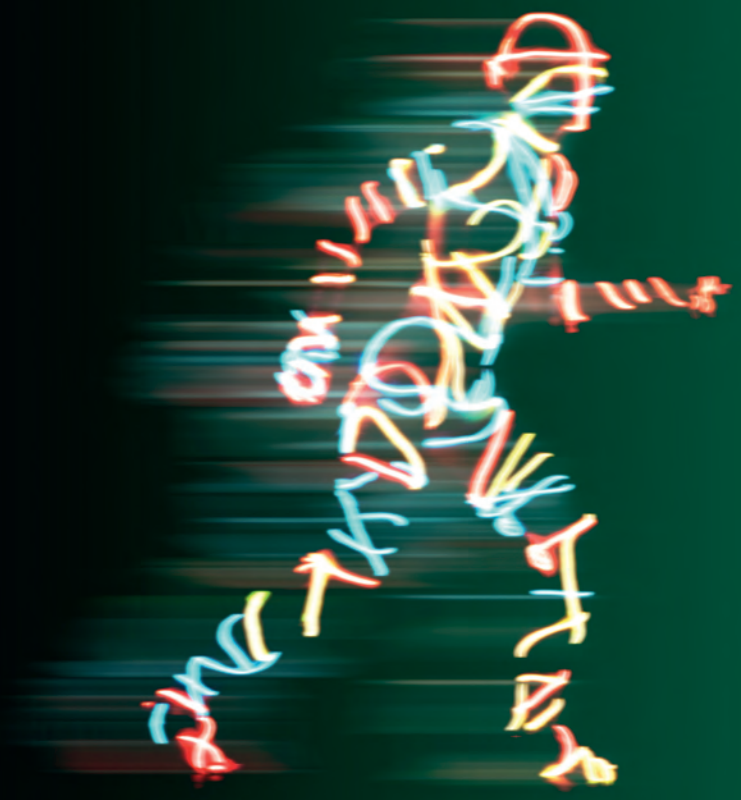
COAL 2011

Energy for a new Way



German Coal Association

Coal Annual Report

2011

German Coal Association

Foreword

The 2011 GVSt Annual Report is entitled 'Energy for a new way' and this is also the message of this year's annual coal convention. This 'energy switchover' means a new set of pathways not just for the energy industry but for the economy as a whole. Power generation by conventional means is set to remain a bridge to the future for decades to come before eventually renewable sources will cover all our energy needs. Nuclear energy will only be involved in this bridging role in the short term – and this makes coal's contribution even more important. Following the recommendations of the 'Ethics Committee for Security of Energy Supply' we now have to develop as broad a consensus as possible on the direction that Germany's future energy supplies have to take. Against this background the question of energy supply reliability is as relevant as ever. Raw materials prices are increasing worldwide and so are the concerns about their long-term availability.

The Coal Industry Financing Act of 20 December 2007 required the Federal Government to present the German Bundestag with a report, on or before 30 June 2012, examining whether or not, and in consideration of factors such as cost effectiveness, energy security and other energy related objectives, the coal industry is to continue to receive financial support. This 'review clause' was subsequently deleted by a change in the law with effect from 15 July 2011.

RAG is now to manage the orderly, socially-acceptable closure of the German coal industry as a reliable partner of policy makers.

The German coal industry is also required to develop its former mining sites in keeping with the needs and wishes of those living in the regions concerned. And new opportunities are opening up in this area: RAG Montan Immobilien is targeting these brownfield sites for the exploitation of renewable energy sources and existing mining know-how can also be used, for example, for developing underground pumped-storage power stations.

In this way the German coal industry is making its contribution to sustainable development and is underlining its potential as a basis for future energy supply.

Herne, October 2011

Bernd Tönjes

Chairman of the Management Board of the German Coal Association

Contents

The Japanese reactor accident at Fukushima triggered a strategic change in German energy policy. The phasing-out of nuclear power has re-ignited the debate on the role that coal should play as a bridging fuel on the road to the renewable-energy era. Coal has now made a dramatic come-back after consumption fell to a record low with the 2009 crisis and last year went on to record the highest growth rate of any fuel (15.4 %). However, the economy has still not been able to match the consumption levels of previous years. In 2010 about 23 % of the total coal volume of 57.1 million tce came from the domestic mining industry. German geological conditions continue to make coal production costs higher than world market prices.

The Federal Government's new Energy Plan stands for an environmentally friendly, reliable and affordable energy supply, with the central objective being to map out the future course into the 'renewable-energy era' in as realistic a way as possible. In the coming years our current pool of gas and coal fired power stations will have to act as a 'bridging technology' by preventing future power supply shortages and at the same time providing energy supply security. The supply scenario that the Energy Plan and the energy switchover are trying to create will be based increasingly on renewables. Energy consumption levels are also expected to be reduced through energy saving measures and improved energy efficiency. And this will require an 'efficiency revolution'. However, Germany's energy-intensive industries have almost exhausted their technical potential in this area and for this reason the focus now has to turn to other areas that can yield more cost-effective results.

Making greater use of co-generation systems (CHP) and establishing connections between existing district-heating networks offer realistic prospects for improving energy efficiency in a climate-, environment- and resource-friendly manner.
Establishing a renewables based power supply system also calls for huge efforts to be made in extending the capacity of the transmission networks. The existing grid will not just have to be expanded in size but will also have to undergo a capacity upgrade – here the talk is all about 'smart grids' –to integrate renewables into the system. At the same time existing storage capacity will have to be increased and new facilities developed and put into service. The German coal industry is currently investigating the feasibility of underground pumped-storage power stations and work is now under way on a project to construct a pumped-storage plant at a former colliery waste heap. However, the most reliable 'buffer' for the electricity supply grid is to be found in the generating capacities of existing power stations as these can also stabilise the supply frequency. Modern coal fired power stations that can operate flexibly are quite capable of providing the required capacity, even at very short notice. And as far as renewables are concerned, market integration must ultimately allow supply fluctuations to be adapted to electricity demand.

As even the ambitious extension proposals laid down in the Energy Plan accept that up to 65 % of electricity production will still based on non-renewable sources in 2020, and as much as 50 % by 2030, it is clear that this can only be achieved by way of a balanced energy mix in which coal plays a key role alongside renewables, rather than being forced out by gas. In its recommendations for the energy switchover the Ethics Committee for Security of Energy Supply has indeed assigned gas fired power stations a 'supporting role', but has also voted for the commissioning of all coal fired installations that are under construction or for which approval has been granted. Moreover, it calls for a 'high-tech strategy for clean coal', along with CO_2 recycling and the revival of the coal-chemical industry. If all Germany's nuclear power stations were to be shut down overnight and 45 % of the nuclear energy replaced by coal-based electricity we would see the annual demand for steam coal increase by about 22 million tce. When measured against the coal consumption figures for 2010 this

Voerde coal fired power station

would mean Germany having to import something in the region of 53 million tce of steam coal every year – along with coking coal and coke for the steel industry. As a result Germany alone would account for about 8 % of the world trade in steam coal and would be buying nearly 30 % of the solid fuel available on the Atlantic market, the relevant sector of operations for Western Europe. Even if the nuclear phase-out is managed gradually Germany will still be heavily reliant on imports of primary energy. This dependence already stands at over 70 % and is set to intensify in the years and decades ahead. Add to this a growing reliance on imported electricity.

Coal imports have now switched from Poland, the Czech Republic and South Africa towards the USA and Russia, in particular, whose German-bound exports have increased by more than sevenfold. Colombia has tripled its supplies, while imports from Australia have seen little change. In 2010 Russia was the dominant supplier of Germany's imports of all three fossil based fuels. Together with the USA and Colombia Russia supplied about 54 % of German coal imports, while along with Norway and the UK it provided about 59 % of crude oil imports and, with Norway and the Netherlands, about 96 % of gas imports.

Annual coal production worldwide has increased by 85 % over the last 20 years and is expected to total about 6.7 bn t in 2010 (10 % up on the previous year). About 5.8 bn t of this is steam coal and 0.9 bn t coking coal. The three largest coal producing nations, which together account for 73 % of world production, are China (3.4 bn t), the USA (nearly 1 bn t) and India (0.5 bn t). The prices being quoted for coal on the world markets have now recovered from their dramatic slump and in some respects have returned to the all-time highs witnessed in the boom year.

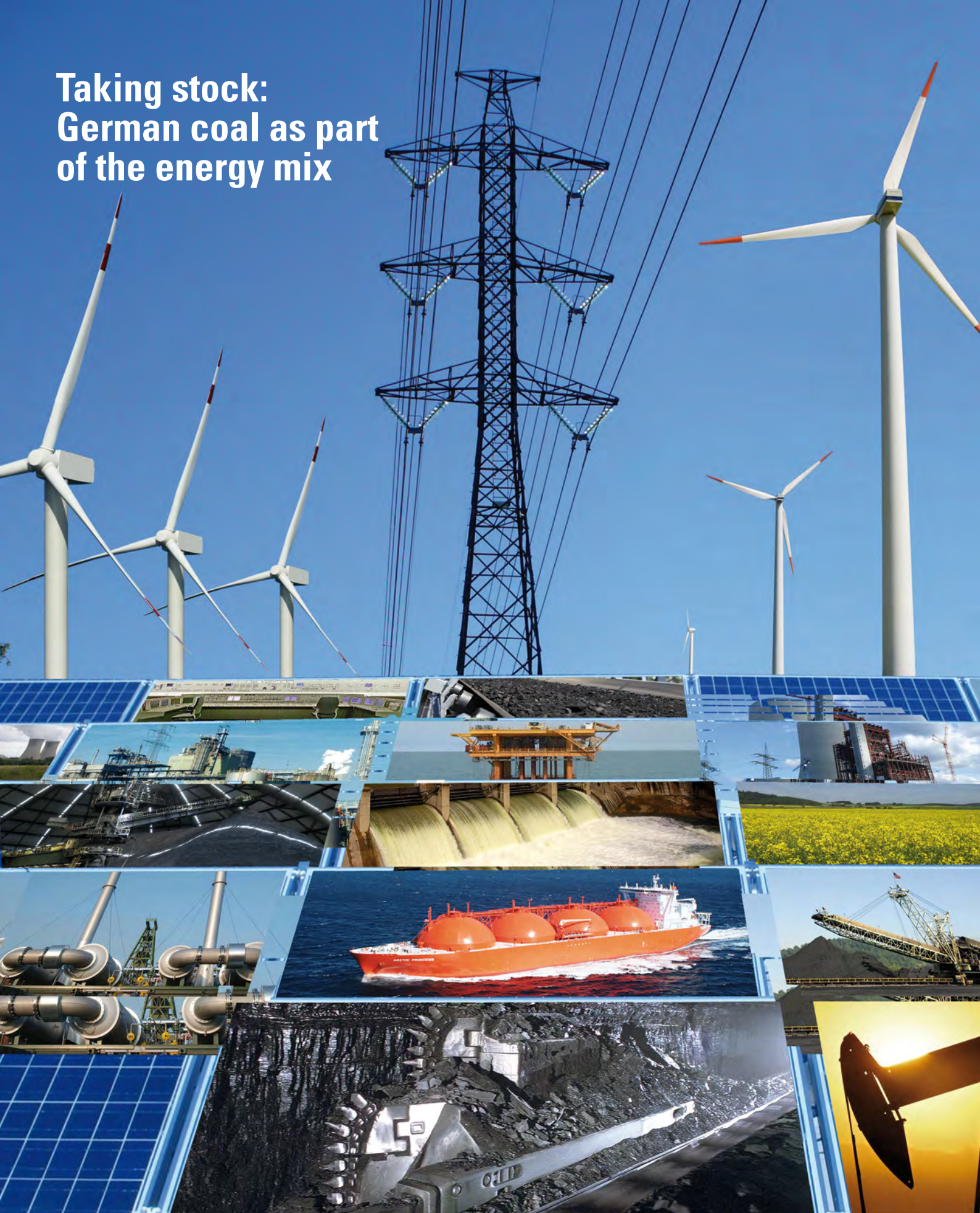
The EU continues to focus on secure energy supplies at competitive prices and the European Commission intends to present an Energy Roadmap before the end of 2011 that will set out different scenarios presenting the long-term pathway to secure, affordable and low-carbon European energy supplies by 2050. This Roadmap should also contain scenarios for low-CO_2 energy systems and the energy policy measures needed to achieve them. There is much evidence to suggest that long-term energy supply issues can no longer be decided exclusively at national level. It is therefore to be welcomed that with regard to future EU energy policy the European Council of Heads of State and Government has confirmed that it intends to complete the single energy market by 2014. This should promote greater competition in an area in which a fully functioning market has been sadly lacking to date. A common energy policy for the EU member states is still a long way off – in spite of the latest provisions of the Lisbon Treaty and the adoption of the Third Internal Energy Market Package. We therefore concur with the European Council in the priority actions that it set in early February 2011: 'In order to further enhance its security of supply, Europe's potential for the sustainable extraction and use of conventional and unconventional (shale gas and oil shale) fossil fuel resources should be assessed.' On the whole, therefore, there is much to suggest that the time is now ripe for a greater Europeanisation of energy policy in a way that will also include indigenous energy sources.

The German coal industry and RAG are now using their know-how to develop and expand new and 'green' strategic actions. This includes the extensive use of renewable energies through projects aimed at wind energy generation on waste heaps, biomass cultivation on unused, former mining sites and heat recovery from mine water, along with the energy storage projects already referred to. Mining sites offer a whole range of opportunities in this area. The feasibility and market potential of a number of these schemes have already been studied and some projects are already under way.

Of course such activities can never compensate for the contribution that German mineworkers have for decades been making to security of primary energy supplies. In 1996, the year before one of the major coal policy decisions, the German coal industry was able to meet 10 % of the needs of the German primary energy market and 21 % of the demand from the electricity generators. Today these figures still come in at 3 % and 6 % respectively.

Our obligations to the people in the coalfield regions and to the environment demand that we adopt a responsible approach to the former coal-mining landscapes. 'Green RAG' has a valuable contribution to make in this area.

Taking stock: German coal as part of the energy mix



General economic situation

In 2010 the German economy made a remarkable recovery from the deep recession that was triggered by the global financial and economic crisis of 2008 and 2009, and this trend seems to be continuing into 2011. After the dramatic economic downturn of 2009, when GDP fell by 4.7 %, the year 2010 saw economic growth rise by 3.6 % in real terms and in their spring forecast the economic research institutes of the Joint Economic Forecast group have predicted a growth rate of 2.8 % for 2011. In their early-year projection the Federal Government indicated that growth would be around 2.6 % and some experts even believe that 'three point something' is quite possible. The crisis-driven economic downturn could then well be over by the end of this year. The common picture to emerge from all these predictions is that the economic situation continues to be on an upward trend and the recovery is continuing – but the economic momentum is gradually easing. This will certainly be the case if there is a slow-down in the expansion of international trade – and hence in the dynamics of the German export sector, which has always been Germany's main driver for growth. The unpredictable nature of external factors was certainly shown all too clearly in 2011 with political unrest in the Arab world, the natural catastrophe in Japan and the reactor accident at Fukushima, and other uncertainties surrounding the global economy: these include the ongoing debt and confidence crisis in the Euro-zone and in the USA, increasing and volatile energy and raw materials costs, problems with raw-materials availability and the speculative bubbles and slowdown in economic growth in a number of major emerging economies like China.

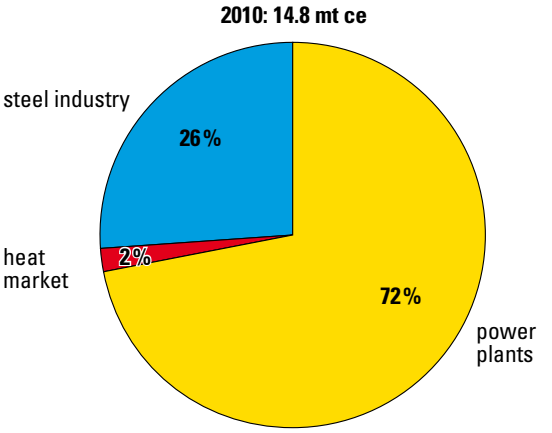
Yet the aforementioned predictions for Germany assume that in 2011 the forces driving the economic upturn are shifting from the foreign trade sector to the domestic front. This will primarily require a sharp increase in inwards investment by companies and a greater impetus for private consumption. The much more positive labour-market perspectives, in purely quantitative terms at least, appear to support the latter scenario. The number of people in gainful employment in Germany has now reached new record levels and in 2011 the average annual figure fell to below three million. Yet the overall picture has to be seen on a more differentiated basis. There are still huge regional imbalances in the labour markets and in the Ruhr area, for example, unemployment levels are still abnormally high.

Noticeably higher rates of inflation than in previous years would also indicate no real growth in earnings, which have been stagnating for years. There is therefore real doubt as to the extent to which consumer spending can actually become a motor for growth. Wage austerity has certainly helped strengthen Germany's industrial base and has contributed to increased international competitiveness, as well as to the export success of German industry. But it has tended to weaken domestic demand. The unions see this as posing a considerable threat to the economy, along with the Government's savings plan, which will further restrict domestic demand, at least in the short term. It is no coincidence that the debates have already started about 'penniless policy making' (IW).

It also remains to be seen just how much domestic investment can remain the main pillar of the economy. In 2010 and in the first six months of 2011 the investment activities of companies in Germany generally developed well, even if this was due to some extent to the catch-up effects of the crisis phase. The BDI and BDA have however been complaining for years about Germany's 'structural underinvestment'. In its position paper of June 2011, entitled 'The future of infrastructure projects: raising acceptance, accelerating project implementation, pushing ahead with planning', the BDI states that 'difficult and protracted planning and approval procedures, along with a lack of acceptance by the public at large, …are

preventing German businesses and foreign investors from making greater investment in Germany'. It is also claimed that the politically prescribed restructuring of the German energy system is being threatened by broad-based public protests against major investment projects of all kinds.

The new German energy policy orientation introduced in 2010 and 2011 will certainly pose huge challenges for the energy infrastructure. At the same time rising energy and electricity costs are affecting the willingness of the energy intensive industries, in particular, to invest in Germany's industrial base. The IW points out that the added value from this sector, together with the mining industry and the 'conventional' energy utilities, has – at least until now – been greater than that of the 'winners' in the energy switchover.

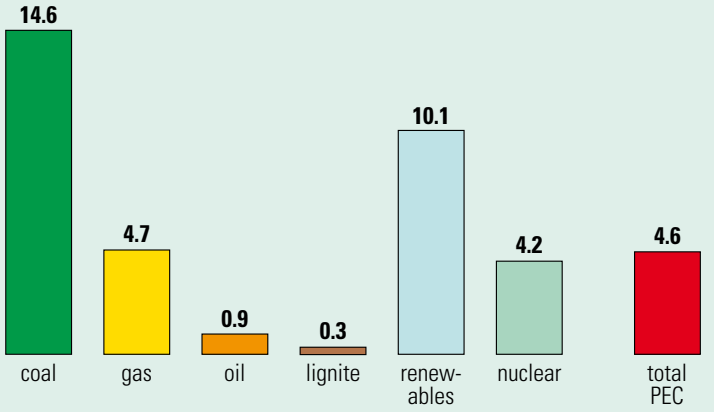


Sales structure for German coal

Sector development

The economic recovery has also benefitted German primary energy consumption, which in 2010 rose to 479 million tce – 4.6 % up on the previous year's figure. This was more than the increase in GDP, though the extreme winter conditions were a factor. In 2010 coal recorded the highest growth rate of any of the fuels (14.6 %), this following the 2009 crisis which saw coal consumption fall to its lowest point for a century. However, consumption figures are still below the level of earlier years. It remains to be seen whether 2011 will bring renewed growth as a result of the economic upturn and the 'Fukushima effect' triggered by the natural disaster and reactor accident that occurred in Japan in the early part of the year, or whether the climate policy decisions – which have been less than favourable for the coal industry – will act as curb on coal consumption.

Growth rates for German primary energy consumption 2009/2010
rate of change in %



Source: Arbeitsgemeinschaft Energiebilanzen e. V., 7/2011

About 23 % of the total volume of coal available in 2010 (57.1 million tce) was produced by the domestic industry. The main consumers were the power generators and the iron and steel industry. Almost three quarters of German-produced coal (72 %) was sold to the power industry, with a further quarter to the steel producers. RAG Anthrazit Ibbenbüren GmbH also supplied small amounts of coal on a subsidy-free basis to the

heat market at a level that has remained fairly stable over recent years.

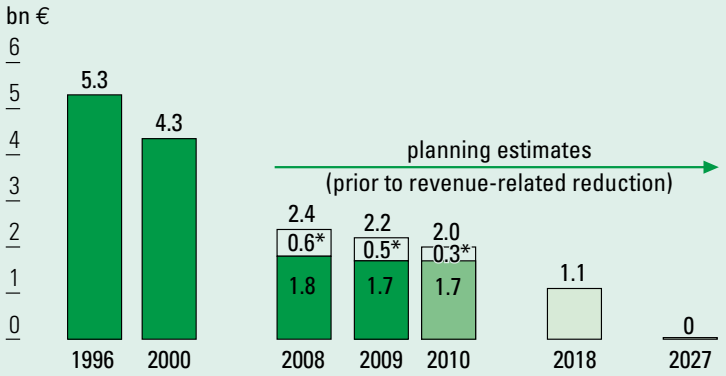
While home-produced coal's contribution to Germany gross electricity production has been declining for decades, the domestic industry still supplies a fairly significant 6.3 % of this market – and could do for many years to come on the basis of existing coal deposits. The BGR (Federal Institute for Geosciences and Natural Resources) carried out a re-assessment of the technically recoverable coal reserves in 2011 and came up with a figure of 2.5 bn tce – which makes coal second only to lignite as the nation's largest energy resource.

