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Data mining and Statistical Review of Optimization Techniques of Hybrid Renewable Energy Systems

Muhammad Imran Khan

ABSTRACT: ***The renewable energy becomes the second-largest source of global electricity worldwide. However, the intermittent nature of RESs (RES)causes great challenges and severed problems regarding system security and reliability. Combining two or more RES in hybrid renewable topologies can overcome these problems and improve the power quality, reliability and increasing the overall system efficiency especially when the combined sources have a complementary nature for each other. For example, Solar Photovoltaic and Wind energy have a complementary nature since they can complement each other in partial failure time and in turn, increases the reliability of the overall system. Optimization techniques are essentially required to optimally coordinate between the combined energy sources, reduce the total system cost, and maximize the extracted power and consequently increasing the total efficiency. Therefore, this paper has a twofold aim which is conducting comprehensive review of the optimization techniques, Software and tools, topologies of hybrid renewable energy systems (HRES)and then applying data mining and statistical calculations to predict the most suitable optimization techniques for a hybrid system composed of Solar PV, Wind Turbine, and battery bank.***

Keywords: Hybrid renewable energy; Photovoltaic; Wind energy; Wind turbine; Data mining, Statistics.

I. INTRODUCTION

The Big Data collected by sensors is a great wealth for forecasting the behavior of running systems under different conditions thereby drawbacks can be resolved or avoided in addition to increasing the enhancement possibilities.

The renewable global status report for the year 2019 shows a continuous increase in the growth rate of renewable energy in power systems worldwide [1].

Fig. 1Chartsthe installed capacity of solar photovoltaic for years from 2008 up to now. It shows the growth rate of solar PV increases significantly from year to year.

On the other hand, Fig. 2 shows the total installed capacity of wind energy sources. It is clear from the figure that, the

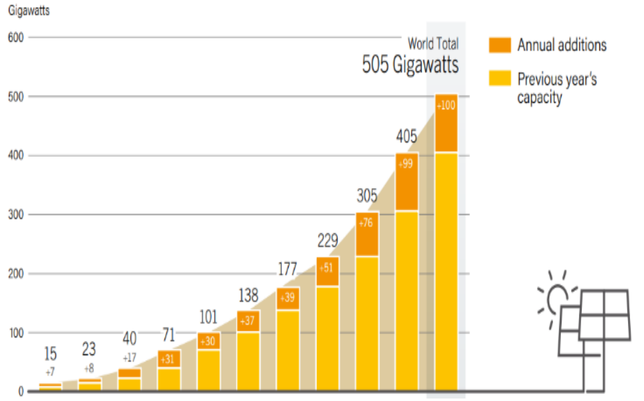

Fig. 1 The installed capacity of solar PV for the last few years

installed capacity of wind energy is highly increasing from year to year. However, the production of these RES is intermittent and depends on weather conditions i.e. Temperature, Irradiance, Wind Speed, etc. So, there are

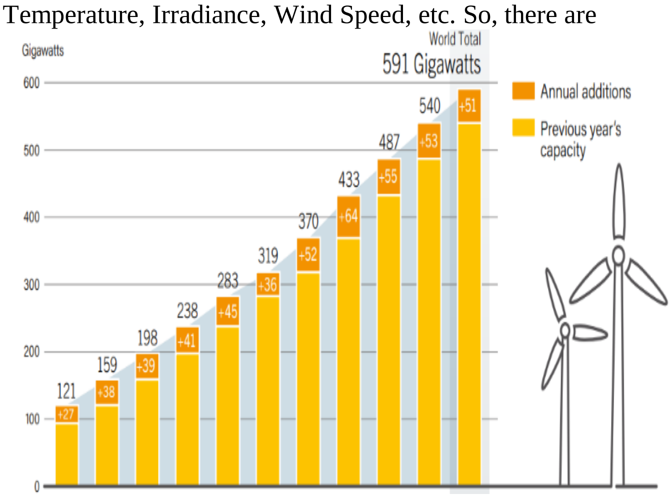

Fig. 2 The installed capacity of wind energy for the last few years

many challenges to overcome this intermittent nature of the output power of RES. Combining two or more RES can overcome these challenges by taking the advantages of the complementary nature of some renewable energy with each other like wind energy and solar energy as shown in fig.3[2]. Optimizing and controlling of HRES is essential for coordination between the combined sources and very important for reducing the size of the system components and satisfying the system security of power demand and quality requirements. Furthermore, HRES controllers are responsible for delivering reliable and stable power and controlling the flow of power and driving the RES to operate at the maximum power point[3].

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***** Correspondence Author
Muhammad Imran Khan*, Department of Electrical Engineering, University of Wollongong, Dubai.

