**Note concerning greenhouse gas reduction pathways and budgets 2012-2050 in a Danish Climate Change Act**

Kim Ejlertsen and Palle Bendsen

NOAH Energy and Climate, 3rd December 2011

Our suggestions for GHG reduction objectives in a Danish Climate Change Act[i] are: 2020: 50%, 2030: 90% and 2050: 100% reduction in GHG.

Denmark is one of the world's richest and most $CO_2$ polluting countries when looking at GDP and $CO_2$-emissions per capita. If Denmark is going to live up to the UNFCCC principle that the broadest shoulders must carry the most, a fair Danish contribution to solving the global climate crisis at least implies that our greenhouse gas reduction rate must be faster than what science says is needed globally.

The choice of reduction rate has been based on our calculation of the Klima SOS campaign[ii] "at least 6% year by year," which actually was a 6.3% year by year reduction. Here all EU-27 countries` reduction rates were calculated by connecting the countries` actual emissions in 2005[iii] with the countries` shares of the global 2-degree budget for 2050[iv]. Thereby we got comparable reductions trajectories for all countries in the EU-27 and a professional basis for the Danish campaign.

It is important to note when we calculate a reasonable Danish contribution to solving global climate problems in this way we are neither taking into account the historical emissions nor that an unequal situation between rich and poor countries will persist until 2050[v].

We are now going to propose reduction rates of Denmark, starting in 2012. To keep the targets, while compensating for the "lost" years without adequate action, we are forced into steeper reduction trajectories. The table below shows an overview of rates and budgets as possible proposals for reduction objectives in a Danish Climate Change Act.

**Danish Climate Change Act - emissions reduction targets and budgets 2012-2050**

**Based on the overview below, the following GHG reduction targets are proposed:**

| | |
|---|---|
| **Year 2020 (1990 basis) reduction:** | **50** |
| **Year 2030 (1990 basis) reduction:** | **90** |
| **Year 2050 (1990 basis) reduction:** | **100** |

| **Initial reduction Total $CO_2$-eq** | **Reduction 2020 (1990 basis) %** | **Reduction 2030 (1990 basis) %** | **Reduction 2050 (1990 basis) %** | **Fossil free Year** | **Total budget 2012-2050 Mt $CO_2$-eq** | **BAU 2012-2030 Mt $CO_2$-eq** | **BAU 2012-2050 Mt $CO_2$-eq** |
|---|---|---|---|---|---|---|---|
| **6.3 percent** | **47.6** | **75.7** | **100** | **2038** | **770** | **1235** | **2535** |
| **7 percent** | **51.0** | **87.8** | **100** | **2032** | **651** | **1235** | **2535** |
| **9 percent** | **59.7** | **95.9** | **100** | **2030** | **536** | **1235** | **2535** |

You see a spread between 47.6% and 59.7% reduction by 2020 and between 75.7% and 95.9% by 2030. On that basis we made the choice to propose the before mentioned rounded 50% for 2020, 90% for 2030 and 100% for 2050 with a phasing out fossil fuels in the period around 2032.

On the following pages figures with reduction trajectories and associated 3-annual greenhouse gas budgets are shown for 6.3%, 7% and 9% starting in 2011 – i.e. 2012 is the first year of the first budget period 2012-2013-2014 etc.

