

Unintended Consequences of Green Technologies

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Abstract: Green technologies (e.g. wind turbines, solar cells, and biofuels) and initiatives (e.g. efficiency, recycling, and organics) yield distinct unanticipated consequences that can partially or fully offset intended environmental benefits.

Intentional human actions cause multiple effects. Some of these effects are planned while others occur unexpectedly. Unintended consequences are unplanned outcomes that occur due to the implementation of a technology, policy, or other initiative. Social scientists typically categorize them as beneficial, detrimental, or controversial. Unanticipated consequences follow directly or indirectly from human activities but occur at a future time and possibly in a different location. Therefore, they can be difficult to identify or directly link to a triggering activity. As a result, journalists, technologists, and policy makers sometimes overlook the impacts of unintended consequences. Negative unanticipated consequences can be challenging to evaluate and remedy since they arise within complex ecological interactions and social conditions. Green technologies (e.g. wind turbines, solar cells, and biofuels) and initiatives (e.g. efficiency, recycling, and organics) yield distinct unanticipated consequences that can partially or fully offset intended environmental benefits.

Theorists of economics, political science, history, and sociology have long evoked the concept of unintended consequences, sometimes called “the law of unintended consequences.” The notion is imbedded in other common concepts such as SNAFU, Murphy's Law, serendipity, windfall, the butterfly effect, and perverse incentive. The concept of unintended consequences is central to moral philosophies of consequentialism, which hold that people should judge actions based on the outcomes they create. For instance, in 1848 the French economic journalist, Frédéric Bastiat, wrote: “In the economic sphere an act, a habit, an institution, a law produces not only one effect, but a series of effects. Of these effects, the first alone is immediate; it appears simultaneously with its cause; *it is seen*. The other effects emerge only subsequently; *they are not seen*.” He reasoned that social scientists should recognize and account for these unseen effects.

In 1936, Robert K. Merton advanced a definition of unintended consequences that would go on to inform much contemporary thought on the

subject. He pointed out two methodological pitfalls that arise when putting the term to work. First, social scientists must determine how much of an observed consequence can be rightly attributed to a purposive action. To what extent, for instance, can the rise of organized crime be blamed on prohibition? The second challenge for social scientists is to determine the intended purpose of an action in the first place. Consequences of actions can be rationalized after the fact, as exemplified by the horseman, who after being thrown from his horse, declared that he was “simply dismounting.”

Merton and other theorists have identified numerous factors that lead to unanticipated consequences: ignorance, error, greed, shortsightedness, cognitive processes, emotional bias, and even the world’s inherent complexity as elaborated in chaos theory. Merton argued that people may occasionally be so eager to realize the immediate effects of an act that they give no consideration to other potential consequences. Similarly, people may overlook further consequences when their fundamental values oblige them to pursue an action. The resulting unintended consequences may actually change basic values over time.

Types of Unintended Consequences

People commonly consider unintended consequences to be negative or positive but they may also be perverse, neutral, or even controversial. The actual categorization may depend on the observer’s perspective. For instance, a medical drug produces many effects. Some are intended while others are not. The unintended consequences can be:

Positive – The drug yields a beneficial side effect in addition to the intended effect. Aspirin is a pain reliever but also acts as an anticoagulant, which can help prevent heart attacks and reduce damage caused by thrombotic strokes.

Negative – The drug produces a detrimental side effect in addition to the intended effect. HIV medications save lives but they can reduce a user’s appetite and even trigger nightmares.

Perverse – The drug produces exactly the opposite of the intended result. Antibiotics can induce antibiotic resistant strains of bacteria. Also, doctors have discovered that some drugs intended to prevent heart arrhythmias actually turned out to be pro-arrhythmic in practice.

Controversial – The drug creates an effect that some view as detrimental but others view as beneficial. Some heart medications induce hair growth and some pain relievers produce euphoric sensations.

A drug may produce any combination of these effects on the body. Public policies, environmental initiatives, business dealings, and other human undertakings regularly produce unplanned outcomes as well. Therefore,

unanticipated consequences are a topic of concern and study across a wide spectrum of disciplines. For instance, developmental economists have shown that simplistic food aid can worsen long-term food security of a target region if international organizations deploy the aid without accounting for local economic conditions. If a community is flooded with free food from abroad, local farmers can not compete and may subsequently earn too little to plant their fields the following season. In this case, the food aid induces the perverse unanticipated consequence of worsening food security by putting local farmers out of business. Developmental economists have developed strategies for avoiding these consequences. For instance, a charity might secure funds for local farmers or introduce the food aid at market prices so local farmers can compete with the imported food.