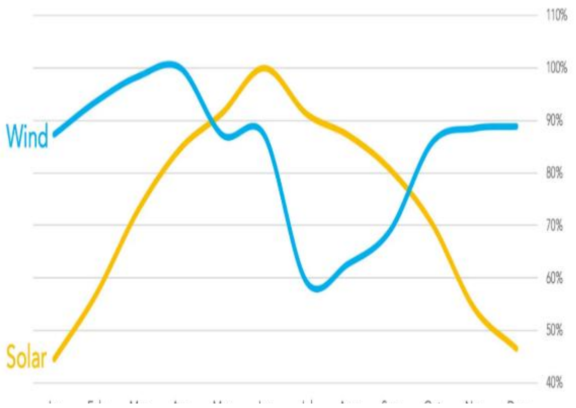

Fig. 3 Complementary nature of wind and solar PV[2].

This paper presents a statistical and datamining based calculations on the resulted data from a comprehensive review of tens of recent researches on HRES control and optimization techniques for concluding the optimum method for controlling HRES composed of PV, Wind, and battery storage for reducing the size of combined components and reducing the total cost with respecting the system security and reliability.

There are many data mining methods i.e. Apriori and FP-Growth. In this paper, the Apriori algorithm is utilized for extracting the Rulesets that decide which optimization and control methods are the most suitable for specific configurations of HRES.

The rest of the paper is organized such that, section 2 reviews dozens of recent researches on HRES including HRES components, Topology, economical optimization method, environmental optimization method, and reliability techniques. Section 3 introduces the methodology of statistical and data mining methodsand the data coding system. Section 4 presents the statistics and datamining extracted rulesets. And section 5 concludes the work and recommends future work,

II. REVIEWSOF HRES

In this section, the bullet information is extracted from dozens of reviewed papers. Table 1 lists the HRES components, its topologies, optimization techniques and methods, software and tools. Besides, the second column presents a unique numerical ID assigned for each item to be used later in statistical and data mining calculations.Table 2 tabulates the extracted data yielded from the conducted survey of tens of papers. Data columns from left to right are: reference number of the reviewed paper, Components of HRES, HRES Topology, environmental optimization method, economical optimization method, Reliability method, optimization method, and the software and or tools were used for optimization.

The extracted information shows that there are many components andseveral topologies of HRES. Also, there are many methods of calculations and evaluation of environmental,economical, reliability, and optimization algorithms in addition to many software tools that are used in the optimization of HRES.By having these data included in a tabular form in one or two pages, dozens of recent researches can be reviewed and referenced for further study. Statistical calculations and data mining algorithms are running the database for getting statistical conclusion and extracting Rulesets of HRES. In the next section, the methodology of statistical and data mining techniques will be introduced.

Table 1: List of the HRES system parameters

HRES Components	**ID**
Solar PV	1
Wind	2
Fuel Cell	3
Hydro	4
Hydrogen Tank	5
Biomass	6
Biogas	7
Biodiesel	8
Diesel	9
Battery	10
Super Capacitor	11
Electrolyzer	12
Topology	**ID**
Stand Alone (SA)	15
Grid-connected (GC)	16
AC Bus	17
DC Bus	18
Hybrid AC/DC	19
Load Dispatch Technique	**ID**
Load Following (LF)	**20**
Cycle Charging (CC)	**21**
Unit Commitment (UC)	**22**
Emission Method	**ID**
CO2	**25**
CO	**26**

SO2	27
NOx	28
Green House Gases GHG	29
Embodied Energy EE	30
Economical Method	ID
Capital Recovery Factor (CRF)	31
Total Annual Cost (TAC)	32
Annual System Cost (ACS)	33
System Total Cost (STC)	34
Cost of Energy (COE)	35
Total Cost (TC)	37
Capital Cost (CC)	38
Total Initial Cost (TIC)	39
Payback Period (PP)	40
Levelized Cost of Energy (LCE)	40
Net Present Value (NPV)	42
Interest Rate of Return (IRR)	43
Cumulative Savings (CS)	44
Life Cycle Cost (LCC)	45
Reliability Method	ID
System Performance Level (SPL)	46
Wasted Renewable Energy (WRE)	47
Total Energy Deficit (TED)	48
State Of Charge (Soc)	49
Loss of Power Supply Probability (LPSP)	50
Correlation Coefficient (CC)	51
Deficiency in Power Supply Probability (DPSP)	52
Loss of Energy Expected (LOEE)	53
Excess Energy (EE)	54
Expected Energy Not Supplied (EENS)	55
Energy Index of Reliability (EIR)	56
Energy Shortfall Probability (ESP)	57
Equivalent Loss Factor (ELF)	58
Final Excess of Energy (FEE)	59
Loss of Load Probability (LOLP/LLP)	60
Loss of Load Risk (LOLR)	61
Energy Fluctuation Rate (K)	62
Loss of Load Hour (LOLH)	63
Unmet Load (UL)	64
Net Dump Energy (NDE)	65
Renewable Energy Penetration (REP)	66
Risk State Probability (R)	67
Percentage of Health(H)	68
Loss of Load Expectation (LOLH)	69
Optimization Algorithm	ID
Linear Programming (LP)	70
Evolution Algorithm (EA)	71
Honey Bee Mating Algorithm (HBMA)	72
Ant Colony (ACO)	73
Genetic Algorithm (GA)	74
Bacterial Foraging Algorithm (BFA)	75
Artificial Immune System (AIS)	76
Tabu Search (TS)	77
Game Theory (GT)	78
Particle Swarm Algorithm (PSO)	79
Simulated Annealing (SA)	80
Simplex Algorithm (SAL)	81
Numerical	82
Iterative	139
Stochastic	83
Probabilistic	84

