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## **An Impossible Ideal: The Use and Misuse of Zero Waste**

In mainstream ideology and public discourse, waste or garbage has always been seen as a technical or a management problem. Many people believe that garbage is merely a wrongly placed resource, and thus the garbage problem could be solved with sufficient technological progress. As one organization puts it:

Zero Waste (ZW) is a re-envisioning of how society relates to production, consumption and disposal of the products and materials we use every day. ... Its goal is to end the generation of toxic and unnecessarily wasteful products through systemic redesign, channeling remaining discards into reuse or recycling for the creation of new products, and using those materials as engines of local job growth. It requires coordination between engaged producers and consumers, governments and citizens, neighborhood activists and neighbors.<sup>1</sup>

This understanding of zero waste pins its hope on two things: efficient technology and efficient social management. Simply put, the zero-waste movement is predicated on the idea that it is possible to have a society that does not produce any waste because everything is recyclable and everything can be used again. However is this, in fact, a reasonable assumption?

If we look at the issue from the perspective of thermal dynamics and ecology, achieving a truly zero-waste society is impossible. However, by examining the principles behind the “circular economy” as well as the guiding principles of contemporary economic systems, zero waste can offer us some valuable insights into what we need in order to create the basis for a future ecological civilization.

1 “Don’t Waste This Opportunity: Policy Recommendations for a Path to Zero Waste and Good Jobs for Boston,” Boston Zero Waste Task Force, 11 March 2014. [http://cleanwateraction.org/files/TaskForce\\_Recommendations.pdf](http://cleanwateraction.org/files/TaskForce_Recommendations.pdf).

## **Zero Waste as a Closed Cycle: Biosphere 2**

The challenges facing the zero-waste model can be illustrated by using the example of Biosphere 2, an attempt to create a closed ecological system which failed dramatically during two trials in 1991 and 1994.

Constructed in Arizona in 1987, Biosphere 2 was supposed to be a rehearsal of the conditions in a space shuttle traveling to another galaxy. It is based on the ideal of a closed material cycle, a complete recycling of matter. For example, humans breathe in  $O_2$  and breathe out  $CO_2$ , plants take in  $CO_2$  and release  $O_2$ . Humans eat parts of plants and discharge fertilizer for them. This, after all, is how it works on “Biosphere 1”—the Earth itself. Biosphere 2 was supposed to be a smaller version of Biosphere 1 and imitate the bioprocesses of nature. If this works, a space shuttle supplied with the necessary basic materials, including water and soil, bacteria, plants, animals, and humans, may run as a self-sustained system; the astronauts living in this space shuttle could have food forever. This is the ultimate zero-waste system in which the matter inside, supported by solar energy from outside, could be used again and again.

In practice, however, this proved to be much more difficult. The first trial of Biosphere 2 began on 26 September 1991. Eight scientists were supposed to live inside independently for two years: they planted food and tried to recycle and reuse everything inside; the only thing from outside was to be the sunshine. Ultimately, the experiment lasted for 21 months and the eight scientists had to leave on 26 June 1993. The experiment failed because Biosphere 2 was not able to be maintained as a self-sustained system. Scientists tried one more time; the second experiment started in 1994 and only lasted for 10 months.

How do we explain this failure? Was it merely due to human error and the immense difficulty of recreating something as complex as an entire ecosystem? Or can it tell us something about other unavoidable problems inherent in the very concept of a self-sustaining, closed system? The laws of thermodynamics can shed some light on this matter.

## The Problem of Entropy

As early as primary school we learn concepts such as water circulation: sunshine evaporates water in the ocean and the vapor condenses into clouds, the clouds move above the continents, turn to rain, and fall down to the earth; the rain water flows into rivers and finally returns to the sea. If water can travel in a cycle like this, it seems that there will always be water available: it cannot be used up because it always exists in one form or another. This agrees with the first law of thermodynamics, the law of conservation of energy and matter. Energy and matter can neither be created nor destroyed, but only transformed from one state to another.

But consider the second law of thermodynamics: the principle of entropy increasing. The transformation of matter and energy is not unlimited, and it always progresses in one direction: from a low entropy state to a high entropy state, from a usable state to an unusable state. Consider the example of a pendulum: as it swings, the ideal pendulum returns to its original starting point. But in reality, an ideal pendulum does not exist, because there is always some friction that creates resistance: the distance of each swing is a little shorter than the one before, until the pendulum eventually stops.

