

ENERGY FOOTPRINTS

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Although the entire human population exists on just one planet, we act and consume as though we have multiple earths at our disposal. Ecological Footprint accounts break down how humanity's actions degrade bioproductive land, leaving future generations without the resources we currently utilize and enjoy. Perhaps we should begin to reduce the global ecological footprint with its biggest source: the fossil fuels sector, a factor with important environmental, sociological, and political implications. Decreasing or even eliminating dependence on fossil fuels and turning towards renewable energy sources offer a great opportunity to shrink humanity's footprint to a size the earth can support.

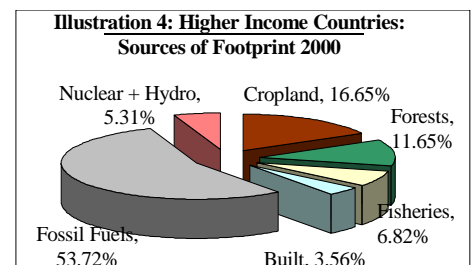
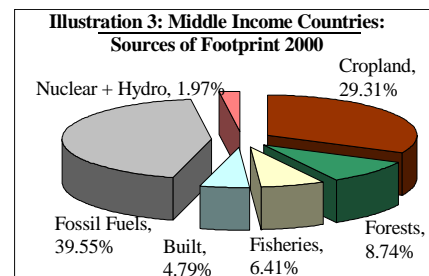
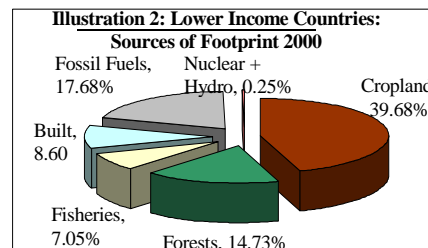
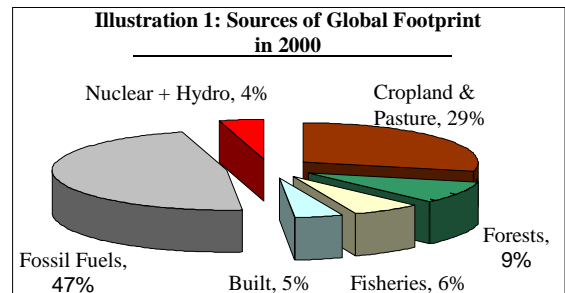
FOSSIL FUEL FOOTPRINTS: LARGER THAN LIFE

The widespread transition to fossil fuels (coal, oil, and natural gas) from pre-industrial to industrial times has resulted in global overshoot, or overstepping natural boundaries by extracting resources and creating waste at rates that exceed the earth's capacity. Despite radical local and regional ecological changes from pre-industrial societies, the human economy only surpassed global limits when fossil fuel use exceeded ecologically sustainable rates and induced the expansion and intensification of extractive industries like agriculture and forestry.

The burning of fossil fuels creates greenhouse gases such as carbon dioxide that contribute to the worsening problem of climate change. Assuming that the primary problem with fossil fuel use lies in the rate at which the earth can absorb carbon dioxide emissions, we can measure in terms of how much land we would need in order to absorb emissions. If we deduct the amount absorbed in the oceans and use a generous sequestration rate of 0.95 tons carbon per hectare per year, a reforested area of over 6 billion global hectares (gha) would be needed to balance current emissions. Over half of our land would have to be used for carbon dioxide absorption, as the total bioproductive land mass amounts to only 10.6 billion gha. However, since we still need land for other uses, such as agriculture and development, our fossil fuel use seems unsustainable.

One could approach fossil fuel sustainability as though fossil fuels were renewable resources similar to water or light. In those terms, we would need one hundred global hectares per person every year to have enough land to regenerate fossil fuels at humanity's rate of consumption. With a global population of 6 billion, current fossil fuel consumption rates would be 50 times the earth's biocapacity. This method provides a footprint 100 times greater than the aforementioned carbon sequestration method, proving that the amount of and control over fossil fuel supplies is even more problematic than the pollution emitted. Thus, fossil fuels are indeed non-renewable as we will deplete the supply completely if we continue to rely on them as a major resource.