Parametric Approach (PA)	**85**
Artificial Bee Colony (ABC)	**86**
Fuzzy Logic (FL)	**87**
Graphical Construction (GCA)	**88**
Graphical User Interface (GUI)	**89**
Biography Based Optimization (BBO)	**90**
Bee Inspirit Algorithm (BIA)	**91**
Cuckoo Search (CS)	**92**
Direct Search Algorithm (DSA)	**93**
Gravitational Search Algorithm (GSA)	**94**
Chaotic Search (CHS)	**95**
Flower Pollination Algorithm (FPA)	**96**
Big Bang Big Crunch (BBBC)	**97**
Imperial Competitive Algorithm (ICA)	**98**
Improved Fruit Fly Algorithm (IFF)	**99**
Intuitive Method (IM)	**100**
Last Generation Algorithm (LGA)	**101**
Discrete Harmony Algorithm (DS)	**102**
Enumeration Based Iterative (EBI)	**103**
Grey Wolf Optimization (GWO)	**104**
Differential Evolution Algorithm (DE)	**105**
Exhaustive Search Technique (ES)	**106**
Clonal Search Technique (CST)	**107**
Two Point Estimate Method (TPEM)	**108**
Markov Method (MM)	**109**
Mine Blast Algorithm (MBA)	**110**
Mixed Integer Linear Programming	**111**
Modified Electric System Cascaded (MESC)	**112**
Monte Carlo Method (MC)	**113**
Multi-Objective Programming (MOP)	**114**
Natural Selection (NSA)	**115**
Pareto Optimization (PO)	**116**
Preference Inspired Coevolution	**117**
Trad Off Technique (TOT)	**118**
Analytical Method (AMA)	**119**
Artificial Bee Swarm Optimization (ABSO)	**140**
A-strong algorithm (AS)	**141**
Neural Network (NN)	**142**
Hybrid Teaching learning-based optimization (TLBO)	**143**
Software and Tools	**ID**
Hybrid Optimization Model of Electric Renewable (HOMER)	**120**
GeoSpatial Planner for Energy Investment Strategies	**121**
The Hybrid Power System Simulation Model (HYBRID2)	**122**
Grid-connected Renewable Hybrid Systems Optimization (GRHYSO)	**123**
Hybrid Optimization using Genetic Algorithm (HOGA)	**124**
H2RES	**125**
The General Algebraic Modeling System (GAMS)	**126**
RETSCREEN	**127**
Optimization of Renewable Intermittent Energies with Hydrogen for Autonomous Electrification (ORIENTE)	**128**
RAPSIM	**129**
Dividing Rectangles (DIRECT)	**130**
PVSYST	**131**
Determining Optimum Integration of RES (DOIRES)	**132**
INSEL	**133**

Simulation of Photovoltaic Energy Systems (SIMPHOSYS)	**134**
OPTQUEST	**135**
WDILOG2	**136**
LINDO	**137**
MATLAB	**138**
TRNSYS	**140**

