

COAL ATLAS

Facts and figures on a fossil fuel

2015

NIGERIA



HOW WE ARE
COOKING
THE CLIMATE

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BÖLL
STIFTUNG

 Friends of
the Earth
International

IMPRINT

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INTRODUCTION

Nigeria needs a power revolution, but where will the electricity come from? The energy sources in the country are many, including fossil materials such as oil, gas and coal – but renewable energy sources such as solar, wind and biomass are equally available in abundance. The government declared in August 2014 that 30% of Nigeria's electricity should come from coal. The country has significant coal reserves – currently it is estimated that Nigeria is host to 2.8 billion tonnes of high quality lignite coal, and although this is small compared to lignite top shot North America, which has almost 1,500 billion tonnes of lignite, it is a substantial natural resource lying under Nigerian soils, from the East all the way to the North. But how much of this resource does Nigeria want to extract? Is there a golden rule that says, 'because you have it, you must use it'?

The implications of using coal for power generation are many, and are hardly discussed in Nigeria. The health implications are the most obvious. Coal combustion accounts for 250,000 deaths per year in China. In Europe, coal-fired power plants cause 2.1 million days on medication, 4.1 million lost working days and 28.6 million cases of respiratory complaints. And that is only on the side of power generation. Before the coal gets to the power plants, the mining operations bear their own kind of hazards. Mining accidents from coal dust explosion, flooding or collapsing shafts make sensational news. Much less light is shed on the permanent impacts coal mining has on host communities, which include loss of farmlands, pollution of ground and surface waters and health problems arising from coal dust inhalation.

Coal is often described as a cheap source of electricity. However, once the health costs, the resettlement of communities, the cleaning up of polluted waters

” Is there a golden rule that says, 'because you have it, you must use it'?

and the reclamation of mining areas are counted, coal comes out roughly at the same cost as solar.

Looking at coal through a microscope in a chemical laboratory, what you see is pure carbon. It is the burning of this carbon in coal-fired power plants, during steel production and in many other industrial processes that has accumulated over the past 100 years and is now causing the global climate to warm up and the weather to become more extreme. This has a direct impact on Nigeria's economic growth. Already, millions of farmers are facing shrinking harvests because their lands are degrading under a scorching sun; fishing villages have been swallowed up by rising sea levels and whole roads and towns have fallen into erosion gullies. It costs trillions of Naira to restore livelihoods and pacify conflicts arising from resource scarcity and migration.

Nigeria would chart a more sustainable economic growth path if it observed very carefully what changes are happening in the global coal landscape, whether cheap coal is really cheap, whether clean coal is really clean, and whether extracting coal really provides a long-term answer to Nigeria's electricity problems.

This Nigeria Coal Atlas wants to feed facts and figures into the debate around Nigeria's energy future, and invite readers to reflect on the different options of cutting Nigeria's megawatt cake into percentages for energy sources such as gas, generators, solar, wind, hydro, biomass... and coal.

Christine K
Director, Heinrich Böll Foundation Nigeria

12 BRIEF LESSONS

ABOUT COAL AND THE WORLD

1 Millions of years of solar power are stored in coal. This energy is released through burning. In the process, large amounts of both carbon dioxide and heavy metals are also released into the atmosphere. This is **HARMFUL** to the climate and environment – and to our health too.

2 The impact of digging coal is tremendous. Whether in open-cast or underground mines, mining coal **DESTROYS** nature, **POLLUTES** water, **DAMAGES** homes and forces the relocation of entire villages.

3 Coal-fired power plants are not very efficient. Most of the energy is **LOST** as heat.

Nevertheless, coal remains the second-most **IMPORTANT SOURCE** of energy in the world, after oil.

Emissions from burning coal are increasing in Europe despite its climate policies. Germany, Britain and Poland are the biggest **CULPRITS**.

Our governments have committed themselves to protecting the climate. If global warming exceeds 1.5° Celsius, it will be impossible to manage the **CONSEQUENCES** of climate change.

Despite all warnings, coal continues to be **SUBSIDIZED**. EU member states continue to support coal projects with taxpayers' money.



6

8

Private banks finance coal projects worldwide; but in the hope of fighting poverty, development banks also invest **PUBLIC FUNDS** in coal.

7

To reach the climate target, 88 percent of all known coal reserves must **REMAIN IN THE GROUND**.

10

The coal industry is well-connected and uses lobbying, generous campaign donations and well-paid climate sceptics **TO SLOW** the switch to renewable energies.

Worldwide opposition to open-cast mining and other coal projects is growing. **PROTEST** takes many forms – human chains, blockades, demonstrations and online campaigns.



Creating economies that rely on renewable energy rather than fossil fuels is a major challenge of our time. **SOLUTIONS** are being sought around the world. They will radically change societies.



HISTORY

THE HISTORY OF COAL IN NIGERIA

A major incentive for colonial rule in Nigeria was the wealth hidden within her soils, including large deposits of minerals strewn across the various regions south and north of the rivers Niger and Benue. So alluring and wide spread were these deposits that the colonial government amalgamated the territories now known as Nigeria for easier management of extraction and transportation of natural resources to Europe. Abiodun Baiyewu-Teru looks at the history of coal in Nigeria.



Coal miners in Enugu State in the late 1950s
Photo: environmental justice atlas

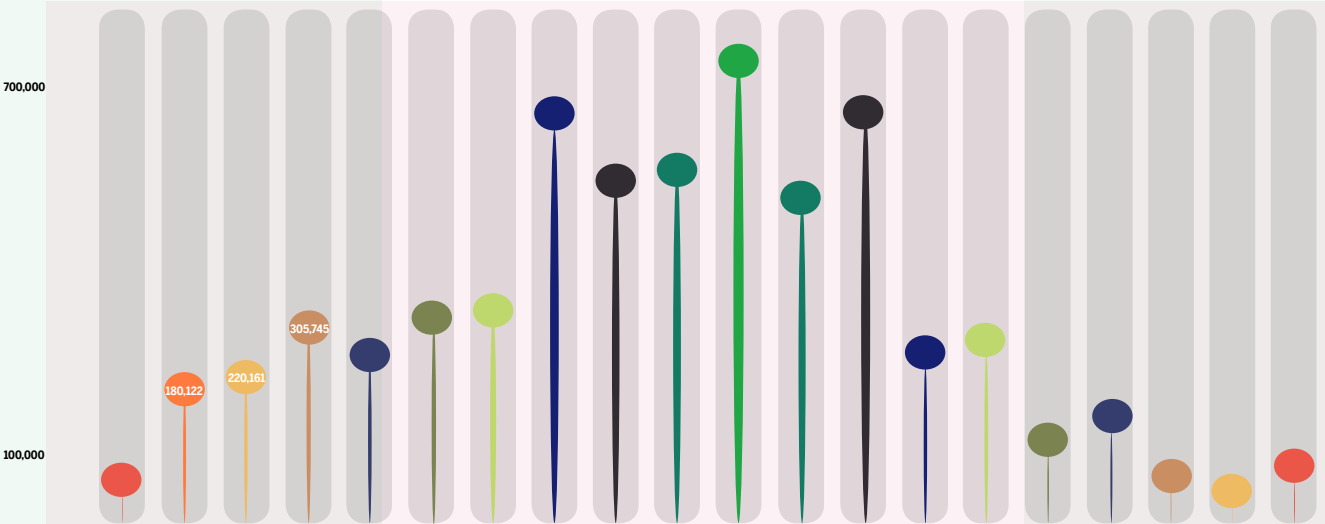
Coal was first discovered in Nigeria in 1909 at the Udi Ridge in Enugu by a British mines engineer, Albert Kitson. Kitson had been prospecting for silver. By 1914, the year of Nigeria’s amalgamation, the first consignment of coal made its way to the United Kingdom from the newly created ports at Port Harcourt.

By 1916, the Ogbete Mine was in full operation and in that year alone, it yielded 24,511 metric tons of coal. Over time, other mines sprang up in the region which became the modern day Enugu State. Coal production hit an all-time high of 790,030 metric tonnes before it faced a steady decline due to reasons discussed below, which resulted in many of the mines being abandoned. Currently Nigeria’s coal deposit is estimated at about 2.8 billion metric tons.

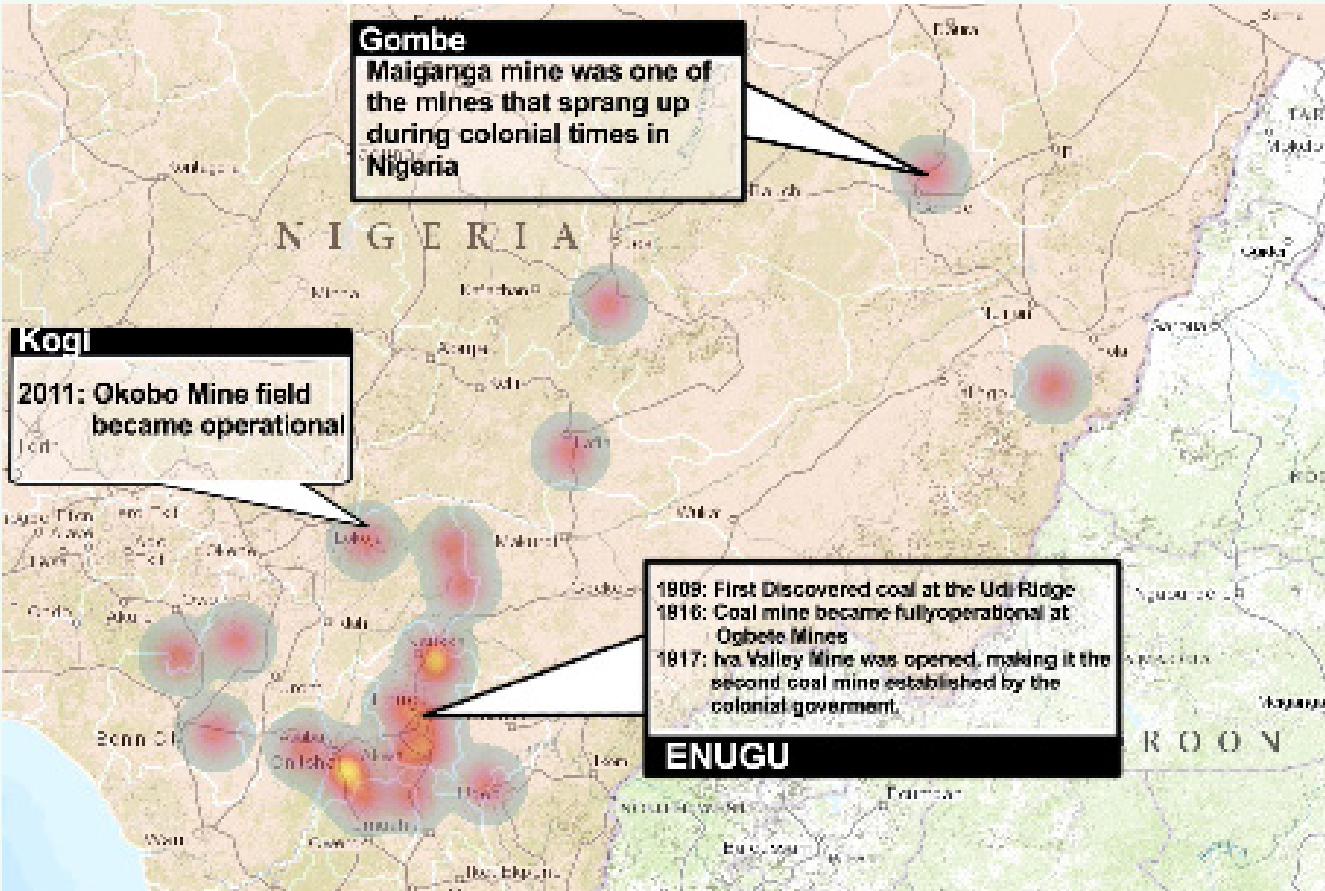
Coal for Rail

To manage the resources produced at these mines, the Nigeria Coal Corporation was incorporated in 1950. The core domestic market for coal production in Nigeria was its emerging rail system which depended heavily on the produce to power its locomotive engines. But with the sudden discovery of hydrocarbons in the late 1950s, the Nigerian Railway Corporation switched from coal to diesel powered energy. The Electric Company of Nigeria also converted its power generation from coal to diesel. The loss of these two big clients played a major role in the decline in coal production as the government did not think it feasible to continue to heavily invest in the sector. Besides, the recent discovery of crude oil at Oloibiri held the promise of greater revenue through exports for the newly independent nation. The Coal Corporation survived the onslaught of crude oil especially because it continued to enjoy a national monopoly on coal production.

The Nigerian civil war was another major factor in the de-



Nigeria coal mining in tonnes. Overall coal reserves are estimated at 2.8 billion metric tons.



Coal deposits in Nigeria

cline of the Nigeria Coal Corporation. A number of the coal mines became inaccessible during the period and were abandoned. Most of the abandoned coal mines were never revived or reclaimed. Interestingly, two mines were commissioned during the civil war: One at Odagbor, which was later known as the Okaba coal mine, located in present day Kogi State, and the Biafra Coal Corporation in Enugu. Both were merged at the end of the war into the Nigeria Coal Corporation.

Attempts at mechanizing the mines in the late 70s and 80s failed, further plummeting production. Another concern in the 1980s and most of the 1990s was the poor management of the Nigeria Coal Corporation. The then military government had a penchant for randomly appointing personnel with little or no experience in management or without technical knowledge to manage public enterprises. The Nigeria Coal Corporation was no exception. With the appointment of a university professor who had no management experience to head the corporation, its further decline came as no surprise. The final blow was in 1999, when the Nigerian government sought to increase direct foreign investment in the country by privatizing the Corporation and opening the nation’s solid mineral market to large private investors. The strategy failed. With the withdrawal of support from the government, the Corporation lost its steam. It however remained in operation till 2002 before eventually shutting down. Unsuccessful in its privatization bid, the Federal Government in 2013 sold off some of the Corporation’s assets to the Enugu State government in order to offset outstanding debts.

Enugu, the Coal Capital

The discovery of coal in Enugu had a kaleidoscope of effects on the town and indeed the nation. For one, it contributed to the rapid development of the town and made it a commercial hub for the region. The wealth generated from coal was so strategic that Enugu became the capital of the Eastern Region in 1938. Its wide spread influence also led to the establishment of a thriving port at the area now known as Port Harcourt (which also became a city of reckon), to ship coal out of Enugu to Europe. Coal mining quickly spurred the growth of the population of Enugu with the influx of miners. The total number of miners working in the region jumped from 6,000 men in 1948, to 8,000 men in 1958.

The aftermath of the Iva Valley Massacre of 1949 played a prominent role in the national agitation for independence. The Iva Valley Massacre revolved around the miners’ strike of 1949 in which miners demanded better wages and conditions of service but was viewed by the colonial government administrators as confrontation and a covert call for independence.

Coal miners against colonial rulers

Historical accounts state that the coal workers, agitated by rising inflation and the failure of the management to recognize the Colliery Workers Union had started to demand for increases in their wages and the recognition of their union as far back as 1944. However, matters came to a head in

November 1949 when the workers decided to embark on a work-to-rule strike to drive home their points: they refused to work for longer than the minimum required hours and operated strictly within the confines of their minimum de



The Iva valley massacre monument in Enugu

Photo: hbs Nigeria

liverables and thus considerably slowed down the operations of several coal mines. Three days into the work-to-rule strike, the management attempted to sack 200 hewers. For several days the fired hewers occupied the mines so they would not be replaced by new recruits. In solidarity with their husbands, the miners' wives protested at the colliery's office destroying equipment and breaking windows.

In response, the management called the police to disrupt the protests and in the fracas that ensued, some of the women were wounded. Even that event did not dislodge the miners. The tenacity and wide support for the protests led the colonial government to believe it was an insurrection with communist backing and that it was instigated by members of the Zikist Movement, who were agitating for national independence. It also feared that the protesters would steal the explosives from the mines and use them in terrorist attacks. It therefore dispatched 900 soldiers and policemen from the northern part of the country to dislodge the miners and secure the explosives. The ensuing standoff between the colonialists and the miners led to the killing of 21 and the grievous wounding of 51 unarmed miners by the Colonial Police. Historical records cite that Captain F.S. Philips, a colonial officer vexed by the striking miners' solidarity chants, fired the first shot, which hit a hewer - Sunday Anyasado - in the mouth, killing him instantly. Another military officer joined Captain Philips in shooting at the protesters and in the aftermath of the ensuing mayhem, 21 miners were dead. These events became known as the Iva Valley Massacre and have become a reference point in the history of the labour movement in Nigeria. It also marked a tipping point in Nigeria's quest for independence – a fact often lost in the formal teaching of Nigeria's history.

The event catalyzed mass protests in other cities including Port Harcourt, Aba and Onitsha. According to political scientist Richard Sklar, "Historians may conclude that the slaying of the coal miners by police at Enugu first proved the subjective reality of a Nigerian nation. No previous event ever evoked a manifestation of national consciousness comparable to the indignation generated by this tragedy".

Coal also managed to play a prominent role in Nigeria's politics in the nation's early years, post-independence. Having earned Enugu, its position as the Eastern Region's capital, it subsequently became the short-lived strategic capital of Biafra, during Nigeria's civil war with the Biafra Coal Corporation providing essential power to the Biafran struggle.

Coal economy at independence

Coal accounted for a sizable chunk of Nigeria's revenue at independence and made a major contribution to the development of its national infrastructure. While there are no accurate records of the number of persons employed at the mines for the entire duration of its existence or its dependent economies, what we do know is that it was considered to have provided employment for a sizeable population of people and that the final demise of the Nigeria Coal Corporation impacted commercial activities in the city. As a mining town, Enugu attracted local, national and international migrants who worked at the mines and provided it with flavor and colour. The city's population in 1952 was estimated at 62,000, of which more than half were non-indigenes. A traditional ruler who witnessed the coal era boom, testified that virtually every family in Enugu had at least one member working at the Corporation and that the mines had a large dependent economy. Later, when crude oil took over from the revenue derived from coal, its impact was less felt on a national scale.

While the benefits of the coal mines were largely economical and immediate, it also had negative and long term effects, especially on the environment. These effects are particularly compounded by the failure of the government to reclaim most of these mines – especially those abandoned during the civil war. Enugu state is reputed to have the worst erosion in the entire nation – a condition attributable to unreclaimed mines and unregulated artisanal mining at abandoned mine sites throughout the state. A study by the Journal of Environmental Science and Technology on the effects of mine drainage on water bodies, specifically looking at coal mining in Enugu concluded that "the quality of the water is significantly influenced by acidic mine drainage and its impact on human health could be severe." There are currently over 22 redundant coal mines around Nigeria, four of which were fully developed coal mines. There is no coherent public discussion about their existence or more importantly, their reclamation. With such a rich and varied history of coal, it's about time Nigeria has a well informed debate about its energy future. ●



Iva valley miners in the mid 1970s

Photo: hbs Nigeria

CLIMATE CHANGE

A 2 DEGREES WARMER NIGERIA

Coal is pure carbon. It is the most intense carbon emitter. How will Nigeria look like in a decade or two, if carbon emissions continue unabated and if the planet warms by 2 degrees Celsius? Christine K of the Heinrich Böll Foundation Nigeria has compiled these snapshots of how climate change is already affecting Nigeria today, from north to south, and what is to come if carbon emissions continue to rise.



Yobe State, 2013

Photo: hbs Nigeria

DESERTIFICATION

Eleven northern states – the so-called frontline states representing 43% of the country's land mass, are facing a relentless expansion of the Sahara. Africa's biggest desert is expanding southwards by more than half a kilometer each year. With a continued rise in carbon emissions and more global warming, it is likely that the sand dunes will reach Abuja. Current science indicates that the number of hot days will double in Nigeria – with implications for agriculture as well as human and animal health. By 2020, if no climate change adaptation is implemented, between 2-11% of Nigeria's GDP could potentially be lost. Where forests used to cool the climate in northern Nigeria, exposed landscapes and communities suffer from intense solar radiation. At the same time, people continue to cut down the remaining trees for cooking and baking of bread. A typical bakery uses one tree per day – that's one forest of 300 trees lost every day for Jigawa State alone.



Onitsha, 2012

Photo: hbs Nigeria

EROSION

Much of Nigeria's catastrophic erosion is man-made and due to poor environmental management such as blockage of water ways and sewage systems, often through misguided construction projects. But carbon emissions and the resulting global warming exacerbate the erosion problem, as rains are becoming more extreme and flush precious farm lands, forests, buildings and whole roads into greedy gullies. The estimated 3,000 gullies present in southeastern Nigeria vary in size - some are vast complexes of eight kilometers with fingers one or two kilometers long. Flooding and gully erosion is taking a large toll on the health, environment, economic and social assets of mostly poor Nigerians. The World Bank estimates the economic losses from erosion at more than 100 million dollars per year in terms of injuries and premature death, loss of vegetation cover and environmental services, income losses and yield reduction (farm to market mobility disruption), damage to infrastructure (transport, water systems, telecommunications, social infrastructure), as well as private property, social dislocation, and migration.

GEOLOGY AND GEOGRAPHY

SUBTERRANEAN FORESTS

Coal is formed from vegetation at high temperatures and pressures, cut off from the air. The older the coal, the more carbon and energy it contains. Deposits are located in all continents.

Coal is a brownish to black sedimentary rock made up of organic material. It was formed in the Carboniferous, a period that lasted 60 million years and spans from about 359 million to 299 million years ago. The name “Carboniferous” comes from “carbo”, the Latin word for coal, because so much of this type of rock dates from this period. The Latin in turn comes from the presumed Indo-European word “ker, meaning “burn”.

The climate was generally warm in the Carboniferous, and the atmosphere was richer in oxygen – 35 percent, compared to just 21 percent today. That stimulated the growth of plants. Vast forests spread over the land surface. A now-extinct tree known as lepidodendrales (from the Greek for “scale tree” after the appearance of their trunks) grew up to 40 metres tall.

Relatives of horsetails, now inconspicuous plants that grow on the edges of fields, reached 20 metres in height. Giant ferns formed massive swamp forests. All these plants accumulated large amounts of biomass. They used chlorophyll, the substance that makes leaves green, to use the energy from sunlight to convert carbon dioxide and hydrogen into organic material. They absorbed enormous quantities of greenhouse gases and turned them into lignin, resins and proteins.

When the vegetation died, the process of coal formation began. Many dead plants sank beneath the water, where they did not rot because of the lack of oxygen, but formed

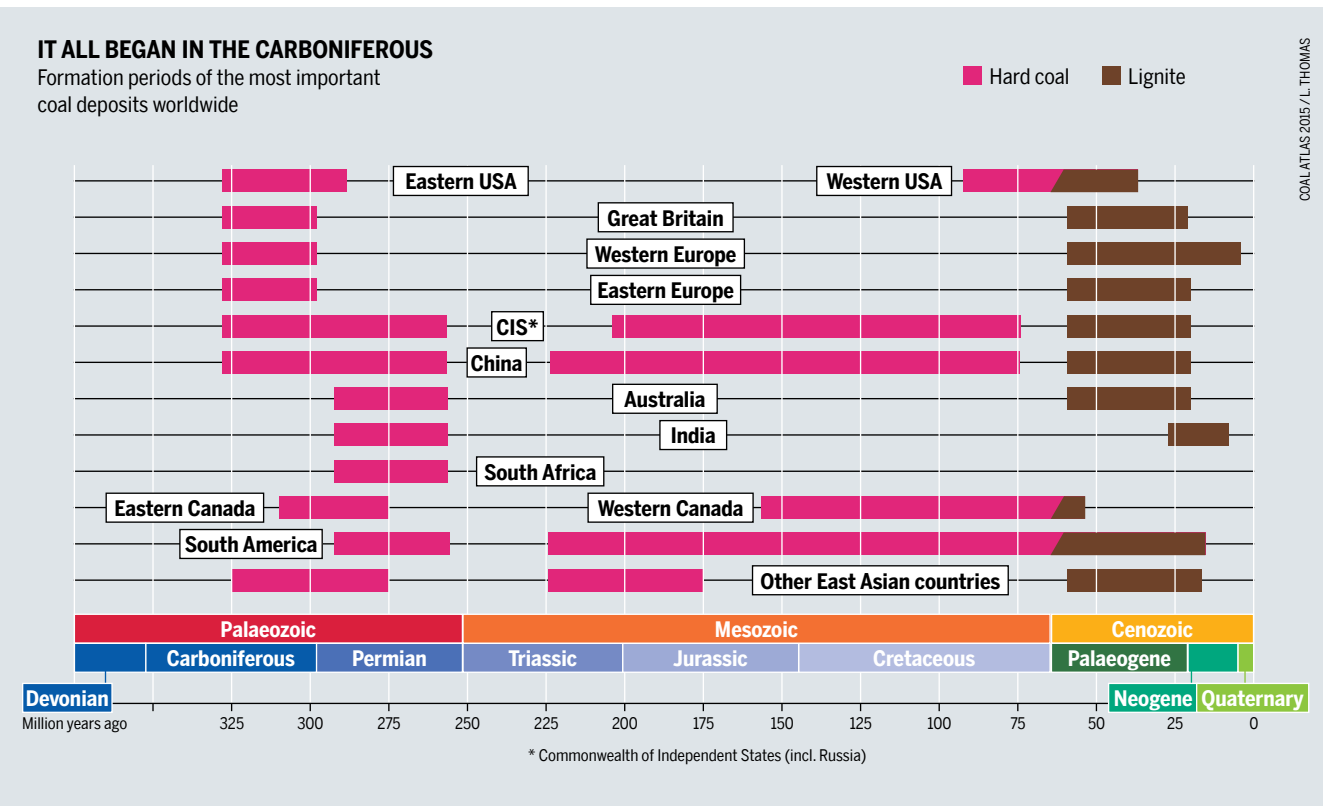
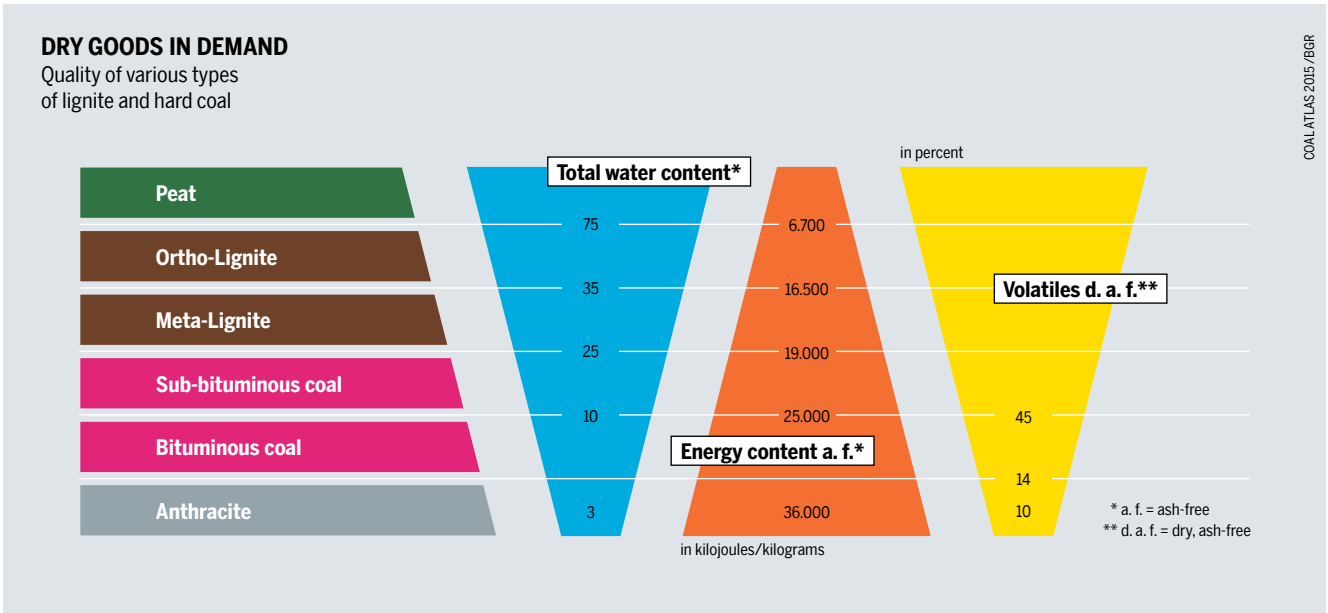
peat. Sediments such as clay or sand were deposited on top, raising the pressure and heat and squeezing out the water.

