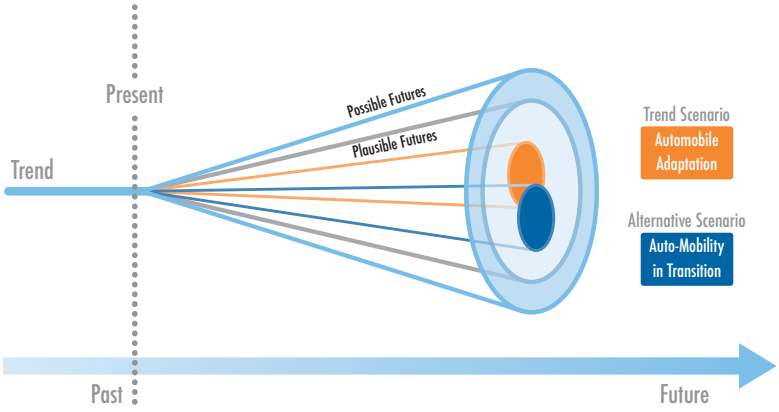
Shell Passenger Car Scenarios up to 2030

Facts, Trends and Options for Sustainable Auto-Mobility

– Abstract –

SUMMARY AND CONCLUSIONS

① Futures Cone and Scenarios



Source: Voros; own graph

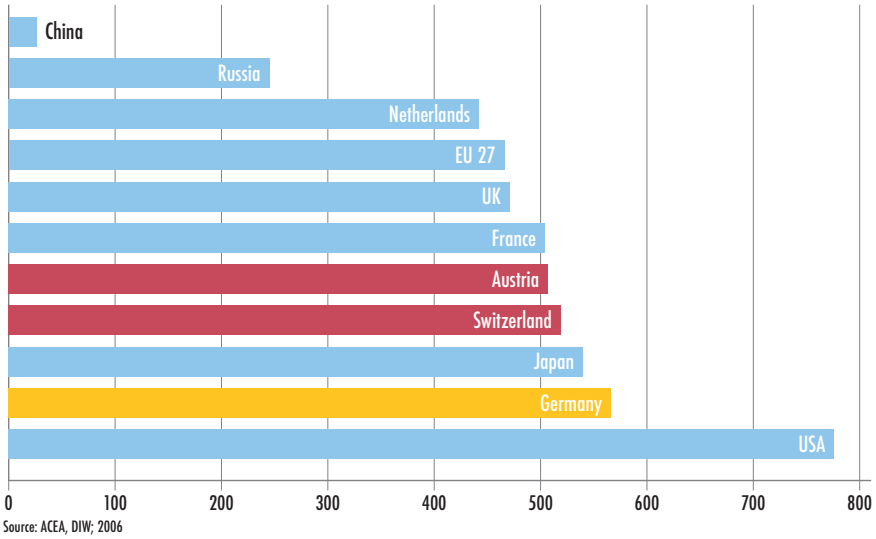
Shell has for many years been focusing on the future of mobility. Shell has been observing the development of motorised individual transport in Germany since 1958. The last Shell passenger car scenarios were published in April 2004. The new version, that is the 25th edition of the Shell Passenger Car Scenarios, is characterised on the one hand by continued demographic change, and on the other hand by auto-mobility in transition, with ever higher demands for sustainability. Far reaching global change is also creating new challenges for the future development of auto-mobility in Germany.

At times of unusually rapid change, traditional forecasts are generally no longer useful; nothing is more valuable than additional information on future developments. Scenarios are not forecasts. But they can help to explore alternative paths of development. Shell is one of the pioneers of the scenario technique. Since 1979 Shell has also been publishing its passenger car studies on the German automotive market in the form of "scenarios" The purpose of Shell scenarios is to examine long-term trends and developments in the relevant business environment; and the aim is to trigger discussions by politicians and society and to move these discussions forward.

The present passenger car study is intended to show possible consequences of demographic change for future auto-mobility in Germany; and it is to explore the sustainability perspectives of passenger car trends on the basis of alternative future designs – or alternative "futures", to put it briefly (see Fig. 1). Shell passenger car scenarios are to give orientation for action, by answering the most pressing questions of our times – How are the key automobile trends developing? How sustainable can and should auto-mobility of the future be? And what are the possible conclusions for the key actors in the auto-mobility sector – for automobile and fuel producers, for transport, energy and climate policy, and above all for motorists?

