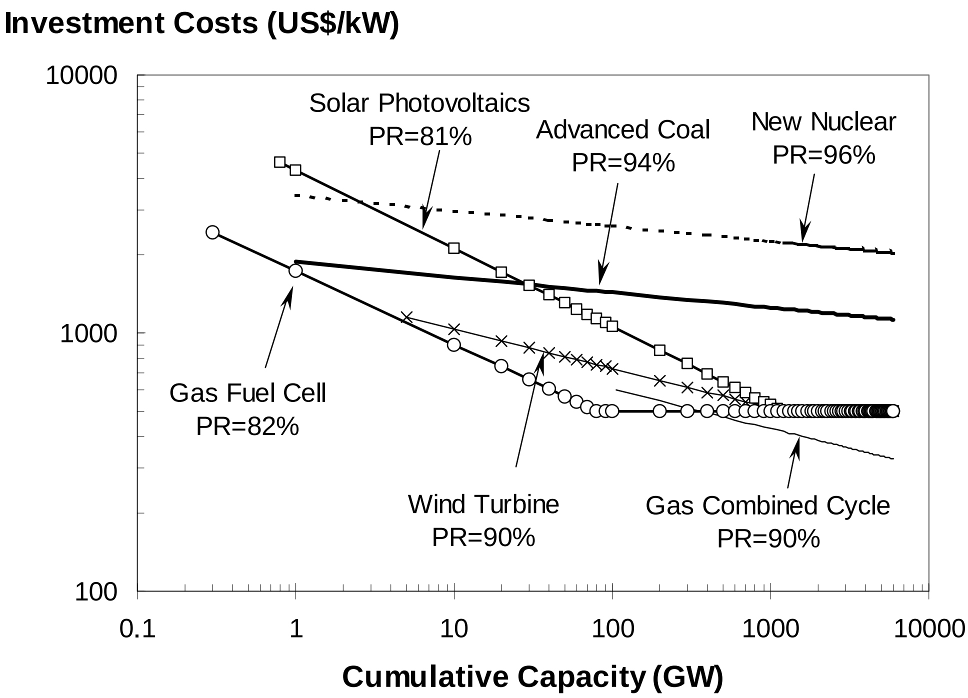

Fig. 1. *Learning curves assumed for electricity generation technologies. Markers are used only to distinguish different curves. Progress ratio (PR) gives the reduction in specific investment cost when cumulative installations double. Figure taken from [15].*

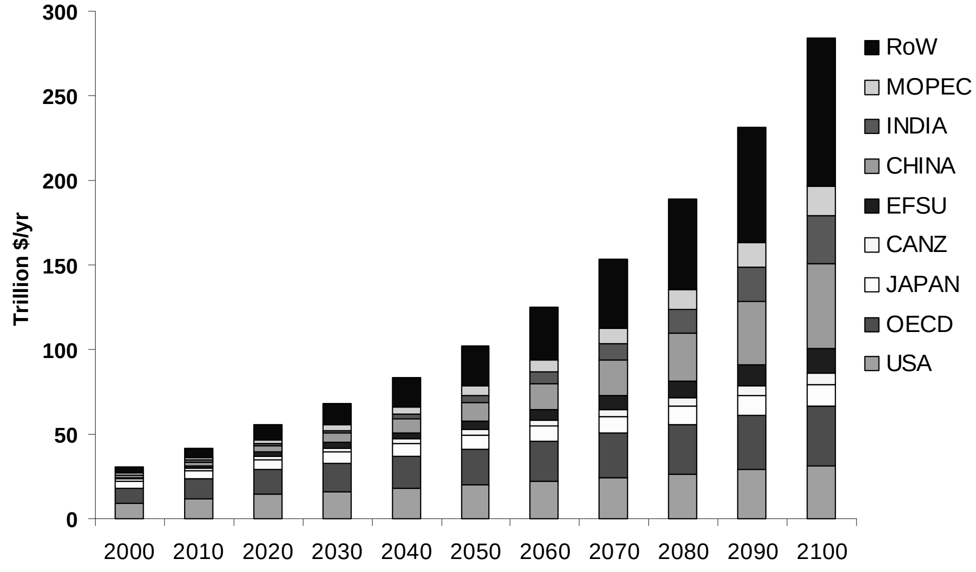

Fig. 2. Regional GDP in the BaUN case; the current developing countries will produce more than 66% of the global economic output late in the century while OECD contributes by only 30%.