Table 2: Extracted information of Surveying dozens of HRES researches

Reference Number	HRES Components	Topology	Environmental optimization	Economical Optimization	Reliability	Optimization Algorithm	Software / Tools
4	PV WIND DIESEL BATTERY	SA		TAC		DHS	MATLAB
5	PV WIND BATTERY	SA		TIC		PSO	MATLAB
6	PV WIND BATTERY SUPER CAPACITOR	SA		TC	LPSP	GA	MATLAB
7	PV WIND BATTERY	SA		TC	LPSP EENS		HOMER HOGA
8	PV WIND BATTERY	SA		LCOE		ITERATIVE	MATLAB
9	PV WIND BATTERY	GC		NPC		ITERATIVE	MATLAB
10	PV WIND BATTERY	SA		STC		ITERATIVE	MATLAB
11	PV WIND BATTERY	SA		ACS		DHS	MATLAB
12	PV WIND BATTERY	SA		STC		ITERATIVE	MATLAB
13	PV WIND BATTERY	SA		STC		ITERATIVE	MATLAB
14	PV WIND BATTERY FC	SA		STC			HOMER
15	PV WIND BATTERY	SA		NPC		ANALYTICAL	MATLAB
16	PV WIND BATTERY	SA		STC	LPSP		HOMER
17	PV WIND BATTERY	SA		STC	LLP		HOMER
18	PV WIND BATTERY	SA		LCC	LPSP		HOMER
19	PV WIND BATTERY	SA		STC	LPSP		HOMER
20	PV WIND BATTERY	SA		LCOE	LPSP		HOMER
21	PV WIND BATTERY	SA	CO2	NPC LCE		LG	MATLAB
22	PV WIND BATTERY	SA		ACS	LPSP	GA	MATLAB
23	PV WIND BATTERY	SA	EE		LPSP	GA	MATLAB
24	PV WIND BATTERY	SA		ACS	CC	LG	MATLAB
25	PV WIND BATTERY	SA	CO2	COE NPC LCOE		GA	HOMER MATLAB
26	PV WIND BATTERY	DC BUS					HOMER
27	PV WIND BATTERY	AC BUS					HOMER
28	PV WIND BATTERY	HYBRID					HOMER
29	PV–WIND–BATTERY	SA		ACS		SA DHS	MATLAB
30	PV–WIND DIESEL BATTERY	SA				GA	MATLAB
31	PV–WIND–BATTERY	SA		COE	EE	GA TPEM	MATLAB
32	PV –WIND–BATTERY	SA		ACS	LPSP	GA	MATLAB
33	PV WIND BATTERY	SA				GA	MATLAB
34	PV WIND BATTERY	SA		ACS	LPSP	GA	MATLAB
35	PV WIND BATTERY	SA		COE	LPSP	GA	MATLAB
36	PV WIND BATTERY	SA	EE	LCC	LPSP	GA	MATLAB
37	PV –WIND–BATTERY	SA		COE		PSO	MATLAB
38	WIND PV DIESEL BATTERIES FC ELECTROLYZER HYDROGEN TANK	SA				PSO	MATLAB
39	PV WIND DIESEL BATTERY	SA				PSO	MATLAB
40	PV WIND FC BATTERY	SA		COE		PSO TS SA HS	MATLAB
41	PV–WIND–BATTERY	SA		TC		SA	MATLAB
42	PV WIND DIESEL BATTERY	SA				MC ANN	MATLAB
43	PV WIND MICRO HYDRO DIESEL BATTERY	SA AC DC	CO2 NOX CO SO2	NPC		MOP	HOMER
44	PV WIND DIESEL BATTERY	SA	CO2	COE			HOMER
45	PV WIND BIOMASS BATTERY		CO2 NOX	NPC.COE			HOMER
46	PV WIND BATTERY	GC SA		ACS			TRNSYS
47	PV WIND BATTERY	SA GC		ACS	LPSP	PSO	MATLAB
48	PV WIND BATTERY	SA GC		ACS	LPSP	PSO	MATLAB
49	PV WIND BATTERY	SA		ACS	LLP	FL	MATLAB

50	BIOMASS WIND PV	SA	CO2	LCC NPC		GA	
51	BIODISEL WIND PV	SA AC BUS		LCC		HS SA	
52	PV WIND BATTERY	AC DC SA		LCOE	LOLR		
53	WIND PV DIESEL BATTERIES FC ELECTROLYZERHYDROGEN TANK.	SA	CO2	TC NPC	UL	PSO	
54	WIND TURBINES PV PANELS FC S ELECTROLYZERS HYDROGEN TANKS BATTERIES DIESEL GENERATORS	SA		TC NPC ACS	LOEE DPSP	DEA FL	
55	PV WIND BATTERY	SA		LCOE	LPSP		
56	PV WIND BATTERY	SA		TAC	LPSP	EA	
57	PV WIND BATTERY	SA		LCE	LPSP		
58	PV WIND BATTERY	SA			LPSP	GA	
59	PV WIND BATTERY	SA			LPSP	GA	
60	WIND PV BATTERY DIESEL	SA			LPSP	PSO	
61	PV WIND BATTERY	SA		ACS		GA	
62	PV WIND HYDROGEN DIESEL BATTERY	SA	CO2	NPC TC		MOEA GA	
63	PV WIND BATTERY DIESEL	SA		ACS	LPSP	PICEA	
64	PV WIND BATTERY	SA		COE LCE	LPSP	GA	
65	PV WIND BATTERY HYDROGEN	SA		NPC TC LCC	LPSP	GA	
66	PV WIND BATTERY	SA		LCC LCOE		GA	
67	PV WIND BATTERY	SA		LCOE		GA	
68	PV WIND BATTERY	SA		LCC	LPSP	GA	
69	PV WIND DIESEL BATTERY	SA	CO2	LCOE		GA	
70	PV WIND BATTERY	SA				SA	
71	WIND PV BATTERY	SA	CO2	NPC COE			HOMER
72	WIND PV BATTERY			COE TAC			HOMER
73	WIND PV BATTERY			COE PP			HOMER
74	WIND PV BATTERY			NPC COE			HOMER
75	PV WIND BATTERY	SA				GA	
76	PV WIND BATTERY	SA				ANN. FL	
77	PV WIND BATTERY	SA	CO2	COE		FL	
78	PV WIND BATTERY	SA				FL GA	
79	PV WIND BATTERY	SA				GA	
80	PV WIND BATTERY	SA				GA	
81	PV WIND BATTERY	SA				SA	