The present passenger car study is entitled "Facts, Trends and Options for Sustainable Auto-Mobility". In terms of content, the passenger car study is based on two key questions; these are derived from long-term trends in passenger car ownership and hard facts on the sustainability of auto-mobility. The major initial findings, core results, consequences and action options from the Shell passenger car scenarios 2009 are as follows:

② Cars per 1,000 Inhabitants in Selected Countries



Source: ACEA, DIW; 2006

CAR OWNERSHIP, AUTO-MOBILITY AND TRANSPORT

Germany is a highly developed auto-nation. The level of car ownership is very high; the automobile is by far the number one means of mobility in passenger transport (see Fig. 2). Nevertheless, car ownership and hence the size of the passenger car fleet continue to grow in Germany. And passenger car mileage has continued to increase until recently, and stayed at a high level despite increasing energy prices. This has happened

despite stagnation, or rather demographic decline, in the population figures in Germany for many years. That gives rise to the **first key question** of the present passenger car study:

How can car ownership and mobility continue to increase in a stable economy, society and population? And for the future, how can auto-mobility continue to increase in Germany up to the year 2030, in terms of car ownership and mileage?

The first key question on passenger car ownership and mobility was examined on the basis of a guideline scenario based on a uniform socio-economic data framework. The main transport policy **findings** were as follows:

The key parameters of passenger car mobility are closely linked with population development – the population is expected to decrease by just under 3.7 million to a total of 78.5 million by 2030. At the same time, demographic change will continue in German society. The proportion of over 65-year-olds in the population will increase from 20% today to 28%, and the percentage of under-20s will drop from 19% to 16% in 2030.

"Automobile emancipation" will continue. Car ownership by women will increase from today's level of about 340 to more than 430 cars per 1,000 women in 2030, reaching about 60% of men's motorisation. Car ownership among men will increase slightly from just under 700 per 1,000 today to about 715 in 2030 (see Fig. 3).

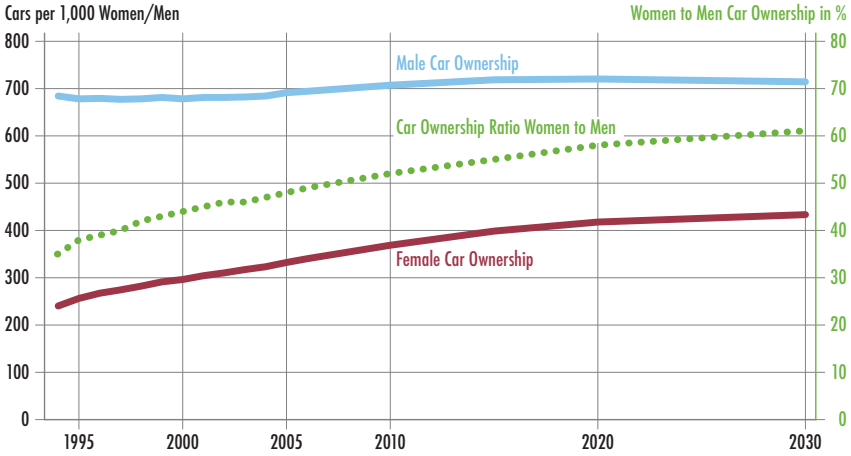
Most age groups take their car ownership level with them as they progress from lower to higher age groups. Particularly women in the over-50 group increase their ownership, and older men slightly increase their ownership. This gives increasing car ownership and car mobility among older people. By contrast, car ownership among under-30s and 35-year-olds continues to decline slightly for both sexes.

The total passenger car fleet will increase from today's level of 47 million vehicles to 49.5 million in 2030 (see Fig. 4); that gives an average "statistical" car ownership level for all owner groups of about 630 cars per 1,000 people, compared with today's level of a little over 570. The level of new registrations needed to achieve this level of car ownership is between about 3 and nearly 3.5 million new car registrations per annum.

