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Accepting Responsibility for Impacts of Consumption

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Accepting Responsibly for Impacts of Consumption

Executive Summary

In this Consuming Responsibly series we have highlighted a number of ways individuals can reduce the environmental impacts of their consumption. Because purchasing, use, and end-of-product life decisions have a significant effect on the environmental and social consequences of consumption, making an effort to understand consequences of decisions, and then acting upon that understanding so as to minimize negative impacts, is the essence of responsible consumption.

But there is one more critically important element of responsible consumption: accepting responsibility for the environmental impacts of those things we consume. The fact is that everything we purchase or use invariably impacts the environment. This is especially evident in extraction and processing of basic raw materials used in producing buildings, vehicles, electronics, and other products of all kinds. Steadfast citizen resistance to domestic raw material extraction, coupled with high levels of consumption and low rates of materials recovery and recycling, has resulted in a massive shift of consumption-related impacts to locations outside the borders of some of the most developed countries – and the United States in particular.

Because the environmental and social impacts of consumption often occur distant from where finished goods are used or consumed, high consumption brings with it a responsibility to understand the impacts of that consumption, to recognize that exporting impacts through resource importation often magnifies environmental and social impacts, and to understand that resource needs are growing all over the world. Responsible consumers should also be willing to accept a level of domestic environmental and social impact commensurate with domestic levels of consumption, while also doing everything they can to reduce the impacts of their own consumption.

Beyond environmental and social issues, there is another reason for citizens of economically advanced nations to modify behavior regarding raw materials sourcing. At the same time that many advanced countries have been increasing raw materials import reliance, the global economy has been expanding at about double the rate of population, a trend attributable in large part to rapidly rising consumption of goods of all kinds in countries other than those with the most advanced economies. The result is steeply increasing consumption of basic resources globally, as well as rising competition between nations for these resources. Consequently, high import reliance is an increasingly risky strategy.

In this report we examine global trends vis-à-vis consumption and basic materials demand, discuss U.S. net import reliance for basic raw materials and reasons for this situation, and point to specific things that individual consumers can do to both reduce and take greater responsibility for impacts of their consumption. This report focuses on non-fuel minerals and metals, although other resources are also referenced.

Consumption Has Consequences

When you pick up your knife and fork in preparation for attacking a T-bone steak you probably don't think about the source of metals used in making the utensils, the quantity of energy expended, or the ingenuity and sweat of the miners who extracted the ore. It is also unlikely that you think about what went into creating the plate, the steak, the ice in your drink, the table they sit on, or the floor beneath. We tend to take these things for granted. Yet, each of us consumes vast quantities of wood, metals, non-metallic minerals, plastics, glass, food, energy, textiles, and other resources each year.

Recent trends have added a new wrinkle to raw material demand. Climate change-driven efforts to convert the global vehicle fleet from internal combustion to electric drive vehicles is forecast to have a substantial impact on metals consumption. Significant increases of consumption of aluminum, copper, cobalt, graphite, lithium, nickel, and titanium are expected. Expanding production of electric vehicles, vehicle batteries, power generating windmills, solar collectors, and vehicle charging stations will all result in sharp increases in metals consumption. Additionally, continued efforts to reduce vehicle weight is accompanied by greater use of magnesium and aluminum alloys, as well as use of petroleum derivatives to produce lightweight carbon fiber reinforced components.

The process of gathering and processing raw materials – including the collection and processing of materials for recycling – results in environmental impacts. This is true of all categories of materials, though for some the impacts are far greater than for others. And, extraction of new raw materials generally leads to greater impacts than recovery of materials for recycling.