As the carbon content of the organic layers increased, the peat turned into denser, firmer lignite, or brown coal. Most deposits of this type date from 40 to 50 million years ago, from the Palaeogene period, formerly known as the Tertiary. Lignite has a moisture content of 45 to 60 percent. The remains of vegetation, such as roots, can still be seen in some pieces of lignite. Hard coal is much older – around 250 to 350 million years old. Lumps of this coal still bear the imprints of past vegetation. Most hard coal has a moisture content of 15 to 20 percent.

The more carbon coal contains, the more energy and the higher its calorific value – its value as fuel. So hard coal is preferable to brown coal. The best type is known as anthracite, which contains very little water or other ingredients. The only minerals that have more carbon are graphite and diamond, which are both usually of volcanic origin.

Ultimately, coal is energy from the sun, preserved in the form of plant remains. The historian Rolf Peter Sieferle refers to coal as a “subterranean forest”. Along with oil and natural gas, lignite and hard coal are fossil fuels. The term “fossil” indicates that they were formed from organic materials in the geological past. Coal and lignite come from vegetation; oil and natural gas are the remains of tiny organisms that were deposited on the sea floor. They were formed between 400 and 100 million years ago – at around the same time as hard coal. More recent deposits, such as those in the North Sea, were, like lignite, formed in the Palaeogene.

Heavy industry loves anthracite.
It can contain more
than 90 percent carbon



Hard coal takes a mere 60 million
years to form – a brief
period on a geological timescale

The German Federal Institute for Geosciences and Natural Resources estimates the world’s coal reserves at 968 gigatonnes (968 billion tonnes). It classifies reserves as deposits that can be exploited economically and profitably using current technology. In 2013 alone, humankind mined and burned 8 gigatonnes, or 253 tonnes every second. In addition to the reserves, the Earth has vast deposits of coal that have been proven but are currently uneconomic to exploit. Altogether, it is estimated that global deposits of lignite and hard coal may amount to 22,000 gigatonnes.

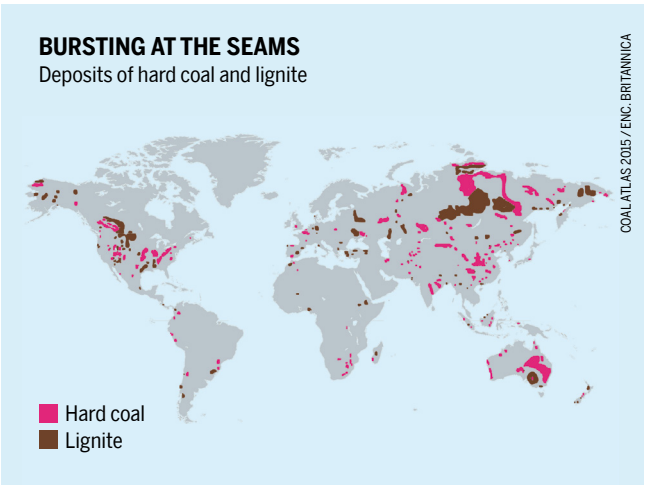
The largest deposits of the economically more important hard coal are found in Asia, Australia, North America and the Commonwealth of Independent States, an organisation of former Soviet Republics. The United States has the biggest reserves of hard coal and anthracite, with 223 gigatonnes. China comes next, with 121 gigatonnes, followed by India, with 82. In 2013, China dug up 3.7 gigatonnes of hard coal, more than half the world’s total output. The United States followed with 12 percent, and then India, with 8 percent. About 20 percent of the world’s hard coal output is traded internationally.

Lignite, on the other hand, is difficult to transport and contains less energy, so it is used as fuel only in the immediate vicinity of the open-cast mines where it is extracted. Some 37 countries around the world exploit lignite, but only eleven account for 82 percent of worldwide production. The biggest producer in 2013 was Germany, with 183 million tonnes, followed by China and Russia. Germany’s lignite production has risen sharply after the country’s move away

Once upon a time, a map of coal
deposits reflected natural wealth. Now it
shows where problems may lie

from nuclear power. This has significantly worsened its carbon footprint. In 2014, renewables overtook lignite as Germany’s most important source of energy, but only by a small margin.

Unlike oil, there is no official shortage of coal. In the long term, output will decline because the atmosphere can absorb only so much carbon dioxide. However, the Energy Watch Group, an international network of specialists, thinks that official estimates of coal reserves are too high. The global estimates are continually being revised downwards – between 1980 and 2005 by about half, despite higher figures for India and Australia. The group expects we will reach peak global coal production as soon as 2020. ●



GREENHOUSE GASES

SPOILING THE CLIMATE

Digging up coal and using it to generate electricity churns out emissions that intensify the greenhouse effect. Coal is one of the biggest sources of climate change.

Greenhouse gases occur naturally in the atmosphere. They absorb part of the energy from the Earth’s surface and from clouds, preventing heat from escaping into space. Without this so-called greenhouse effect, the Earth would be a lot colder than it is. But since the Industrial Revolution, we have added sharply to the amount of carbon dioxide, methane and other greenhouse gases in the atmosphere: levels of CO₂ in the air have gone up from 288 to 395 parts per million. Such concentrations boost the greenhouse effect.

The average global temperature has risen by 0.85 degrees Celsius since temperature records began. That may not sound like much, but the effects on our climate are considerable. Extreme weather such as droughts and heavy downpours are increasing. The mean sea level has risen by 19 cm since 1901. The Arctic ice pack is dwindling, the Greenland ice sheet has lost considerable mass, and glaciers worldwide are shrinking.

No other source of energy contributes as much to greenhouse gas emissions as coal. In 2014 it was responsible for emitting 14.2 gigatonnes of CO₂. That is 44 percent of all energy-related carbon dioxide emissions, and more than one-quarter of all greenhouse gas emissions.

The 35 biggest coal producers have been responsible for one-third of the global emissions since 1988. This was the year the Intergovernmental Panel on Climate Change was founded, and the Toronto climate conference requested governments to set targets for reducing their emissions. The coal industry could no longer deny the harm its product was causing. Private companies, state-owned enterprises and government-run industries have made huge profits from

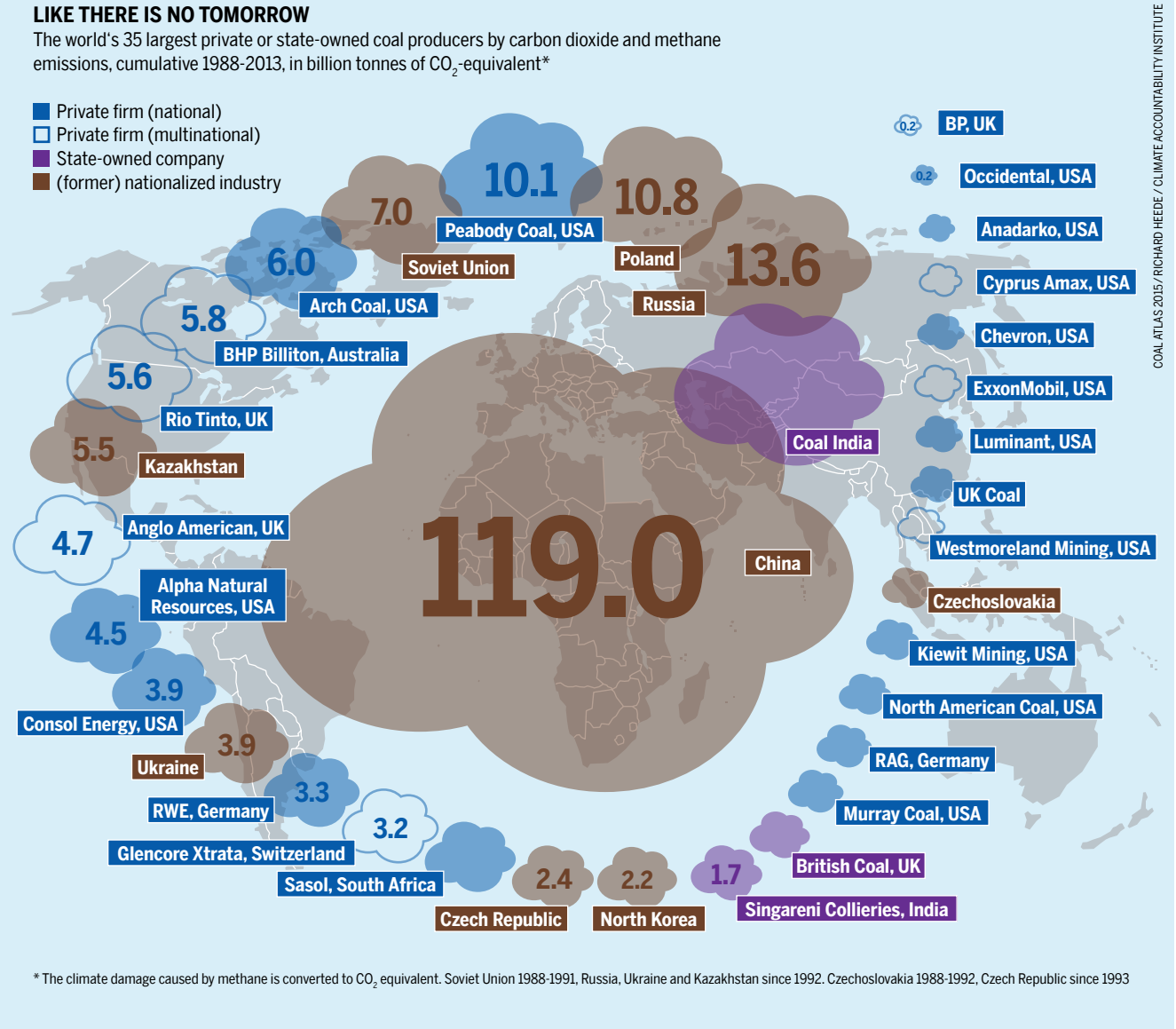
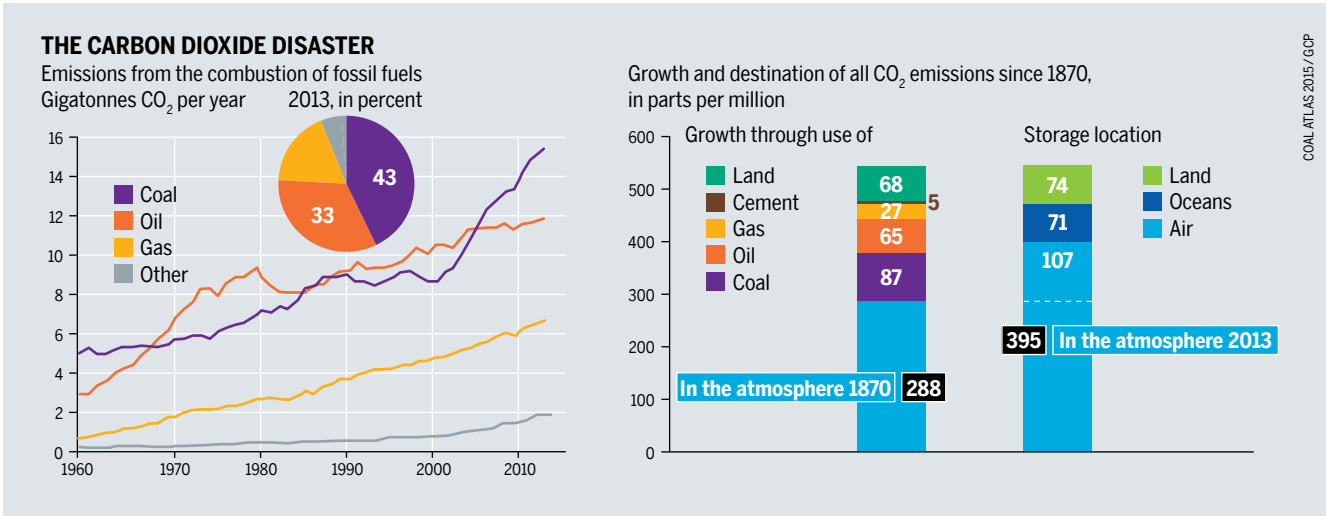
producing and selling coal. But they have not been held accountable financially or legally for the loss and damage they have caused, and continue to cause, around the world.

The majority of coal is burned to produce heat and electricity. That releases a lot of carbon dioxide, along with smaller quantities of methane (CH₄) and nitrous oxide (N₂O). Different greenhouse gases have a different impact on the climate; converting them to a “CO₂ equivalent” measure makes them comparable.

The amounts of CO₂ and other greenhouse gases that escape into the atmosphere for each kilowatt-hour of electricity produced depend on the carbon content of the coal and the efficiency and operations of the power station. Only about one-third of the heat generated from burning is converted into electricity by turning water into steam that spins a turbine. A critical question is whether the power plant uses the residual warmth for heating purposes, or whether it merely releases it into the environment. In general, generating electricity from coal damages the climate most; gas-powered plants emit only half as much CO₂ as modern coal-fired power stations.

The carbon footprint of coal is further enlarged by emissions of mine gas. This is created during the formation of the coal, and consists mainly of methane. In 2010, mines added the equivalent of another 500 million tonnes of CO₂ to the atmosphere. In addition, hard coal often has to be transported long distances. That involves energy and contributes to the climate damage. Burning coal, whether in a power station, furnace or stove, releases soot particles that also fuel the greenhouse effect. Mining and transporting lignite produces fewer emissions. But using it to generate electricity still harms the climate more than hard coal. This is because lig-

With its voracious appetite for energy, global industry is overburdening the atmosphere



nite is less compact: it contains less energy - more has to be burned to produce the same amount of power.

Coal does not just feed power plants. It also goes into the blast furnaces of the iron and steel industry where it is converted into coke, which acts both as a fuel and a reducing agent to remove the oxygen from the iron oxide in the ore. This process also releases CO₂.

With enough energy, coal can be transformed into a liquid or gas that can be used as a raw material in the chemicals industry or as a fuel-oil substitute. This is economically feasible only if oil prices are very high and coal prices very low. Only China, India and South Africa currently use this climate-damaging technology on a large scale.

There are already enough greenhouse gases in the atmosphere to raise the Earth’s average surface temperature by 1.5 degrees Celsius. This figure should not be exceeded, say scientists, nongovernment organisations and the nations that will be most affected, because doing so would jeopardize lives and livelihoods in many parts of the world.

If the temperature rises above that limit, the climate could cross a critical threshold. The permafrost at high latitudes could thaw, releasing the methane that it holds.

1988 is a key year. The Intergovernmental Panel on Climate Change is founded, and the damage caused by CO₂ can no longer be denied. But the coal producers are not too worried

The West Antarctic ice cap might melt. Such temperature thresholds are known as climate “tipping points”. Beyond the tipping point, the climate would not return to its current state, but would undergo further changes that are impossible to predict.

At the Climate Change Conference in the Mexican city of Cancún in 2010, the international community agreed to limit temperature change to 2 degrees Celsius above pre-industrial levels. To have a 50 percent chance of keeping under this limit, the CO₂ content of the atmosphere must be kept under 450 parts per million. That means that humanity must emit no more than 1,000 gigatonnes of CO₂ by 2050. That is possible only if 88 percent of the currently confirmed coal reserves stay in the ground, along with one-third of the mineral oil and half the natural gas reserves. Our consumption of coal will have to fall sharply, from 1.07 tonnes per person today to only 80 kilograms in 2050. ●

NOT WHAT WE EXPECTED

Outside the traditional coal areas in Eastern Nigeria, coal is also found in Kogi State. Okobo, a small town in Enjema District of Ankpa Local Government Area, has reserves of up to 380 million tonnes of coal. Abiodun Baiyewu-Teru, Executive Director at Global Rights Nigeria, describes the human rights perspective of coal mining in Nigeria.



A piece of coal from the Okobo coal mine

Photo: hbs Nigeria

Okobo, a small town in Enjema District of Ankpa Local Government Area, has reserves of up to 380 million tonnes of coal. The civil society group Global Rights focuses on human rights issues in mining communities in West Africa, and have visited Okobo community regularly to monitor the impact of coal mining on the lives of its people. Abiodun Baiyewu, Executive Director at Global Rights Nigeria, describes the human rights perspective of coal mining in Nigeria.

Gathered in a primary school classroom on a quiet Thursday afternoon, were some members of Okobo community – the community chief, their titled elders, women and youth representatives as well as some concerned residents. As they sat fidgeting and speaking with one another in whispers, they cut a picture of most Nigerians who live on less than a dollar a day, and grapple daily with the dividends of underdevelopment. Present also at this gathering was a government representative from the office of the Special Adviser to the Kogi State Governor on Mineral Resources.

Okobo is a remote, peaceful, agrarian community which recently began to play host to commercial coal mining after the Federal Government negotiated and assigned a mining license to ETA Zuma Group. Evidence of governance at this community is deficient. Okobo lacks access to basic infra-

structure: there is no electricity, pipe borne water, tarred roads, hospitals, schools, public buildings, public transportation or even a police station. Talks of a multi-million dollar project which held the potential of putting them on the map and improving their quality of living was exciting news for them. But after welcoming the development and the promises it portended for their community, they, like most mining communities in Nigeria, were beginning to be confronted by the challenges extractive activities bring to their host communities. It was these challenges that this meeting sought to discuss.

Promises of development

Mr. Idris Ibrahim, assuming the role of the community spokesperson at the gathering, read out loud from a piece of paper in his right hand: “some years ago when the company by name Zuma Nigeria Limited came and approached us to establish a company to mine coal in our community, we granted their request hinged on some conditions.” Mr. Ibrahim went on to list the social and economic demands the community had made as a precondition for permitting min-

COAL IN OKOBO

Okobo has reserves of 380 million tonnes of coal

ETA Zuma Group has a license to mine 100 million tonnes of coal, and is applying for additional licenses

ETA Zuma Group has licenses to build coal power plants in Itobe, Kogi State, to generate up to 1,200 MW

Okobo coal is sufficient to feed the Itobe power plants

Until construction of the Itobe power plants is completed, the mining in Okobo provides coal for bricks for cooking, or possibly for firing steel production.

ing activities in their vicinity. These had included a block of classrooms for a school, potable water, a health centre, and a sundry list of conditions most underdeveloped communities would think to add to a Community Development Agreement. “But to our dismay,” he read on, “the company did not strictly adhere to the conditions mentioned above - except for a few”.

The villagers nodded in agreement as Mr. Ibrahim read his statement. Supporting his statement, the traditional chief and paramount ruler of the community, Chief Aminu Abubakar, stated that ETA Zuma Group, had promised to develop and provide the basic infrastructure Mr. Ibrahim had listed in his speech, once the coal mine was in full operation. While acknowledging that the company had built and handed over a new school building to the community,

the Chief insisted that that was not enough - It was just one item on the list of conditions the community had proposed and Zuma Energy had assented to. “A community cannot survive without good roads” he lamented “We don’t have good water because the chemical from the coal mine is polluting our only source of water, no hospital and we are also not properly recognized by the company!”

Compensation or joint development planning?

The Nigerian Mineral and Mining Act of 2007 makes it compulsory for mining companies to seek social license for their activities from their host communities and to reach a community development agreement (CDA) with them before a mining license is issued. Yet, there was no documentary evidence of a CDA reached between Zuma Energy and Okobo community. Evidence of its existence became even more confusing when neither the company nor the community representatives could provide one. In a separate interview, Ambassador Joseph Ayalogu, the Corporate Relations Director at Zuma Energy, explained that a community development agreement existed, but only as an addendum of some sort to a lease agreement signed by both the company and the community. The community however insisted that they had never seen a copy of the signed agreement and that they had no knowledge of the parties who were signatories to it. They insist that their agreement with the company had been oral.

According to Ambassador Ayalogu, “But the Ministry of Mines has a new approach...there should be a standalone CDA, which we have already prepared and sent to the community”. At the time of writing this article, the newly prepared community development agreement was also in contention as the community leaders insisted that they had never received it.

The primary school classroom in which Okobo community members had gathered to discuss their plight, is the core tangible community development project undertaken by ETA Zuma Group. The primary school building boasts of six sparsely furnished classrooms (which was still of better quality than government built schools in the state), two lavatories and an overhead water tank which supplied the water needs of the school and recently had been extended to the community after the pollution of their stream. The water which filled the overhead tank was supplied by a water tanker truck with which the company fetched water from a neighbouring source. While grateful for the school block, Okobo’s indigenes insist that the building was only constructed to replace a previously existing one which collapsed due to strong vibrations from the company’s large excavation tractors. ETA Zuma Group claimed that the former school building’s foundation was already defective and was destined to collapse in any event. According to the community, the collapsed school building killed a pupil who was buried in its rubble. The community’s paramount chief, who had been the deceased pupil’s guardian till his tragic death, said that the company was yet to officially acknowledge the incident or offer any form of compensation to them. The government claimed no knowledge of the event.

At the inception of the coal mine operations in 2011, residents of Okobo community had such great expectations. According to them, they were promised the mines would bring numerous job opportunities and would radically improve their standards of living. Four years on and 30,000 metric tonnes of excavated coal later, only 14 members of the community had been employed by the company. The number of indigenous people employed by the company represents only a small fraction of the total staff strength of over a hundred people. Counting off the tips of his fingers, the paramount chief acknowledged the number of local residents



Contaminated water inside Okobo coal mine pit

Photo: hbs nigeria

who had been employed by the Mine, “We have 14 people working in the company - 3 are drivers, 2 are helpers, 3 are cleaners and the rest are security guards”.

“Too much dust!”

The environmental degradation they suffered from as a result of the mines operations was another source of contention for the community. “Dust! Too much dust! Once they remove and lift the coal, the entire village is covered in coal dust. The roads too are very dusty. When their big tractors run at top speed, we are covered in dust.” According to the community, there had been a definite increase in respiratory diseases since the Zuma Energy commenced its operations. The dust emanates not only from the lorries trawling the untarred roads around Okobo, but also from the grinding of the coal within Okobo. Once the coal from the pit is ground in Okobo, it is then transported in lorries to neighboring Okaba, where a factory presses the powder into bricks used for cooking.

There has been no official survey of the health impacts of the coal mining operation on the community so far. Without such a baseline survey, the community has no scientific evidence to defend their claim that the mine is affecting their health. But global comparison indicates that people’s health is at stake in Okobo. Statistics from Mpumalanga Province in South Africa, which has a long history in coal mining, show that inhaling the dust from coal pollutants is instrumental in the development of chronic obstructive pulmonary disease (COPD), a lung disease characterized by permanent narrowing of airways and quite common in coal mining host communities. Trace amounts of mercury in coal dusts affect the nervous system and can cause loss of intellectual capacity. Studies in Mpumalanga have shown the relation between coal mining and stunted growth in children. The correlation between coal mining and asthma in mining host communities has been established in several countries including the US where environmental pollution regulation is much stricter than in Nigeria. Many community members in Okobo are not aware of these potential consequences. To make matters worse, community members have no health care facilities in Okobo. The two room clinic built by ETA Zuma Group is reserved exclusively for its staff.

Contaminated stream

But the biggest problem for Okobo citizens is water. Before the coal mine opened, residents were fetching water from the stream that runs through the village. The coal mining has changed all that as the excavation activities within the 5-meter deep open pit affect the ground water. ETA Zuma Group’s surface mining activities consume large volumes of water and excavation activities have possibly disrupted the water bed in the community. The contaminated residue water from the activities find their way back to the community’s stream. Globally, it is acknowledged that the greatest risk that mining brings to water sources is Acid Mine Drainage. Acid mine drainage consists of three interrelated problems: first, the pyrite in the rock gives rise to water with a low pH level. This acid water in turn mobilizes heavy metals from the environment, in the mine or in the river course from the

sediments. The oxidation of pyrites due to excavation activities causes chemical reactions of the metals which in concentrated amounts are dangerous for human consumption.

The mining related pollution of the community’s water source has resulted in residents – especially women and children - having to travel long distances to neighboring communities to fetch water for their consumption. According to them, the water from their stream has become so bad that they cannot use it even for their laundry. A scientific analysis commissioned by Global Rights also revealed that their water’s turbidity and chemical content was higher than the World Health Organization’s recommended levels for human consumption. Turbidity is the cloudiness or haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water quality.

As the mining pits are awash with fresh and contaminated waters, they have become a breeding ground for weeds and all sorts of vectors including malaria bearing mosquitoes and reptiles in unprecedented numbers in the community.

A new start

According to the community’s leaders, the oral MoU between the company and the community expires in 2016 and will need to be renewed. This would give them an opportunity to negotiate a better deal and also to ensure that this time around, they have proper representation at the negotiating table - something that they lacked during the previous negotiation four years ago.

According to Gago Majiadah, a community elder, the people who had negotiated and signed the CDA on their behalf did so for their own selfish interests. Majiadah argues that those people were not from the core clans that were affected by the mining activities, even though they come from the area. Speaking in his local dialect he says, “Their water is safe for them to drink, their land is arable for them to farm. The real people who are affected are ignored and the company seems not to understand”.

While they were largely disappointed, the community still credits the company for fulfilling some of their statutory obligations. For example, according to them, the company has never defaulted in meeting its annual obligation of paying surface rights to the land owners. They had put up a new school building for the children, provided a monthly stipend for the administration of the school and leveled the major road leading to the community. “It is not like we are ungrateful with what the company has done,” says Mr. Idris Ibrahim.

“Things are just not the way we expected”. ●



Exposed water in Okobo coal mine pit

Photo: hbs nigeria

CLIMATE CHANGE

A 2 DEGREES WARMER NIGERIA

More scenarios of how Nigeria will look like when global temperatures would have risen by 2 degrees Celsius as a result of increasing carbon emissions



Photo: world agro forestry

AGRICULTURE IMPACT

They might not know that global carbon emissions are the cause of their problems, but millions of Nigerian farmers – both women and men – are living the reality of climate change in form of degrading soils, diminishing harvests and resulting hunger. With further increases in carbon emissions, food security will be under extreme stress in Nigeria as large areas of land will become useless. Long-term records show that over the past 105 years, the average amount of rainfall per year dropped by 81 mm. As temperatures increase, agricultural outputs decline because of high evaporation rates, reduced soil moisture, lowering of the groundwater table and shrinking of surface water. Heat stress reduces farmers’ productivity and leads to rapid deterioration and wastage of farm produce. The biggest obstacle, however, is lack of knowledge on how to adapt to the changing climate – only 5% of Nigerian farmers have access to improved, climate resilient seeds. Bush burning remains a significant source of carbon emissions and is the no.2 emitter in Nigeria, after gas flaring in the Niger Delta.