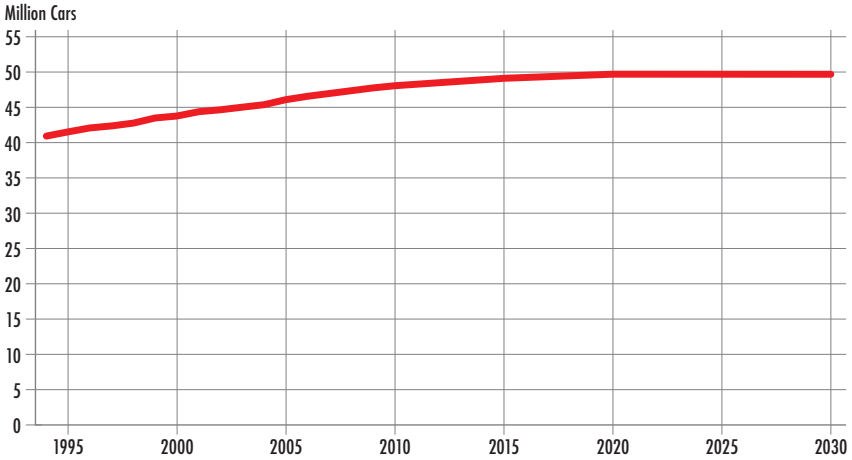
The rise in car ownership means that average mileage will decline from about 12,500 kilometres today to about 11,900 kilometres per car in 2030. But total mileage for all passenger cars will increase from today's 588 billion vehicle miles to 595 billion by 2020, and then drop slightly to 590 billion kilometres by 2030. The share of over 50s in total passenger car mileage will rise to 35% by 2030 – in 1995 they accounted for only 23% (see Fig. 5, below).

Despite demographic change, demand for auto-mobility will continue to be high up to the end of the period under

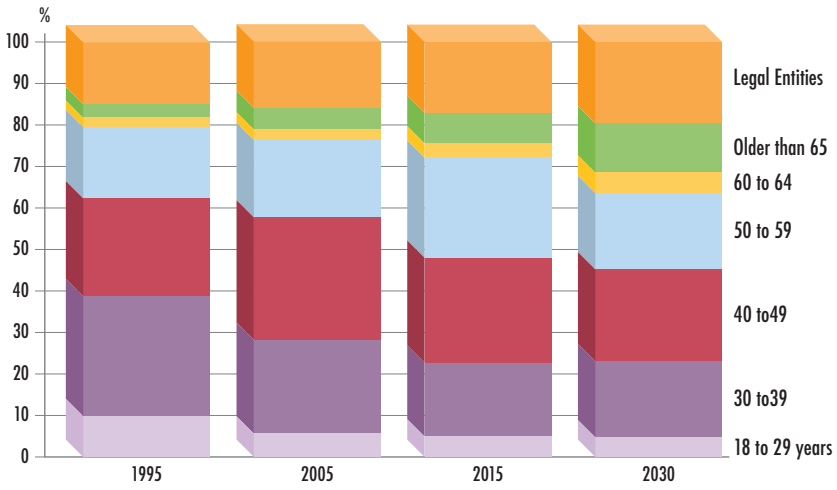
③ Car Ownership by Women and Men to 2030



④ Total Passenger Car Fleet in Germany to 2030



⑤ Mileage Related to Age to 2030



review in 2030. What **conclusions** can be drawn from the future development of car ownership and mileage?

The German passenger car market will continue to be the highest-volume car market in the EU, even though there will hardly be any further growth in the number of new registrations per annum. That does not exclude further growth in the value of car sales, as in the past. At any rate the incomes and assets will be available for people to continue fulfilling their automobile wishes in the future.

With increasing significance of women and older motorists, with smaller households, fewer children and fewer younger people, there will also be a change in automobile needs – in terms of use and operating of cars, in safety and comfort, and also in everyday road traffic.

Increased passenger car ownership and (slight) increase in passenger car mileage will increase the demands on the infrastructure, and also demands for sustainability of auto-mobility; that applies all the more in view of the substantial growth in goods transport to be expected on Germany's roads in coming years.