Of course the geological conditions of the German mining industry continue to make coal production costs higher than the world market price. While the price gap has continued to narrow, even in 2011, it is difficult to imagine a subsidy-free German coal industry any time soon.

At the end of 2007 the Federal Office of Economics and Export Control (BAFA) drew up a notice of appropriation of funding for the period 2009 to 2012 that provided a legal basis for the financing of coal disposals and the costs necessarily resulting from the closure programme – this entering into force as the Coal Industry Financing Act, which represents the national legal basis for the phasing-out of subsidised coal mining in Germany. Like the decisions taken in relation to previous years this Act provides for a degressive scaling-down of state aid to the industry.

If the industry realises a higher level of revenue than was assumed in the coal-policy agreement reached prior to the Coal Industry Financing Act the actual amount of aid paid to the industry can be well below the budgeted estimates ('revenue capping'). This already happened in 2008 to 2010. During this period nearly 1.5 bn € of confirmed aid did not have to be paid at all because of higher world market prices – resulting in a very welcome reduction in expenditure for both the Federal Government and the Land North Rhine-Westphalia. Recent price trends on the international coal markets suggest that we may see a similar scenario in 2011.

Reductions in state aid to the German coal industry

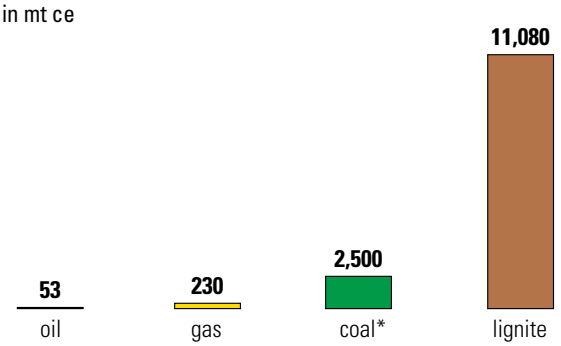


without RAG's own contribution, * revenue-related reduction

until 2008: as in the 2003 coal-policy agreement (not considering deferred payments);
as from 2009 planning estimates according to the 2007 framework agreement;
from 2019: no state-aid.

German energy reserves

technically and economically recoverable reserves
in mt ce



*German coal deposits including new and adjoining production districts with proven and technically recoverable reserves.

Sources: Federal Institute for Geosciences and Natural Resources*, RAG AG

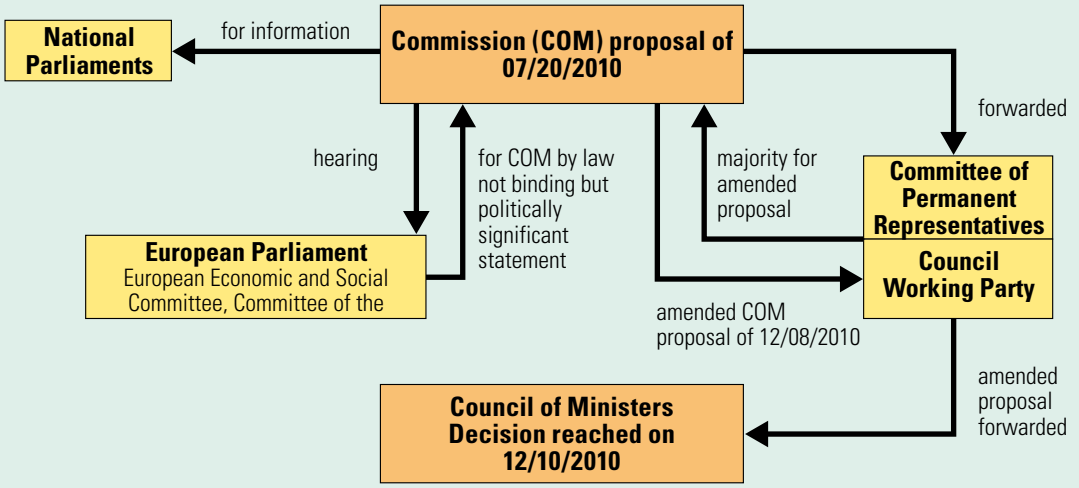
New legislative framework for state aid

Since the Coal Industry Financing Act came into force most of those involved in its drafting have repeatedly stressed that the transposition of the Act was absolutely dependent on having a follow-up regulation in place as soon as possible to replace Council Regulation (EC) No 1407/2002 of 23 July 2002, which expired at the end of 2010. This has to date provided the legal basis for the granting of state aid to the coal industry. By way of a succession mechanism the European Commission presented a proposal on 20 July 2010 for a 'Council Regulation on state aid to close uncompetitive coal mines'. This proposal intended only to provide aid to cover exceptional costs and colliery closures. Aid to closures was only to be allowed until October 2014, and this only in the context of a definitive closure plan. This news hit the coalfield regions like a bolt from the blue – and strong objections were also expressed from political quarters. The Commission's proposal was not only inconsistent with the views of the Federal Chancellor and the representatives of all the main political parties but also conflicted with the wishes of the regional governments in the mining regions of North Rhine-Westphalia and Saarland, and the Bundesrat.

These various institutions pointed out in particular that the Commission's proposal was not consistent with the provisions that had been adopted in Germany in 2007 for the planned cessation of subsidised coal mining by the end of 2018. More importantly, it would render impossible the mutually agreed process for the socially responsible reduction of the industry's workforce. The proposal would also dramatically reduce the time window available for building up the capital assets of the RAG Foundation that was to assume responsibility for long-term liabilities, a process that had already been agreed in the Coal Compromise of 2007. This would threaten the very existence of the Foundation and its undertakings.

The Commission eventually presented a new proposal – in response to the sustained and cross-

EU aid to the coal industry
Formal route to the Council Decision of 10 Dec. 2010



party criticism being expressed in Germany and in other coal producing countries, and notably also in the European Parliament. This requires subsidised coal mines to be definitively closed by the end of 2018 and allows operating aid, defined as 'closure aid', to offset losses from current production up to the point of closure. This closure aid is only to be granted until the end of 2018 and is subject to strict degression requirements. Aid to cover exceptional costs arising from the closure of coal mines can however be granted beyond 2018 and up until the planned expiry of the Council Decision on 31 December 2027, provided that it is primarily intended to alleviate the social and ecological impact of the intended closure.

This proposal, which the European Commission presented just before the crucial meeting of the EU Council of Ministers, is essentially compatible with the German regulations in that it also takes account of the regional and economic importance of the indigenous mining industry in North Rhine-Westphalia and Saarland. The Council of the European Union adopted the proposal on 10 December 2010 as a Council Decision on state aid to facilitate the closure of uncompetitive coal mines (Council Decision No 2010/787/EU) and it entered into force on 1 January 2011.

In March 2011 the Federal Government submitted, for the Commission's approval, a closure plan to phase out the subsidised German coal industry until the end of 2018. According to the Council Decision a binding closure plan is one of the conditions under which state aid is approved as part of the annual payment system. This plan also contains details of appropriate measures to mitigate the environmental impact of coal production.

By virtue of Germany's 2007 decision to phase-out subsidised coal mining in a socially responsible way by the end of 2018 the Federal Government had acted in December 2007 to provide the European Commission with a restructuring plan running up to 2018. The Commission was then presented with an updated version of the plan in June 2008 following the earth tremors that hit Saarland in February 2008. However, the Commission did not consider that it was in a position to approve the restructuring plan as it did not at that time see any legal basis for granting coal-industry aid after 2010. The closure plan now being presented to the Commission tied in with the restructuring plan drawn up in 2008 and at the same time took into consideration the requirements imposed by the Council Decision, including the stricter degression arrangements.

The member state in question is required to pay back the full amount of aid granted for the period covered by the closure plan if the coal production units to which aid is granted are not closed on the date fixed in the closure plan as authorised by the Commission. The Council Decision therefore contains strict clawback regulations that will make the path to a non-subsidised coal mining industry a much more difficult one.

Amendment of the 'Coal Industry Financing Act'

At national level the Coal Industry Financing Act continues to provide the legal framework for all contracts and agreements made under the 2007 Coal Compromise. From a business perspective its adoption enables coal industry to manage the rundown to 2018 in an economically and socially acceptable manner. In this respect the situation remains unchanged, even in the context of the changes made to the Coal Industry Financing Act in mid-2011.

In November 2010 the Federal Government deleted the 'review clause' from the Coal Industry Financing Act in order to facilitate the EU system for state aid. This deletion was justified on the grounds that the impending

Council Decision would make the review arrangements unworkable. The aim of the review clause was to compel the German Bundestag to re-examine the agreement on the phasing-out of the subsidised coal mining industry. In concrete terms this meant that the Federal Government had to present a report by 30 June 2012 at the latest. The Bundestag would then examine, on the basis of this report and 'bearing in mind the key aspects of cost effectiveness, security of energy supply and other energy policy objectives', whether the coal mining industry should continued to receive state aid after 2018.

The Government bill was approved by the German Bundestag in mid-April 2011 following the first debate in the Bundesrat and the first reading in the German Bundestag in February 2011. Prior to this the Bundestag Economic Affairs Committee had submitted a resolution to a full sitting of the Bundestag recommending that it adopt the draft bill. It had at the same time rejected a motion for a resolution providing for negotiations in and with Brussels on ways to secure the option of a non-subsidised coal industry. However, if 'in a few years time' the world market price for coal were to permit subsidy-free coal production 'the issue could be re-considered'. The recommendation for a resolution was tied in with a report on an expert consultation that took place on 11 April 2011 with representatives from the German Coal Association and the IG BCE Industrial Union.

The concluding debate was held in the Bundesrat at the end of May 2011 and the amended Coal Industry Financing Act came into force on 15 July 2011 after publication in the Federal Law Gazette.

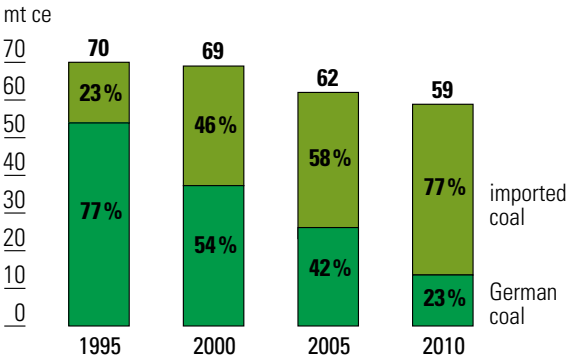
Coal as part of the energy mix

By revoking the review clause the Federal Government was giving clear expression to the historical significance that the coal industry has for Germany. The following statement by CDU representative Thomas Bareiss was placed on record at a sitting of the Bundestag on 14 April 2011: 'The Ruhr is one of the most important industrial regions in Germany and in Europe as a whole. Its development would never have been possible without the mining industry. The domestic coal industry has for decades made a vital contribution to the building of our nation and to the prosperity of our people'.

Prior to 2010 coal was an integral part of the energy mix in the Federal Republic of Germany, the reason being that it was readily available and reasonably priced. However, the Energy Plan that was adopted by the German Bundestag in late summer 2010 no longer found a role for coal in its most important sales market – power generation – on account of the CO_2 emissions produced during coal burning. An even more stringent stance was taken in respect of lignite, while natural gas was to be less affected because of its lower CO_2 burden. According to the Energy Plan renewables should play a leading role in electricity generation by 2050 at the latest. Low-cost nuclear installations would fulfil a bridging function for power generation in the transition period until appropriate storage technologies can be developed and built that will make renewables capable of supplying baseload electricity.

The events at the Fukushima nuclear plant in Japan in March 2011, however, were to result in another energy rethink for Germany. The second agreement in June 2011

Structural change in consumption of indigenous and imported coal in Germany



Source: Arbeitsgemeinschaft Energiebilanzen e. V., 7/2011

for a withdrawal from nuclear energy – the first was back in 2000 – means that the generating capacity that will be lost ahead of schedule will have to be replaced by fossil fuels, unless Germany becomes dependent on power supplied from nuclear generators in neighbouring countries. This opens up new prospects for solid fuel – including coal – together with natural gas. These resources will be needed as a bridge to the renewable-energy era and to provide back-up capacity – in other words to balance out the fluctuating energy availability of wind and solar sources. They will at the same time exert a cost dampening effect on electricity prices. These will tend to increase as a result of various factors associated with the expansion of the renewables sector – such as the extension of the high-voltage network and rising feed-in tariffs. At the same time, however, there are still questions surrounding the longer-term prospects for new coal fired power stations. Building additional installations and replacing the older, inefficient generators calls for investment running into billions of euros. Yet these power stations are unlikely to be economically viable. The reason: the increasing cost of CO_2 emission rights and a low utilisation rate due to the priority feed-in of electricity from renewable sources. Capital payback would be non-existent. Because of this investment uncertainty a significant number of new power station projects have already been abandoned or postponed indefinitely.

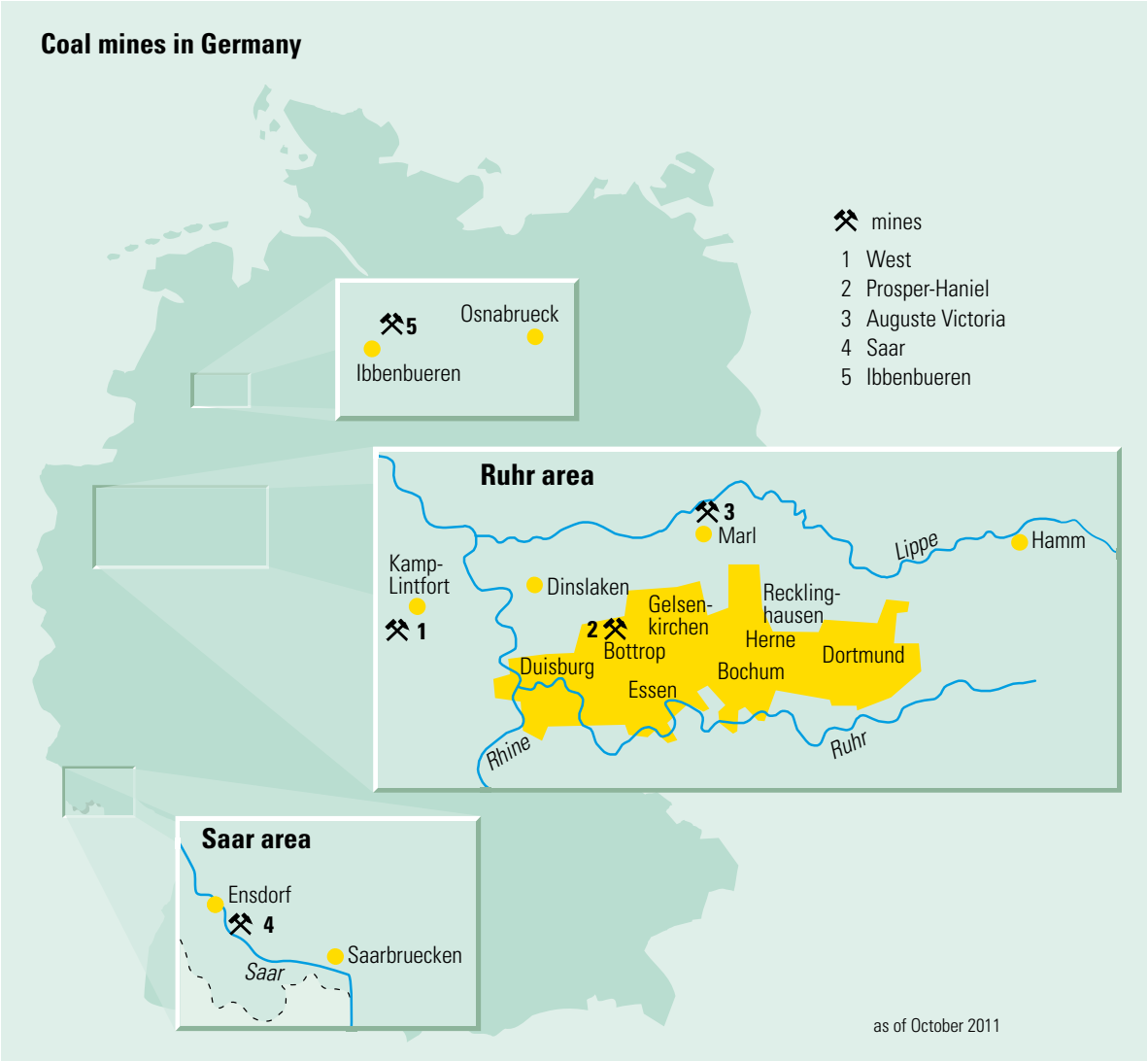
Germany is not the only country to be giving coal utilisation a greater role than before. Immediately after the reactor disaster Japanese coal demand on the world market rose dramatically and this is set to increase further when that country too implements its decision to withdraw from nuclear power. Add to this the fact that China, in spite of its own increasing production levels, is and will remain the world's largest importer of coal. India too is now importing increasing quantities of coal to feed its own economic development. The combination of all these factors means that we are already beginning to see a major shift in seaborne coal trade from the Atlantic to the Pacific market.

There are good reasons why renewables should in future form the backbone of energy supplies. However, until they can fully take over this role we need to clarify exactly how they are to be technically and economically integrated into the system. A fully renewables-based supply is still a long way off. Coal can help get us through the transition period – both as a fuel and as a raw material.

Corporate development

Corporate planning at RAG Aktiengesellschaft is based on the Coal Industry Financing Act of 2007 and associated contract arrangements. RAG is the exclusive operator of the remaining German coal mines. In 2008 it adapted its mine planning arrangements to comply with the requirements of the Act. These plans provided, among other things, for annual production to be cut to below 12 million t and for manpower to be downsized to fewer than 15,000 employees by the year 2012. The entry into force of the new EU regime on state aid and the amendment of the Coal Industry Financing Act in 2011 means that there is now a legally binding framework in place: on this basis the German coal industry can shape its strategy for bringing mining operations to a close by the end of 2018 and for managing the ongoing issues relating to inherited and long-term liabilities. This it will do irrespective of the new decisions being taken by German energy policy makers.

Germany produced 12.9 million t of coal in 2010, which was 0.9 million t less than the previous year. The number of coal-industry employees fell to 24,000, with the closure of Ost colliery in Hamm on 30 September 2010 a major factor in this. The restructuring of the mining sector is still ongoing: on 1 June 2011 the last industry-owned coke works – the Prosper coking plant in Bottrop – was sold to the steel producing company ArcelorMittal Bremen GmbH.



This sale will also ensure that the Prosper plant, and the jobs that it provides in the Bottrop area, will still be there beyond 2018 – in other words, after subsidised coal mining comes to an end.

Concrete measures aimed at achieving the existing mine planning targets were agreed back in 2008. These included the decision to bring about the complete cessation of mining in the Saar coalfield with the closure of Saar colliery on 30 June 2012. The plans also provide for West colliery in Kamp-Lintfort to be closed at the turn of 2012/2013, even though there has still been no official decision on this. This means that by 2013 the German coal industry will be based

around three collieries in North Rhine-Westphalia: Prosper-Haniel in Bottrop, Auguste Victoria in Marl and Ibbenbüren on the border with Lower Saxony.

The rundown of the mining sector means that RAG Aktiengesellschaft has to adopt a responsible approach in managing the available mining infrastructure. RAG is therefore also seeking to use its existing know-how to develop new 'green' concepts as a contribution to innovative and environmentally friendly energy supply.

The emergence of the renewables sector has now seen the development of a new business segment at RAG in addition to the many and diverse property and land based activities that have been under way for more than 30 years. Colliery waste heaps, mine shafts, mine water, surface buildings, real estate and in-house expertise can all be used as a basis for projects involving wind energy, photovoltaics, pumped-storage power stations, geothermal energy and the extraction of heat from mine water (see also the guest contribution at 'Coal and the environment').

RAG, operating through its subsidiary RAG Montan Immobilien, recognises its obligations in the provision of support for structural change in the coalfield areas. Its subsidiary is involved in a wide range of future-oriented projects, with the current focus on the re-use of vacant mining sites and surface buildings.