III. METHODOLOGY

After conducting a comprehensive survey on tens of recent research papers listed in table 2, a statistical calculation will be run on the extracted data and data mining technique will be applied as well on the extracted data for determining the rulesets of HRES. These rulesets are useful forselecting the optimum topology, optimization technique, software tool, economical, reliability, environmental optimization methods and techniques for a specific combination of HRES components.

3.1 statistical method:

The statistical analysis has been done simply by calculating the maximum, minimum, mean, standard deviation, and a correlation between items with each other. In addition, linear regression is applied to the extracted data for calculating the correlation between items as in [82]. The linear relationship between two variables X and Y can be formulated in equation (1,2) where m is the slope of the linear line and c is the intersection with Y-axis. The value "*r*"represents the correlation between the two variables X and Y which representsthe measurements of how much the linearityof the relation between the two variables.

$$Y = mX + c \qquad (1)$$

$$r = \frac{\sum_{k=1}^{N}(X_i - \hat{X})(Y_i - \hat{Y})}{\sum_{k=1}^{N}(X_i - \hat{X})\sum_{k=1}^{N}(Y_i - \hat{Y})} \qquad (2)$$

Where m:The slope.
C:The intersection with y-axis.
$\hat{X}$: The mean value of X.
$\hat{Y}$: The mean value of Y.
r: The regression value.

3.2 Data mining technique

There are two main techniques of data mining which are APRIORI and FP-Growth. The first is easier in implementation and programming and faster in convergence while the second is more accurate but it is more complicated due to processing a tree hierarchical data structure[83,84]. In this paper,

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APRIORI technique has been selected to be utilized for determining the frequent patterns rulesets. Fig. 4 depicts the logic flow of the APRIORI algorithm.

For describing the philosophy of logic of the APRIORI algorithm, two terminologies that should be predefined. The support value which represents the frequency of occurrence of the item within a transaction and the confidence which represents the certainty of the frequency of combined items. In Fig. 4, the logic starts by count the support of items if it is greater than the minimum value of consideration it is proceeding in calculating the confidence of combined items otherwise it discards the transaction and go checking another one. Then it calculates the confidence of the pattern to evaluate it as a frequent pattern or it is less than minimum confidence so it discards the pattern. The process ends after checking all transactions. The output of the process is the frequent pattern with their support and confidence. For simplifying calculations, data has been converted from text format to numerical format by giving each item a unique numerical IDthanks to table 1 at the previous section.Table 3 shows an example of that conversion. In the first row, original data in text format is presented while the second column lists the converted numerical format and the last row displays the final transaction in numerical format whom the data mining algorithm takes as input. In the next section, results are presented and discussed in details.

