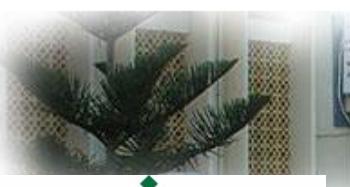


Presentation

Mohamed Ali Abuella
mhdabuella@gmail.com



UNC CHARLOTTE
Energy Production and Infrastructure Center (EPIC)



كلية التقنية الصناعية_ مصراتة

The College Of Industrial Technology_Misurata



HALMSTAD
UNIVERSITY



Northumbria
University
NEWCASTLE



Presentation Outline



Introduction

Mohamed Abuella

<https://mohamedabuella.github.io>

<https://www.linkedin.com/in/mohamed-abuella/>

About Me..

An electrical engineer by training, traditionally is interested in Mathematical and Computational Analysis, Modeling and Optimization, and who is recently passionate in Artificial Intelligence and Data-driven Analytics.

A researcher works to modernize the electric grid and optimize its integration of distributed energy resources by applying descriptive, predictive and prescriptive analytics.

His broader interest involves utilizing Artificial Intelligence to foster Sustainability.

An adaptative to work in a diverse environment for an interdisciplinary research.

Introduction

<https://mohamedabuella.github.io/cv>

To sum it up in a broad sense, let's imagine that.. If my professional development was a book, its title would be "**Energy Systems Modeling and Analysis: Operation, Planning, and Integration.**"

Thus, the chapters of this book would be as follows:

Ch.1 Fundamentals of Electrical Engineering. This chapter covers Instrumentation & Control, Basics of Power Electronics such as Diodes & Thyristors as rectifiers, (maneuvered by applying Laws of Physics). With getting hands-on electrical installation & wiring and maintenance of electrical control equipment at pumping stations.

Ch.2 Power Systems Analysis. It includes Power Flow and Faults Calculations, (applying Numerical Analysis methods, such as Newton methods, Differential eqs & Integrals, etc). Get hands-on some simulations of power systems and programmable logic controllers (PLC).

Ch.3 Optimal Power Flow (OPF) and Security-Constrained Economic Dispatch (SCED). It is considering renewables as well, specifically for wind energy resources at the transmission level, (applying Optimization techniques). Get hands-on more of modeling and analysis of power systems.

Ch.4 Optimize the Integration of Renewables into the Grid. Solar Power Modeling and Forecasting, (applying Descriptive, Predictive and Prescriptive Analytics, AI and ML techniques). Get hands-on data-driven analytics and become more familiar with conducting & publishing research.

Ch.5 Postdoctoral Researcher at the Center for Applied Intelligent Systems Research (CAISR) at Halmstad University, (Integrated Academy-Industry Collaboration, Applying AI techniques). Dig into research on AI for Sustainability.

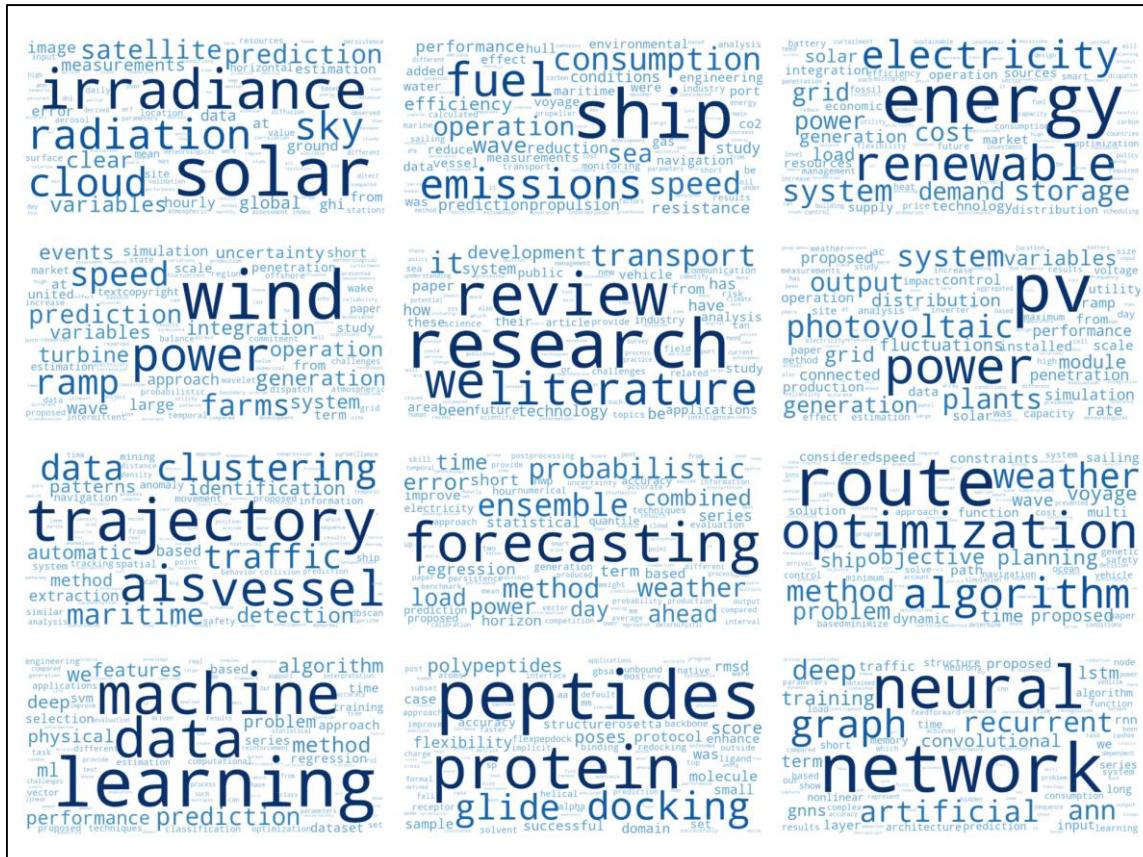
Ch.6 Research Fellow at Northumbria University in HI ACT: Hydrogen Integration for Energy