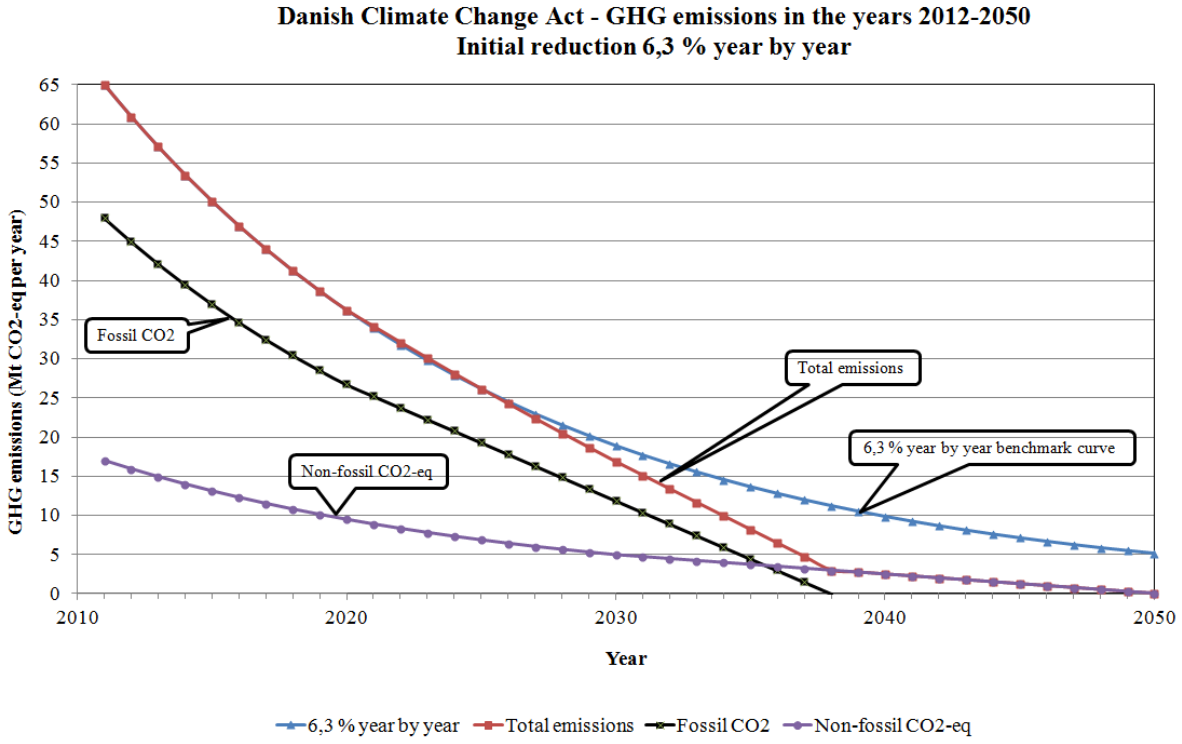
The reduction trajectories shown on the top of each page are constructed in such a way that the fossil and non-fossil energy curve first decreases with x.y% year on year (here 6.3%, 7%, 9%) then after a number of years move to a linear reduction, leading the curves to zero. The fossil + non-fossil = total emissions. Total emissions will follow e.g. the 6.3% curve, until the fossil curve moves to the linear part - it is reflected in the total curve that begins to deviate from the theoretical 6.3% curve that will never go to zero.

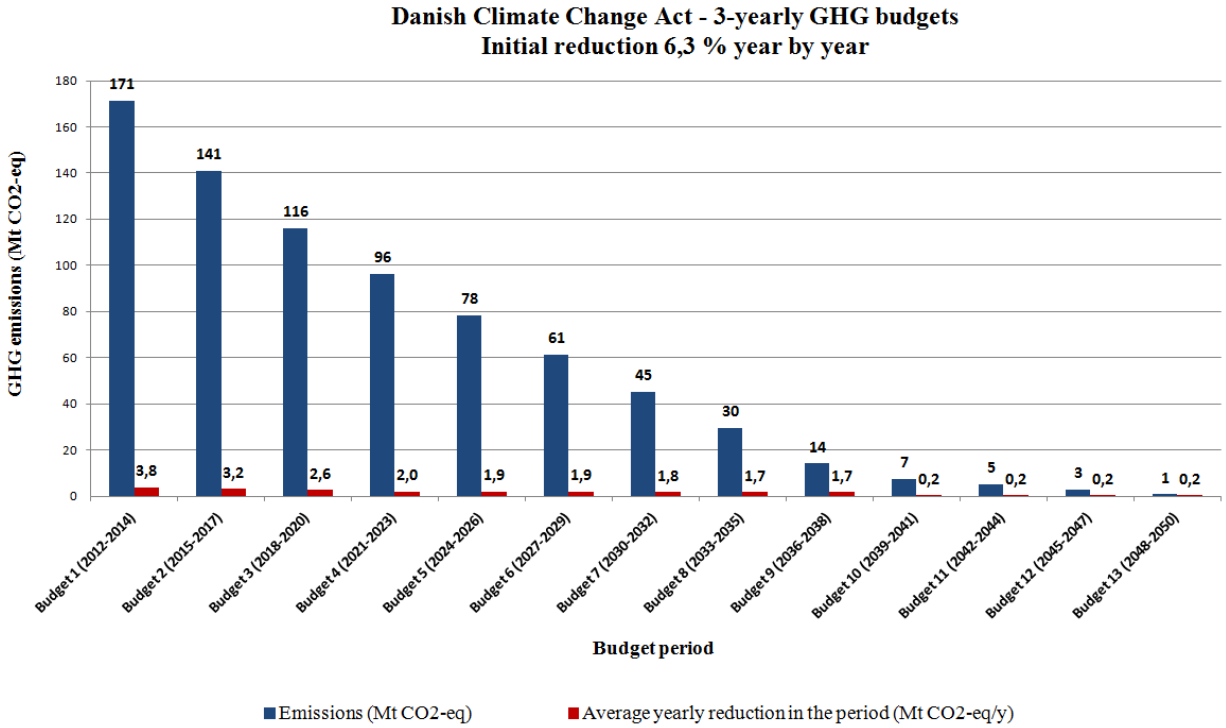
The 6.3% curve is drawn at the top as a benchmark. In the 6.3% figure, the transition to a linear trajectory happens in 2021 (fossil curve) respectively in 2031 (non-fossil curve), and the phasing out of fossil fuels can take place only in 2038. Generally speaking, the lower initial rate the later the fossil curves will hit zero. The 6.3% curve is phasing out fossil fuels by 2038, the 7% curve in 2032 and the 9% curve in 2030.