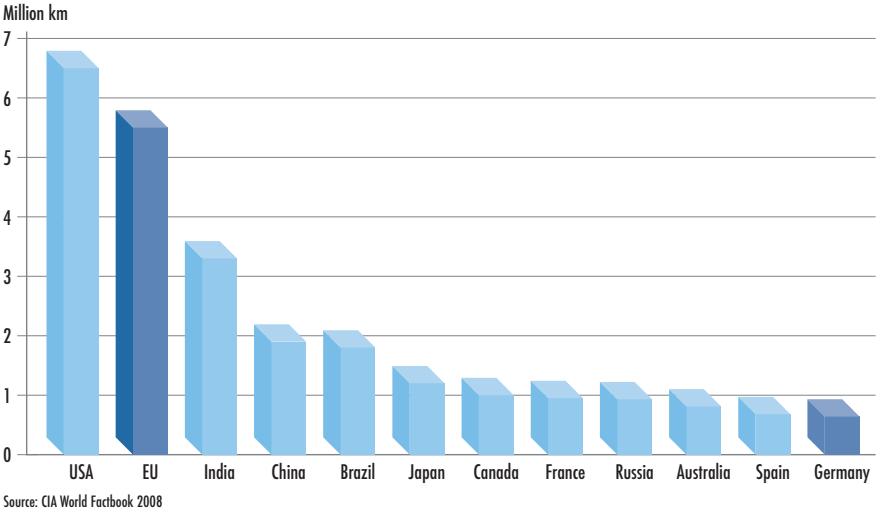
Germany's road network, comprising some 645,000 km, is one of the most extensive worldwide (see Fig. 6). The total main road network includes 12,600 km of motorways and more than 40,000 km of national roads, making up one of the most closely meshed networks of strategic roads in Europe. About half the annual mileage in Germany is done on the national road network, although it accounts for only about a quarter of all main roads. The motorways take an even more prominent position, comprising about 5.5% of the main road network, but carrying nearly a third of passenger car mileage.

Nevertheless, even a high-efficiency road network cannot meet all individual and social needs for mobility and exchange at the same time. Further increases in traffic density and volume on the trunk roads would reduce the quality of travel unless transport policy measures are taken to counteract that. They would also cause an increase in fuel consumption and CO_2 emissions.

The arrangement of transport systems is a matter for government transport policy. What action **options** are available to improve the quality of transport?

The transport intensity of motorised individual transport (passenger car mileage in relation to GDP) will continue to go down; but the demand for auto-mobility will continue to be high, with increasing car ownership. That is shown by the persistent and largely inelastic demand for auto-mobility. In addition, today's housing trends and regional development trends will continue. Intermodality and a shift from passenger car to other forms of land transport may help to relieve the burden on the roads in well-structured conurbations, but that in itself will not be enough to meet the future demand for personal mobility in Germany.

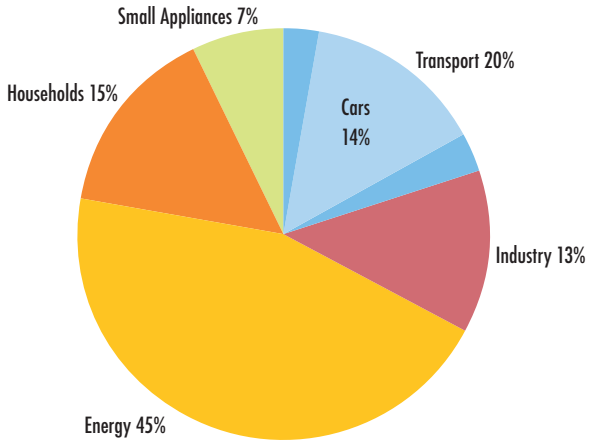
⑥ Road Network in Selected Countries



Source: CIA World Factbook 2008

In view of the shortage of budgetary resources, more efficient use and design of the existing road network will take top priority in transport policy in Germany, especially as an ever larger proportion of road construction funding will have to go into maintenance of the existing road network. The most important optimisation measures will include increased use of traffic management systems (transport telematics), segregation of faster passenger car transport and slower heavy goods traffic, and elimination of bottlenecks by means of building programmes.

⑦ CO_2 Emissions in Germany



Source: UBA; own graph; energy related CO_2 emissions (2006)

A well developed, efficient road network not only contributes to mobility, but is simultaneously an important factor in location of business and in competition. Germany is a leading logistics location and transport hub within Europe. The increase in car ownership, and in particular the strong growth in goods transport by road, will therefore require further improvement in road traffic infrastructure, particularly on the main long-distance routes. To meet the sustainability requirements, transport policy will have to balance increasing mobility requirements with environmental and social criteria. And quality and future car usage will be an equally important focus of transport sustainability strategies.