Introduction

In a nutshell, what I am often doing is finding the optimal & root values and curve fitting of nonlinear equations.

..But usually it is not as simple as that!

For more details, you may have a look at pdf copies of my [CV](#) and [Cloud of Key Skills & Interests](#).



Introduction

What can I bring to the team..?

- Transfer knowledge and skills to integrate the collaboration between academy and industry:
 - ✓ Energy Systems Modeling & Analysis, Optimization, AI, Geospatial Analysis.
 - ✓ Including Transportation and Maritime Systems.
 - ✓ Including Water and Wastewater experience
- An adaptatively to diverse environment and flexibility to multidisciplinary research:
 - ✓ Study and work in Middle East (Libya): Engineering, Electricity, Water and Wastewater.
 - ✓ Study and work in North America (USA): Energy, Optimization, Statistics, AI.
 - ✓ Work in Europe (Sweden): Energy, Transportation, Maritime, AI.

Motivation

- Professional Advancement
 - ✓ Get an opportunity to collaborate and work with the experts of the field.
 - ✓ To transfer, improve, and acquire knowledge and skills.
- Personal Advancement
 - ✓ Better alignment with personal values and interests.
 - ✓ Better self-esteem.
 - ✓ Better financial security.

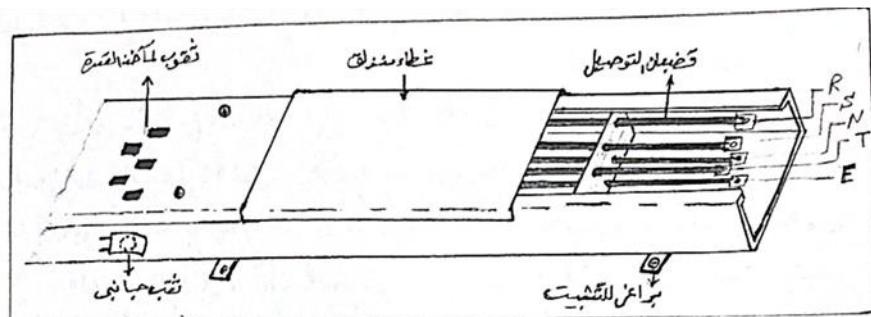
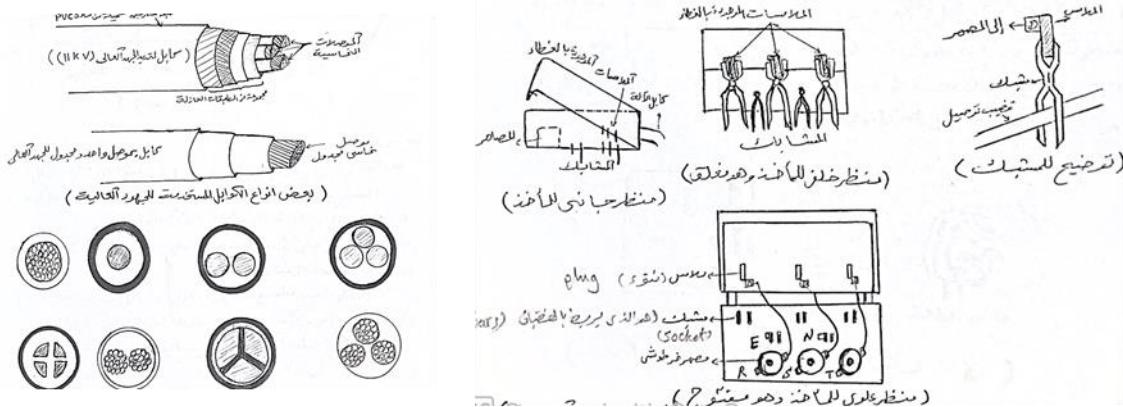
Research

Technical Report of Operation & Maintenance, Internship at Shoes Factory in Misurata, Libya

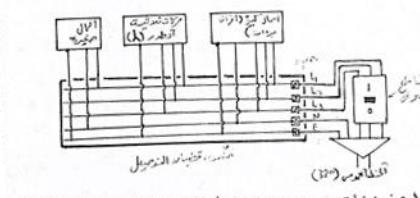
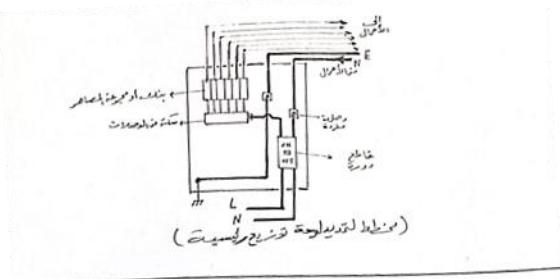
https://www.researchgate.net/publication/344772515_Technical_report_of_maintenance_and_operation_internship_at_shoes_factory_in_Misurata_Libya

