14 Germany

14.1 Summary of Coal Industry

14.1.1 Role of Coal in Germany

Germany was the world's eighth largest producer of coal in 2012 and is the world's largest producer of brown coal (lignite), accounting for an estimated 18 percent of global output in 2012 (EIA, 2014a). Coal is Germany's most important indigenous energy resource, accounting for almost 45 percent of the country's total primary energy production in 2012. Brown coal accounted for over 25 percent of German electric power generation in 2012 and hard coal accounted for just over 19 percent (Mathews, 2013). Nearly all coal production serves the power and industrial sectors (EIA, 2014b). Although total coal production in Germany has been steadily declining to a low of 182 million tonnes in 2010, brown coal production has started to increase in recent years (EIA, 2014a). Brown coal-fueled electricity production in Germany reached its highest level since 1990 in 2013 (Wagstyl, 2014). Germany's coal consumption has increased after Japan's Fukushima reactor accident occurred in March 2011, as Germany has increasingly relied on coal as a substitute for nuclear power (EIA, 2014b). Table 14-1 summarizes Germany's coal reserves and production.

Table 14-1. Germany's Coal Reserves and Production

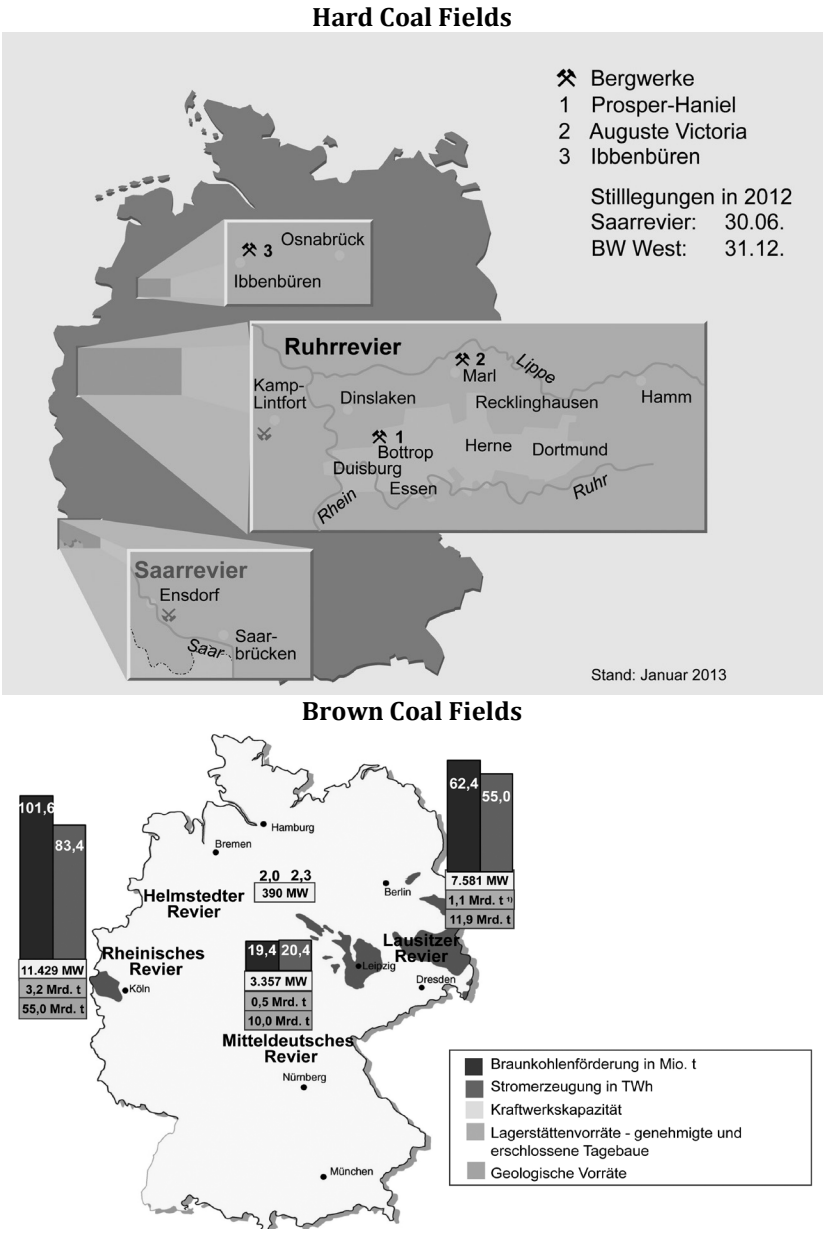
Indicator	**Anthracite & Bituminous** (million tonnes)	**Sub-bituminous & Lignite** (million tonnes)	**Total** (million tonnes)	**Global Rank** (# and %)
Estimated Proved Coal Reserves (2011)	48	40,500	40,548	6 (4.6%)
Annual Coal Production (2012)	11.6	185.4	197.0	8 (2.5%)

