A sensitivity analysis of the global deployment of CCS to the cost of storage and storage capacity estimates

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Motivation and research question

◊ A wide range of Carbon Capture and Storage (CCS) deployment projections (220-2200 GtCO_2) can be found in the literature [1].
◊ One factor of uncertainty that can cause this range is technological development [1], which may be reflected in the wide range of values for techno-economic variables along the CCS-chain.
◊ To what extent the uncertainty in these variables causes uncertainty in future CCS deployment, and which parameter has the most severe impact, is investigated in Koelbl et al., [2].
◊ Here, preliminary results for the effect of the uncertainty in storage cost and storage capacity estimates are presented.

Method

◊ Collection of input data from literature.
◊ Sensitivity analysis with the TIMER model - a global, regional explicit energy system simulation model [3][4].
◊ In this model, storage cost differ per reservoir type, while the distance to the reservoir differs per region and reservoir type. Therefore, each region has its individual cost supply curve for storing CO_2, which also depends on the available capacity per region (see Fig. 2).
◊ The Baseline is the OECD 2012 [5] revised by the transport sector described in [6].
◊ The Reference scenario follows a 450 ppm CO_2-eq emission pathway as derived from a revised version of the Baseline of the OECD 2012 [5].
◊ In this Reference scenario, medium values for all parameters and a medium fossil fuel price development as derived from [7][8] are used.
◊ On the basis of this Reference scenario, cost of storage are varied and the storage capacity is decreased.

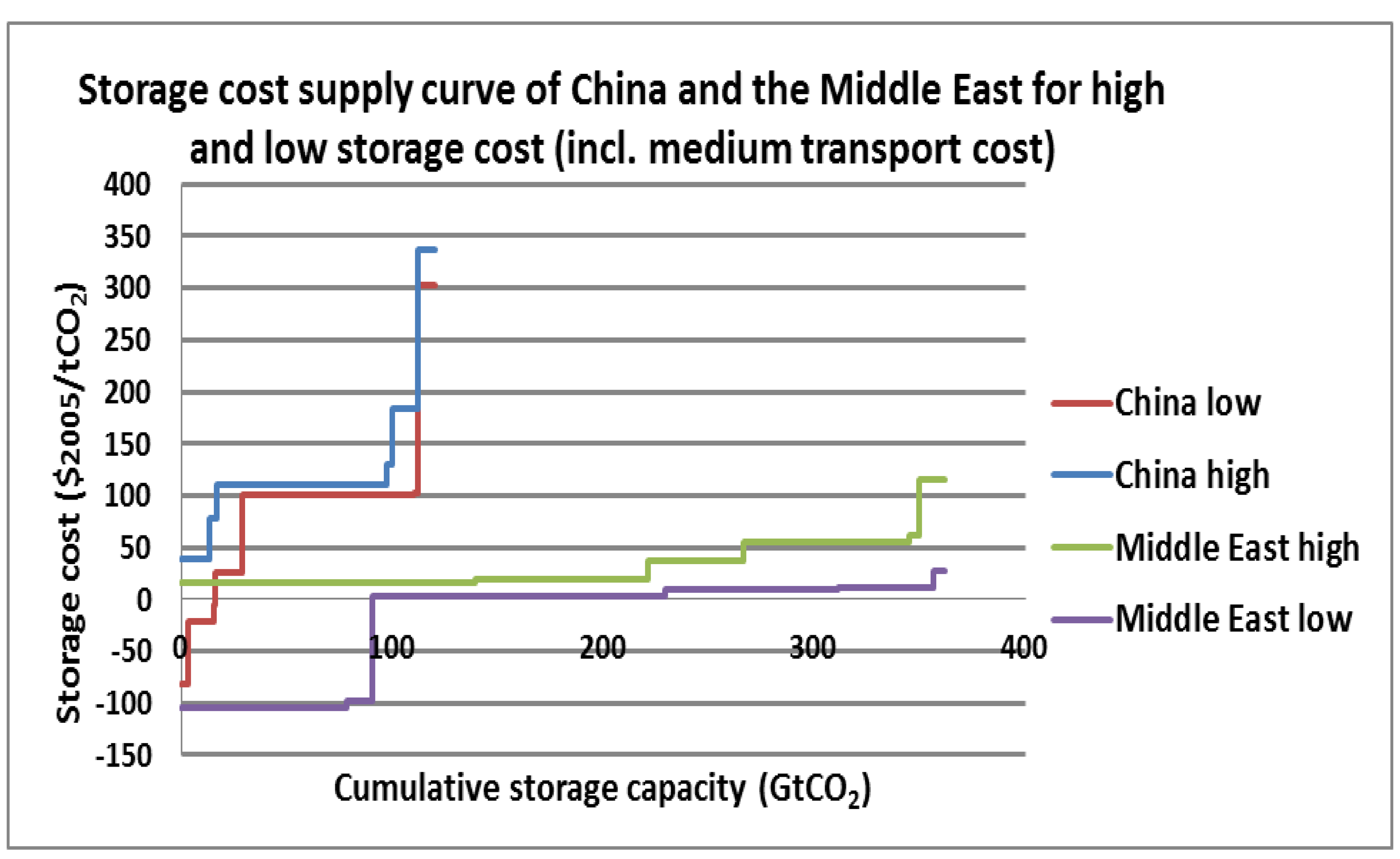

Fig. 1: Regional cost supply curve for storage cost in the low and high price scenario with default storage capacity and medium transport cost for the Middle East and China. The individual cost supply curves for China and the Middle East are different because of the differences in the amount of the storage supply of each reservoir type and the distance to the storage location.