Table 3 sample of converting data from text format to numerical format

PV WIND BATTERY	SA	LCC	LPSP	GA
1,2,10	15	45	50	74

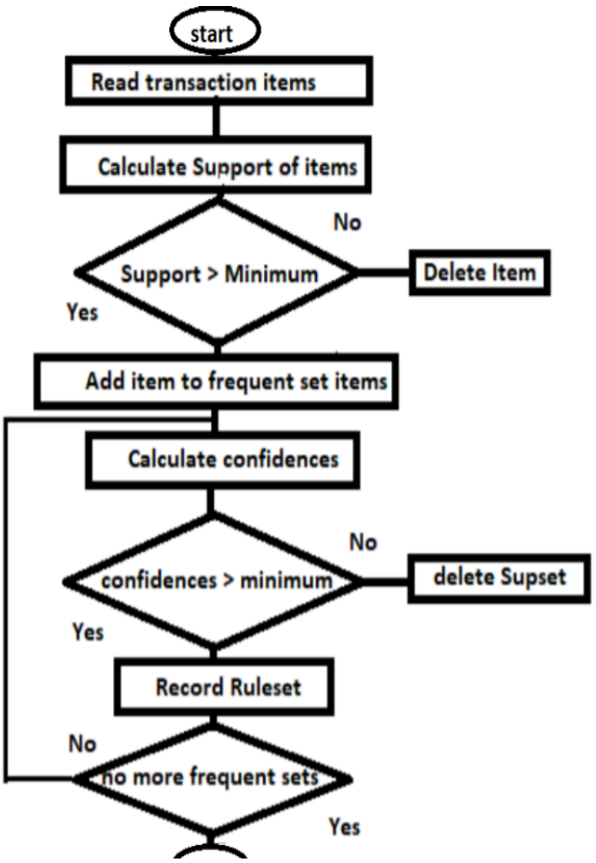

Fig. 4APRIORI frequent pattern algorithm flowchart.

IV. RESULTS AND DISCUSSION

The conducted survey fruits the extracted data in table 2 which lists one record for each reviewed paper extracting the important data like HRES components, optimization algorithms,software and tools, economical, reliability, environmental optimization methods .. etc. The proposed statistical and datamining-based analysis has been run on these pieces of information.

4.1 statistical results Fig. 5 Shows the permutable combinations of HRES components. The combination of PV. Wind and Battery is the most frequently appeared as an HRES of the surveyed papers.

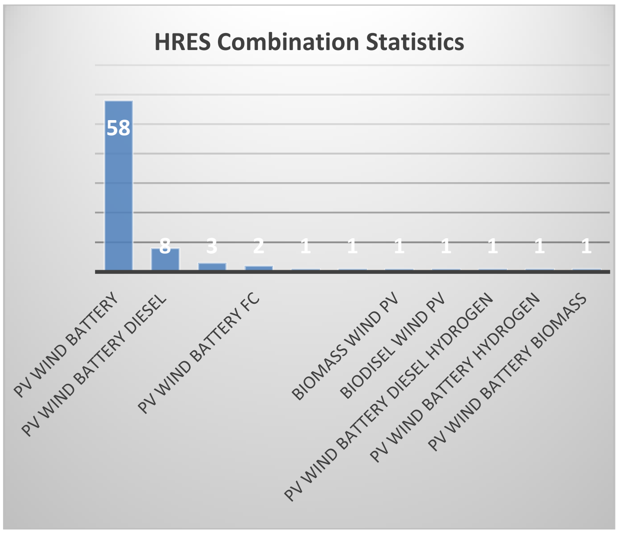

Fig.5 HRES Combination Statistics

Fig. 6 charts the statistics of the HRES topologies used in the surveyed researches. It shows the stand-alone topology is the most frequent. And grid-connected comes next after standalone topology.

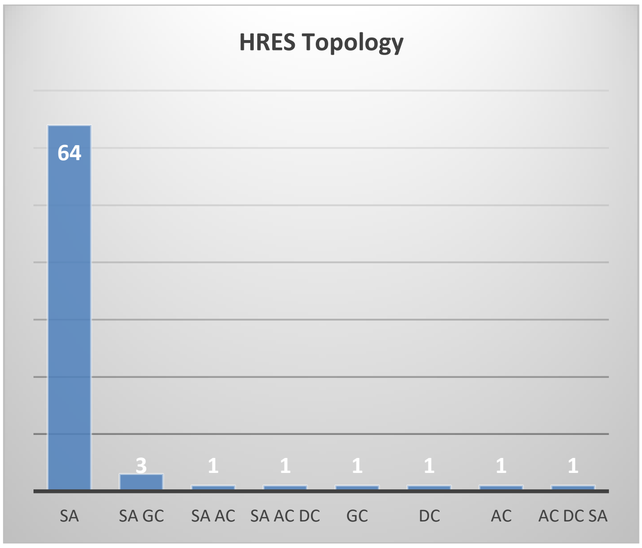

Fig. 6 HRES Topologies Statistics

Fig.7 charts the statistics of the environmental methods. It shows CO2 is the most used for optimizing the environment of the surveyed HRES researches.

