APPENDIX 4: BENEFIT CALCULATIONS

Assessing the magnitude of environmental benefits of investments in power projects to reduce carbon dioxide emissions

Energy investments to cut carbon dioxide emissions range from energy saving measures to replacing non-renewable power systems that produce carbon dioxide with renewable technologies such as hydro, wind, solar and with nuclear power.

Figure A.4.1 presents a simplified version of a somewhat optimistic IPCC scenario for carbon dioxide emission trends along with the author's estimate of the corresponding environmental impact (curves 1e for emissions and 1i for environmental impact). This emission scenario foresees a three-degree increase in the average global temperature. It is used here as the basic scenario for purposes of discussion. We assume that by mid-century carbon dioxide emissions will be reduced globally either through technological and social measures, or as a result of some kind of crises.

Figure A.4.1. also shows a theoretical emissions scenario where the feedback system in the greenhouse phenomenon is broken immediately and the resulting negative environmental impacts are put in check (curves 2e and 2i). This makes it possible to estimate the positive environmental impact from investing in technologies or approaches that reduce carbon dioxide emissions.

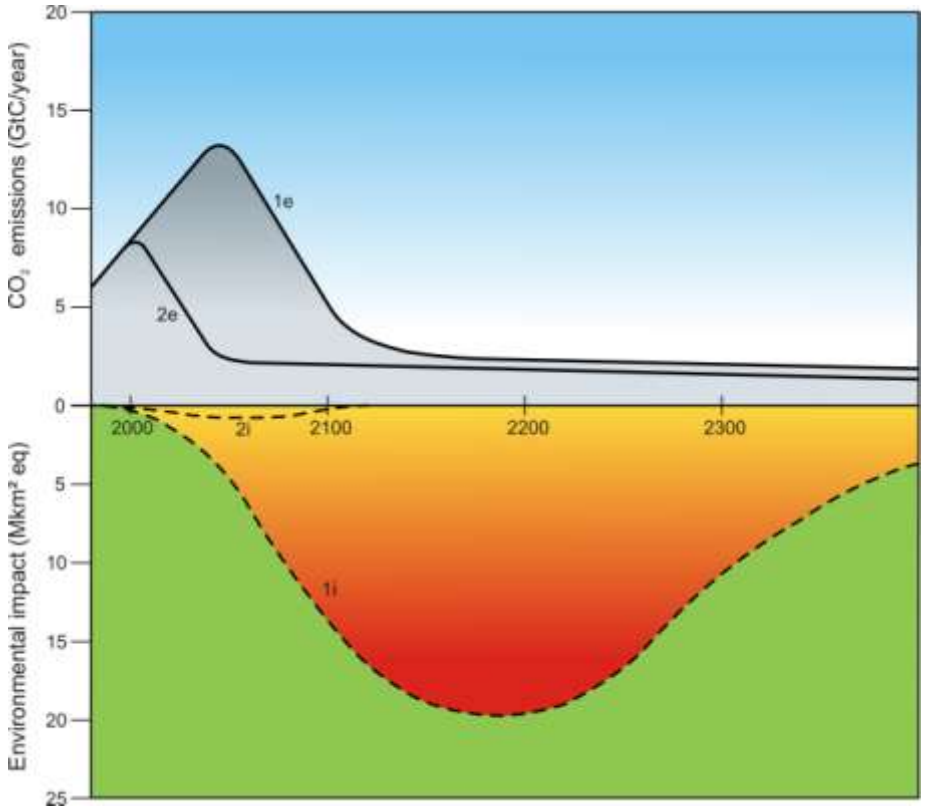

Figure *A.4.1. Two trend scenarios for carbon dioxide emissions and estimates of their environmental impacts as a function of time.*

In reference scenario 1, about 680 more gigatons of carbon (C) or 2,500 more gigatons of carbon dioxide (CO_2) are emitted into the atmosphere than in scenario 2. The introduction of this additional carbon occurs over an approximately 80-year period.