Photo: hbs Nigeria

FLOODING

Global warming has raised global sea level about 8 inches since 1880, and the rate of rise is accelerating. Rising seas dramatically increase the odds of damaging floods from storm surges. A Climate Central analysis finds that the likelihood of so-called century floods occurring will double until 2030. A climate change projection map for Lagos shows how the megacity will be flooded: under a 2 degree global warming scenario, coastal areas such as Lekki Phase I will be totally submerged whilst Lagos Island and Amuwo Odofin will be partially under water. Under a 4 degree global warming scenario, a huge area of Lagos would be under water, from the Lekki Free Trade Zone and its new deep sea port (currently under construction) all the way north to Surulere and Lagos Mainland. The catastrophic flooding of 2012 will repeat itself many times over, as rivers suddenly swell with excessive rains.

NATURE

A CONTAMINATED FUTURE

Open-cast mining destroys the landscape of both the pit and the surrounding area. Efforts to restore these areas often fail and the surface above the underground mines sinks.

Coal extraction has huge impacts on the environment. In open-pit mining, which accounts for about 40 per cent of global coal production, the entire overburden has to be removed to reach the coal seams underneath. The landscape is completely destroyed. Communities are removed, plants and animals are eliminated, and the living soil is shovelled away. Excavators dig enormous craters, hundreds of metres deep. Appalachia, in the United States, has a particularly extreme form of open-pit mining: to get at the coal, entire mountaintops are blasted away and the rubble is dumped in the valleys.

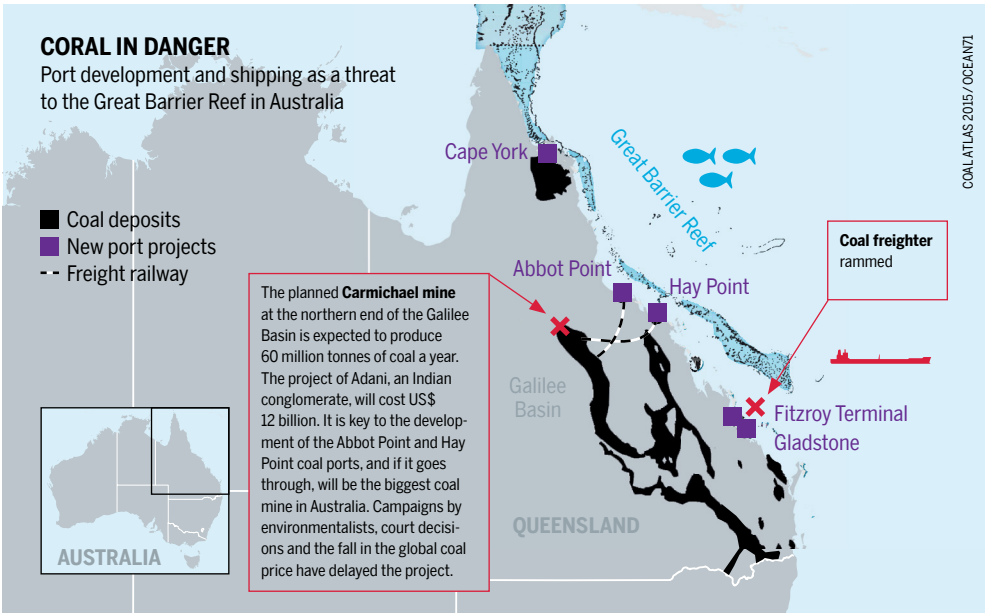
Our planet is littered with thousands of coal mines. The largest mine in the world, measured in terms of reserves, is the North Antelope Rochelle Mine in Wyoming, in the western United States that is estimated to hold some 2.3 billion tonnes of coal. It produces over 100 million tonnes annually from a vast open pit covering 250 square kilometres. The second-largest operation is the Haerwusu Mine in Inner Mongolia in China. This mine has an estimated 1.7 billion tonnes of reserves and an annual output of 20 million tonnes. It covers over 67 square kilometres. Other mega-mines can be found in Australia, Colombia, Indonesia, Mozambique, Russia and South Africa.

The ecological consequences are similar across countries, though standards for mining, restoration and legal enforcement differ widely. Mining means digging up and shifting huge amounts of earth. In some types of soil, iron and sulphur compounds can oxidize to iron and sulphate when they come into contact with the air. After extraction ceases the groundwater levels rise again and sulphuric acid is produced. As a result, the flooded pits and groundwater acidify. Adding alkaline materials such as limestone can reduce the level of acidity but cannot prevent it completely. Some of the iron that is set free is converted to iron hydroxide, or limonite. This rust-coloured mineral clogs pipes and pumps, blankets the spawning grounds of fish, and smothers their food supply.

Pumps are used to lower the water table and prevent the pits from filling up with water. This has severe consequences for the groundwater. In Germany's largest open-pit mine, at Hambach, this will require pumping out almost 45 billion cubic metres of groundwater over the next 60 years the mine is expected to be in operation. Keeping a mine dry disrupts the hydrology of the neighbouring areas: lowering the water table by as much as 550 metres dries up the springs that feed rivers, kills trees, desiccates wetlands and reduces biodiversity. This pumping, or what the experts call "mine dewatering", may also dry up wells, endangering drinking water supplies. It can take a hundred years for the groundwater level to regain its previous level.

Mozambique's Tete province used to be famous for its beautiful baobab trees, many over 1,000 years old. But coal-mining companies have destroyed vast numbers of them, ignoring their importance for the environment, local culture and peoples' diets. Such trees may take hundreds of years to regrow. Clouds of coal dust, polluted water and soil contaminated by acid drainage from mines also harm local communities. None of the companies operating in Mozambique have published environmental management plans, leaving the public ignorant of the environmental consequences of their operations.

Fast eaters. The largest coal fields in the United States will be depleted in around 20 years



More mines, more ports – Australia wants to ship more coal to China and India

In Nigeria, the government has signed a memorandum of understanding with the Chinese firm HTG-Pacific Energy to exploit coal in Enugu, in the southeast of the country. But no environmental impact assessment has been made – though this is required by law – and the right of affected communities to be involved in the project development has been ignored.

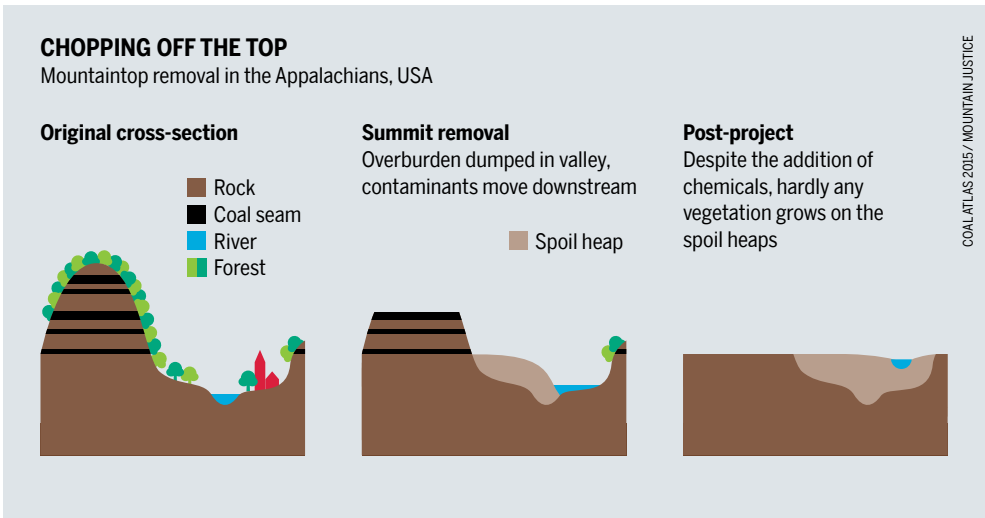
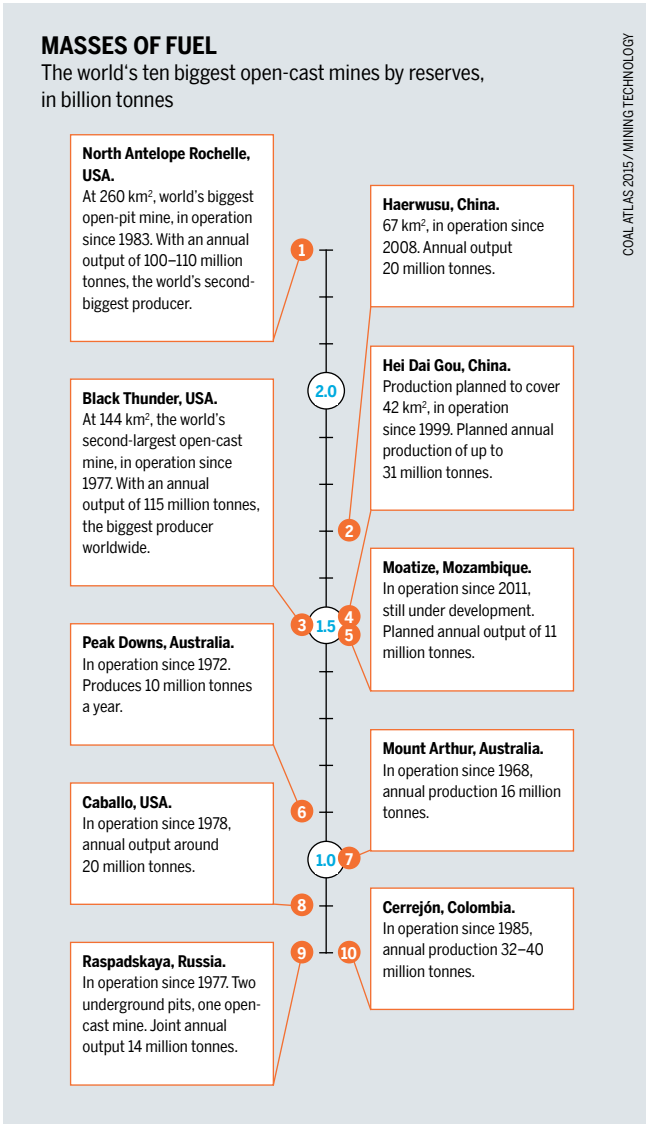
Cerrejón, a massive open-cast mine in Colombia, has impoverished the surrounding soils and contaminated or dried up water sources, with devastating impacts on farming and livestock keeping. The whole mining complex here extends over 69,000 hectares. Ninety percent of Cerrejón's hard coal is shipped abroad to fuel power plants, mainly in Europe and the United States.

While becoming the world's largest coal exporter, Indonesia has destroyed vast areas of rainforest and deprived local people of their land and homes. In Borneo, the indigenous Dayak people are fighting against mining companies' activities, particularly against the mining giant, BHP Billiton. The Dayak are trying to stop a series of large coal mines and railways that would decimate primary rainforest, pollute water sources, displace indigenous peoples and

endanger orangutans. This project would destroy the headwaters of 14 major rivers that provide clean water to 11 million people.

Coal mining leaves its mark on the landscape in other ways too. Lethal landslides can occur in open-cast pits decades after mining operations have ceased. Underground mines cause surface subsidence that damages buildings and roads. These "inherited liabilities" will continue to be a burden to future generations. In the Ruhrgebiet, a mining and industrial area in western Germany, water has to be pumped out of abandoned underground pits to stop the water table from rising too high, and in some areas continuous pumping is needed to prevent entire neighbourhoods from being flooded.

The ash from power plants also gives cause for concern. Landfills that store this toxic by-product of coal burning are often inadequately secured, allowing the ash to leak out. A particularly serious case occurred in 2008 in Tennessee, in the eastern USA. A retaining dam next to the Kingston coal-fired power station collapsed. Four million cubic meters of ash sludge containing heavy metals were released, carpeting the surrounding areas and polluting a nearby river. ●



Mining leaves behind a lunar landscape. It is next to impossible to reclaim such areas for farming.

HEALTH

FINE DUST, FAT PRICE

Smoke and fumes from coal-fired power plants make us ill. They are responsible for hundreds of thousands of deaths worldwide each year. Atmospheric and environmental pollution from coal costs billions in health expenses.

Mining and burning coal harm human health both directly and indirectly. The European Pollutant Release and Transfer Register, a database of emissions, lists 53 pollutants released by coal-fired power stations into the air, water, and the soil. Burning a kilogram of hard coal, releases more pollutants than burning a kilogram of lignite. But then again, you need three times as much lignite to produce the same amount of energy. That is why lignite is regarded as the dirtier fuel.

According to the World Health Organization (WHO), air pollution is one of the major health risks. In 2012, the WHO estimates that worldwide, 3.7 million people died prematurely as a result of diseases attributed to outdoor air pollution. The smog in Asia's cities is caused mainly by vehicle exhaust and burning coal.

Estimates of the number of victims worldwide due to coal-fired power vary widely. A study conducted by the Chicago School of Public Health reveals that coal combustion in China accounts for 250,000 deaths per year in the country. The researchers base this number on an estimated 77 deaths per terawatt hour from a coal-fired power plant. Detailed figures for Europe come from the Health and Environment Alliance (HEAL), a coalition of 65 European non-governmental organisations. They blame coal power for 18,200 deaths in the European Union annually. The coalition says that

8,500 people are diagnosed with chronic bronchitis a year because they come into contact with pollutants from coal plants. If power plants in Croatia, Serbia and Turkey are included, the number of deaths in Europe rises to more than 23,000 a year. HEAL calculates that the health costs add up to almost 43 billion euro a year. These high health costs ought to be included when comparing the prices of various sources of energy.

The amounts of emissions depend on the filtering systems the power plant uses. Although these have improved considerably in recent decades, coal-fired plants are still responsible for releasing 70 percent of the EU-wide emissions of sulphur dioxide – a particularly important class of fine particles – along with half of the industrial mercury emissions.

When fine particles are inhaled, they penetrate the lungs and bloodstream, causing various harmful effects on the body. They can cause chronic inflammation of the lungs, impair the pulmonary reflexes, and reduce the functioning of the lungs. That can lead to diseases such as asthma, chronic bronchitis, and in the long term, lung cancer. Another effect is reduced blood flow to the brain because the blood coagulates faster and can carry less oxygen. High blood pressure, irregular heartbeat and heart attacks may result. There is no official limit below which fine particles are considered harmless.

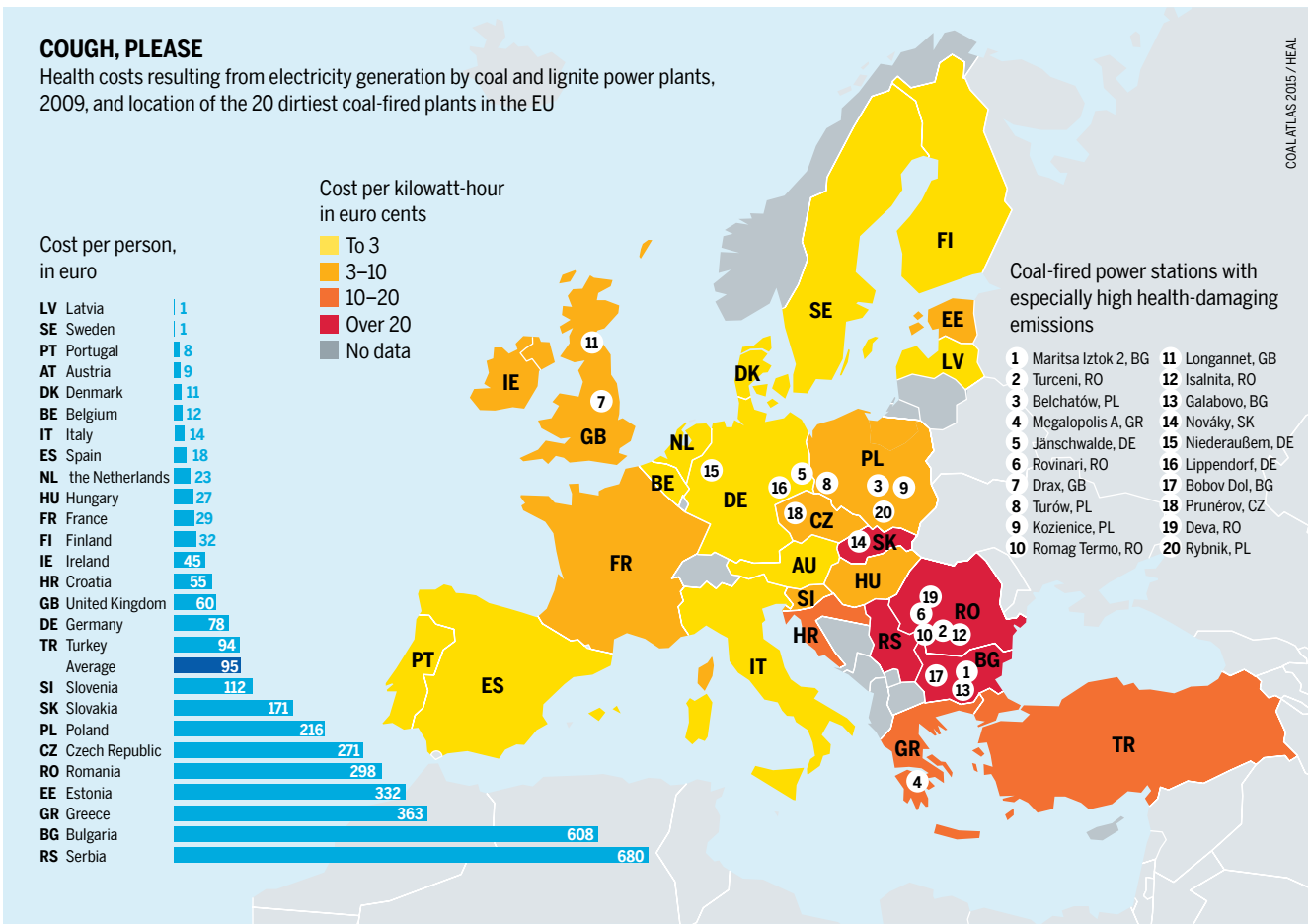
Children are especially susceptible to the harmful effects of heavy metals in emissions: lead, mercury, cadmium and arsenic. If their lungs are damaged early in life, they may be permanently weakened. While still in their mother's wombs, children who are exposed to large amounts of lead or mercury risk developing cognitive disorders and often have lower IQs. They may also suffer irreversible organ damage.

Measurements show that power stations with especially high carbon dioxide emissions also emit many other toxic pollutants. If less CO₂ is released, the emissions of sulphur dioxide, nitrogen and fine particles also fall. That is why the American Lung Association supports President Obama's climate change plan, which aims to reduce the emissions from new power stations by around one-third.

But the burning of coal is only one health hazard; mining is harmful too. People living near open-cast mines are exposed to high levels of particulate matter, which can lead to respiratory diseases or allergies. Mine tailings contain heavy metals and other toxic substances that can enter the groundwater and air.

Radioactivity is another problem. Lignite contains uranium, thorium and potassium-40. In the Rhineland, Germany's largest open-cast mining area, 100 million tonnes of lig-

More and more women are working in coal mines. More are dying from miner's lung, while fatalities among men are declining



nite and 460 tonnes of overburden are excavated each year. Friends of the Earth Germany estimates that this includes 388 tonnes of uranium. These radioactive substances are also present in the airborne dust and find their way into people's lungs – with incalculable consequences to their health.

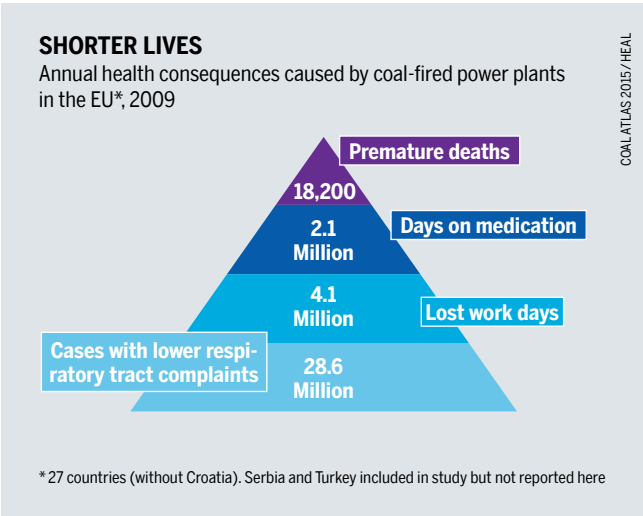
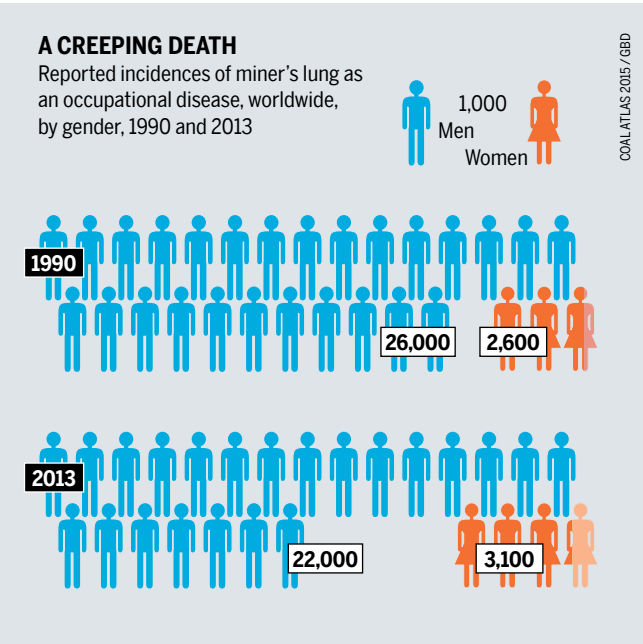
Such health problems are particularly evident in the Mpumalanga Highveld coal-mining area in South Africa, home of 12 of the largest coal-fired power stations in the world. Toxic substances and waste water from the open-cast mines contaminate the limited amounts of drinking water in the area. Local people have little choice but to consume it. Research by Friends of the Earth South Africa indicates that coal is responsible for half of the deaths caused by respiratory and cardiovascular diseases in the region. Respiratory problems such as asthma and whooping cough are widespread among local people. Children and elderly people are especially at risk. Most of the power plants do not have to comply with national clean air standards – for cost reasons.

The permissible limits for pollutants vary widely from country to country. The United States has significantly stricter mercury and sulphur dioxide limits than the European Union. As a result, many coal-fired power plants there have been closed or retrofitted.

Climate change caused by using coal is an indirect threat to human health. In June 2015, a Lancet Commission

43 billion euro in health costs should be added to the price of coal in the EU alone

of international health experts warned about the health consequences of global warming. The last five decades of development and health advances could be nullified. The commission pointed at the dangers posed by air pollution, rising temperatures and extreme weather. This included increasing heat stress, the spread of infectious diseases such as malaria and dengue, threats to food security, malnutrition, and a rising number of refugees and armed conflicts. ●



LABOUR

DIRTY JOBS IN A DIRTY INDUSTRY

Although coal production is still on the rise, the sector is employing fewer people. Structural change has spread to all continents. Nevertheless, mining underground remains one of the most dangerous occupations worldwide.

In 2012, an estimated seven million people were employed in the coal industry, most of them in coal and lignite mining. That number is likely to be lower in 2015, with employment falling especially in China. The world's largest coal producer is beginning to exploit its reserves more efficiently, however, it still needs many more workers than the United States, where modern equipment and optimized operations enable about 90,000 people to mine 0.9 billion tonnes, mainly in open-cast mines. In China, 5.7 million people are needed to dig out 3.7 billion tonnes, mainly from underground mines. In the United States 10,000 jobs were lost in 2013 alone, partly because the shale-gas boom has made coal production less profitable.

Fewer workers are needed in countries where productivity is rising quickly. For example, the Chinese government has closed thousands of small, inefficient mines. India also needs fewer workers to produce the same amount of coal. Coal India, the state-controlled producer, slimmed its employee rolls from 500,000 in 2005 to 350,000 in 2014. In the same period, its output rose by one-third. Moreover, both India and China have invested in Australian mines to boost their own supplies. These extensive coal imports mean that Australia is one of the few countries where employment in the coal sector was rising in the last decade.

The European Union is also cutting thousands of jobs every year. In 2008, 342,000 miners worked above and below ground; in 2013 the number was only 326,000. In the Czech Republic, which relies heavily on coal, there has been a decrease in employment in the coal sector. After a delay, structural change is now starting in Poland, which obtains most of its energy from coal. Britain has almost completed the transition: by 2016 only two pits will still be in operation, an old mine and a new one, both owned by their workforces.

In 1950, almost 540,000 people worked in Germany's hard coal mines, and 360,000 of them underground. Today the figure is 12,100, and by 2018 there will be no miners underground. In the country's lignite mines, the number of people directly employed in digging out the rock and transforming it into electricity has fallen from 130,000 in 1990 to 21,000 today.

While coal is declining as a source of employment around the world, renewables are growing in importance. In 2013, 6.5 million people were employed in this sector, 800,000 more than in the previous year, according to the International Renewable Energy Agency. This organization

estimates that the coal and renewables sectors now employ a similar number of people worldwide. In Germany and the rest of the European Union, jobs in renewables have overtaken those in coal. In developing countries and emerging markets, however, employment figures cover only the coal industry itself, and do not include the related project development, transport and power-plant operations.

Despite such uncertainties, it is still possible to discern some trends. China is the leading power in renewable energy, employing 2.6 million people in 2013. Most jobs can be found in the production and installation of renewable-energy plants. Brazil follows with around 900,000 jobs, the USA with 600,000 and India with 400,000. Germany is fifth. Its employment in renewables has doubled since 2004; by 2013 it had reached 370,000. By comparison, the German lignite industry directly and indirectly employs 70,000 people.