AUTOMOBILES AND SUSTAINABLE MOBILITY

Today car usage accounts for about 11 % of primary energy consumption in Germany, and about 14 % of energy-induced CO_2 emissions (see Fig. 7). The aim of transport, energy and climate policy in the EU and Germany is to make auto-mobility more sustainable – by increasing the energy efficiency of cars, reducing specific fuel consumption and using more alternative fuels, and thus reducing greenhouse gas emissions.

Germany is one of the few industrial countries to reduce its greenhouse gas emissions substantially since 1990. Passenger-car induced CO_2 emissions have been declining since the end of the 1990s. But despite this recent favourable development, the automotive sector cannot (yet) compete with the overall performance of other sectors since 1990, the Kyoto baseline year. That makes the second key question all the more important, with a view to the goals of auto-mobility:

? How sustainable will automobile development in Germany be in the coming years, in terms of energy consumption and CO_2 emissions? How and in what timeframe can the automobile make a contribution to sustainable mobility, and how big is that contribution?

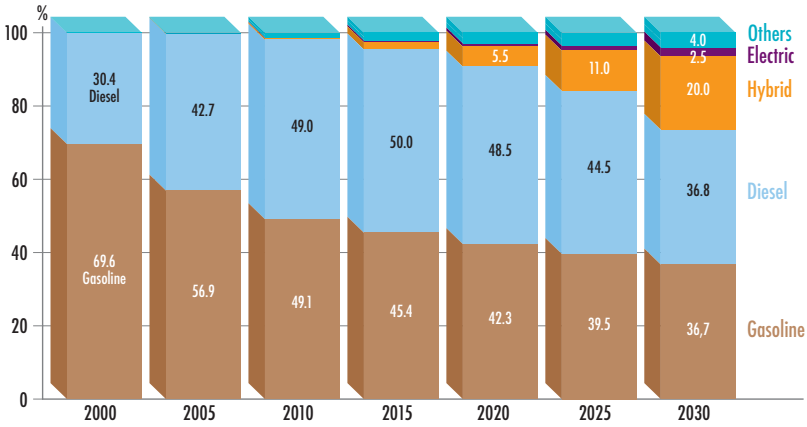
The passenger car module in the present Shell passenger car scenarios is based on the uniform guideline scenario for car ownership and aggregate mileage. It develops two alternative futures for auto-mobility in Germany up to 2030: a trend scenario called **"Automobile Adaptation"**, which basically assumes a continuation of the trends of current developments and behaviour patterns, and an alternative or sustainability scenario called **"Auto-Mobility in Transition"**, where more stringent environmental and sustainability goals are systematically pursued in the transport sector, with a whole range of environmental policy instruments and regulations.

The first scenario is strongly based on the passenger car trends of the recent past; it is a conventional trend forecast, answering the question of what changes will result in terms of energy consumption and greenhouse gas emissions if the current passenger car trends are continued.

The second sustainability scenario assumes significant changes in auto-mobility in the period up to 2030. It gives an idea of what additional sustainability contribution the automobile could make if there were accelerated change in the specified period up to 2030, and also what changes would be necessary in order to do that. The core findings of the two scenarios are as follows:

The Trend scenario **"Automobile Adaptation"** is characterised by only very gradual technological change (see Fig. 8, below). Today's propulsion and fuel technologies continue to be dominant. But there are still further shifts in the conventional fuel mix. The dieselisation of the German passenger car fleet continues, even though to a lesser extent. The diesel percentage of the passenger car fleet rises, in

