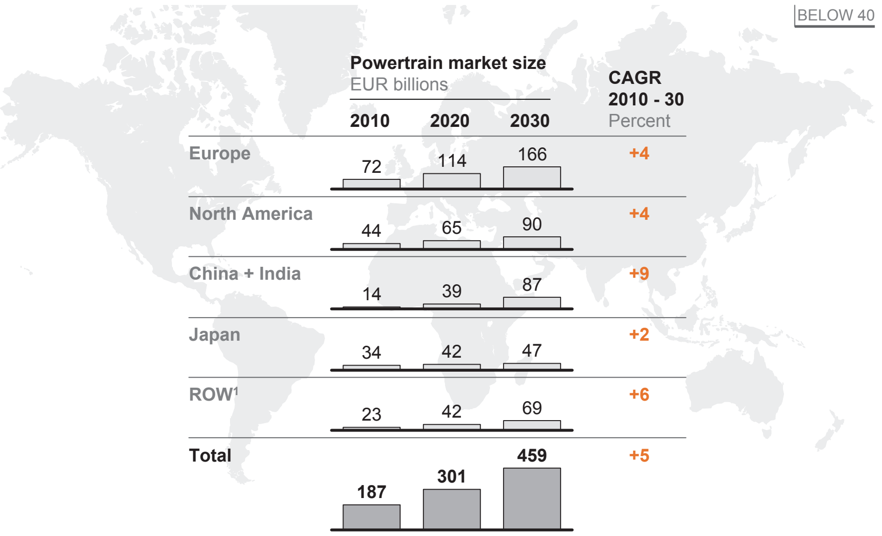
Exhibit 2

Regional shifts

Market growth for all major regions is expected, but while the triad markets of Europe, North America, and Japan will only grow by 2 to 4 percent annually until 2030, China and India will do so three times as fast, growing by 9 percent per year (Exhibit 3). This rate will make China and India the third largest powertrain market by 2030.

China and India will grow 9% p.a., becoming the third largest market by 2030

BELOW 40



1 Rest of World

SOURCE: McKinsey

Exhibit 3

On the component level there will be differences between the regions (Exhibit 4). While ICE components mainly grow in emerging markets, xEV markets will rapidly increase across all regions. Decreases in the ICE component markets will be moderate for the triad markets from 2010 to 2020. After that, the decreases will become more marked. The moderate decrease in the first ten years will be largely driven by a catch-up race toward the optimization of ICEs – mainly in North America, where turbochargers, for example, will show annual growth rates of 16 percent.

In emerging markets, ICE components will grow moderately even up to 2030, but growth rates for the xEV components will be even higher throughout the next 20 years. Thus, emerging markets and especially Chinese suppliers and carmakers could be in a comfortable position to capture the powertrain growth wave. All technologies will be in high demand, so no “break-down” of “old” industry structures for the enablement of new technologies is required. Triad markets in contrast will have to fight against the “stickiness” of the combustion engine world that may slow down the evolution.

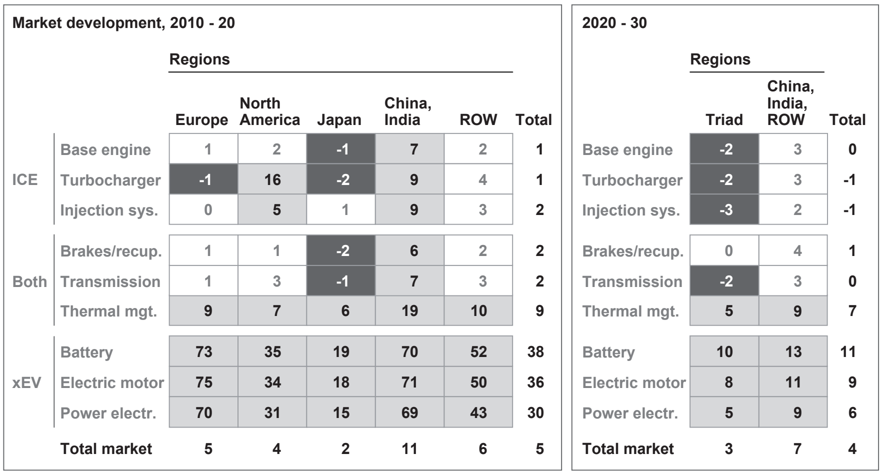
Exhibit 4

While ICE components mainly grow in emerging regions, xEV markets will rapidly increase across all regions

