



Transition and transformation: A review of the concept of change in the progress towards future sustainable energy systems



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ABSTRACT

It seems generally accepted that change will occur in global energy systems. There also appears to be consensus on the kinds of changes that may be possible for the future, even though there may be disagreement over the exact mix of technologies and policies needed to increase sustainability or mitigate climate change. The terms transition and transformation have both been used to denote the type of change needed in large socio-technical systems. However, the terms have been used both in contradiction of each other and synonymously by different authors. A comprehensive review of both theory and usage in scientific publications was conducted to determine if the terms have been used to denote fundamentally different concepts and if the concept of change is framed differently by usage so as to affect understanding. Despite two camps being readily identifiable, it was concluded that the terms generally refer to the same fundamental concept. At the same time, framing of the concept can be viewed as somewhat different, resulting in a potential for confusion on the part of the reader that may detract from achieving the outcome of change. It is suggested that change to physical forms and systems be denoted as transformations, and that changes to large socio-technical systems be denoted as transitions when the focus is on a higher order of change that highlights the ways that society motivates, facilitates, and benefits from change.

1. Introduction

Global energy systems constantly evolve in response to a myriad of drivers. At the moment, and likely well into the future, the key drivers appear to be mitigating climate change, strengthening energy security, ensuring economic competitiveness, providing social justice, reducing energy poverty, and stimulating technological innovation. With such strong forces of change, and the possibility of yet unforeseen disruptive technological advances or other game changers, it seems obvious that energy systems of the future may be very different from those today. However, the nature, speed and degree of change remains elusive, at least in its description and denotation. At the heart of the matter appears to be whether the change should be referred to as a transition, or a transformation. The expressions *energy system transition* and *energy system transformation* are commonly used to denote the change, but there appears to be some confusion over the actual meanings of these expressions.

A cursory view of popular definitions of the words denoting change in energy systems is shown in Table 1. From these definitions, it appears that the word *transition* infers slightly more focus on the process or period of change, whereas *transformation* infers more focus on the magnitude, significance, or result of the change. This difference

is seen in the following abstract, which uses both expressions (underlined).

The paper highlights the energy dilemma in China's modernization process. It explores the technological and policy options for the transition to a sustainable energy system in China with Tsinghua University's Low Carbon Energy Model (LCEM). China has already taken intensive efforts to promote research, development, demonstration and commercialization of sustainable energy technologies over the past five years. The policy actions cover binding energy conservation and environmental pollution control targets, economic incentives for sustainable energy, and public R & D supports. In order to achieve the sustainable energy system transformation eventually, however, China needs to take further actions such as strengthening R & D of radically innovative sustainable energy technologies and systems such as poly-generation, enhancing the domestic manufacturing capacity of sustainable energy technologies and systems, creating stronger economic incentives for research, development, demonstration and commercialization of sustainable energy technologies, and playing a leading role in interna-

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Table 1
Definitions from common online dictionaries.

Dictionary	Transition	Transformation
Oxford University Press	<i>the process or a period of changing from one state or condition to another</i>	<i>a marked change in form, nature, or appearance</i>
Cambridge University Press	<i>a change from one form or type to another, or the process by which this happens</i>	<i>a complete change in the appearance or character of something or someone, especially so that thing or person is improved</i>
Merriam-Webster (2015)	<i>a change from one state or condition to another</i>	<i>a complete or major change in someone's or something's appearance, form, etc.</i>
Wiktionary	<i>the process of change from one form, state, style or place to another</i>	<i>a marked change in appearance or character, especially one for the better</i>

itional technology collaborations (Chai and Zhang, 2010).

Here the word *transition* is used close to the word *process*. By contrast, *transformation* is used later in the paragraph to denote what China ultimately strives to *achieve* after the process is over. However, definitions of words are only part of the analysis. Further insights should be gained from both the frequency of use and the communicative intention of the people using such expressions. The frequency of each expression was examined by seeing the number of hits they would receive from common academic and general search engines (Table 2).

