Decoupling environmental pressures from economic activity, evidence from OECD data

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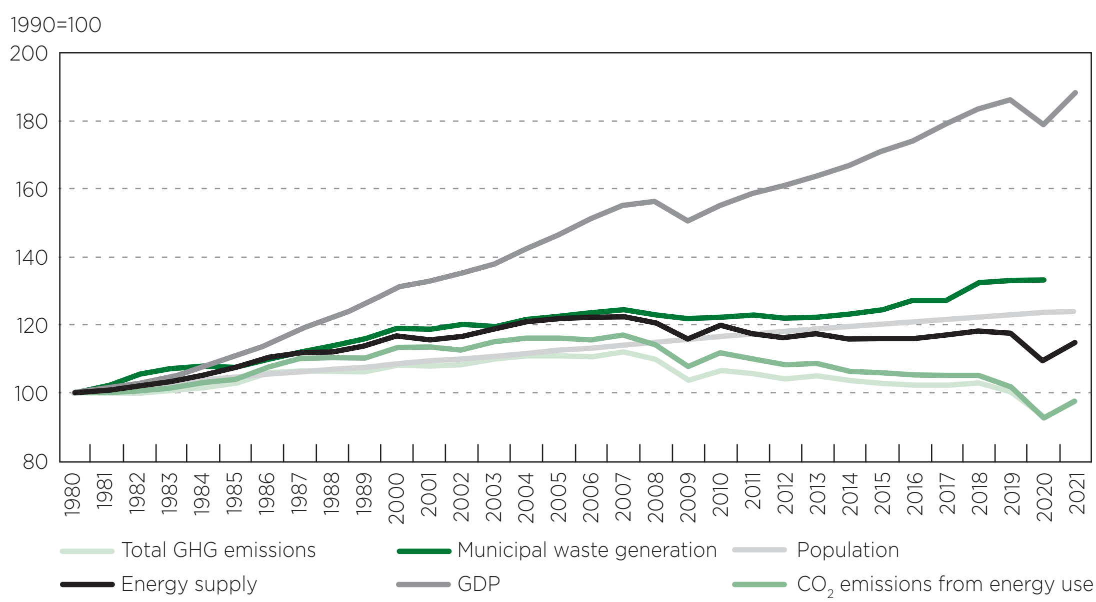
The golden question facing our societies today is how to continue expanding our economic welfare, well-being and shared prosperity, while reducing the ensuing environmental pressures. This is where decoupling comes in. *Decoupling* refers to de-linking our resource-hungry economic activity from the environmental pressures it generates, which can follow two paths. As long as GDP remains a good proxy for shared prosperity, decoupling GDP growth may be relative to the inputs it requires, such as energy, materials, and other natural resources; or it may be relative to the outputs it produces, such as GHG emissions, air pollutants and waste, which have direct impacts on human well-being.

The idea of decoupling environmental pressures from economic growth –one of the main objectives of the OECD Environmental Strategy for the First Decade of the 21st Century– is to implement structural changes to create a circular and more sustainable economy that can stand the test of time, outgrowing itself and its own impacts.

Such structural changes to improve productivity –the driver of green GDP growth– include using less resources and improving the quality of goods produced. Taking the example of organic farming, the same product can become more sustainable by being produced with less water, synthetic nutrients and brown energy, while at the same time being more

FIGURE 1. OECD COUNTRIES SHOW A MIXED DECOUPLING PERFORMANCE.
Decoupling trends in the OECD area, 1990-2021



Source: OECD (2023), OECD Environment Statistics (database).