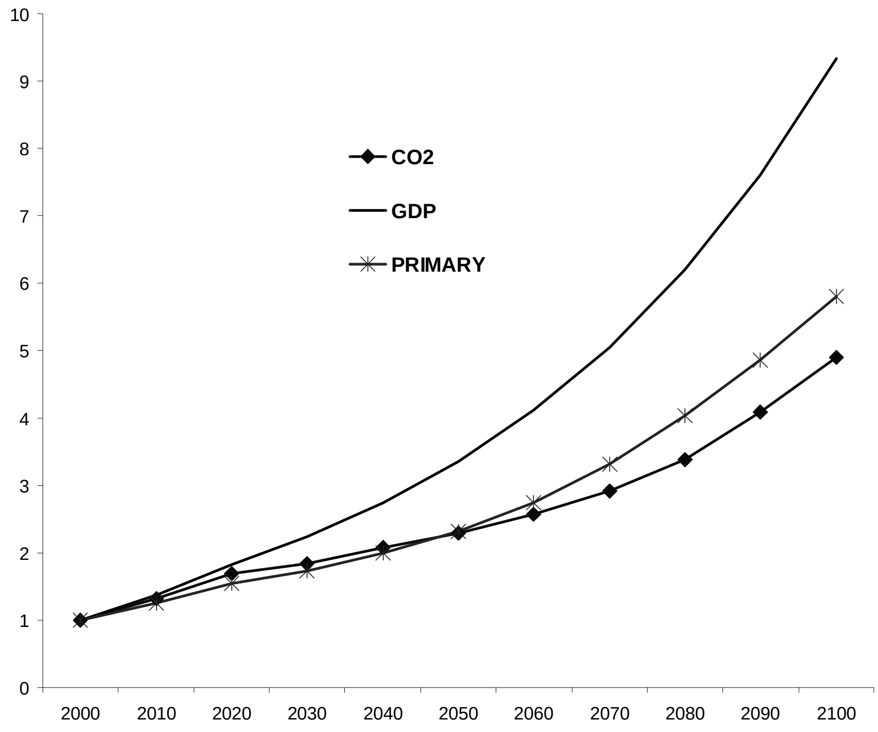

Fig. 3. Energy and Economic Indices for the baseline BaUN case

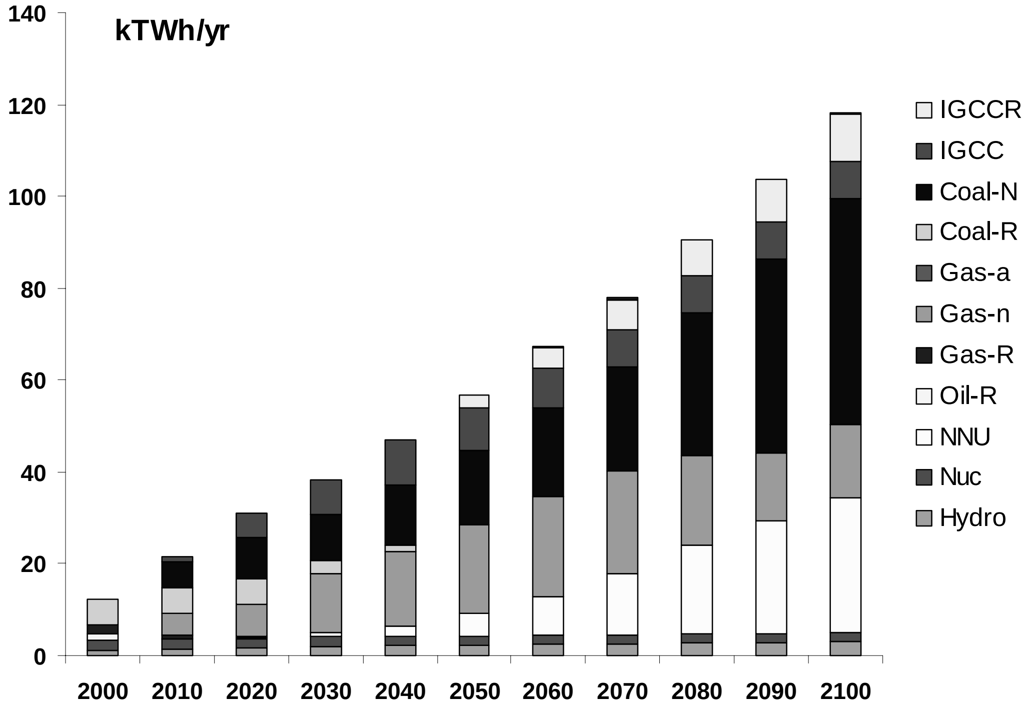

Fig. 4. Electricity Generation in the BauL case

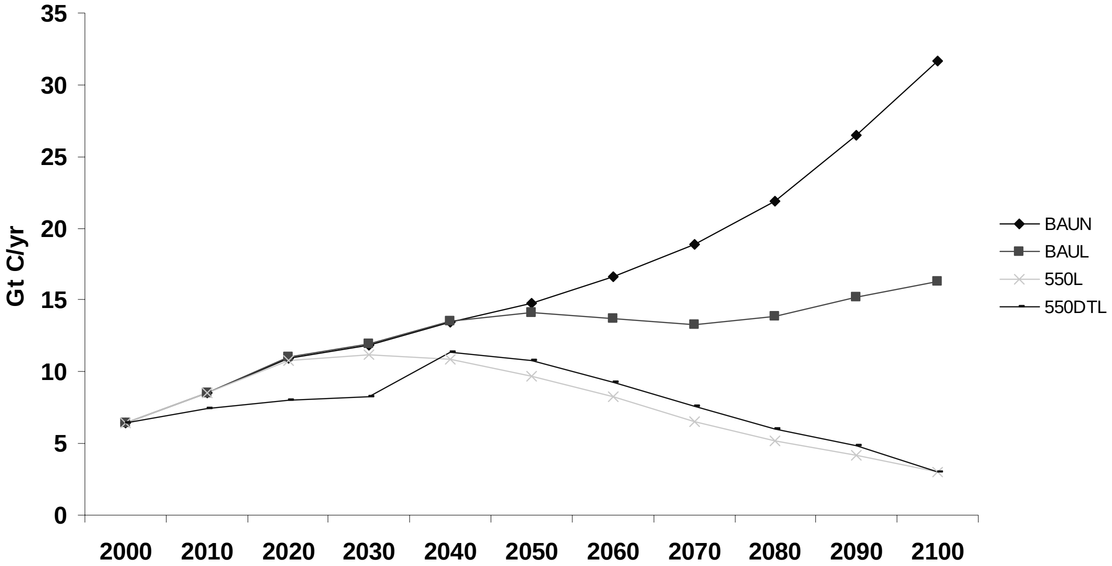