Mohamed Abuella, 2000 at Higher Center of Poly-Profession, Misurata, Libya

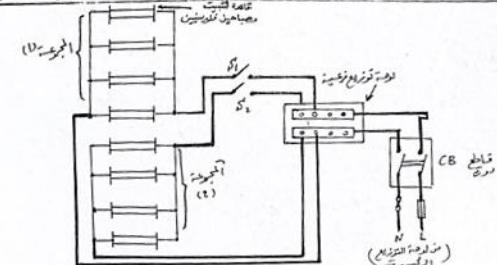
Electrical Operation & Maintenance for fulfilling requirement of the Higher Diploma



(حىندر طولى بى قىچىلەنلىقىمىل)



مختلط لتقديره صناديق المحتفظات الترسانية بمراحله بمخطط الرؤساء



مخطط لقرص إنشاء نسخة المخطوطة المائية

Research

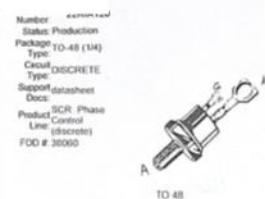
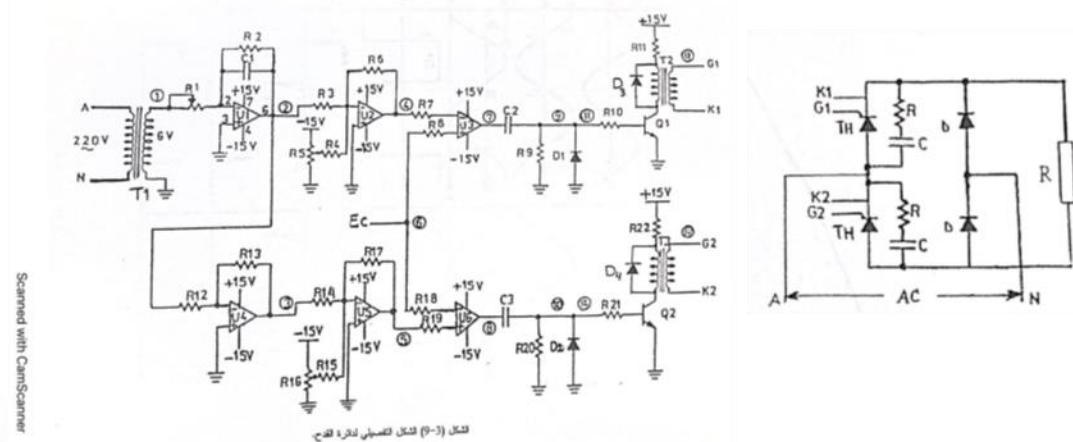
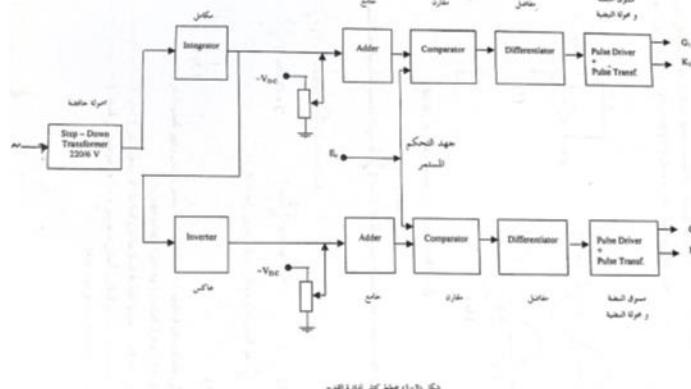
Triggering Circuit for SCR Thyrists of an AC-DC Converter

https://www.researchgate.net/publication/277109663_Triggering_Circuit_for_SCR_Thyristors_of_an_AC-DC_Converter

Mohamed Abuella, Ali Mohamed, Al Sayed Hamady, Advisor: Safa Samarmad
Tech Diploma Project, 2001 at Higher Center of Poly-Profession, Misurata, Libya

Higher Diploma project was in Power Electronics area. Since the task of the project of three-members-group was to build a triggering electronic circuit for a rectification bridge of Thyristors

Acquired Expertise: Electrical Wiring & Installations, Maintenance & Operation



Parameter	Limit	Units	Condition	Value
VDRH	MIN	Volts	NA	1200
IT(RMS)	MAX	Amps	NA	35
IT(av) comp. (a)	MAX	Amps	NA	22
@ TC	—	°C	NA	85
ITSM (50Hz)	MAX	Amps	NA	335
ITSM (60Hz)	MAX	Amps	NA	355
Vgt	Max	Volts	NA	2
Igt	Max	mA/mos	NA	60
VTM comp. (a)	MAX	Volts	NA	1.7
@ ITM comp. (a)	—	Amps	NA	70
DV/dt	MAX	Volts	NA	300
Rth(JC)	MAX	m°C/W	NA	80