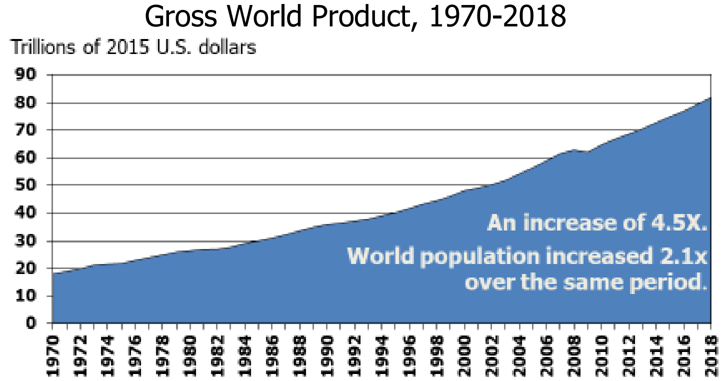
The fact is that virtually all of the products each one of us uses every day have their origins in mining, forest harvesting, or agriculture. Like it or not, we all depend heavily on the labor and ingenuity of people engaged in mining, drilling, logging, farming, and fishing. And while, for the most part, care is taken to minimize or mitigate the effects of these activities on the environment, each of these things, nonetheless, results in impacts to the environment.

Population, Economic Growth Drive Consumption Globally

The rate of population growth is slowing around the world. As of June 1, 2020, the world population was 7.8 billion, about 78 million more than a year earlier, an increase translating to about 215,000 each day. The annual increase of 78 million is about the same as in 2000, but roughly 6 million fewer than in 2010. Increases in population are occurring primarily in low and lower middle income countries.

The global economy is growing as well, and at a much more rapid rate. For instance, between 1970 and 2018, a period in which world population slightly more than doubled, the global economy expanded by a factor of 4.5X in real terms (i.e., in constant dollars) (Figure 1).

Figure 1
Gross World Product, 1970-2018



Source: United Nations Statistics Division (2020)
(http://unstats.un.org/unsd/snaama/dnllist.asp)

As documented by the late Dr. Hans Rosling[1], the economic fortunes of countries all across the income scale have been steadily rising for over 70 years, translating to good news for billions. Poverty and hunger have declined, health care has improved, educational opportunities for both boys and girls have expanded, electricity and clean drinking water have become more widely available, and the rates of vaccination against infectious diseases have risen.

Economic expansion has also served to realign differences in economic well-being of world regions and individual countries – a realignment that is ongoing. For instance, between 2000 and 2020 the economies (as measured by Gross Domestic Product, or GDP) of both high and middle-income countries expanded. However, particularly rapid economic growth in the middle-income countries increased the percentage of global GDP attributable to these countries. The high income countries as defined by the World Bank (see text box) accounted for less than 20% of world population in 2000, but 83% of the world gross domestic product (GDP). The middle income countries, in which 75% of the world population resided, accounted for only 16% of global GDP. However, by 2017 the share of the global economy attributable to the high income countries had dropped to 64%, while that of the middle income countries had grown to 35% (Figure 2). This is a remarkable shift over a period of less than two decades.

The World Bank classifies countries as low, lower-middle, upper-middle or high income based on an annually updated threshold of Gross National Income (GNI)[1/] per capita; the low and middle income countries are referred to in the World Bank (and elsewhere) as "developing countries."

Current thresholds (July 1, 2020) are as follows: (Dollar figures are GNI per capita expressed in US dollars)

