ENERGY AND ITS RELATION TO COMPLEXITY OF THE ECONOMY

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The energy-complexity spiral of Joseph Tainter postulates societies become more complex over time to solve problems, and more energy is required to create and maintain that complexity [1-4]. Further, information theory can be used to quantify the complexity of the economy in terms of both efficiency (less connectivity) and redundancy (more connectivity) over time [5]. A complex system must have a mixture of both efficiency and resilience because nether a fully efficient or redundant network is complex.
This presentation looks at system-wide metrics that compare the cost and rate consumption of energy to the structure, or complexity, of the economy. The cost of energy is measured by the fraction of gross domestic product that is used for purchasing energy. Here complexity metrics focus on a topological description of the economic flows of the U.S. and World economies as measured via economic input-output tables. In this sense, the economy is a network of flows (of money). Initial results suggest that the U.S. economy expanded while becoming less hierarchical, or complex, from the 1940s to the 1970s as energy consumption increased at a high rate (4.7%/yr). After the 1970s the U.S. increased its complexity, or hierarchical structure, when the rate of increase of energy consumption slowed after the 1970s to below 2%/yr. The presentation concludes with implications for economies powered by future energy systems (e.g., renewable and low carbon).

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