Research

Study of NEPLAN Software for Power Flow and Short Faults Analysis

https://www.researchgate.net/publication/277110587_Study_of_NEPLAN_Software_for_Load_Flow_and_Short_Faults_Analysis/stats



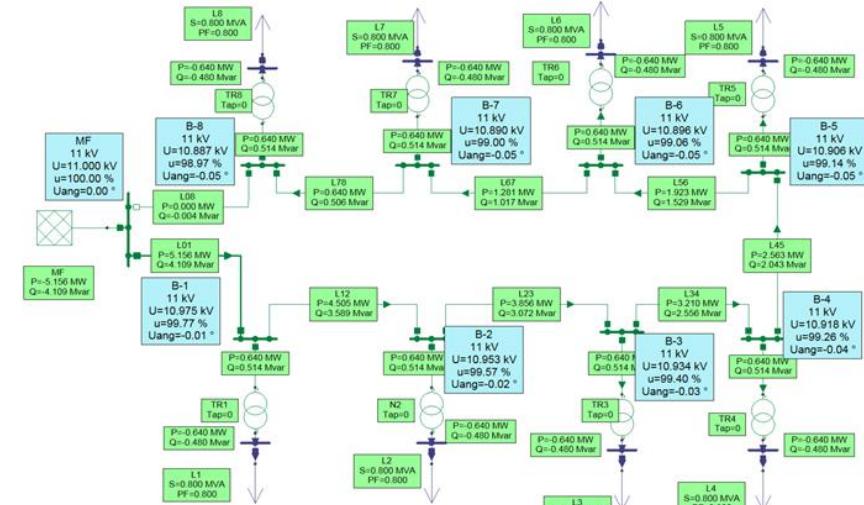
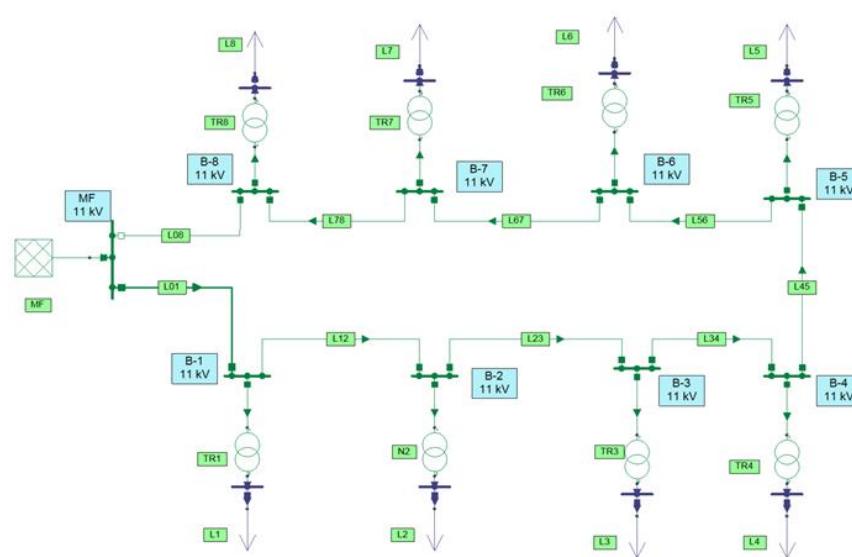
B.Tech Project, 2008 at College of Industrial Technology, Misurata, Libya

Advisor: Mohamed Shetwan

Acquired Expertise: Teaching, Tutorials, Lab Modeling & Simulations, Curriculum Revision & Preparation, Dedication, Listening, "Try to Modeling the Student's Way of Thinking."

Software Tools including: MS Office, MATLAB, NEPLAN, PLC's Ladder Logic

• حساب سريان القدرة لشبكة التوزيع:



النتائج ظاهرة على مخطط شبكة التوزيع الكهربائية (11/0.4 KV) للوحدات السكنية

Research



SMART GRID, Seminar

<https://www.slideshare.net/MohamedAbuella/smart-grid-37661484>

Smart Grid Presentation in Seminar Course, 2012 at Southern Illinois University at Carbondale

Study of particle swarm for optimal power flow in IEEE benchmark systems including wind power generators

<https://www.proquest.com/openview/21da3b4335a4c23278e9bd91d67a7784/1?pq-origsite=gscholar&cbl=18750>

Master of Science Thesis, 2012 at Southern Illinois University at Carbondale, USA

Advisor: Constantine Hatziadoniu

Acquired Expertise: Power Systems Analysis, Operation and Planning, Systems Optimization, Smart Grid, Research Conducting, Software Tools: MATPOWER, PowerWorld, PSAT, LaTeX

Research

Study of particle swarm for optimal power flow in IEEE benchmark systems including wind power generators

<https://www.proquest.com/openview/21da3b4335a4c23278e9bd91d67a7784/1?pq-orignsite=gscholar&cbl=18750>



Master of Science Thesis, 2012 at Southern Illinois University at Carbondale, USA
Advisor: Constantine Hatziadoniu

$$J_{Min} = \sum_i^M C_i(p_i) + \sum_i^N C_{wi}(w_i) + \sum_i^N C_{p,i}(w_i) + \sum_i^N C_{r,i}(w_i)$$

