Re-Thinking the Future

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Abstract: The first Industrial Revolution marked a step change in resource use. Since then there have been significant technological changes accompanied by an ever-growing resource use and waste and pollution production. The fourth Industrial Revolution builds on the third Industrial Revolution that was known as the Digital Revolution. The fourth revolution will see more and more people and technologies connected along with advances in techniques, such as robotics. Some believe that this will allow us to improve the way we manage our activities and reduce the environmental impacts. However, evidence shows that environmental impacts are increasing and will continue to do so. In order to reduce impacts a stricter environmental policy is needed. This article will posit that a more fundamental reform is needed. It will show that the problem lies with economic policy. The article will look at how resources for the production of communications media are gathered, the manufacturing process, the resources need to operate them and the disposal practices. It will show that economic policy is causing growth of the media sector and this will require more resources. If there is a serious desire to reduce the environmental impacts of the sector then fundamental economic change is needed.

Key Words: Media Sector, Environmental Impacts, Sustainable Development, Climate Change, Resources, Waste, Pollution, Neoliberal Economics

I. Introduction

Humans have interacted with the environment for many millennia. However, it is in the last 200 years that we have seen a step change in the relationship between humanity and the planet on which we depend. The Industrial Revolution, beginning in the eighteenth century, marked a major turning point in Earth’s ecology and humans’ relationship with their environment. The Industrial Revolution

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dramatically changed every aspect of human life and lifestyles and continues to do so. There are four phases to the Industrial Revolution. The first phase took place from the 18th to 19th centuries in Europe and America. It was a period when mostly agrarian, rural societies became industrial and urban. The iron and textile industries, along with the development of the steam engine, played central roles in the Industrial Revolution. It was during this phase that we saw the growth of cities and increasing urbanization. This continues today and now more than half of the global population lives in cities. It is forecast to grow to 70 percent by 2050. Also during this phase the financial system began to change with a shift in banking practice that has now fulminated in the capitalist system. The second phase, termed the Technological Revolution, took place between 1870 and 1914. This was a period of growth for pre-existing industries and expansion of new ones, such as steel, oil and electricity, and used electric power to create mass production. Major technological advances during this period included the telephone, the light bulb and the internal combustion engine. The third phase, known as the Digital Revolution, refers to the advancement of technology from analog electronic and mechanical devices to the digital technology available today. The era started during the 1980s and is ongoing (Rifkin, 2011). Advancements during this phase include the personal computer, the internet and information and communications technology (ICT). The Fourth Industrial Revolution builds on the Digital Revolution, representing new ways in which technology becomes embedded within societies and even the human body. The fourth phase is marked by emerging technology breakthroughs in a number of fields, such as robotics, artificial intelligence,
nanotechnology, quantum computing, biotechnology, the Internet of Things, 3D printing and autonomous vehicles (Schwab, 2016).

**II. Environmental Policy**

There is not a great deal of evidence that the environment was a major concern for our developing societies. Even after the Industrial Revolution there is little evidence that the environment and our impact on it was a concern. Some scientists such as Arrhenius (1896) had hypothesised that carbon dioxide could impact the climate by making it warmer. But in general concerns about the environment did not really take shape until after WWII. The first major piece of policy was the Clean Air Act in the UK. This was in response to smog in London that was caused by the burning of coal. To deal with this problem the government banned the burning coal of coal in homes, regulated industrial use and phased out coal in transport systems, particularly railways.

This led to increasing interest in the environment. The three most important players in promoting environmentalism were:-

Rachel Carson, whose book Silent Spring, set out the dangers of chemicals on the natural environment (Carson, 1962). Some commentators credit this work as being instrumental in the shaping the Environmental Protection Agency (EPA) in the US. Much of the agency's early work, such as enforcing the 1972 Federal Insecticide, Fungicide, and Rodenticide Act, was directly related to Carson's work (Hynes, 1989).

The writings of Barbara Ward crossed so many disciplines and
interest groups that different people remember her for different things. Environmentalists know her for the book she wrote with René Dubos called Only One Earth: The Care and Maintenance of a Small Planet (published in 1972); also for her seminal contributions to the UN Conference on the Human Environment in Stockholm (also in 1972) and to the concept of sustainable development and how it might be applied (Sattherthwaite, 2006).