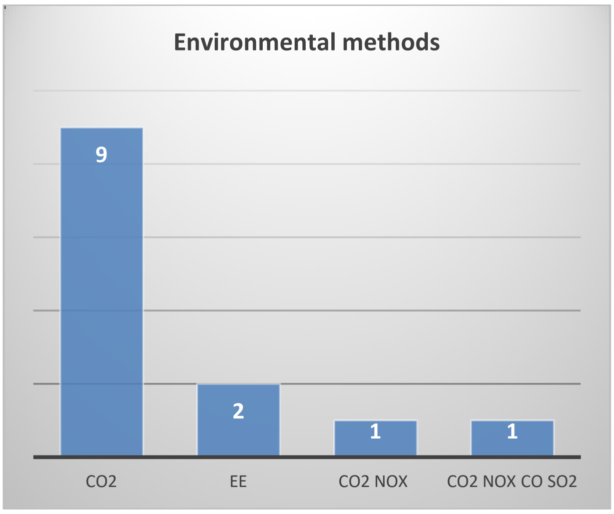

Fig. 7 HRES Environmental Statistics

Fig. 8 depicts the statistics of economical methods. It shows the Annual cost is the most frequent methods used in the survey and then the cost of energy comes in the second position.

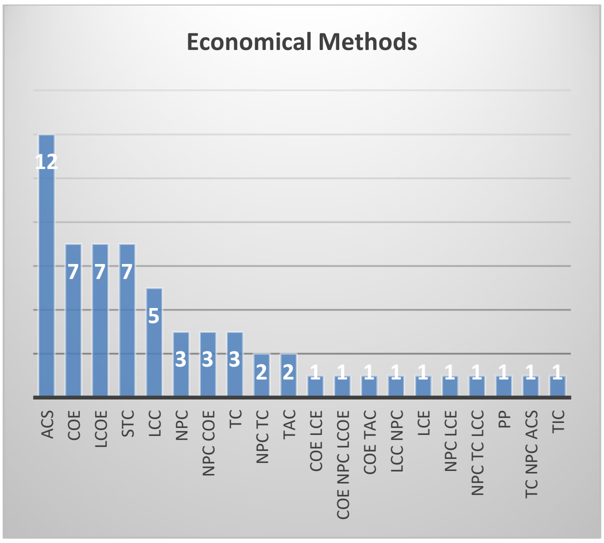

Fig. 8 HRES Economical Statistics

Fig. 9 shows the statistics of reliability techniques of HRES. The Loss of power supply possibility is the most frequently used method in the surveyed researches.

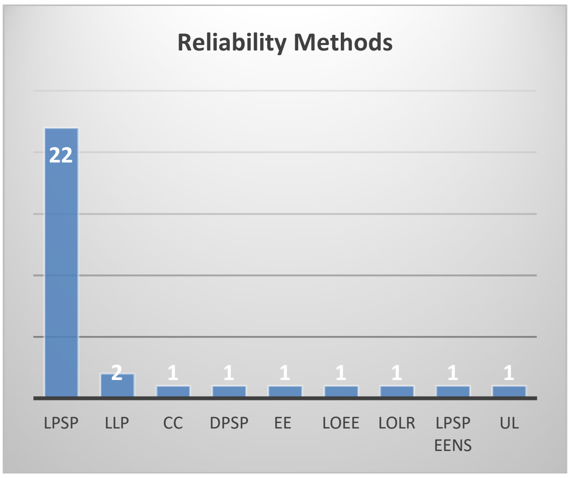

Fig. 9 HRES Reliability Statistics

Fig. 10 charts the statistics of the optimization algorithms. It shows that Genetic algorithms are the most optimization algorithm used in the surveyed researches.

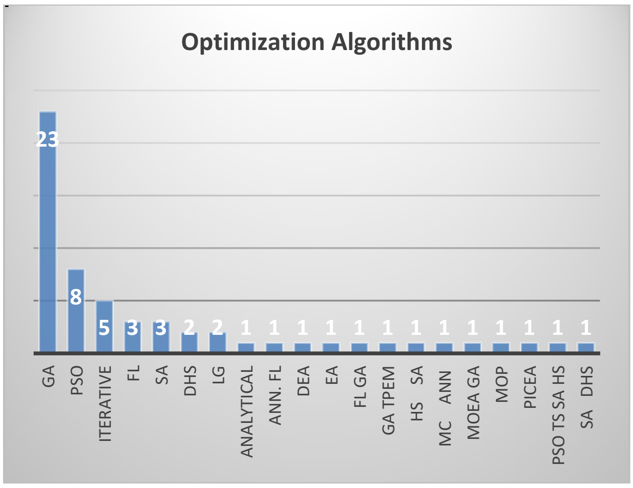

Fig. 10 HRES Optimization Algorithms Statistics

Fig. 11 shows the bar charts of the statistics of the frequent appearance of software and tools used in optimizing HRES system. Matlab is the most frequent software package used in optimizing HRES in the surveyed papers.