Subject to: Where: $C_i = a_i P_i^2 + b_i P_i + c_i$

$$p_{i,\min} \leq p_i \leq p_{i,\max}$$

$$C_{w,i} = d_i w_i$$

$$0 \leq w_i \leq w_{r,i}$$

$$C_{p,i} = k_{p,i} \int_{w_i}^{w_{r,i}} (w - w_i) f_W(w) dw \text{ (underestimation)}$$

$$\sum_i^M p_i + \sum_i^N w_i = L$$

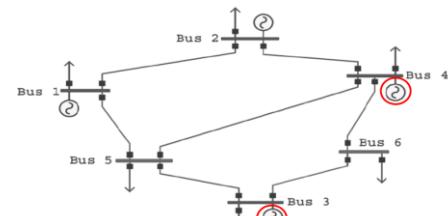
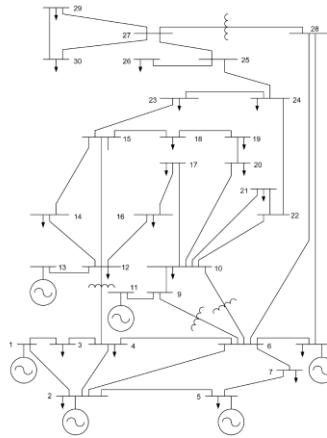
$$C_{r,i} = k_{r,i} \int_0^{w_i} (w_i - w) f_W(w) dw \text{ (overestimation)}$$

$$S_{line,i} \leq S_{line,i}^{\max}$$

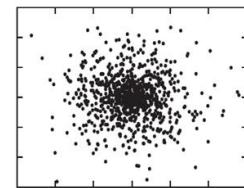


$$C_i = a_i P_i^2 + b_i P_i + c_i$$

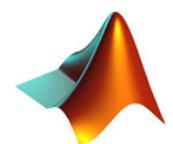
$$C_{w,i} = d_i w_i$$



Gen. No.	a (SMW ⁻² .hr)	b (SMW.hr)	c	P _{G_low} (MW)	P _{G_high} (MW)
1	0.012	12	105	50	250
2	0.0096	9.6	96	50	250
3	0	8	0	0	40
4	0	6	0	0	40



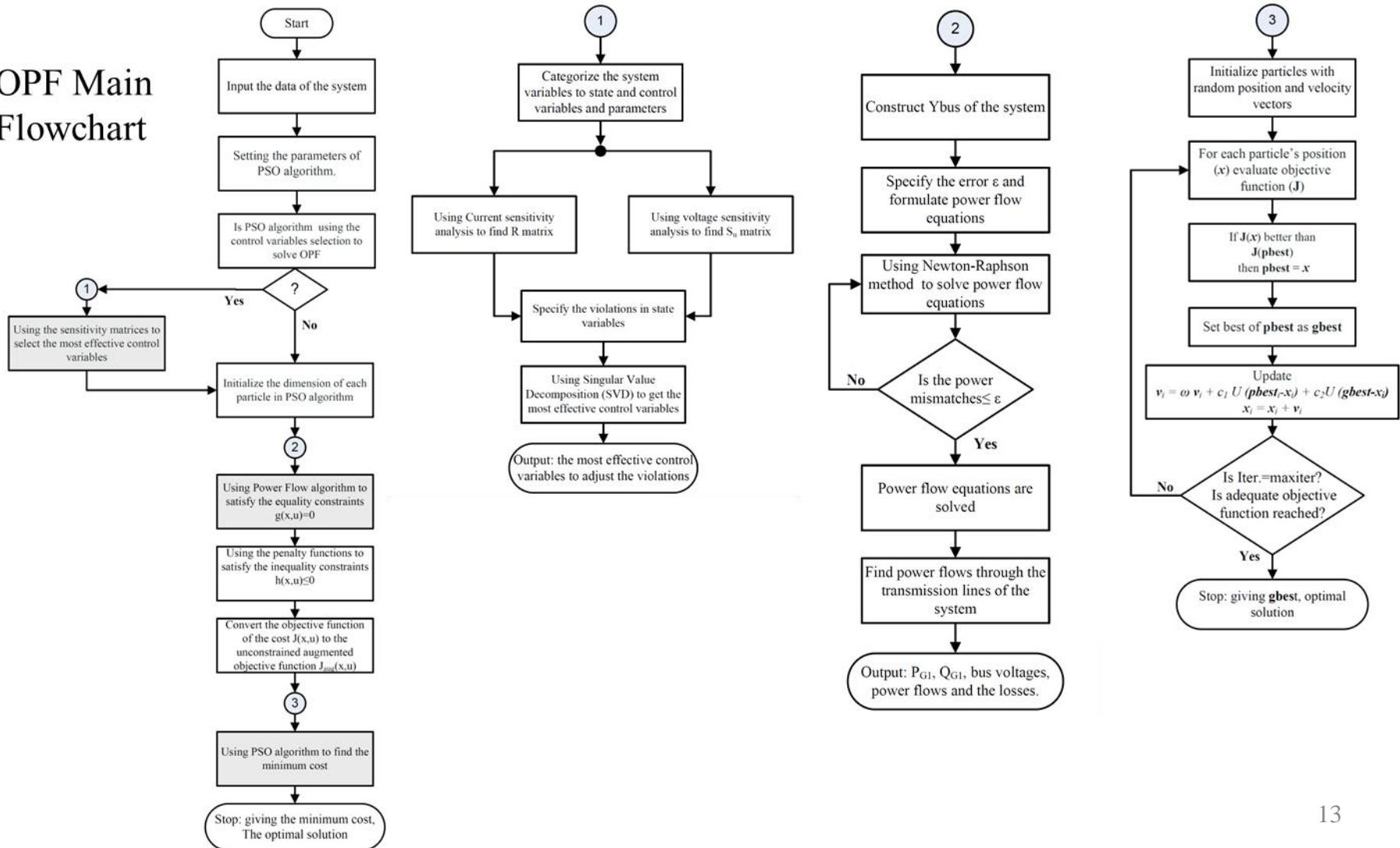
Particle Swarm Optimization (PSO) algorithm is used for solving this optimization problem.