Source: EIA (2014a)

Germany is a net coal importer, importing more than 45 thousand tonnes of hard coal in 2013 from Russia (11.8 thousand tonnes), the United States (11.5 thousand tonnes), Colombia (8.1 thousand tonnes), European Union (EU) countries, Australia, Poland, South Africa, and small quantities from other countries (Statistik der Kohlenwirtschaft e.V., 2014a).

Germany's current hard coal production is from three underground mines—Prosper-Haniel, Auguste Victoria and Ibbenbueren—located in North-Rhine-Westphalia in western Germany (Euracoal, 2013; Euracoal, 2014), while all brown coal production is from surface mines in basins across the country (Figure 14-1).

Figure 14-1. Germany's Coal Fields



Source: Statistik der Kohlenwirtschaft e.V. (2013)

14.1.2 STAKEHOLDERS

Table 14-2 lists potential stakeholders in coal mine methane (CMM) development in Germany.

Table 14-2. Key Stakeholders in Germany's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining Companies	▪ RAG Deutsche Steinkohle AG	Operator of hard coal mines
Equipment Manufacturers	▪ GE Jenbacher, Deutz Power Systems GmbH & Co. KG ▪ ETW-Energietechnik GmbH ▪ Pro2-Anlagentechnik GmbH ▪ G.A.S. Energietechnik GmbH ▪ LAMBDA-Gesellschaft für Gastechnik mbH ▪ Lennetal Industrie Service	Power generation equipment supplier Power plant engineering and construction
Developers	▪ Minegas GmbH und Mingas Power GmbH ▪ A-TEC Anlagentechnik GmbH ▪ Evonik New Energies GmbH ▪ Stadtwerke Herne AG ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering, Consultancy, and Related Services	▪ Deutsche Montan Technologie GmbH ▪ ATEMIS GmbH ▪ Umwelttechnik Bojahr ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Testing, consulting, engineering
Universities, Research Establishments	▪ Fraunhofer UMSICHT ▪ RWTH Aachen ▪ Deutsche Montan Technologie GmbH	Examining, developing, and optimizing technical processes in the areas of environmental, safety, process, and energy technology
Regulatory Agencies	▪ State Ministry for the Environment ▪ Nature Conservation and Reactor Safety	Project identification and assessment support
Government Groups	▪ Bezirksregierung Arnsberg / Abt. 8 Bergbau und Energie	Mining authority
Professional Associations	▪ IVG e.V. ▪ Landesinitiative Zukunftsenergien NRW	Establishes project network, advises members on technical, economic, and legal issues
Other	▪ KfW Banking Group ▪ Emissions-Trader ET ▪ Emissions-Trader ET ▪ Future Camp ▪ Daldrup & Söhne AG ▪ Anger's Söhne ▪ RAG-Stiftung	Investment finance, emissions trading Drilling contractors Coal Mining Foundation

14.1.3 STATUS OF COAL AND THE COAL MINING INDUSTRY

Germany has experienced a recent increase in brown coal production after a post-reunification downturn, in response to an increased demand from power plants and interim power arrangements stemming from Germany's Energiewende. Energiewende is a term coined in the 1980s meaning "energy transition" referring to the country-wide energy infrastructure transition commenced in 2011 when the German parliament voted to abolish nuclear power following Japan's Fukushima disaster. Germany is replacing nuclear energy with renewables and new combined-cycle gas turbines; however, in the interim, power arrangements have involved marginally more coal being burned. Brown coal increased by a full percentage point of German electric power generation in 2012 and hard coal rose 0.6 percentage points (Euracoal, 2014; Mathews, 2013).

There has been a downsizing of the hard coal sector due to incremental reduction of subsidies which are scheduled to fully expire in 2018 (Morris, 2014). In 1991, Germany operated 26 hard coal mines and employed 122,871 miners, while in 2013, only 3 mines were in operation and 12,500 miners employed (Euracoal, 2014).

Table 14-3 provides recent statistics on German coal mines.