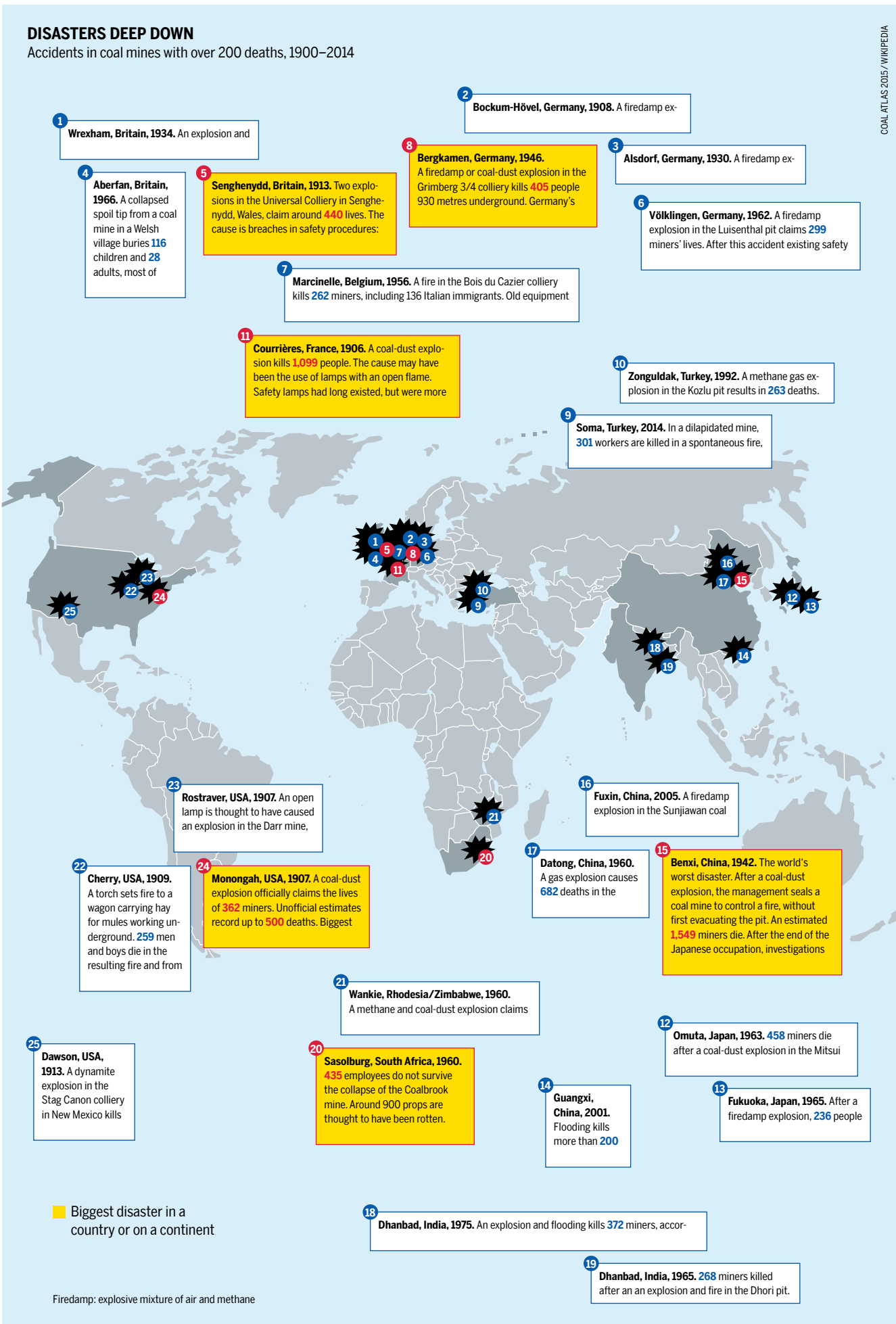
Working conditions in the renewables sector are generally better than in coal, although the renewables still entails risks, as in the chemicals companies that make solar cells. But workers in coal mines are subject to much greater risk to life and limb. And to their lungs, where the coal dust settles causing chronic diseases. Mining accidents are often dramatic, claim many lives, and attract a lot of publicity. With 150 years of experience underground, the coal industry has a deep understanding of the risks, and has detailed regulations to prevent accidents. If accidents occur, they are usually due to safety precautions that have been ignored in order to save costs, to negligence, or to equipment failure.

The situation in China, which accounted for 80 percent of worldwide deaths in coal mining, is improving. The small mines that are being closed are also the most dangerous. In the 1990s, 5,000 to 7,000 miners died every year. In 2010 the figure was 2,400, and 930 in 2014, according to governmental data.

In the western world, the image of a miner is still one of a hard-working, soot-covered man. And indeed, in Europe or Canada – and also in India – women still account for less than 20 percent of the workforce. In the ex-socialist countries, however, more women go underground. In many parts of the world it is not easy for women to find work in the coal industry. And if they do land a job, they are usually paid less than men and have to fear sexual assault in the mine.

According to a Greenpeace study, the coal industry will shed another two to three million jobs by 2030. The renewables sector is growing fast enough to compensate for these losses. In 2014, the Ibbenbüren mine in Germany recruited 56 maintenance trainees. It was the last such hiring. ●

Many mining accidents happen because the operators do not comply with the safety rules



INTERVIEW

POWER vs PEOPLE?

Hard Talk between Ambassador Joseph Ayalogu, Executive Director Corporate Relations of ETA Zuma Group, the company that holds licences for coal mining and coal power plants in Kogi State, and Nnimmo Bassey, Director of the Health of Mother Earth Foundation, who advocates for 'leaving coal in the hole' and opposes extraction. Will coal push Nigeria into the industrial age? Or will it leave host communities as impoverished and polluted as some communities in the Niger Delta? The Hard Talk was moderated by Christine K, Director of the Heinrich Böll Foundation Nigeria.



Christine K, Heinrich Böll Foundation (hbs): ETA Zuma is investing in coal fired power plants in Kogi State. When will Nigeria get its first megawatts from Kogi coal?

Ambassador Joseph Ayalogu of ETA Zuma Energy: Well, we have a 1,200 megawatt power plant license for Itobe, which will be broken into four modules of 300 megawatts each. The financing will come from both local and international investors and of course the beauty of it being a private sector driven activity is that one has to be efficient to make profit. Let's assume we start construction next year with the first tranche of 300 megawatts. It takes approximately 30 months to complete and roll into action, so we are looking forward to actualizing the 1,200 megawatt limit within the next 5 years or so.

hbs: Let me turn to Nnimmo Bassey - you're known to advocate for "leaving coal in the hole". Would you rather leave all Nigerian coal in the soil and not have electricity?

Nnimmo Bassey of Health of Mother Earth Foundation: The whole world knows we are facing a climate crisis. If we exploit coal, keep on exploiting oil and gas, and keep on burning them, then we are burning our future and that future is getting very near, it's not a distant future. I'm really surprised that Kogi State is taking on energy sources that are actually questionable. For example, there is a proposal to

establish two nuclear power plants in Nigeria, one in Kogi State and one in Akwa Ibom State, and this is completely outrageous. Coal may not be as dangerous as nuclear power plants, but having coal power plants and nuclear power in Kogi State? Oh my goodness, I don't know what is going to happen to Kogi State.

hbs: So what solution do you proffer? How will Nigeria get the much needed 100,000 or more megawatts needed for development?

Nnimmo: I think coal is not the only option. Neither is gas the only option. We have other options: solar, wind and thermal solutions are options that are not burning fossil fuels. I think Nigeria is very slow in exploiting sustainable options. Also, every coal mine has a life span – they are exhaustible, so coal is a short term source of energy but we need to have energy in the long term from something that is safer for the environment.

hbs: Germany has had a long tradition of using coal, and knows the problematic legacy it leaves behind. Impoverished coal mining areas, environmental devastation, polluted ground waters, sinking cities and toxic pits are long-term legacies that are costly to deal with. How is ETA Zuma going to deal with these predictable consequences of coal mining and power generation?

Ayalogu: Thank you for the question. Germany is a place we'd all love to be, the home of the Mercedes Benz and the good life, so we'll say "give it to us and when the negative aspect comes, we'll deal with it". The point is that Germany needed power and got it and became a world power based on the fact that it was able to become industrialized. When Germany was at the peak of getting power from coal, technology was a little bit backwards, but the situation has changed. There are environmental mitigation processes and so on. There is a robust ESIA [Environmental and Social Impact Assessment] arrangement for the Itobe plant. The technology we are going to use meets the minimum World Bank standard with regards to sulfur and nitrogen.

hbs: Are you planning for carbon capture and storage (CCS), which is a relatively new technology that captures the carbon out of the smoke emissions from the coal plant and forces it back into the soil?

Ayalogu: Yes, we will use CCS. Itobe is a modern technological engagement. We are not going to pick up some old used technology from Europe. The intention is that we deploy the best of technologies that is currently available.

hbs: There aren't many sites in the world where CCS has really been tested and proven to be successful, and where it is in operation in the US and in Norway, there is no scientific

study to prove that the carbon actually stays underground. What if the carbon starts leaking out of the soil?

Ayalogu: Carbon is always with us.

hbs: But not in that concentration...

Ayalogu: This is why the technology that will be deployed in Itobe will meet the minimum World Bank standards. That's what we are aiming for. In this world, you can't have everything that is crucial but if you know what the challenges are and you minimize them, and you adapt technology to it, then you can take part, not totally but reasonably.....but on the other side of it, you need energy. I agree that there are renewable options, which of course the country will have to adapt to. And maybe that is why the government is talking of just 30% of power generated from coal. Maybe if we develop the other forms of energy sources, we may not even have 30% from coal. So like you said, the important thing is to be aware that it is not just coal, or gas, but you can't exclude them. You will have to continue to develop the other forms of energy sources.

Bassey: I think the best thing is to nip the problem in the bud. We don't have to wait until we have a problem then start to solve it or look for ways to mitigate the impact. It's an erroneous notion that human beings can use technology to fix any kind of problem that affects the environment and the people. Mr Ayalogu mentioned the fact that ETA Zuma is going to take care of the sulphur emissions, the nitrogen emissions, but besides these things, you are going to have all kinds of impacts on our communities and these are communities where you don't have health infrastructure to support them and of course the industry will tell us it is a part of a corporate social responsibility project to building clinics. But of what use is a clinic if I'm being poisoned? It's like when Nigerians talk about subsidy in the oil sector, the real subsidy is paid with the lives of people dying in the Niger Delta and not from government paid marketers.

hbs: What kind of environment and social impacts does ETA Zuma foresee? And how are you going to address them?

Ayalogu: Well, I have said earlier that our technology will be one that reduces emissions at least to the minimal level.

hbs: Does that mean that when you live close to the coal power plants, you won't have any respiratory issues?

Ayalogu: Well, even without coal power plants, we have respiratory problems. I don't want to sound like one is too sanguine. You can't have an omelette without breaking some eggs and this is the way life is. Even without any plant at all, people still have health problems. The only thing that helps everybody is knowledge about what you are doing and what can be the mitigating strategies to put in place and then to make sure that these things are being done.

Bassey: Anytime anyone says coal is not that bad, I just laugh because coal is really bad for the environment, and you know, nobody can only go on coal forever because it is not a renewable resource. Nigeria is in a desperate situation when

it comes to energy production, but this should not force government to take desperate actions. They should sit down to think, to weigh the impacts. I have seen many coal mining communities in Germany where one would not expect there would be problems of this nature. If you go to South Africa, you see the coal mines, you see the acid rain damages, you see the fires in the abandoned coal mines. I went to Windbank community where they have fires burning underground for almost 50 years and they have seen houses disappearing. You go to fields and just see waves of heat coming from underground and you have to look carefully where to put your legs so you won't disappear into an abandoned coal mine. The Nigerian environment is already so trashed that we don't need to create new problems.

hbs: So you are proposing zero megawatts from coal... What is the one major obstacle to achieving this?

Bassey: It is the power of the corporation. They have the ears of the government. Especially this government that is saying that the country is broke and there is no money because of the price of crude oil, they will hang on to anything, and of course, every governor is now saying we are going to develop solid mining. Coal is a solid mineral and we have a fairly good solid minerals law that was enacted in 2007 which gives some scope for communities to determine whether they want to allow mining or not and to be paid rent for the land, to be paid for the resources taken from them. If this is implemented, if that law is implemented rightfully, the communities will have a say because at the end of the debates, what communities will be ready to accept will be based on knowledge. They need to know the impacts of the mining, they need to know what jobs will come to them, they need to know what will happen to their health, they need to know what will happen to their social infrastructure and culture and all this. If they see all of this and say, 'Yes we want mining!' – of course, we won't go against their decision. But we want them at least to be informed so that they can say like the Ogoni people said, we don't want mining, we don't want drilling from our communities except you clean the mess.

hbs: Mr Ayalogu, would you expect government to pay for the social and health costs arising from coal mining and power generation, or would you expect the operating companies to cover the cost?

Ayalogu: Well, it depends on governments to provide health care. Of course, there are companies that provide energy, coal, that are also bound by their CSR and by community development commitments to make sure that the outcome of whatever they do in terms of health and other social issues is taken care of by them. So I will expect that government will come down heavily on the operators. Monitoring is the key thing to make sure that whoever is doing whatever, is aware and responsible for what he does. That has been the problem with the fossil fuel sector as it pertains to Nigeria but it's not that bad in other countries because there is a government that is always behind your back to ensure that each step you take is the correct thing. And once you do that, I'm not saying that the world will be a totally clean place, but at least you know how to live with it. ●

SUBSIDIES

HIDDEN PAYMENTS, UNPAID BILLS

The coal industry uses taxpayers' money to keep its prices low – and it does not compensate for the costs of climate change or disease. A brief look at the scale of the problem.

Supporters often say that coal produces cheap energy. But things are not quite as simple as the industry suggests. The real cost depends on what is included in the reckoning, and who pays for that. The price of power reflects the costs incurred by the energy producer, along with taxes and levies.

However, some factors are not included in the price and never show up on an electricity bill. These are the so-called external costs. These externalities occur when a market actor (in this case, the coal company) affects the welfare of others but does not compensate them. In other words, the person or organization that causes a problem does not pay fully for its consequences. It pulls in a profit but passes part of the costs on to third parties, or to society at large.

Mining and burning coal involve enormous external costs. The most significant costs are government subsidies, environmental damage and harm to human health. Taking this into account, coal becomes an expensive commodity. The International Monetary Fund has revealed that post-tax subsidies for coal amounted to 3.0 percent of global GDP in 2011, rising to 3.9 percent in 2015. This is largely due to the high environmental costs associated with coal consumption.

Those costs include greenhouse gas emissions and air pollution. It is impossible to put hard numbers on these; instead, we have to rely on estimates and judgement. Some types of damage cannot be reversed. In addition, costs are

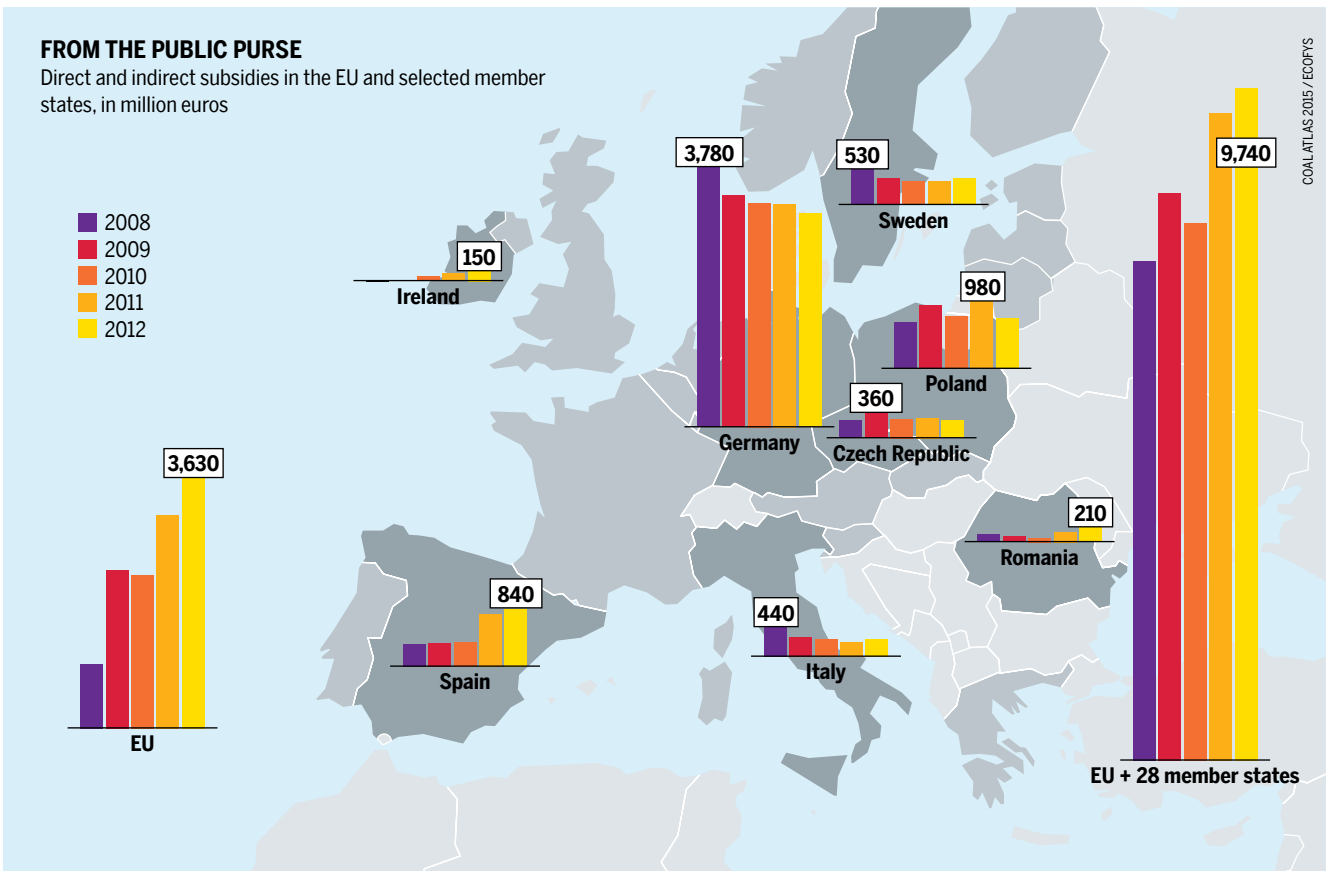
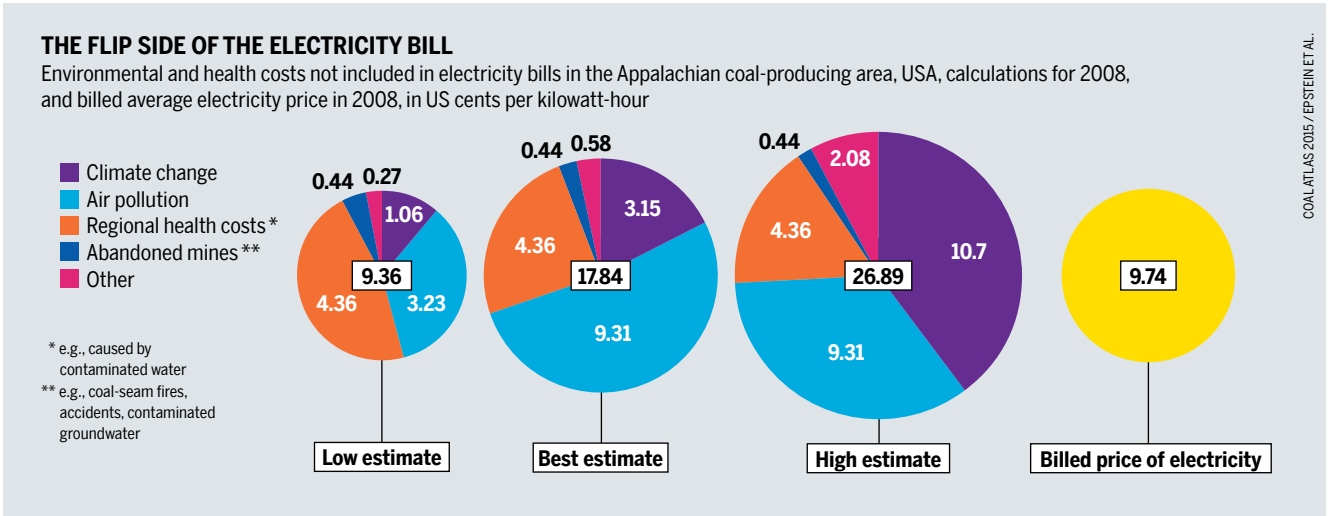
not based on the intrinsic value of ecosystems harmed by climate change, for example, but on the economic losses. The costs of repairing damage after a major accident are included, but only to a limited extent, to avoid forcing the business concerned into bankruptcy if damages are claimed.

These considerations mean that any figures – such as those provided by the British consulting firm Trucost to the United Nations Environment Programme – are politically tinged. The numbers should be treated with caution, but they are huge, even if they are just the tip of the iceberg. According to Trucost, the external costs of using coal to generate power in 2009 amounted to \$452 billion in East Asia alone. These costs were mainly attributed to greenhouse gas emissions and air pollution. In the same year, the costs in North America reached \$316 billion.

In Germany, air pollution and greenhouse gases added up to more than 28 billion euros – exceeding what was spent to support renewable energy. For lignite, the German Federal Environment Agency puts the environmental costs at around 11 euro cents per kilowatt-hour; for hard coal, the figure is 9 cents. If these costs were reflected in the energy price, electricity bills would rise. In the USA, researchers estimate that a coal-fired kilowatt-hour would have to cost between 9 and 27 US cents more than the customary 10 cents appearing on the electricity bill. If the coal companies were to internalize these external costs, coal would barely be competitive and would be displaced from the market as a result.

A more realistic price would not automatically compensate people harmed by climate change or those suffering

If climate, environment and health damage by coal power production were properly taken into account, the electricity bill would look radically different



from air pollution. The coal companies should have to take on the legal as well as the financial responsibility. A public admission of guilt and an apology to the victims would be appropriate. Both are taboo for the industry.

The apparent cheapness of coal is also a result of subsidies from the taxpayer, both current and in the past. Energy producers are still profiting from the support they received in the past. In 2014, the German consulting firm Ecofys put together some impressive numbers for the European Commission. Between 1990 and 2007, the current 28 members of the European Union subsidized the expansion of coal-related infrastructure to the tune of 200 billion euros. Only nuclear power got more support, with 220 billion euros. Aside from 100 billion euros spent on hydropower, renewables were not directly subsidized.

Government support has ensured that locally produced coal stays competitive. Between 1970 and 2007 this support cost the EU countries a total of 380 billion euros. Germany leads in the subsidy race. One source of funding is the 1.2 billion euros that the German government contributes directly to the hard-coal mining industry.

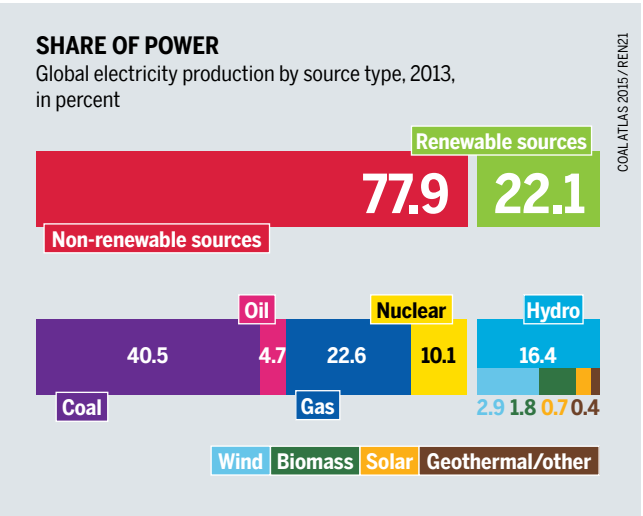
Between 1974 and 2007, the EU governments as a whole spent around 87 billion euros on fuel research and development. Nuclear power got the biggest chunk, at 78 percent. Another 12 percent went to renewables, and 10 percent to fossil fuels – with coal getting more than oil and gas. In 2012, the member states of the EU handed out a total of 13.4 billion

Subsidies make sense if they improve the energy mix. But coal is part of the problem, not part of the solution

Every year, the coal industry in the EU receives nearly 10 billion euros of taxpayers' money. Germany contributes the biggest amount

euros to the fossil-fuel industry. Outside the EU, coal subsidies are huge, too. A study by the Global Subsidies Initiative found that in Turkey, for example, they amounted to \$730 million. The OECD puts the figure for Australia at over \$125 million in 2011.

In 2009, the governments of the G20 group of major economies committed themselves to phase out subsidies for fossil fuels in the medium term. The worldwide shift to renewable energy will gather pace if they put their promises into action. ●



PROFITABILITY

DEFLATING THE CARBON BUBBLE

Successful climate policies mean that coal is becoming a less valuable resource. This affects the companies that dig it up.

In 2009, a team of researchers at the Potsdam Institute for Climate Impact Research published a ground-breaking study calculating the size of the global carbon budget. That is the amount of CO₂ that can be emitted if the rise in the Earth's surface temperature is to be held below 2 degrees Celsius. A key finding: if we continue pumping out as much greenhouse gas into the atmosphere as we have so far, we will have used up the budget in just 14 years – and the temperature will rise more than 2°C. In addition, it means that the carbon budget sets a limit to the amount of coal, oil and

gas we can burn. All the fossil energy sources beyond this limit are “unburnable carbon” – a phrase coined by the Carbon Tracker Initiative that has become an important measure in global climate policymaking. The Carbon Tracker Initiative calculates that 2,795 gigatonnes of CO₂ are stored in oil, gas and coal reserves in private and government hands and listed on stock exchanges. Compare that to the global carbon budget of 565 gigatonnes. In a nutshell: four-fifths of the reserves are “unburnable carbon”.

Two scientists at University College London have worked out what these calculations imply for the use of individual fossil fuels in different locations. They published their findings in the journal *Nature* at the beginning of 2015: to keep within the 2°C limit, we can burn only about 12 percent of current global coal reserves, two thirds of the oil and about 50 percent of the natural gas reserves. The restrictions would be even tighter if we are to keep within a 1.5°C rise, as recommended by climate science.

Policy decisions and lower market prices for energy, partly as a result of advances in renewable energy, could leave most fossil-fuel investments as “stranded assets”. Against investors’ expectations, such assets would bring in no profit; on the contrary, they would have to be written off as more or less worthless. The Carbon Tracker Initiative calls this misinvestment problem the “carbon bubble”; named after the speculative peaks in the world of finance, such as the property bubble that sparked the economic crisis in 2008. The phenomenon is not restricted to coal: oil and gas reserves are also affected.

Despite this, private and government financial institutions continue to invest in the companies affected, or to grant credit on the basis of the previous policy situation. Fossil-fuel reserves are included in the trading value of companies: the production licenses of mining companies, the generation capacity of power producers, and the investments by banks in these firms. If the bubble bursts, these companies will see their value crash.

A study commissioned by the European Greens looked into the risks in 2014 for 43 of the EU's biggest banks and pension funds. It identified a total of over one trillion euros. The good news: some funds have already started to divest themselves of these holdings in order to avoid a crisis if the investments in coal and oil become “stranded”. In June 2015, the Norwegian parliament voted to remove coal firms from the investment portfolio of the country's pension fund. This is the biggest divestment so far by a single investor, which is also Europe's largest pension fund.