RAG Mining Solutions GmbH, which was established in 2009,

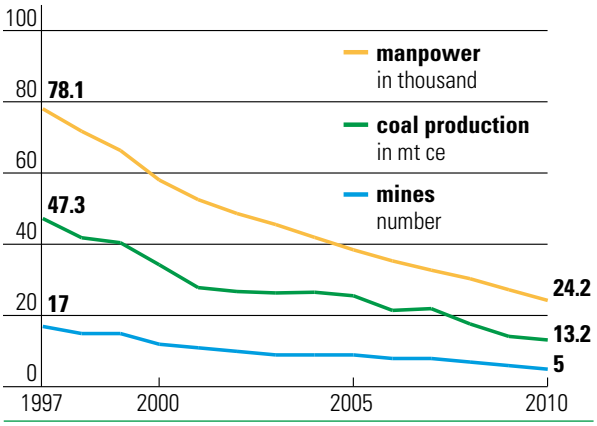
Mining technology tried and tested

German mining technology is highly regarded the world over, as evidenced by the fact that export sales by home-based mining equipment suppliers have been increasing for years. However, to help secure this technological edge we need ongoing technical development and the capacity to test new equipment under real conditions. Because of their demanding geological and climate conditions, and the high health, safety and environmental standards that have been put in place, those German collieries that are still operational are ideally suited to serve as test-bed facilities. An RAG-developed, fully integrated control and communications centre, which will help improve underground transport logistics, is now undergoing trials at Auguste Victoria colliery in Marl. This system will subsequently be put into regular operation at Prosper-Haniel mine in Bottrop, where its forward-looking process technology can be demonstrated to potential customers from all over the world.

2011 research award

The annual RAG research award recognises exceptional achievements in the field of research and development. This year's award was given in recognition of the database that was developed as part of the research project 'Geometric monitoring of the ground surface for active mining operations, closed collieries and abandoned mining sites based on the integrated application of GIS and the GeoMon multi-sensor recording system'. The database was created for the sustainable and future-proof management, processing, analysis and retrieval of all surface points on RAG-owned property and has the capacity to process data from remote-surveillance radar satellites.

Adaptation in the German coal industry



is another example of how the decline of the mining sector is having a direct impact on the group structure. This company has grown steadily as a consultancy and service provider. With coal production on the increase around the world there is now a growing demand for modern, field-tested mining and consulting services based around decades of accumulated mining know-how.

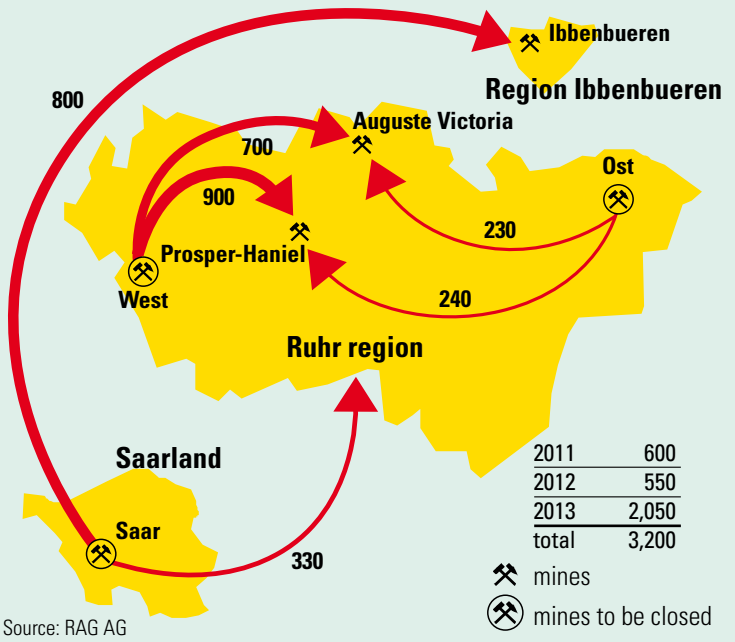
Another change in the corporate structure of RAG Aktiengesellschaft involved the acquisition of 2 % of the shares in RVG GmbH, which were previously held by Evonik Industries AG. This increases the RAG group's stake in the company to 51 %. At the same time the RAG group agreed to take over the remaining 49 % of the shares held by Evonik Industries AG on 1 January 2013. The main operating remit of RVG GmbH, which has now been renamed RAG Verkauf GmbH, is to market German coal products and ensure a dependable supply to its customers. As well as marketing German steam coal and coking coal RAG Verkauf GmbH procures the coking coal that is needed for the Prosper coke works in Bottrop and is also responsible for selling the plant's products, namely coke and coking by-products (including gas and coal tar). RAG Verkauf GmbH also markets a proportion of the refuse material that is a by-product of coal production and is involved in fuel and recyclables processing through its subsidiaries and affiliates.

Evonik Industries AG for its part has also disposed of its majority holding in the power station subsidiary Evonik Steag GmbH – a member company of the GVSt. After 51 % of its shares were acquired by the public utilities group Rhein-Ruhr the Essen-based energy producer has been trading under the name STEAG GmbH since 8 June 2011.

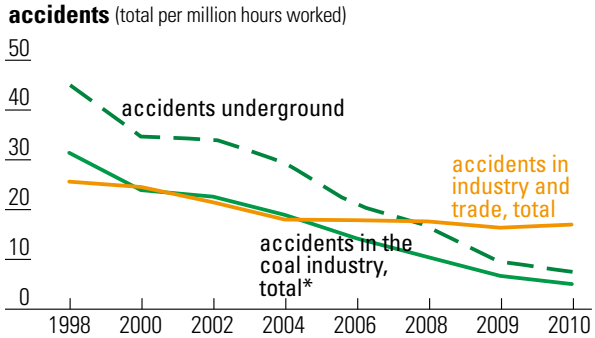
Social support measures/socio-political aspects

The operating parameters for the German coal industry also included the 2011 round of pay talks. The pay settlement that was agreed for a period of 24 months to 31 December 2012 represents a fair compromise for both employers and trade unions. On one hand, it adheres to the principle that the restructuring process must continue to be managed in a socially acceptable way while complying with the budget requirements laid down in the Coal Industry Financing Act. On the other, coal industry employees are granted a pay increase that is above the expected inflation rate, this comprising a

RAG: staff transfers 2010 to 2013



Source: RAG AG



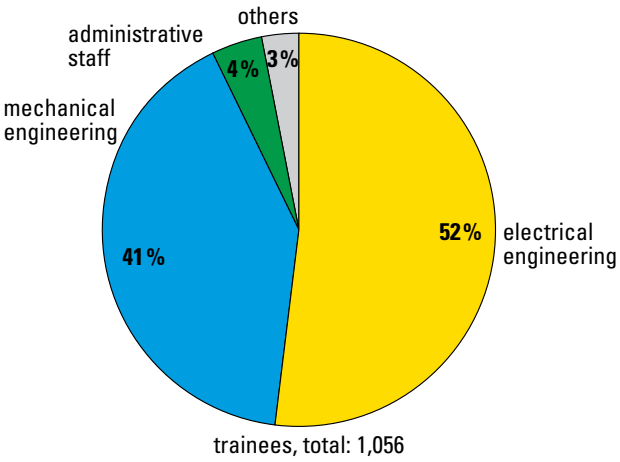
* only corporate units under mining-authority supervision

Sources: Deutsche Gesetzliche Unfallversicherung, RAG

Falling accident rate in the German coal industry

3.3 % increase in standard wages and salaries on 1 April 2011 plus a lump sum payment. This was made in recognition of the exceptional achievements of the industry's employees who, during 2010, continued to show true dedication and commitment in spite of the enormous personal stress that EU-related issues were causing for themselves and their families.

Vocational training in the coal industry



Managing staff cuts in a socially acceptable way has been a real challenge in 2010 and will remain so in the years ahead. One of the main tasks has been to relocate employees when production facilities are closed down. The transferred workers help make up for the staff shortages arising at other sites as a result of personnel leaving the industry. Between 2010 and 2013 some 5,000 such transfers will have been organised, with 3,200 of these relocations still to be completed in the next few years. One of the biggest such transfers will affect the 1,130 workers at Saar colliery, who will be moving to the Ruhr coalfield (330) and to Ibbenbüren (800). This will call for exceptional flexibility and solidarity from all those involved. The transferred employees will have to adjust to a new and unfamiliar working and living environment, while the in-situ workforce will also be called upon to show that they are willing partners in the integration process.

Against such a background it is especially pleasing to note that efforts in the area of health and safety have continued to yield positive results. In recent years we have seen accident figures for the coal industry, both below and above ground, fall more sharply than in the trade and industry sector as a whole. While in 2010 accidents rates in general industry rose both in absolute terms (+ 8.3 %) and in relation to the number of hours worked (a 3.8 % increase to 16.5 accidents per million hours worked), RAG Deutsche Steinkohle AG saw its own accident rate per million hours worked fall to 4.62 (previous year 6.3), with a figure of 6.98 for underground operations (previous year 9.1).

The coal industry is still one of the country's main training providers – and this in spite of having continuously to adjust manpower figures to match the decline in production. Mining is therefore fulfilling its social and regional obligations in every way. In 2011 another 254 young apprentices took up their places at RAG Aktiengesellschaft, taking the number of industry trainees to 1,056 at the start of the training year. The most popular courses tend to be industrial mechanics, industrial electronics, mechatronics and business administration.

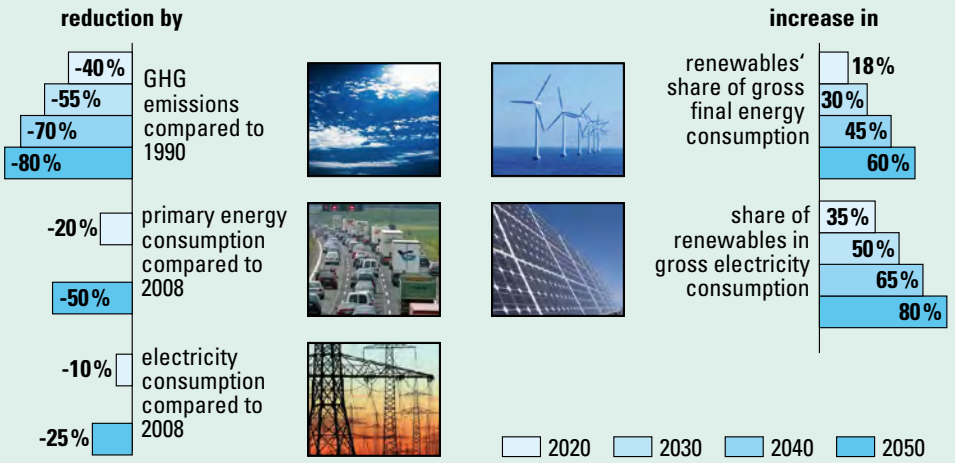
The energy switchover: 'new horizons'

Energy Plan 2010

In the autumn of 2010 the Federal Government presented its 'Energy Plan for an environment-friendly, reliable and affordable energy supply', which had been announced as part of the previous year's coalition agreement. This was the first time in thirty years that any German Government had laid down a long-term energy strategy. The 2010 Energy Plan is based around an extremely ambitious set of national environmental and energy saving targets. Its objectives are intended for the long term: Germany's energy-related greenhouse gas emissions are to be cut by between 80 and 95 % by 2050 and by 40 % as early as 2020 (each target set against the reference year 1990); primary energy consumption is to be halved by 2050 and is to be reduced by 20 % by 2020; electricity consumption is to be cut by 25 % by 2050 and by 10 % by 2020 (each set against the reference year 2008). Additional intermediate targets are laid down for each decade. The Energy Plan's central objective is to 'pave the way to the renewable-energy era'. By 2050 renewables' contribution to gross energy consumption is to be increased to 60 %. This means that by that date renewables should have an 80 % share of the electricity generating market, having achieved levels of 50 % and 35 % in 2030 and 2020 respectively. These targets will set a 'new world record', according to Chancellor Merkel, speaking during a publicity campaign for the Energy Plan. In justifying the thinking behind the Plan she also stated that 'the age of coal and oil is drawing to an end' – something that, at least as far as coal is concerned, could only be taken as a political declaration of intent, as unlike mineral oil the national and international reserves of coal are sufficient to last for centuries to come.

Nuclear energy is to assume the role of a 'bridging technology' – taking us out of the 'old fossil-based' energy age and into the renewable, carbon-free energy future. Nuclear power would be needed to provide the time required to rebuild the energy system and 'at the same time to keep electricity prices affordable'. A communication from the Federal Government dated October 2010 further stated that the 2022 deadline for phasing-out nuclear energy, which was agreed in 2000 by the Government of the day, was 'too short': one quarter of the nation's electricity supply could not be replaced 'without significant costs, import risks and an environmental impact.' This was why the coalition Government took the decision last year – before Fukushima – to extend the operating life of Germany's nuclear power stations by an average of 12 years. The later generation of nuclear installations could even remain in service for a further 14 years. Coal, on the other hand, was (for the time being) not to be assigned such a bridging function, even though it remains the country's most important indigenous energy source and has traditionally been the strongest pillar of the German electricity production industry. Yet the Energy Plan 2010 treats coal and lignite as marginal factors

The German Energy Plan – objectives and assumptions

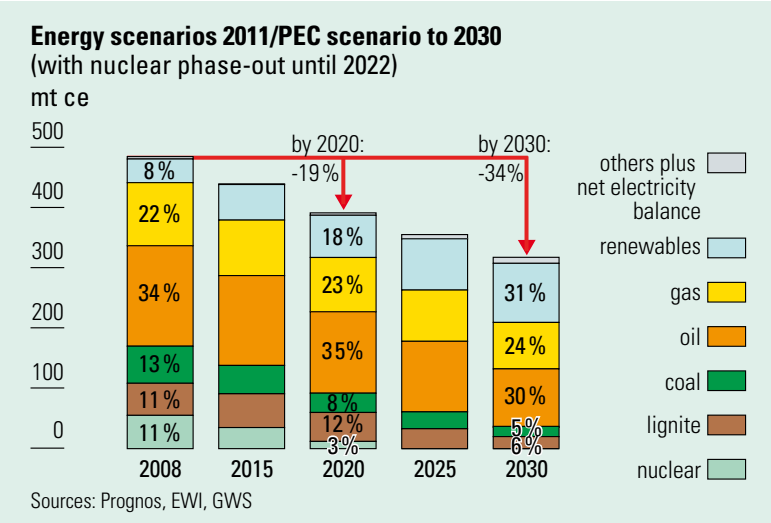


and their future prospects appear rather poor. The energy scenarios that were commissioned in advance of the Energy Plan proposed that national coal consumption be practically halved by 2020, with a further 50 % reduction by 2050. This was the case presented in decision-compliant target scenario II a, which suggested extending the operating life of Germany's nuclear power stations by 12 years. However, according to this there would still be a residual coal requirement of about 15 million tce in 2050, which would have to be met entirely by imported coal. This is because as far as home-produced coal is concerned the Energy Plan states that 'subsidised production will be ended in line with national and European rules'. The relevant regulations have now been adopted in this regard.

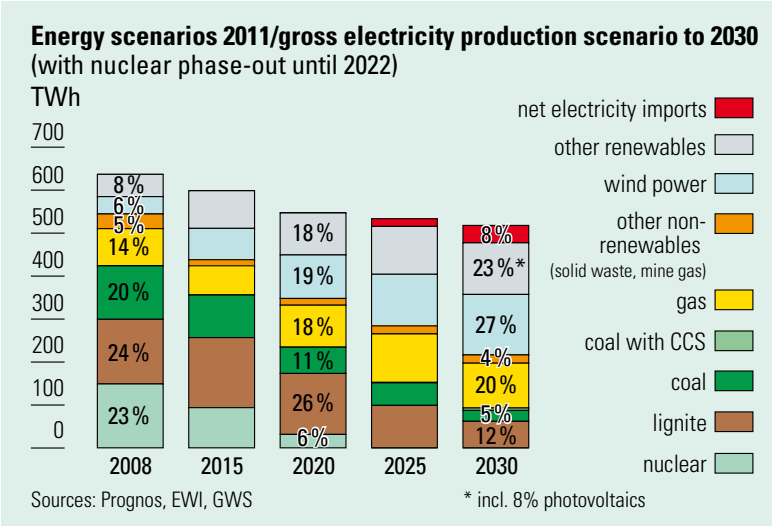
The key aims of the 2010 Energy Plan and the background to the Cabinet decision have already been presented in detail in the GVSt 2010 Annual Report (page 44 et seq.). The overall concept and the first major package of measures for its implementation, including amendments to the Nuclear Energy Act, were subsequently adopted by the coalition in the Bundestag by the end of 2010. However, there was a lot of harsh criticism even during the decision-making process. Political opponents and environmental organisations were particularly scathing about the decision to prolong the operating life of the nuclear installation. The IG BCE called for coal, rather than nuclear energy, to be assigned the 'bridging role'. Industry and consumer bodies alike expressed serious doubts about the affordability of an energy system rebuild and about the practicability of the energy saving targets. The BDI, for example, raised concerns about the planned-economy nature of detailed energy objectives for a 40-year period. Experts also referred to a series of unsubstantiated assumptions in the underlying energy scenarios. These included various presuppositions, such as a global climate agreement, economic growth in line with expectations and a fully integrated and properly load-shared European electricity and renewable-energy network, along with various timely energy developments and innovations (such as storage and CCS technology) and the resolution of all the acceptance problems that currently affect the energy sector. Moreover, Energy Plan 2010 glosses over a number of issues associated with security of energy supply. These include the concurrent requirement for an expansion of the supply grid and, as the Energy Plan itself acknowledges, the ongoing reliance on imports of fossil fuel – especially oil and gas – until the year 2040 at least. This particular aspect has taken on an even greater significance following the political unrest in North Africa and the Arab world. The combined effect of all these factors meant that even in 2010 there were calls from various quarters that energy-policy 'fallback options' should be retained.

Energy switchover 2011

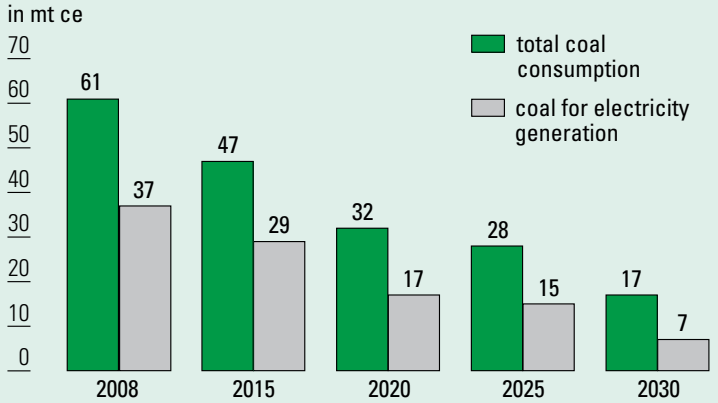
Just a few months after its adoption the Energy Plan underwent a revision that was to accelerate the pace of Germany's energy switchover. The reactor accident at the Fukushima nuclear plant, which was triggered by a terrible natural disaster that occurred on 12 March 2011, not only had serious ecological and economic consequences for Japan – it also aroused major concerns about nuclear technology in other countries too. Germany in particular had to re-examine its nuclear energy policy, which meant taking a fresh look at other parts of the energy mix as well. The German public simply lost all faith in nuclear power. The Federal Government declared 'Japan changes everything' and moved quickly to alter the course of the nation's energy policy. A safety review was immediately announced for every German nuclear plant and on 15 March a three-month moratorium was declared on the proposed lifetime extension of Germany's nuclear power stations. The order was then given to shut off the seven oldest reactors completely for the duration of the moratorium. The Reactor Safety Commission and a newly appointed Ethics Committee for Security of Energy



Supply were then called upon to assess the safety and security situation in Germany and to put forward proposals for alternatives to nuclear energy in the event of an earlier than planned nuclear withdrawal. Their findings were presented in May 2011 against the background of an intense public debate on energy. On the basis of these discussions Chancellor Merkel very quickly made it clear that the 2010 decision to extend the operating life of nuclear installations was being revoked: the objective was now to withdraw from nuclear energy as fast as possible. At the same time guarantees had to be given on environmental protection and security of supply and, moreover, energy had to remain affordable. The Government convened talks with the premiers of all Germany's federal states to discuss how the pace of the energy switchover could be accelerated. An ambitions timetable was then established and by early June decisions had already been taken on the reorientation of the Energy Plan. The centrepiece was the legislative package adopted for a further amendment of the Nuclear Energy Act – the intention now being complete withdrawal from nuclear energy by 2022. Other provisions included the earlier than scheduled revision of the Renewable Energy Sources Act (EEG), acceleration acts for power grid expansion and the planning of new power stations and storage capacity, along with adjustments to the Energy Industry Act. This legislative package is accompanied by supporting measures for energy R&D, energy conservation, building renovation, CHP, e-mobility and offshore windparks. The seven older installations temporarily shut down for the duration of the moratorium, together with the Krümmel nuclear power station, were subsequently closed permanently in mid-2011. Germany's remaining nine nuclear plants are to be gradually phased out in line with fixed closure dates – beginning late 2015 and ending late 2022. A solution is also soon



German coal market projections to 2030 according to 2011 energy scenarios (nuclear phase-out)



Sources: Prognos, EWI, GWS

to be found to the problem of the (permanent) storage of radioactive waste. Any shortage of generating capacity is to be made up in the coming years by the existing pool of gas and coal fired power stations. The implementation of the new Energy Plan is to be monitored by panels of experts and specialist institutions.