Gro Harlem Brundtland, who served as the Prime Minister of Norway, was invited in 1983 by then United Nations Secretary-General Javier Perez de Cuellar to establish and chair the World Commission on Environment and Development (WCED), widely referred to as the Brundtland Commission. The commission, which published its report, Our Common Future, in April 1987, provided the momentum for the 1992 Earth Summit/UNCED, which was headed by Maurice Strong, who had been a prominent member of the commission. The Brundtland Commission also provided momentum for Agenda 21. The commission also gave a definition for the term sustainable development:

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

(World Commission on Environment and Development, 1987, p.27)

In the last 30 years most countries and many organizations and movements have adopted the Brundtland definition of sustainable development and many claim they are using this as a benchmark for policy development. However, Hopwood, Mellor and O’Brien (2005)
point out that many developed world nations and bodies, such as the World Bank and the EU, tend to favor the status quo (see Figure 1). There is evidence of some change but it is very incremental. It also varies between nations and other organizations. It is difficult to assess if there will be a concerted global push for a more sustainable future, but it does seem unlikely.

This interest in sustainable development should be seen as the framework for environmental policy. Generally policy is enacted at the national level. However, there are a growing number of international agreements that are generally aimed at protecting the public commons such as the United Framework Convention on Climate Change (UNFCCC) and the Montreal Protocol that deals with ozone depleting substances. International agreements generally deal with a particular problem.
Whereas at the national, sub-national and the local level environmental policy will deal with a number of problems (O’Brien and O’Keefe, 2014).

Another powerful impact of the Industrial Revolution was urbanisation. There is a long history of city development. However, the Industrial Revolution accelerated the process of urbanisation. Today, more than 50 percent of the global population lives in cities and this is expected to grow to 70 percent by 2025 (UN, DESA, 2015). At the same time the global population is expected to grow from its current level of some 7.3 billion to some 9.6 billion by 2050 (UN, 2012). That means that some 6.7 billion people will live in cities. Currently some 3.6 billion people live in cities. By 2050 the global city population will have grown by some 3 billion people.

Taylor, O’Brien and O’Keefe (2016) argue that cities are demanding. Using Jane Jacobs ‘city first’ theory they also claim that the city demanded the invention of agriculture. As cities grew it was realised that pastoralism could not provision the city and another source of food was needed – agriculture was invented by city demand. Smith (1984) argues that capitalism which developed during the Industrial Revolution demanded two things. First urban space that was produced by an accumulation of labour required to meet the needs of industrialization. Second the ecology where Smith’s production of thesis has defined the production of nature as a historically embedded process and it as a result of bourgeois capitalism, “nature” has become a stand-alone (external) category devoid of human relations.

What essentially has happened is that with increasing industrialism along with population growth and increasing urbanisation has led to a position where cities are having profound environmental impacts. To put it broadly environmental policy is an attempt to address the adverse
impacts of our activities. Environmental policy is about the commitment to the laws, regulations, and other policy mechanisms concerning environmental issues. These generally include air and water pollution, waste management, ecosystem management, maintenance of biodiversity and the protection of natural resources, wildlife and endangered species (Eccleston and March, 2010).

According to the Worldwatch Institute there are now more than 1.7 billion members of “the consumer class”—nearly half of them in the developing world and in 2015 they spent some 40 billion US dollars on household goods and services. A lifestyle and culture that became common in Europe, North America, Japan, and a few other pockets of the world in the twentieth century are going global in the twenty-first. As incomes rise, people are gaining access to a multitude of consumer items associated with greater prosperity:

• In 2015, 1.4 billion households of a total of 1.9 billion owned at least one television set.
• There were 1 billion fixed phone lines in 2015, and another 7.5 billion mobile lines.
• The Internet now connects about 3.2 billion users.

The Institute concludes that we must find ways of curbing excessive consumption (Worldwatch Institute, 2017).

