The Questionable Merits of Carbon Capture Readiness

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Overview

Carbon capture and storage is accepted by money to play a major role in reducing future carbon dioxide emissions. Recently, many studies of new coal- and gas-fired power plants have been conducted focusing on performance as well as cost. Due to the fact that the technology is not yet commercially available or economically not reasonable and the need of new coal-fired power plants today causes a high increase in capacity of conventional coal-fired power plants. Therefore, capture-ready power plants with capture-ready investments are seen to be an attractive solution enabling a later retrofit.

The economic value of those investments has to be evaluated cautiously and depends on the time and the probability of the actual CCS-retrofit. In order to estimate the time and the probability, alternative technical options available for switching from conventional coal-fired power plants to CCS power plants have to be taken into account. Caused by the competition of those alternative options, the retrofit of a capture-ready power plant might be further delayed or even canceled.

In our study, we compare three alternative technical options, which are: First, retrofitting a modern (η = 47%) coal-fired power plant (capture-ready or non-capture-ready). Second, the replacement of older power plants with an efficiency between 35 and 40 percent (including an early shut-down) and the construction of a new CCS power plant. Third, the early shut-down of a modern power plant (η = 47%) and construction of a new CCS power plant.

Methods

For our analysis of the optimal investment timing we use an advanced net present value (NPV) model including path- and technology-dependent risk. Therein, the value of the different technologies depends on the specific cost of investment and the incoming and outgoing cash flows (revenues and costs). These cash flows can generally be seen as a technology-dependent combination of the price of basic underlying assets, such as the price of electricity, fuel, and carbon dioxide allowances, which may themselves be modeled as correlated stochastic prices. The path-dependency is caused by the uncertain future price development and the fixed combination of input- and output quantities during the power plant's operation. This results in a time-varying ratio between the future cash-flows and, consequently, a time-varying risk.

Results

The results presented in Fig. 1 are for the reference case using technological data from the German "Pilot Study 2010" ("Leitstudie 2010", Nitsch et al., 2010), which provides projections for the required specifications till 2050. The separate investigation of the various investment options in new coal-fired CCS power plants or capture retrofits leads, for each option, to a cumulative probability of technology adoption. Due to the non-availability of CCS before 2020, no investment is suggested by the model in the first steps. As soon as CCS becomes available, an almost immediate investment in a new CCS power plant is proposed, replacing the older power plant with an efficiency of 35% which was originally intended to operate until 2030. The probability of replacing the second existing power plant (efficiency 40% and expected lifetime up to 2040) is slightly higher than 80% in 2025. However, it also increases to almost 100% by the year 2030. For the new power plant (built in 2015 with an efficiency of 47%) the concurring options of a replacement with a new CCS power plant or the retrofit (capture-ready and non-capture-ready) with CCS are shown by the dotted, chain-dotted and solid line, respectively. Contrary to prior expectations, the probability of a replacement is much higher than the one for a retrofit. However, a large difference between the capture-ready and the non-capture-ready power plant is found. As the retrofit becomes unattractive with increasing age (and decreasing remaining lifetime) of the power plant, the cumulative probability rises only up to 2030. Nevertheless, for the capture-ready case, the cumulative probability stays below 40%.

Additionally to the base case, the influence of different parameters such as the power plants' efficiencies and expected remaining lifetimes, the price levels of the underlying assets and the cost of investment was investigated.

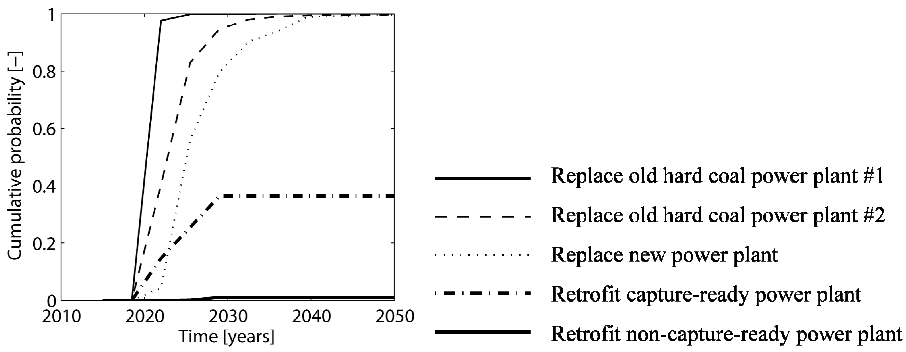

Fig. 1: Cumulative probability of the different clean-coal technology pathways, indicating their merit order for the reference case. Source: Rohlfs and Madlener (2013)

Conclusions

In conclusion, we find in our study that the option of replacing older power plants including a premature shut-down with a new CCS power plant is, in the majority of investigated scenarios, found to be the preferred choice. In addition, we show that the option of replacing a new conventional coal-fired power plant (built in 2015) with a new CCS power plant is also much more likely than retrofitting a non-capture-ready or even a capture-ready power plant. For the value of capture-readiness, we conclude that although capture-readiness strongly increases the chance of a retrofit, compared to a non-capture-ready power plant, the chances of conducting a retrofit are still low due to the additional option of a premature shut-down in combination with a new build CCS power plant. Expenditures for capture-readiness should, therefore, be well deliberated.

References

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