Growth heat map for component markets
CAGR, percent

BELOW 40

■ < 0 ☐ 0 - 4 ▨ ≥ 5



Market development, 2010 - 20

		Regions					
		Europe	North America	Japan	China, India	ROW	Total
ICE	Base engine	1	2	-1	7	2	1
	Turbocharger	-1	16	-2	9	4	1
	Injection sys.	0	5	1	9	3	2
Both	Brakes/recup.	1	1	-2	6	2	2
	Transmission	1	3	-1	7	3	2
	Thermal mgt.	9	7	6	19	10	9
xEV	Battery	73	35	19	70	52	38
	Electric motor	75	34	18	71	50	36
	Power electr.	70	31	15	69	43	30
	Total market	5	4	2	11	6	5

2020 - 30

	Regions		
	Triad	China, India, ROW	Total
Base engine	-2	3	0
Turbocharger	-2	3	-1
Injection sys.	-3	2	-1
Brakes/recup.	0	4	1
Transmission	-2	3	0
Thermal mgt.	5	9	7
Battery	10	13	11
Electric motor	8	11	9
Power electr.	5	9	6
Total market	3	7	4

SOURCE: McKinsey

Value-add shifts

It is not yet clear who will capture the growth opportunities, but the race is certainly on between carmakers, incumbents, and new entrants. To take advantage of the powertrain evolution, it is crucial to get the component portfolio right – capture growth opportunities, manage market decreases, and hedge against technological uncertainties. Competing in the right business areas can enable a company to grow by more than 20 percent a year. Retaining traditional components and raw materials while focusing on mature markets could lead to losses of 15 percent (-1 percent annual growth).

With business as usual, it is unlikely that carmakers and regions will be able to maintain their share of value-add as new competences are required for xEV powertrains. The core competence of today's car-producing nations in mechanical powertrains will be in lesser demand with the pullback of the ICE. Furthermore, risks need to be managed actively. Remaining viable will require great effort, but the payoff could be significant. Strategic partnerships between carmakers and suppliers will be essential to achieve a competitive advantage and build competences with shared risks for all technologies needed in the portfolio game.

Electric motors and batteries are the key drivers in deciding how value-add will be split between carmakers and suppliers. To keep today's value-add share, carmakers would need to cover 50 percent of the electric motor industry and dominate battery packaging and integration. Battery cell production will probably be dominated by specialists, as the massive investment in chemistry research can only pay off by scale effects. In addition, the required competences for fundamental research and financial risks would overburden the R&D departments of a single carmaker or supplier.

Over time, different profiles of value-add depth will appear: at the beginning, carmakers do have a strategic interest to dominate the new xEV components to drive system performance, build up (sourcing) competence, and reduce dependency of very few electric Tier-1 suppliers. In the long run, carmakers might profit from leveraging a supplier base, opening growth opportunities especially to today's Tier-2 supplier.

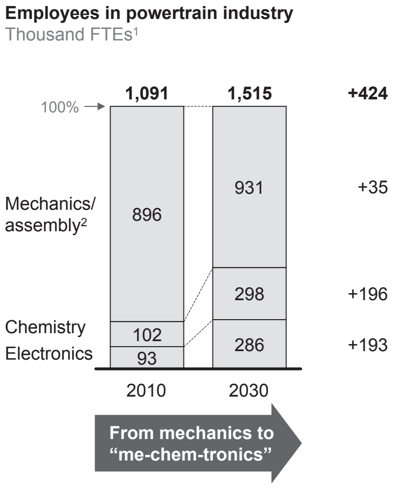
Next to value-add shifts, the powertrain transformation offers tremendous chances for new business models along the value chain. Integrated mobility concepts allow companies to increase their share of the customer's wallet.