Low income - < $1,320

Lower-middle income - $1,036-$4.045

Upper-middle income - $4,046-$12,535

High income - >$12,535

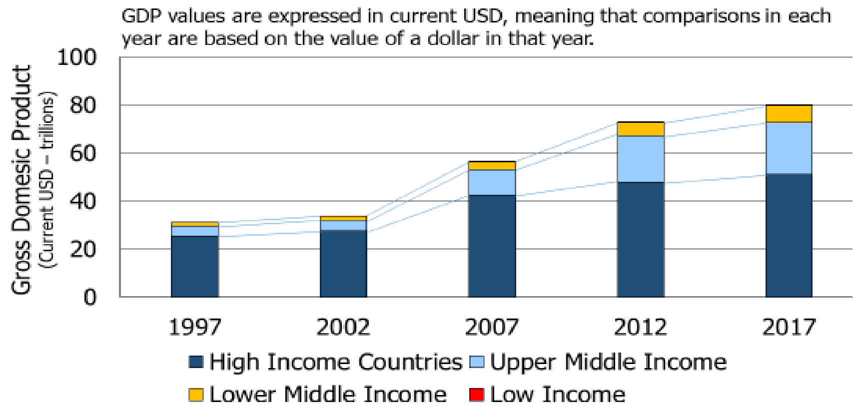
In comparison to the World Bank, the United Nations has no formal definition of developing countries, but still uses the term for monitoring purposes, classifying as many as 159 countries as developing. Under the UN's current classification, all of Europe and Northern America, along with Japan, Australia and New Zealand are classified as developed, and all other regions are classified as developing.

The terms "emerging countries" or "emerging market countries" are also sometimes used. The fundamental difference between countries classified as emerging and those classified as developing is that emerging countries are growing in economic terms much more rapidly than other countries in the developing classification and becoming more important in world economics.

[1/] GNI is the total income earned by a nation's people and businesses in a given time period, including investment income, regardless of where it was earned. It also includes money received from abroad, such as foreign investment and economic development aid. Gross domestic product (GDP), in contrast, is the total value of goods and services produced in a country in a given time period.

[1] Rosling (2011, 2019)

Figure 2
Share of Global Economy Attributable to Country Groups by Income Level, 1997-2017

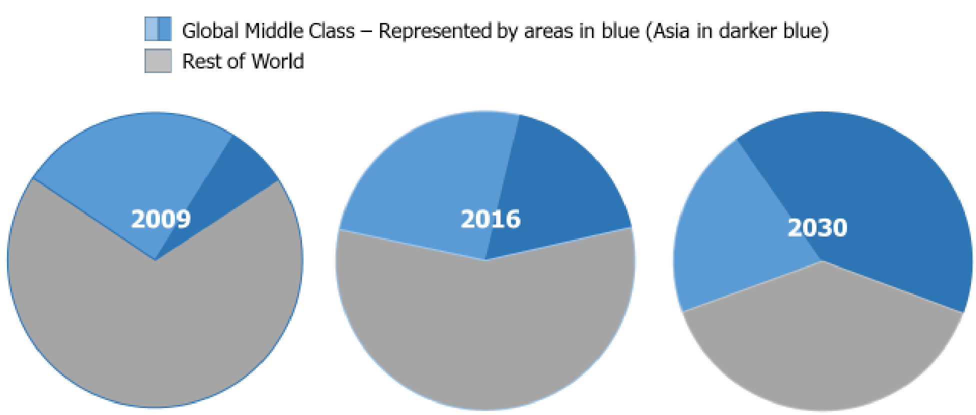


Source: World Bank (2019)

Expanding Consumption of Raw Materials

In addition to increasing contribution to the world economy, middle income countries have experienced a remarkable expansion of the numbers of people who are part of the middle class, which by most estimates will accelerate in the relatively near term. As pointed out by Dr. Homi Kharas, "People are moving much faster from being 'vulnerable' to being in the middle class (5 people per second) than from middle class to being classified as 'rich' (0.5 people per second) as of early 2019." He pointed out that this is leading to a fast-growing global consumer class.[2] The global middle class, which was composed of 1.8 billion people in 2009, grew to 3.2 billion by 2016, and is expected to reach 4.9 billion in 2030 (Figure 3). By that 2030 date, only a decade from now, Asia is expected to represent about 66% of the global middle-class population and 59% of middle class consumption, compared to 28 and 23%, respectively, in 2009.[3]

Figure 3
Percent of World Population Included Within Economic Middle Class



Source: Graphic developed based on Kharas (2017)