Fig. 5. Carbon emission paths for the reference and the stabilisation cases analysed

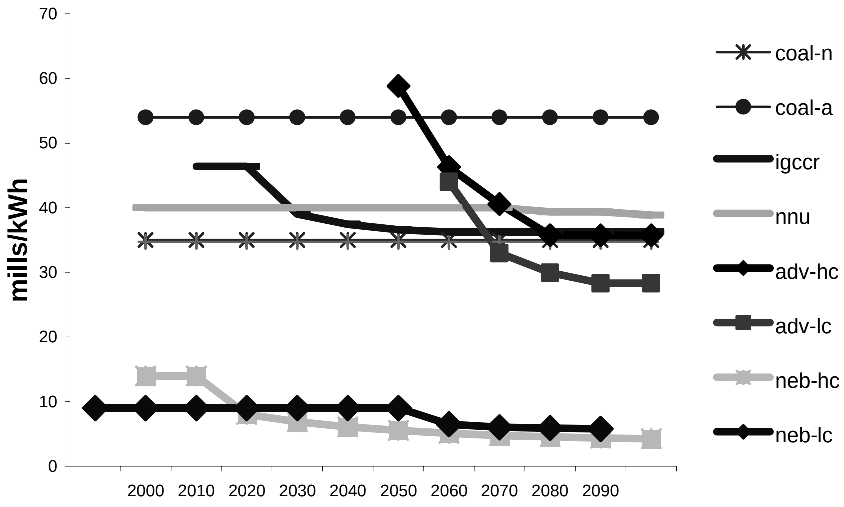

Fig. 6: Electricity generating cost in the 550L case. Here the autonomous cost reduction is not shown; ADV-HC, ADV-LC, IGCCR, NEB-LC, NEB-HC and NNU assume cost reduction due to LBD.