Wackernagel and Rees (1996) developed the concept of the ecological footprint as a way of measuring human demand on nature; that is the quantity of nature it takes to support people or an economy. It tracks this demand through an ecological accounting system. In 2003 Wackernagel founded, with others, the Global Footprint Network (Every year, the Global Footprint Network publishes the National Footprint
Accounts, including the Ecological Footprint and biocapacity for over 200 countries and regions. Wackernagel, Kitzes, Moran, Goldfinger and Thomasl (2006) calculated that in 2002 we were using the equivalent output of 1.2 Earth’s to meet our needs. This varies from country to country. For example, the average Canadian required more than 7.5 average hectares to provide for his or her consumption, whilst the average Italian lived on a footprint almost half that size (4.0 global hectares). The Global Footprint Network estimates that in 2013 we were using the equivalent of 1.6 planets (Global Footprint Network, 2017)

What is clear is that the impact of our lifestyles is having a significant impact on the environment despite efforts by many countries to reduce impacts through environmental policy. Dechezleprêtre and Sat (2014) find environmental regulations can reduce employment and productivity by small amounts, in particular in pollution- and energy-intensive sectors, at least during the transitory period when the economy moves away from polluting activities and towards cleaner production processes. They also find that there is little evidence that they the harm international competitiveness. There can be benefits: the estimated health benefits from the Clean Air Act in the United States are two orders of magnitude greater than the employment costs of the policy.

The European Union (EU) is considered by some to have the most extensive environmental laws of any international organisation. Its environmental policy is significantly intertwined with other international and national environmental policies. The environmental legislation of the EU also has significant effects on those of its member states (Jordan and Adelle, 2012).

Despite this there are examples of where the standards set by the EU
are not being met. In the UK there are reports that the EU has issued a final warning over air pollution standards in 16 areas of the UK including the capital London (Neslen, 2017).

According to the Royal College of Physicians (2016) some 40,000 Britons die prematurely each year from respiratory, cardiovascular and other illnesses associated with pollutants such as nitrogen oxide (NO₂), particulate matter (PM) and ozone. The public health costs have been estimated at £20bn a year, with 6m working days lost each year as a result of the externalised costs of polluting emissions.

One of the main reasons for poor air quality in the UK is the number of diesel engines used in transport in the UK. In 2001 the UK Chancellor introduced tax breaks for diesel cars because they emit less carbon dioxide (CO₂) than petrol-powered cars, but it is now known that they emit other harmful pollutants, known as nitrogen oxides, as well as particulates. A former minister admitted that this was a mistake and that there should be a move to electric vehicles (Hope, 2015).

The diesel engine problem was compounded by the use of ‘cheat devices’ to cut emissions drastically when the car’s computer detected it was being tested. What this meant was that diesel engines emissions were much higher than thought (Carrington, 2015). Matters worsened when in 2013 the World Health Organisation (WHO) produced a report that took a key step forward in the understanding of the health effects of NOx which indicated for the first time that the chemicals were dangerous by themselves and not simply an irritating accompaniment. This mattered because, out in the real world, NOx emissions were stubbornly failing to obey the commands of the politicians’ regulations and fall (WHO, 2013).

According to UNEP (2012) from a global perspective the environment
has continued to degrade during the past decade, and significant environmental problems remain deeply embedded in the socio-economic fabric of nations in all regions. Progress towards a global sustainable future is just too slow. A sense of urgency is lacking. Internationally and nationally, the funds and political will are insufficient to halt further global environmental degradation and to address the most pressing environmental issues—even though technology and knowledge are available to do so.

In the future, the continued degradation of natural resources, shortcomings in environmental responses, and renewable resource constraints may increasingly lead to food insecurity and conflict situations. Changes in global biogeochemical cycles and the complex interactions between environmental problems such as climate change, ozone depletion, and acidification may have impacts that will confront local, regional, and global communities with situations they are unprepared for. Previously unknown risks to human health are becoming evident from the cumulative and persistent effects of a whole range of chemicals, particularly the persistent organic pollutants. The effects of climate variability and change are already increasing the incidence of familiar public health problems and leading to new ones, including a more extensive reach of vector borne diseases and a higher incidence of heat-related illness and mortality. If significant major policy reforms are not implemented quickly, the future might hold more such surprises. This view is supported by the current assessment by UNEP, GEO 6 (UNEP, 2016).