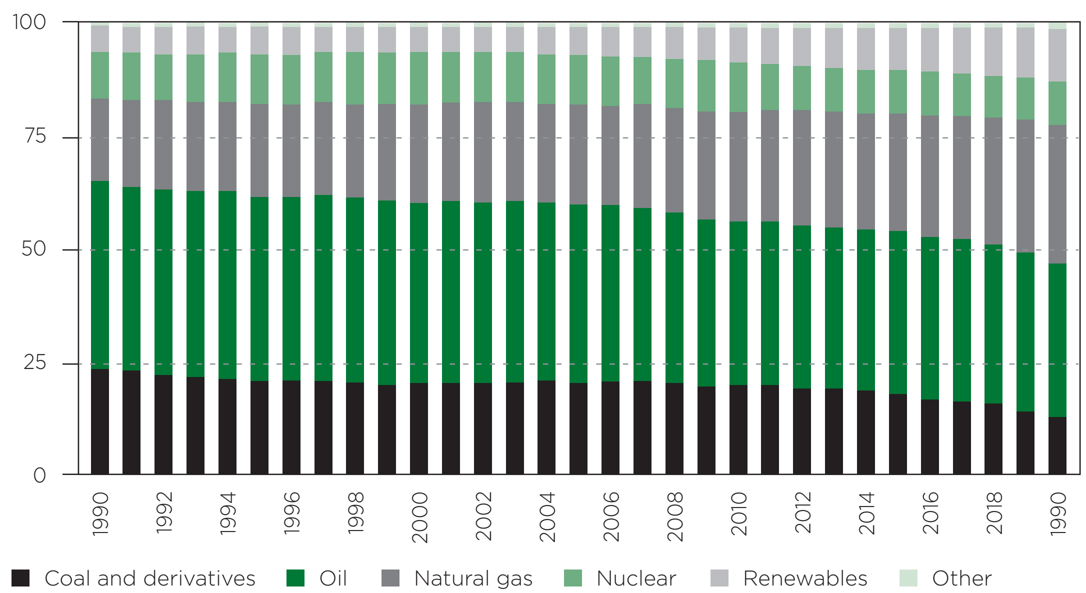
highly valued through its increased quality and use of environmentally friendly agricultural techniques. This article explores the links between inputs and outputs to create a more circular and sustainable economy.

Evidence from the OECD area over the past three decades shows that decoupling GHG emissions from economic growth is not only possible, but well on its way. Relative decoupling between GDP and GHG emissions has taken place at least since 1990. Indeed, the growth rate of GDP, indicated with the grey line, is faster than the growth rate of GHG emissions, indicated with the blue line (Figure 1). Since the Great Financial Crisis of 2008, a new phenomenon emerged: the absolute decoupling of emissions from GDP growth, with emission growth slowing down as GDP continued to grow. More generally, we distinguish relative decoupling when environmental pressures grow, albeit at a slower rate than GDP, from absolute decoupling when environmental pressures decrease in real terms (in volumes). While both cases indicate a more efficient use of resources, absolute decoupling is preferable to restore and secure resources over the long term.

The reasons behind this welcome development are twofold: energy efficiency has improved, meaning our activities require less energy than they used to, and we have begun to significantly substitute GHG-emitting fossil fuels with renewable fuels. Both these factors have been at play, proof of which is the decreasing energy supply –around the time that emissions did so too– as well as the simultaneous increase in the share of renewables in the total energy supply, matched with a sharp decrease in coal production from 2010 onwards (Figure 2 and Figure 3).

Energy production and consumption is responsible for roughly 80% of GHG in OECD

FIGURE 2. ENERGY SUPPLY MIX. Percentage of total energy supply, OECD, 1990 – 2020



Note: Total energy supply (TES) is made up of production + imports - exports - international marine bunkers - international aviation bunkers ± stock changes. Primary energy comprises coal, peat and peat products, oil shale, natural gas, crude oil and oil products, nuclear, and renewable energy (bioenergy, geothermal, hydropower, ocean, solar and wind). Electricity trade is included in total energy supply, but excluded from the calculation of the breakdown by source.