Skill shifts

There will be a demand for 420,000 additional FTEs in the global powertrain industry over the next 20 years.[1] But the skills and competences required will change. A shift of skills and competences from mechanics to "me-chem-tronics" will occur. More electronics and chemicals competences will be required across all regions (Exhibit 5).

Required skills shift from mechanics to "me-chem-tronics" – 420,000 new jobs especially in chemistry and electronics

BELOW 40



1 Full-time equivalents
2 E.g., from casting, grinding, and milling to mixing, filling, winding, and coating

SOURCE: McKinsey

Exhibit 5

Overall, the share of chemicals and electronics specialists will double from today's level of around 20 percent of the powertrain workforce to 40 percent in 2030. This implies that more than 90 percent of the additional jobs created will require electronics and chemicals competences. Qualifying, recruiting, and training employees for these new jobs in electronics and chemicals in the manufacturing, research, and develop-

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[1] Estimation based on typical employment intensities by component and region; without taking significant shifts in imports/exports into account and assuming that all components are produced in the country of car production.

ment sectors will prove challenging in the very near future for the industry as a whole and for individual players. Carmakers, suppliers, and governments will have to undertake joint efforts to develop these competences. Nationwide programs need to be launched, and universities and other research institutes have to be granted significant budgets to tackle this skill development challenge. The future of the production and R&D sites is tied to their ability to adapt to these new competence requirements.

Employment shifts

In global production there will be a decrease in demand for the metal and mechanical workforce, a reduction of 47,000 FTEs. At the same time, there will be an increase of 110,000 FTEs in jobs related to plastics and 148,000 FTEs related to micro systems. In global R&D the number of mechanical engineering employees will decline by 8,000, whereas the number of employees skilled in chemistry, materials, electronics, and IT science will increase by 69,000 FTEs (Exhibit 6).

Traditional technologies losing importance in production and R&D, high demand for chemical and electronics competences

Regional shift in employees, 2010 - 30

Thousand FTEs

BELOW 40

Production ■ < 0 □ 0 - 14 ▨ ≥ 15

	Regions					
Competences	Europe	North America	Japan	China, India	ROW	Total
Metal	-10	-11	-23	28	-5	-21
Joining	11	5	-1	19	5	39
Mechanical	-12	-11	-20	22	-5	-26
Assembly	13	4	-6	32	7	50
Chemical	18	9	4	20	9	60
Plastics	32	15	10	37	16	110
Micro systems	38	18	10	57	25	148
Total	90	29	-26	215	52	360

R&D ■ < 0 □ 0 - 2 ▨ ≥ 3

	Regions					
Competences	Europe	North America	Japan	China, India	ROW	Total
Mechanical engineering	-3	-4	-1	1	-1	-8
Chemistry/ material science	8	3	3	6	3	23
Thermodynamics	0	0	0	2	0	2
Electrical engineering	10	5	4	9	4	32
Software/IT	3	2	2	3	2	12
Total	18	6	8	21	8	61

SOURCE: McKinsey

Exhibit 6

The development of regional competences will be essential as regions compete for these jobs. Most of the new components are very asset intensive. Asian countries might have advantages in labor cost, subsidies, raw materials access, and a strong consumer electronics industry, but triad markets might compete with their automation and engineering power as well as their market size. Batteries for example are difficult to transport due to the risk of overheating when they are not under the control of a management system.

Therefore, which region will import or export components will be key to future job deployment. Under the assumptions that all components of a car are produced in the country where the car production takes place, more than half of the required additional 420,000 FTEs in the global powertrain industry will be located in China and India. By 2030, the demand for FTEs in these regions may double from 230,000 to 470,000, accounting then for one-third of the global powertrain workforce. China and India even need to build up their workforce's classical competences (largely mechanical), whereas workforces in triad countries need to transform and develop in the new "me-chem-tronics" competences. High asset intensity and low labor share will make xEV production attractive even for high-wage countries.