Many governments are concerned about the financial risk represented by the carbon bubble. Divesting from coal now is necessary to prevent disastrous climate change and

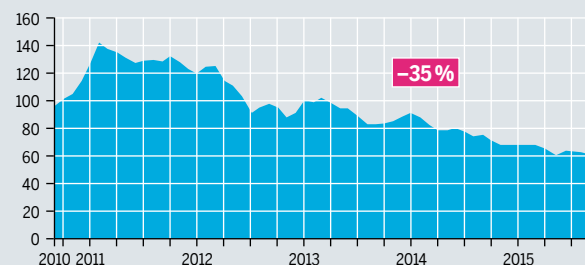
Pressure on global energy policies will put further pressure on coal share prices

GOING DOWNHILL

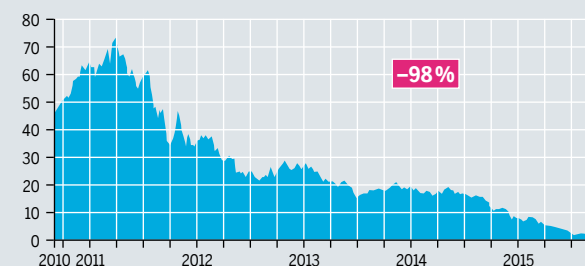
Financial crises in the coal sector, three examples, August 2010 to August 2015

Prices for exported Australian coal, in US dollars per tonne

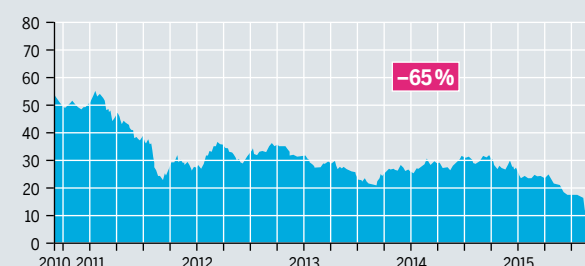
Percentage loss in 5



Share prices for Peabody Energy, biggest US coal producer, in US dollars

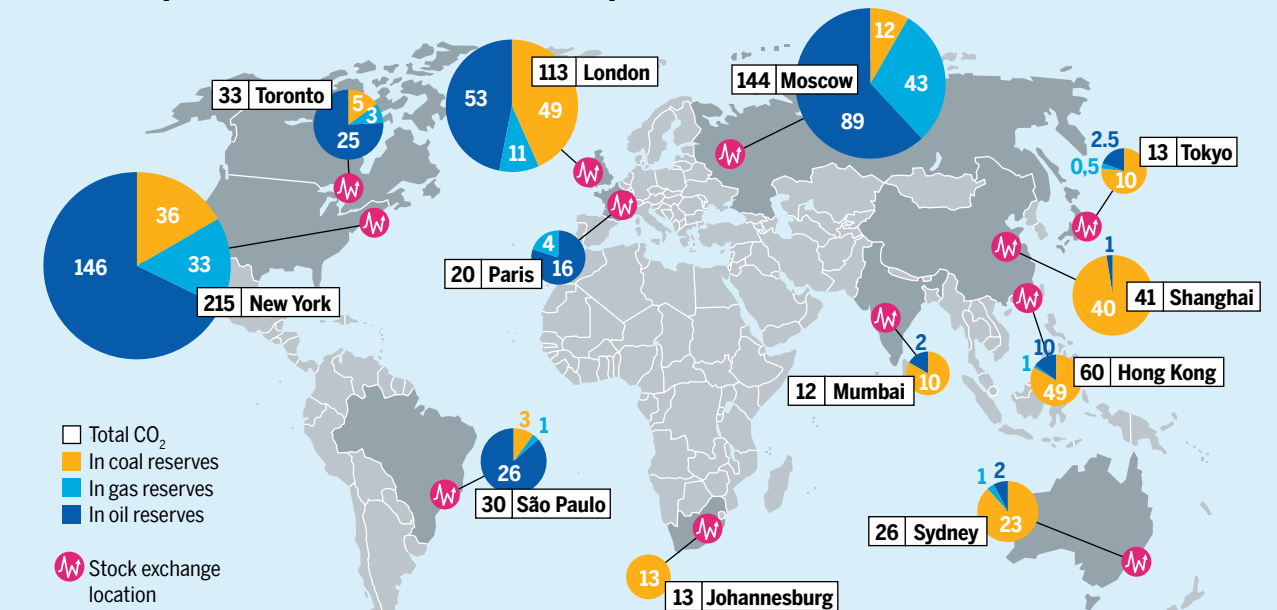


Share prices of RWE, largest German power generator, in euros



TODAY'S INVESTMENT IN TOMORROW'S POLLUTION

The 12 stock exchanges with the biggest coal, oil and gas reserves of listed companies, expressed as CO₂ content of the reserves, 2013, in billion tonnes of CO₂



a global financial crisis. The big coal producers at least partly recognize the sign of the times. E.ON, Germany's biggest power firm, is splitting in two. One part of the firm will focus on renewable energy and power services, while the rest will be responsible for conventional power plants. Rio Tinto, a mining multinational, has hived off its coal investments into a separate firm while signalling it will move away from this type of mining. Its competitor, BHP-Billiton, has also parted coal investments into a separate firm, thereby halving its coal activities.

These actions are late. In Europe, power firms have lost touch with developments because they have not changed their strategy quickly enough. Only eight percent of German investments in renewables came from power suppliers like E.ON and RWE. In 2014, the French energy giant GDF Suez had to write off stranded assets to the value of 15 billion euros. The power firms did not take the EU's goal of reducing emissions by 2020 seriously. They assumed that energy efficiency and renewables would be long in coming, if they arrived at all.

The coal industry is now waking up. Low prices on the world market are putting revenues and profitability on hold. In 2014, coal consumption in China, the biggest consumer, fell for the first time on record. In an effort to reduce air pollution, the country is consuming significantly less. Demand in the United States and Europe is also declining; rising consumption in India cannot make up the difference. As a result, coal prices have halved from a peak in 2011, and are now as low as during the global financial crisis in 2008. Low

The end of coal exploitation does not have to trigger a stock-market crisis – if investors change course

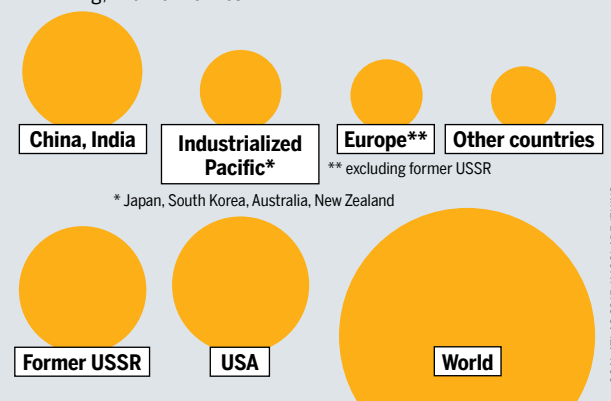
A decline in the value of fossil fuel reserves translates into a fall in the share price of the firms that own them

world prices affect the Chinese market too, bringing losses to coal producers there. In mid-December 2014, Glencore, a mining giant, shut its 20 mines in Australia for three weeks and told 8,000 workers to take their annual leave – a sign of the depth of problems faced by the industry.

Investors should perhaps regard some coal producers themselves as “stranded assets”. Political moves to reduce carbon emissions and develop alternative technologies send the right signals to chief financial officers. More important still, companies in the fossil-fuel sector are also getting a clear message; they should not waste any more money looking for new reserves. ●

IT'S BEST TO LEAVE IT IN THE GROUND

Coal reserves that are “unburnable” with a 2-degree limit to global warming, in billion tonnes



* Japan, South Korea, Australia, New Zealand

** excluding former USSR

CARBON CAPTURE AND STORAGE

PROBLEMS AT DEPTH

With the promise of “clean coal”, the industry intends to store carbon dioxide underground. However, this method of dealing with the climate crisis fails for both technical and economic reasons.

In recent years, political and economic circles have discussed a particular way of making coal-fired power stations more climate friendly. This method is known as “carbon capture and storage”. The technique involves capturing the carbon-dioxide emissions from power plants and factories, and storing them in geological formations deep underground. Some scientists and environmentalists hope that this will decelerate the rise of carbon dioxide in the atmosphere, or perhaps even reduce it. Many of the scenarios prepared by the Intergovernmental Panel on Climate Change assume that if carbon capture and storage is used the probable warming level will stay below 2°C. But such assumptions carry a critical flaw. It is already evident that the technologies currently under development cannot achieve what they promise.

It is now possible to capture only 85 to 90 percent of the CO₂ from power stations. Doing so takes energy, which has to come from the power plant itself. The plant, therefore, works 11 to 15 percent less efficiently, cutting its operating efficiency from 35 to 30 percent – back to levels common in the 1980s. The plant would have to burn up as much as one-third more coal to produce the same amount of energy. The commercial use of carbon capture and storage would re-

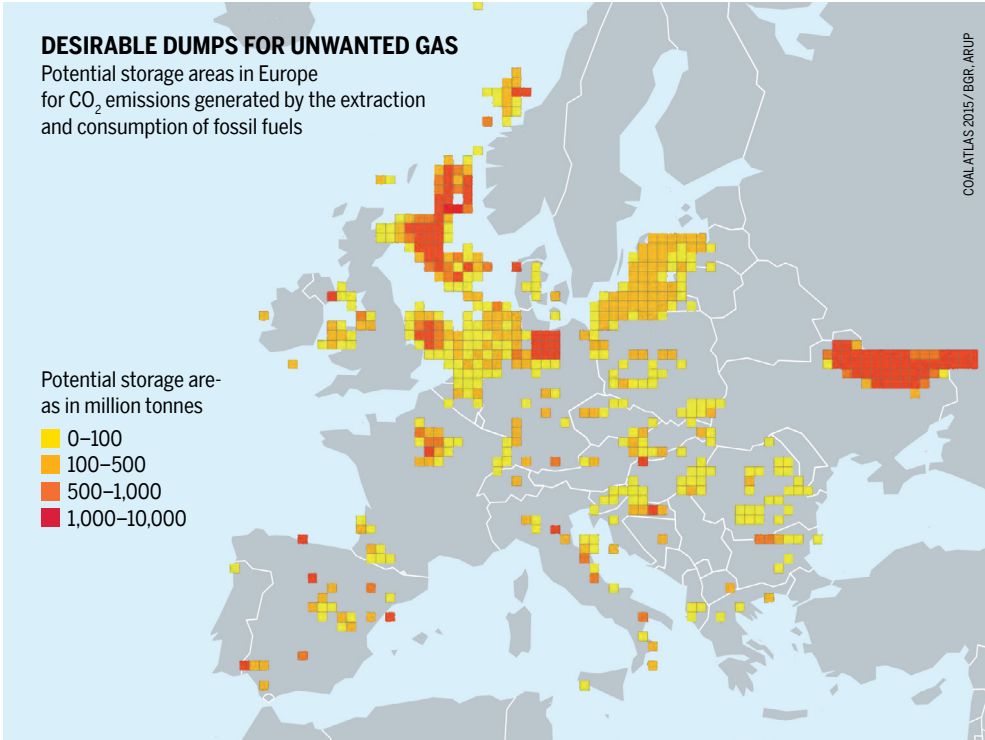
quire digging up yet more coal – with all the accompanying negative environmental consequences.

Where could the captured CO₂ be stored? One possibility is in depleted oil and gas fields. In the United States and Norway injecting CO₂ into oilfields is a common procedure to boost the yield of oil. A much bigger but more controversial potential store is in saline aquifers: porous rock formations filled with saline water that are capped by impermeable layers of rock.

The Norwegian energy firm Statoil launched one such storage-and-capture project in 1996 at the Sleipner gas field under the North Sea. Because the natural gas extracted from this field contains too much CO₂, Statoil separates almost a million tonnes of the gas each year, and injects it into rock formations above the gas field to reduce its carbon tax bill.

But it is uncertain whether the storage locations will stay sealed over the long term, whether gas can leak out, or whether the seals on the boreholes will corrode. A sudden release of a lot of CO₂ would endanger humans and other living creatures. The saline water displaced by the CO₂ might be forced up into shallower rock layers and contaminate groundwater with salt and toxic substances. The risks are just as high if the CO₂ is injected into rock formations below the seabed, as planned in countries including Australia and Britain. This type of offshore storage can severely damage the marine environment through leaks of CO₂ and contaminated saline water.

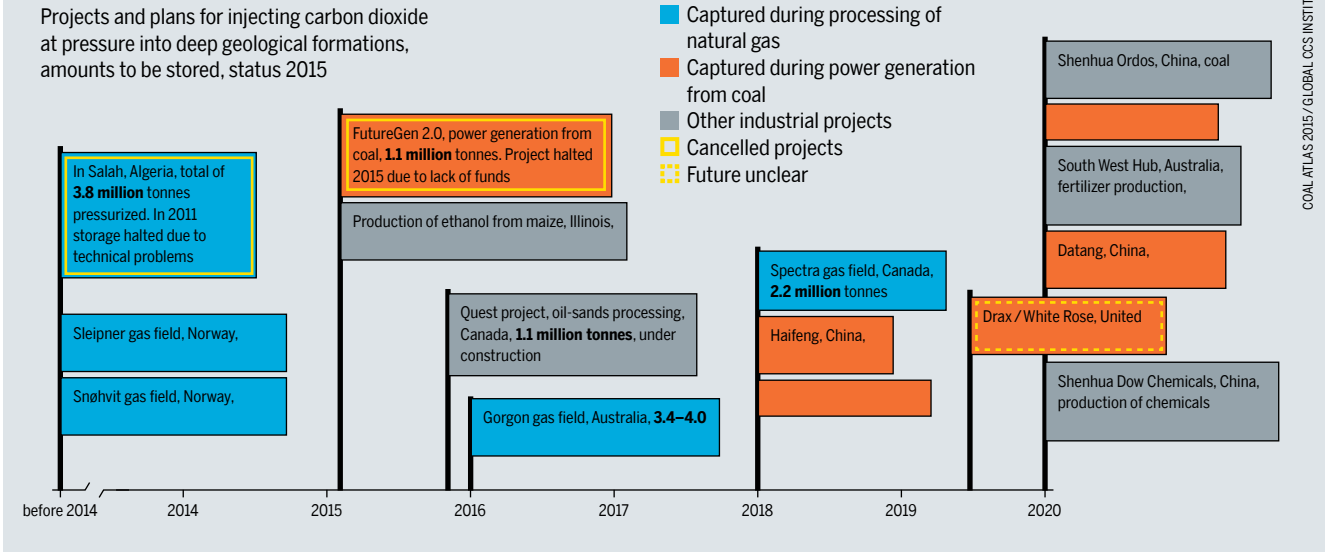
No technique yet exists to monitor CO₂ storage sites, systematically identify leaks or plug them when they are found. A flagship project at In Salah in Algeria was shut



Europe’s carbon storage potential is constantly being revised downwards. Current estimates are 5 to 8 billion tonnes a year

RISKY, COSTLY, TRICKY

Projects and plans for injecting carbon dioxide at pressure into deep geological formations, amounts to be stored, status 2015



down in 2011 because of concerns about storage safety. At present, as a result of technical difficulties and the high cost, which would amount to several billion euros for a big power plant, no plant anywhere in the world separates significant amounts of CO₂ for storage. A small power station in Canada is the only project that gets support from the public purse to boost production from an oilfield. A major project in the United States to demonstrate carbon capture and storage, called FutureGen, would have cost over \$1.6 billion. It was suspended in 2015.

Technically, there are several ways of capturing carbon. One is to use chemicals to “wash” CO₂ out of the stream of exhaust gases after combustion. A second approach relies on the principle of coal gasification; it extracts the CO₂ before combustion takes place. A third method involves burning coal using pure oxygen, making it easier to extract the CO₂ from the exhaust. From a technical point of view, carbon capture is better suited to the steel and cement industries because they are less able to avoid producing CO₂.

Despite all the failures, the promise of “clean coal” is still used as a justification for building new coal-fired power plants and thus extending the life of the fossil-fuel business model and decelerating the transition to renewable energy. Carbon-capture plants are less flexible than traditional coal-fired plants in responding to fluctuations in demand for power.

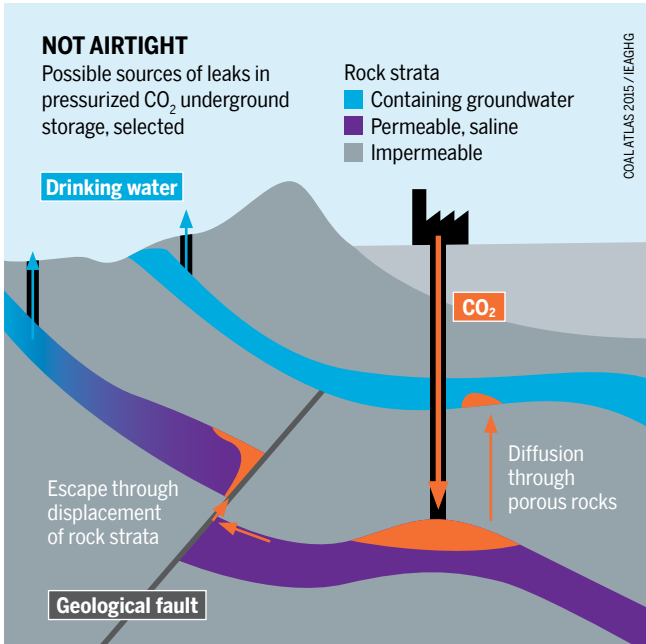
Some coal-fired plants, such as the Drax station in Britain, are able to burn wood as well as coal. In theory, such power stations are supposed to achieve negative carbon emissions by combining carbon capture and storage with the use of bioenergy. Trees absorb CO₂ as they grow. When they are burned, the resulting CO₂ can be pulled out of the cycle if it is captured and stored. A nice idea – but experts say the sums do not add up. Monoculture plantations of fast-growing trees merely displace intact forests, and store a lot less CO₂.

Out of sight, out of mind? We do not know how carbon dioxide might move through geological formations

The coal industry emits billions of tonnes of CO₂ a year. Carbon capture and storage projects may reduce that by a few tenths of one percent

In addition, it is questionable whether the trees absorb as much CO₂ as is released by fertilizer applications, wood processing, transport and the destruction of intact soils. Using bioenergy would further raise the pressure on arable land as investors acquire large areas to plant biomass. Critics call attention to the connection between this “land grabbing” and the violation of traditional land-use rights of local people who lose their means of subsistence.

At Drax, however, an ambitious carbon-capture project hit an obstacle when the plant owner halted its investment. A cut in subsidies for renewable energy caused a sharp decline in the company’s share price. The other partners in the consortium say the project will continue; a feasibility study will be completed in 2016. ●



THE ENERGY TRANSITION

TURNING FROM BURNING – POWERING UP RENEWABLES

The share of renewable energy in the global power mix is growing fast. Nations and corporations are switching over. However, a complete shift away from fossil energy is still not in sight.

The structure of energy supplies is changing rapidly, but in different ways in different places. On the one hand, the share of renewable energy in power generation is climbing constantly. On the other hand, new coal-fired power plants are still being built. European power generators face a tricky period. Many countries have excess capacity in conventional forms of power; these have to compete with renewables.

In 2014, Denmark and Germany consumed the same amount of energy as in the 1970s. They have managed to decouple their energy use from economic growth. Investments in ageing power plants and stricter standards for air pollution are pushing the generators' costs upwards.

Even new plants like the coal-fired power station in Hamburg-Moorburg, which was put online by its operator Vattenfall in 2015, are scarcely economic today. The expansion of renewables in Germany has significantly exceeded most predictions. Many scenarios drawn up in the early 2000s predicted a share for 2020 that was attained by 2010. Renewables are emerging from their niche. Wind and solar power account for 79 percent of all new generation capacity. In Germany, more and more communities are deciding

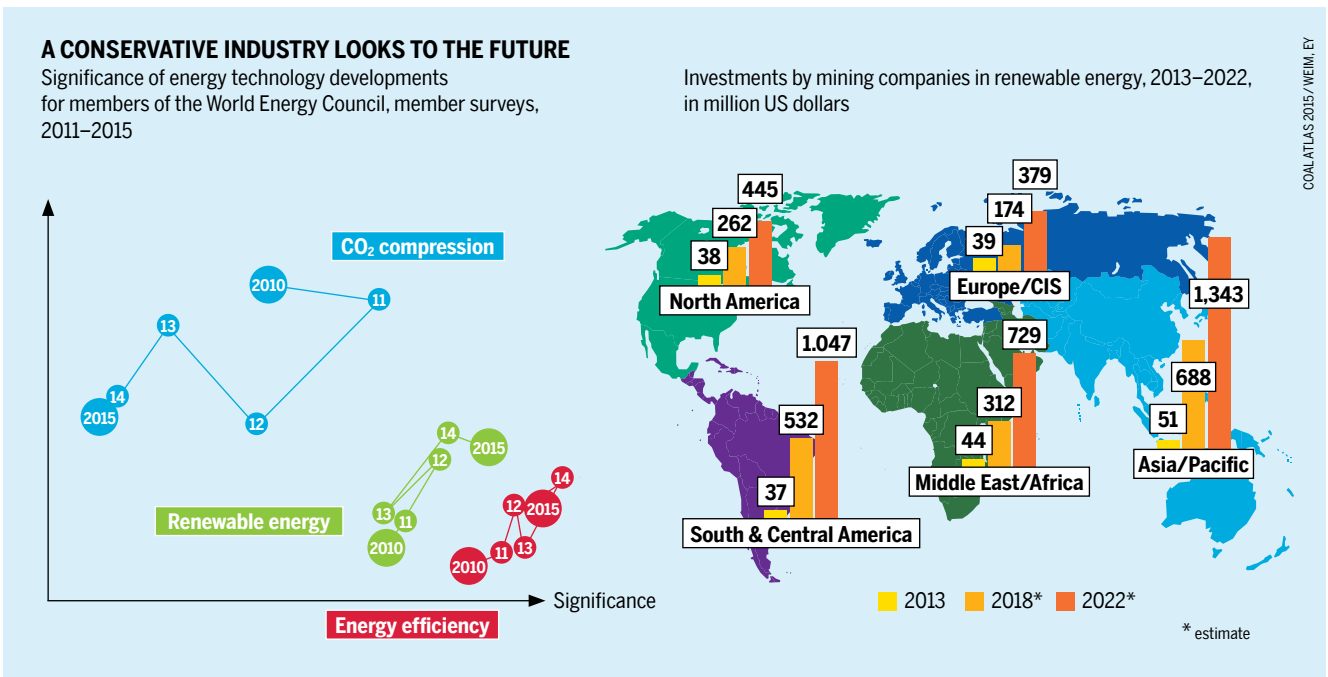
to go fully renewable; around 20 million people now live in so-called 100-percent regions. Power cooperatives in which citizens own shares are leading the shift to decentralized and eco-friendly energy. This grassroots energy transition has attracted interest from abroad. In Germany, the focus is now on maintaining an energy market that does not restrict citizen's initiatives and is legally aligned to and supports renewable power sources.

Renewables already produce 25.8 percent of the electricity generated in Germany. Together, solar, wind, biomass and co. have displaced lignite from the top of the pecking order of energy sources. On sunny and windy days, renewables can supply up to 80 percent of the German demand – unimaginable only a few years ago. But around noon on 11 May 2014, this was achieved for the first time.

This new reality necessitates a redesign of electricity grids, because the locations where the power is now being generated have moved. To cater for variations in wind and solar power, more flexibility is needed from conventional power plants and from consumers, as well as more storage capacity.

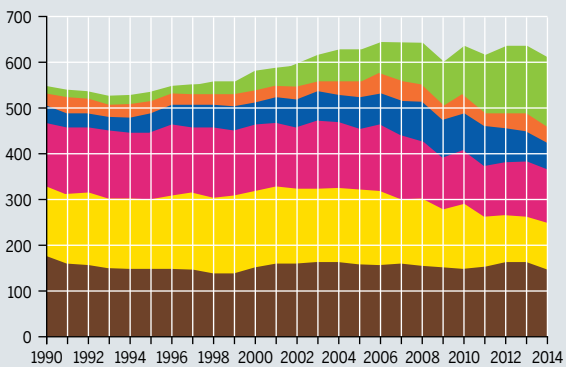
But Germany is just one example; renewables are advancing throughout the world. Half comes from "old" renewables such as hydropower or wood burning. But the "new"

Mining companies are on the lookout for new types of activities. Meanwhile, they carry on with the old

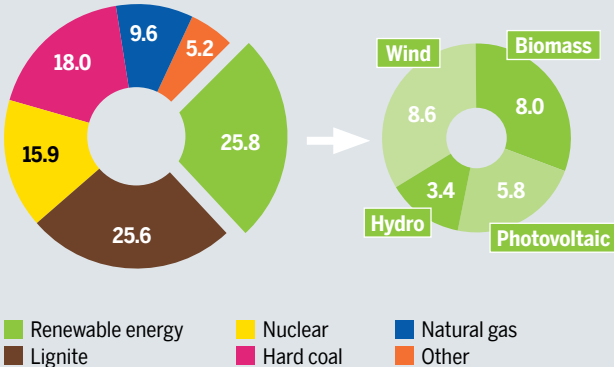


OLD POWER AGAINST NEW ENERGY

Change in electricity generation in Germany, in billions of kilowatt-hours



Electricity mix in Germany, 2014, in percent



renewables such as photovoltaic, wind, geothermal, wave and biogas are gathering steam. In global rankings, large countries such as Germany, China and the United States are normally at the forefront. But relative to their economic capacity, Uruguay, Mauritius and Costa Rica are investing significantly more in renewables than their larger counterparts. The fact that energy guzzlers in the information technology sector like Facebook and Google are switching to renewables should be a signal to other sectors too. Greenpeace praises Apple because it already gets all the energy it needs from renewables. Data centres worldwide consume more than 30 gigawatts of power – the amount generated by 30 large nuclear plants.

Developments in wind and solar energy are promising. Mass production, technical advances and bigger markets mean that the costs of facilities are falling fast, in some cases by half in just four years. More and more projects are funded without government support because they are cheaper than fossil-energy sources. For wind power, 2014 was a record year. Globally, new turbines with a total capacity of 51 gigawatts were installed, 44 percent more than in the previous year. China is out in the lead; the 23 gigawatts that joined its grid accounted for almost half of the new global capacity. In Europe wind energy also increased sharply, by 12 gigawatts, led by Germany and Britain. After a weak performance the previous year, the United States also grew by 4.8 gigawatts.

In addition, the market for photovoltaics expanded strongly. In 2014, more than 40 gigawatts of capacity were added. China accounts for about one-quarter of the total market. The United States added 6 gigawatts; solar power there produces enough energy to supply four million homes. Upward trends can also be found in Japan (+9 gigawatts), Europe (+7), Latin America and South Africa.

In many developed countries, it is now cheaper for most homeowners to produce their own energy from solar cells on their roof than to buy it from the grid. Solar power is crit-

Not just renewable: the energy production of the future should also be decentralized, ecological and democratic

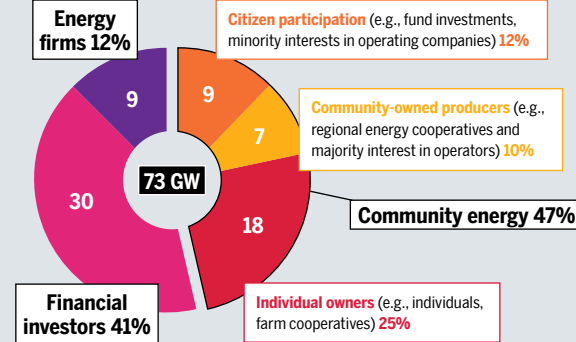
Renewables generated more power than lignite for the first time in 2014

ically important in developing countries, in particular in rural areas that are not yet connected to the grid. For the first time, solar power can supply electricity to residents of these areas and thus improve their lives. This development would have taken years if the rural areas had to wait for power to be supplied by big centralized plants.

Renewables can also present ecological and social problems. Large hydropower dams, mega windparks and big plantations to produce biofuels can lead to human-rights abuses and often to evictions. Widespread planting of monocropped biofuels harms the environment, and the use of agrochemicals is bad for the climate balance. Therefore, the global energy transition is not just about moving away from fossil fuels toward renewable sources. It is also about producing energy in a decentralized, ecological and democratic way. ●

NEW BUSINESS MODELS

Installed renewable energy capacity by type of owner, 2012, in gigawatts and percent



Terminology based on Renewable Energy Agency, Germany. Does not include pumped storage power plants, offshore wind turbines, geothermal or biological waste

RENEWABLES ON THE RISE IN NIGERIA

The rise of renewable energies worldwide has caused prices of solar, wind and biomass technologies to drop by up to 80 percent. Clean energy has become affordable and communities, companies and nations are switching over. Hannah Kabir of CREEDS Energy describes the clean energy opportunities for Nigeria.

