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Life Cycle Safety Assessment in the Energy Industry

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Introduction

The renewable energy industry is a booming sector, as global climate change continues to threaten our planet. However, this increase in demand for renewable technologies is leading to an increase in workforce. This in turn can likely lead to a larger probability for incidents in the workplace, ranging from minor injuries to fatalities. While much research has been performed on how renewables can be more beneficial for the environment (compared to fossil fuels), any disparities in worker safety must also be considered.

Abstract

Research was performed concerning the occurrence of injuries and fatalities in the renewable energy sector, and this was compared to natural gas, a fossil fuel. This data for each type of energy was compiled and used to form graphical representations. According to the final data tables/graphs, there is no conclusive evidence suggesting that the renewable industry is safer for worker health than fossil fuels – or that any one is safer than another. They are also not significantly (if at all) more detrimental to worker than any other industry – mining was used as a reference.

Objective Questions

What is the energy output? i.e. how many watts per solar panel, wind turbine, etc.

What raw materials are used?

What does the life cycle of each technology consist of?

- Manufacturing
- Construction/Installation
- Maintenance/Operations
- Decommission
- Transportation (Natural Gas)
- Extraction (Natural Gas)

Based on the amount of work/hr in each stage and number of individual panels, turbines, etc. constructed, what is the incident rate per hour?

Data

To answer all the objective questions, the following data-gathering procedure was performed for each type of energy (Solar PV is shown in the next column as an example). Annual hours worked and incidents/fatalities were sourced from the Bureau of Labor Statistics website. Other data has the corresponding source listed under the column titled 'Source.' (applies for BLS as well).

Methods

$$\#\ hrs\ worked\ per\ year = (avg\ hrs\ per\ week) \times 52$$

$$incidents\ per\ hour = \frac{(incidents\ per\ year)}{(hours\ worked\ per\ year)}$$

$$fatalities\ per\ hour = \frac{(fatalities\ per\ year)}{(hours\ worked\ per\ year)}$$

Results

Solar PV		
Description	**Data**	**Units**
solar panel capacity (W/panel)	**250**	(W/panel)
Mining Raw Materials (how much of each)		
silicon (kg/kW)	**29**	(kg/kW)
copper (kg/kW) - in CIGS (copper, indium, gallium, selenide) pa	**0.05**	(kg/kW)
aluminum (kg/kW)	**45**	(kg/kW)
iron (kg/kW)	**N/A**	(kg/kW)
silicon mining productivity (kg ore/hr work)	**3594.017**	kg ore/hr work
silicon mining yield (kg silicon/kg ore)		
metal/non-metal mining safety rate (fatalities/x hours)	**~1 fatality/ 119.24 hrs (19 for year)**	
metal/non-metal mining safety rate (incidents/x hours)	**~1 incident/ 1 hr**	
Manufacturing		
manufacturing safety rate (fatalities, incidents / x hours)	**0.4**	**incident/hr**
Construction / Installation		
installer safety rate (fatalities, incidents / x hours)	**~1 incident/25.458 hrs, ~1 fatality/169.72 hrs**	
Maintenance / Operations		
maintenance safety rate (fatalities, incidents / x hours)	**0.78 incidents/hr and 0.006 fatalities/hr**	
Decommissioning		
decommissioning safety rate (fatalities, incidents / x hours) **I	**~1 incident/1 hr, ~1 fatality/66 hrs**	
Total Fatalities (per GW solar installed)	**3.23**	**Fatalities/GW**
*Total Incidents (per GW solar installed) **DO not include const*	**178.59**	**Incidents/GW**
Current Installed Capacity (GW as of 2020)	**97.7**	**GW**
Future Installed Capacity (GW as of 2030)	**419**	**GW (by 2030)**
Capacity Factor	**20.53% (current montly average for 2021)**	

The chart below (Table 1) displays the occurrence of injuries during each life cycle stage.