It appears that in both academic and general usage, *energy system transformation* appears somewhat more frequently as a phrase, even when describing the same concept of change. This begs the question of what may be the underlying illocutionary force, or intention of producing one versus the other in speech or in writing. For example, a simple expression such as *I am cold* can have different illocutionary forces depending on the context. It could be a simple statement of fact, an answer to a question, or a directive to close a window. Similarly, two expressions such as *I am cold* and *Please close the window* could have the exact same illocutionary force (a request to close a window) yet quite different morphological forms.

Fairclough and Wodak (1997) discuss how linguistic factors (in addition to semiotic and interdiscursive features) can influence and be influenced by society. Words, grammar, organizational structures, etc. can shape societal values, attitudes and behaviours by framing issues and problems in a certain respect so as to highlight various levels of problem recognition, the degree of change needed, underlying actions needed and obstacles along the path of change. These linguistic factors represent a discourse, or “a shared way of apprehending the world”. Further, different discourses can shape the acceptability of various alternatives of change, such as promoting one alternative over another. In extreme cases, not promoting one or more alternatives can be the result of hegemonic power in society. This is typical of systems that either do not tolerate or do not need change, especially radical change. Importantly, Fairclough and Wodak (1997) argue that words or expressions that are used to convey concepts, representations or future realities should not always be taken at face value as they “are themselves elements of discourses which are associated with particular strategies for change”.

Table 2
Frequency of use of expressions. The search was performed in June, 2015.

Expression	SCOPUS	ScienceDirect	Google Scholar	Google
Energy system transition	34	98	306	6920
Energy system transformation	27	108	915	10200

In particular, Fairclough and Wodak (1997) commented on the use of the words transition and transformation in the context of the climate change agenda. In this work, a transition was defined as “passage from a well-known defined point of departure to a unitary and well-defined destination”. In terms of efforts related to social change, using the word transition was “difficult to reconcile with the complexity and diversity of the processes which are actually taking place”. Fairclough and Wodak (1997) then cite other authors (Stark and Bruszt, 1998) who prefer *transformation* in such cases.

Insights into the concept of change can also be gathered from the field of Natural Science, particularly from the seminal writings of Stephen J. Gould (Eldredge and Gould, 1972; Gould, 1977), who argued that evolutionary change in species did not happen through slow, gradual change (phyletic gradualism), but by discontinuous breaks and jumps followed by long periods of stability (punctuated equilibria). Accordingly, phyletic gradualism was described as process of slow, steady, directional transformation from one morphological form to another. On the other hand, punctuated equilibria were characterized as long periods of stability in the fossil record broken sharply by rapid, divergent, discontinuous, and abrupt transitions (Gould, 1977).

In the field of Futures Research, the word *transformation* has been reserved for a change in human society that is quite unique. As one of the “four generic futures” that govern future scenario development (the others are continued growth, collapse, and discipline), a transformation occurs through the power of new or innovative niche technology that anticipates “a change from its present form into a new ‘posthuman’ form, on an entirely artificial Earth”, thereby creating a so-called “dream society” (Dator, 2009). In this sense, transformational scenarios are not only much less likely, but often viewed as being highly radical in their nature. They are inherently different from, and perhaps opposite to, business as usual. As such, the end state appears fundamentally different from the starting state.

From the field of economics, seminal work by Polanyi (1944) outlined the rise of the current market economy, which he dubbed *The Great Transformation*. Polanyi describes how the evolution of modern nation states forced changes in both social structures and human nature which in turn created favourable conditions for capitalism. Implied in this account is that relationships among societal actors and the norms they follow underwent major reorganization to produce a new social order and way of life. In this case, social-based regulatory systems were replaced by self-regulating markets. In this new world order, nothing new or innovative was created, as market-based economic activities were already in place for commodities that were either rare or traded over long distances, nor was anything destroyed outright – social-based regulation still exists in some areas. The change involved a redirection of the system whereby the new system evolved out of the old.

Recent work related to sustainable development and mitigation of climate change shows confusion in naming what is happening to

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