One Man's Carbon is Another Man's Bread: Further Understanding Differences in the Structure of Carbon Emissions

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In previous work, we summarized a new method for comparing carbon emissions from various countries. We call this the "mine-yours" comparison. In this paper, we provide details of the comparisons methodology, and carry out the comparison on a number of IEA countries. We calculate the average energy intensities **I** for a sample of countries ("yours") and multiply them by structural parameters **S** for a particular country ("mine"). Comparing the results with the vector **IS** product for the country in question gives us an estimate of how much energy that country would use with its own intensities but with average structural conditions. The converse can be calculated as well, that is, own structure and average intensities. Emissions can be introduced through the **F** term. The entire exercise can be carried out bilaterally as well. Results can be expressed on a per capita basis, or per unit of GDP. These calculations show where differences in the components of emissions lead to large gaps among countries, and where those differences are not important. These differences are important for negotiating changes in emissions.

We show which components cause the largest variance in emission by sector. In households, home size, average winter climate, and space heating energy intensity appear to be the most important differentiating characteristics. In the service sector, built area per capita and the mix of inputs used to generate electricity are the most important factors. In manufacturing, output per capita and the energy intensities of individual branches are the key differentiating factors. In personal and freight transportation, total activity (in passenger- or tonne-km) is by far the most important distinguishing feature, but the energy intensity of travel or freight, particularly that of automobiles, is also important.

Interestingly, in freight and in manufacturing, some important features appear to interact and offset each other. Several countries with very energy intensive manufacturing output mix (Sweden, Norway, Canada) also rely heavily on hydro or nuclear power, which lowers significantly emissions per unit of output. Similarly, the largest countries (Canada, U.S. Australia) have the highest levels of freight activity per unit of GDP, but these also have the smallest shares of carbon-intensive trucking, which offsets somewhat the influence of the geographical feature. Finally, the coldest

countries tend to have the most efficient space heating. Thus careful analysis of emissions by sector reveals many characteristics that offset each other.

Overall, GDP differences account for the largest part of differences in per capita emissions among IEA countries. Energy intensities, structural differences (including winter temperatures), and utility fuel mix share about equally in explaining the differences in the carbon/GDP ratios among countries. Individual binary comparisons can show extremes, however. Norway, with more than 40% of its primary energy in the form of hydroelectricity and most of the rest in the form of oil, is far less carbon intensive (with average or even above-average energy intensities) than w. Germany, which has lower energy intensities but much more carbon-intensive fuels. Because some of the differences are "built in" – geography, climate, natural resources endowment – we conclude by questioning whether uniform emissions reductions targets make sense. Indeed, the "mine-yours" tool provides a valuable guide to important ways in which emissions may or may not be flexible. The tool does not prove that Country "A" can copy Country "B'. but it does provide insights as to where to look for carbon reductions based on international comparisons.