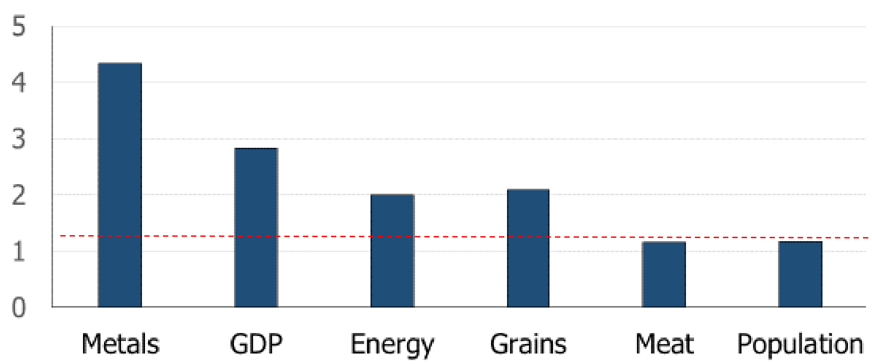
[2] World Data Lab (2019)
[3] Kharas (2017)

In view of the fact that the global economy is expanding at more than twice the rate as population, it is not surprising that the rate of world consumption growth is increasing. Rising populations and economic expansion translate to rapidly growing capacity to consume food, fuel, housing, and durable and non-durable goods of all kinds.

Middle class consumption in developing countries increased from 25% of global consumption in 2009 to just over half of global consumption in 2015, and is expected to reach 70% by 2030.[4] An example of what this kind of expansion translates to in real terms can be seen in vehicle ownership patterns. During the span of a single decade (2004-2014), the number of vehicles per 1,000 people doubled in countries of the Asian Far East, tripled in Indonesia and India, and increased five-fold in China. In other world regions largely classified as economically developing, vehicle ownership rates rose 50-75% in the decade ending in 2014.[5]

The result of rapidly growing consumer spending is rapid growth in consumption of basic materials to support that consumption (Figure 4). For example, the average annual rate of growth for metals during the two decades following 1997 was almost four times greater than the rate of population growth, and greater even than the combined rate of growth of gross domestic product (GDP) and population. Growth in consumption of both energy and grains was significantly greater than the rate of population growth during that period.

Figure 4
Global Commodity Average Annual Demand Growth (Percent) 1997-2017
(Red dashed line is average annual population growth over that period)



Source: World Bank (2018). Meat data from OECD/FAO (2018).

Data for some of the most used materials illustrates a long history of rising and accelerating consumption. Even though the efficiency of raw materials use is steadily improving, and recycling is more and more common, consumption of basic raw materials continues an upward trend. Focusing on some of the materials used in greatest quantity illustrates that world consumption of steel, aluminum, cement, plastic resins, and wood ranged from 2 to 42 times greater in 2018 than in 1960 (Table 1). In other words, consumption of all these materials, except for wood, grew more rapidly – and in several instances far more rapidly – than population. Per capita consumption, therefore, increased.

Not shown in Table 1 are fossil fuels, the consumption of which in 2017 was 4.3 times greater than in 1960. Over this same time period, consumption of petroleum increased by a factor of 4.8 times. Again, consumption has grown, and continues to grow, much more rapidly than population.

[4] Kharas (2010, 2017)
[5] U.S. Department of Energy (2018)

Table 1
World Growth in Consumption of Principal Raw Materials,
1960-2018
(**Population growth during this period: 2.5x**)

Crude Steel*	Cement	Aluminum	Plastics	Industrial Roundwood**
5.4x	**18.6x**	**16.4x**	**42.2x**	**2.0x**