The concept of entropy is not only applicable to energy, but also to matter, and similarly, matter usage can't be 100 percent efficient. That means garbage recycling can never be 100 percent. While matter may never disappear, over time its form becomes less and less usable for us: the structure of materials such as plastic and even metal breaks down over time, becomes disorderly and mixed with other elements. Therefore, while recycling may enable reuse, it cannot offer unlimited reuse. Moreover, manufacturing processes require energy. And no matter how efficient we become, no matter what energy sources we use, some of that energy will be lost every single time.

In other words, zero waste is impossible from the perspective of thermodynamics. Now, consider a pendulum with a clockwork spring that is powered by a source like solar energy—will it run forever? Actually, this is the simplest model of Biosphere 2: to build a perpetually self-circulating system of matter, supported by an inexhaustible source of energy from the outside, solar power.

Nonetheless, the powered pendulum will eventually stop because the axle will be worn down by friction. What then?

This seems like a sophistry. But it is true for all physical systems in reality. Take an engine, for example: in fact, there are two processes happening during an engine's running. On the one hand, it turns energy to waste heat; on the other hand, the engine itself gradually wears out. Biosphere 2 seemingly could run a self-cyclic system for some time, but eventually its mechanisms will wear out and the system will collapse.

### **Garbage: A Globalized Problem**

If we consider a city as a thermodynamic system, it becomes clear that, generally, matter and energy with high entropy goes out of the city, and that with lower entropy goes into the city. Food, clean water, gas, oil, and electricity go into the city, and garbage, dirty water, and polluted air go out of the city. To remain healthy, it needs the supply of energy and matter from outside, as well as a possibility to get rid of garbage by sending it outside. This is the precondition of a city's existence and functioning.

Paul Gauguin, a French post-impressionist painter, raised three questions in a famous painting entitled "Where Do We Come From? What Are We? Where Are We Going?" We can ask these questions about everything produced in the industrial world. Traced to its source, everything in the city comes from outside: wood, mineral resources, and natural water resources. Then, it turns into different forms of garbage after it has been worn out. Soon garbage will be everywhere.

To continue this analogy, globalized modernization and modernized globalization is a food chain: the upper stream area has the priority to take the resources, energy, and matter with lower entropy value from the downstream area and discharge its waste to those areas.

The upstream and the downstream are intermingled with each other. Generally speaking, North America, Europe, Japan, and other industrialized nations are in the upstream, and South America, South Asia, Africa, and China in the downstream. But within a country there is upstream and downstream too. In China, the east is the upstream, and the west is the downstream. In any city, the central part is the upstream, and the urban part of the city is the downstream. Thus it is a common phenomenon that every city is surrounded by garbage dumps—what we might call the garbage-besieged city.

## **The Growth Model of Society**

Economic growth is one of the key values of industrial society. Every economic activity is concerned with a transformation of energy and matter, so that society is like an engine which transforms nature into garbage; the more developed it is, the more garbage it produces.

In the ideology of industrial civilization, economic growth, development, and progress are all good words and admirable notions. So someone like Steve Jobs was seen as a hero, and the invention and update of iPhones, iMacs, and such things are highly esteemed by society, governments, and people. Young people are hailing the new generation of iPhones and expecting the next. Actually, such things are protected and promoted by the whole social structure, the economic and legal system, and the institutions of science and technology. Every round of updates of industrial products is connected to a transformation chain of energy and matter, and to a transformation of nature into garbage. Modern industrial societies are based on the principle of economic growth. And yet this is a paradox: how could the economy increase continuously and ceaselessly? Even just a small rate of increase every year would result in an exponential increase and end up in collapse. It would require infinite resources and energy, and would definitely output infinite waste. Thus, if we consider the implications of this growth model, industrial civilization is definitely not sustainable.

## **Industry and Its Discontents**

Nature, our Biosphere 1, is an ecological system that spans the entire globe. Things in nature depend on each other. The waste of one species might be the resource of another species. Is it possible that the Earth is a zero-waste system? And if Biosphere 1 is a zero-waste system, can humans imitate it?