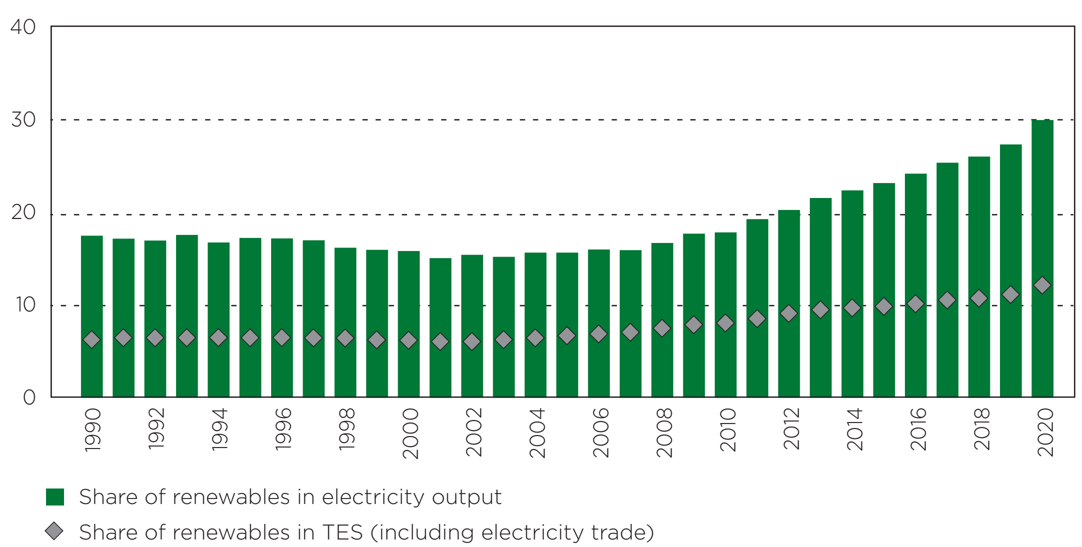
Source: OECD calculations based on IEA, "World energy statistics", IEA World Energy Statistics and Balances (database), https://doi.org/10.1787/data-00510-en.

countries (OECD, 2023[1]) mostly in the form of CO_2, and to a much lesser extent CH_4. Three patterns are visible between 1990 and 2020. The decrease of coal in the energy mix, from 22% to 15%, is explained by a shift from coal to natural gas (Figure 2). This was driven by two reinforcing factors. One is the transformation of the electricity asset production base. The second is the increase of natural gas for heating purposes. Coal-fired and natural gas-fired power plants have a similar function in the electricity system. They can be used for the base load, as well as for the peak load. Reactors can quickly be turned on to respond to peak demand. Coal-fired power plants emit more than twice the amount of CO_2 per kilowatt-hour of electricity produced than natural gas plants.

A second pattern in the energy mix is the gradual decrease of oil the mix, from 41% to 37% over this period. This is driven by two forces: one from the transport sector, and a second from industry. The consumption of motor gasoline peaked in 2004, with a shift to diesel powered engines. Motor and gasoline consumption for transport has been plateauing since 2005, displaying even a slight decreasing trend in volume over the period 2005-20. This is mostly explained by increasing efficiency of vehicles, rather than a drastic behavioural change. In industry, the recourse to different oil derivatives and products was substituted over time. This is the case for fuel oil which main purpose is heating of industrial facilities or homes. It was replaced either by natural gas or by reuse of lost heat in industrial processes.

A third pattern of the energy mix is the gradual increase of renewables from 6% to 10%. Historically, biofuels are the main renewable fuel, including wood fuel. While not the largest source of renewable energy, solar and

FIGURE 3. PERCENTAGE OF RENEWABLES IN ELECTRICITY OUTPUT AND TOTAL ENERGY SUPPLY. OECD, 1990 – 2020



Note: Total energy supply includes electricity trade. Renewables include hydro, geothermal, solar (thermal and PV), wind and tide/wave/ocean energy, as well as combustible renewables (solid biomass, liquid biomass, biogas) and waste (renewable municipal waste). The underlying data on "renewables and waste energy supply (ktoe)" are obtained from the World - Renewable and Waste Energy Statistics dataset of the IEA Renewables Information Statistics Database. Data on Total Primary Energy Supply (TPES) are obtained from the IEA database on World Energy Statistics and Balances.