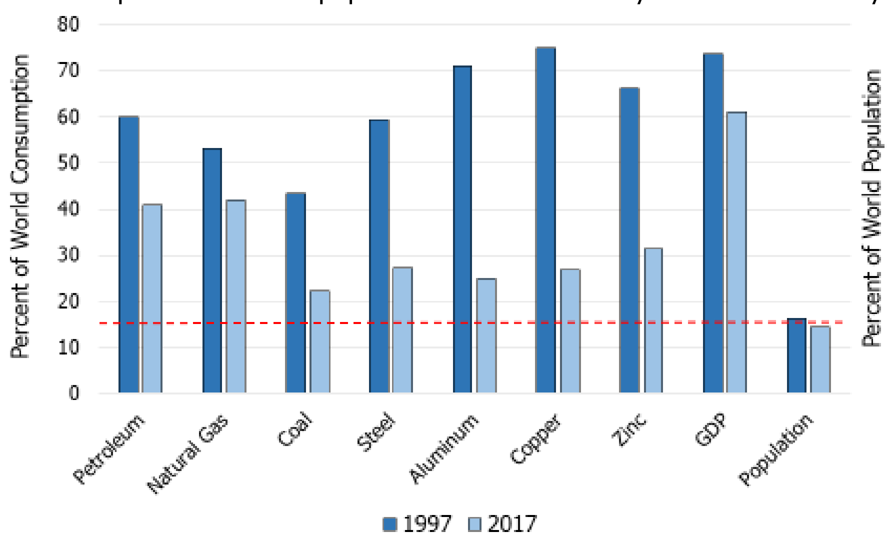
* Crude steel is the first solid steel product upon solidification of molten steel. Two-thirds of crude steel production is from iron ore.

**Industrial roundwood is that part of the annual timber harvest which is used in producing goods such as building materials, furnishings, paper, and other wood products.

Source: Data for wood from FAO (2020); for cement from Morgan (1986) and from PR Newswire (2020); for aluminum from the Institute of Geological Science (1966) and from the British Geological Society (2020); for steel from the International Iron and Steel Institute (1978) and from the World Steel Association (2019); and for plastics from Plastics Europe (2016) and the Association of Plastics Manufacturers in Europe (2019).

Throughout the twentieth century, consumption of basic resources was concentrated in a very small number of countries which collectively accounted for a small fraction of world population. Even as late as 1997, advanced economies[6], which together comprised 16.3 percent of the global population, consumed over 50 percent of global energy and about 70 percent of the total quantity of global metals consumed in that year (Figure 5). However, a trend of more rapid economic

Figure 5
Advanced Economies Share of World Consumption of Basic Energy and Mineral Resources, 1997 and 2017
(Red dashed line is percent of world population accounted for by advanced economy countries)



Source: World Bank (2018). Data for steel from International Iron and Steel Institute (2002 and 2019) for years 1997 and 2017.

[6] Economies classified as advanced by the IMF in 2017 included the United States, Puerto Rico, Canada, all of the countries of western and northern Europe, six countries of eastern Europe (Slovak Republic, Lithuania, Slovenia, Latvia, Estonia, Czech Republic), Iceland, Singapore, Japan, Taiwan, South Korea, Hong Kong, Macao, Australia, New Zealand, and Israel.

growth in developing than in developed countries, that had been quietly taking place for at least several decades, came into full view following the turn of the century. As explained by the World Bank, over the 20 years following 1997 "the structure of global commodity demand fundamentally changed." By 2017, the share of advanced economy energy consumption had dropped to about 40 percent from over 50, and the share of metals consumption had declined by more than half, from about 70 to around 30 percent – a stunning shift over the short span of just two decades.

Much of the shift that has taken place is attributable to the emergence of China as an economic power. Indeed, four-fifths of the increase in global metals consumption, and half of the increase in global energy consumption that has occurred over the past several decades is attributable to China.[7]