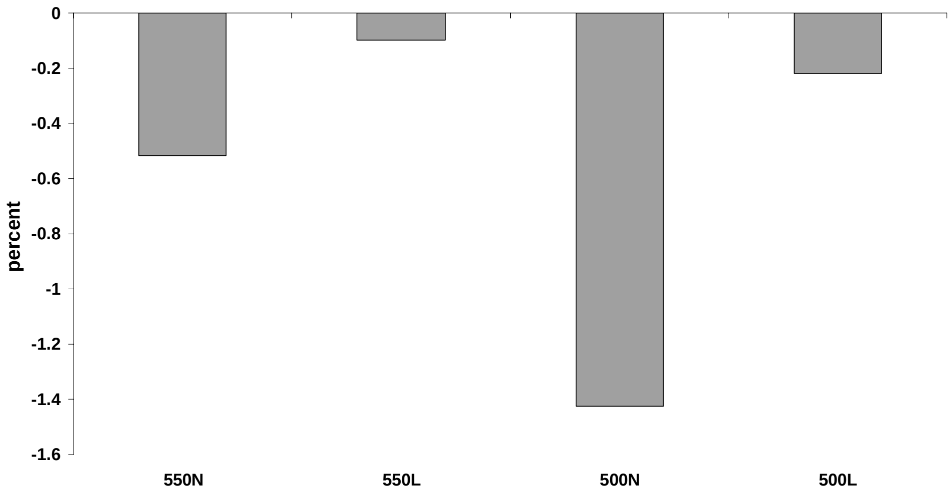

Fig. 7. Cumulative and undiscounted GDP losses for the atmospheric carbon stabilisation cases, relative to the GDP of BaUN, in percent. The cumulative and undiscounted GDP losses are significantly reduced by LBD; thus, in the 550-ppmv-stabilisation case the cumulative losses (0.52%) are reduced to 0.1 % while in the 500-ppmv case losses are reduced from 1.42% to 0.22%.

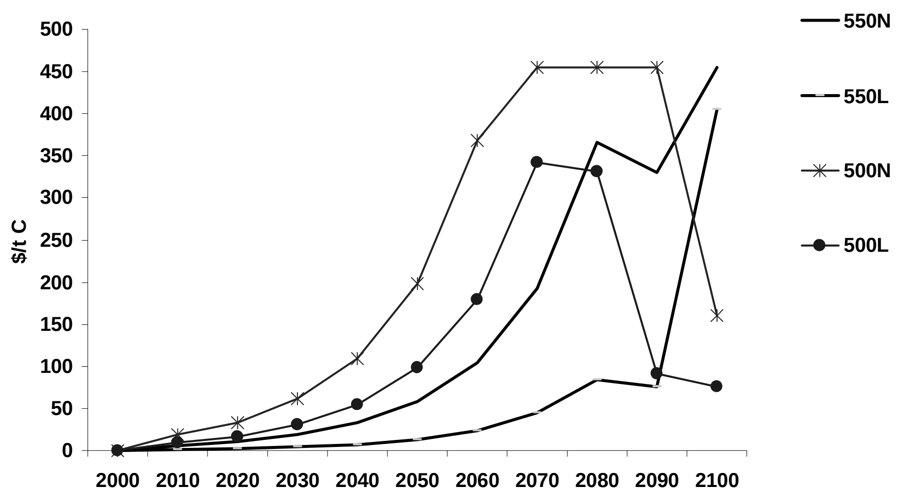

Fig. 8. The marginal costs in the case of LBD are reduced well below $100 per ton of Carbon by the year 2090 in the 550-ppmv cases due to the introduction of fossil fuel sequestration options and the penetration of renewables in the non-electric markets. The shape of the marginal costs reflects the price of a resource with limited cumulative availability. Only in the last period an extra constraint that is forcing a maximum production of emissions to 3 Gt of carbon, is changing the shape of the marginal cost function. The 500-ppmv stabilisation cases imply higher marginal costs.