More than 10% of global electricity is produced from renewable energies, and the trend is rising. The UN programme on Sustainable Energy for All thinks that the percentage can rise to 45% of global power production in the year 2030. The rise of clean energy will bring a sharp fall in demand for coal power, which is already slowing down as some of America's biggest banks are divesting from coal. Nigeria might soon be offered 'tokunbo' coal power plants for importation, as industrialised nations are phasing out coal.

The rise of renewables goes hand-in-hand with the trend towards decentralized power generation. A growing number of power plants operate independently of the national grid, providing clean energy to citizens. Their size can range from large-scale megawatt grids to small-scale options of just a few kilowatts for a single household or business. The world's largest private bank, Zurich based UBS, advised its clients and investors in 2014 that national grids are "not relevant" for future electricity generation, and that centralized power stations will become redundant within 10 - 20 years as electric cars, cheaper batteries and new solar technologies transform the way electricity is generated, stored and

distributed.

South Africa, known for its heavy dependence on coal power has in less than four years added 4,322 megawatt of renewable energy capacity. The competitiveness of renewables vis-à-vis fossil based power generation is evident in one of South Africa's renewable energy investments: the Cookhouse wind farm feeds 138 megawatt of clean power into the grid at 5 US cents per kWh - half the price of new coal.

Fossil energy for a fossil Nigeria?

In stark contrast with global developments, Nigeria's government announced in 2014 to generate 30% of total electricity from coal. Meanwhile, renewables account for less than one percent of Nigeria's energy mix, despite the enormous resource potential Nigeria has in solar, wind and non-fossil biomass.

The prevalent perception about renewables in Nigeria is that the renewable energy systems and technology do not work. The loss of confidence in renewables as viable alternatives for electricity generation stems from bad experiences with imported sub-standard products and poorly executed projects. One example of poor execution is the Lagos State sponsored off-grid solar PV system in Bishop Kodija, which was meant to provide power for lighting, water pumps and fish driers in the fishing village. The system worked for three months and then stopped functioning, according to the traditional ruler.

Poorly executed solar street lighting projects in Lagos, Sokoto, Borno, Nassarawa, Delta and Abuja that failed short-



Faulty solar system at Bishop Kodija village

Photo: Yinka Obebe



40kW off-grid solar-wind hybrid system for a block of apartments in Abuja

Photo: hbs Nigeria

ly after installation have served to deter further investments in renewables.

In most instances, these bad experiences are caused by lack of maintenance, pilfering, poor quality imported products and components, poor design and installation. Technical expertise within the renewable energy space is few and far between, making it difficult to access quality services. Component retailers and contractors with little or no knowledge about the design and engineering behind providing renewable energy solutions end up executing failed projects.

Renewables are successful in Nigeria

These negative experiences have overshadowed some significant successes in off-grid and grid connected renewable energy projects by professionals. Private sector developers are turning to renewables for captive power generation as Nigeria's real estate, building and construction sectors experience strong growth. It is no wonder that Suleiman Yusuf, CEO Blue Camel, decided to incorporate rooftop solar hybrid systems on his block of serviced apartments in the heart of Nigeria's capital city, Abuja.

The cost of the 40kW hybrid solar PV-wind system will be amortized over the next ten years as service charges, which tenants are already used to paying in serviced apartments.

Indirectly, Mr. Yusuf is saving the Abuja Distribution Company 40kW of power, which his apartments are not taking from the grid. Imagine the possibilities if new buildings in urban areas were obliged to self generate using rooftop solar hybrid systems.

In underserved rural communities where extending the grid does not make economic sense, renewable energy technologies are becoming the main source of power supply. Green Village Electricity (GVE) installed a 24kWp solar PV system in Egbeke community, Rivers State in 2013. According to the CEO, Ifeanyi Orajaka, the solar PV mini-grid created 36 jobs within the community during the course of implementation. These included artisans like welders who fabricated the PV array structure, electricians who did the cabling, technicians and engineers who installed the panels and system components. The mini-grid provides electricity for 1,920 people living in 240 households, the community church, health center, school and market. In September 2015, GVE commissioned a 24kW solar PV mini-grid installation in Bisanti, Niger State. The system currently serves 1,600 people living in 200 households.

Key to achieving success was that most of the projects highlighted were designed and managed by experienced private sector developers who are service and sustainability oriented. As such, there was no compromising on quality products and components, standard operations and main-



Solar PV mini-grid installation, Egbeke community

Photo: Gve ltd

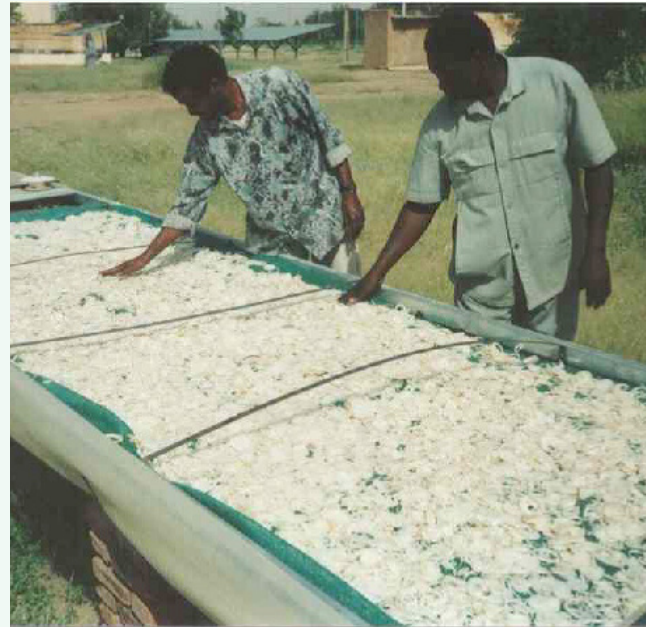


Mini-grid solar PV array in Egbeke community

Photo: Gve ltd

tenance measures, and all parties recognised the need to build lasting relationships with suppliers and end users.

Renewable energy resources- solar PV, concentrated solar power (CSP), wind and non-fossil biomass hold promising potentials for Nigeria's power generation. Taking into account all the suitable areas that can be used to generate power, Nigeria can get 32,456 terrawatt hours per year from solar PV, plus 10,045 terrawatt hours per year from concentrated solar, and another 12,867 terrawatt hours per year from wind energy.



Forget the grid, here comes solar

Small-scale solar PV rooftop or ground-mounted systems can provide backup power supply as stand alone solutions for individual households and small businesses with predictable energy consumption patterns such as schools, health centers, provision stores, barbershops, tailors, restaurants and market stalls. Smallholder farmers, the majority of whom are women, can benefit immensely from solar powered solutions for function specific uses such as irrigation and food processing. Farming yields and incomes can increase significantly with access to solar water pumps with a drip irrigation system, solar powered grinding machines and solar food dryers.

On a micro-level, quality solar lanterns can substitute for kerosene lanterns used in over 15 million off-grid households. These can reduce the effects and mortality from indoor air pollution.

Undoubtedly, Nigeria needs to increase its power generation capacity by strengthening its base load with conventional power systems from plants that can generate steady flow of electricity into the grid, independent of variables such as sunshine hours, periods of wind slackness or availability of biomass. Base load electricity can be boosted from thermal gas plants rather than coal plants. Gas is much cleaner than coal and more cost effective. Last year, the UK's electricity generation from coal fell to its lowest level since industrial revolution from 36% in 2013 to 29%. This sharp

decrease was attributed to the fall in gas prices compared to coal, making gas more economical to use for electricity generation.

Balancing grid and off-grid options

Whatever feeds the grid, the question remains whether the existing grid infrastructure is robust enough to accommodate substantial power generation increase beyond its current transmission wheeling capacity of 5000MW? And how long will it take to expand the grid? There is no quick fix for the grid. Repairing it will take a long time, expanding its capacity and reach will involve extensions, which require huge investments. The existing grid also lacks the ability to function smartly to accommodate intermittency from renewables.

Despite the intermittency of renewables like wind and solar, these resources are far from being unreliable. Even with conventional power supply, there is a planning process that ensures consistency in electricity supply to meet demand. For renewables, the planning involves balancing sudden fluctuations, having reserve capacity, having a mix of complimentary sources and having spare capacity from a conventional source to smoothen supply. Numerous countries have been able to integrate electricity supply from solar and wind on the strength of modeling and predicting aggregate renewable power available to the grid from existing resource data with reasonable accuracy. It boils down to having a robust grid infrastructure and an enabled operator that can seamlessly integrate conventional and renewable generation to consistently meet demand in an efficient electricity market.

The quick win for Nigeria lies in decentralized renewable power such as Pay-As-You-Go solar. These individual solutions can bring electricity to millions of households, small and medium sized enterprises within months rather than years. This option needs the least investment and regulatory framework – it's a ready to roll project. And for once, this power would be power in the hands of the people who have been waiting, for too long. ●



Combined wind and solar power allow for balancing of fluctuations in the power supply from renewables

Photo: hbs Nigeria

THE POWER OF RENEWABLES



Price crash: As the cost of solar technologies has shrunk by more than 80%, investments into clean energy are now outpacing investments into fossil energy in many markets around the globe.

PAYG Solar

1 KVA SOLUTION

Providing for:
3 sewing machines,
1 TV, 1 ceiling fan,
4 lighting points

N 30,000 down payment
N 11,250 monthly fixed charges

3.5 KVA SOLUTION

Providing for:
12 computers,
photocopy machine,
server, lighting points

N 93,000 down payment
N 35,000 monthly fixed charges

Customers get a tailor-made installation and pay it off over 2 years. Afterwards, their electricity is for free. Who pays for sunshine?

Companies install high-quality products and give a warranty for them. They receive customers' payments through mobile money. When customers do not pay, companies cut off the solar panels through GIS technology.

Pay As You Go Solar could provide millions of small enterprises in Nigeria with reliable and clean electricity within months.

Turning away from coal: 2014 was the first year where China reduced its use of coal by almost 3%. At the same time, the country increased its electricity production by almost 4% - from renewable energies.

40 COAL ATLAS 2015

COAL ATLAS 2015 41

CHINA

BLACK FUEL, IN THE RED

Change is under way for the world's biggest coal consumer; consumption in 2014 was down. Renewables are up. Coal-fired power plants are working at less than full capacity.

China burns more coal than any other country. In the 15 years since it became the workshop of the world and developed a booming domestic market, its consumption of coal has doubled. Between 2010 and 2014 alone, China built new coal-fired power plants capable of generating 228 gigawatts – three times more than Germany's total electricity consumption. Because of its dependence on coal, China now emits significantly more carbon dioxide than the long-time number-one climate offender, the United States – though it still churns out less of the greenhouse gas per person. Counting the cumulative emissions since 1990, China is now on the verge of overtaking the USA.

But 2014 was different. For the first time in over three decades, China burned less coal than in the previous year. Consumption declined by 2.9 percent, and imports slumped by around 11 percent. Not long ago, the International Energy Agency predicted that both figures would continue to rise until 2020. Despite the decline in coal, power consumption was up by 3.8 percent, and the gross domestic product rose by more than 7 percent. It is unclear whether this decoupling is a blip or a turning point.

The decline in consumption did not just happen. The government wants to reduce the use of coal for various reasons. The most important reason is the smog that blankets Chinese cities causing asthma and boosting the risk of cancer. The Chinese people, and especially the emerging middle class, are becoming increasingly irritated. Released in 2015, the documentary "Under the Dome" by journalist Chai Jing, focuses on widespread air pollution, and has attracted attention. Over 150 million Chinese watched this film within just three days. It has since been censored by the authorities.

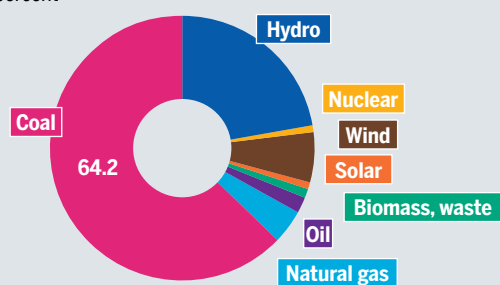
In the face of widespread dissatisfaction, cities have been switching off their older coal power plants and dozens of provinces have decided to reduce their consumption. A planned national market for CO₂ pollution rights strives to support such efforts. These may make the goal of the "Energy Development Strategy Action Plan", which aims to reduce the share of coal in the total energy mix to below 62 percent by 2020, down from today's official 64.2 percent, possible.

The national government is also pushing for the rapid expansion of renewable energy. By 2020, non-fossil energy sources, including nuclear, will account for 15 percent of

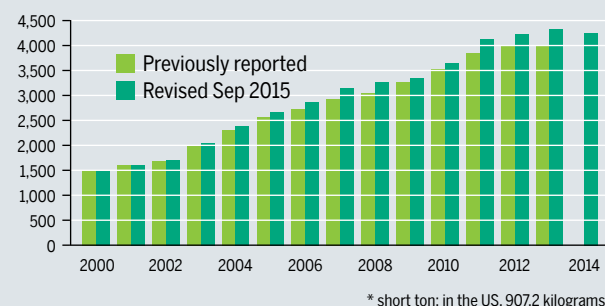
New data released in 2015 revealed China had used 14 percent more coal than previously thought. Even so, 2014 saw a slight drop

UPS AND DOWNS IN CHINESE COAL USE

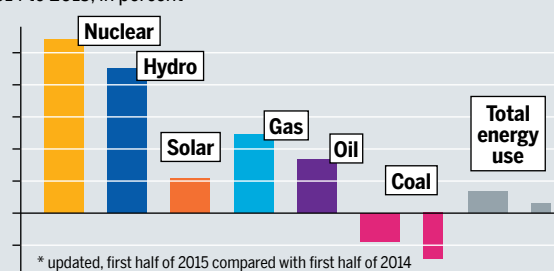
Installed electricity capacity share by fuel, mid 2014, in percent



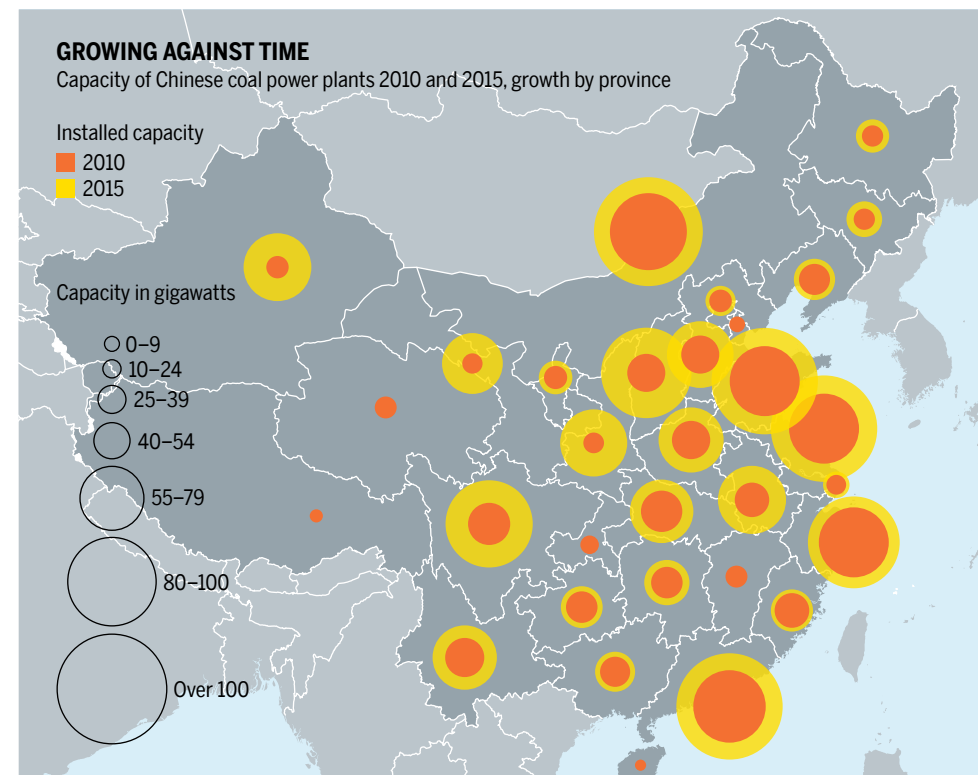
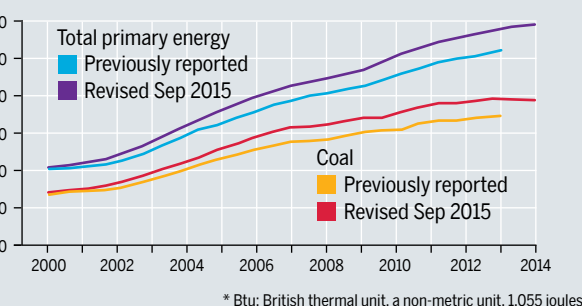
A coal plateau? Raw coal production, old and new data, million short tons* per year



Less coal, more nuclear and hydropower: changes in energy use, 2014 to 2013, in percent



Ever higher: energy consumption, old and new data, quadrillion Btu* per year



If China's demand for coal continues to decline, many power stations will be superfluous

primary energy consumption; by 2030 their share should rise to at least 20 percent. Meanwhile, no other country is investing as much in hydro, wind and solar power; in 2014, China spent about \$90 billion on these power sources. Such investments are not without controversy. Big hydropower projects have been criticized for their negative impacts on the environment and for serious human rights violations. The construction of the Three Gorges dam alone forced the resettlement of almost 1.5 million people. Compared with the previous year, China boosted its installed wind capacity by 26 percent and solar capacity by 67 percent.

That has led to a decrease in coal production. In 2014, the coal-fired plants produced 1.3 percent less power than in the previous year; on average they are now only running at 54 percent capacity, the lowest level for three decades. China's coal sector is now suffering from serious overcapacity. That is one reason why several planned coal projects have been halted in recent years.

Falling prices, a ban on especially dirty types of coal, and more stringent environmental requirements have depressed the profits of mining outfits. Three out of four Chinese coal firms have reported losses recently. In the last four years, almost 6,000 coal mines have had to close down. By the end of 2015 another 2,000 mines will padlock their gates. Yet as mining companies are yielding to financial and political pressures, other firms are still planning new coal-fired power plants.

Experts warn of an investment bubble caused by an overcapacity in power generation, because still more new plants are being planned that might go unneeded. The val-

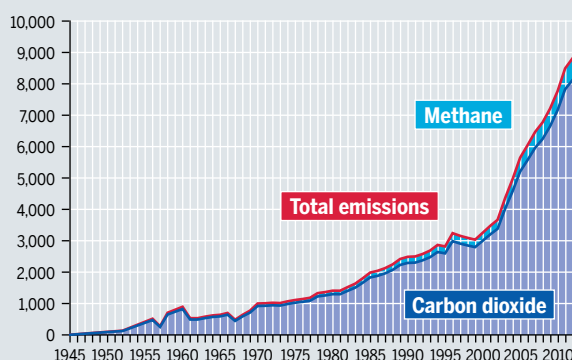
ue of companies with extensive coal reserves will undergo a correction on the stock markets as their reserves lose value. That will have knock-on effects on related sectors, on major investors, and on banks that have invested in coal firms or have outstanding loans to them. If the Chinese coal bubble bursts, it will threaten not only the country's own financial situation but also the rest of Asia. The big Australian and Indonesian coal exporters, which are oriented entirely to the Chinese market, will quickly feel the pain.

The Chinese government has started to treat coal critically and is ushering in an era of renewable energy. That is a strong signal for the rest of the world. Because China stimulates the mass production of modern facilities, their cost will fall. Strange as it may seem, it is the country with the world's worst pollution that is leading the global energy turnaround. ●

Emissions from the Chinese state coal industry have doubled in a decade. It will take a long time to reverse that trend

NATIONAL COAL INDUSTRY OF CHINA

Emissions of CO₂ and methane from coal mining, production and combustion, 1945–2013, million tonnes, methane CO₂ equivalent



RICH IN COAL BUT POOR IN ENERGY

Coal is an important part of India's energy mix, and consumption is rising quickly as the economy expands. Local production is not enough: strong demand is attracting imports from Australia and elsewhere. However, India has huge potential for renewable energy, especially solar and windpower.

Of the 1.2 billion people worldwide without access to electricity, over 300 million live in India. Two-thirds of the 80 million households affected are located in villages that are nonetheless connected to the electricity grid. "Energy poverty" – the lack of modern, non-polluting forms of power – harms lives in numerous ways. Daily power shut-downs, known as "load shedding", increase business costs, reduce efficiency and stop farmers from pumping irrigation water. Burning firewood, cow dung and kerosene pollutes the air indoors and causes respiratory problems, especially among women who do the cooking. Poor lighting means schoolchildren cannot do their homework in the evenings.

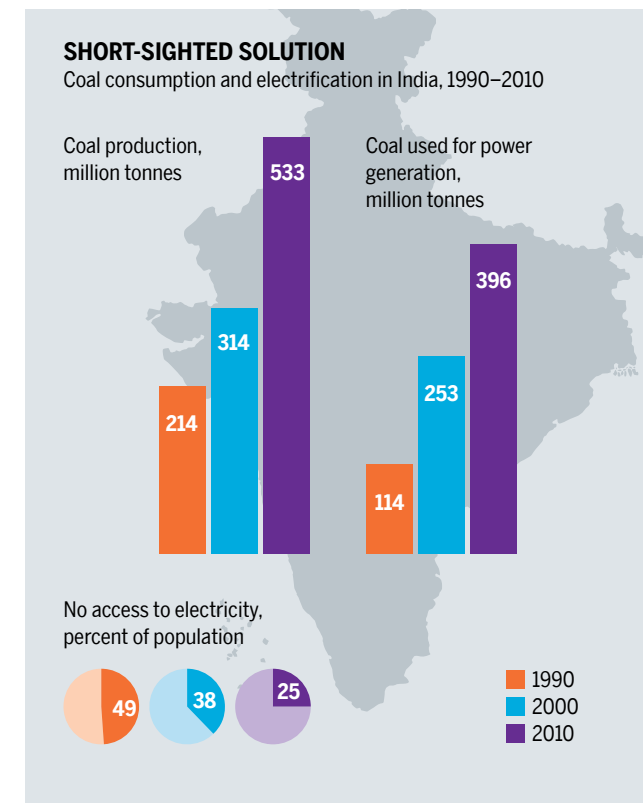
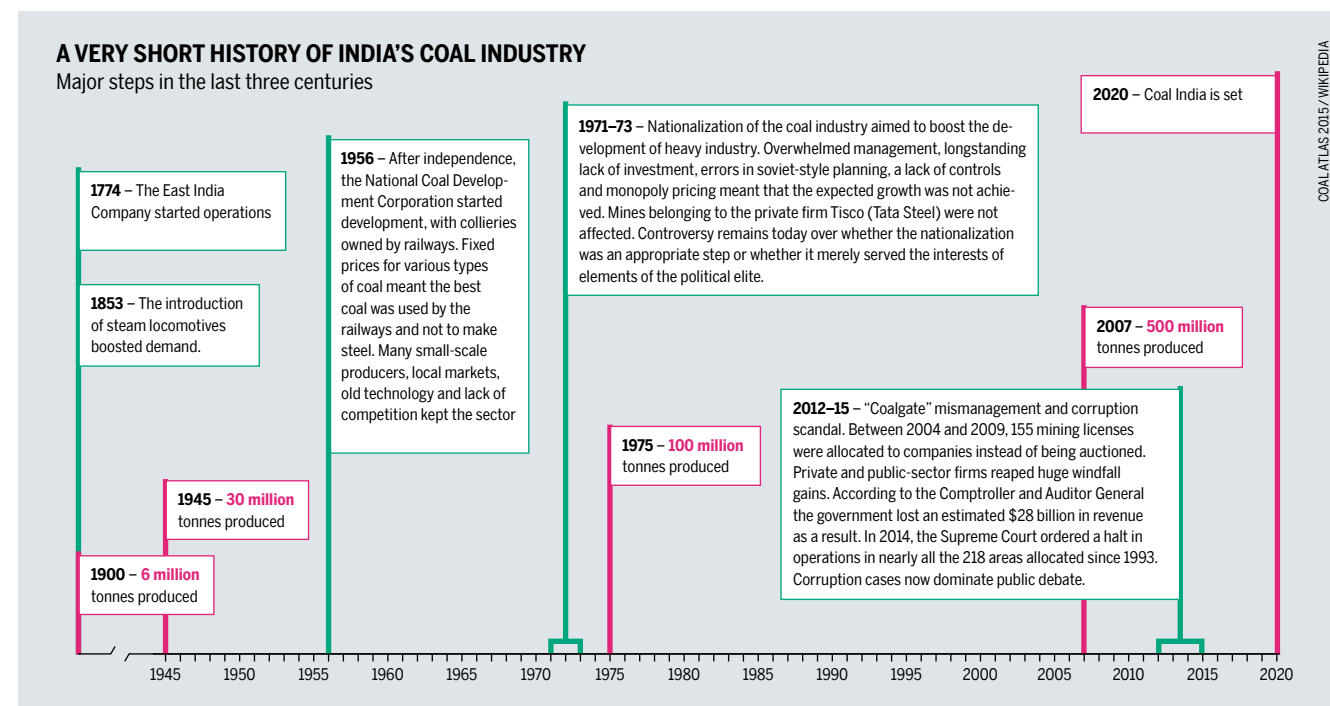
India has been able to reduce poverty alongside a massive expansion of coal use over the last two decades. Power production and the amount of coal consumed to produce it nearly quadrupled between 1990 and 2013. The percentage of the population living below the poverty line fell by about one-third, while the proportion of the population with access to electricity rose from half to more than three-quarters. Coal has alleviated India's energy access problem and contributed to poverty reduction – though at substantial health,

social and environmental costs. And yet each Indian consumes the equivalent of only 0.47 tonnes of oil a year: less than a third of the world average.

Coal provides more than half of India's total primary energy, a share that is projected to decline only slightly by 2030. In 2013–14, the country consumed 740 million tonnes, more than 70 percent of it to produce power, and much of the rest to make steel and fertilizer. The government has targeted a coal consumption of 1 billion tonnes for 2020. Current consumption makes India the world's second-biggest coal consumer, and number three in terms of total CO₂ emissions, even though its per capita emissions of around 1.7 tonnes per person a year remain by far the lowest among the BRICS countries.

Much of India's coal mining and many of its coal-fired plants, often situated directly on the mining sites, are located in forest areas inhabited by indigenous groups called Adivasi. Living on the fringes of India's mainstream society, they are among the poorest communities in India, while bearing the brunt of the environmental destruction and pollution caused by the extraction of coal and other minerals. Large-scale coal mining and power plants in the Singrauli area in Madhya Pradesh have displaced local people and led to land grabs, the loss of forests and numerous health issues, including mercury pollution. Here, local protests recently stopped plans to expand mining in the Mahan forest. In the

For more than half a century, state-ruled Indian coal production and disposition has not succeeded in becoming efficient



open-cast mining areas of Jharia, Jharkhand, uncontrolled underground coal fires have burned continuously for nearly a century. Also in Jharkhand, Maoist guerrillas fight the government; while claiming to defend local communities they themselves thrive on their own coal operations and on protection money paid by coal companies.

India has enormous coal reserves of 300 billion tonnes that could provide the country with energy for hundreds of years at current consumption rates. State-owned, Coal India is the single largest coal company in the world, with over 350,000 employees in 2013 and producing close to half a billion tonnes of coal in 2014–15. Together with numerous state-owned coal power plants and Indian Railways (which derives nearly half of its freight earnings from transporting coal) they constitute a veritable pro-coal lobby within India's government institutions.