In Europe, approximately 110,000 new jobs will be created both in production and R&D – an increase of more than one-third. The new jobs will be created in chemicals and electronics, as the demand for FTEs in mechanics-dominated industries stagnates.

North America will experience a demand for approximately 35,000 additional FTEs by 2030. This overall increase more than compensates for the decrease in mechanical and assembly jobs by 17,000 FTEs.

Japan is the only region with an actual net decrease in required FTEs – 20,000 FTEs, around 10 percent of the total powertrain workforce. This reduction is mainly driven by the reduced demand for mechanical employees in production (-50,000), which cannot be compensated by the increasing demand for chemical and electrical employees.

The employment evolution will massively be affected by the competitiveness of local suppliers and their export success. Grants, regulations, and incentives are launched to position local engineering and production. These actions need to be closely monitored as they may distort competition and hinder cost reductions required for the xEV technologies to compete against traditional combustion technology.

Raw materials shifts

Managing raw materials will be essential. New components that are already facing shortages in raw materials today – such as rare earth elements (for electric motors) and lithium (for batteries) – will be stretched to a much greater extent. Also, carbon fibers and other lightweight solutions are gaining in popularity.

Demand for steel and aluminum for the powertrain will almost double, with change rates of 1.6 and 1.8 respectively (similar including car body[2]). Compared to the moderate increases predicted for steel and aluminum, the demand for copper will be extreme – 13 times today's levels by 2030. This spike will be driven by the increasing demand for electric motors. The rise will be even more staggering for neodymium. The demand for this rare earth element is expected to increase 120-fold. Topping the list will be lithium. The need for Li-Ion batteries will drive demand for this element in the industry to 200 times the current level (Exhibit 7).

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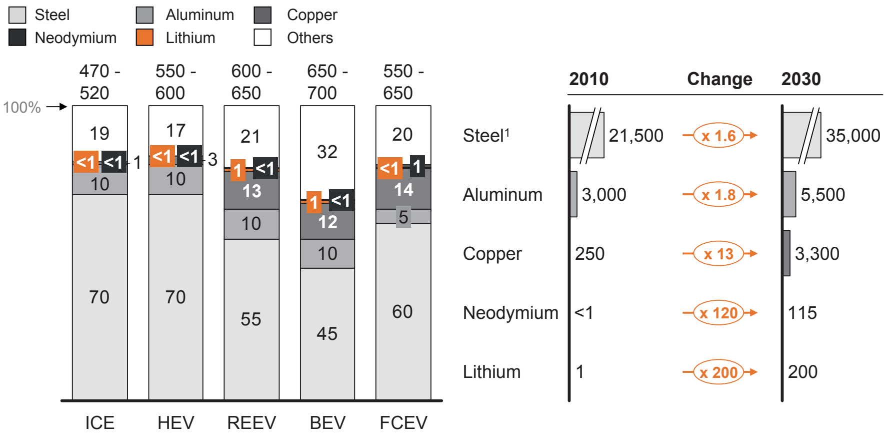
[2] Including car body production, there is a change of 1.7 for steel, growing from approximately 23 million tons today to 40 million tons in 2030 and the same change of 1.7 for aluminum, growing from almost 5 million tons to 8 million tons.

While demand for steel increases only slightly, demand for copper, neodymium, and lithium will grow up to 200 times of today

ROUGH ESTIMATE BELOW 40

Raw materials demand by powertrain type
Percent of total demand (kg/vehicle)

Raw materials demand of the powertrain industry
Thousand tons



Note: Figures are rounded
1 Powertrain only with 1.6 times demand increase in steel (instead of 1.7 times for total vehicle)
SOURCE: McKinsey

Exhibit 7

Achieving excellence in raw materials management and developing new competences, such as materials trading, will be a vital step in securing access to these raw materials. Some automotive players are already forming joint ventures or investing in lithium mines.