In prehistory, every species depended on the others, and their behaviors were part of the natural ecological process. Humans were one species among many. However, as human civilization developed, human behavior departed farther and farther from natural processes. Although agriculture in ancient China was no longer a part of a natural ecosystem, it still tried to be in harmony with the environment and nature, or Heaven in

Chinese. But in industrial civilization, a factory is totally alien to the natural ecosystem. In today's concept, nature is just a collection of materials and resources. Humans have the ability to move mountains, thus, mountains were moved; they have the ability to fill a lake, lakes were filled; they have the ability to dam up a river, rivers were dammed. Such anthropocentric behavior will inevitably lead to a comprehensive environmental pollution and ecological crisis. Normally an industrial factory takes in raw material, water, and electricity from the local environment and outputs garbage into the local ecosystem—harming the ecosystem in the process.

The chemical industry was an important turning point in the relationship between humans and nature. After the development of the chemical industry, humans started to use more and more artificial materials. Today, the components of garbage are totally different than in a preindustrial society. Traditional garbage was mainly made of materials derived from nature, such as wood, metal, animal skin, and bone, and nature had evolved corresponding microorganisms for degrading them. They came from nature and could easily return to nature, from dust and back to dust. But most industrial chemical products have never existed in nature: they are created by humans, so there are no microorganisms to decompose them.

For industrial garbage, so-called garbage treatment is actually garbage transfer: from one state to another state, from one place to another place, from upstream to downstream, or from a place people can see it to a place too far away to see. The garbage problem became a problem only because people suddenly discovered that humans cannot put garbage outside human society.

In the age of a limited Earth, the garbage problem will become the most severe social problem, surpassing even the energy problem or food problem. Thus garbage is not a marginal issue, but a crucial one. In the future, wars may very well be caused, not as a result of plundering energy and resources, but for sending out garbage. In a sense, the Kyoto Protocol and the Copenhagen Climate Change Conference are global games of gaseous garbage emissions.

But what if future technology could imitate natural processes and result in a zero-waste system? Unfortunately, it's impossible. Biosphere 2 showed us why.

If industrial civilization is going to collapse in the near future, what should we do?

We are at a turning point of civilization. Humans have to find a new way of life and stop their harmful behaviors to nature. The solution that many have suggested is creating an “ecological civilization.” This is a positive term in China right now, even a political buzzword. But what does it mean when we talk about this?

“Ecological civilization” is a new ideological term in China that refers to a change of direction of society. With this slogan, the Chinese government moves away from the emphasis on economic development that began in the late 1970s. Instead, it builds on a national aim that started in the 2000s to promote “scientific development,” which prioritizes social justice and equality to create a “harmonious society.” Ecological civilization integrates aspects of the Western notion of “sustainable development,” but potentially has a broader meaning. Generally, it refers to a new kind of civilization that contrasts with “agricultural civilization” and “industrial civilization.”<sup>2</sup> However, there is no general agreement about the precise characteristics of this society or the framework for making it a reality.

### **Saving Ourselves through Science?**

The most prevailing and dominant version of ecological civilization in China regards it as a more advanced stage of industrial civilization that could be reached by improving industrial civilization or repairing its problems: replacing contemporary technology with “lower-carbon technology,” fossil fuel energy with “clean energy,” and the current wasteful economy with a “circular economy.” To some extent, zero waste is based on this idea: it suggests that humans could live sustainably and avoid an ecological crisis while still continuing their modern lifestyle.

This is accompanied by a specific understanding of science. Science or technology is a double-edged sword, but generally, the positive part is seen as the main one, and the negative parts are local, random, and temporary, and could and will be overcome by more advanced science and technology in the future. To solve the problems created by science, the argument goes, we must rely on science.

2 For more on this idea, see: James P. F. Oswald, “What Does Eco-civilisation 生态文明 Mean?,” *The China Story*, 4 September 2014, <https://www.thechinastory.org/2014/09/what-does-eco-civilisation-mean/>.



This vision of ecological civilization is highly dangerous. Einstein once said that you can't solve a problem using the method that caused the problem. Our attempt to do this is based on a misunderstanding of science and technology, a misunderstanding of the history of science, and a misunderstanding of human civilization. It provides a deceptive illusion of a good future that could cause us to waste the limited time left for humanity to save itself.

In fact, the negative parts of science are never fixed by new science. Generally, the more advanced science is, the greater its potential negative effect. As soon as the cumulative negative effects of science are greater than the positive ones, we would have to say that, generally speaking, science and its technology are harmful to human society and nature. And the harmful effects are not temporary, but long-lasting; not accidental, but determinate; not local, but global; not curable, but terminal.