IN A GLOBAL CONTEXT: IS THE U.S. CONSUMING MORE THAN ITS FAIR SHARE OF FOSSIL FUELS?



On a global scale, the burning of fossil fuels accounts for the largest portion of the Ecological Footprint. The very high amounts of coal, oil, and natural gas consumption in the wealthier regions of the world heavily influence this global pattern. In contrast, nearly half of the Footprint in lower income countries is attributable to the utilization of cropland, not fossil fuels (Illustrations 1-4).

Is there a correlation between Ecological Footprint and economic income/consumption? In looking at countries in 2000, the answer seems to be yes.¹ This is not surprising given that gross domestic product (GDP) and energy use tend to be highly correlated, and globally Footprints are dominated by fossil fuel consumption. Thus, highly industrialized countries must be held accountable for a large portion of the fossil fuel footprint and therefore the global footprint.

Illustration 5 shows the skewed ratio of the United States' energy production and consumption versus its share of world population. Comparisons to other regions of the world are exhibited in illustration 6.

Illustration 5: U.S. Share of the World, 2002

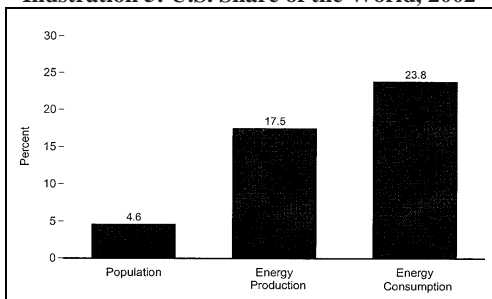
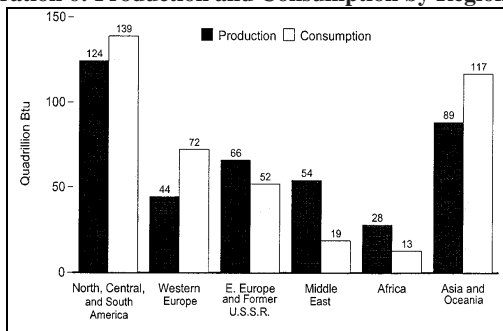


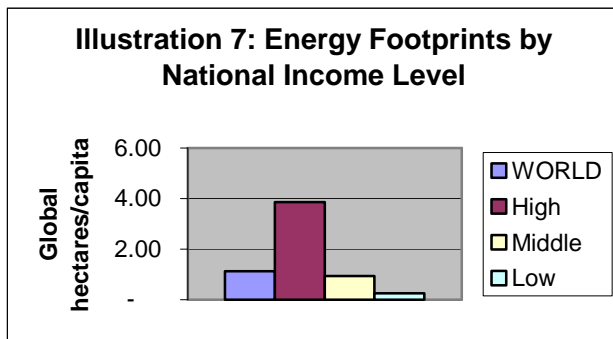
Illustration 6: Production and Consumption by Region, 2002



Although the US represents less than 5% of the world population, it consumes nearly one quarter of the world's energy. The whole world suffers the consequences as the pollution emitted affects everyone on a global scale. Balancing this disproportionate relationship must begin by re-evaluating fossil fuel consumption rates.

In policy terms, this analysis suggests two directions.

First, international cooperation in many areas is clearly important in addressing the distribution inequalities in global Footprints. Illustration 7 exhibits energy footprints by income group, accentuating the disparity between the rich and the poor.



High income countries have per person footprints sixteen times those of low income countries. While it is important that all nations work together to stabilize fossil fuel emissions and to lessen the threat of global warming, the burden rests on higher income countries. The United Nations' Kyoto Protocol stands as the major initiative to reduce global greenhouse emissions, focusing on developed countries.