In the reference scenario, the maximum environmental impact is assumed to be -20 million km² eq. and the total environmental impact 5,000 million km² eq. x years. In the second scenario, environmental impact is assumed to remain below a significant level.

The maximum environmental impact would thus be 20 Mkm² eq./2,500 Gt CO_2 =
-8 km² eq./Mt CO_2

The total environmental impact is 5,000 Mkm² eq. x v/2,500 Gt CO_2 =
-2 km² eq. x years/kt CO_2

Investment in clean energy production or energy saving measures reduces carbon dioxide emissions by 7,000 tons a year per megawatt if it is assumed to replace coal-fired power plant capacity. If investment is made in the current decade, the savings from avoiding the 70-year transition period amounts to 500 kt CO_2/MW.

For the maximum environmental impact, savings average +4 km² eq./MW relative to the reference scenario.

For the total environmental impact, savings average +1,000 km² eq. x years/MW

Environmental impacts accumulate exponentially as a function of carbon dioxide emissions. Thus, lowering the peak of curve 1 has a huge positive environmental impact. Moreover, even if carbon dioxide emissions cut by only a third from that in the reference scenario, the total environmental impact is reduced to a fraction from that in the reference scenario. In accordance with the law of diminish returns, further reductions in carbon dioxide emissions as large environmental benefits.

This also has a basis in game theory. If others cut emissions first, then it diminishes pressure on those who delay as the harms of climate change takes longer to materialize and are manifested in more subdued forms.

Benefit analyses for the Vuotos hydropower project and off-shore wind farms

The Vuotos hydropower project would produce about 350 GWh of clean electrical power during periods of high demand, which converts to an average of 40 MW. From this, we obtain the following environmental benefit (I):

I= 40 MW x 1000 km² eq. x years/MW = +40,000 km² eq. x years

In other words, the benefit is an order of magnitude larger than the harm. The Vuotos power plant would produce adjustment electricity during periods of peak demand long into the future. According to the IPCC, the environmental impacts of carbon dioxide emissions are the greater the longer cuts are postponed.

Moreover, the peak-power generation capacity of the Vuotos hydropower plant could compliment other clean energy projects, such as the construction of two 100 MW offshore wind farms (average power 35 MW) by supplying the power grid during peak demand when wind conditions are poor.

The environmental benefit of cutting carbon dioxide emissions for one 100 MW offshore wind farm, assuming it is built immediately, would be:

I = +35 MW x 1,000 km^2 eq. x years/ MW = +35,000 km^2 eq. x years

The benefit is three orders of magnitude greater than the harms from producing the steel for the turbines and masts, construction work and operation. The benefit must extend beyond the assumed life of the wind farm. In other words, the planned 50-year service life of the wind farm must be extended either through maintenance, by building a new wind farm in place of the old one, or by finding other ways to compensate for the lost production.

In Finland's sea territories it is easy to identify shallow areas suitable for construction of around 5,000 MW of wind turbine capacity, generating electricity at a reasonable price by European standards. Wind power generated at this scale, however, needs to be supported at peak-demand times by an adjustment source, for example traditional hydropower or pumped hydropower.

The environmental administration had resisted the Vuotos artificial lake project with all possible means including the Commission card. In 2002 The Supreme Administrative Court decided, after considering also EU directives, that the creation of the artificial lake would cause so large harmful environmental changes in the area that it denied the permit in accordance with article 2, clause 5 of Finland's Water Act.

In light of the above calculations, the ruling of the Supreme Administrative Court decision on the Vuotos project is quite interesting. The environmental benefits alone appear to be an order of magnitude greater than the harms. There would have also been large economic and social benefits in the area suffering from high unemployment. The law also says that there should be a comparison of benefits and harms in permit consideration.

Given the above discussion, it is also worth noting that the Ministry of the Environment blocked the start of construction on a small offshore wind farm by issuing a demand for a complete EIA (see Chapter 6). The examples illustrate the administration's attitude towards rapid and positive measures to cut carbon dioxide emissions.