Table 14-3. Germany's Coal Mining Statistics 2013

Type of Mine	Production (million tonnes)	Number of Mines
Underground (active) mines - total	7.5	3
Surface (active) mines - total	182.6	14

Sources: Statistik der Kohlenwirtschaft e.V. (2014a); Statistik der Kohlenwirtschaft e.V. (2014b)

14.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (GMI) International CMM Projects Database currently identifies 43 CMM projects operating in Germany (GMI, 2014). Thirty-seven are located at abandoned mines, nine are at active, underground mines, and two are undetermined. The methane from 30 projects is being used for power generation, while the remaining 13 projects use the methane for combined heat and power (GMI, 2014).

14.2.1 CMM Emissions from Operating Mines

Table 14-4 quantifies Germany's recent methane emissions from coal mining. The data in this table may vary from the EPA data presented in the Executive Summary due to differences in inventory methodology and rounding of digits.

Table 14-4. Germany's CMM Emissions (million cubic meters)

Type of Mine	2000	2005	2010	2015 (projected)*
Underground mine	646.65	374.14	180.27	
Post-underground mine	28.45	21.09	10.92	
Surface mine	2.71	2.88	2.74	
Abandoned Mines	189.76	4.22	1.05	
Total liberated (= sum of all above)	**867.57**	**402.33**	**194.99**	**247.0**

Source: UNFCCC (2014a); USEPA (2012)

14.2.2 CMM Emissions from Abandoned Coal Mines

There are substantial abandoned mine methane (AMM) recovery and utilization activities underway in Germany, with 37 individual projects reportedly in operation. These projects are power generation and combined heat and power projects and together account for more than 113

MW of electricity. German AMM projects mitigate more than 400 million cubic meters (m^3) of methane emissions annually (GMI, 2014).

14.2.3 CBM FROM VIRGIN COAL SEAMS

There are no CBM recovery efforts from virgin coal seams in Germany at present. The absence is attributable to high exploration and production costs, and unsuitable available technology. However, with German energy demand and energy prices on the rise, the Technical University of Aachen (RWTH Aachen) is currently reevaluating German CBM potential. A pre-feasibility study was carried out by FUMINCO GmbH and RWTH Aachen in 2007 and 2008, examining the technical feasibility of CBM production by drilling deep wells in the Ruhr and Münsterland area. The pre-feasibility study was the first step in a three phase project, which was financed by the government of North Rhine-Westphalia, Minegas GmbH and Mingas-Power GmbH. The second phase of the project was an economic study of CBM production and the third phase, a risk assessment, has yet to commence (FUMINCO GmbH, 2014). These efforts are primarily motivated by advances in drilling and simulation technologies. Germany has potential in-place CBM resources of 3 trillion m^3, of which 2 million m^3 is concentrated in the mining fields in the Ruhr area alone. Prospects for CBM recovery are thus poised to develop (Mösle et al, 2009).

14.3 Opportunities and Challenges to Greater CMM Recovery and Use

Germany has ratified the Kyoto Protocol. Under Europe 2020, the EU's growth strategy, the EU has a greenhouse gas (GHG) emission reduction target of a 20 percent reduction compared to 1990 by 2020. Germany has set its own national target of a 14 percent reduction compared to 2005 by 2020. The national target on GHG emissions (-14 percent) covers emission sources not already included in the European exchange system of emission quotas (EU Emissions Trading Scheme) and uses 2005 as reference year. The EU target (-20 percent) covers all emissions sources and use 1990 as reference year (EC, 2013a). Germany has also set a national energy efficiency target to reduce primary energy consumption by 20 percent compared to the 2008 level by 2020 (EC, 2013b). Table 14-5 summarizes Germany's commitment to international climate change mitigation agreements. Ratifying the Kyoto Protocol has made Germany eligible to benefit from the growing world market for carbon emission reduction credits.

Table 14-5. Germany's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 12, 1992	December 9, 1993
Kyoto Protocol	April 29, 1998	May 31, 2002

Source: UNFCCC (2014b)

Germany has purchased credits from 207 Clean Development Mechanism (CDM) projects, including from two CMM projects in China. Germany has purchased credits from 27 Joint Implementation (JI) projects and hosted 11 JI projects, three of which are CMM projects including the Methane Capture, Power and Heat Generation from Coal Mine Gas in the Concession HER-TEUTO and Methane Capture, Power and Heat Generation from Coal Mine Gas in the Concession HER-Wan-Thal in North

Rhineland and Mine gas flaring at shaft Nordschacht in Saarland. Table 14-6 shows the breakdown by project type and domestic versus non-domestic project hosting.