What we are seeing is that the implementation of environmental policy is being held as states are using market approaches to solve the problems that markets have produced. Cubitt (2017) cites the
example of emissions trading where rich and organisations can shift the burden of their polluting to poorer countries without resolving the initial problem. Goldman (2005) argues that green policies by such bodies as the World Bank are political in that they only encourage environmental protection in forms that serve neoliberalism. Neoliberal environmentalism is one of the factors that underpins the fractured nature of global and national environmental management.

We can see the result of poorly enforced environmental policy. The Great Pacific Garbage Patch is not the only marine trash vortex—it’s just the biggest. The Atlantic and Indian Oceans both have trash vortexes. Even shipping routes in smaller bodies of water, such as the North Sea, are developing garbage patches. Such garbage patches occur in areas known as gyres. The area in the center of a gyre tends to be very calm and stable. The circular motion of the gyre draws debris into this stable center, where it becomes trapped. A plastic water bottle discarded off the coast of California, for instance, takes the California Current south toward Mexico. There, it may catch the North Equatorial Current, which crosses the vast Pacific. Similarly was plastics from Asia are drawn in to the Garbage patch. About 80 percent of the debris in the Great Pacific Garbage Patch comes from land-based activities in North America and Asia. Trash from the coast of North America takes about six years to reach the Great Pacific Garbage Patch, while trash from Japan and other Asian countries takes about a year. The remaining 20 percent of debris in the Great Pacific Garbage Patch comes from boaters, offshore oil rigs, and large cargo ships that dump or lose debris directly into the water. The majority of this debris—about 705,000 tons—is fishing nets. More unusual items, such as computer monitors and LEGO’s, come from dropped shipping containers (National Geographic, 2014).
There has also been great loss of human life because of poor environmental standards. At 11.00 PM on December 2 1984, while most of the one million residents of Bhopal slept, the pesticide plant owned and operated by Union Carbide failed releasing some 40 tons of methyl isocyanate gas into the atmosphere. The gas is extremely poisonous and there are estimates of between 10,000 and 20,000 deaths related to the accident. The key point to note is that the plant operated with safety equipment and procedures far below the standards found in its sister plant in Institute, West Virginia (Broughton, 2005).

There are examples of the impact of products we use in our daily lives. One such product is palm oil which is an ingredient that is used in many foods, cosmetic and household products and it is also used as a biofuel. Research by Vijay et al. (2016) reveals regional trends in deforestation associated with oil palm agriculture. In Southeast Asia, 45 percent of sampled oil palm plantations came from areas that were forests in 1989. For South America, the percentage was 31 percent. By contrast, in Mesoamerica and Africa, we observed only 2 percent and 7 percent of oil palm plantations coming from areas that were forest in 1989. Palm oil production has a large impact on biodiversity. According to the charity the orangutan project Indonesia is home to some of the most rich and biodiverse rainforest in the world. It contains over 80 endemic species and some of the world’s most unique and iconic endangered wildlife such as the orangutan, elephant and tiger. In the last 20 years, over 3.5 million hectares of Indonesian and Malaysian forest have been destroyed to make way for palm oil. Almost 80 percent of orangutan habitat has disappeared in the last 20 years. We are losing over 6,000 orangutans a year. There are now only 400 Sumatran tigers left in the world (Orangutan Project, 2016).
Palm oil is increasingly being used as a biofuel. Todts (2017) claims that crop biodiesel – which makes up 80 percent of the market – is, on average, 80 percent worse for the climate than fossil diesel and is increasingly sourced from palm oil. Recently, the European Parliament adopted a resolution on palm oil and deforestation. The resolution, which was adopted with overwhelming support, acknowledges that the EU’s biofuels policy has led to deforestation, land grabbing and the destruction of peoples’ and animals’ livelihoods.

What this is telling us is that our lifestyles are having very adverse impacts on the environment. The greatest threat we face is climate change. Climate change is driven by our use of energy. Access to energy defines our lifestyles. The greater access we have to energy resources the higher our standard of living (O’Keefe et al., 2010). The majority of energy we use comes from fossil fuels.