The figures at the bottom of each page shows for each budget period, the total emission in 3-yearly budgets (left column) and the average annual reduction in the budget period (right column). The average annual reduction thus gives an idea of the extent of initiatives to be implemented. For the first budget period in the 6.3% figure the average annual reduction of 3.8 Mt $CO_2$ covers a need for initiatives in the first year leading to reductions of 4.1 Mt $CO_2$, next year another 3.8 Mt $CO_2$ and in the last year during the budget period reductions of 3.6 Mt $CO_2$. The reductions can obviously be distributed differently, as long as the 3-year budget is kept.

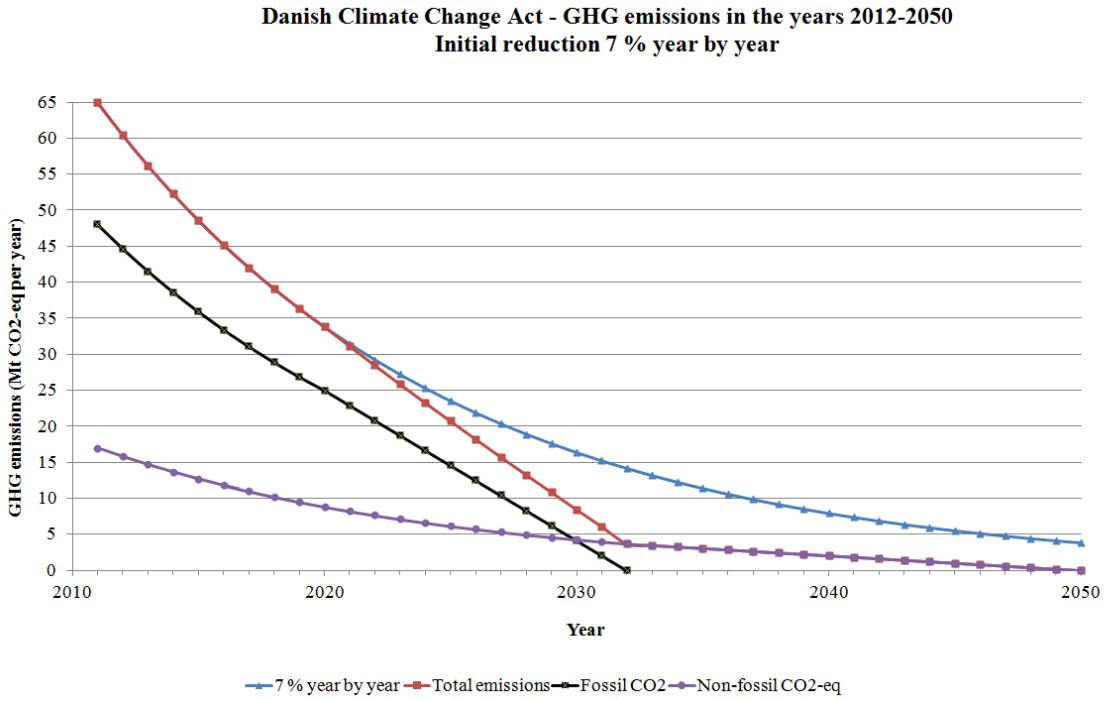
By time when the 3-yearly budgets diminish, new initiatives can include smaller and smaller annual reductions. Some initiatives are going to have immediate impact (behavior, speed on roads, etc.) other decisions will only be reflected in subsequent budgets (decisions on construction of new wind farms, building renovation, etc.) and the various initiatives can have varying range in time. It is of greatest importance for the total greenhouse gas budget of the entire period (and hence climate, security of supply, employment, etc.) that the greatest reductions are in the first budget periods.