⑧ New Car Sales in Trend Scenario Split by Engine Technology



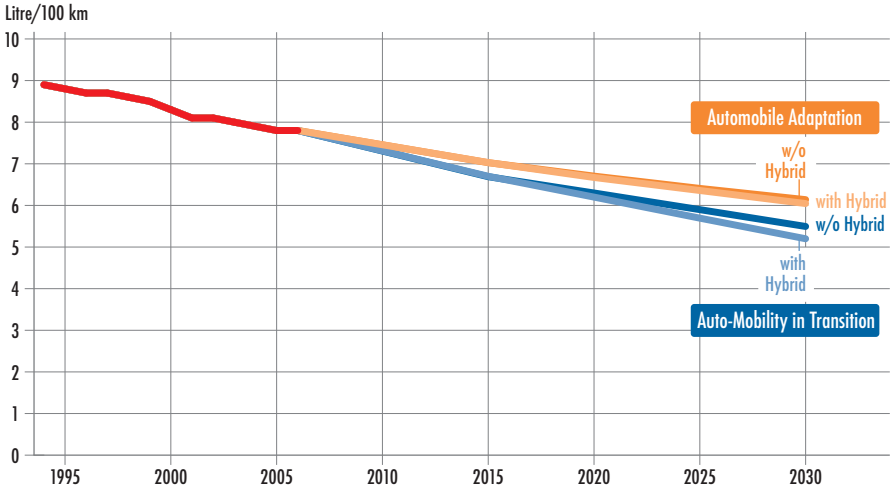
a situation of continuing high levels of new car registration, from today's level of 24% to nearly 40% in 2030. Biofuel usage increases only slowly up to 2030 – from today's level (2007) of less than 4% to 10% in 2030. Among the alternative propulsion forms, only hybrid vehicles can gain substantial shares of the market, accounting for about 20% by 2030. The other alternative fuels and propulsion systems can expand their specific niches, but are not able to obtain substantial market shares. Thus in 2030 three quarters of all passenger cars will basically be equipped with conventional combustion engines and if hybrids are included the figure is more than 90%.

The specific fuel consumption of the passenger car fleet will drop from 7.8 to 6.1 litres per 100 km (see Fig. 9). Fuel consumption overall (excluding propulsion electricity and hydrogen) will drop in the Trend scenario from 35.1 million tonnes in 2005 by about one fifth to 28.1 million tonnes in 2030 (see Fig. 10, below). Conventional propulsion systems will undergo very different developments – whereas gasoline powered vehicles will consume about 45% less in 2030 versus baseline 2005, diesels will continue to increase their consumption up to 2020 and their consumption will be about 30% higher in 2030 versus 2005. Taking account of biofuel use, passenger car consumption of fossil fuels will decrease to 25.3 million tonnes in 2030. The CO_2 emissions of all passenger cars will be down **14%** by 2020 and down **23%** by 2030 versus baseline 2005, taking account of all alternative fuels and propulsion systems (see Fig. 12, below).

The Alternative scenario **"Auto-Mobility in Transition"** is characterised by accelerated technological change, backed by purposeful transport, energy and climate policy (see Fig. 11, below). The result is faster establishment of alternative fuels and propulsion systems via new registrations in the passenger car fleet. Here too, there will be further dieselisation of the passenger car fleet up to about 2020. But the most striking change in the passenger car fleet is rapid hybridisation; by 2030 about half of all new registrations will be hybrid vehicles – more than pure gasoline and diesel engines put together. In parallel to that, technical progress of conventional propulsion systems will continue, and will be apparent in a rapid decrease in specific fuel consumption. There will be larger quantities of sustainable biomass available, and by 2030 biofuels will increase to 15% of conventional liquid fuels. Electric vehicles will account for 10% of new registrations by 2030, and will then account for about 2 million vehicles in the passenger car fleet. Hydrogen technology will gradually be more widely used, with the first large-scale commercial applications. Although passenger cars with exclusively conventional propulsion will account for only just over one third of all new registrations by 2030, about 85% of all passenger cars will still rely on the combustion principle, taking gasoline, diesel and hybrid drives together.

Specific fuel consumption of the passenger car fleet will decline from 7.8 to 5.2 litres per 100 km (see Fig. 9). Fuel

⑨ Average Specific Fuel Consumption of Car Fleet (Gasoline and Diesel, with and without Hybrid Technology)