Still, national coal production lags behind official expectations, because of local resistance, outdated production techniques and the cancellation of licences for private mine operators after corruption allegations (known as "Coalgate"). Twenty-five years ago, nearly all the coal used in India was produced locally. Today, nearly one-quarter is imported, most of it from Indonesia, Australia and South Africa. In 2014–15, the import share was 19 percent higher than in the preceding year, and India may overtake China as the world's biggest coal importer in 2015. To supply the growing import market, Indian companies have gone global. For example, the Adani company, which operates a coal power plant and India's largest coal port in Mundra, Gujarat,

Government-owned India Coal's greenhouse-gas emissions have risen steadily for half a century. Only global economy crises caused some delay

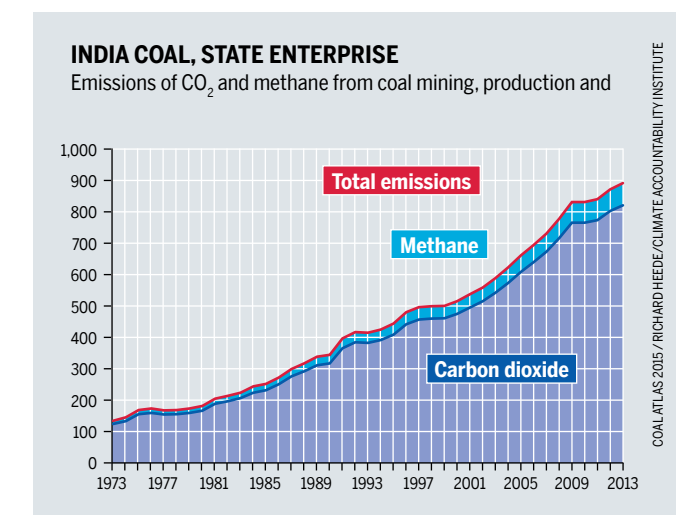
India is the last big country where coal is supposed to promise growth and modernization

wants to invest in large-scale mining in the Galilee Basin in Queensland, Australia. To handle exports to India, the company has leased the Abbot Point port and plans to expand it, endangering the Great Barrier Reef, a World Heritage Site.

India's government views anti-coal and divestment campaigns as threats to national energy security and inimical to the country's strategy of rapid economic growth. The government acts against local groups as well as international NGOs such as Greenpeace that advocates a rapid end to the use of coal worldwide. Other NGOs, such as the Centre for Science and Environment, argue that coal has to be phased out in the longer run, but may be required as a cheap energy option in the meantime. They lobby for increased efficiency and higher pollution reduction standards. A "green rating" environmental audit undertaken in 2014 revealed that many of the country's coal-fired power plants perform very poorly. Even the best did not achieve more than "average" ratings.

Coal is likely to remain prominent in India's power mix, but alternatives are being pursued as well. There are plans to build several additional nuclear power plants, as well as numerous dams especially in the Northeast; but they meet substantial opposition, particularly at the local level. India has a huge potential for solar energy, and in 2014, the government announced an ambitious plan to expand solar-generated capacity to 100 gigawatts by 2022, about three times the total current solar installations of countries such as China or Germany. From April 2015, the tax on coal was doubled to 200 rupees (about €3) per tonnes, and the proceeds will be used to promote renewables.

Energy poverty provides a potential for technological leapfrogging. Today nearly 97 percent of India's 600,000 villages have a grid connection, however, due to poverty or erratic power supply, 43.2 percent of rural households still relied on kerosene for lighting in 2011. This is why businesses and NGOs see opportunities to establish small-scale solar installations and off-grid or micro-grid solutions based on solar power or small hydroelectric plants. ●



GERMANY

A TURNAROUND YET TO TURN

Germany is phasing out nuclear power and has come to rely more on coal for its electricity. Despite a steep rise in renewable energy, the use of coal is endangering Germany’s ambitious target to reduce its greenhouse gas emissions.

Germany has declared an “energy turnaround”, but is still heavily dependent on coal. Lignite is the only significant fossil fuel that the country has and does not have to import. The reserves are estimated at 40 billion tonnes, and are split among three major regions: the Rhineland, Lusatia and central Germany. In 2014, more than one-quarter of the electricity produced came from lignite, and its output of 178 million tonnes a year makes Germany the world’s biggest producer. The industry has benefited from 95 billion euros in subsidies (in real terms) since 1970, and open-cast mines have gobbled up 176,000 hectares of land. Current mines cover 60,000 hectares.

The mine sites are rehabilitated and brought back into cultivation after mining ends, but the original ecosystem never fully recovers. In many cases, the pits are flooded to form lakes. In the Rhineland that means diverting river water into the pits for decades on end. The negative environmental impacts of mining include damaged ecosystems, degraded soil, acidified water, water contaminated with sulphates and sludge containing iron, as well as disturbed groundwater regimes. In Lusatia, sulphate from nearby open-cast pits threatens the water quality in the River Spree and, therefore, Berlin’s drinking water supplies.

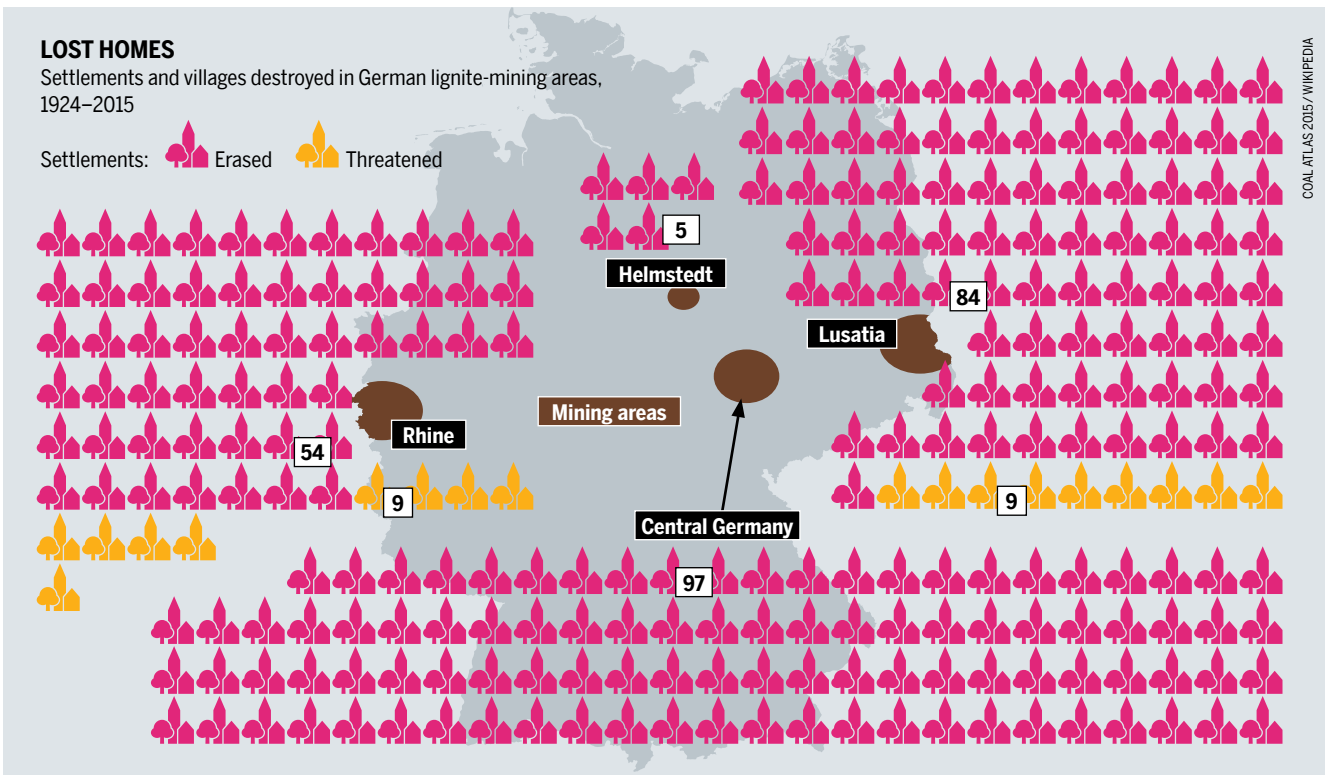
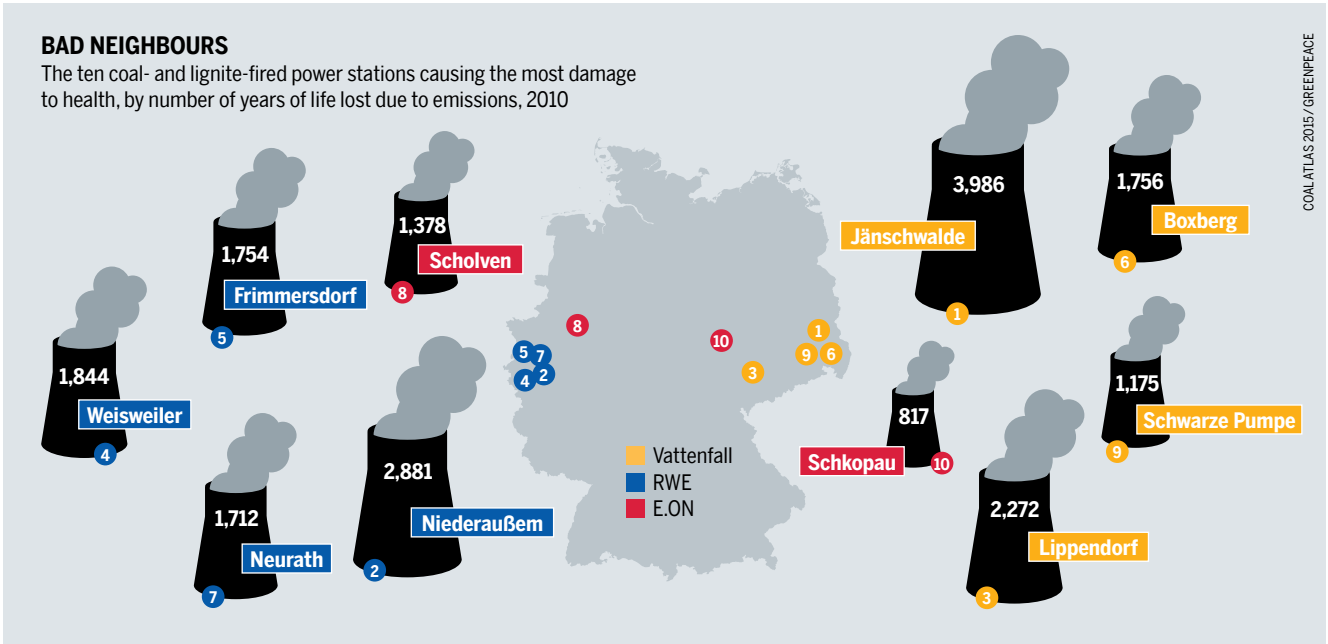
The federal states that host lignite reserves plan to continue mining well into the 2040s. Vattenfall, the state-owned

Swedish power generator, plans to develop five mines in Lusatia in eastern Germany. Two of these were recently approved. The excavators will demolish ancient Sorbian villages, even though this minority group is protected by the constitutions of both the federal states of Brandenburg and Saxony. In North Rhine-Westphalia, in western Germany, the state government decided to reduce the size of Garzweiler II, an extension of an existing pit.

If Germany intends to stick to its target of cutting its greenhouse gas emissions by 80 to 95 percent by 2050, two-thirds of the lignite reserves already approved for mining will have to stay in the ground. In contrast, Germany’s extraction of hard coal will end in 2018. The three pits still in operation produced 7.6 million tonnes of coal in 2014. Germany still gets about 18 percent of its power from hard coal. Despite repeated public criticism regarding the human rights situation and environmental effects of coal mining in many coal-exporting countries, Germany imported more than 56 million tonnes in 2014, of which 42 million tonnes were destined for power stations. Most of this coal comes from Russia, followed by the United States, Colombia and Australia.

Germany’s remaining hard-coal mines are closing down because government subsidies are due to end in 2018. Without these government funds, the mines would have been unprofitable since the middle of the 20th century. Since 1970, the mining companies have benefited from subsidies to the tune of €327 billion in real terms. One of the so-called “inher-

It is possible to calculate the number of years of life lost as a result of emissions from individual power stations



ited liabilities” of hard-coal mining is the need to pump out mine water to protect groundwater. From 2019 onwards, dealing with this and other liabilities will cost at least €220 million a year, indefinitely. The money is supposed to come from an endowment fund set up by the industry, but this will probably not be sufficient to cover the costs.

Unlike hard coal, the inherited liabilities of lignite are not recognized politically, and the perpetrators have not had to make adequate financial arrangements. Furthermore, the public cannot access the financial presumptions and models that the mining companies use to make plans for reserves to cover damage caused by mining.

Renewables account for around 26 percent of Germany’s energy mix. That is slightly more than lignite, but lignite and hard coal together make up 44 percent. Fixed feed-in tariffs (long-term contracts for energy producers) have spurred the expansion of renewable power and made compensation for the loss of generating capacity possible after Germany decided to turn off its nuclear power plants.

Germany is likely to miss its climate goal of 2020 (a 40 percent reduction in greenhouse gas emissions compared to 1990), mainly because of the increase in burning coal. In addition to those measures that have already been decided, supplementary measures are needed to achieve further necessary reductions in the power sector.

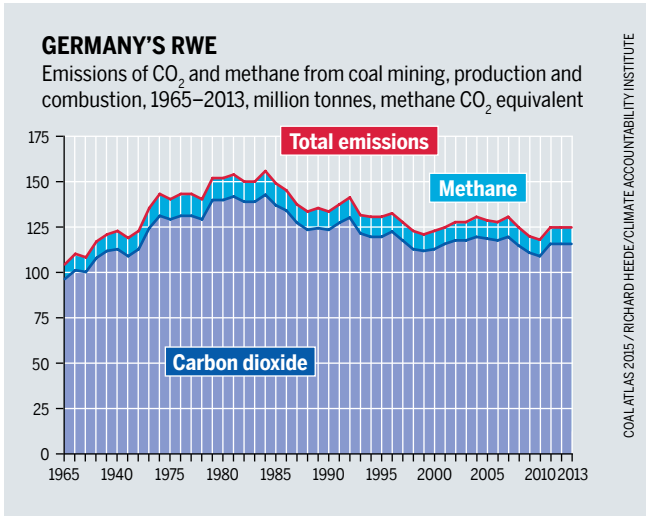
In early 2015, the government proposed to limit emissions from coal-fired power plants with a so-called “climate levy” on old, emissions-intensive power plants. This plan was supported by environmentalists. The public debate over these proposals has been very lively, and there has

From a peak in the 1980s, RWE’s greenhouse-gas emissions have declined only slightly. RWE is Germany’s second-biggest electricity generator

Over the last 90 years, more than 250 settlements and 110,000 people have had to give way to lignite mines in Germany

been strong and effective resistance from coal companies, trade unions and the governments in the three affected states.

The failure of the climate levy and its replacement by a capacity reserve for old coal plants demonstrates the strength of the coal lobby. Unfortunately, the replacement will not be enough to attain the climate goals. Many local governments own shares in the energy group RWE, and they fear a loss of income, which is a major obstacle to the switch away from coal. Nevertheless, the general public’s opinion has turned against coal, and opposition is rising. In fact, accelerating a coal phase-out is the top priority for German activists. ●



EMISSIONS TRADING

STRONG PLAYERS, FEEBLE INSTRUMENTS

Trading in pollution permits has blossomed into a big business. The system has produced little benefit for the climate. Even so, the alternatives are barely discussed.

To limit the amount of greenhouse gas they churn out, the European Union and various other countries have set up emission-trading schemes. Based on national plans these schemes set the total amount of emissions permitted for the affected industries. The operators of these industries can trade permits among themselves. If an operator emits less of the offending gas than allowed, it can sell the permits that it does not need. An operator that emits more gas has to buy additional permits. This system is supposed to provide a financial incentive for reducing emissions. A company that discharges too much gas has to pay more, while one that cuts its emissions can sell permits to pay for the investments needed.

Seventeen such schemes have been set up around the world, and several more are planned. The biggest is the European Emission Trading Scheme. National schemes exist in Switzerland, New Zealand and South Korea; California, the Canadian province of Quebec, Tokyo and several provinces in China have regional schemes. By 2016, some 6.8 billion tonnes of CO₂ equivalent will be covered by such measures.

Emissions trading is based on two premises. First, that it limits the emissions of climate-killing CO₂. Second, the scheme aims to stimulate investments in protecting the climate. Sadly, it does neither, as can be seen from how the European scheme has performed.

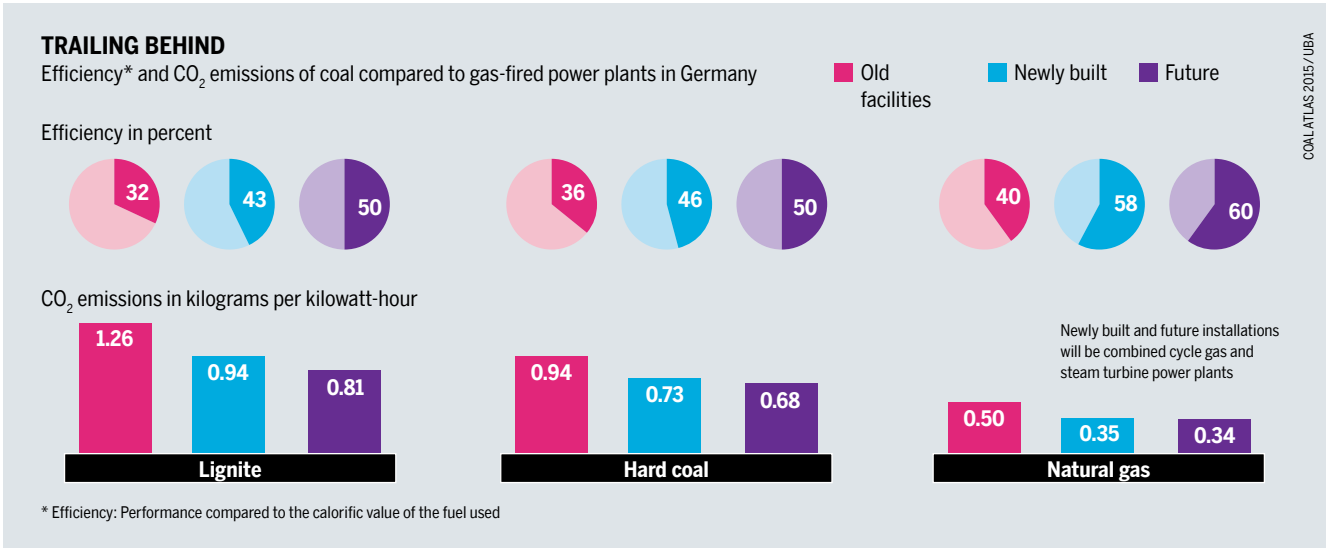
Under heavy lobbying pressure, the EU set the permitted limits for emissions far too generously, and subsequently cut

them back too slowly. From the start, the number of permits has been too high, so the prices they have attracted have been too low to stimulate investment in climate protection. In addition, governments have given away permits for free to the most climate-damaging firms, handing them a big financial windfall.

The recipients, including large power generators, took advantage of the situation and sold their excess certificates. Between 2008 and 2012, the ten major beneficiaries profited by 3.2 billion euros. The energy companies must now bid for the permits they want, but lavish exemptions mean that nearly all polluters in the industry still get them for free. Plus, all companies continue to benefit from the transfer of their surplus permits from earlier trading periods. The steel firm ArcelorMittal, for example, will not have to buy any extra permits before 2024.

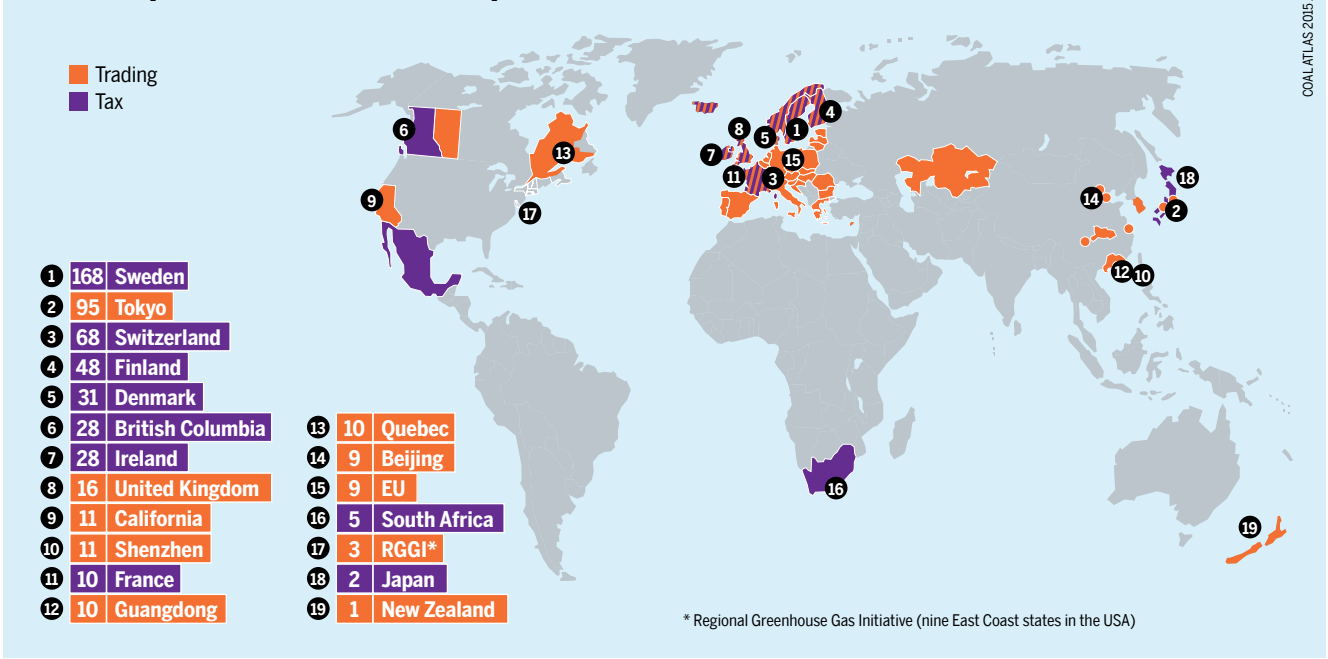
In theory, emissions trading is capable of reducing CO₂ emissions while still allowing entrepreneurial freedom. In practice, however, the trading scheme has not made a significant contribution to climate protection. This is because of the so-called offset credits that companies have been able to buy in large numbers outside the emissions trading scheme. The reasoning goes like this: it does not matter where in the world the CO₂ emissions are cut, so rather than investing lots of money in reducing their own emissions, European companies may as well contribute to initiatives that save emissions elsewhere. But how would the initiatives have performed without this financial support? Between

The latest technology doesn't help: even the most modern coal-fired power plants still lag behind on the most important criteria



SOME ARE SERIOUS

Regulation of CO₂ emissions through market mechanisms (trading) or state regulations (tax) by countries, regions and cities; prices for CO₂ emissions in US dollars per tonne of CO₂, 2013/2014, selected



one-third and one half of such projects result in no additional benefit because the investments would have been made anyway. Further, these offsets reduce the pressure in Europe to switch to products that produce fewer emissions.

Emissions trading has long become a business opportunity for the financial industry. Simple, direct transactions between buyers and sellers of pollution permits have become rare. For institutional investors, carbon dioxide is now something akin to a raw material, and is traded in the form of various financial products. But because of the oversupply of permits, trade is virtually at a standstill. Scandals involving tax fraud, including those involving the Deutsche Bank, have revealed the susceptibility and vulnerability of the system. HM Revenue & Customs, the British tax authority, believes that a large share of emissions trading is laced with fraud.

Through offsets, oversupply, the economic crisis of 2008/9 and the associated erroneous forecasts, the number of excess permits in Europe has risen to over two billion. As a result, the price of CO₂ is far too low. Combined with low prices for coal and high prices for natural gas, coal has boomed. Between 2010 and 2013, emissions from this sector rose by six percent. The CO₂ surcharge was not high enough to make power generated from less-harmful natural gas competitive with the more-harmful coal. To achieve the desired effect, the trading scheme needs stricter limits on emissions.

An alternative approach, used by several states in the United States, as well as by Canada and Britain, is to impose CO₂ standards on power plants that use fossil fuel. Since 2013, the British government has set a minimum price for CO₂ and annual emission budgets for new power plants,

Most trading systems do not cover the majority of CO₂ emissions; those that are covered are still too high

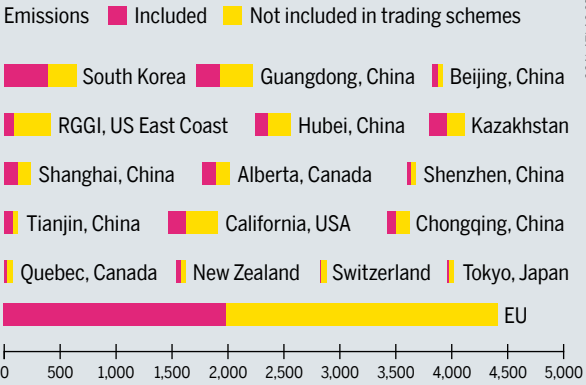
To encourage investment by pushing up the price of CO₂ emissions, taxes are more effective than most trading schemes

equivalent to the emissions from a modern gas-fired plant. Since 2014, France has charged a tax – albeit a small one – on fuels. The rate will quadruple until 2020. It is also possible to force old power plants offline by applying a technical criterion to their efficiency. The Netherlands will bring in a minimum requirement that will ensure that four older plants will shut down by 2017.

Explicit criticism of emissions trading as the “wrong solution” came recently from an unexpected quarter. Pope Francis wrote in his encyclical “Laudato si” that emissions trading gives rise to a new type of speculation, but does not serve the cause of cutting greenhouse gases. ●

OUTSIDE THE SYSTEM

CO₂ emissions in various trading schemes, in million tonnes of CO₂ equivalent



LOBBYING

PAID TO PREVENT PROGRESS

Wherever climate and energy negotiations take place, the coal industry wants to have their say. They often succeed.

Ever since climate change and the role of fossil fuels in it became a hot topic, the coal industry has intervened in the debate and used its political and economic weight to tip the scales. In the 1990s, global industry came together to combat research on climate change. The biggest private coal firms, collectively known as Big Coal, have been hindering efforts to prevent climate change for decades. The fact that many of the biggest coal companies are state-owned – for example in Poland, the Czech Republic, India and China – has helped brake the progress of reform.

The coal sector often has a seat at the table when political decisions are made. In 2007, when Chancellor Angela Merkel took over the EU presidency and hosted a G8 summit on the Baltic coast, the German government had previously appointed the Swede Lars Göran Josefsson as one of two climate-protection advisors. At the time, Mr Josefsson was the boss of Vattenfall, the largest energy company in the European Union and the owner of lignite power plants in Lusatia, in eastern Germany. He later became an advisor to the UN Secretary-General Ban Ki-moon.

