Chapter 39
A System Safety Analysis of Renewable Energy Sources

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ABSTRACT
This chapter is focused solely on whether renewable energies can be implemented safely and if they are safer than the technologies they are replacing or supplanting albeit in small quantities at the current pace of implementation. Renewable or sustainable energy sources are necessary due to the ultimate erosion of traditional energy sources and the harmful effects they introduce into the environment and negatively affect our health. Regardless of how you personally feel concerning renewable energy sources, they are here and here to stay. With that simple understanding, we should ensure these systems are safe. This chapter evaluates the hazards associated with renewable energies and compares and contrasts them to those hazards posed by the traditional or legacy fossil fuel energies. The advantages of renewable energies are palpable and discussed in great detail in the other chapters of this book. This chapter focuses specifically on the safety of the renewable energy systems.

INTRODUCTION
Renewable energies are certainly controversial depending on your political persuasion, proposed financial gains or loss et cetera which makes objective research difficult. Renewable energy technologies are considered cleaner sources of energy possessing a much smaller environmental impact than conventional energy technologies. Notice I said smaller not nonexistent. Their acceptance is growing exponentially all over the globe as conflicts are prevalent in almost all fossil fuel producing countries with the continual fear that a war could shut down major supplies of petroleum. Regardless of how you personally feel concerning renewable energy sources, they are here and here to stay. With that simple understanding, we should ensure these systems are as safe as reasonably practical for the general public.

This chapter focuses specifically on the safety of renewable energy systems using a MIL-STD-882 DoD Standard Practice for System Safety or its commercialized counterpart ANSI/GEIA-STD-0010 Standard Best Practices for System Safety Program Development and Execution approach to identifying...
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and proposing mitigations to the hazards identified within these pages. It should be understood that all systems that control or harness energy will possess hazards as well as residual risk.

This analysis is further focused on wind turbine and solar renewable energy technologies since they are at the time of this writing the most prominent. Additionally solar energy is divided into individual units (solar panels) and commercial distributed systems.

BACKGROUND

This chapter was written with an open mind. There are no intentional prejudices or presumptions prior to performing the research to write this paper. The author does not work in the energy field and is not a lobbyist, manufacturer, or solicitor of either conventional energies such as oil or natural gas. This is a simple system safety analysis of the various energy sources, identifying potential hazards and mitigations resulting in what are hopefully an honest assessment of the safety of wind and solar energy systems as compared to the more traditional energy sources. Not being in the industry obviously makes it difficult to gather actual safety data and a lot of the data that is available on the internet is either spun or outright wrong to fit ones political and or economic leanings. This analysis has tried to determine fact from fiction and spin from reality to form an honest and unbiased assessment. Validation of the analysis will be determined by the hoped for criticisms from both sides of the debate.

WIND TURBINES

Before being able to conduct a system safety analysis, the analyst must understand the environment in which the system, in this case wind turbines, is to operate for normal, abnormal, and emergency conditions.

Wind turbines operate in an extremely complex and ever changing environment commonly referred to as the weather. Weather variations are understood by most; however wind turbines are not exclusively built for specific geographic weather conditions. Wind turbines must be built for all credible weather environments ranging from extreme dry heat (i.e., Sahara Desert) to extreme cold (i.e., Artic) or hot humid Ocean environments (i.e., Northern Indian Ocean), and for tornados and extreme electrical storms in the Mid-Western United States, flooding, et cetera. Thoughtful consideration of weather drives the design of wind turbines to consider all credible weather conditions. A universal wind turbine designed to meet the environmental challenges of temperature extremes, humidity and moisture concerns (corrosion), friction and chaffing, health, and environmental concerns, and stability concerns. Each of these hazards, complete with potential mitigations, will be discussed as follows:

- **Temperature Extremes**: Temperature extremes can lead to several hazards including:
  - Equipment wear-out,
  - Metal and structural fatigue, and
  - Over and under-temperature to name just a few of the major hazards associated with weather. Mitigations include but not limited to the following:
    - Build in effective heating and cooling systems. The cooling system would likely contain Ethylene Glycol (EGW), Propylene Glycol (PGW), or Polyalphaolefin (PAO). All are toxic if ingested, however this is usually only an issue with animals and pets due to