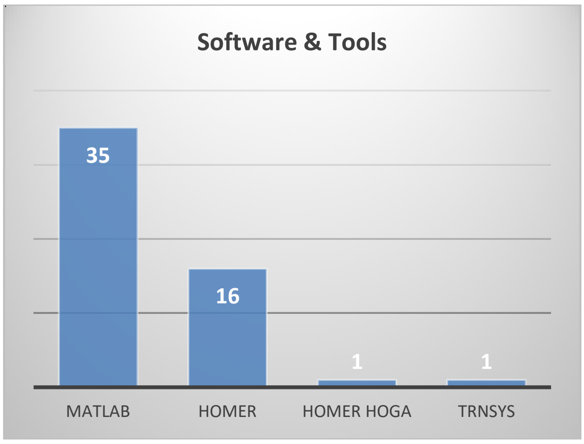

Fig. 11 HRES Tools and Software Statistics

4.2 Data mining Results

The data mining results show the frequent patterns with its support whom APRIORI algorithms determined after running on the extracted data of the conducted survey. Again, the obtained data has been converted from text format to numerical format for facilitating and speed up the convergence of the algorithm. The minimum support has been selected to be 5% which means the items that have been represented in 5% or above of the total number of transactions will be considered otherwise it will be not be considered for processing. Fig. 12 reports the output of running the APRIORI algorithm. It shows that candidate count is 368 and frequent itemsets are 238. Processing took 100ms and 75.3557 MB of memory. Moving to the results, the pattern of PV, wind, and Battery has the greatest support 220. Results shows also the frequent pattern of PV,Wind,Battery in SA topology has the support of 201 which means SA is the most frequent pattern same as the statistical analysis results.

Besides, the third frequent pattern was PV,Wind, Battery , SA, and Matlab with support 106 which means Matlab is the most software package used in optimization HRES composed of PV, Wind, and Battery. Also, it comes next in order of the most frequent pattern the PV, Wind, Battery, and ACS with support 58 which shows the annual system cost is the most economical optimization method used with PV, Wind, Battery HRES. For reliability, the loss of power supply possibility was the most frequent reliability method for optimizing HRES composed of PV, Wind, and Battery with support 56.

Candidates count	368	
Frequent item sets count	238	
Maximum memory usage	75.5377mb	
Total time	100 ms	
Itemset (Numerical format)	**Itemset (character format)**	**Support**
1, 2, 10	PV Wind Battery	220
1,2,10,15,	PV Wind Battery SA	201
1,2,10,138,	PV Wind Battery MATLAB	106
1,2,10,15,138,	PV Wind Battery SA MATLAB	103
1,2,10, 33,	PV Wind Battery ACS	58
1,2,10,120,	PV Wind Battery HOMER	58
1,2,10,50,	PV Wind Battery LPSP,	57
1,2,10,15,50,	PV Wind Battery SA LPSP,	56
1,2,10,35,	PV Wind Battery COE	55
1,2,10,15,42,	PV Wind Battery SA NPV	53
1,2,10,15,35,	PV Wind Battery SA COE	48
1,2,10,15,120,	PV Wind Battery SA HOMER	45
1,2,10,74,	PV Wind Battery GA	44
1,2,10,25,	PV Wind Battery CO2	43
1,2,10,37,	PV Wind Battery TC	43

Fig. 12 The Frequent pattern report from running the Apriori Algorithm

V. CONCLUSION

Investigating the most recent renewable energy global reports showed that, renewable energy sources occupied the second position in electricity production thanks to the greatest two sources which are PV and Wind. In addition, surveying dozens of the most recent researches of HRES yielding a big database by extracting the most important pieces of information like HRES components, Topologies, optimization techniques, software and tools, economical, environmental, and reliability optimization methods. Furthermore, by applying statistical and data mining based calculations on the extracted data, a statistics and frequent pattern rule sets have been resulted to show most frequent patterns of HRES component, topology, optimization algorithm, economical, environmental, and reliability calculation methods. The results showed in the form of bar charts for the statistical results and frequent pattern with frequent support value for the data mining work. Data mining work has been done by utilizing the APRIORI algorithm. The results of statics and data mining were aligned which validate the concluded rulesets. They showed that the HRES composed of PV, Wind, Battery is the most frequently used; the standalone is the most frequent topology; the Genetic algorithm is the most used optimization algorithm; the annual system cost is the most frequently used optimization method for economics; the CO_2 is the most frequently used for environmental optimization; the loss of power supply possibility is the most frequently used for reliability optimization of HRES. By having the extracted data yielded from surveying tens of the most recent papers on HRES and the results from statistical and data mining calculations, there is a source of the most important information of dozens of research papers in tabular form in one page in addition to the concluded results in form of charts and frequent patterns to help in deciding the best optimization parameters of HRES.

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AUTHOR PROFILE

Muhammad Imran Khan is Electrical engineer who has got his master degree of Electrical engineering from university of Wollongong (UOW) 2017-2019.