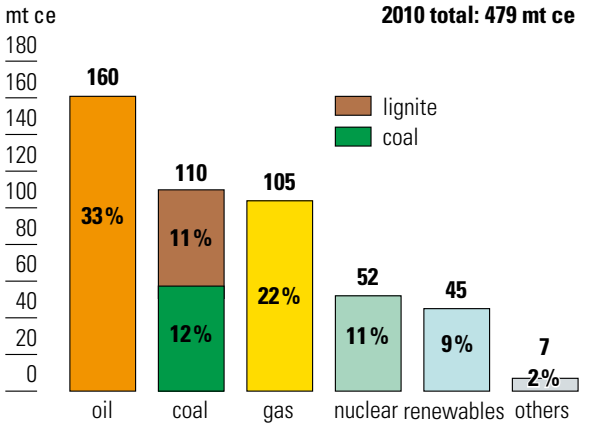
Operating margins for the future energy mix

Any future energy mix can only be developed from the energy mix of today, as the latter will exert a formative influence in the short and medium term. German primary energy consumption in 2010 was still nearly 80 % based on fossil fuels – oil, gas, coal and lignite. Nuclear energy’s share was just short of 11 %, while all renewables together contributed 9 %.

The energy mix is structured rather differently when it comes to electricity generation. In this market oil and gas play a much smaller role, whereas they dominate primary energy supplies to the heat and transport sector. The German electricity production industry has for many years been based primarily on solid fuel (in 2010 the breakdown was 23 % lignite and 19 % coal) and nuclear power (23 %). Then come renewables (17 %) and gas (14 %). This does not include the primary energy input of electricity imports because in 2010, as has been the case for many years, an even larger portion of domestic gross electricity production (the net balance was nearly 3 %) was exported.

The future energy supply structure being proposed by the Energy Plan and energy switchover therefore has to be vastly different from that which exists at present. Renewables are to be given the lion’s share, while fossil fuels will play a declining role and nuclear energy will be totally excluded. And this applies not just to the energy sources and technologies that will be used to meet future energy needs but to consumption levels too, which are to be dramatically reduced through energy saving measures and energy efficiency improvements. An ‘efficiency revolution’ is deemed necessary to achieve this, and it certainly will be: the energy scenarios for 2010 have clearly indicated that the objectives of the 2010 Energy Plan can only be achieved if energy productivity can be increased by an average of 2.3 % a year until 2050.

German primary energy consumption in 2010



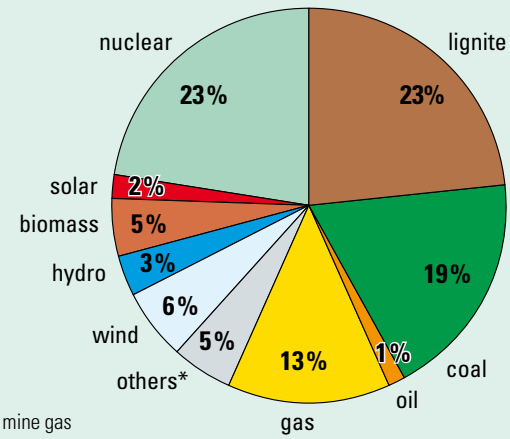
Source: Arbeitsgemeinschaft Energiebilanzen e. V., 2011

This is based on the assumption of a modest economic growth of barely 1 % a year on a continuous basis for more than 40 years. Even allowing for the effects of reunification, German energy productivity has only increased by 1.6 % a year over the last two decades, i.e. since 1990. Germany remains one of the most energy efficient economies in the world, yet there are still areas with a huge efficiency potential to be exploited – such as the building and transport sectors. The annual improvement in energy efficiency needs to be massively and permanently greater than any rate previously achieved and this will in effect require revolutionary technological breakthroughs.
Figure: German post-1990 trends for GDP, PEC and overall energy productivity

Even if this efficiency drive were to succeed in the foreseeable future, this 'miracle of energy efficiency' could prove to be illusory, as has been explained in the 25 April 2011 edition of Handelsblatt. We should heed the warnings that the famous British economist William Stanley Jevons gave back in 1865 in his book 'The Coal Question'. At that time, when the industrial revolution was in full cry, the British feared that their coal deposits could be used up faster than expected and as a result put an end to their prosperity. This fear was to prove unfounded, though for other reasons. It was a time when new blast furnaces were being developed that consumed less coal and with them came the expectation that greater energy and raw-material efficiency would reduce coal consumption. Jevons contested this thesis and claimed that the very opposite was true: more efficient blast-furnace technology would reduce steel prices and this would in turn stimulate steel demand – which would lead to an upturn in steel production and also to an (absolute) rise in coal consumption. Jevons was right and so gave his name to the 'Jevons paradox'. Today we speak in a similar vein of the boomerang and rebound effect: efficiency (often) triggers growth! This applies to energy consumption too and the consequences of such effects are immense. We will never get anywhere near achieving the planned 50 % reduction in energy consumption by 2050 if German economic growth to 2050 proves stronger than is being proposed in the 2010 energy scenarios (which means an

German electricity generation by sector

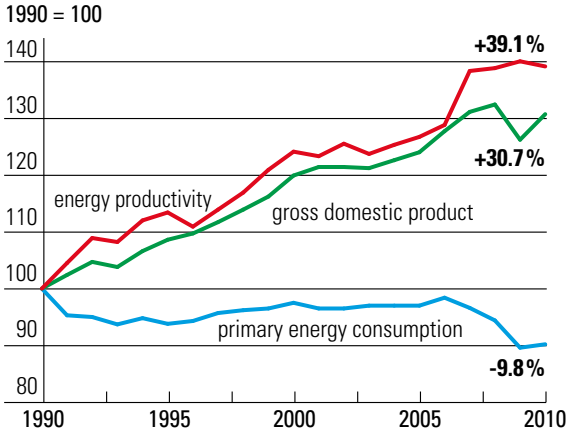
2010 total: 624 TWh



* incl. mine gas

Source: Arbeitsgemeinschaft Energiebilanzen e. V., 2011

German post-1990 trends for GDP, PEC and overall energy productivity



average rise of rather more than 1 % a year) and if energy efficiency is not improved to the degree that is being assumed – and neither of these would be unrealistic developments. A responsible energy policy should at the very least examine such possibilities and ensure that in future the capacity is also available to meet a higher level of energy consumption than is proposed in the target scenarios.

A particularly realistic approach to improving energy efficiency, and one that is also environment friendly and resource efficient, clearly involves the increased exploitation of combined heat and power (CHP) technology. The co-generation of heat and electricity allows a larger proportion of the primary energy input to be converted into useful energy – provided that the downstream electricity and heat demand can be properly synchronised. In the heat sector, for example, 'CHP efficiency technology' (dena) can be employed by industry to provide process energy and in combined heat and power stations it can be used to supply district heating to whole urban districts and also to provide targeted consumers with heat and electricity (using mini or even micro CHP units). In its 2010 Energy Plan the German Government still appears to be keeping further CHP funding under review. Yet in its key energy policy parameters of June 2011 it announced that it would 'boost energy production from CHP installations' and continue to provide support to this sector 'beyond 2016' by introducing an amendment to the Co-generation Act. This will allow established structures to be developed in a future-oriented way. In the densely populated Ruhr area, for example, district heating has a long tradition and the Ruhr district heating grid that was set up in 1978 was Germany's first transregional district heating network. The Ruhr heating grid brings together the Essen-based STEAG company, which is the largest provider of district heating in North Rhine-Westphalia, and other undertakings and public utilities. The heat to supply the grid is mainly obtained from combined heat and power stations burning coal, gas and biomass. Waste heat from industrial sources is also used. The Saar district heating network operates on the same principle. After a lengthy period of inactivity in the development of the Ruhr's district heating system STEAG, operating with its partners the municipal utilities, is ideally placed to undertake an upgrade of the district heating network throughout North Rhine-Westphalia. As well as bringing considerable benefits by reducing fuel consumption and environmental emissions such a scheme will also help stimulate competition in the energy market. The particular advantages of district heating are now being highlighted through STEAG's involvement in the InnovationCity Ruhr project that is helping to transform the mining town of Bottrop into a model of energy efficiency ('Innovation City').

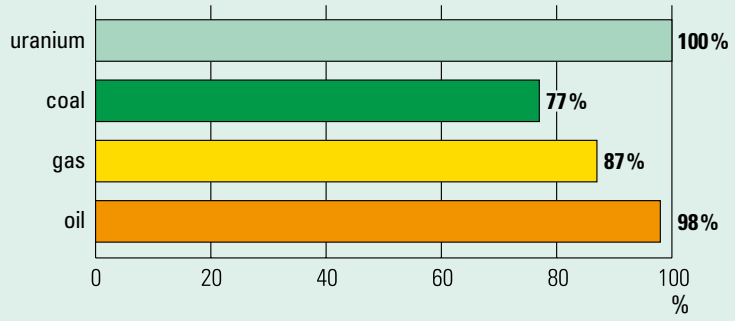
Realism is also needed in dealing with the opportunities and problems that individual energy sources bring to the energy mix of tomorrow. Renewables are to be the future cornerstone of our energy supply. But to achieve this we still have a long hard road to travel and the route is anything but clear. In Germany the expansion of the renewables sector has mainly been focused on electricity production. But this is an area in which the fossil fuels oil and gas have only a subordinate role to play: for while they have clearly dominated our energy supply system to date, these resources have the shortest life expectancy in terms of the reserves available at both national and global level. From a resource scarcity point of view it is therefore oil and gas that will have to be replaced by renewables sooner than anything else. As we exceed the tipping point for oil production sometime in the years ahead the response will be, at best, to use in-feed from renewables to make up for that proportion of oil consumption that can be replaced on a regenerative basis by electromobility. In a study completed at the beginning of 2011 by the Bundeswehr Transformation Centre the 'peak oil problem' is rated as presenting a 'systemic security risk' for the entire economy ('Peak oil – implications of resource scarcity on security').

The debate now under way in Germany on nuclear withdrawal and the energy switchover takes little or no account of the following fact: according to latest figures, and at current production levels, Germany's remaining conventional reserves of oil and gas will be completely exhausted by 2022, or certainly by 2025. The country will then be totally reliant on imports for its oil and gas supplies, as indeed it will be for coal – although in the latter case this will be due not to insurmountable geological problems but rather to deliberate policy decisions. As a consequence, Germany's high dependence on primary energy imports, already standing at over 70 %, is set to increase further in the years and decades ahead. Deliveries of oil, gas and coal from Russia alone already make up 21 % of the country's primary energy supply market – which is exactly the same as the combined input from nuclear power and renewables.

The energy scenarios for the 2010 Energy Plan have clearly established that as Germany moves towards the renewable-energy age era its energy mix will still be dominated, at least up to 2040, by fossil based resources – and in future that will entirely mean imported fossil fuels. This was already on the horizon prior to the decision on a faster withdrawal from nuclear energy. What is more, imported electricity will also feature increasingly in the mix. It is therefore incomprehensible that gas-based electricity generation is being seen in many quarters as the natural replacement for nuclear energy, as this can only be achieved through additional gas imports. There has recently been a great deal of examination and discussion as to whether and when unconventional indigenous deposits of shale gas could contribute in any significant way to energy supplies. However there are at present no credible estimates available for this fuel. It should also be remembered that while using natural gas does have certain environmental advantages over the other fossil based fuels, particularly in terms of its lower CO_2 content, this consideration tends to mask the overall environmental balance for natural-gas extraction and transport when it comes to gas imports. The same applies to the question of what kind of replacement energy are the gas exporting countries using, and under what conditions. The high cost and price volatility of gas raises real doubts as to whether in the long term it will really prove beneficial from an economic point of view – even taking account of CO_2 pricing – to continue to use natural gas for electricity generation. Investing in new gas fired power stations is simply not a viable proposition for many energy companies. As the Westdeutsche Allgemeine Zeitung recently put it: 'even the gas bridge is wobbling'.

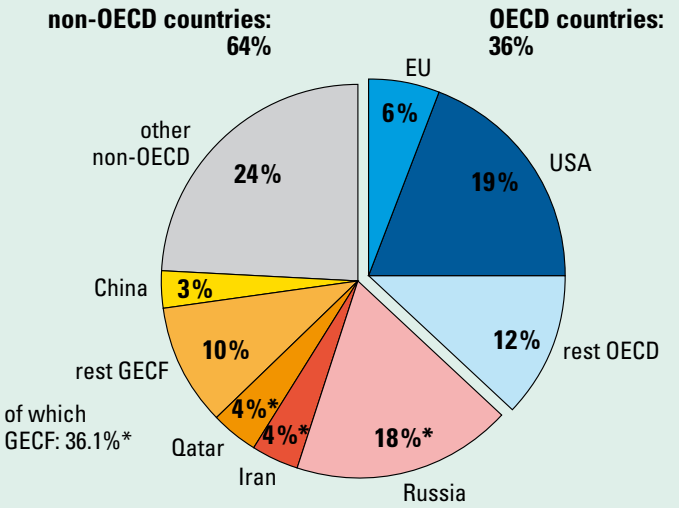
It remains to be seen how much additional gas based capacity will actually be built over and above the nine gas fired power station projects currently under construction or already approved. These nine installations have a combined output of 2.8 GW and are due for completion by 2014. Meanwhile, Germany has also given the go-ahead for nine new coal fired power station projects with a combined capacity of 10.4 GW (this does not include the Datteln power plant which is now almost completed though remains the subject of a legal dispute) and these are already under construction. This means that over the next three years new power stations will be coming on stream with a combined output of over 13 GW,

German reliance on energy imports 2010



their role being to close any gaps that may arise in the power supply system. Coal fired installations are now technically just as capable as gas fired when it comes to balancing out the fluctuating supply of electricity that comes from renewables. Coal fired power stations have in fact been providing flexible middle-load coverage for many years and today's new coal burning installations can also be run back quite considerably without any loss of efficiency. Then there is the question of reliability and diversification of fuel supply. In the context of supply security all the concerns that have been raised in the past about additional gas imports continue to apply. As with global oil reserves, the world's conventional reserves of natural gas are concentrated in a relatively small number of countries. Through the GECF these countries have set up an OPEC-style cartel organisation. They are engaged to some extent in pursuing their own power-political interests and are located in geopolitical risk zones. What is more, many of the international gas transit routes – and this includes both pipelines and shipping channels for liquefied natural gas (LNG) – run through the world's crisis regions.

Geographic concentration of world gas production 2010



*GECF (Gas Exporting Countries Forum) members comprise – in addition to Russia, Qatar and Iran – Egypt, Equatorial Guinea, Algeria, Bolivia, Kazakhstan, Libya, Nigeria, Trinidad/Tobago and Venezuela

Source: BP, 2011

Renewables, on the other hand, can largely be regarded as indigenous energy sources. Yet even here imports will assume increasing significance: in some cases directly with the import of biomass and bio-fuel, in others indirectly – in the form of 'green electricity' from non-domestic wind and water power sources and the proposed DESERTEC project to supply solar energy. However, even leaving aside the problems of being import dependent on renewables there are still huge questions surrounding their security of supply. The intermittent nature of their availability means that as things stand at present only a fraction of this capacity can be regarded as secured power. In the aforementioned analysis, for example, the Federal Network Agency estimates that on average just 20 % of Germany's regenerative electricity generating capacity can be regarded as secure. This availability failure can only be bridged by introducing a number of as yet untested measures: by employing flexible regimes at conventional power stations – which will therefore be under-utilised at certain periods; by including consumers in the load management process (consumption shifting, interruptible supplies, decentralised self-sufficient supply, etc.) – for which there is still no suitable regulating mechanism; by developing additional renewable potential – which has been under-developed to date; or by using large-scale power storage systems – which do not exist as yet. Intensive research is also under way in the field of storage technology – centralised and decentralised storage con-

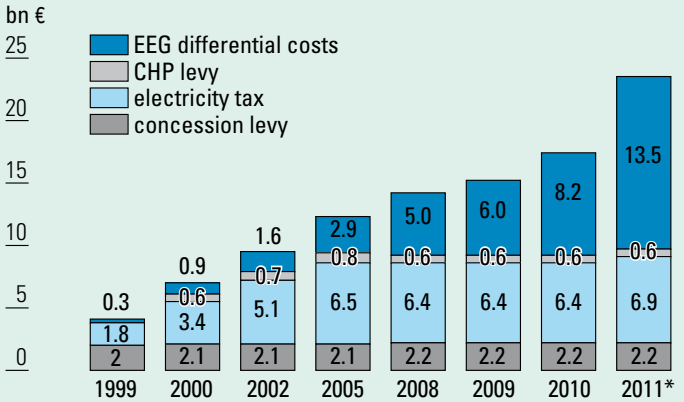
cepts, mechanical storage systems such as pumped-storage plants, flywheel energy and compressed air storage systems, electronic storage devices (especially in the form of batteries) and even intermediary electro-chemical hydrogen-methane energy storage systems – though this has not yet delivered a sure formula for success. The most economically viable solutions appear to be pumped-storage systems and, to a lesser extent, compressed air storage technology. However, the capacity of this kind that is currently available in Germany (pumped-storage plants are now producing about 7,000 MW) would have to be increased seventy-fold by 2030 if, for example, it is to provide secure coverage during a week of wind-free weather. Every available device will certainly be needed to achieve this.

A renewables based electricity supply system will also require huge efforts to be made in expanding the capacity of the power supply network. The German Government is now going to great lengths to speed up the grid extension programme. The dena Grid Study II of 2010 has come up with the following calculations: if 30 % of the electricity from renewables is to be integrated into the grid system an extra 3,600 km of transmission lines will be needed for the high-voltage system alone and this new capacity will have to be in place within the next decade. This will not only mean stepping up the pace of the planning, approval and development process but will also involve huge investment. Dena has put the cost of the project at close on 10 bn €. Technological alternatives such as laying cables below ground, for example, would in fact prove even more expensive. While the supply grid certainly has to be extended in terms of its size – which is why for example it could be extremely useful to be able to share existing integrated systems such as that operated by Deutsche Bahn – it will also be necessary to carry out qualitative improvements to the transmission capacity. Upgraded networks of this kind are commonly referred to as 'smart grids'. This is an area in which some fascinating technological developments have been taking place – and not just where 'smart grids' are concerned, whose mass-market suitability has still to be tried and tested. However, the rapid expansion and interconnection of the power supply networks can also cause greater levels of interference and disruption at 'critical infrastructures' – such as transmission node points.

As well as creating technical and technological problems, the expansion of the renewables sector – and the development of suitable storage and network systems – will also pose enormous economic and in some cases environmental challenges. These will have to be overcome if the energy, envi-

Herdecke pumped-storage power station (RWE)

Evolution of the state-imposed tax burden on electricity prices



* predicted

Source: BDEW Bundesverband der Energie- und Wasserwirtschaft e. V., 2011

ronmental and resource related benefits of the energy switchover are really to be achieved. The EEG levy, by which electricity consumers bear the added cost of feed-in from renewable sources, is expected to reach a new record high in 2011 with a contribution rate of 3.5 Ct/kWh and a volume of some 13 bn. The cost differential between the feed-in tariff for renewables based power and the market or quoted exchange price for electricity can, in economic terms, be likened to a subsidy. Wind power, solar energy and bio-electricity are now individually more heavily subsidised than German-mined coal. Add to this various other forms of specific state funding for renewables, such as the market incentive programme, the R&D funding programmes and the low-interest KfW loans for investment projects in the field of renewable energies.

An EEG progress report submitted in 2011 by the BMU (Federal Ministry of the Environment, Nature Conservation and Nuclear Safety) predicts that the cumulative volume of differential costs for the period 2012 to 2030 will be in the region of 175 bn €. Another BMU reference scenario for the development of renewable energies to 2020, which was drawn up in 2010 and published in 2011, makes a distinction between different variants based on the electricity price path and a hypothetical appropriation of external costs. Yet here too each variant shows a sustained upward trend that is only reversed around 2020. Renewables are not expected to break through the viability threshold to any significant degree before 2025, and possibly even later than this. Until that day comes the German economy – if it is to realise the opportunities presented by this new technology – will have to bear the additional cost of a renewables expansion programme that has support from politicians on all sides.

The nationwide expansion of the renewables industry (and the supply network) will also cause certain problems from an environment and public acceptance viewpoint and much opposition is expected from nature and landscape conservation bodies and local residents groups. Such cases have to be factored-in and successfully mediated right at the start of the planning process. Other interests, such as agriculture and industry, will also be vying for the limited land space and resources. This makes it even more important to have solutions that will avoid clashes of this kind and provide new ways of using established and accepted infrastructures. A proper and careful assessment also needs to be undertaken of the options available for the expansion of the renewable sector.

Such a large-scale operation as transforming the energy system will necessarily be fraught with imponderables and this makes it all the more important to retain a reliable core structure that will support the power supply industry on its journey into the future. A balanced energy mix will therefore be indispensable – and even in presenting its ambitious expansion proposals the Energy Plan accepts that non-renewable sources will still be meeting as much as 65 %

of our energy production needs by 2020, and will still be providing 50 % by 2030. Coal therefore has to retain its key role alongside renewables and must not be displaced by gas. Coal has always been the premier fuel for electricity production – with a 41 % share worldwide and 43 % in Germany – in addition to its role as a feedstock for non-energy uses. This primacy will continue for the next 25 years, according to the main scenario put forward in the IEA's World Energy Outlook 2010. What is more, over the last decade coal recorded the biggest growth rate worldwide of any fuel. It has significant advantages over competing forms of energy when it comes to price and security of supply. Its environmental shortcomings can be limited in the long term by using the latest technologies for clean coal winning and utilisation – with CCS possibly being introduced at some point in the future – and by further efficiency improvements in the electricity generating sector.