According to REN21 (2017) fossil fuels accounted for some 78.4 percent of energy production in 2015. However, it should be noted that other sectors that contribute to climate change. Research by Chatham House (2014) finds that consumption of meat and dairy products is a major driver of climate change. Greenhouse gas (GHG) emissions associated with their production are estimated to account for over 14.5 percent of the global total. This is more than the emissions produced from powering all the world’s road vehicles, trains, ships and aeroplanes combined (Bailey, Froggatt and Wellesley, 2014).

Not only do our agricultural practices contribute to climate change they also produce what are termed dead zones. Dead zones occur because of a process called eutrophication, which happens when a body of water gets too many nutrients, such as phosphorus and nitrogen. At normal levels, these nutrients feed the growth of an organism called
cyanobacteria, or blue-green algae. With too many nutrients, however, cyanobacteria grows out of control, which can be harmful. Human activities are the main cause of these excess nutrients being washed into the ocean (Codd, 2000). For this reason, dead zones are often located near inhabited coastlines. According to the Environmental Protection Agency (EPA) in developed countries, such as the United States and nations in the European Union, heavy use of animal manure and commercial fertilizers in agriculture are the main contributors to eutrophication. Runoff from large agricultural fields enters creeks and bays because of rain or irrigation practices (EPA, 2017).

What we are seeing is that there are a number of environmental trends that are harming the environment. Zimmerman (2016) claims that the five most damaging trends are climate change and air pollution, deforestation, species extinction, soil degradation and overpopulation. None of these are easy to address without a collective effort by all countries.

### III. Unintended Consequences of the Fourth Industrial Revolution

The four phases of the Industrial Revolution have introduced technological advances. But as discussed earlier technological advances have often led to unintended environmental degradation. Is the fourth phase likely to further contribute to environmental degradation? The fourth phase is marked by emerging technology breakthroughs in a number of fields, such as robotics, artificial intelligence, nanotechnology, quantum computing, biotechnology, the Internet of Things, 3D printing
and autonomous vehicles (Schwab, 2016). These technologies have great potential to continue to connect billions more people to the web, drastically improve the efficiency of business and organizations and help regenerate the natural environment through better asset management (Marr, 2016). However, it should be noted that the fourth phase will have an increasing dependence on technology. The industry has adverse effects both in manufacture, use and disposal.

IV. Semiconductors

Semiconductors are the basis of the electronics industry. The manufacture of these takes place in fabrication plants or ‘fabs’. There has been a history of outsourcing and offshoring in the industry. There have been accusations of many ‘fabs’ being sweatshops. However, Cubitt (2017) does point that many manufacturers have responded to consumer pressure to ameliorate working conditions. Despite efforts in the last 5 to 10 years to clean up atmospheric emissions, waste dumping and water pollution there are historic emissions of perfluorinated chemicals that will persist in the atmosphere for many thousands of years and have twenty thousand times more impact than carbon on the greenhouse effect (EPA, 2008). Cubitt (2017) claims that many wastes of these plants are composed of carcinogenic materials and others of unknown effects. There is clear evidence that employees in the fabs are contaminated. Further, for female employees that have families then it likely that their children will also be affected. Some 2,200 gallons of water is needed to make the average integrated circuit. Some 1500 gallons of that has to be Ultrapure Water (UPW), it takes 1,400 gallons
of water to make 1000 gallons of UPW. In the US, the materials removed from the water to make the UPW are regarded as toxic waste (Cope, 2009).

The amount of energy being used by the internet is rising rapidly. Data centers are likely to be the fastest growing contributors to greenhouse emissions as there carbon footprint will rise fivefold between 2002 and 2020 (Boccaletti, Loffler and Oppenhein, 2008). However, it should be noted organizations such as Google tend to site facilities close hydroelectric dams and more recently wind farms and Apple builds biomass generators at their new sites. Worthy though this is Carr (2009) argues that the main driver is energy costs as opposed to sustainability in its own right.

Andrae and Edler (2015) have developed scenarios of best, expected and worst, up to 2030 of energy uses ascribed to Communications Technology (CT). The most significant trend, regardless of scenario, is that the proportion of use-stage electricity by consumer devices will decrease and will be transferred to the networks and data centers. Still, it seems like wireless access networks will not be the main driver for electricity use. The analysis shows that for the worst-case scenario, CT could use as much as 51 percent of global electricity in 2030. This will happen if not enough improvement in electricity efficiency of wireless access networks and fixed access networks/data centers is possible. This will be offset if renewable energy production is increased. Despite that the researchers conclude that CT electricity usage could contribute up to 23 percent of the globally released greenhouse gas emissions in 2030.