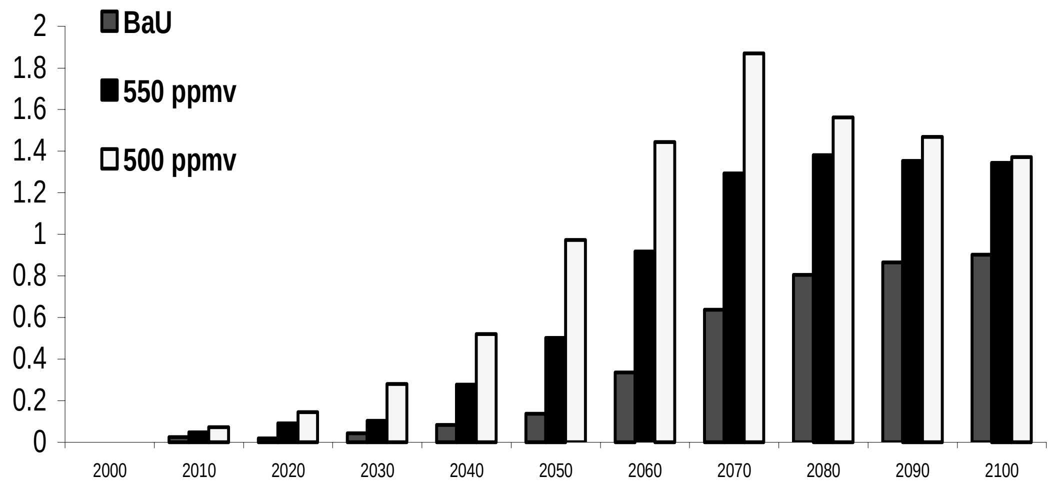

Fig. 9. "GDP gains" from "learning-by-doing" expressed as percentage change relative to the baseline case without LBD, (e.g., 100 (BaUL-BaUN)/BaUN); gains increase at lower CO_2 stabilisation targets.

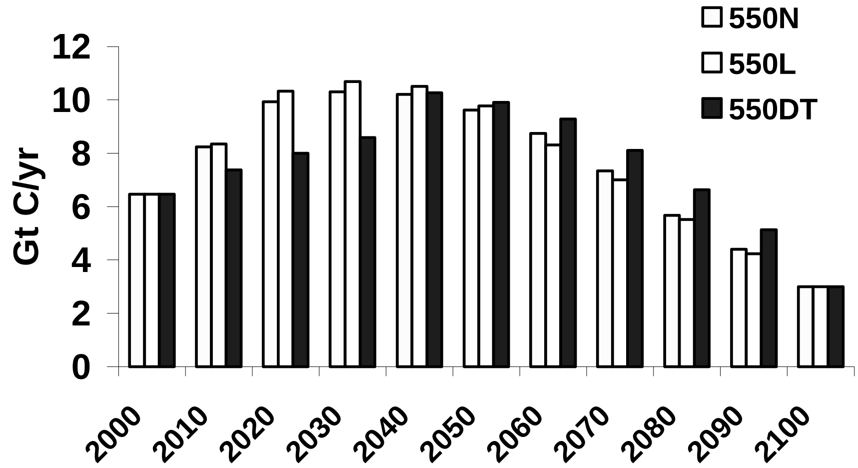

Fig. 10*:* LBD (second column) is postponing actions to reduce carbon emissions by a few decades while annual emissions remain almost as in the BaUL case. Results are quite different if another constraint is imposed concerning the rate of temperature change (e.g., by applying a maximum temperature increase of 0.21 degree Celsius per decade) as shown for the 550DT case.