These drawbacks will in any case assume a different perspective in an energy mix that is based increasingly on renewables. In their recommendations for the energy switchover the Ethics Committee for Security of Energy Supply have indeed assigned gas fired installations a 'supporting role', but they also voted for the commissioning of all coal fired power stations under construction or already approved and, moreover, called for a 'high-tech strategy for clean coal' together with CO_2 recycling and a revival of the carbochemical industry. One thing is undisputed: the world's coal reserves, and Germany's too, will last much longer than the gas deposits. The world market for coal is supplied from a much broader geographic base and is also more competitive. Germany itself has reserves of low-cost lignite at opencast mines that could remain in operation for decades to come. And of course the country also has indigenous coal deposits, which admittedly have to be deep-mined under more expensive conditions using state of the art technology – and with production subsidies set to be phased out by the end of 2018. Coal has continued to contribute to the nation's energy supply, albeit it at a declining rate. Germany still has large deposits of indigenous coal and these are not disappearing from the scene. During the 2011 debate on the deletion of the 'review clause' the Coalition members on the Bundestag Economic Affairs Committee accepted that, world market prices permitting, the potentialities of a subsidy-free German coal industry should definitely be examined. However, given this unpredictability the strategic course was set for closing down the industry. Yet the opportunity is still there to take steps to retain the know-how that has been built up within the German coal industry and to ensure that coming generations continue to have access to the coal deposits too. And where the mining infrastructure is concerned that is already being done – as a contribution to a sustainable and 'green' energy future.

International energy and coal markets

Germany's energy supply situation

Security of raw materials supply

From 2003 to 2008 Germany was the world's leading export country. In 2009 it was overtaken by China and so moved to the number two spot. Last year it dropped to third place, after China and the USA. Germany's continuing export strength is mainly based on its capital goods industry, which essentially means engineering, motor manufacturing and chemicals production. As the BDI (Federation of German Industry) pointed out in a position paper on raw-materials policy back in June 2010, secure and competitive access to natural resources is crucially important for this sector. Now this security of supply is threatened. Global demand has increased dramatically as a result of the catch-up effect of emerging nations like China and India and as the commodities market has not yet adapted to the new situation we are now seeing prices occasionally reach unprecedented levels. This trend has been felt all over the world and has more or less had an impact on every international commodities market. It was only temporarily interrupted by the financial and economic crisis of 2009, as recent developments in 2010 and in the first half of 2011 were later to show. In the autumn of 2010 and the first months of 2011 this upsurge in demand triggered a huge escalation in raw-materials prices. In early February, for example, the price of copper broke through the 10,000 US$/t mark for the first time ever, the prices being paid for top quality cotton tripled within a year to their April high and the price of rare earths doubled within a period of three weeks to a new June record.

Qinhuangdao container port

Measures for raw materials security

In the 1990s the German primary processing industry all but withdrew completely from the international mining sector. This was one of the facts that emerged from the raw materials strategy put forward by the German Federal Government on 20 October 2010. But with market conditions as they are at present any vertical and backward integration into upstream markets will be extremely difficult for most branches of industry to achieve. Government policy makers therefore introduced a series of measures aimed at securing raw materials supply and these initiatives are showing the first signs of success. What is significant is that the western economies and public at large are now truly beginning to realise that world supplies of raw materials, once thought of as secure, are becoming increasingly scarce and expensive as a result of the upsurge in demand from the newly industrialising countries. In 2008 the European Commission launched a Raw Materials Initiative aimed at securing access to resources on the world markets, increasing the availability of raw materials sourced within the EU and reducing consumption levels. These objectives were to be achieved by building up stocks of 'critical' raw materials (similar to the national

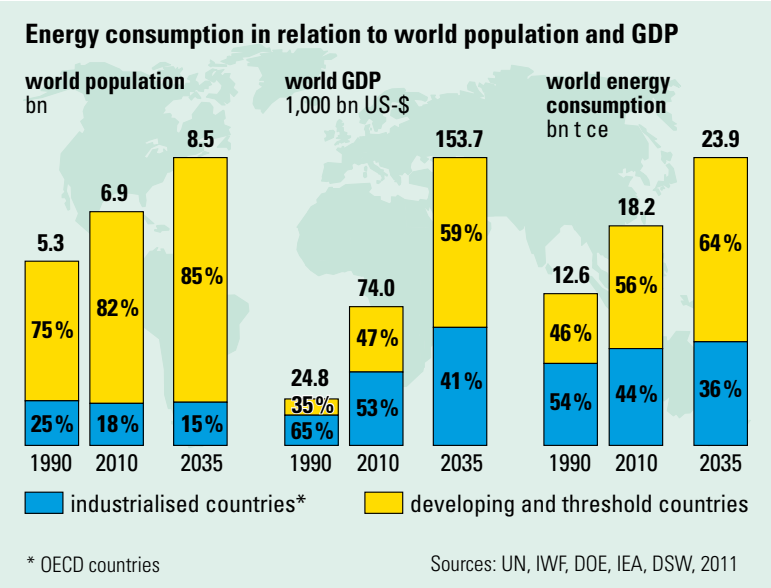
oil reserves), active raw-materials diplomacy, trade policy measures and agreements and a development and security policy targeted at the raw materials sector. Firmer action is also to be taken against unfair competition in general, and export restrictions in particular. In 2009, for example, the European Commission, along with the USA and Mexico, brought a complaint to the World Trade Organisation against China for unfair competition (notably in the case of zinc, manganese and magnesium) and export restrictions on coke and rare earths. In the latter case China had a market share of about 97 % in 2010 and virtually monopolised this sector. Chinese companies were paying much less than their overseas competitors and so gained a competitive advantage. There were also obstacles in the form of restricted export licences and customs duties. On 5 July 2011 the WTO ruled in favour of the EU. China, which has been a member of the WTO since 2001, was given 60 days in which to appeal. Under the ruling China is legally required to phase out its unfair market practices within a few months.

The Federal Government now places a greater onus on commerce and industry to make provisions for their own raw materials supply. This philosophy is manifested not only in long-term contract agreements and the sourcing of raw materials around the world but also in the work of the trade associations. The Federation of International Mining and Mineral Resources, in which the GVSt plays a major role, is a new body that has been set up within the VRB (Raw Materials and Mining Association). German economic policy employs various supporting measures to back-up these industrial initiatives. In October 2010, for example, a resources strategy was adopted for non-energy materials supply. The strategy's core elements were measures aimed at diversifying sources of supply and increasing raw materials efficiency. In specific terms they included the provision of investment, export and untied-loan guarantees. The BRG (Federal Institute for Geosciences and Natural Resources) was also instructed to carry out preliminary geological surveys around the world. Existing legislation on the extraction and exploitation of indigenous resources was considered to be adequate and further regulation was not considered necessary in this area. The German Raw Materials Agency is another body that was established within the BGR in October 2010. In addition, in February 2011 the Federal Ministry of Economics and Technology (BMWi) set up a new Raw Materials Policy Unit with the remit to focus on obtaining secure access to international deposits.

Global economic climate and world energy consumption

According to calculations by the German Institute for Economic Research (DIW, Berlin) and the Kiel Institute for the World Economy (IfW) world economic growth has picked up again following the crisis of 2010. Both these bodies expect global GDP to grow at a somewhat slower pace in the years ahead. Economic growth in the emerging nations of China and India, which slowed down slightly in the crisis year 2009 only to develop strongly again in 2010, is now slowly reaching its limits, mainly as a result of high capacity utilisation. The industrialised nations are still getting to grips with the impact of the economic and financial crisis and are attempting, among other things, to reduce their high levels of debt by adopting a restrictive financial and economic policy. The sharp rise in raw materials prices is another factor exerting a dampening effect on global economic growth. The earthquake and nuclear disaster in Japan also played a part in this development. These events were to cause temporal and spatial shifts in the international ocean freight market (Pacific and Atlantic) and this then led to price rises in the Pacific market because of Japan's increased level of coal and gas imports.

Initial estimates show that world primary energy consumption in



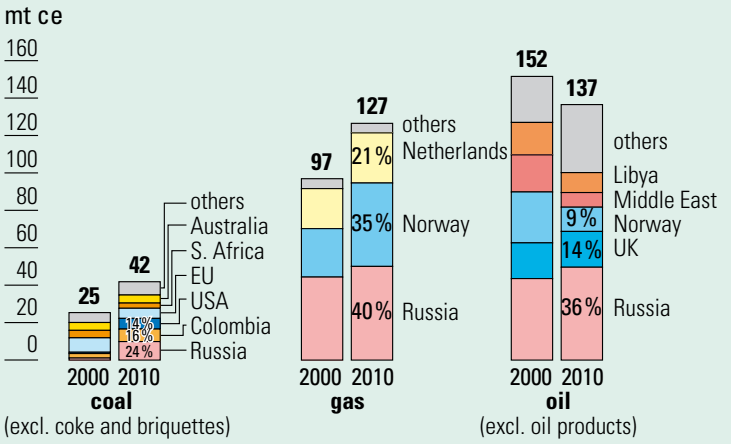
2010 increased to 18.2 bn tce – a rise of about 4.5 % over the previous, crisis-affected year. This was mainly attributable to the sustained high level of economic growth in Asia and the economic recovery taking place in some industrial countries. Energy consumption in the industrialised nations did in fact increase by 2.6 %, which was still slightly below the 2008 level. By contrast, even in the crisis year 2009 energy consumption in the developing and emerging countries increased by 3.2 % and, the following year, went on to grow by 6.1 %. Nearly 80 % of world primary energy consumption in 2010 was met by the fossil fuels, namely coal (28 %), oil (31 %) and gas (21 %). Barely 5 % was provided by hydropower and renewables. Fossil fuels also dominated the world's net electricity production sector with a share of 66 %. Two thirds of this market was supplied by coal alone, which also recorded the strongest growth of 7.5 %.

According to predictions put forward by the International Energy Agency (IEA, Paris) in November 2010, world primary energy consumption, as based on their New Policies Scenario, is set to increase by 1.2 % a year to 23.9 bn tce between 2008 and the end of the projection period in 2035. The latest IEA scenario for the new energy policy framework assumes that all climate commitments and plans already in place will actually be implemented worldwide. The scenario predicts that fossil fuels' share of primary energy consumption will decline from 81 % in 2008 to 74 % in 2035. Renewables (including biomass and solid waste) will be supplying just under 19 % of the energy market by 2035. Trends also indicate that the shift from the industrialised nations, on one hand, towards the developing and emerging countries, on the other, is set to increase right up to the end of the projection period in 2035, whereby population and economic growth will remain the most important drivers of energy consumption in the developing and transition countries. Population trends in the industrialised nations, by comparison, are expected to remain fairly static and energy consumption will increase at a slower pace than economic growth. This can be attributed to the decoupling of economic growth from energy consumption taking place in this group of countries.

German imports of energy resources

Despite having some energy resources of its own, Germany remains heavily reliant on imported fuels and this dependence is set to increase. Eurostat figures confirm that by 2009 Germany's energy import quota (ratio of net imports to gross domestic consumption) for coal (including coal products) had more than doubled within a period

German fossil-fuel imports 2000/2010
Shares of the three largest supplier countries in 2010



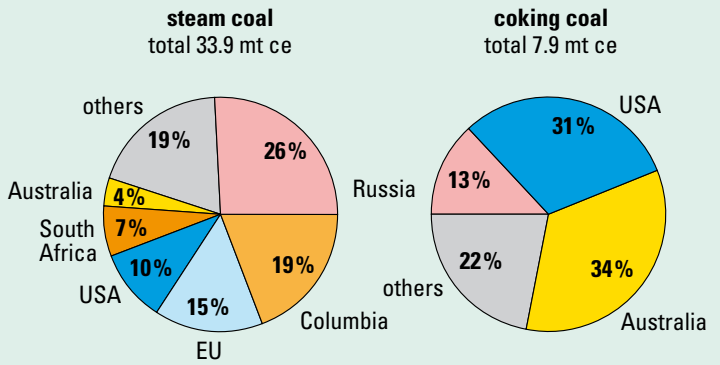
Sources: Statistik der Kohlenwirtschaft e. V., Bundesministerium für Wirtschaft und Technologie, Wirtschaftsverband Erdöl- und Erdgasgewinnung e. V.

of 10 years. This was due mainly to the ongoing restructuring process taking place in the German coal industry. The relevant figure for gas was over 10 %, this being attributable to an increase in gas fired electricity production and a higher level of gas consumption in the heat market. The import quota for oil has changed little over time and rose 1 % or so between 1999 and 2009.

In 2010 Russia was the dominant supplier of Germany's imports of all three fossil based fuels. Together with the USA and Colombia Russia supplied about 54 % of German coal imports, while along with Norway and the UK it provided about 59 % of crude oil imports and, with Norway and the Netherlands, about 96 % of gas imports. The supplier structure for gas and oil imports has essentially remained unchanged over the last decade (from the reference year 2000). The coal import sector, on the other hand, has seen major structural changes, with sources of supply increasingly shifting from Poland, the Czech Republic and South Africa towards the USA and Russia, in particular. German-bound exports from both these countries have now risen more than seven-fold. Colombia has also tripled its deliveries, while imports from Australia changed little over the period. Generally speaking, supply sources for German coal imports remained as highly diversified as in previous years.

This was mainly a result of the highly diversified make-up of the steam coal import sector, which at nearly 34 million tce accounted for more than four fifths of total coal imports. Imports of coking coal, on the other hand, are concentrated around much fewer sources, with 78 % of the total volume coming from just three supplier countries. In global terms the coking coal market is generally less widely diversified that the steam coal sector.

Sources of supply for German coal imports 2010



Source: Statistik der Kohlenwirtschaft e. V., Gesamtverband Steinkohle e. V.

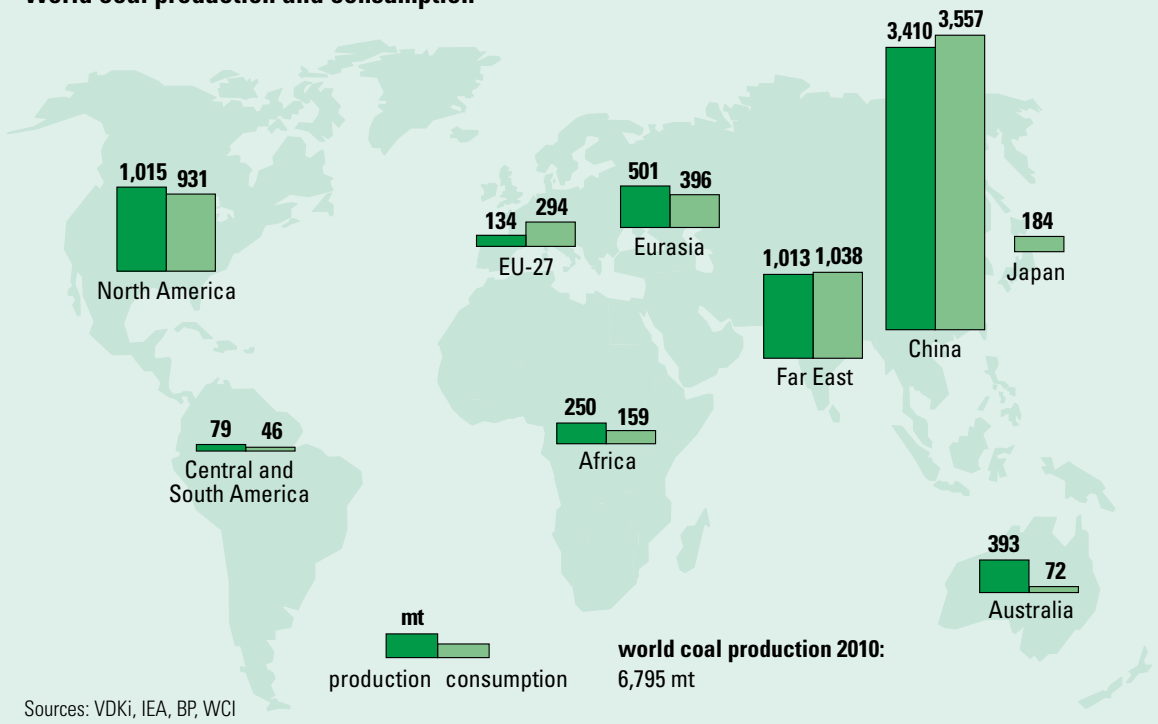
Developments on the world coal market

Annual coal production worldwide has increased 85 % in the last 20 years and in 2010 was estimated at about 6.8 bn t (up 10 % on the previous year). Of this, 5.9 bn t was steam coal and 0.9 bn t coking coal. The three largest coal producing countries – China with 3.4 bn t, the USA with 1 bn t and India with 0.5 bn t – together accounted for about 73 % of the total world output. These three nations were at the same time the world's biggest coal consumers. Most of the coal produced was consumed by the home market and in neighbouring countries (inland trade), with only about 14 % of world production (approx. 960 million t) being traded overseas. This sector comprised 713 million t of steam coal and 250 million t of coking coal. The main steam-coal exporters were Indonesia (39 %), Australia (20 %) and Russia (11 %) and the main coking-coal suppliers were Australia (64 %), the USA (19 %) and Canada (10 %).

Prices

The prices being quoted for coal on the world markets have now recovered from their dramatic collapse at the low-point of the global economic crisis in mid-2009 and since then have generally reported a strong upturn. Spot prices for coal have in some cases been approaching the record highs witnessed in the boom year of 2008 – driven by the fast pace of economic growth in China and India and

World coal production and consumption



Sources: VDKi, IEA, BP, WCI

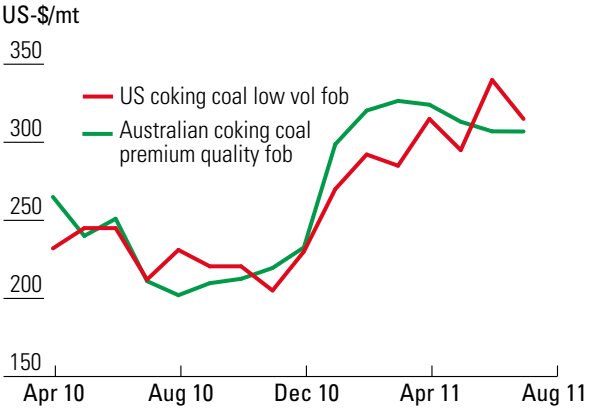
supported by the cold winter in the northern hemisphere. However, prices were slightly dampened by the somewhat moderate economic recovery in most industrialised nations and the inadequate expansion of export capacity in the coal supplier countries.

Coking coal

In the first few months of the current year the international coal market was beset by a series of severe supply disruptions that caused prices to rise dramatically, particularly for coking coal. The serious floods that were triggered by heavy rainfall in the Australian province of Queensland led to huge production losses – and this was aggravated by dock-worker and mineworker strikes, natural disasters and other extreme weather conditions. A large number of suppliers were compelled to issue force majeure declarations. The delivery shortfalls alone have now been estimated at some 25 million t a year and the problem dragged on for several months. The benchmark price for premium grade Australian coking coal rose steeply and by February 2011 the monthly average figure was already over 320 US$/t fob, i.e. free at the Australian port of shipment.

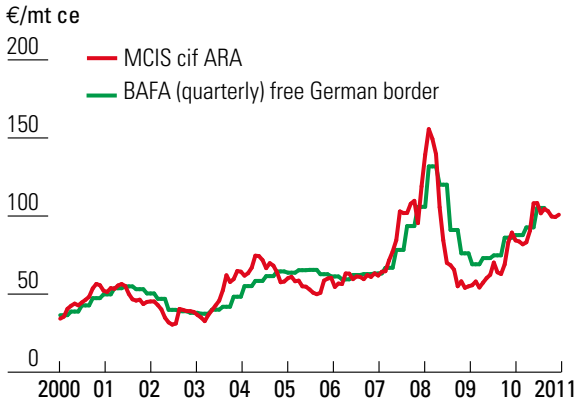
Pacific buyers in search of alternative sources of supply have found rich pickings in the USA (east coast), a region that has traditionally tended to serve the Atlantic market. The USA has still to recover from the impact of the global economic crisis and the recession there means that tonnages are still available – and this is now finding its way on to the international coal market. However, this has proved to be a difficult process, as the capacity conditions of US coal logistics are not aligned to such large trade flows. Add to this the fact that coal exports have already come under the spotlight in that part of the world. This is in contrast to the European steel industry (EU-27), which managed to recover from the crisis in 2011 and succeeded in increasing its crude steel output by some 24 % over the crisis year 2009. However, production is still nearly 13 % down on the boom year of 2008. The coking-coal price surge has therefore spilled over to the Atlantic market.

By mid-2011 there were growing signs – again emanating from China – that the market was steadying. This put increasing pressure on coking coal suppliers like BHP Billiton (BHPB) in their attempt to keep the price of premium grades above 300 US$/t. Against this background BHPB and many others will be left wondering whether, with falling price expectations, switching from the quarterly pricing system – which was only introduced in 2010 – to monthly pricing is really a worthwhile move. Since the beginning of 2011 BHPB has been attempting, via individual contract agreements, to introduce monthly-based pricing arrangements, but despite offering price discounts it has encountered stiff resistance from its customers. Caught in an increasingly uncertain market because they are sandwiched between the raw materials suppliers and the consumers (which include the automotive industry) the steel producers have become more and more nervous about the future. In some cases this has meant long-standing BHPB customers switching to rival operators (for example US coking coal suppliers). In July 2011, according to company sources, BHPB achieved the deal they had been looking for, initially with Japanese steel producers and subsequently with Indian buyers, and agreement was reached on 50:50 split between quarterly and monthly price setting. However, with market prices then on a downward trend this could hardly be considered a breakthrough.