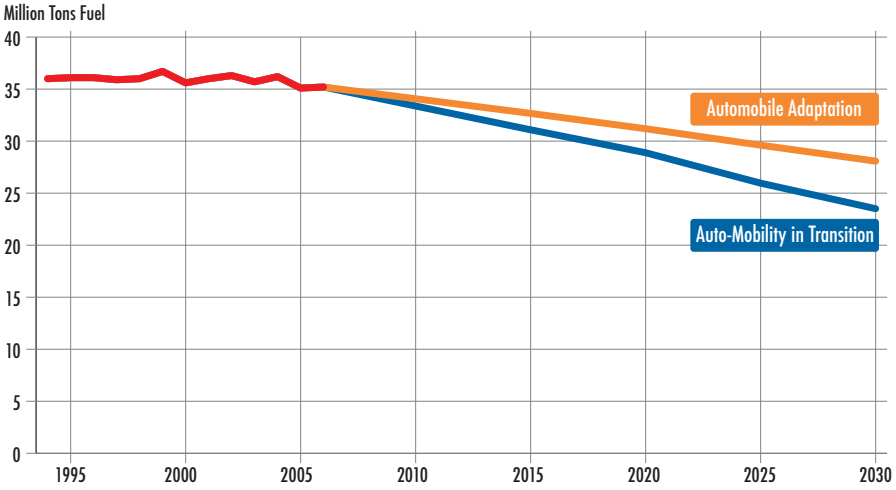
consumption overall (excluding propulsion electricity and hydrogen) will decrease in the alternative scenario from 35.1 million tonnes in 2005 by about one third to 23.5 million tonnes in 2030 (see Fig. 10). Here again, consumption development of main propulsion systems will vary very widely: gasoline will be down about 50% in 2030 versus 2005; the fuel consumption of diesel vehicles will rise in the period up to 2015 and then drop to the level of 2005 again. Taking account of the biofuel component, passenger car consumption of fossil fuels will only be about 20 million tonnes by 2030. The CO_2 emissions of all passenger cars will be down **21%** by 2020, and down **38%** by 2030 versus baseline 2005, taking account of alternative fuels and propulsion systems (see Fig. 12).

The difference between the Trend and Alternative scenarios is thus quite substantial. What **conclusions** can be drawn from the two passenger car scenarios?

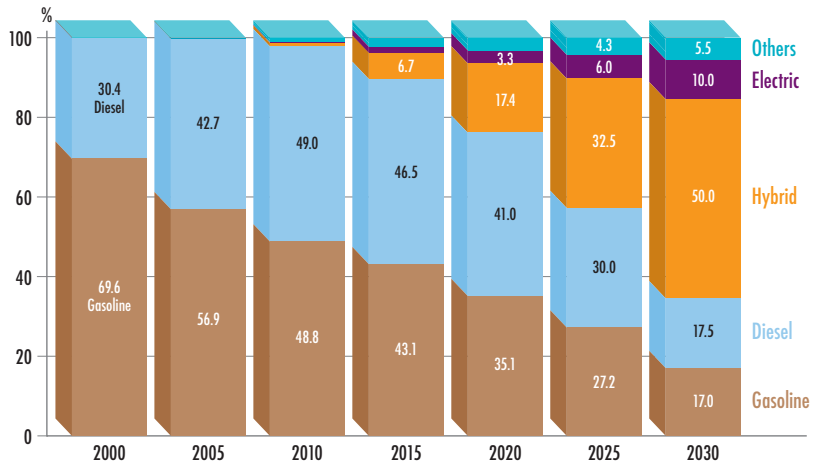
As there will be practically no increase in aggregate mileage, due to demographic change, reduction in specific fuel consumption with conventional propulsion will be improved very evidently and significantly in future. Thus the expected emission reduction in the Trend scenario makes it possible to achieve the climate policy target of the EU for non-emission trading sectors in Germany, i.e. 14% reduction in greenhouse gas emissions by 2020 versus 2005; but the Trend conditions permit only gradual diversification of propulsion/fuel combinations – primarily via alternative fuels.

The sustainability scenario "Auto-Mobility in Transition" is characterised by a further significant

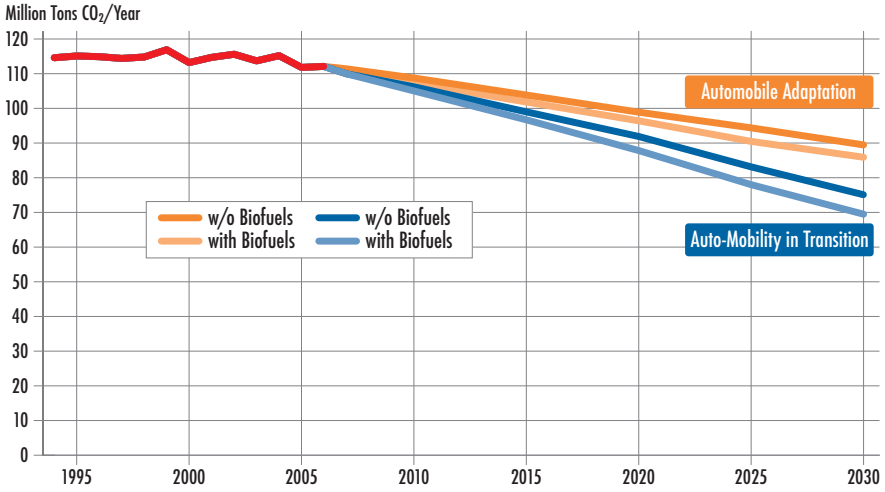
10 Overall Car Fuel Consumption (not including Electric and Hydrogen Vehicles)