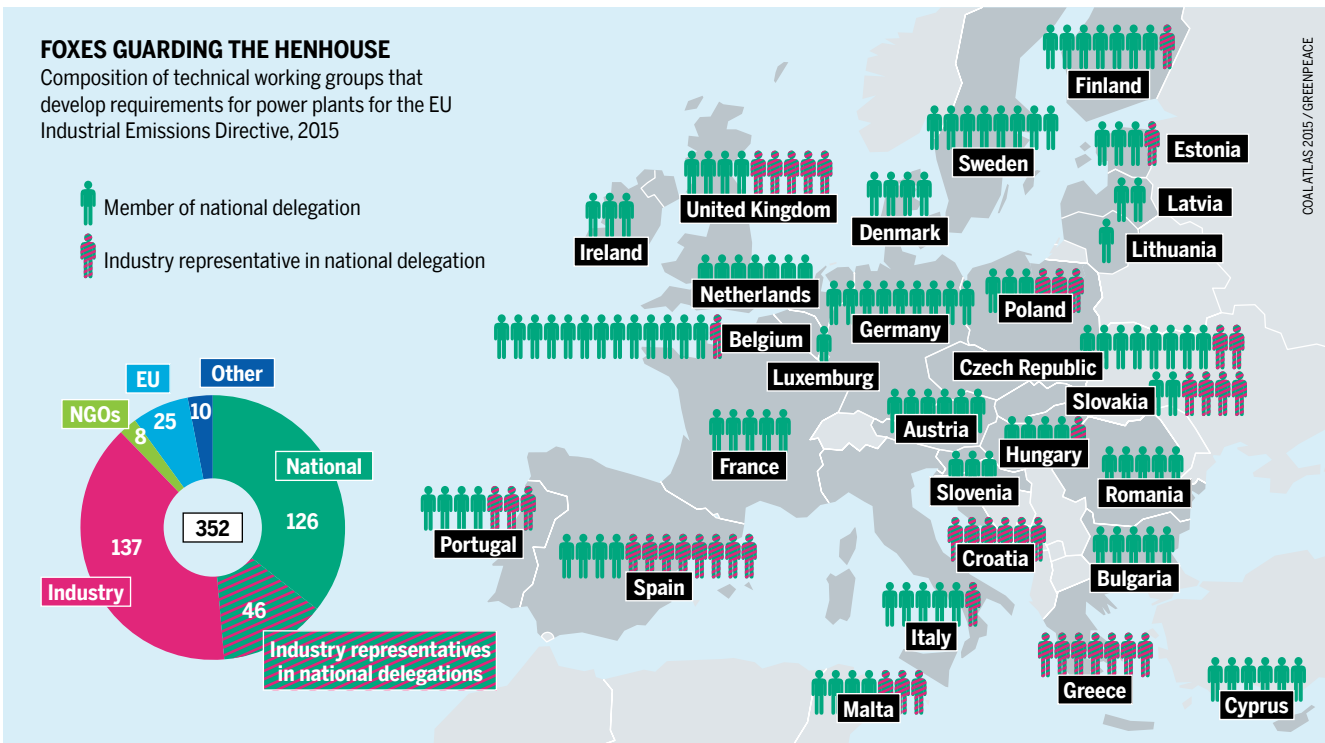
At a climate summit in Durban, South Africa, in 2011, two of the host government’s delegates were representatives of local companies. One came from Eskom, Africa’s largest power producer, and one of the biggest CO₂ emitters in the world. The other was from Sasol, the world’s biggest producer of synthetic petrol, a fuel produced by liquefying coal.

Over the years, critical voices such as the Corporate Europe Observatory have watched as companies try to influence international climate negotiations. The energy companies’ tactics range from sponsoring conferences to the formulation of draft agreements. The oil and gas majors are more active than the coal industry in international climate discussions. The coal industry prefers to shape national discourse and legislation because its activities are more strongly affected by policies at this level.

In the EU, the coal lobby has mainly targeted renewable energy. It argues that it is not necessary to fix what proportion renewables must have in the overall energy mix; emissions trading will be enough to determine this. One of the loudest voices in this debate has been Euracoal, the European Association for Coal and Lignite. Lo and behold, the EU’s climate targets for 2030 no longer include binding national targets for the expansion of renewable power or for improving energy efficiency.

Europe’s planned limits for air pollution have also been subject to influence from the coal lobby. The methods are simple: some of the specialists named by member states to the crucial technical working groups are direct representatives of the industry’s interests. The makeup of the Greek delegation was particularly biased. All the delegates worked either for the Public Power Corporation, whose power plants are among the dirtiest in Europe, or for Hellenic Petroleum.

The coal industry enjoys close contacts with governments around the world and tries to influence the direction of international negotiations



Limits for power plants? No problem. The industry constitutes the majority on the relevant committees

The United States traditionally has a powerful coal lobby. A core element of all its campaigns has been to discredit scientific studies. Since the 1990s, coal companies and industry associations have financed scientists who dispute the findings on global warming - and with success. In 2014, only eight Republicans in the US Congress recognized global warming as scientifically proven; 278 denied it. This reflects the spending patterns of the coal industry which donated \$57.5 million to American politicians, 84 percent of them Republicans, between 1990 and 2014.

The American Coalition for Clean Coal Electricity is one of the more important associations of coal lobbyists in the USA. It campaigns against regulations in the coal sector and climate protection. The conservative American Legislative Exchange Council is composed of state legislators and financed partly by money from the energy sector, including Big Coal. In 2013/14, it was active in at least 16 states working against renewable energy.

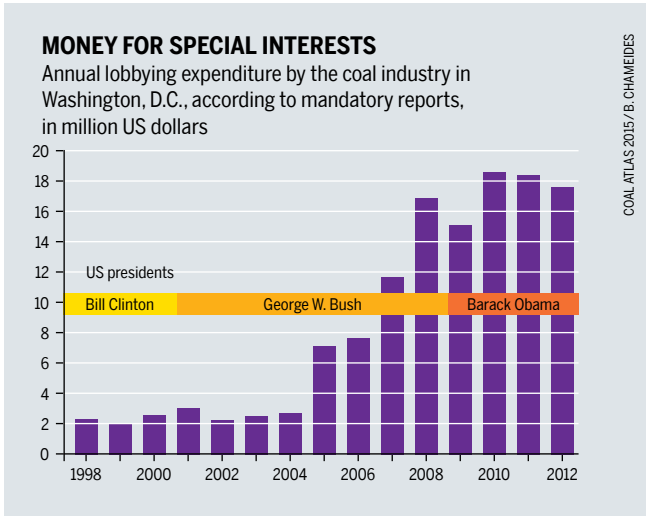
The lobbyists have everything covered: from the drafting of regulations against the supply of privately generated solar power into the grid, to combating the Environmental Protection Agency and President Obama’s climate policies. Even schools are included. The Kentucky Coal and Energy Education Project distribute educational materials that are one-sided in their portrayal of the coal industry.

Big Coal is fighting renewable energy in Australia, too. The Conservative government, in power since 2013, has reversed comprehensive laws to protect the climate. In 2014, it turned its attention to the requirement obliging Australian power generators to obtain 20 percent of their electricity from renewable power by 2020. Then Prime Minister Tony

A booming business: the climate debate is generating lots of business for coal-industry representatives in Washington

Abbott called on Dick Warburton, a noted climate-change sceptic, to review the target. The industry ran big advertising campaigns that were supported by media owned by Rupert Murdoch, whose reports repeatedly question the efficiency of renewable energy and the findings of climate science. Sowing the doubts has borne fruit; the 2020 target for expanding renewable energy was reduced from 41,000 to 33,000 gigawatt-hours.

In 2014, Australia invested less money in generating clean electricity than Honduras or Myanmar. A new government directive is even expected to halt Australia’s “green bank”, the Clean Energy Finance Corporation, from investing in wind and rooftop solar power because the federal government does not regard them to be emerging technologies. ●



A BROAD ALLIANCE WITH STAYING POWER

Around the world, people are fighting back against the coal industry. They face repression, harassment and violence – but sometimes they are successful.

International environmental organizations have been protesting for 30 years against the exploitation of nature and the mining of coal. At the grassroots level, local communities are fighting back, too. The Wayúu community in Tamaquito is struggling against Cerrejón, a huge open-cast coal mine in Colombia. Locals have mounted a health campaign against two urban coal-fired power plants in Chicago. In Shenzhen, China, the city council rebelled against a 2,000 megawatt plant.

The most visible protests can be found in the developing world, where the use of coal is rising quickly. All around the

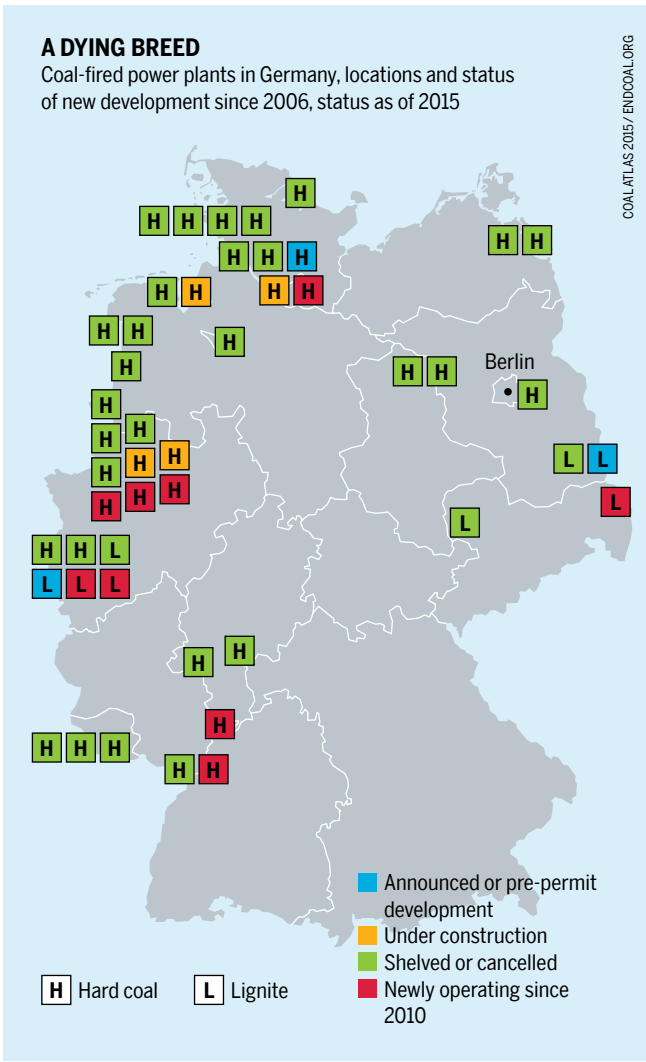
world, people are taking to the streets: in Australia, Bangladesh, China, Croatia, Finland, France, Germany, India, Malaysia, Mozambique, the Philippines, Sri Lanka and South Africa. Farmers in Inner Mongolia, China’s biggest coal region, have risked their lives by blocking coal transports. In the big cities, people demonstrate against the smog.

Communities affected by coal in Mozambique have repeatedly protested by blocking the Sena railway line that carries coal to the port of Beira. India’s government is expanding the use of coal more than any other country; a national alliance has responded with hunger strikes and protest marches. The activists have been ordered about, imprisoned and threatened. Despite adverse conditions in Colombia, communities are working together to expose the truth about coal mining. Their actions include holding popular tribunals against mining, visits to sacred sites, and autonomous public hearings.

In Australia, the world’s second-biggest coal exporter, an alliance of Aboriginal communities, farmers, churches, doctors and environmentalists wants to halt the construction of new port infrastructure and the expansion of existing ones in Queensland. These facilities are intended to serve new or expanded mines to be sited across the Galilee Basin. The alliance uses a variety of tactics, including strategic legal action, lobbying, divestment campaigns, public education and non-violent direct action. It has secured significant victories. For example, Friends of the Earth Australia helped establish Lock the Gate, a powerful alliance that is active throughout Australia. Also, Market Forces, a campaigning organization, has helped shift many millions of dollars in investment away from destructive fossil-fuel projects.

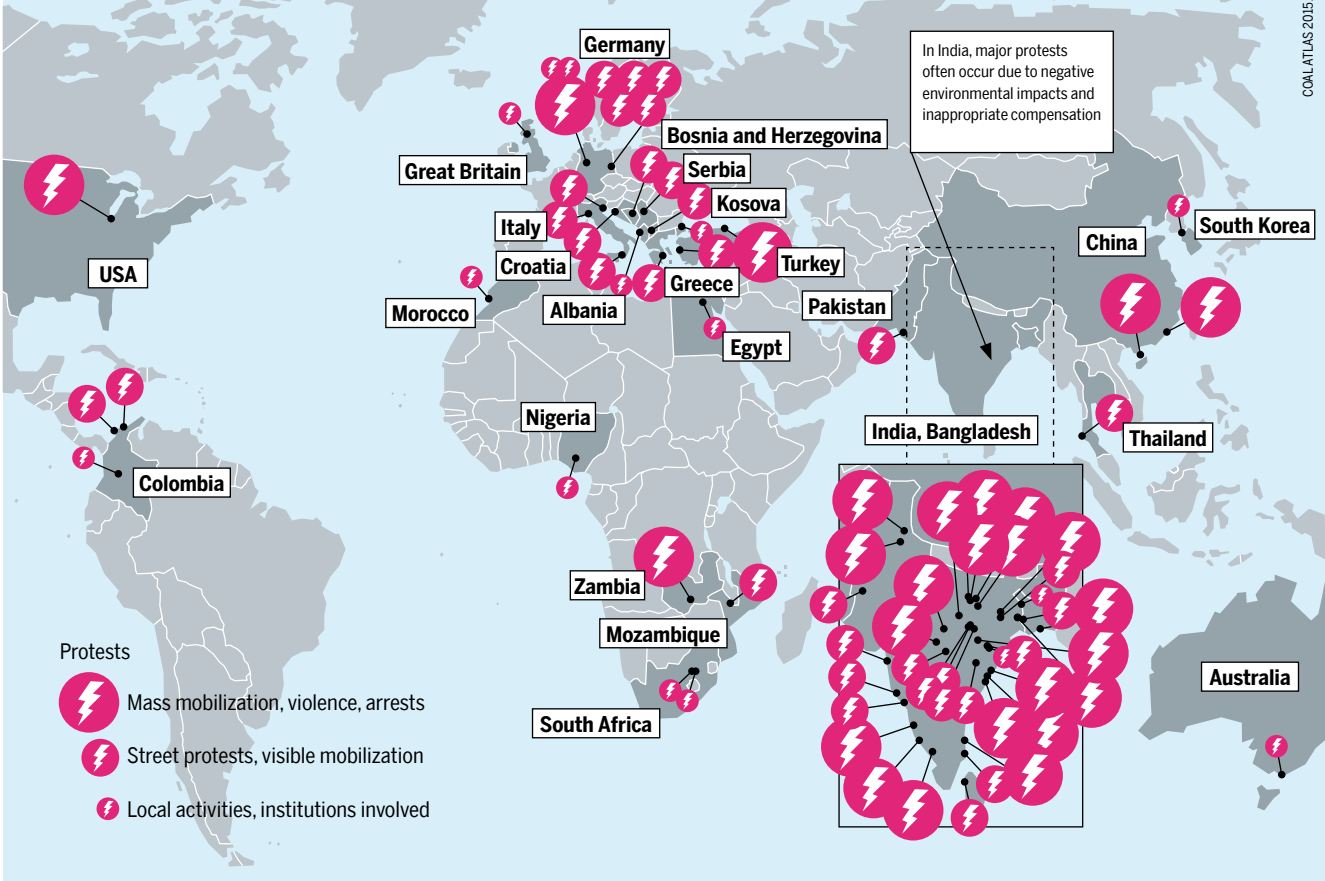
In the United States, environmental organizations have been fighting to phase out coal. Thanks to the efforts of a broad coalition, a total of 200 coal-fired power plants – some 40 percent of the country’s total – have been retired since 2010. Such successes are based on a wide-ranging set of arguments: climate change, health threats and environmental damage. In 2014, mass protests against the discharge of toxic waste from mines into rivers took place in West Virginia and North Carolina. Hundreds of thousands of people had been left without drinking water for weeks.

Friends of the Earth Korea works with local communities who have long fought against the expansion of coal-fired power plants. Plans to expand the Yeongheung plant were cancelled recently as a result of protests against air pollution. In an unusual move, the provincial government backed health research in Dangjin, site of a 4,000 megawatt plant.



WORLDWIDE MOBILIZATION

Intensity of protests against coal mines, coal harbours and coal-powered plants according to the Environmental Justice Atlas (ejatlas.org)



This study revealed high levels of hazardous heavy metals and other toxins on people living near the plant.

In Europe, protesters in countries ranging from Denmark to Italy, Croatia and Turkey have undertaken various actions against new coal power plants. They draw attention to the environmental and social costs, the need to protect the climate, and the goal of making energy supplies renewable. The United Kingdom was one of the first countries where such protests gained visibility. The first “Camp for Climate Action” was set up near the Drax power station in Yorkshire in 2006. In a highly symbolic action, some 600 activists tried to break into the plant to disrupt its operations. In the Thames estuary, Greenpeace activists repeatedly blocked access roads to the highly polluting Kingsnorth coal-fired plant over a period of three years.

When the operator abandoned the site, Greenpeace claimed a major victory. Although the British anti-coal movement lost steam during the economic and financial crisis, the approaches it pioneered live on. Climate camps, with their mix of actions, information and discussions, have spread to Belgium, Germany, the Netherlands, Scandinavia, South Africa, and the United States.

In Germany, campaigns against coal have been held for decades, though they have been only local or regional in scope. Around 2006, however, protests grew louder after investors announced plans for 38 new coal-fired power plants. Climate Alliance Germany was formed in 2007. This broad coalition includes churches and development organisations

Not all protests against the coal industry are registered in the Environmental Justice Atlas. But many are, revealing major areas of conflict

such as Bread for the World and Oxfam, which added coal to their campaign agendas. The alliance launched an anti-coal movement in 2008. In the following years, environmental groups such as Friends of the Earth Germany and Deutsche Umwelthilfe tried to stop the projects, in part through the courts. They were successful: 22 new plants were stopped and many more delayed. The court orders have been accompanied by public pressure questioning the role of coal in climate and energy policies, and pointing out the plants’ lack of economic viability.

Since 2011, the German lignite mining areas have also seen a range of protests: both local rallies and big, international actions. In 2014, environmental NGOs organized a human chain stretching several kilometres through Lusatia, with 7,500 people from all over Europe. In 2015, 6,000 people formed another chain in the Rhineland. There, in August of the same year, about 1,500 protesters took part in the largest act of civil disobedience seen in Germany for decades. Under the banner “Ende Gelände” (Here and no further) they climbed into the Garzweiler mine, forcing it to shut down for nearly a day. The mine’s operator, German coal giant RWE, has taken legal action against 800 demonstrators. Nevertheless, activists consider the event a huge success for the climate movement. ●

INVEST OR DIVEST



The imaginary thoughts of an African investor about to invest in coal, or not. Weighing the desire for profits in the 'era of the megawatt boom' against fears of investing in stranded assets as elsewhere, the time of coal seems to end. This is a hypothetical piece. Written by energy analyst Mej Obada.

Thursday 16 April: (It's been a while since I kept a record of activities; this should make for interesting reading when the project is up and running.) Had another meeting with the power plant developer and the regulator today. Came away with a long list of requirements - problem is we have to meet up with everything. No cutting corners here oooo!

Tuesday 28 April: Still expecting EIA template from inside man at the Ministry. I did not know they insisted on these environmental impact assessments now. I hope he doesn't fail to deliver. It doesn't matter if it's for a limestone quarry in the South-South; we'll just modify it for our coal project in North State and no one will be the wiser.

Wednesday 29 April: Chai! See me see wahala ooo! Some disturbing news! Those environmentalists have picketed the mine site. Their leader (who has refused to see reason; maybe I should increase the offer to \$20,000.00?) is saying all sorts of things about the future impact of excavation on the land. Why should I care about that? (E no concern me at all). It's in the future and I'd have recouped my investment and been long gone by then.

Friday 01 May: Relaxing in the business class lounge at Schiphol airport en-route to Geneva to meet our investors and bankers. I do hope our press contacts have been able to "kill" the story about the protests; enough money was shelled out for that purpose. We wouldn't want our Swiss

friends worried about the deal at this late stage. Those activists are not good for our country, they oppose rural electrification! Luckily the government committees on these matters are not aware of all the issues raised by the protesters.

Monday 04 May: The meeting went quite well under the circumstances. I was able to reassure them that the risks are not as serious, and that our EIA process is flexible. They liked to hear that, one was even smiling saying that the lack of enforcement can be a good thing sometimes.

Tuesday 05 May: Europe can make you worry too much. I picked up the papers this morning and read that a farmer is now taking RWE to court for producing carbon emissions. That's one of Germany's leading energy companies, the queen of coal! Carbon what? Community what? Our communities at home need the electricity. But what if someone decides to take my company... for carbon's sake... how can we avoid being taken to court over smoke from some chimneys?

Wednesday 13 May: Good story on the project appeared in "Business Times". Finally the media are picking up on the great advantages of coal, that it's cheap and so on. Great job, they didn't mention the health cost and environmental cost that comes with decommissioning coal plants. We've got it sorted.

Saturday 16 May: Ran into Senator Ilag at a wedding ceremony; he was happy that Sonnix Investments' project is in his zone and has pledged all the support he can provide. He promised his people coal jobs during the campaign. Smart move, it made him win the elections. Coal jobs that will bring more electricity - the coal revolution was a good sell! Obviously, most of the jobs will not go to the locals in his constituency. Not a chance - that would mean a lot of investment into training for them. We didn't put that in our business plan. Let's get the best people wherever we find them...

Friday 29 May: Listening to the President's speech on my way to the gubernatorial inauguration; he listed solids minerals mining as one of the areas by which youth unemployment will be tackled. Too early for specifics but very encouraging nonetheless; must be sure to send full text of the speech to Geneva.

Arrived at Gomboro City in time for the ceremony there - got to shake the Governor's hand and let him know his continued support is appreciated.

Thursday 04 June: Invited to a conference on sustainability - I'm able to sustain so who needs that? Let them keep their conference; some of us have businesses to run.

Saturday 30 May: Decided to visit the mining site since I'm here - work here is proceeding quite well. The Australians are

worth every US cent they're charging but I can't wait to see them leave. Person must make profit from this venture after all. Meanwhile the village head and youth leader have come up with some fresh demands. What did they think they were signing 3 years ago, when we met with some of their chiefs... it wasn't a blank cheque after all. Sonnix is not a charity.

Monday 13 July: Super-exciting - latest reports from the mining crew indicate that we're likely to exceed our projected output by at least 15% per annum! Based on available information there should be sufficient coal resources to support the mining operation for over 30 years at this rate of production. Where is that bottle of Dom Perignon?

Tuesday 21 July: Conference call with the Swiss investors

and Australian mining crew; the former are worried that we still don't have clear policies/direction on mining... Luckily the 2 local banks providing funding for the venture are not as jittery about this situation; they're certainly well hedged against risk and their interest rates are through the roof in any case. But still, we need direction from the Ministry. They should come out clear and loud to say that our country is not interested in carbon reductions, but in coal power. That's how successful businesses grow.

But what do I do with my plots of land near Gomboro City... they were meant for my children, for their future. Should I buy somewhere else now, in case the place becomes like Beijing where you cannot know night from day with all that coal smoke in the air. This carbon question is starting to vex me... ●

A 2 DEGREE WARMER NIGERIA

The scenario of intensifying conflicts in a Nigeria under 2 degrees Celsius of global warming

CONFLICTS



Photo: hbs wikipedia

Even before the violence in the North East spiraled out of control, young populations in northern Nigeria were facing an extremely devastated environment. Water shortages led to farmlands turning into sand dunes and the number of kidney patients was rising as people simply did not have enough drinking water. There is a steady and silent movement of thousands of people southwards, all the way from Lake Chad to Sokoto and Kebbi States, as the land does not feed its people any longer. The southward movement will soon be met by a northward movement of climate refugees from flooded zones in Nigeria's coastal regions. When all of these internally displaced people converge in Nigeria's Middle Belt, increasing conflict is the likely scenario, with a wide variety of manifestations such as farmer-herder conflicts, community clashes over access to water, tension between so-called indigenes and so-called settlers, legal action of landlords versus farm workers, and more.

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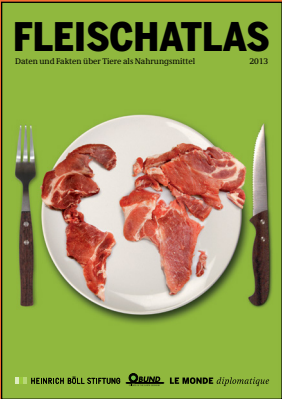
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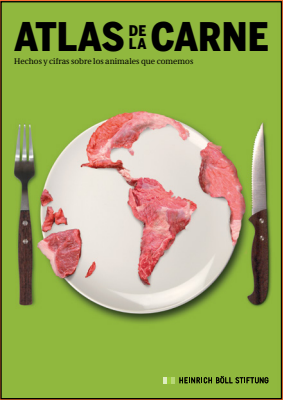
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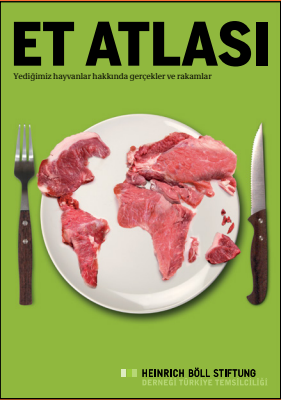
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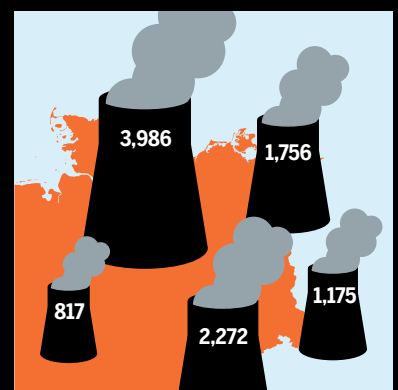
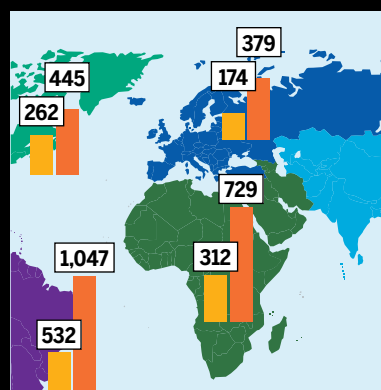
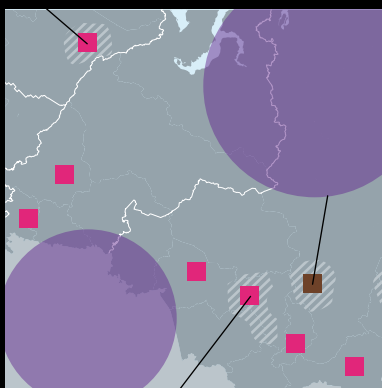
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Generating electricity from coal damages the climate most. Gas-powered plants emit only half as much CO₂.

from **SPOILING THE CLIMATE**, page 14

The apparent cheapness of coal is also a result of subsidies from the taxpayer, both current and in the past.

from **HIDDEN PAYMENTS, UNPAID BILLS**, page 27

No technique yet exists to monitor CO₂ storage sites, systematically identify leaks or plug them when they are found.

from **PROBLEMS AT DEPTH**, page 46

Divesting from coal now is necessary to prevent disastrous climate change and a global financial crisis.

from **DEFLATING THE CARBON BUBBLE**, page 30