Source: IHS McCloskey Coal Report

Price trends for premium coking coal fob USA (east coast) and Australia (Queensland)



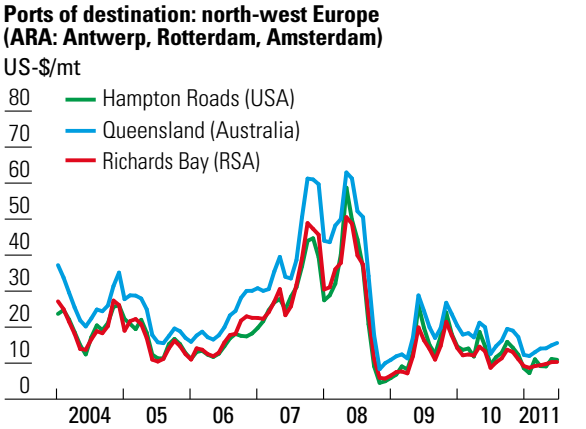
Sources: IHS McCloskey Coal Report / BAFA

Price trends for steam coal cif north-west Europe

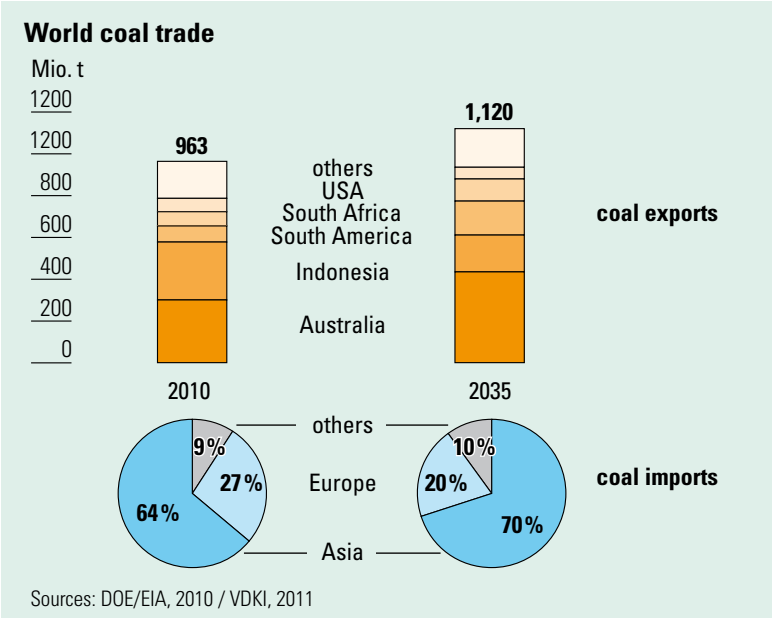
Steam coal

In 2010 and during the first months of 2011 the north-west European steam coal market found itself well supplied, apart from a few temporary problems caused by extreme weather conditions, including heavy rainfall in Colombia. With demand at a very low level and stock volumes high the spot market prices for steam coal held up surprisingly well, with a price range of 120 to 130 US$/t. However, this was also due to contributing factors such as the euro exchange rate in relation to the US$, development trends in Richards Bay (South Africa), speculative influences, prices on the downstream electricity market and oil price levels (Brent crude). By mid-2011 the electricity producers were again taking larger volumes from stocks, with the result that a slight increase in activity can be expected on the steam coal market by the end of the summer.

Price trends for sea freight rates to Europe



Source: IHS McCloskey Coal Report



Sources: DOE/EIA, 2010 / VDKI, 2011

Sea freight

Maritime cargo rates for capesize bulk carriers (with capacities of 80,000 to 120,000 DWT), which are mainly used for transporting coal and ore, have again been falling since the beginning of 2011. For Atlantic destinations in particular (Hampton Roads and Richards Bay) they have temporarily slipped into the single-digit range. This is a consequence of the Australian floods (December 2010/January 2011) and the earthquake in Japan (March 2011), which in the medium term saw shipping capacity shift into the Atlantic.

There are still expectations of moderate cargo rates, as capesize shipping space is likely to increase both this year and next because of bulging order books.

EU responsibility for energy policy

Energy policy remains a high priority for the European Parliament, the European Council and the Commission. This is reflected in the fact that the Treaty of Lisbon contains a specific section on energy. Yet the EU's future energy strategy is also faced with new challenges. Policy makers need to establish, for example, what impact the events in Japan and North Africa will have on the European energy market. Whatever happens, an EU-wide expansion of the network infrastructure is a key requirement for a fully functional internal energy market and the greater integration of renewables into the power supply system.

The EU needs to have appropriate powers of responsibility if it is to implement its energy objective. The Treaty of Lisbon recognises that energy policy is one of the Community's key fields of action. The Treaty's new Article 194 on the functioning of the European Union (TFEU) contains a specific competence for the enactment of energy policy measures that establishes a number of EU energy objectives, including ensuring the functioning of the energy market, safeguarding EU energy supplies, developing new and renewable forms of energy and promoting the interconnection of energy supply networks (Article 194 I lit. a) to d) TFEU).

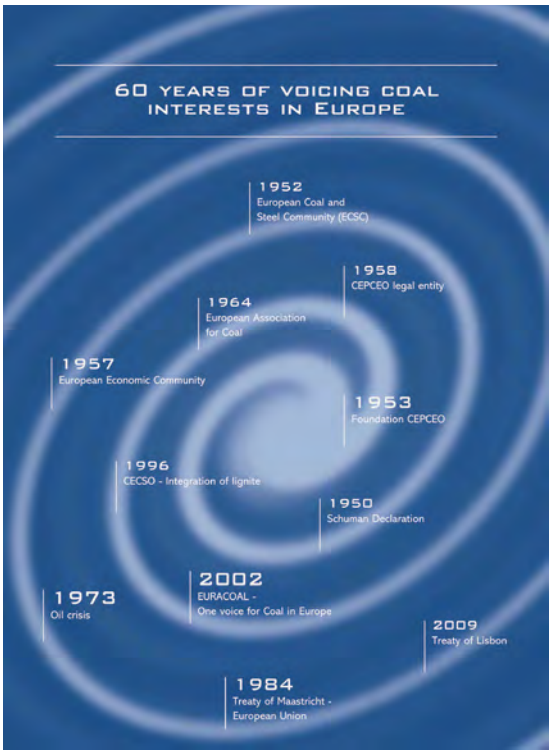
Energy policy is still not brought entirely within the Community sphere and EU energy competence remains restricted. Member states will continue to have the right to determine their energy sources and the structure of their energy supply (Article 194 II subparagraph 2 TFEU). This reflects the different energy policies that have been adopted to date by the 27 member states. At the end of March 2011 the European Council again confirmed that the choice of energy mix falls within the competence of the member states. The Commission also concedes that the EU has to respect the fact that member states have national responsibility for decisions on energy mix. In the context of subsidiarity and the agreements reached on the production targets for renewables to 2020 each member state is free to decide its own particular energy mix – and this includes the option to utilise its own indigenous energy resources.

Nevertheless, the EU is ascribed a whole range of competences in areas that are relevant for the development of renewables, though these are mainly associated with actions in the environment field. Article 192 I TFEU provides a new competence base for EU actions aimed at implementing the environmental objectives set out in Article 191 TFEU. Energy research, energy efficiency and energy-related environmental measures undertaken by the member states, along with national support for renewables, all have to be in line with Community aims. Ultimately, however, energy and environment policy remain closely tied and this will continue to result in overlapping remits. One such example is the European emissions trading system: while this is clearly an environment and climate protection measure it does, however, have serious repercussions for the energy sector. In the third trading period beginning 2013 the national caps – which are the carbon emissions quotas – are to be replaced by an EU-wide cap. The aim is to impose sanctions on the use of fossil fuels. The EU's environmental measures are at least subject to unanimity (Article 192 II lit. c) TFEU) inasmuch as they apply to actions significantly affecting a member state's choice between different energy sources and hence the nature and general structure of its energy supply.

In matters of national energy competence there is a real need for clarification on the extent to which the EU can restrict national energy policy space by way of environmental protection measures. There are also questions of demarcation arising from the fact that the unanimity requirement only applies to energy policy measures that directly affect the basic energy supply structure. In the case of the EU Directive on the Promotion of Renewable Energies, for example, there was some disagreement as to whether this constituted significant interference in the energy supply structure of the member states. Moreover, with regard to the economic integration of renewables, some clarification

is required on the extent to which priority feed-in will still be possible or acceptable as renewables' share of the market continues to expand.

Where coal is concerned the EU has also been able to influence the existing energy mix under its competition remit. On 10 December 2010 the Council adopted a Decision on state aid to facilitate the closure of uncompetitive coal mines which provides for the definitive termination of subsidised coal mining in the EU by the end of 2018 (see above 'Taking stock: German coal as part of the energy mix'). The Commission's entitlement to introduce energy policy regulations was rejected by the other Community institutions in that they regarded this as an infringement of other objectives and an excessive use of the Commission's powers. Questions exist as to whether it is possible and acceptable that the energy option of a member state should be completely blocked by the EU remit to rule on state aid. Retaining a minimum production level of indigenous coal as a contingency measure is precisely what the national energy option is all about – and this was also the declared aim of the Community regulation that applied to the end of 2010.



The Commission's 2020 Energy Strategy also constitutes intervention into the energy mix of the member states. This energy and environmental package sets the following goals for the EU: a 20 % reduction in CO_2 emissions, an increased share of renewables to 20 % and a 20 % improvement in energy efficiency – and all by 2020. The initiative also seeks to provide reliable energy supplies at competitive prices. The European Commission now intends to present a scenario-based energy roadmap by the end of 2011 that will set out the long-term prospects for a reliable, affordable and low-emission European energy supply for the period to 2050. The roadmap will also describe scenarios for energy systems with low CO_2 emissions and the energy policy measures needed to achieve them. Implementing this strategy at national level will place an additional burden on fossil fuels.

As long as there are overlapping competences in the energy sector European energy policy will be caught between a set of centrally oriented actions and a decentralised allocation of powers that are based on the individual member states. This applies especially to coal and nuclear power – the very energy sources that have had by far the longest-standing Community dimension under the ECSC Treaty, now expired, and the Euratom Treaty, which is still in existence.

The Treaty establishing the European Coal and Steel Community (the ECSC Treaty) was signed sixty years ago, on 18 April 1951, by the representatives of Belgium, Germany, France, Italy, Luxembourg and the Netherlands. It was the first Treaty of the European Community and would lay the foundations for European integration and security of energy supply in Europe. The Coal and Steel Community, which provided for common

Federal Chancellor Adenauer (third from right) after the signing of the ECSC charter; other signatories are (from left) von Zeeland (Belgium), Beck (Luxembourg), Maurice (Belgium), Sforza (Italy), Schuman (France), Stikke (Netherlands) and van den Brink (Netherlands).

supranational control of the coal and steel industry, came into being on 23 July 1952. The signatory nations thereby undertook to transfer part of their sovereign powers to a supranational organisation and therefore to give up part of their sovereignty. The European Coal and Steel Community came to an end fifty years after its founding when the ECSC Treaty expired on 23 July 2002.

Against this historic background it is especially interesting that an issue that has been increasingly debated in recent months is whether the EU should be given more powers over changes to the energy mix. Transferring more responsibilities to the EU requires the agreement of all the member states. One of the reasons given for such an extension of powers is the need to expand renewables' input and ensure their technical and economic integration into the energy system. This will require further expansion of the transmission grid and a harmonised link-up of the energy infrastructures at European level. At the same time storage potential also has to be built up in different locations to serve EU-connected third countries. The Third Single Energy Market Package has already taken various steps towards this.

The question of extending powers is particularly relevant in the nuclear energy sector. The EU has until now had no real rights of control over the construction, operation and safety of nuclear power stations. The EU is only able to impose minimum standards for plant safety. This has now been reflected in the decision taken by the European Council at the end of March 2011 to carry out comprehensive risk and safety assessments (stress tests) of all nuclear plants operating in the EU. In

undertaking such a European-wide stress test, however, the EU has no formal legal basis to fall back on. There is nothing of this kind either in the Euratom Treaty or in the Treaty of Lisbon. Those participating in the stress test therefore do so on a voluntary basis.

The legal basis for such an action is predominantly given in European Environmental Council Directive 2009/71/EURATOM of June 2009 establishing a Community framework for the nuclear safety of nuclear installations. If a nuclear power station should fail the test it is ultimately the responsibility of the member state in question to take the plant out of service. It was therefore logical that in March 2011 the EU Commissioner for Energy, Günther Oettinger, should describe the provisional agreement on stress tests for nuclear power stations as an initial step towards the Europeanisation of nuclear energy policy. It would still be left to EU member states to decide whether or not to use nuclear energy. However, as safety was indivisible for Europe the Commissioner therefore called for new EU powers in this area.

Even in 2010 the Energy Commissioner noted that in his opinion there were few areas in which the perception of Europeanisation was as far advanced as the energy sector. He believed that there was broad support for measures aimed at greater Europeanisation of energy policy. The question was whether the member states were ready to give up some of their powers. If the EU remit were to be widened, even if this only meant responsibility for coordination, the national energy policies of the member states would always have to take this additional factor into account. At national level this could mean having to make additional efforts that were previously not required or had been disregarded. It could also mean that from a Community perspective any pioneering initiatives at national level would run counter to European harmonisation efforts and the principles of equal competitive conditions for all.

It seems evident that long-term energy supply issues can no longer be dealt with at national level alone. It is therefore to be welcomed that the European Council of Heads of State and Government has confirmed its intention, where future EU energy policy is concerned, to complete the single energy market by 2014. This should promote real competition in a market that has been relatively ineffective to date.

The deadline for achieving this target seems very ambitious to say the least and even the implementing instruments for the Third Single Energy Market Package have yet to be fully incorporated in the member states. It is also hoped that the single market will make gas and electricity supplies more secure Europe-wide and that greater support will be provided for renewables. For the Commission it is in this context especially important to ensure that the EU Renewable Energy Directive is transposed and implemented into national law. This will require a massive expansion of the supply grid. According to the Commission some 45,000 km of new or upgraded transmission lines will be needed in the electricity sector alone over the next ten years.

Günther Oettinger, EU Commissioner for Energy

Building these new electricity and gas networks will cost hundreds of billions of euros.

EU energy policy continues in many respects to be caught between national and European interests. A common energy policy for all EU member states is still a long way off – in spite of the new provisions laid down in the Treaty of Lisbon and even after the adoption of the Third Single EU Energy Market Package. We therefore have to endorse the European Council's statement of early February 2011: 'Europe's potential for the sustainable extraction and use of conventional and unconventional (shale gas and oil shale) fossil fuel resources should be assessed in order to further enhance Europe's security of supply.'

There is therefore much to indicate that the time is ripe for a greater Europeanisation of energy policy in a way that also includes indigenous energy resources.

Coal and the environment

In 2010 the climate debate was dominated by the environmental issues surrounding the new EU regulations on emissions trading after 2013 and their transposition into national law. Mine gas recycling plants are now affected by these provisions for the first time. The proposed exploitation of unconventional gas deposits has triggered a fierce debate, especially in North Rhine-Westphalia. The use of renewable energies is one of RAG's new strategic fields of actions and mining sites offer a wide range of opportunities in this area. The feasibility, financial viability and market opportunities associated with such ventures are now being examined and some projects are already underway.

In December 2010 the Land Government of North Rhine-Westphalia presented a first draft bill to change the Water Abstraction Levy Act (WasEG). The time-limit for water abstraction laid down in the WasEG of 8 December 2009 was revoked and the annual reduction in the rate of the levy was abolished. Another amendment was then tabled and the law came into force on 25 July 2011. This change will impose a high financial burden on the mining industry of North Rhine-Westphalia. The derogation on the extraction of mine water, defined as the 'Abstraction of groundwater in the mining of natural resources where the water being extracted is discharged directly into receiving waters and is not used elsewhere', was deleted. This compulsory levy on mine effluent and drainage water will be abolished after the cessation of mining activities.

On 21 July 2011 the Land Government approved the bill for a law to promote climate protection actions in North Rhine-Westphalia. The new legislation proposed a reduction of at least 25 % in total greenhouse gas emissions in NRW by 2020 and a minimum 80 % reduction by 2050, both in relation to the reference year 1990. These regional environment targets were to be given concrete shape in the form of a Climate Protection Plan and a set of regional planning instruments. Even though a number of changes and corrections had been made to the previous bill, business and industry still protested against this legislative initiative as it would impose binding regional targets in addition to those laid down at European and Federal level. Business undertakings were fearful of planning uncertainty, particularly in the area of regional development and urban land-use planning, because without presentation of a Climate Protection Plan – which was not to be drawn up until 2012 – many questions would be left unanswered when it came to actual implementation. Even the 'priority rule', according to which measures aimed at achieving environmental targets would take priority over all other private or public policy considerations, contained ambiguities when applied to other legally protected rights. As the Climate Protection Plan specifies the measures that have to be taken to achieve the environmental targets the business sector considers it vital that the Plan be adopted either before or at least at the same time as the legislation.

CO_2 emissions trading

Following the introduction of an EU-wide emissions trading system in 2005 the third trading period for CO_2 emission permits is due to begin in 2013 and will span the period 2013 to 2020. The emissions trading system (ETS) was extended to the airline industry in 2012 and other emission-intensive sectors will be brought into the scheme by 2013. The total volume of emissions for all installations subject to compulsory emissions trading is determined by an emissions 'cap', which will be continuously reduced by 1.74 % a year from 2013 on. After 2013 the allocation rules will cease to provide free allowances for electricity generation, and for industrial power too, and will introduce a 100 % auctioning system for emission permits.

Installations operating in certain sectors that are considered highly exposed to competition from third countries (carbon leakage) are given the opportunity to reduce their costs: emissions trading permits were issued free of charge

to these undertakings up to 2010. This free allocation was based on product-specific benchmarks for industrial undertakings and on heat benchmarks for heat generating installations. Businesses not affected by 'carbon leakage' are required to take the auctioning route: for them free permit allocation will be for a transitional period only and will be reduced from 80 % in 2013 to 30 % in 2020. Operators of smaller installations producing less than 25,000 t of CO_2 emissions a year can apply to opt out of the ETS, though in return they must commit to implementing equivalent measures for emissions reduction.

By 2020 the emissions trading system is expected to be making the biggest single contribution to greenhouse gas reduction in Europe and to this effect a greater degree of harmonisation is being introduced EU-wide. Up to now the 27 member states could each determine their own rules for the free allocation of trading allowances. After 2013 uniform rules will be applied to all member states for the free allocation of trading permits and for their auctioning. Participating undertakings will be given permits allowing them to emit certain quantities of CO_2 and will be able to sell on any that are surplus to requirements.

The amendment to the Greenhouse Gas Emissions Trading Law (TEHG) transposes the unified regulations on EU emissions trading into the German legal system. Differences of opinion were expressed in the Bundesrat as to the respective competences of the Federal and Länder governments. In future, emissions monitoring will be undertaken by the German Emissions Trading Office (DEHSt), which comes under the Federal Department for the Environment. According to current German law the revenue from the auctioning of trading permits is assigned exclusively to the Federal Government – as determined by the Allocation Act and the TEHG and its latest draft. Auction proceeds of over 900 million € currently flow to the special Federal 'Climate and Energy Fund' (EKF) under the terms of the Climate and Energy Fund Act (EKFG). This fund is primarily intended for measures aimed at reducing emissions at both national and international level and increasing energy efficiency. In the view of the North Rhine-Westphalia Government it is not logical that all the proceeds from the auction should be handed over to the Federal Government when a large proportion of the funds are in fact raised in the NRW area – and, what is more, the Land consequently suffers a loss of tax revenue at local level.

On 8 July 2011 the Bundesrat approved the 'Law amending the legal basis for the continuation of the emissions trading system', as adopted by the Bundestag on 9 June 2011.

Inclusion of mine gas in the CO_2 emissions trading system

Under the terms of the Kyoto Protocol the European Community is committed to reducing CO_2 levels and also cutting emissions of five additional greenhouse gases. This group includes methane (CH4), a substance also found in mine gas – which is a combustible mixture of air and methane that becomes explosive when its methane content is between 5 and 14 %. Mine gas is an unavoidable product of coal winning operations and it goes on being released into the atmosphere for many years after mining activities have ceased. Germany now leads the world in the development of technology for mine-gas extraction and acts as a consultant in newly emergent nations like China and India.

Before the Renewable Energy Sources Act (EEG 2000) came into force mine gas utilisation was not generally a cost-effective operation and after being pumped out of the workings the gas was simply released into the atmosphere in an unaltered state. The large-scale and cost-effective exploitation of mine gas only became possible when it was ranked alongside the renewable energies under the terms of the EEG. The Act also imposed restrictions on the practice

of venting the gas directly into the atmosphere.