Research

Study of particle swarm for optimal power flow in IEEE benchmark systems including wind power generators

OPF Main Flowchart



Research

A Post-Processing Approach for Solar Power Combined Forecasts of Ramp Events

<https://www.proquest.com/openview/42049145119c7760f93ea736b37a0930/1.pdf?pq-orignsite=gscholar&cbl=18750>

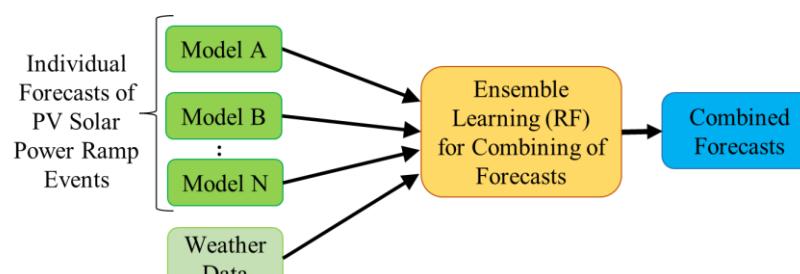
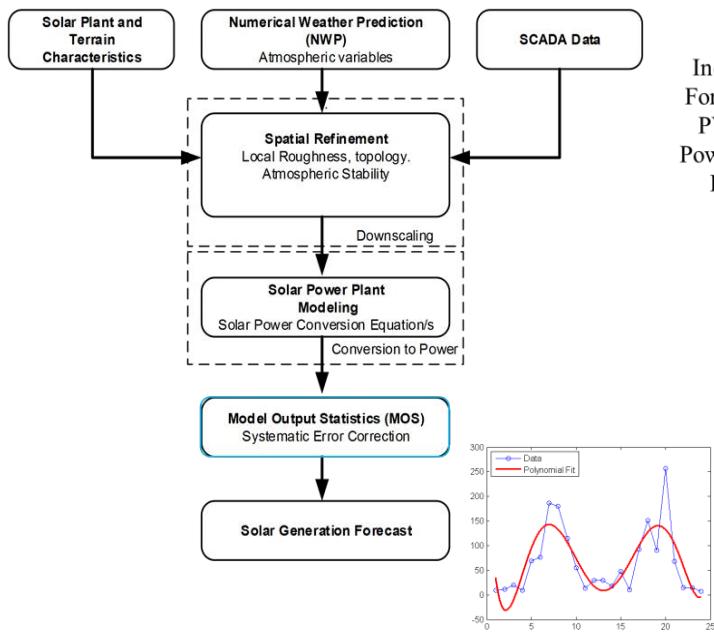
PhD Thesis, 2018 at University of North Carolina at Charlotte, USA

Advisor: Badrul Chowdhury



UNC CHARLOTTE

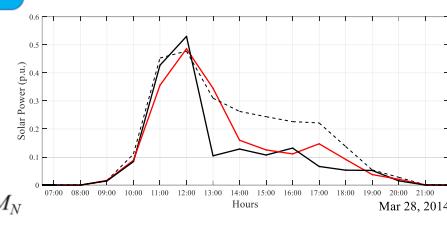
Acquired Expertise: Energy Analytics, Energy Markets, Renewable Energy Integration, Asset & Supply Chain, Time Series Analysis & Modeling, Risk & Uncertainty Quantification, Machine Learning, Big-Data Processing, Research Publishing & Peer Reviewing, Software Tools including SAS, R, and Python



General diagram of combining different models

$$F_{comb} = W_A * M_A + W_B * M_B + W_C * M_C + \dots + W_N * M_N$$

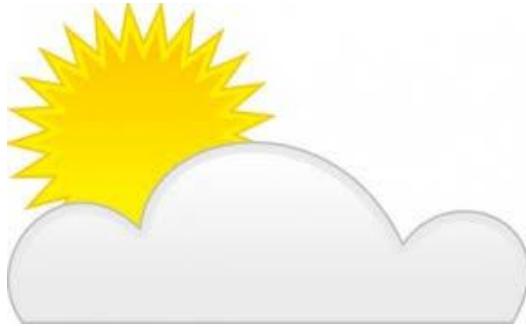
Method of Combining The Models → Random forest (RF) is chosen to be the **ensemble learning** method for combining the various models' outcomes.