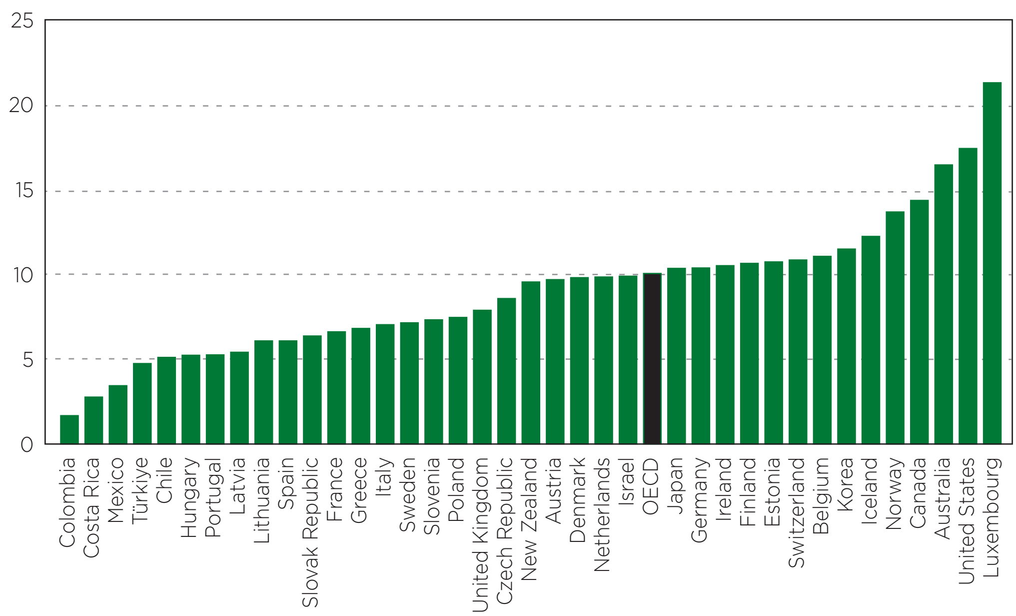
Source: OECD, "Green growth indicators", OECD Environment Statistics (database), https://doi.org/10.1787/data-00665-en, based on IEA data.

Absolute decoupling of waste generation from GDP growth is yet to become a reality, as there is both a degree of higher efficiency and higher substitution that can be built upon

wind experienced an increase in electricity production from 2004 onwards, with the early 2000s marking the ramping-up of support to the development of renewable electricity with feed-in tariffs.

As for waste, the past three decades have seen a relative (rather than absolute) decoupling, with municipal waste generation continuing to increase as our societies grow, albeit at a slower rhythm. Alarmingly, from 2016 onwards, waste generation has increased faster than population growth, being a source of concern. Here, the same story applies as with emissions: decoupling can be achieved through higher efficiency in our material consumption and generation of waste, and through better substitution of non-renewable products with renewable products, by recycling. Absolute decoupling of waste generation from GDP growth is yet to become a reality, as there is both a degree of higher efficiency and higher substitution that can be built upon.

FIGURE 4. DEMAND-BASED CO_2 INTENSITY PER CAPITA. Tonnes of energy-related CO_2 per capita, 2020



Note: Demand-based CO_2 intensity is calculated as CO_2 emissions per capita (tonnes/person). Included are CO_2 emissions from combustion of coal, oil, natural gas and other fuels. The estimates of CO_2 emissions are obtained from the IEA's database of CO_2 emissions from fuel combustion. Default methods and emission factors are given in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Population is the de facto population in a country, area or region as of 1 July of the year indicated. The main source of population data is the World Population Prospects database from the United Nations, complemented with data from the World Development Indicators of the World Bank.