When San Francisco and other cities banned plastic bags, stores switched to sturdier paper and reusable plastic bags. However, consumers still disposed of the thicker-walled bags, leading to greater stress on city waste facilities than before the plastic bag ban had been implemented. In contrast, Seattle stores charged a small fee for each bag. Shoppers brought their own reusable bags to avoid the small charge. This policy yielded the intended effect of decreasing waste without the perverse unintended consequence. However, critics point out that while bag charges are successful from a waste and carbon perspective, bag fees place a disproportionate burden on poor residents.

Unintended Consequences of Alternative Energy

Fossil fuel energy yields many benefits but the associated extraction operations, distribution networks, and combustion practices yield a host of negative unintended consequences. Environmental groups, politicians, and businesses frame green energy technologies as clean alternatives to fossil fuels. Through, green energy alternatives generate unanticipated consequences of their own.

As with traditional energy production, the unanticipated consequences arising from green technologies can generate political tensions. Once a government or organization backs a certain green technology, it risks losing credibility if detrimental consequences are exposed. For instance, in 2008 riots broke out around the world in response to rising corn prices. Some blamed the increase on weather conditions, others claimed that demand from India and China was to blame. The World Bank studied the price jump but kept its findings secret, presumably because they might have upset the bank's major donor, the United States. However, *The Guardian* obtained a leaked copy of the report and published its findings. The World Bank study group had determined that the rise in corn prices was an unintended consequence of biofuel production. The report concluded that biofuel producers' demand for corn pushed prices higher for everyone, including those who needed corn for food.

Economists and ecologists have identified numerous other unanticipated consequences of biofuel production. Biofuel proponents maintain that their fuel cycles net no additional CO₂. In theory, biofuel feedstock plants absorb and

offset combustion-related CO₂ emissions. However, when Indonesian swamps were drained in order to grow palm oil crops, soil decomposition accelerated, unexpectedly releasing large quantities of greenhouse gasses into the atmosphere. France, Germany, and other European nations withdrew support for palm oil when they discovered that these rogue emissions were more than ten times greater than the potential savings afforded by converting from petroleum to palm-based biofuels.

Biofuel producers can refine fuel from sugarcane but critics maintain that sugarcane cropping practices endanger rainforests and biodiversity. Authors of an article published in the journal *Science* argue that the benefits of producing biofuels from sugarcane are greatly diminished if the unanticipated consequences of sugarcane production are taken into account. They argue that carbon rich rainforests are frequently leveled to make room for sugarcane plantations. This not only interrupts the carbon cycle but also endangers local biodiversity, hydrological functioning, and soil stability. Ideally, farmers would plant biofuel crops exclusively on abandoned farmland but such land is relatively rare and usually less fertile. Even on suitable sites, crop residues left behind from farming activities release methane, a greenhouse gas with 23 times the warming potential of CO₂. Furthermore, fertilizing fields of sugar, corn, rapeseed, and other biofuel feedstocks with nitrogen rich fertilizers yields nitrous oxide. Nitrous oxide has a global warming potential 296 times greater than CO₂ and additionally damages stratospheric ozone.

Many people admire solar photovoltaic cells for silently extracting clean energy from the sun's rays but the panels contain heavy metals that can leach into groundwater when disposed at the end of their lifecycle, according to the Silicon Valley Toxics Coalition. Photovoltaic manufacturers employ toxic and explosive compounds that can lead to unintended health risks for workers and local residents. While solar cells do not produce CO₂, the photovoltaic manufacturing industry is one of the leading emitters of hexafluoroethane (C₂F₆), nitrogen trifluoride (NF₃), and sulfur hexafluoride (SF₆), greenhouse gasses that are 10,000 to 25,000 time more harmful than CO₂ according to the Intergovernmental Panel on Climate Change. The unintended consequences of photovoltaic production offset at least part of the carbon and environmental benefits of solar cells.

Wind turbines generate energy from a freely available and renewable resource. Though, large turbines can disturb residents and therefore regularly generate NIMBY (Not In My Back Yard) resistance when sited near residential communities. If sited in remote regions, associated maintenance roads can inadvertently afford poachers and loggers access to ecologically sensitive areas.

Alternative energy generation may also instigate unintended macroeconomic consequences. Alternative energy promoters aim to reduce dirty fossil fuel use by expanding clean energy production. However, increasing any form of energy supply can exert downward pressure on energy prices, thereby stimulating overall demand for energy services. Economists warn that without appropriate countermeasures, any increase in energy production, alternative or

conventional, may unintentionally perpetuate energy intensive modes of living. Also, when energy consumers believe their energy is derived from clean sources, they may be less concerned about conserving it.