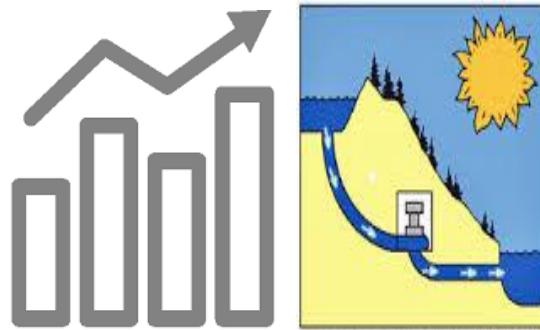
Research

$$P_{\text{Supply}} = P_{\text{Demand}} + P_{\text{Loss}}$$

PV Solar Power Generations are Too Variable



Coordination with Operating Reserves and Energy Storage Systems



Reducing Cost and Pollution

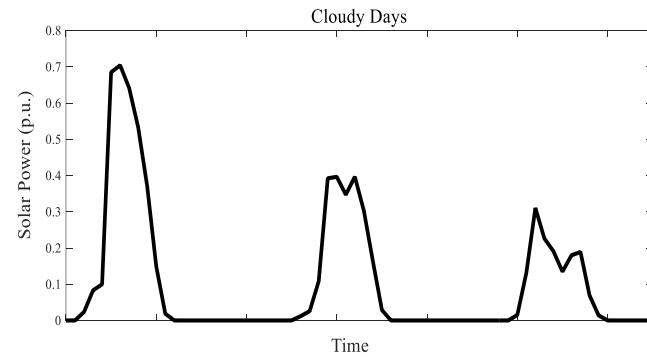
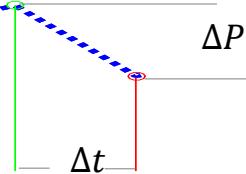


Illustration of the motivation of PV solar power forecasts

Research

Solar power ramp rate (RR) is *the change of solar power during a certain time interval*.

$$\text{Ramp Rate, } RR(t) = \frac{dP(t)}{dt} = \frac{P(t + D) - P(t)}{D}$$



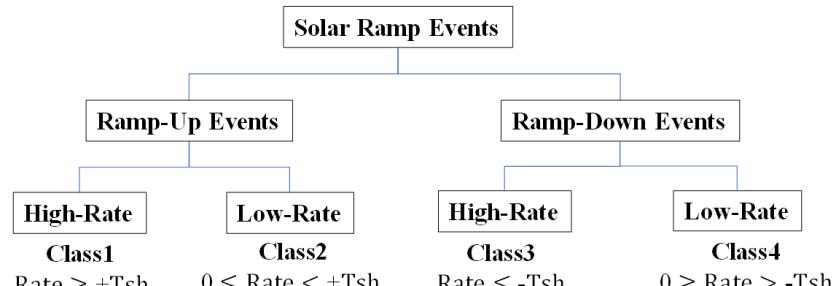
where $P(t)$ is the solar power of the target hour, it can also be its forecast $F(t)$; D is the time duration for which the ramp rate is determined.

For the illustrated cloudy day below:

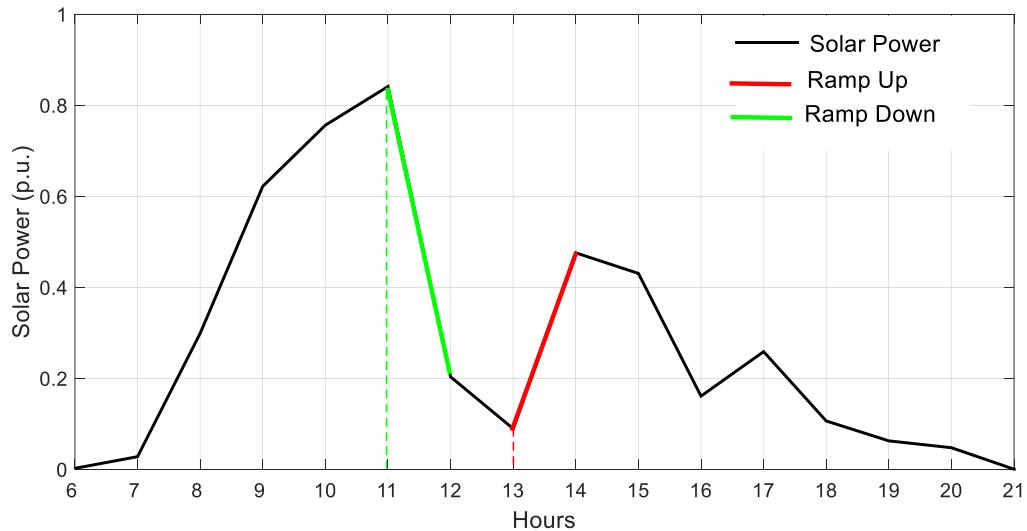
Ramp rate, $\frac{\Delta P}{\Delta t} = \frac{0.2 - 0.85}{12:00 - 11:00} = -0.65$ (-65%) *ramp down of its normal capacity, (pu/hr)*

Ramp rate, $\frac{\Delta P}{\Delta t} = \frac{0.48 - 0.1}{14:00 - 13:00} = +0.38$ (+38%) *ramp up of its normal capacity, (pu/hr)*

Some ramps are with low rates, while others with high rates.