The mine gas-fuelled power plants operating in NRW and Saarland now have a total installed electrical output of 250 MW. In 2009 Germany produced some 1,240 GWh of electricity by this means, enough to supply more than 400,000 households. To this can be added about 400 GWh/a of heat from high-efficiency combined heat and power (CHP) operations.

As well as bringing safety benefits, the targeted extraction and utilisation of mine gas makes a significant contribution to reducing greenhouse gas emissions. This is because burning the methane contained in the mine gas to produce CO_2 minimises its environmental impact by a factor of 18.25. Yet in spite of this very beneficial aspect, from 2012 onwards mine gas installations with a rated thermal input of > 20 MWth will also be included in the aforementioned emissions trading system.

The inclusion of large mine gas-burning installations into the emissions trading system is inconsistent with its practicable implementation: the ETS is supposed to assess environmental emissions and create incentives for reducing emission levels. This concept is not relevant for mine gas as the methane emissions that are averted by operating mine gas-burning plant de facto yield a much greater environmental benefit.

In 2009 Germany emitted about 0.9 million t of CO_2 as a result of using mine gas for generating electricity and heat – an operation that prevented some 5.5 million t/a of CO_2 equivalent from being released into the atmosphere. This equates to an emission avoidance quota of about 84 %. This demonstrates how mine gas exploitation companies are now being set up at both active and disused mining sites across the region. However, it is simply not possible to meet both objectives at once, namely to capture and burn as much of the fuel (mine gas) as possible while at the same time reducing CO_2 emissions.

In the Ruhr coalfield the size of the combustion installation is determined by the local methane deposits. Where circumstances permit corresponding numbers of combined heat and power (CHP) units have been established to extract all the available methane at a particular site. The interconnected mine gas grid that was set up in the Saar coalfield after the Second World War, and which has been continuously expanded ever since, provides the opportunity – at sites where there is a high heat demand – to combine mine gas CHP units into larger installations (with a rated thermal input of over 20 MWth) instead of dispersing them across the region at the different gas extraction stations. This has the advantage of being able to use the mine gas for combined heat and power generation, whereby the fuel is consumed at an efficiency rate of about 80 % and the heat is fed into district and local heating grids. This practical concentration of gas utilisation units around heat sinks could see its economic viability seriously threatened by future emissions trading regulations – and the fixed EEG feed-in tariffs would prevent the higher production costs from being passed on to the end users.

CO_2 recycling – from 'pollutant' to reusable resource

Recent years have witnessed an increase in university and industry based research into CO_2 utilisation and recycling. Rational CO_2 utilisation is also on the agenda of the new Potsdam Institute for Advanced Sustainability Studies (IASS), whose founding director is the former Federal Environment Minister Klaus Töpfer. According to Töpfer 'We must be able to do something with CO_2 other than let it escape into the atmosphere or inject it below ground as a waste product'. The Federal Government and Land Brandenburg provide about 9 million €a year to the Institute, which sees itself as an interface between science, government and the community. The

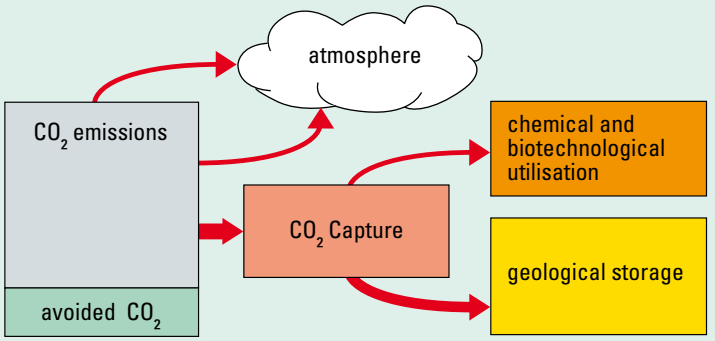
IASS is a forum where researchers from all around the world can meet together and develop concepts for a more sustainable future.

Pure CO_2 is already being used today: it is employed, for example, as an industrial gas for chemical cleaning, as a working medium in refrigeration systems and in greenhouses to promote better plant growing conditions. The foodstuffs industry needs CO_2 for the carbonation of beverages and for water neutralisation. Carbon dioxide and carbon monoxide are used as raw materials for the manufacture of various substances, including polyurethane, carbonates and methanol.

The range of applications is still very small when compared to the quantity of man-made emissions being released. Current CO_2 usage, which is about 100 million t/a, still accounts for less than 0.5 % of the volume of CO_2 emissions being produced worldwide.

The Federal Ministry of Education and Research (BMBF) has developed a three-pronged approach: avoiding CO_2 emissions, subsoil storage of CO_2 (CCS - carbon capture and storage) and utilisation of CO_2 as a raw material. In May 2009 the BMBF published the details of its funding programme 'Technologies for sustainability and climate protection – chemical processes and utilisation of carbon dioxide', which will provide support to scientific bodies and industrial undertakings to work together to develop and test innovative technologies and processes. The objective is to alter and/or extend the resource base by using CO_2 to produce basic chemicals. There is also the possibility of recycling CO_2 as a carbon building block for chemical products. A total of 100 million €is to be allocated to this funding programme over the next five years.

CO_2 options



Source: Arbeitsgemeinschaft Energiebilanzen e. V., 12/2010

One objective is to use the CO_2 that is emitted from power stations as a replacement for the CO_2 that is needed for manufacturing certain products and has to be specially produced for this purpose. Up to now the chemical industry has obtained its carbon from mineral oil. Bayer AG has now set up a pilot plant to trial a new catalyst technology that has successfully produced a chemical precursor into which CO_2 is incorporated. This precursor product can then be processed into polyurethanes. The CO_2 is obtained by separation from flue gas in a CO_2 scrubber at a lignite fuelled power station operated by RWE Power AG.

There are also various biotechnology based processes that can contribute to CO_2 reduction. These include methane production by microalgae, the induction of offshore algal blooms by iron fertilisation and algae based systems that absorb CO_2 from flue gases that are passed through them. Microbes can also help produce biomass from flue gas and this can be processed into viable industrial products – including new biomaterials and chemical intermediates. If all this potential is to be exploited in the near future a huge body of reliable data will be required for systematic analysis so that a widely diversified range of promising new applications can be developed for CO_2 recycling and utilisation.

A 'green RAG'

Using renewables is one of RAG's new strategic fields of action. Mining sites have a huge potential for exploiting geothermal energy, wind power, photovoltaics, regrowth resources and pumped-storage power stations. RAG AG and its subsidiary RAG Montan Immobilien are currently working with partner companies to investigate a range of possible renewable energy options. In a discussion with NRW Environment Minister Johannes Remmel in June 2011 RAG Chairman Bernd Tönjes was quite emphatic: 'We want to make our corporate contribution towards structural change and to the development of the Ruhr as future clean-climate zone'. He went on to say: 'We want above all to investigate the extent to which electricity and heat can be produced from renewable energies by using our existing mining infrastructure and technical know-how and to find out if we can help develop solutions for the storage of electricity from renewable sources'.

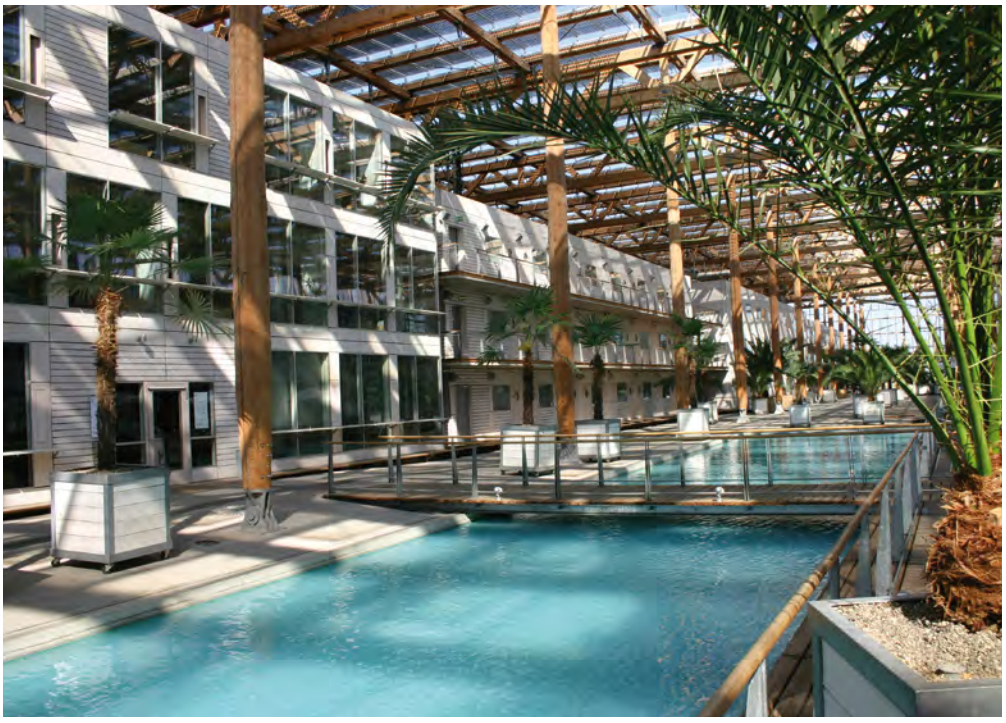
Johannes Remmel welcomed these plans: 'RAG is on the right track. The future belongs to renewable energies and whoever chooses the right course now will be on the winning side. …We need courageous entrepreneurs and companies with vision to drive the era change with innovative technologies. RAG has some very interesting and promising plans in the pipeline.'

RAG's portfolio of projects includes:

- installing wind turbines on waste heaps,
- cultivation of biomass on disused former mining land, such as the 22-hectare brownfield site at Hugo colliery in Gelsenkirchen,
- recovery of heat from mine water,
- building pumped-storage power stations on colliery waste heaps and
- investigating the viability of underground pumped-storage power stations at disused mines.

In the words of the Environment Minister: 'We need modern and innovative pumped-storage technologies for our future energy system. This process has enormous potential. We therefore need to look into how and where we can install such storage installations and some firms are already doing this. And now RAG has also presented a number of interesting proposals in this area.'

Photovoltaics building at the Mont Cenis Academy, Herne



Guest contribution from RAG Aktiengesellschaft
Dr Peter Fischer, *Head of Site Services and Geoservices at RAG Aktiengesellschaft*

'Renewable energies thanks to mining resources'

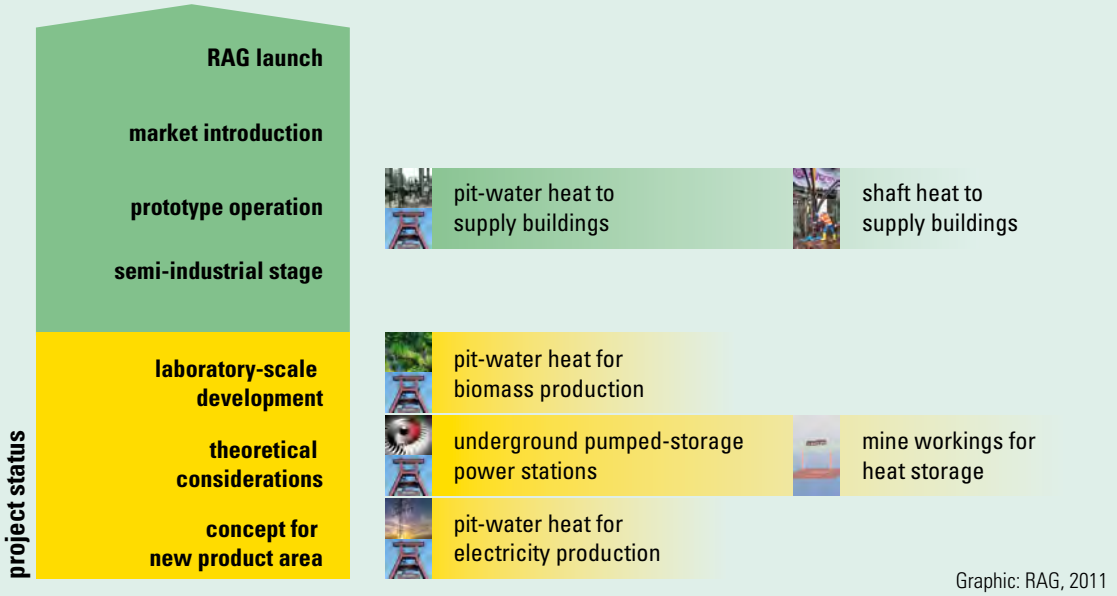
Over the last few years RAG has been examining different ways in which its mining infrastructure and internal know-how can be exploited for the production of renewable energy. The first concepts have now been transformed into real projects and from basic ideas have now come scientific investigations and feasibility studies.

RAG believes that all actions on renewables that use company-own resources are a logical way to complement and enhance the company profile. Building on existing infrastructures makes an effective contribution to the run-down process. At the same time a future-proof business segment is being developed for that time to come when there is no coal mining industry.

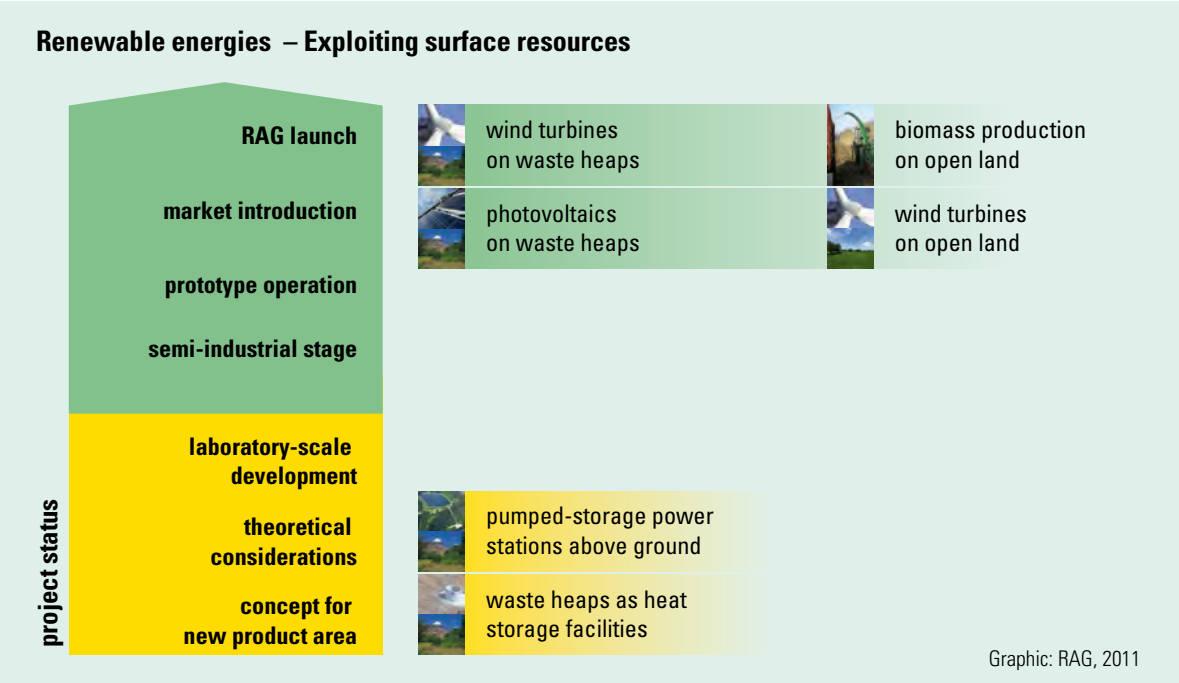
RAG uses its mining infrastructure for renewables production in a whole range of ways. Mining has left behind a huge legacy: countless waste heaps 100 m or so in height, mine shafts that go down as far as 1,300 m, large areas of undisturbed land and huge buildings. Warm mine water is being pumped to the surface at temperatures of around 30°C. And then there is the industry's indispensable technical know-how that will stand us in good stead for future projects.

The EU, the Federal Government and the Länder all want to see dramatic reductions in CO_2 emissions in the future. The Federal Government has set a number of targets for the year 2020, including a 40 % reduction in greenhouse gas emissions, a 20 % cut in primary energy consumption and an 18 % increase in renewables' share of gross final energy consumption, which is to be raised to 60 % by 2050 – all measured against the reference year 1990. The Land Government has also set high standards in its draft bill on supporting climate protection in North Rhine-Westphalia: greenhouse gas emissions are to be reduced by 25 % from 1990 levels

Renewable energies – Exploiting underground resources



Graphic: RAG, 2011



by the year 2020, with a target of 80 % by 2050.

RAG is in a position to contribute towards achieving these goals by making its mining infrastructure available for further use in support of renewable energy projects.

Current project development presents a varied picture. Some schemes have already been implemented while others are still on the drawing board. RAG distinguishes between surface and underground projects for resource utilisation. Mine workings can for example be used on one hand as sites for pumped-storage power installations below ground and on the other as both a heat storage facility and as a heat source for surface buildings.

Surface resources such as waste heaps and areas of open land can be used as future sites for wind turbines, photovoltaics and biomass cultivation.

Implementing projects of this kind gives RAG an opportunity to work with various regional partners – and public utilities, housing development associations and power supply companies have already participated in schemes of this kind.

One of RAG's project partners is a locally based energy supply company that is currently exploiting the wind conditions up on the waste heaps, where the wind potential is on a par with coastal areas. This wind energy is best suited for electricity generation. In 2010 two 100 m-high wind turbines, each of 2.3 MW output, were built on the Scholven tip in Gelsenkirchen and these units now have the capacity to supply power to 10,000 local residents. This highly successful project will pave the way for more wind-powered generators to be set up on many other RAG waste heaps in North Rhine-Westphalia and Saarland.

The site of the former Hugo 2/5/8 colliery has now been transformed into a biomass park where fast-growing trees such as poplar and willow are being planted for the recovery of alternative fuels. This biomass project was set up as a joint venture partnership involving the NRW Ministry for the Environment and Conservation, Agriculture

and Consumer Protection, the NRW Forestry and Timber Department and RAG Montan Immobilien. The quick-turnaround plantation is now open to the public as an area of parkland. The residents of Gelsenkirchen benefit from this development as the plantation represents an ecological upgrade of what was previously a mining landscape.

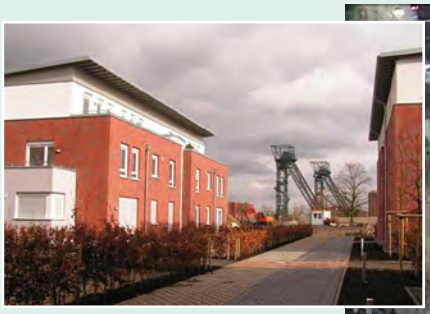
Using solar energy is now a tried and tested and very effective technology. The expansive roofs of RAG coal blending sheds are ideally placed for the installation of photovoltaics systems. These RAG buildings have some 10,000 m2 of south-facing roof covering that is at just the right angle for exposure to the sun. The coal blending shed at Pattberg in Moers, which has been fitted with an array of solar collectors, is a perfect example of this technology in action.

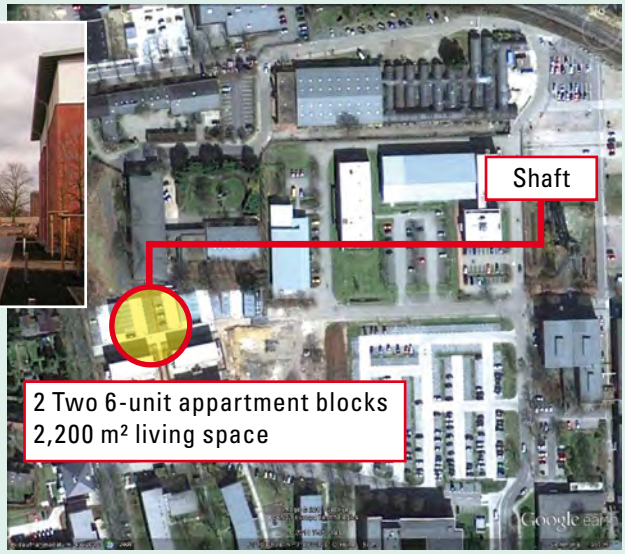
Another factor associated with the mining industry – and something that sets RAG apart when it comes to renewables usage – is mine water. This too can be used as a source of energy due to the fact that it is present at temperatures of around 30 °C. RAG pumps about 100 million cubic metres of water a year from its underground workings and now plans to exploit this thermal energy at several locations. Clients would mainly be large consumers such as schools, outdoor swimming pools and garden centres. The Sanaa Building on the Zollverein World Heritage Site in Essen has been supplied with heat from mine water since 2007 and the thermal energy stored in the pit water at the former Zollverein workings could be used as a source of heat for many more buildings. Potential consumers would be the Zollverein college and a new hotel that is to be built on the site.

More properties are also to be supplied with heat from mine water by the end of 2011. The Bochum public utility company plans to use this source of energy to deliver heat to a fire station and school complex close to the Robert-Müser shaft. The water being pumped from the mine contains so much thermal energy that there is sufficient to supply heat to more of the new buildings on the industrial estate that has now been established at the site.