In terms of waste, each year, the electronics industry - one of the world’s largest and fastest growing - generates up to 41 million tonnes
of e-waste from goods such as computers and smart phones. Forecasts say that figure may reach 50 million tonnes already by 2017. According to UNEP (2015) a staggering 60-90 per cent of this waste is illegally traded or dumped. There are estimates that the price of a tonne of e-waste at around US $500. Following this calculation, the value of unregistered and informally handled, including illegally traded and dumped e-waste ranges from US $12.5 to US $18.8 billion annually.

Exporting hazardous waste from EU and Organisation for Economic Co-operation and Development (OECD) Member States to non-OECD countries is banned. However, UNEP (2015) says thousands of tonnes of e-waste are falsely declared as second-hand goods and exported from developed to developing countries, including waste batteries falsely described as plastic or mixed metal scrap, and cathode ray tubes and computer monitors misleadingly declared as metal scrap.

There is little doubt that electronics has had a significant impact on development. The introduction of new electronic products has had a significant impact on society. Many can now work from home. Products such as Skype allow us to communicate visually and orally to contacts all over the world. There have been improvements to manufacturing processes and this is welcome. However, the massive growth of demand for electronic products is likely to outstrip any gains made in improved environmental performance of individual processes. The following looks at electric vehicles (EVs). Many believe that such vehicles will improve urban environmental performance. In the longer term with the introduction of autonomous vehicles the impact of vehicular transport can be greatly reduced.
V. Electric Vehicles

EVs are becoming increasingly popular and commentators such as Seba (2014) believe that the internal combustion engine is likely to be obsolete by 2025. Other researchers such as Hawkins et al. (2012) researched into the environmental life cycles of both electric and conventional vehicles find that EVs powered by the present European electricity mix offer a 10 to 24 percent decrease in global warming potential (GWP) relative to conventional diesel or gasoline vehicles assuming lifetimes of 150,000 km. However, the researchers find that EVs exhibit the potential for significant increases in human toxicity, freshwater eco-toxicity, freshwater eutrophication, and metal depletion impacts, largely emanating from the vehicle supply chain. The researchers go to point out that in regions where fossil fuels are the main sources of power, electric cars offer no benefits and may even cause more harm.

Magill (2014) reports on a study undertaken University of Minnesota that the environmental and human health costs of operating an electric vehicle using electricity generated from coal may be as much as 80 percent greater than driving a gasoline–powered vehicle. However, the study shows that environmental health cost of driving an electric vehicle using electricity from solar or wind generators could be as much as 50 percent less than the environmental and health toll of using gasoline. It is clear the EVs offer real environmental benefits – but is there a cost associated with this?
VI. Batteries

EVs rely on batteries for energy storage. Lithium is used in the manufacture of batteries used in EVs. According to Cubitt (2017) about 75 percent of the global reserves of lithium are found in the salt lakes of Uyuni in Bolivia, Atacama in Chile and Hombre Muerto in Argentina: the “lithium triangle.” This desert expanse in the high Andes provides the raw material that moves the world of information technology and communications. Though the salt lakes do not have much flora or fauna, they do provide a home for flamingos. Wanger (2011) points out that the flamingos feed on cyanobacteria, food for the birds but lethal to humans and other plants and animals. There are a number of concerns about mining lithium in this area. The impact of mining lithium is devastating, particularly on water supplies. Though lakes exist despite low rainfall there is concern that more mining will disrupt water supplies for people and agriculture. In addition, crops can be affected by run off-off saline solution from which the lithium salts are gathered (Tahill, 2007). Traditionally, gathering salt has been part of local livelihoods. However, this becomes impossible as the salt ponds are contaminated by lithium mining.

There is also concern that regulation designed to minimise the adverse environmental impacts of lithium mining will not be effectively enforced. None of the governments of the lithium triangle have a good history of environmental regulation and there is evidence that poorly paid officials often take bribes. There are fears that in the long run lithium mining will make the area unfit for its indigenous inhabitants (Ribera and Requena, 2011; Hollender and Schultz, 2010; Cubitt, 2017). The demand for lithium is increasingly driven by the push for electric vehicles. These
should solve the urban air quality issue, but their batteries are causing environmental degradation in both their production and disposal.