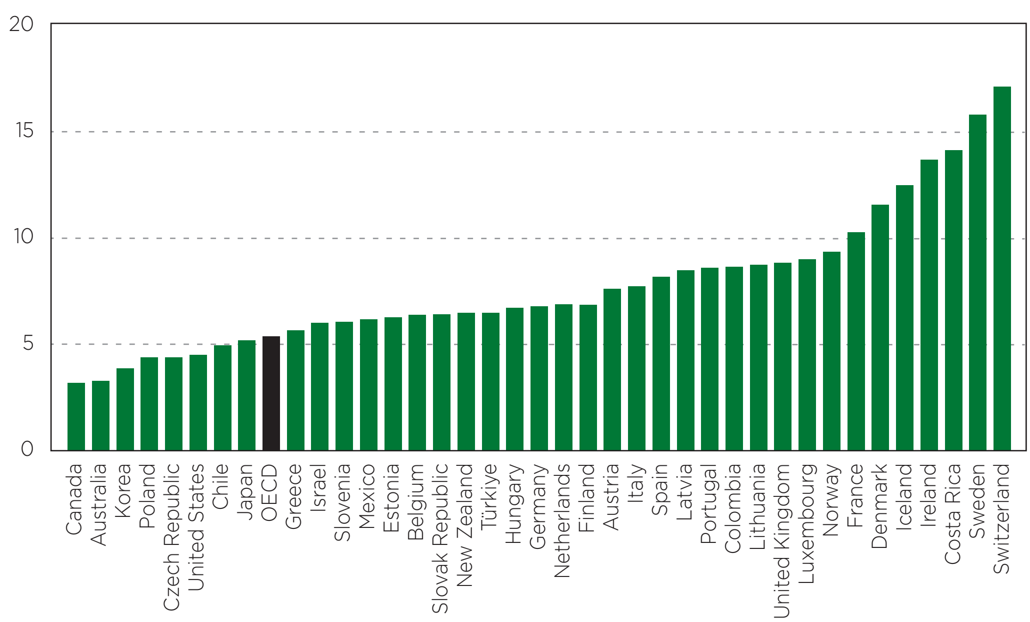
Source: OECD, "Green growth indicators", OECD Environment Statistics (database), https://doi.org/10.1787/data-00665-en, based on OECD and IEA data.

The picture of an economy's use of resources can be further developed by separating out demand-based from production-based indicators (Figure 4 and Figure 5). Demand-based indicators include environmental flows that are embodied in imports, and deduct those embodied in exports, providing insights into the net (direct and indirect) environmental flows resulting from domestic final demand (the "footprint" approach). In contrast, production-based indicators capture environmental flows generated by direct domestic production and consumption.

Energy is not the only input our economies use to work, neither are GHG emissions the only environmentally harmful outputs produced. Other materials come into play. Indicators on material consumption give a broader perspective on the variety and quantity that we use for our daily economic activities. Materials are classified in four main categories: biomass, fossil energy materials, metal ores and non-metallic minerals. Metals are used in a growing number of applications: digital technologies, renewable energy technologies, and electric vehicles to name a few. Non-metallic minerals are important inputs for the construction sector, among others, for example to produce cement. Likewise, fossil energy materials for non-energy uses are diverse, including road construction with bitumen, or glass with plastics.

Domestic material consumption (DMC) is a measure of the total amount of materials directly consumed in an economy by businesses and households, comprising domestic extraction plus imports minus exports. Integrating the

FIGURE 5. PRODUCTION-BASED CO_2 PRODUCTIVITY. GDP per unit of energy-related CO_2 emissions (USD/kg), 2020



Note: Production-based CO2 productivity is calculated as real GDP generated per unit of CO2 emitted (USD/kg). Included are CO2 emissions from combustion of coal, oil, natural gas and other fuels. The estimates of CO2 emissions are obtained from the IEA's database of CO2 emissions from fuel combustion. Default methods and emission factors are given in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Gross Domestic Product (GDP) is expressed at constant 2015 USD using PPP.