RAG mine shafts have a huge potential for providing unending supplies of 'geothermal energy'. These structures obviate the need for costly and, in some cases, difficult drilling operations and there is no uncertainty as to the degree of heat actually present when the borehole reaches its target. RAG is in a position to avoid the drawbacks normally associated with conventional geothermal energy production and is able to do so risk-free by using its open mine shafts as access routes to the heat source. The first project of this kind has already been implemented at the Auguste Victoria 2 shaft in Marl. A system of probes installed in the shaft draws the heat from the strata and the housing development company Evonik Wohnen GmbH is now using

Renewable energies – heat from deep mine shafts

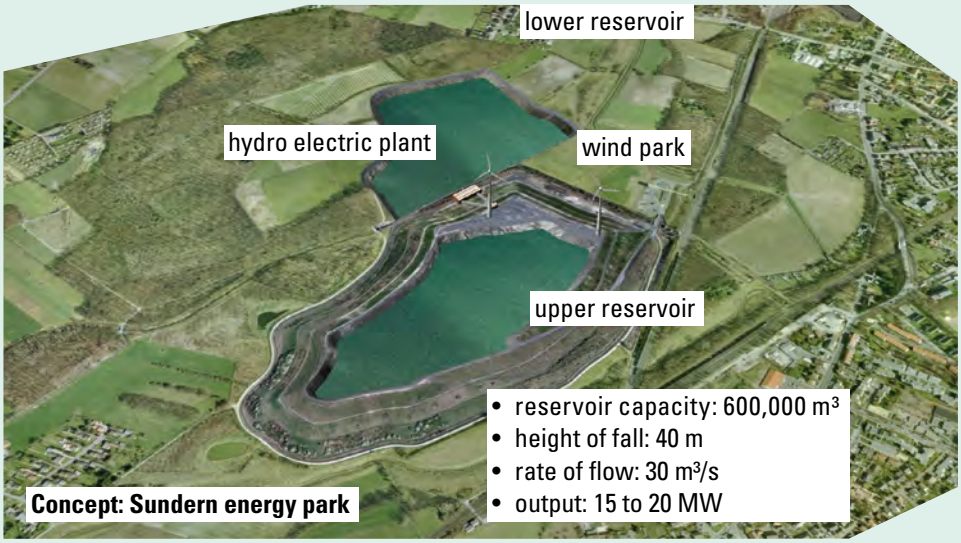




- Joint venture with housing development company (EVONIK)
- Complies with EEWärmeG (Renewable Energies Heat Act)
- Better long-term rentability

Source: RAG AG; Google Earth, 2011

Renewable energies – pumped-storage power station above ground



Source: RAG AG, 2011

this 'shaft heat' to supply a number of new apartment buildings.

Another building in Bottrop is also being provided with heat – and in a rather unusual way. Here the energy is being obtained not from the earth's interior but as surplus process heat from the Bottrop coking plant that was under RAG ownership until May 2011. The thermal energy is held in a storage medium built into a container truck that transports it to its destination, in this case a primary-school building.

One way of storing energy on a larger scale is by developing pumped-storage power stations. This is an area in which RAG is able to exploit its waste heaps and mine shafts as intermediate storage facilities for wind energy, which can then be fed into the grid to meet peak period demand.

On windy days these pumped-storage power stations are able to use the excess power from wind turbines to pump water from a lower level into a large storage basin located high up on the tip. At peak demand periods the water is allowed to flow back down into the lower reservoir and in doing so it passes through a turbine and generator system to produce electricity. RAG Montan Immobilien is currently collaborating with a national energy provider in the preparation of a feasibility study for such a pumped-storage power station at a spoil-tip site.

Underground pumped-storage installations operate on the same principle as surface pumped-storage power stations. However, in this case the mine workings act as the lower reservoir and the colliery surface provides a location for the upper reservoir. A shaft is used to connect the two operating levels.

Power stations of this kind can generate as much as 300 MWh of electricity, depending on the volume flow and height of fall. Such a project provides an additional role for the mine shafts and underground workings, along with other equipment and infrastructures, that have to be kept available for general drainage operations – and this makes a useful contribution to the basic cost of mine dewatering. Underground pumped-storage power stations would therefore be helping to mitigate the long-term financial burden left by the coal mining industry. The draft concept for such a project is now to be developed in conjunction with the two Ruhr universities of Bochum and Duisburg-Essen.

Projects of this kind are providing RAG with an opportunity to use its property and land space in an economically viable and sustainable way. They also allow RAG to exploit the means at its disposal for launching a series of initiatives aimed at developing a future-oriented industry that will have a positive impact on the process of structural change under way in the region and provide opportunities for a new range of business ventures.

Mining and Culture –
Extra shift at the mine Ewald

Global electricity generation

year	coal and lignite	nuclear energy	mineral oil	natural gas	hydro and others	total
	TWh					
1970	2,075	80	1,625	–	1,175	4,955
1980	3,163	714	1,661	976	1,802	8,316
1990	4,286	1,989	1,216	1,632	2,212	11,335
2000	5,759	2,407	1,402	2,664	2,968	15,200
2005	7,040	2,640	1,240	3,750	3,550	18,220
2007	7,950	2,580	1,120	4,290	3,955	19,895
2008	8,160	2,620	950	4,380	4,090	20,200
2009	7,750	2,558	910	4,360	4,240	19,818
2010	8,330	2,725	828	4,560	4,290	20,733
2020	10,630	3,712	689	5,881	6,462	27,374
2035	11,241	4,883	480	7,557	11,174	35,335

Sources: GVSt 2011; BP Statistical Review 2010 / Prognosis by IEA New Policies Scenario 2010

World reserves of coal, lignite, mineral oil and natural gas

regions	coal and lignite[1]	mineral oil	natural gas	total
	bn tce			
EU-27	33	1	3	36
Eurasia[2]	142	28	72	242
Africa	26	27	17	71
Middle East	1	156	90	247
North America[3]	210	15	12	237
Central and South America	10	50	9	68
China	159	3	3	165
Far East	82	6	12	100
Australia	50	1	4	54
World	713 58 %	287 24 %	222 18 %	1,220 100 %

[1] data of 2009; [2] remaining Europe and GUS; [3] including Canadian oil sands

Sources: BP 2010; BGR 2011

World reserves and production of coal

regions	reserves[1] bn tce	production[2] mt ce
EU-27	14	134
Eurasia[3]	106	501
Africa	26	250
Middle East	1	0
North America	199	1,015
Central and South America	8	79
China	155	3,410
Far East	73	1,013
Australia	38	393
World	620	6,795

[1] data of 2009; [2] data of 2010; [3] remaining Europe and GUS

Sources: BGR 2010; VDKi 2011

World primary energy consumption

year	nuclear energy	non-renewable energies: coal and lignite	non-renewable energies: mineral oil	non-renewable energies: natural gas	renewable energies: hydro	renewable energies: other fuels	total
	mt ce						
1970	28	2,277	3,262	1,326	146	827	7,866
1980	247	2,724	4,320	1,853	206	1,066	10,416
1990	738	3,205	4,477	2,525	271	1,420	12,636
2000	955	3,123	5,005	3,091	329	1,534	14,037
2005	1,031	4,191	5,488	3,522	379	1,960	16,571
2007	1,024	4,544	5,653	3,772	375	2,120	17,488
2008	1,020	4,724	5,619	3,898	380	2,150	17,791
2009	1,005	4,670	5,404	3,756	387	2,190	17,412
2010	1,050	5,000	5,580	3,890	395	2,249	18,164
2020	1,348	5,671	6,215	4,479	538	2,529	20,816
2030	1,820	6,626	7,667	5,360	681	3,799	23,953

nuclear energy and renewables evaluated by efficiency method; incl. traditional energies

Source: GVSt 2011; BP 2011; WEC 2011; forecast for 2020/2030 of IEA in New Policies Scenario, 2010

Global CO_2 emissions

regions/ countries	1990 (base year)	2000	2005	2010	changing rates[3] 2010 vs 2009	changing rates[3] 2010 vs 1990
	mt				in %	
Annex-I-countries[1]	14,958.7	14,417.7	14,895.6	14,110.0	3.4	- 5.7
EU-27	4,401.1	4,118.2	4,249.5	3,857.3	2.2	- 12.4
thereof EU-15[1]	*3,365.8*	*3,369.3*	*3,481.3*	*3,145.6*	*2.4*	*- 6.5*
thereof Germany[1/2]	*1,062.2*	*913.4*	*874.9*	*815.9*	*2.2*	*- 23.2*
Australia[1]	278.2	349.7	382.3	367.9	- 8.1	32.2
Canada[1]	458.5	562.7	573.4	578.5	6.7	26.2
USA[1]	5,091.6	5,966.2	6,014.8	5,719.6	4.1	12.3
Russia[1]	2,498.6	1,471.3	1,524.8	1,620.1	6.1	- 35.2
Ukraine[1]	719.2	289.0	321.0	285.1	4.0	-60.4
Japan[1]	1,141.2	1,251.6	1,282.3	1,174.5	2.6	2.9
Korea	229.3	431.3	468.0	551.8	8.5	140.6
India	589.3	976.4	1,159.5	1,689.4	9.1	186.7
China	2,244.0	3,077.6	5,108.3	7,591.3	10.4	238.3
rest of Far East	689.8	1,151.8	1,445.0	1,793.0	3.4	159.9
Middle East	588.2	975.1	1,245.0	1,615.1	4.9	174.6
Africa	546.2	688.3	823.4	931.0	3.1	70.5
Latin America	604.0	866.7	950.3	1,107.2	5.9	83.3
Other States	1,960.4	1,982.0	2,251.0	2,468.1	3.7	25.9
World	22,040.6	24,158.3	27,888.6	31,349.9	5.6	42.2

[1] Annex I Countries according to United Nations Framework Convention on Climate Change (see also http://unfcc.int)
[2] temperature- and inventory-adjusted
[3] calculated on the basis of decimal place

Source: Hans-Joachim Ziesing in ET 9/2011 and ET 4/2011

Primary energy consumption in EU-27

year	coal and lignite	mineral oil	natural gas	nuclear energy	hydro and others	total
	mt ce					
2005	431	1,003	606	367	123	2,530
2006	458	1,032	627	371	132	2,620
2007	455	1,006	615	347	144	2,567
2008	431	1,005	631	350	138	2,555
2009	371	958	590	289	191	2,399
2010[1]	385	947	633	297	215	2,477
2020	315	778	656	349	366	2,464
2035	193	659	702	59	564	2,477

[1] preliminary
Source: BP Statistical Review 2010
Prognosis New-Policies-Scenario in World Energy Outlook by IEA 2010

Primary energy consumption in Germany

year	coal	lignite	mineral oil	natural gas	nuclear energy	wind power	hydro and others	total
	mt ce							
1980	85.2	115.7	206.7	73.9	20.7	0.0	5.9	508.1
1990	78.7	109.2	178.0	78.2	56.9	0.0	7.2	508.6
1995	70.3	59.2	194.1	95.5	57.4	0.2	10.2	486.9
2000	69.0	52.9	187.6	101.9	63.2	1.2	15.6	491.4
2005	61.7	54.4	176.3	110.2	60.7	3.3	29.4	496.0
2006	67.0	53.8	174.7	111.3	62.3	3.8	31.6	504.5
2007	68.8	55.0	157.8	106.5	52.3	4.9	36.7	482.0
2008	61.4	53.0	167.3	104.4	55.4	5.0	38.6	485.1
2009	51.1	51.4	158.2	100.2	50.2	4.7	42.4	458.2
2010[1]	58.5	51.6	159.6	104.9	52.3	4.5	41.7	479.1

[1] preliminary
nuclear energy and renewables evaluated by efficiency method
Source: Arbeitsgemeinschaft Energiebilanzen 2011

Power generation in EU-27

year	coal and lignite	mineral oil	natural gas	nuclear energy	hydro and others	total
	TWh					
2005	990	160	660	930	440	3,180
2006	995	140	710	966	474	3,285
2007	1,040	110	710	935	515	3,310
2008	990	95	780	920	587	3,372
2009	832	92	768	928	576	3,196
2020	668	42	853	937	1,071	3,571
2035	389	23	936	963	1,626	3,937

Source: BP Statistical Review 2010
Prognosis New-Policies-Szenario in World Energy Outlook by IEA 2010

Power generation in Germany

year	coal	lignite	nuclear energy	mineral oil	natural gas	wind power	hydro and others	total
	TWh							
1980	111.5	172.7	55.6	27.0	61.0	0.0	39.8	467.6
1990	140.8	170.9	152.5	10.8	35.9	0.1	38.9	549.9
1995	147.1	142.6	154.1	9.1	41.1	1.5	41.3	536.8
2000	143.1	148.3	169.6	5.9	49.2	9.5	50.9	576.5
2005	134.1	154.1	163.0	11.6	71.0	27.2	59.6	620.6
2006	137.9	151.1	167.4	10.5	73.4	30.7	65.9	636.9
2007	142.0	155.1	140.5	9.6	75.9	39.7	74.4	637.2
2008	124.6	150.6	148.8	9.2	86.7	40.6	76.6	637.1
2009	107.9	145.6	134.9	9.6	78.8	38.6	77.8	593.2
2010[1]	117.4	145.0	140.6	8.1	87.3	36.5	93.4	624.7

[1] preliminary

Coal and lignite production and imports in EU-27 in 2010

country	production			imports
	coal	lignite	total	coal
	mt ce			
Poland	66	17	83	11
United Kingdom	16	0	16	23
Germany	11	50	61	40
Czech Republic	10	13	23	2
Spain	7	0	7	8
Bulgaria	3	8	11	3
Romania	2	8	10	1
Greece	-	17	17	1
Hungary	-	3	3	2
Slovenia	-	1	1	0
Slovakia	-	1	1	3
Italy	-	-	-	19
France	-	-	-	17
Netherlands	-	-	-	11
Finland	-	-	-	5
Danmark	-	-	-	4
Belgium	-	-	-	3
Sweden	-	-	-	3
Portugal	-	-	-	3
Austria	-	-	-	3
Ireland	-	-	-	2
EU-27	115	118	233	164

[1] Sources: EURACOAL 2011; BP Statistical Review 2011; VDKI 2011

German coal sales

year	domestic			EU countries		third countries	total sales
	heat market	power stations	steel industry	steel industry	others		
	mt ce						
1960	61.3	22.1	31.3	27.0		5.3	147.0
1970	28.5	31.8	27.9	19.8	5.7	3.2	116.9
1980	9.4	34.1	24.9	13.0	4.8	2.1	88.3
1990	4.1	39.3	19.8	5.2	2.2	0.4	71.0
2000	0.7	27.6	10.0	0.0	0.3	0.0	38.6
2005	0.3	20.3	6.1	0.0	0.1	0.0	26.8
2006	0.3	18.3	3.7	0.0	0.1	0.0	22.4
2007	0.3	18.8	4.1	0.0	0.1	0.0	23.3
2008	0.3	15.0	4.1	0.0	0.1	0.0	19.5
2009	0.3	11.7	3.0	0.0	0.2	0.0	15.2
2010	0.3	10.6	3.7	0.0	0.2	0.0	14.8

Rationalisation efforts in German coal industry

year	output per manshift underground	output[1] per working face	mines[2]	working faces
	kg saleable[3]	t saleable[3]	number	
1960	2,057	310	146	1,631
1970	3,755	868	69	476
1980	3,948	1,408	39	229
1990	5,008	1,803	27	147
2000	6,685	3,431	12	37
2005	6,735	3,888	9	24
2006	6,409	3,686	8	21
2007	7,071	3,680	8	22
2008	6,309	3,740	7	18
2009	5,597	3,375	6	15
2010	6,092	3,018	5	16

[1] daily face output
[2] data status: end of year excl. small mines
[3] until 1996: Saar figures in t=t

German coal industry workforce[1)]

by end of year	workers		white-collar employees		staff (workers and white-collar employees)	
	underground	surface	underground	surface	total	thereof apprentices
	in 1,000					
1957	384.3	169.3	16.3	37.4	607.3	48.2
1960	297.0	140.2	16.8	36.2	490.2	22.7
1965	216.8	110.5	15.6	34.1	377.0	15.2
1970	138.3	75.6	13.0	25.8	252.7	11.5
1975	107.9	60.9	11.5	22.0	202.3	14.1
1980	99.7	55.8	10.6	20.7	186.8	16.4
1985	90.1	47.4	10.2	18.5	166.2	15.7
1990	69.6	35.9	8.9	15.9	130.3	8.3
1995	47.2	25.7	6.1	13.6	92.6	2.9
2000	25.6	18.2	3.8	10.5	58.1	2.3
2001	23.0	16.2	3.4	10.0	52.6	2.2
2002	21.6	14.4	3.1	9.6	48.7	2.4
2003	20.0	13.6	2.8	9.2	45.6	2.7
2004	19.6	11.6	2.8	8.0	42.0	2.9
2005	17.7	10.9	2.6	7.3	38.5	3.2
2006	16.2	9.9	2.4	6.9	35.4	3.0
2007	15.1	9.1	2.3	6.3	32.8	2.4
2008	13.6	8.5	2.0	6.3	30.4	1.8
2009	12.1	7.6	1.8	5.8	27.3	1.3
2010	10.7	6.7	1.5	5.3	24.2	1.1

[1] workforce including short-time workers and trainees

Coal production in Germany

year	area				Germany
	Ruhr	Saar	Aachen	Ibbenbueren	
	mt saleable				
1957	123.2	16.3	7.6	2.3	149.4
1960	115.5	16.2	8.2	2.4	142.3
1965	110.9	14.2	7.8	2.2	135.1
1970	91.1	10.5	6.9	2.8	111.3
1975	75.9	9.0	5.7	1.8	92.4
1980	69.2	10.1	5.1	2.2	86.6
1985	64.0	10.7	4.7	2.4	81.8
1990	54.6	9.7	3.4	2.1	69.8
1995	41.6	8.2	1.6	1.7	53.1
2000	25.9	5.7	–	1.7	33.3
2001	20.0	5.3	–	1.8	27.1
2002	18.9	5.4	–	1.8	26.1
2003	18.2	5.6	–	1.9	25.7
2004	17.8	6.0	–	1.9	25.7
2005	18.1	4.7	–	1.9	24.7
2006	15.2	3.6	–	1.9	20.7
2007	15.9	3.5	–	1.9	21.3
2008	14.2	1.0	–	1.9	17.1
2009	10.9	1.0	–	1.9	13.8
2010	9.6	1.3	–	2.0	12.9

‘Landmark Tetrahedron’ –
at waste heap Beckstraße in Bottrop-Batenbrock

designed by the architect Wolfgang Christ

Organisation of the GVSt (German Coal Association)

Vorstand

Vorsitzender (Präsident):

Bernd Tönjes, Herne,
Vorsitzender des Vorstands der
RAG Aktiengesellschaft

Stellvertretende Vorsitzende:

Dr. h. c. Wilhelm Beermann, Herne,
(Ehrenpräsident)

Jürgen Eikhoff, Herne,
Mitglied des Vorstands der
RAG Aktiengesellschaft

Dr. Jürgen-Johann Rupp, Herne,
Mitglied des Vorstands der
RAG Aktiengesellschaft

Mitglieder des Vorstands:

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Vorsitzender der Geschäftsführung
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K.-Rainer Trösken, Essen

Prof. Dr. Franz-Josef Wodopia, Herne,
Geschäftsführendes
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Michael G. Ziesler, Saarbrücken

Geschäftsführung

Prof. Dr. Franz-Josef Wodopia, Herne,
Hauptgeschäftsführer

Elmar Milles, Herne

Geschäftsbereiche

Wirtschaft/Energie/Umwelt
Prof. Dr. Franz-Josef Wodopia, Herne

Recht/Soziales/Tarife
Elmar Milles, Herne

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Ibbenbüren

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RAG Mining Solutions GmbH,
Herne

RAG Montan Immobilien GmbH,
Essen

RAG Verkauf GmbH, Herne

STEAG GmbH, Essen

Bergwerksgesellschaft
Merchweiler mbH, Quierschied

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List of figures and tables

For further charts go to www.gvst.de

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Coal industry data for 2010

Mines	**5**
coking plant (number)	1
Workforce[1] total	**24,207 employees**
- Ruhr coalfield	18,563 employees
- Saar coalfield	3,208 employees
- Ibbenbueren coalfield	2,436 employees
Coal production total	**12.9 M t saleable**[3]
	= 13.2 M t ce[2]
- Ruhr coalfield	9.6 M t ce
- Saar coalfield	1.3 M t ce
- Ibbenbueren coalfield	2.0 M t ce
coke production	2.0 M t
Technical characteristics	
production at working face	3,018 t (saleable)/day
mean thickness of coal seam	194 cm
mean face length	337 m
mean depth of extraction	1,142 m
maximum depth of shafts	1,750 m
Sales total	**14.8 M t ce**
- power plants	10.6 M t ce
- steel industry	3.7 M t ce
- heat market	0.5 M t ce
German coal's contribution	
- in primary energy consumption in Germany	3 %
- in electricity generation in Germany	6 %
- in consumption of coal	23 %
- in electricity power generation by coal	31 %

[1] End of the year; man power inclusive those with status structural short times and qualification

[2] ce = coal equivalent; 1 Kg ce = 29,308 K Joule

[3] saleable = production excluding moisture and ash content