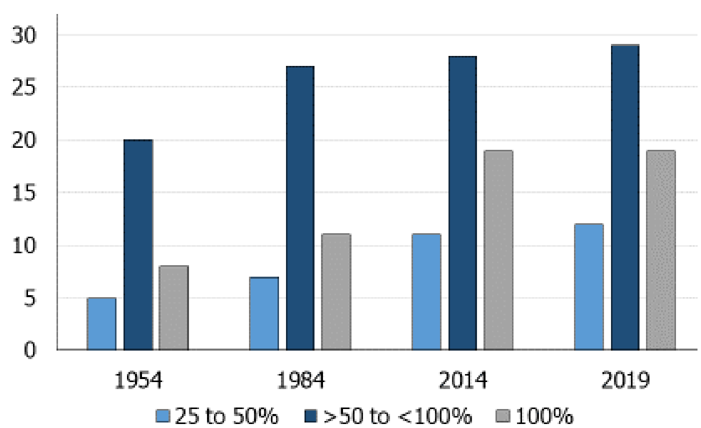
To summarize, consumption of basic resources is growing rapidly, driven to a large extent by rising consumption of goods of all kinds in countries other than the advanced economies. This trend is expected to continue. One projection indicates levels of demand for metals and non-metallic minerals of 250% and 230%, respectively, by 2060 as compared to 2011, as well as increases in fossil fuel and biomass consumption relative to 2011 on the order of 170%.[8]

A Pattern of Importation

Recent Past and Present

Of 94 metals, metalloids, and non-fuel minerals reported by the U.S. Geological Survey (USGS), the U.S. in 2019 was a net importer (i.e. imports exceeded exports) of 78 of them, including 33 of 35 minerals deemed critical to U.S. national security. For almost two-thirds of minerals which are imported on a net basis, net imports were 50% or more.[9] In the mid-1950s the U.S. was a net exporter of minerals; since that time the number of non-fuel minerals on the net import list has grown steadily as has the degree to which the U.S. relies on net imports (Figure 6). The European Union has a similar import dependence.[10]

Figure 6
U.S. Non-Fuel Mineral Net Import Reliance, 1954-2019
(Number of minerals on net import list by magnitude of import reliance)



Source: USGS (2015, 2020)

[7] World Bank (2018)
[8] OECD (2018)
[9] USGS (2020)
[10] European Innovation Partnership on Raw Materials (2018)

The net import numbers take into consideration trade flows of basic minerals, mineral ores, and resources contained within parts and semi-finished products, but do not take into account raw materials contained and involved in production of finished products. Were these counted, net imports of most materials would be even greater than indicated by USGS figures.

The National Academy of Sciences studied imports and exports of several nations, including the United States, focusing on raw material equivalents (RME) of traded goods, including finished products. A central finding was that RMEs of finished goods tend to be several times greater than the volume of raw materials actually traded, and that for economically advanced economies the raw RMEs of imports is substantially greater than for exports. For the United States, the RME of finished product imports was determined to be about 3 times greater than that of exports. The study also found that in absolute values, the United States is by far the largest importer of primary resources embodied in trade.[11] By any measure, the U.S. is a net importer of raw materials, and on a massive scale.

Why Net Imports

The United States is a net importer of basic raw materials on a grand scale, in part, because some of those resources don't occur within the boundaries of the U.S., or because they can be obtained at less cost than domestically. Still other basic materials flow to the U.S. as a result of citizen resistance to domestic resource extraction. On the whole, the U.S. is not resource poor and is not necessarily a more expensive place in which to procure basic materials. On the net import list are minerals of all kinds, including key raw materials used in alternative energy development, and principal structural materials used in building construction (steel, cement, and timber).

Resource Availability - As to mineral resources, which are massively supplied to the U.S. as net imports, some types of minerals are imported because they do not occur within the boundaries of the country. For the most part, however, domestic occurrence is not an issue. In this regard the U.S. Geological Survey observed in 2017 that:

> "*A common misconception is that the United States must import mineral commodities because no domestic resources exist. In general, the United States does not lack mineral resources*. *For example, it* [the U.S.] *has resources of 43 mineral commodities with high NIR* [net import reliance]." [12]

Cost - Mining tends to be focused in those places in which the economics of minerals extraction is most favorable. Factors contributing to favorable economics include easy access to ore deposits (i.e., shallow deposits) and transport networks, ore concentration and quality of ore[13], proximity to markets, political stability, policy certainty, skilled workers, low energy and labor costs, and costs of regulatory compliance. High cost in one or more of these areas can have a major influence on where mining takes place. In this regard, the U.S. is attractive for mining investment based on some factors, but not so based on others.