Table 14-6. Germany's CDM and JI Activity

Project Types	CDM Projects	JI Projects (non-domestic)	JI Projects (domestic)
Biomass Energy	26	3	
Cement	1		
Coal Mine Methane	2		3
Energy Efficiency	17	6	
Energy Distribution	2	2	
Fossil Fuel Switching	2	1	
Geothermal	1		
HFCs	1		
Hydro	70		
Landfill Gas	17	1	
Methane Avoidance (Waste Water, Composting)	20		
Nitric Acid Destruction	4	8	8
Solar	12	6	
Wind	32		

Source: UNEP (2014a); UNEP (2014b)

14.3.1 Market and Infrastructure Factors

The GHG emissions targets set by the EU as well as the 2011 decision by the German government to phase out nuclear power present an improved market for new energy streams in Germany, particularly from renewable sources. The Renewable Energy Sources Act of 2004 (EEG) established CMM and AMM as renewable energy sources in Germany (Langefield and Agasty, 2013; Schloenbach and Schluter, 2005).

Potential CMM end uses in Germany include both mono- and co-firing boiler systems, combined heat power generation from gas and diesel engines and gas turbines, and secondary fuel sources including methanol, liquid gas, and substitution of natural gas. A 110-km long CMM network in the Saar District currently supplies CMM to a steel plant, the local chemical industry, a coking plant, electrical power plants, and central heating installations (Dinkelbach and Mader, 2003).

14.3.2 Regulatory Information

The legal framework for the economic utilization of mine gas in Germany is set by the Federal Law on Mining and the EEG. Exploration, extraction, and processing of mine gas are administered by the Federal Mining Authority. CMM ownership rights are transferred to a coal mining company for the duration of a coal mining license, after which the capture and utilization of CMM requires a gas license for the subsequent 30-year period (USEPA, 2011). The Federal Mining Authority considers an application for license after the applicant has submitted a utilization program which clearly demonstrates that "planned activities are sufficient and within an acceptable time frame for the

type, scope and purpose of the methane extraction." A license can be refused or withdrawn if found to be inadequate with respect to legislatively fixed factors, including the availability of sufficient funds, feasibility of a proposed extraction technology within a given timeframe and public interests (World Bank, 2007).

According to the guidelines defined in the EEG, CMM is a renewable energy source from which electrical power production is supported by federal legislation (Schloenbach and Schluter, 2005).

Germany's primary policy incentive for CMM recovery and use projects is through a feed-in tariff for CMM used to generate power under the Renewable Energy Sources Act of 2004 (RESA). The RESA requires electric grid system operators to connect plants generating electricity from mine gas to their systems, bear the costs of the grid upgrade, and guarantee priority purchase and transmission of all electricity from such plants. RESA provides a guaranteed fixed payback tariff for 20 years through feed-in tariffs or fees paid for electricity produced from mine gas (USEPA, 2011; IEA, 2009).

CMM operators have the authority to sell the carbon credits generated by the project and have the added incentive of paying no local taxes or royalties on CMM projects. Taxes for gas extraction are waived in Germany as long as gas is removed for safety reasons (Backhaus, 2013). Since CMM is included in the RESA category, all CMM projects receive priority attention at all stages of the project development (IEA, 2009).

14.4 Profiles of Individual Mines

There are three main hard coal fields in Germany, the Ruhr, Ibbenburen, and Saar; however, mines are only operating in the Ruhr and Ibbenburen Coalfield as listed in Table 14-7. There are four brown coal districts.

Table 14-7. Germany's Mine Overview

Coalfield/District	Mine
Ruhr Coalfield (Hard)	▪ August Victoria ▪ Prosper-Haniel
Ibbenburen Coalfield (Hard)	▪ Ibbenbüren
Rheinland District (Brown)	▪ Garzweiler ▪ Hambach ▪ Inden
Helmstedt District (Brown)	▪ Schöningen ▪ Restkohle Werkstätten
Lausitz District (Brown)	▪ Cottbus-Nord ▪ Jänschwalde ▪ Welzow-Süd
Mitteldeutschland District (Brown)	▪ Nochten ▪ Reichwalde ▪ Profen ▪ Profen gesamt ▪ Schleenhain ▪ Amsdorf

Source: Statistik der Kohlenwirtschaft e.V. (2014a); Statistik der Kohlenwirtschaft e.V. (2014b)

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