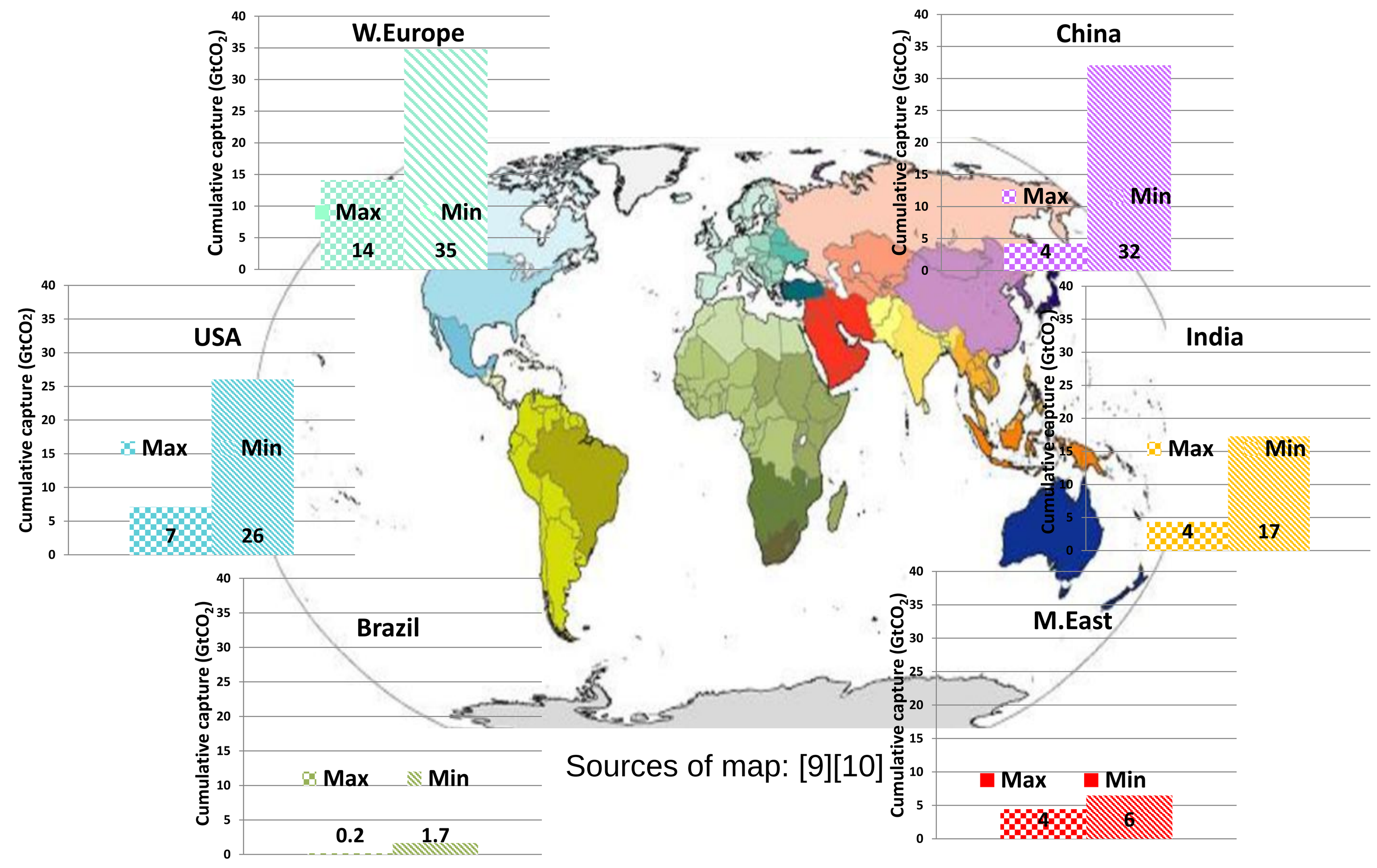

Fig. 2: Regional effect of storage cost variations on cumulative CO_2 captured from power generation until 2050. Under high storage cost assumptions (Max), the amount of CO_2 captured is in all regions lower than under low storage cost (Min). However, the difference of the strength of the effect is very large due to differences in the regional storage cost supply curves.

Results and Conclusions

◊ The uncertainty in storage cost translates into an uncertainty range in global cumulative CO_2 captured from electricity production of 46-162 GtCO_2 until 2050.
◊ Regional differences for these impacts are high, which is shown for selected regions in Fig. 2. For example, in the China region, the decrease in cumulative CO_2 captured from electricity production from the high to the low cost case relative to the low cost case is -87%. In contrast, in the Middle East this decrease is -32%.
◊ As can be seen in Fig. 1, the storage cost supply curves for China are much steeper than in the Middle East. Furthermore, relative to the emission levels, the (low cost) storage capacity is much scarcer in the China region compared to the Middle East. Therefore, China stores at much higher cost levels. At this high cost level, China reacts much more sensitive to an increase in storage cost.
◊ Decreasing the storage capacity has very mild effects on the total global cumulative CO_2 captured until 2050 from power production. This figure decreases only by -3Gt when we assume low capacity estimates.
◊ The China region, however, has only 37% of its original storage capacity left in 2050. This implies that impacts of lower capacity assumptions on cumulative CO_2 captured can become stronger after 2050.

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