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Master thesis

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Comparative assessment of severe accident risks in China's energy sector with focus on coal, oil and natural gas

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Abstract

On the one hand China is not only the world's largest energy consumer, but is also the country with the highest coal production and consumption. On the other hand the accident risk in Chinese coal mines is known to be the highest among all countries. In the early 2000's a comprehensive study by the PSI within the China Energy Technology Program (CETP) has analyzed the situation in detail. About one decade later the present thesis aims to provide an update of Chinese accident risks primarily for the coal sector, but also for the oil and natural gas energy chains.

For this purpose PSI's Energy-related Severe Accident Database (ENSAD) was updated for the period 2000-09.2012, using a broad range of publicly available international and domestic information sources. All accident records were subjected to extensive cross-checking and harmonization to ensure a high data quality. For the coal chain it could be shown that the level of completeness for severe (≥5 fatalities) accidents was fully comparable to the cumulated numbers officially published by the authorities. The updated ENSAD data set was then used to calculate key risk indicators such as for example aggregated fatality rates and frequency-consequence curves. The results were also compared with those from the CETP and other recent studies on the subject. Finally, the Chinese accident risks were put into a broader perspective by comparing them to results obtained for OECD, EU 27 and non-OECD countries.

For the period 2000-09.2012, a total of 8208 coal chain accidents occurred in China, resulting in 28665 fatalities. Of these 1571 accidents (19.1%) were classified as severe with 18648 fatalities (65%). Gas accidents dominate both in terms of numbers of accidents and fatalities. For severe accidents, a total fatality rate of 1.03 fatalities/Mt produced coal was calculated and 0.36 fatalities/Mt for smaller accidents. In 2000-2011, Guangdong province showed the highest fatality rate with 18.50 fatalities/Mt, while Nei Mongol had the lowest value with 0.13 fatalities/Mt produced coal. The most severe accident occurred in the year 2005 in Liaoning province, causing a death toll of 215 people. Lastly, the Chinese fatality rate was extrapolated to the future, resulting in a value of 0.25 fatalities/Mt produced coal. In summary, it could be shown that the situation in China's coal chain has improved since the CETP, and is currently slowly approaching similar risk levels as in other non-OECD countries. The main reasons for this are the closure of small mines with low safety standards forced by the central government, merging of small mines into larger ones, stricter regulations and safety procedures as well as their enforcement, and general improvements in the levels of mechanization and equipment used in the mines.

During 2000-09.2012 a total of 172 oil chain accidents with 268 fatalities took place in China, of which 21 were severe (149 fatalities). In the natural gas chain 58 accidents, with a total number of 370 fatalities happened (16 severe accidents with 322 fatalities). Fatality rates for both energy chains exhibit a decreasing trend too.

Overall, this work indicates that efforts to reduce accident risks in the Chinese energy sector start to pay off particularly for coal, but also other energy chains.