11 New Car Sales in Alternative Scenario Split by Engine Technology



12 CO_2 Emissions of Passenger Cars (with and w/o Biofuel Components)



reduction in CO_2 emissions from passenger cars, by almost two fifths in 2030 versus 2005. However, targets of minus 40% CO_2 emissions in 2020 versus 1990 are clearly not achievable for the passenger car sector. On the other hand, there is substantially more diversification in terms of new fuels and propulsion systems. Even so, in both scenarios the fuel supply of the passenger car fleet in 2030 is still more than 80% based on conventional fuels in primary conventional propulsion systems. This shows that improvements in fuel economy of conventional propulsion systems will be decisive for the accelerated development path, for the Sustainability Scenario, too.

Finally, it could be asked which of the two futures would be "better". In its current energy scenarios, Shell has for the first time expressed a preference for one of the scenarios – that is for 'Blueprints'. Based on the climate and energy policy assessment criteria energy consumption and CO_2 emissions, the Alternative scenario is clearly preferable. An even more important point is that the Trend scenario with its propulsion and fuel mix does not (yet) give any response to the question "What will auto-mobility look like beyond 2030?".

The alternative scenario not only shows prospects for (more) sustainable auto-mobility; it also poses a much greater challenge for all auto-mobility players. Hence the question: How can we prepare for the Sustainability Scenario? And what **action options** are available to us for that purpose?

The first requirement for acceleration of environmental modernisation of the passenger car fleet is faster fleet turnover, whether with conventional or alternative propulsion systems; that in turn can only be achieved by a higher rate of de-registration and new registration. With a statistical passenger car lifespan of 13 or 15 years today, it is not possible to revolutionise auto-mobility within a few years. With today's registration figures for alternative propulsion systems, it may be assumed that structure and composition of today's fleet will have a major influence on auto-mobility in Germany until at least 2020. In the window for action up to 2020 as envisaged by climate policy, substantial contributions can be made practically only by system-conforming solutions, i.e. by conventional propulsion systems and liquid fuels and by more fuel-efficient driving behaviour.

Secondly, automobiles are the longest-life consumer durable following real estate. Consumers need clear framework conditions for their decisions. As the greenhouse gas problem is a kind of market failure, it is up to governments to set the framework conditions – for example by economic incentives or by standards for CO_2 emissions and efficiency. Consumers expect a mobility offering that is competitive in price and performance – and that applies equally to alternative technologies.

Thirdly, alternative propulsion and fuel technologies are still very expensive. All the alternatives require intensive research and development work. Major investments are still needed to establish sustainable technologies in the market. Automobile manufacturers and fuel suppliers also need stable framework conditions in order to do that. But ultimately there is a need for global technology concepts for sustainable auto-mobility, because large production and sales volumes are essential for the enormous up-front investment that are required.

All in all, there is a wide range of options available to make auto-mobility more sustainable. It is not possible to say at the present time which combination of propulsion system and fuel will become established. The only thing that is certain is that the combustion engine and, with it, conventional fuels, will continue to play a major role for a long time to come. In the meantime, it is necessary to follow up on a wide range of alternative propulsion systems and fuels simultaneously – biofuels, synthetic fuels, electric systems and hydrogen technology. Ultimately all the options will be needed for rapid growth in global demand for individual mobility, fuels and energy.

The transformation of today's energy and mobility systems is a demanding and complex task. That makes it all the more important to start acting early, to involve the millions of motorists and to achieve close cooperation between all automotive players – the automobile manufactures and fuel developers, government and the business community, and also between governments. That is the only way to solve the global greenhouse gas problem – by global action.

The full version of the Shell Passenger Car Scenarios is available (in German) at the website www.shell.de/pkwszenarien