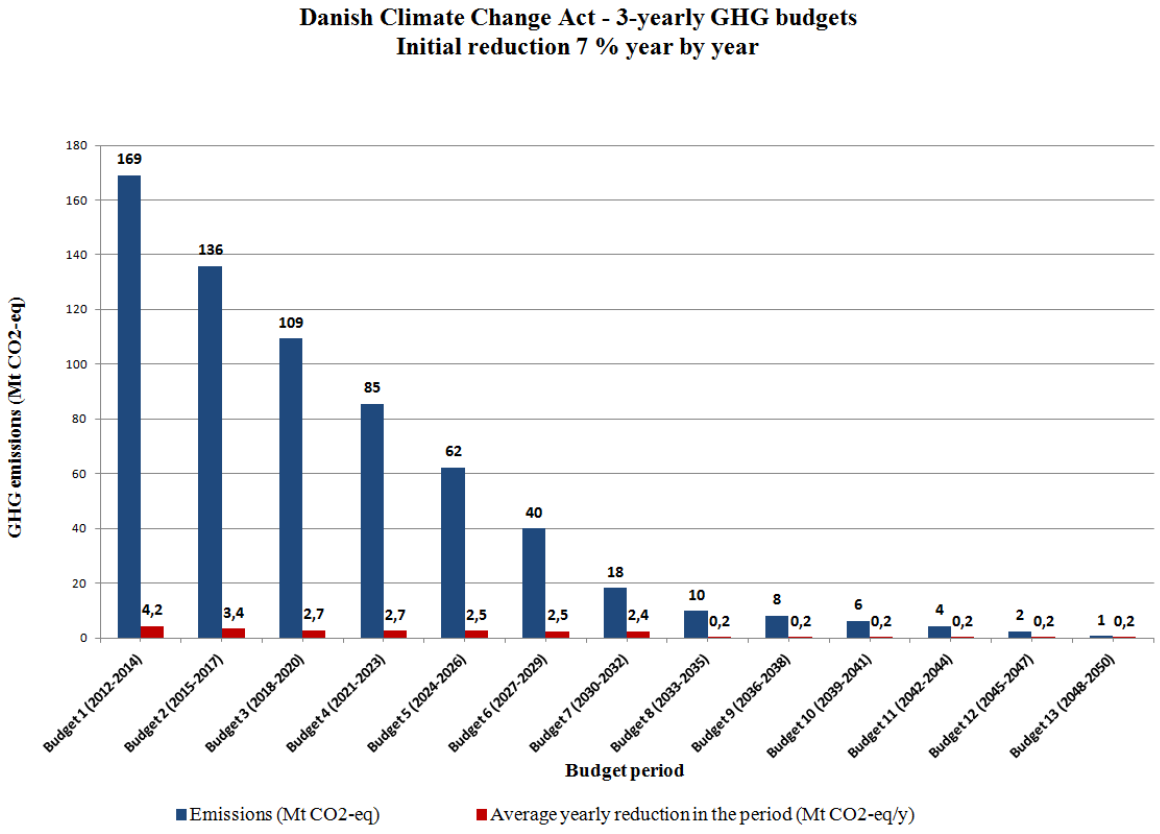
## Initial reduction 6.3% year by year



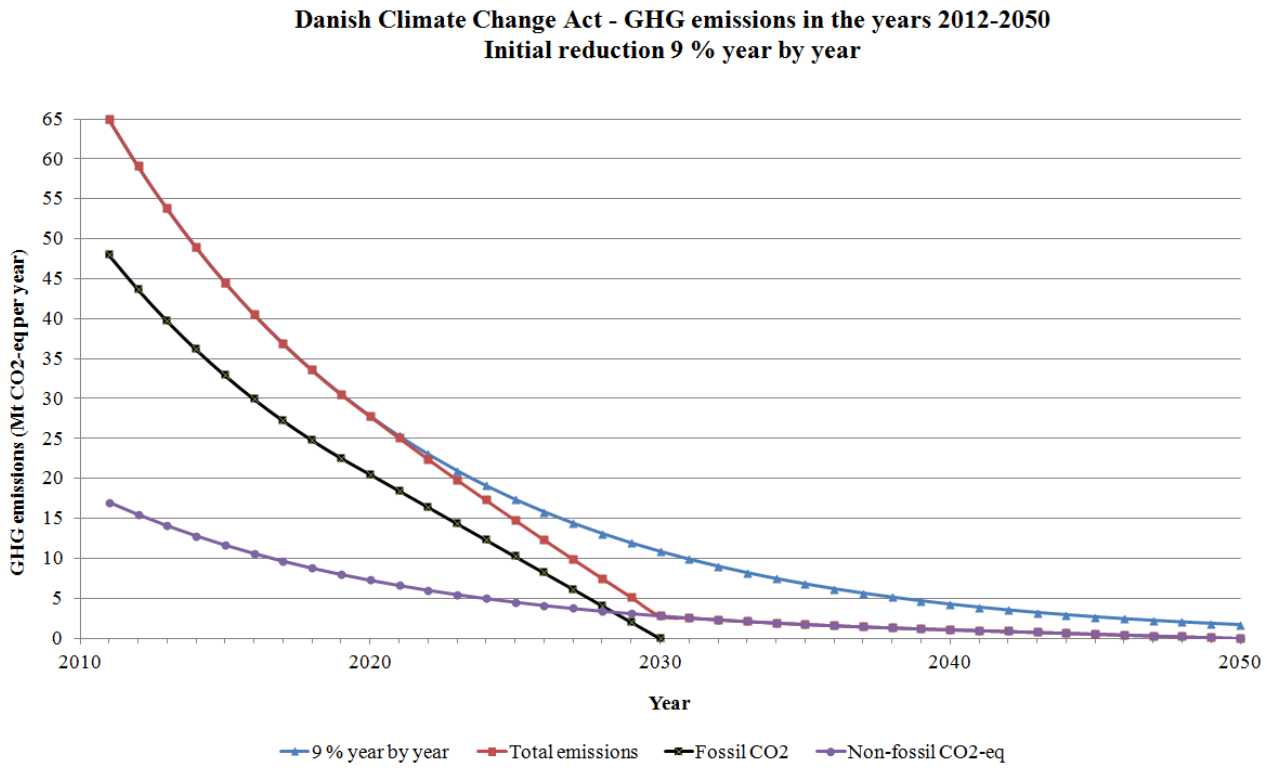



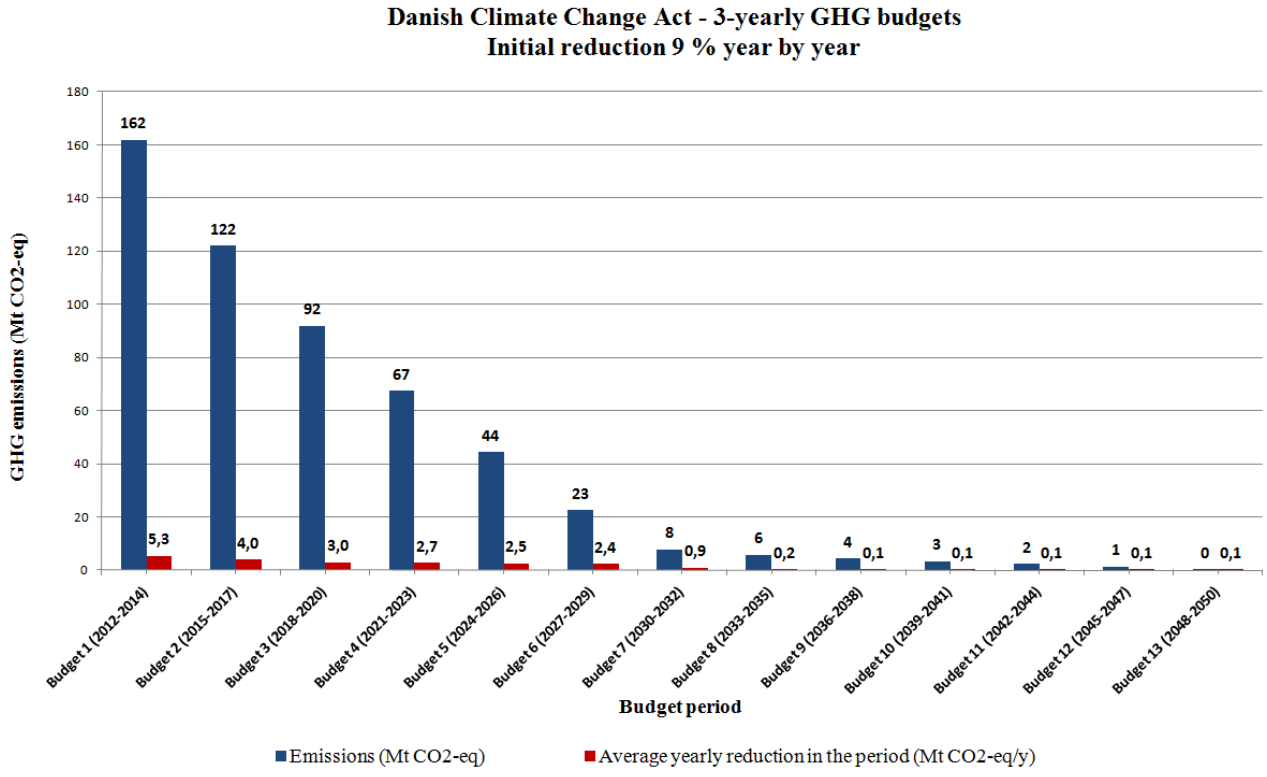
## Initial reduction 7% year by year



# Initial reduction 9% year by year



[i] See NOAHs draft for a Danish Climate Change Act: http://kortlink.dk/noah/8y5m

[ii] The Klima SOS campaign is the Danish version of the European Big Ask campaign, which since February 2008 has been running for 17 countries in Europe. The campaign was inspired by the British Big Ask campaign, launched in May 2005 by Friends of the Earth England, Wales and Northern Ireland. In November 2008 this campaign led to the British Parliament adopting the world's first Climate Change Act. The Act has binding targets