Occurance of injuries from various life-cyvcle phases ((incidents+fatalities)/hr of work)						
	Manufacturing	Construction/Installation	Maintenance/Operations	Decomissioning	Exctraction	Transportation
Solar PV	0.4	0.0452	0.786	1.015		
Wind	0.4	1.823		1.015		
Hydroelectric	0.4	10.22	1.823	3.08		
Natural Gas	10.22		1.823	3.08	1.485	0.423

The data in the above chart (Table 1) is represented as a graph (Figure 1) displaying the occurrence of incidents and fatalities during each life cycle stage as a percentage.

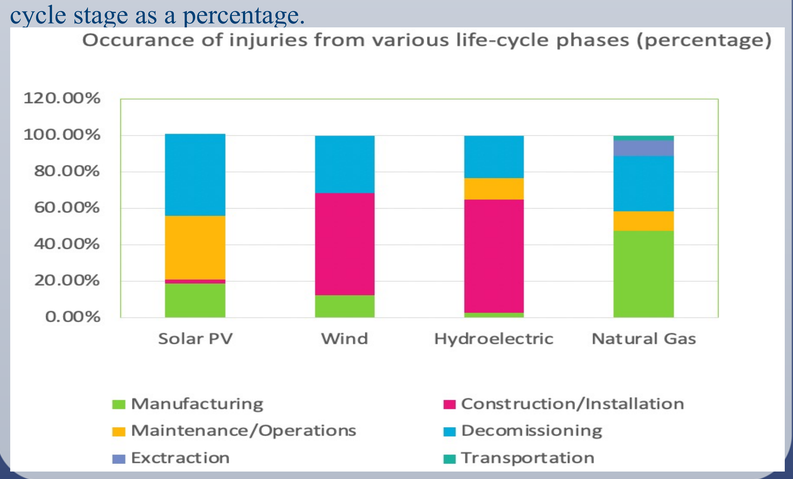

Figure 1 (bottom of previous column: Occurrence of injuries from various life-cycle phases: shows which percentage of incidents comes from which life-cycle stage for each energy type

Table 2 (as shown below) represents the incidents and fatalities per giga watt produced.

Incidents per GW	Solar PV	Wind	Hydroelectri	Natural Gas
Incidents	178.59	474.65	203.17	4200
Fatalities	3.23	6.55	4.8	110

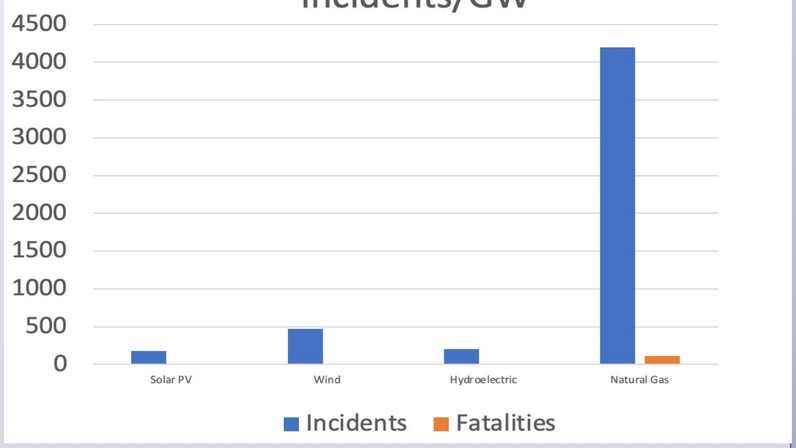

Figure 2: Incidents/GW is a graphical representation of Table 2, visually representing the large disparity between renewables and natural gas

Conclusions

Despite their apparent environmental benefits, renewable energy, much like most other industries, still contain apparent hazards for workers during various stages of their life cycles. While not necessarily concentrated amongst a certain stage for the renewable sources, it can still be seen that one stage (in each particular energy type) tends to dominate the others in terms of incidents.

How will the energy industry change in the future?

- Renewables can potentially account for 70% of the world's energy mix in the next twenty years
- 80% less carbon will be emitted in 2040
- Global energy demands increase by 28% in 2040
  - Will lead to more investment in renewable technology

As seen above, our reliance on renewable energy will only continue to grow. Consequently, it is of utmost importance to ensure the health and safety of the workers within this industry to the greatest degree.

A limitation of this study is the lack of specificity. As more precise data becomes available in the future, this can be amended in order to make the data more accurate.

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