Permitting Processes, Regulations – A major factor discouraging mining activity in the U.S. is policy uncertainty regarding permitting and regulation. A report from the Stanford Institute for Economic Policy Research noted that the U.S. ranked first in the world for longest mine permitting

[11] Wiedmann et al. (2015)

[12] Lederer and McCullough (2018)

[13] Ores in which metals of interest make up a high percentage of the overall weight are referred to as high quality ores; lower quality ores contain lesser percentages of metal.

delays, citing intertwined bureaucratic layers of governance at federal and state levels and persistent litigation brought by groups opposed to mining activity.[14] Another investigation of prospects for domestic mining of critical rare earth materials found that ". . . the earliest any new rare earth mine could begin production in the United States would be within the next 7-10 years" and that litigation might result in even longer delays. The result of such delays and uncertainty, it was found, was to deter mining investment in the U.S.[15] The U.S. Geological Survey explains the importance of policy certainty in the context of mining project costs by noting that "The overall financial attractiveness of a potential venture depends on all the costs and risks (e.g. regulatory or policy uncertainty) associated with the project."[16] A number of additional studies and reports point to the same issues.

Strategies for Reducing New Materials Extraction

Both greater efficiency of materials utilization and recycling/reuse are important components of the national and global raw materials picture.

Increasing Resource Use Efficiency

Improvement of materials use efficiency is a goal pursued on a daily basis by industries all over the world. Competitive pressures alone act as a constant incentive for business and industry to provide goods and services at lower cost, often translating to improvements in materials use efficiency and reduction of waste.

It is competition-driven incentives that have led to increasingly lighter and less resource intensive computers and other electronic products, vast reductions in the thickness of steel and aluminum beverage cans and plastic bottles, reduced basis weights of paper products, development of lightweight structural concrete, orders of magnitude improvements in voice and data transmission capacity from previous use of copper wire to use of thinner and lighter optical fiber, and so on. While all of this is quite impressive, sharp growth in metals consumption is occurring despite these gains.

The U.S. Department of Energy, in its *Critical Materials Strategy*,[17] advocated greater investment in research and development in a number of areas, including magnets, motors and generators, batteries, photovoltaics, lighting, and materials processing, with a goal of increasing materials use efficiency. A need for greater investment in development of environmentally better ways to mine and development of substitutes for certain critical materials was also highlighted.

Recycling

Recycling is likewise important. In the U.S. in 2017 62 million tons of municipal solid waste (MSW) were recycled. Materials recovered included metals, paper, plastics, glass, textiles, rubber, leather, and more, with recovery and recycling directly reducing demand for virgin raw materials. However, while this number might be viewed as impressive, U.S. recycling of MSW (35%) is lower than in other economically advanced countries, and further progress in materials recovery from trash for reuse and recycling is needed.[18] Within global manufacturing industries there is considerable room for increasing recycling rates. A 2011 global study[19] of recycling rates for 60

[14] Ghorashi et al. (2011)
[15] Clagett (2013)
[16] Lederer and McCullough (2018)
[17] US. Department of Energy (2010)
[18] Bowyer et al. (2020)
[19] Graedel et al.(2011)

metals and metalloids[20] revealed that while end-of-life recycling rates of the most commonly used metals (including iron, aluminum, copper, nickel, zinc, lead, manganese, cobalt, and gold) are above 50%, recycling rates for most other metals are far below that. Of the 60 metals examined, recycling rates for over two-thirds were less than 50%, and for over one-half of them, less than 1%. Recovery and recycling rates are particularly low in the electronics industry.[21] At present, technical and economic issues are the primary barriers to recovery for reuse.