Mass production of carbon fibers will allow the material to become more important in vehicle production. Battery vehicles in particular will benefit from the use of light components for weight reduction and experience greater range and improved driving dynamics. Some automotive manufacturers have already begun positioning themselves and will start mass production as early as 2013. The automotive industry's demand for carbon fiber could increase by more than 20 percent per year, potentially surpassing the aviation industry's demand for this raw material, transforming an industry currently dominated by aviation into an automotive industry.

Implications of powertrain value chain transformation

In order to leverage their strengths in the portfolio game, manufacturers and regions must prepare for the transformation now and position themselves in the market. The trump card in this game will be in the hands of those who skillfully capture growth opportunities (e.g., xEV components and lightweight), manage ICE market decreases, build competences (e.g., chemistry and electronics), ensure access to raw materials, form strategic partnerships, and make investments in line with a stringent portfolio strategy.

Current players and new entrants in the powertrain market need to redesign their strategies to profit from the value chain transformation along three steps: understand, adapt, and manage.

The first step in strategy definition is a detailed understanding of the individual starting position. Every company needs to understand how the value chain shift affects its current business on a component level. Carmakers, for example, need to understand how electrification and hybridization affect complexity cost.

The second step for companies is to identify how to profit from the opportunities in the shifting market environments. They have to adapt their portfolio to capture (regional) growth opportunities with current products (e.g., expand footprint in emerging markets), transfer their competences to new products (e.g., battery system management, electric motor), and potentially exit (e.g., ICE-driven) business areas to free up capital and allow investments in new, more value-generating terrains. The powertrain portfolio game will be on for several decades, but companies must determine their actions now – waiting is no option. Taking little steps early on with pilot projects, for example, will be key to benefiting from the change as long as xEV volumes are very low.

One of these early actions is the definition of a clear make/buy/cooperate strategy for each powertrain component. Portfolio management on the component level is integral to setting R&D priorities and defining investment/divestment/cooperation options. Component market development and differentiation potential have to be aligned with the competences and capabilities of each company.

Specific component strategies can be derived from the assessment of companies' capabilities

SUPPLIER PERSPECTIVE

EXEMPLARY STRATEGIES

Today's competences/assets

○ Low ● High

Brakes and recuperation –
"reach scale effects"

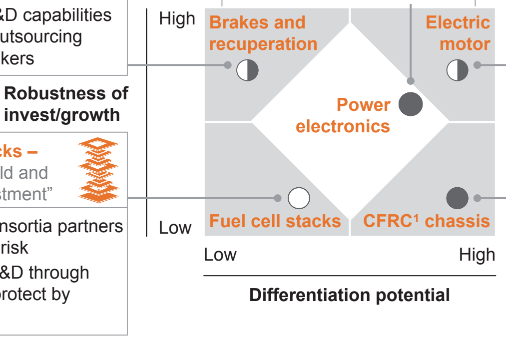
- Try to reach high volumes to benefit from scale effects
- Build up R&D capabilities to absorb outsourcing from carmakers

Power electronics –
"push for excellence"

- Try to become preferred partner for major carmakers
- Invest in R&D and production process optimization

Electric motor –
carmakers' home turf: "try to support"

- Develop superior sub-components to become first choice of carmakers
- Push selected sub-components and build up R&D and production capabilities



Fuel cell stacks –
"gain a foothold and manage investment"

- Look for consortia partners to diversify risk
- Amortize R&D through scale and protect by patents

CFRC[1]/lightweight chassis –
"deep partnership"

- Build joint venture with carmakers
- Invest in R&D and production in strategic partnership with carmakers

[1] Carbon fiber reinforced composites

SOURCE: McKinsey

Exhibit 8

Market development and total future market size of components need to be checked for robustness across scenarios. The next important issue in deriving a component strategy is the differentiation potential of each component. What are the opportunities and threats for the future market participants? The market perspective for all components has to be matched with market participants' current position and their future plans. Each player should assess its own competences and capacities and decide where to stay active or enter new business areas (e.g., battery, carbon fiber reinforced composites – CFRCs), where to build competence and capacity, and where to reduce involvement (Exhibit 8).