THE KYOTO PROTOCOL

On February 16, 2005 128 nations became legally bound to the Kyoto Protocol. The voluntary treaty asks countries to work together to reduce greenhouse gas emissions on a global scale. By the year 2012 developed nations must reduce combined emissions to below their 1990 levels and can trade allowances in order to meet their goals. The only industrialized nations that have yet to sign the treaty are Australia, Liechtenstein, Monaco, and the United States. Australia and the U.S. have claimed they have no plans to participate, despite their responsibility for one-third of the industrialized world's greenhouse gases. As a leader in global issues as well as fossil fuel consumption, US ratification of the agreement would pave the way towards environmental change simply due to the sheer amount of fossil fuel emissions that would be eliminated from the atmosphere. The framework for this international treaty was modeled after the Montreal Protocol, an agreement that limited the ozone damaging greenhouse gases of chlorofluorocarbons (CFCs) and hydrochloroflourocarbons (HCFCs). The Montreal Protocol success shows that the world can work together to combat environmental issues if everyone cooperates.²



Second, local efforts are necessary to reduce resource use on a smaller geographic scale. Higher income communities may invest in renewable energy sources instead of relying on fossil fuels. Source reduction, or using less of a resource overall, also remains the number one method for reducing any type of Footprint. Implementing more efficient public transportation systems, offering incentives for green energy use, and investing in research and development are all methods of contributing to Footprint reduction.

EVERYONE HURTS

Fossil fuel use results not only in adverse environmental problems but also social and political issues. Oil has risen in global prominence to become the largest primary energy source, causing serious debates and conflicts over resource management and control. Finite resources create tension in a world where everyone competes for their use. Stripping ourselves from dependence on oil could potentially decrease competition over resources in foreign affairs and calm debates over choices for drilling sites in domestic affairs.

High energy consumption contributes to other problems that affect individuals as well as the world. Fine particulates and gases that are emitted in the burning of fossil fuels worsen asthma and other respiratory problems. Climate change has already caused crop damage, severe weather, and increased heat strokes. The potential dangers of extreme climate change can cause disastrous effects on nature that can lead to dire consequences.

SOLUTIONS EXIST

Using electricity from renewable "green" sources like wind, solar, and small-scale hydropower substantially reduces Ecological Footprints. Exact measurements remain undetermined as technology continues to develop and renewable energy sources remain an insignificant percentage of all commercial energy. However, current estimates show that using renewable energy lessens Footprint size dramatically³.

Alternatives to fossil fuels currently exist, each with their advantages and disadvantages. Each renewable source of energy has a reduced footprint as seen in table 1. However, barriers to large-scale implementation make viability difficult. Improved storage and distribution mechanisms are needed to

Actions needed to reduce energy consumption and CO2 emissions:

- Increase the use of energy-saving technologies; eliminate wasteful energy consumption in transport, industry, and the home.
- Increase the supply of energy from sources which reduce or eliminate pollution, especially renewable sources such as solar and wind.
- Assist lower-income countries to invest in sustainable energy technologies.
- Increase energy prices to cover the full environmental costs of energy use, and remove government subsidies on energy.
- Use energy dividends from higher prices to restore ecological and social damage caused by energy consumption.
- Stop deforestation and promote reforestation of deforested areas in an ecologically and socially appropriate manner.

alleviate logistical problems; moreover, the idea of changing infrastructure (such as converting pipelines to transport new sources of energy) increases resistance. Technology advances and further understanding of the benefits make renewable energy sources a strong possibility for the future. One example, photovoltaic power, can reduce energy Footprints dramatically.

Table 1: Ecological Footprints of Power Production

ENERGY SOURCE	FOOTPRINT (global hectares/megawatt)
Coal	1,903
Natural Gas	1,053
Hydroelectric	46
Wind	21
Photovoltaic	221

Photovoltaic arrays (PV), or solar power, can deliver an impressive energy output without compromising bioproductive areas. One hectare of PV panels can deliver the thermal energy contained in 100 tons of oil annually. PV arrays covering a square 160 km on each side could supply the electricity demand of the United States. With a national population of 280 million people, this amounts to 0.01 ha/cap. In order to provide energy for the entire global population, PV panels must cover 310 km, leading to a mere 0.002 ha/cap. These panels could rest atop buildings already in place or in sunny, arid regions such as deserts, thereby reducing Footprints on bioproductive land.