**VII. Lithium Recycling**

There are 2 types of batteries used for electric and hybrid vehicles. Hybrid vehicles initially used nickel-metal hydride batteries. Electric vehicles use lithium ion batteries. In 2012, about 27 percent of the global lithium consumption came from rechargeable batteries while it was only 15 percent in 2007 and only 8 percent in 2002. The world lithium consumption from 2000 to 2008 had a steady 10 percent rate increase. The demand for energy storage and transportation is expected to grow 20 percent per annum until 2025 (Mancha, 2016).

EV batteries often contain other useful metals such as high-grade copper and aluminium in addition to, depending on the active material, metals such as cobalt and nickel as well as rare earths. To prevent a future shortage of cobalt, nickel, and lithium and to enable a sustainable life cycle of these technologies, recycling processes for lithium batteries are needed.

As EVs started to become more popular it was thought that recycling was a non-starter as the price of elements such as lithium were still quite low and supplies were plentiful. However, it was thought that re-use as storage capacity was the most likely solution for dealing with batteries from EVs (Kumar, 2011). It is increasingly thought that the introduction of vehicle to grid charging, where EV batteries are accessed for power to offset peaks on the power grid means that using old batteries for storage capacity is less attractive. There are now efforts
in the US and Europe to develop recycling facilities (Taylor, 2009; EBRA, no date).

In the longer term a technological development may offer a better solution. Nickel metal hydride batteries are not used in EVs. However, research by BASF suggests that the capacity of these batteries could be considerably higher than that of lithium ion batteries. Nickel metal hydride batteries are considerably lighter that lithium ion batteries which means that there will be a price advantage (Bullis, 2015).

VIII. Concluding Thoughts

The Industrial Revolution teaches us that human ingenuity has enabled us to dominate the planet. We have learned to use planetary resources to meet our needs. This has led to environmental degradation. There are some that believe that we are at a point where we are destroying our future. Is it likely that the fourth Industrial Revolution will lead to a better environmental future?

It sees slow economic growth along with increasing inequality as well as financial corruption and short-termism that suggest that the capitalist economic model may not be delivering for people. At the same time, the Fourth Industrial Revolution is fundamentally transforming societies, economies, and ways of doing business. Last but not least, as people seek to reassert identities that have been blurred by globalization, decision-making is increasingly influenced by emotions.

What we are doing is to continue to rely on the neoliberal system that has led to increasing environmental degradation. Taylor, O’Brien and O’Keefe (2015) posit that our current society can be characterised as
being focused on conspicuous consumption. As the global consumer portion of society continues to grow then demand for consumer products, many increasingly based on electronic technology, will exacerbate the environmental problems discussed earlier. According to the authors instead of a society that is focused on economic goals we need to focus on social goals. In short, the current economic model, neoliberalism, which assumes that we make rational economic decisions and that there is an infinite resource base as well as an environment that can absorb all the wastes we produce, is flawed. The World Economic Forum (WEF) report (2017) recognises that the benefits of growth suggest that the capitalist economic model may not be delivering for people. There are likely to be some implications for environmental policy. Where it is thought that environmental policy may harm economic growth, then it is possible that environmental policy development will be curtailed. We have seen examples of this in terms of climate change. The USA did not implement the Kyoto Protocol and is withdrawing from the Paris Agreement. Perhaps it is time to look at another approach.

There have been a number of researchers who have advocated an alternative approach. For example, Herman Daly, has argued for a steady state economy (Daly, 2008). What would that mean for our current global economy? In brief, it is clear that we cannot continue to produce products in ever increasing numbers. Recycling and re-use have to become fundamental aspects of the way in which we design products of all kinds. We will need to develop a culture that recognises the importance of human values as opposed to the possession of products being a way we judge the status of a person. Cities are now dominating our world and as discussed earlier have brought about major changes through their demands. It is clear that the solutions to the problems we
face will be found in cities. Cities will be the places where people will have to decide upon the changes needed for a less damaging approach to economic activity.

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