for 2020 and 2050 with related national greenhouse gas budgets, reporting obligations and an independent Climate Change Committee to advise the government. In 2009 a Climate Change Act was adopted in Scotland and in 2011 in Austria. In Belgium, Finland, Slovenia and Ireland changes in the parliamentary situation, at the last minute, prevented the adoption of climate laws. Read more about climate legislation in Europe here: http://www.climatedatabase.cz/

[iii] The latest figures, one could get at that time were found in "EEA Report No. 5, 2007: Greenhouse Gas Emission Trends and Projections in Europe 2007 ".

[iv] UN´s Fourth Assessment Report (AR4) of 2007 published as something new that if we are to keep temperature increase below 2 degrees Celsius we need an 85% global reduction in greenhouse gases by the year 2050 (2000 base). This implies emissions of approx. 44.7 Gt $CO_2$-eq to be reduced to about 6.7 Gt $CO_2$-eq. Until then the general assumption had been that a 50% reduction by 2050 (1990 base) was sufficient (emissions of approx. 39.4 Gt $CO_2$-eq in 1990 to be reduced to approx. 19.7 Gt $CO_2$-eq in 2050). AR4 also pointed to the need of global emissions to already peak in the period 2000-2015 in order to avoid excessive total emissions. See "IPCC 2007, WG III AR4 Summary for Policymakers", page 15, Table SPM 5, category I, http://kortlink.dk/noah/afzf or "IPCC 2007, Climate Change 2007: Synthesis Report", fig. 2.1 p. 36 as well as Table 5.1 p. 67, http://kortlink.dk/noah/afzn.