ICELAND'S HYDROGEN FUEL ECONOMY

Change is possible. In 2002 Iceland announced its decision to rid itself of dependence on fossil fuels by transforming the basis of its economy to hydrogen fuel. This plan, which the country expects to complete over the next 30 years, hopes to reduce Iceland's carbon dioxide emissions by up to 50%. Infrastructure will change to accommodate automobiles, and all ships in the large fishing industry will operate on hydrogen fuel. The country hopes to serve as a model for sustainability for the rest of the world.⁴

SUCCESS STORIES

Efforts have been made to implement alternative energy throughout California. California's Energy Commission is currently reviewing a bill requiring that twenty percent of the state's energy be from renewable sources by the year 2010. Los Angeles' governor has signed into action a bill of the same intentions by the year 2017.

In 2001 San Francisco voters overwhelmingly agreed to have the city match the nation in the amount of solar panels installed on rooftops annually. They approved a \$100 million bond towards this project and hope to see other cities in the United States follow suit.

Table 1: California Green Schools Savings SUMMARY OF ESTIMATED NO-COST SAVINGS

Name of District, School	Period	Kilowatt hour Savings	Dollar Savings	% Savings
Rialto Unified School District				
Bemis Elementary School	9/02 – 8/03	229,159	\$38,461	30%
Myers Elementary School	9/02 – 8/03	37,530	\$6,874	10%
Dixie School District				
Mary Silveira Elementary School	3/02 – 6/03	15,211	\$3,277	7%
Oakland Unified School District				
Bret Harte Middle School	3/02 – 6/03	49,272	\$7,540	7%
James Madison Middle School	1/03 – 6/03	27,294	\$3,818	15%
Ross Valley School District				
Manor School	3/02 – 6/03	19,528	\$4,418	16%
Southern California Private				
Ambassador Christian School	9/02 – 8/03	20,168	\$3,758	15%
West Contra Unified School District				
DeAnza High School	3/02 – 6/03	42,975	\$6,654	4%
Mira Vista Elementary School	3/02 – 6/03	12,790	\$2,158	7%
TLC/North Campus	10/02 – 6/03	10,503	\$1,594	7%

The California Green Schools Program, run by the Alliance to Save Energy, has already managed to save schools all throughout the state thousands of dollars in energy savings. Participating schools have boasted increased awareness on saving energy,

student and teacher action, improvements to energy efficiency at the schools and the students' homes, and savings in energy bills. Students become involved in energy audits and discover ways to reduce energy costs in their schools and homes. Table 1 shows the amounts that just some of the schools in the San Francisco Bay Area saved in 2003.

CHANGE CAN HAPPEN

Ultimately, the global Footprint is comprised mostly of the fossil fuel Footprint of highly industrialized countries such as the United States. One of the most important steps societies can take towards sustainability lies in freeing themselves from dependence on fossil fuels and turning towards more sustainable resources, both in small scale ventures and in large scale economies. Using renewable resources remains a viable option we must work towards before depleting the fossil fuel supply. Technology allows us the opportunity to reduce our footprint dramatically, yet we must first understand the developments as advancements and improvements and invest in their futures. Transition to renewable energy sources can only lead to smaller footprints, healthier conditions, less strained political relations, and a better sense of stewardship towards the earth.

¹ A strong correlation was found between per capita Gross Domestic Product and per capita Ecological Footprints for 134 countries in 2000. A bivariate regression on per capita Footprints and GDP resulted in a 0.14 adjusted R-square at a 0.01 significance level. Both findings suggest a positive relationship between economic activity measured by GDP and Footprints.

² For more information on the Kyoto Protocol and the status of US ratification, please visit the US Energy Information Administration at <http://www.eia.doe.gov/oiaf/kyoto/kyotobrf.html>

³ Updated from Wackernagel et al., "Tracking the ecological overshoot of the human economy," *Proceedings of the National Academy of Sciences*, **99** (2002). Numbers do not add due to rounding.

⁴ BBC news <http://news.bbc.co.uk/1/hi/programmes/newsnight/archive/2208013.stm>

