Appendix

A1. Cost curve of carbon storage

In WITCH, CO_2 can be captured and stored underground with costs endogenously related to the cumulative quantity of CO_2 stored in each macro-region via supply cost functions calibrated by Hendriks et al.(2004). Table A provides the regional supply cost curves used in the model.

Table A The Regional Capacity of Carbon Sequestration

Carbon Price ($/tCO₂)	**Cumulative CCS ($GtCO_2$)**													
	USA	WEURO	EEURO	KOSAU	CAJAZ	TE	MENA	SSA	SASIA	CHINA	EASIA	LACA	INDIA	World (with Storage flexibility)
20	62	83	10	65	19	228	137	38	51	77	64	117	51	1002
30	72	99	11	76	21	320	202	43	59	90	75	130	59	1257
40	78	109	12	83	23	372	241	46	64	99	83	138	64	1411
50	83	116	12	88	24	408	268	48	67	105	89	145	67	1521
75	91	129	13	96	27	468	314	51	73	115	100	155	73	1705
100	96	137	13	102	28	506	344	54	77	122	107	162	77	1825

A2. The cost of DAC

As APS (2011) does, we break down the DAC costs into physical capital cost, maintenance cost and energy inputs. The first two costs are assumed to be constant following directly APS' 'realistic' estimations, \$470/tCO_2. The energy inputs are subcategorized into electricity and non-electricity (heating). The prices of the energy sources are endogenously decided, taking into consideration the costs of investment/maintenance/carbon emission of providing the energy services. The electricity price is an average over all types of energy sources that fuel the power plants, at \$38-\$56/tCO_2. The price of non-electric energy is that of the non-electric use of natural gas with CCS, \$86-\$209/tCO_2. We also show the cost of carbon storage in Fig.A1, which includes the storage costs for both the CO_2 captured from the air by DAC and the CO2 captured from the natural gas burned to provide high-temperature heat for the DAC plants. This part of the cost is calculated using the cost curve provided in Table A, and ranges from \$11-\$100/tCO_2 captured.

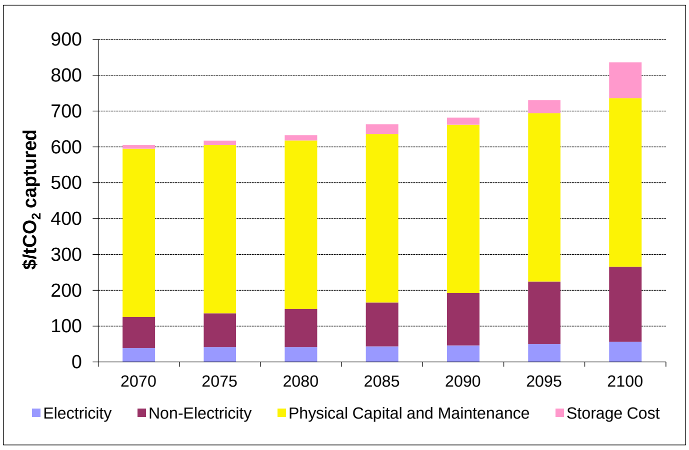
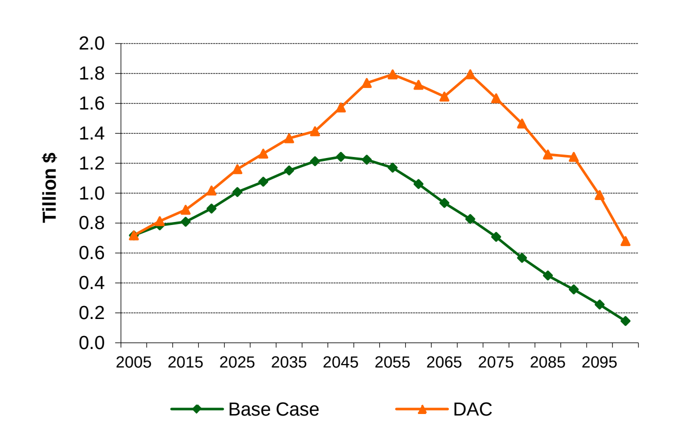


Figure A1 Breakdown of DAC Costs (global average)

A3. EEX' Two-fold benefit from DAC

Implementing DAC benefits EEX in two ways. The first is from the oil market by preserving the value of oil reserves, which has been noted by Nemet and Brandt (2010). Due to the increased trade volumes, the market value of international oil trading does not fall as much as in the base case, since more oil is used and traded and its price is higher (Fig.A2-a). The second benefit is from the carbon market, where EEX turns from buyer to seller of carbon permits in the international markets (Fig.A2-b).



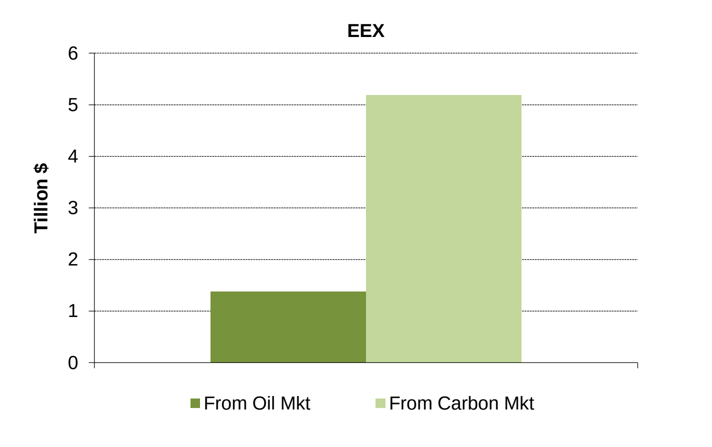


Figure A2 Benefit of DAC for EEX countries

(left: Figure A2-a. The market value of the Oil Market;

right: Figure A2-b. Economic benefits of DAC in the EEX countries)

A4. Policy cost of the "clean oil" scheme

The "clean oil" scheme would induce roughly neutral cost for energy exporters, who do not bear policy cost but have some benefit that accounts for 0.9% of their cumulative GDP. But other regions who take excessive emission burden face a significant penalty that amounts to 5.8% of their cumulative aggregate GDP, as a result of the inevitable efficiency losses due to the non equalization of marginal abatement costs of the partial agreement.

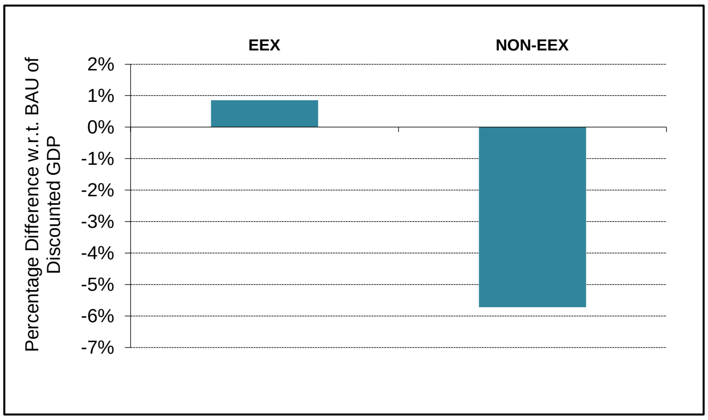


Figure A3 Costs of the 'clean oil' policy