Unintended Consequences of Energy Efficiency

Instituting energy efficiency measures can lead to both beneficial and detrimental unintended effects. According to behavioral psychologists, when energy users employ more efficient energy technologies they may in turn increase their frequency of use. In one study, participants that purchased energy efficient washing machines subsequently started doing more loads of laundry. When individual or organizational energy consumers institute energy efficiency measures, such as using more efficient light bulbs or machinery, they also save money on energy. However, consumers may choose to spend these savings on other products or endeavors that still lead to energy consumption. In this case, money-saving energy efficiency measures can unintentionally stimulate other forms of consumption, leaving overall energy footprints unchanged. Energy efficiency measures can spur similar unintended effects on a macroeconomic scale. Efficiency measures frequently lead to larger profits, which can spur more growth and higher energy consumption overall. This unintended consequence of energy efficiency is termed the Jevons paradox. It is named after William Stanley Jevons who in 1865 explained how James Watt's introduction of the steam engine greatly improved efficiency, which in turn made steam engines more popular and subsequently drove the use of coal ever higher.

Energy efficiency advocates argue that instituting energy taxes or other incentives designed to thwart energy demand can block some of these unintended consequences. They point to California, which instituted a system called decoupling three decades ago. Decoupling is a financial arrangement that rewards energy companies for selling less of their energy services rather than more. Since its introduction, decoupling has stabilized per capita electricity consumption in California even though national per capita electricity consumption surged fifty percent higher over the same period.

Energy reduction endeavors can clearly spur positive unintended consequences as well. For instance, when cities started to shift to energy efficient LED municipal lighting they also realized maintenance savings and traffic safety improvements since the new bulbs failed less frequently than the bulbs they replaced. In older cities, builders often constructed dwellings shoulder-to-shoulder in order to efficiently utilize urban space and save energy (heat transfers from one flat are absorbed by others, reducing everyone's energy bills). Physical proximity brought people closer together in novel ways, allowing for the efficient walkable neighborhoods and cosmopolitan exuberance now taken for granted in cities such as Paris, Tokyo, New York, and London. Downshifter – people who choose to greatly reduce their material consumption – often unexpectedly discover new interests and report higher satisfaction with their low consumption lifestyles.

Unintended Consequences of Organic, Fairtrade, and Local Food

Numerous mainstream environmental organizations and concerned citizens throughout the world support organic, fairtrade, and local food initiatives. These movements aim to bring agriculture, food processing, and distribution activities in line with ecological justice and sustainability principles. These initiatives yield many intended benefits but their successes are at least partly offset by detrimental unintended consequences. For instance, Fairtrade programs aim to assist small farmers by guaranteeing that buyers will purchase their commodities, such as coffee and sugar, at a price above market value. This system produces two distinct negative unanticipated consequences. First, guaranteeing an elevated price leaves producers with no incentive to maintain or improve quality. Second, Fairtrade subsidies may block market signals by subsidizing goods that are being overproduced. Typically, overproduction drives prices lower, signaling producers to switch to other crops. Fairtrade subsidies can prevent this signal from getting through and may even attract more producers to market. Intensified overproduction shoves market prices even lower. This risks leaving all non-Fairtrade producers poorer unless program directors institute measures to counteract this unintended consequence.

Local foods often require little energy to distribute. However, if local farmers employ heated greenhouses or inefficient transport methods, locavores may unintentionally expand their energy footprints when prioritizing local fruits and vegetables over those shipped from warmer climates via efficiently-packed containers. While locavorism clearly benefits local farmers and communities, it can unintentionally hurt export farmers in the global South.

Organic farmers reduce environmental harms stemming from pesticides and fertilizers. However, organic farming techniques require extensive plowing in order to control weeds. This in turn requires more petroleum. Additionally, Nobel Peace Prize laureate Norman Borlaug has argued that in order to supply organics to everyone on the planet, cultivated land would have to be tripled since organic farming is more land intensive than conventional farming. Therefore, he claimed that demand for organic foods unintentionally places rainforests and other sensitive areas at risk. Here, the intended benefits (reducing fertilizer and pesticide contamination) are difficult to weigh against the unintended consequences (increased petroleum use and rainforest endangerment).

Critiques of Unintended Consequences

Critics of the concept of unintended consequences point out that the concept can obscure deeper structural problems that should be addressed. For instance, journalists, corporations, and politicians frequently frame oil spills as accidents, or unintended consequences of resource extraction. However, they could alternately frame spills as the inevitable and expected outcome of an undertaking with extreme environmental risks.

Some political and economic theorists stress the many negative unintended consequences of government spending and regulation in order to argue for limiting the government's reach. Others claim that this use of the concept of unintended consequences is politically motivated and suspect. Presumably if legislators suspend an activity in order to eliminate its unintended consequences, the intended benefits of the activity will also be lost. These theorists maintain that all human actions yield unanticipated consequences and strong governance, even if imperfect, is required to prevent even greater injustices from harming people and their ecosystems.

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SEE ALSO: Appropriate Technology; E-Waste; Luddism; Reflexive Modernization; Science and Technology Studies

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