The finding that so many metals are not being recovered for recycling, and at a time when global competition for minerals is rapidly rising, is the basis for the UNEP/OECD initiative to reduce resource consumption, especially within high consuming nations, and to achieve closed-loop recycling of resources.[22] Referred to as "decoupling" or, in some circles "dematerialization,"[23] the idea is to uncouple rising consumption from needs for more and more new resources, relying instead on resource recovery and reuse and technological advances to increase efficiency of materials use. The end goal is a drastic reduction in extraction of new raw materials within the relatively near term.

In this regard there is considerable activity within the private sector to find solutions. As just one example, Apple Corporation has developed a robot which disassembles the Taptic Engine from iPhones to better recover key materials such as rare earth magnets and tungsten. All iPhone, iPad, Mac, and Apple Watch devices released in the past year are made with recycled content, including 100 percent recycled rare earth elements in the iPhone Taptic Engine — a first for Apple and for any smartphone.[24]

A Summary of the Current Situation

Despite a slowing rate of population growth, human numbers continue to increase. Increasing as well is the size of the global economy, and at a much more rapid rate than population. Both of these things contribute to rising consumption of food, energy, clothing, shelter, and durable and non-durable goods of all kinds – and to increasing consumption of basic raw materials despite ongoing advances in material use efficiency and recycling.

As these trends play out, the U.S. – one of the world's greatest per capita consumers of resources of all kinds – is a net importer of basic raw materials as well as finished products on a massive scale, with recent trends toward even greater import dependence. And this is the case despite capacity for greater reliance on domestic resources.

That the magnitude of importation is as great as it is, and is continuing to increase, is in large part due to citizen resistance to domestic resource extraction, with objections almost always based on environmental concerns. Relatively low rates of materials recovery and recycling at both the industrial and consumer level contribute to the level of materials importation.

But resources must come from somewhere. So when local actions succeed in preventing resource extraction or heavy industry, the effect is not to stop these activities, but to simply shift them to some other location – often magnifying impacts in the process. That this is often the outcome of processes ostensibly designed for the purpose of protecting the environment is ironic.

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[20] Metalloids are elements that have properties of both metals and non-metallic minerals, and include boron, silicon, germanium, arsenic, antimony, tellurium, and polonium.

[21] Bowyer et al. (2018)

[22] Fischer-Kowalski et al. (2011)

[23] Smil (2014)

[24] Apple Corp. (2020)

But there are reasons other than ethics that require self-examination of current practices. Many of the raw material exporting countries, long characterized by low per capita incomes and consumption, are now experiencing rapid economic growth – growth that is improving the lives of billions while also sharply increasing global consumption of basic raw materials as well as competition for them. These realities, coupled with changing global demographics, suggest a need to rethink the relationship of the most economically advanced countries to the rest of the world vis-à-vis sourcing of needed raw materials.

What Individuals Can Do

Solutions to large-scale importation of basic raw materials will require involvement of business and industry, government, academia, and society at large. But involvement of the public is critical to success. The importance of an informed citizenry cannot be overemphasized. There is much that an individual can do to contribute to long-term solutions. These include:

- Giving serious thought to global implications of consumption, and of local, regional, and national environmental policies and decisions which serve to transfer impacts of local consumption elsewhere.
- Taking steps to learn more about the world beyond our nation's borders.
- Seeking opportunities for informed, rational discussion about population, consumption, and global equity issues.
- Participating fully in community recycling and electronics take-back programs.
- Encouraging elected officials to pursue greater recycling program participation and success.
- Supporting shifts in public policy which would reduce uncertainty and delays in permitting processes for resource extraction, provide incentives for greater industrial materials recovery and recycling, and stimulate greater research and development aimed at materials efficient design, materials reuse, and development of substitutes for high impact materials.
- Supporting federal and state funding of research and education focused on environmentally safe minerals extraction.
- Thinking carefully before offering your support to initiatives designed to thwart domestic resource extraction.
- Reconsidering support of environmental organizations which routinely demonize resource procurement and consistently seek to block domestic activity without addressing the displacement of those impacts or associated consumption patterns.

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