This is because the primary role of institutional science and technology in industrial civilization is to increase capital, not to serve the needs of humans. The only science and technology that can be easily funded, developed, and applied is that which promises to make money and help the economy grow. Money has its own logic, and it tries to proliferate in the most effective way.

Science has not always been like this, however. From ancient Greece through the Middle Ages, science was a part of natural philosophy. During this period, the purpose of science was to explore the mysteries of nature, and to satisfy the human craving and curiosity for knowledge. Since industrial civilization started, the role of science and scientists has gradually changed. In industrial society, the scientific community is first an interest or profit community, then a knowledge community, but never a moral community. As an interest or profit community, the best policy for the scientific community is to ally with capital and political power. There are many interest groups promoting science and technology: GMOs, nuclear power, nanotechnology, and so on. Every group tries to apply higher and higher technology to society and nature. So there is an emergent task for society: to warn science, to establish an institutional system to prohibit science from harming society and nature.

## A Change of Direction

However, there is also an alternative understanding of ecological civilization, one which regards it as a totally different style of civilization. It is not a 180° turn, an attempt to backtrack or reverse course. We need to make a 90° turn: the beginning of a new path. It necessarily involves a comprehensive transformation of industrial civilization, including mainstream ideology, social structure, and lifestyles. The revolution of ideology is the basis for other changes.

What will this new civilization be? Since it is a new kind of civilization, nobody knows exactly what it will look like. But unlike industrial civilization, it will have to be sustainable. Humans have to learn how to make a life, a happy life on the one and only Earth and under the one and only sun—the simple fact that we only have one of each means that the resources and energy humans can use are limited.

Nowadays the ecological premise of overall human society has become difficult to achieve. Mankind has enough technical ability already. The pattern of human civilization needs to be adjusted; we need to abandon industrial civilization and build a brand new cultural mode. I suggest that there are two principles we should use to establish an ecological civilization.

Firstly, we need to reevaluate the current industrial civilization comprehensively and completely. We need to reimagine the aim of society and envision a standard for a better society. This requires examining our basic way of thinking, social structures, the economic and legal systems, the role of science and technology, and so forth.

Is economic growth necessary for a society? Social development treats economic activity as a measure of progress, and ultimately changes the overall system of human society. The need to obtain more material and resources from nature (and the accompanying increase in garbage discharge) threatens to destroy the ecological premise of civilized existence.

We could imagine a different kind of society: one in which the population is stable around a constant number and humans live a stable life by producing the same products every year, within a stable environment. Their happiness would not depend on having the newest iPhone model, but on spiritual creation, such as poems, painting, and music.

Secondly, we need to learn from ancient wisdom, from traditional cultures. Learning from traditions does not mean regressing to ancient times. Industrial civilization may be a single, homogenized form of society, but traditions are plural—they are different within different environments. Traditions are the only source of knowledge gained from generations of continuous practice that we could use for reference.

Time flows in only one direction, and the environments in which most traditional societies existed have been destroyed, so it's impossible to go back. So how about stopping instead? Stop development, stop the ideology of economic growth, and stop the update of iPhones? If people start to think about how to stop, they will naturally go more slowly. If more and more people think about how to stop, maybe humans could find a workable approach for saving human civilization.

This is why the idea of zero waste is useful after all. Although in practice it is an impossible ideal, it offers a good attempt to start saving human civilization. There are different kinds of zero-waste efforts. Some of them still pin their hopes on new science and technology; they try to promote eco-friendly technologies and make notable advances. But under the social structure of industrial civilization, such eco-friendly technology could only be used in certain idealistic communities, and it could not be applied to the whole of society, because such technology would not help capital to proliferate effectively.

Some people pin their hopes on so-called clean energy. They firmly believe that clean energy can either save industrial civilization or lead human society into ecological civilization. However, there is no energy that could be called clean. The key point is not what kind of energy, but how much energy we use. Any energy could be dirty if our usage exceeds a certain amount. Moreover, in industrial society, new energy technology is no more than a tool for capital's proliferation, a tool for new capital competing with the old. With regard to the second version of ecological civilization, establishing eco-friendly technologies and clean energy as the final aim is dangerous. But if we simply understand it as a temporary approach to explore a new kind of civilization, it is operable or workable. Similarly, zero waste should not be our final goal, but if we strive for it, it will be a great starting point and an operable approach that will lead us towards the larger goal of an ecological civilization.

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