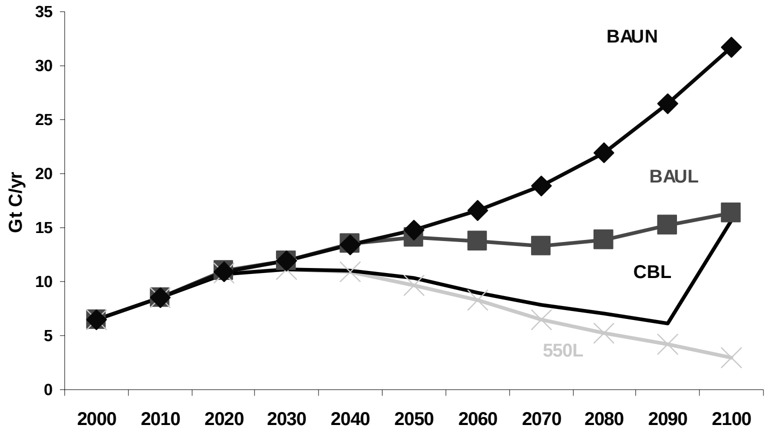

Fig. 11. Emissions in the C/B case with ETL are quite similar to the emission levels of the 550-ppmv case while the corresponding concentrations remain around 590-ppmv.

Table 1: Technologies used in MERGE-ETL and naming conventions

Technology name	Identification/Examples	
Electric Technologies		Introduction date
HYDRO	Hydroelectric, geothermal and other renewables	Existing
NUC	Remaining initial nuclear	Existing
GAS-R	Remaining initial gas fired	Existing
OIL-R	Remaining initial oil fired	Existing
COAL-R	Remaining initial coal fired	Existing
GAS-N	Advanced combined cycle	2000
GAS-A	Advanced combined cycle with sequestation and LBD	2020
COAL-N	Pulverized coal without CO2 recovery;	2000
COAL-A	Pulverized coal with CO2 recovery and LBD	2020
IGCC	Integrated gasification and combined cycle without CO2 removal	2010
IGCCR	Integrated gasification and combined cycle with CO2 removal and LBD	2020
ADV-HC	Carbon-free technologies (e.g., SPV); costs decline with LBD (high cost)	2000
ADV-LC	Carbon-free technologies (e.g., WND); costs decline with LBD (low cost)	2000
NNU	Carbon-free technologies (e.g., New nuclear); costs decline with LBD (low cost)	2010
Non-Electrict Technologies		
CLDU	Coal Direct use	Existing
OIL1-OIL10	Oil categories	Existing
GAS1-GAS10	Gas categories	Existing
SYNF	Synthetic fuels w/o Learning	Existing
RNEW	Renewables w/o Learning	Existing
NEB -HC	Renewables Back-stop High cost with LBD e.g., Hydrogen from SPV, nuclear, etc.	2010
NEB -LC	Renewables Back-stop Low cost with LBD	2010

Table 2: Technical data for systems used in MERGE-ETL

		Gen. Costs mills/kWh	Carbon Emissions Kg C/kWh	specific cost $/kW	load factor	life years	Learning rate (-)	floor cost $/kW
Electric Technologies								
HYDRO		40	0					
NUC		37	0					
GAS-R*		6.3	0.1443					
OIL-R*		6.3	0.2094					
COAL-R		20.3	0.2533					
GAS-N*		9.1	0.087					
GAS-A*		18.4	0.01	1010	0.7	25	0.11	550
COAL-N*		35	0.209	1300				
COAL-A		54	0.0068	2090	0.7	25	0.05	800
IGCC		34.7	0.193	1400				
IGCCR		46.4	0.026	1910	0.7	25	0.05	1000
ADV-HC		220	0	5000	0.25	25	0.2	1000
ADV-LC (Wind)		44	0	1000	0.25	25	0.11	400
NNU		40	0	2500	0.7	25	0.04	1000
Non-Electric Technologies								
		$/GJ	t C/GJ	$/GJ				$/GJ
CLDU		2.5	0.0241					
OIL1-OIL10	3.00-5.25		0.0199					
GAS1-GAS10	2.00-4.25		0.0137					
SYNF		8.33	0.4					
RNEW		6	0					
NEB -HC		14	0	13.3	1	20	0.15	4
NEB -LC		9	0	10	1	20	0.1	4

* Gas and oil systems do not include fuel cost