A number of recent reports and articles confirm that there is a need for faster and deeper cuts than previously thought - see e.g. WBGU 2009, pp. 15-16, fig. 3.2-1, $CO_2$ only, http://kortlink.dk/noah/ap45 and Meinshausen M. et al. 2009, Table 1, http://kortlink.dk/noah/ap8g.

In connection with the Climate SOS campaign startup in 2008 we calculated Denmark´s and the EU-27-countries' fair contribution to addressing global climate change under the 2-degree target http://kortlink.dk/noah/afzu. At that time 2004 was the last year where the IPCC had calculated the global GHG emissions (49 Gt $CO_2$-eq). Since we wanted 2005 as start year, we estimated the global 2005-emissions from the IEA's inventory of fossil $CO_2$ emissions in 2005 (28.192 Gt $CO_2$) and AR4 synthesis report, fig. 2.1 (indicating a fossil share of total emissions of 56.6%). This gave an estimated GHG emissions in 2005 of about 28.192/0.566 = 49.8 Gt $CO_2$-eq.

With increasing greenhouse gas emissions in the period after 2000, it would be misleading only to apply an 85% reduction of global emissions in 2005. For precautionary reasons, a global reduction of 87.5% (2005 basis) was used rather than a global reduction of 85% (2000 basis). In practice this meant that the global target for 2050 was 6.2 Gt $CO_2$-eq instead of the above mentioned 6.7 Gt $CO_2$-eq. A corresponding budget for the period 2005 (49.8 Gt $CO_2$-eq) to 2050 (6.2 Gt $CO_2$-eq) can be calculated to approx. 940 Gt $CO_2$-eq (45 year period) with a **global reduction rate of 4.6% year on year**. All EU countries` reduction rates should therefore be significantly above this global reduction needs. Denmark came out at 6.3% year on year, EU-27 at 6.1% year on year.

If we want to change the assessment, having start year 2010 instead of 2005 (our proposal to a Danish Climate Change Act starts in 2012) again robust data on global GHG emissions are missing. IEA's 2011 report on fossil $CO_2$ emissions shows a 2.627 Gt $CO_2$ increase from 2004 to 2009. If using the IPCC's global GHG emissions in 2004 (49 Gt $CO_2$-eq) as start point and assuming the increase in fossil emissions to be reflected in the figure for global emissions,

we get an estimate for 2009 of 51.6 Gt $CO_2$-eq. If we use the same estimate for 2010 (51.6 Gt $CO_2$-eq) and the adjusted target for 2050 (6.2 Gt $CO_2$-eq) we get a total budget for the period (40 years) of approx. **860 Gt $CO_2$-eq** and a related global reduction rate of **5.3% year on year**.

For comparison Meinshausen M. et al. 2009 (http://kortlink.dk/noah/ap8g) estimated that the remaining global greenhouse gas budget for the period 2010-2050 (40 years) is in the range of **830-985 Gt $CO_2$-eq**. Despite keeping this budget range the probability for exceeding the 2-degree target is 20-25%.

With the UNFCCC´s principle of the broadest shoulders must carry most in mind, the results of a Danish Climate Change Act that has 2012 as the start year can be summarized briefly: When our calculation with 2005 as the start year gave 6.3% year on year to Denmark based on a global 4.6% year on year reduction, then a global reduction from 2010 of 5.3% year on year implies, that the reduction rate in a Danish Climate Change Act must lie well above the originally estimated Danish reduction rate of 6.3% year on year. In this paper we therefore elaborate on Danish initial reduction rates of **6.3%, 7% and 9%**.

[v] In the absence of a global climate agreement that addresses these issues, the choices we make regarding the level of the Danish efforts will largely be based on ethics, which in itself is enough to justify the transformation process. But in addition a range of good reasons for immediate action can be added e.g. improved energy security, increased employment and an improved long term economy. Together with the prospect of rapidly rising oil, coal and gas prices there are in other words, many good reasons for Denmark as fast as possible to become fossil-free with sustainable agriculture and sustainable land use, all together reducing the atmospheric content of greenhouse gases.

If we take historical emissions into account further actions are needed. See e.g. The Greenhouse Development Rights Framework. The right to development in a climate constrained world. A report by Paul Baer, Tom Athanasiou, Sivan Kartha, and Eric Kemp-Benedict. (Ecoequity 2008). http://gdrights.org/