Source: OECD, "Green growth indicators", OECD Environment Statistics (database), https://doi.org/10.1787/data-00665-en, based on OECD and IEA data.

trade balance is important to take into account possible outsourcing or border linkages. The material footprint extends this notion by considering indirect flows of materials extracted abroad that are necessary to satisfy domestic final demand.

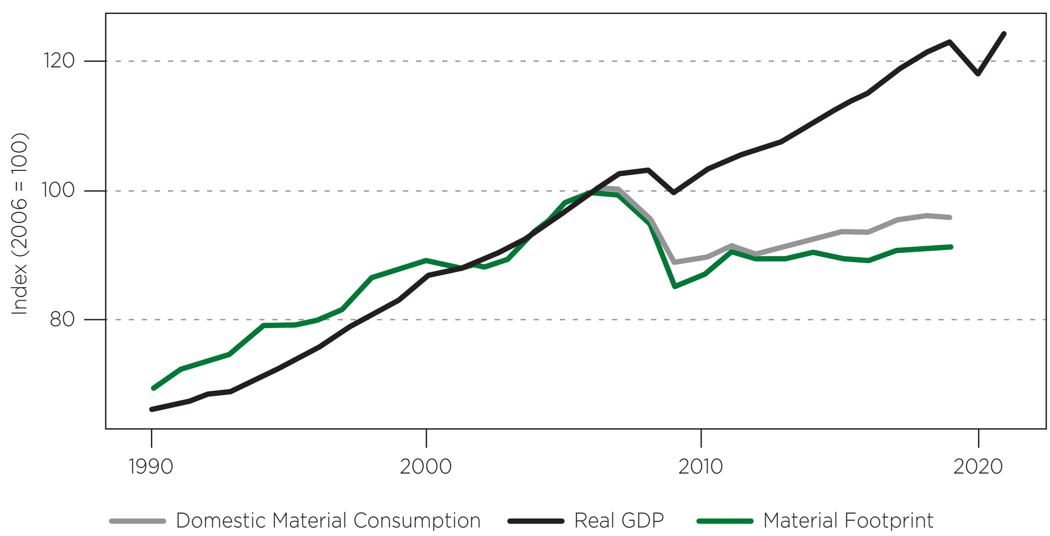
We observe a decoupling between GDP and DMC in the OECD from the Great Financial Crisis onwards (Figure 6). While real GDP grew by more than 20% between 2006 and 2019, DMC diminished by 4% over the same period. This is mostly driven by the decreased use of non-metallic minerals, which still composed 40% of DMC in 2019 in the OECD, and fossil fuel carriers, that composed close to a quarter of DMC in 2019.

Decoupling is more pronounced between GDP and material footprint, suggesting a decoupling of the full value chain, as this accounts for the indirect supply of materials for final products, as well as lasting gains in productivity both domestically, abroad and between trade partners.

Statistics on materials consumption are an important piece in the puzzle, and the monitoring of progress made in the sustainable use of natural materials can be strengthened and generalised by continuing to develop materials accounts. This calls for, among others, the systematic integration of natural material inputs into accounts, as well as linking these accounts to industry classifications, to identify the progress made by different economic actors over time.

If we are serious about reaching our climate and sustainability targets, while meeting the needs of every person, present and future, absolute decoupling of economic growth from its use of resources and its emission of environmental harms is a logical necessity. Green growth considers not only the short-term, but also the medium- and long-term, meaning that it is not only GDP which must be tracked, but also measures of sustainability. The need for sustainability in our systems becomes more apparent than ever in the face of price and geopolitical volatility, against which decoupling can ensure a degree of, and thus stability in growth, underlying the well-being of our societies. ●

FIGURE 6. DOMESTIC MATERIAL CONSUMPTION, MATERIAL FOOTPRINT AND REAL GDP. Index base 2006 = 100, 1990-2021, OECD



Source: OECD (2023), "Material resources: Material resources", OECD Environment Statistics (database), https://doi.org/10.1787/data-00695-en.