Beyond component portfolio strategy, xEV players have to ensure that the EV components meet the automotive industry's tough requirements regarding quality and logistics. They need to develop market entry strategies and new business models to leverage the unique electrification opportunities and thoughtfully consider preparing options for an exit strategy for ICE-focused components.

The third step of strategy definition is to manage uncertainty. Companies have to establish "scenario thinking" with defined trigger points (e.g., regulation changes, incentive changes, changes in customer preferences) to track market development. To cope with a "moving" market, companies have to develop a flexible transformation path to adjust their trajectory to market needs. Strong raw materials management and a sustainable build-up of "me-chem-tronics" competence are key success factors. Finally, each company needs to define a transformation path to meet new regional, competence, and capacity requirements.

Governments will play an important role in the powertrain evolution, as new eco-friendly technologies need funding, regulation, and incentives to take off and as massive shifts in the value chain will occur. Governments will have to cautiously assess the implications of their actions on costs and investments. It can massively harm the profitability and financial stability of the industry if regulations are too tight. If regulations are too loose, things won't move.

To enable the evolution of a strong local powertrain industry, cooperation between industry and the public sector is needed to define the xEV roadmap based on a sound business case. This roadmap has to incorporate clear guidelines regarding "preferred" powertrain technology, access to raw materials, qualification of employment to prepare for the growing need for "me-chem-tronics" (first in R&D and in the long run in production), infrastructure and energy supply implications, regulations, and incentives. Concrete action plans should be jointly developed (e.g., large electro-mobility showcases to be built in specific regions). In addition to optimizing their own situations, governments need to secure global alignment and harmonization regarding the electrification of the powertrain to control complexity for all players in the powertrain market.

Joint efforts of industry and government will prove decisive in the race to secure profit in the powertrain portfolio game. Together, they can master the transformation of the powertrain value chain shifts.

Key contacts

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McKinsey&Company

Europe

Dr. Andreas E. Zielke is a Director in McKinsey’s Berlin office.
andreas_zielke@mckinsey.com

Dr.-Ing. Christian Malorny is a Director in McKinsey’s Berlin office.
christian_malorny@mckinsey.com

Andreas Tschiesner is a Director in McKinsey’s Munich office.
andreas_tschiesner@mckinsey.com

Dr. Wolfgang Pointner is a Principal in McKinsey’s Stuttgart office.
wolfgang_pointner@mckinsey.com

Dr. Nicolai Müller is a Principal in McKinsey’s Cologne office.
nicolai_mueller@mckinsey.com

Dr.-Ing. Lutz Frick is an Engagement Manager in McKinsey’s Munich office.
lutz_frick@mckinsey.com

North America

Hans-Werner Kaas is a Director in McKinsey’s Detroit office.
hans-werner_kaas@mckinsey.com

Russell Hensley is an Expert Principal in McKinsey’s Detroit office.
russell_hensley@mckinsey.com

Asia

Dr.-Ing. Philipp Radtke is a Director in McKinsey’s Tokyo office.
philipp_radtke@mckinsey.com

Sha Sha is a Principal in McKinsey’s Hong Kong office.
sha_sha@mckinsey.com

Sergei Kirov is an Associate Principal in McKinsey’s Tokyo office.
sergei_kirov@mckinsey.com

Prof. Dr.-Ing. Achim Kampker, MBA, Chair of Production Management,
RWTH Aachen University
a.kampker@wzl.rwth-aachen.de

Dr.-Ing. Bastian Franzkoch, Chief Engineer, Department of Production Management,
RWTH Aachen University
b.franzkoch@wzl.rwth-aachen.de

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