Distribution of the classes of solar power ramp events



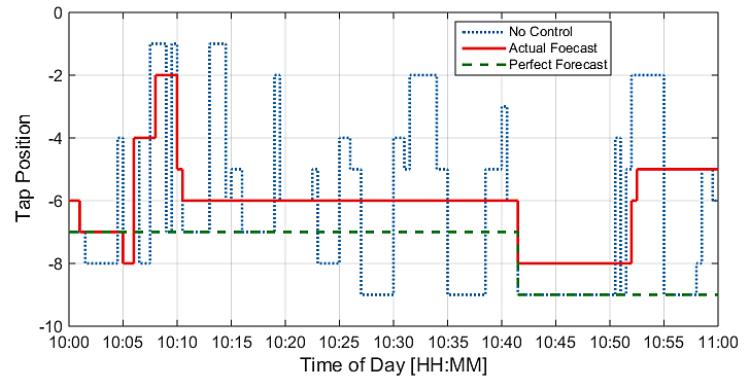
Ramp Events During a Cloudy Day

Research

There are several applications of power systems that rely on solar power ramp event forecasts

Distribution level:

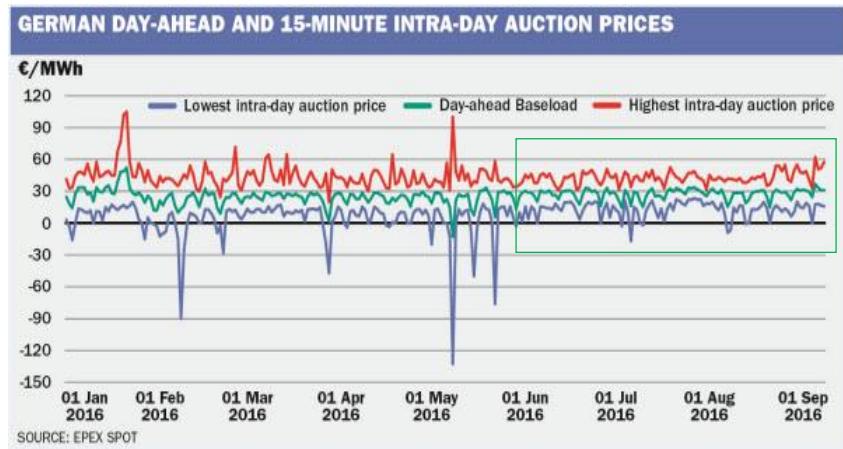
- Optimizing the voltage regulation equipment.
- Control schemes of energy storage systems.



Optimizing the Transformer's Tap Changer position sequences using the solar forecast

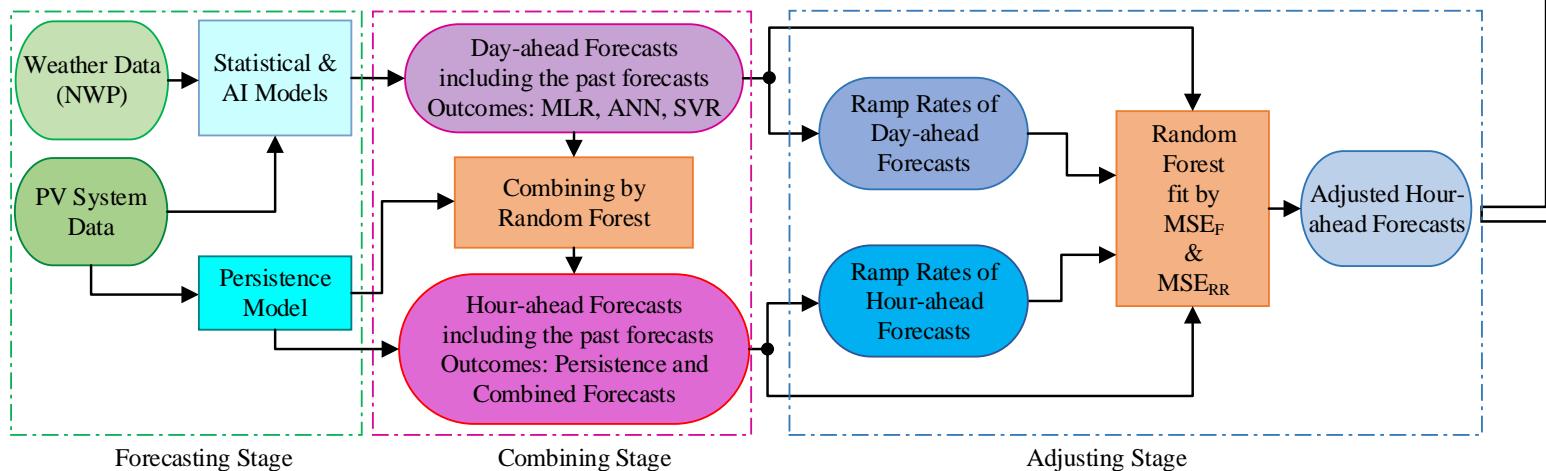
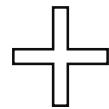
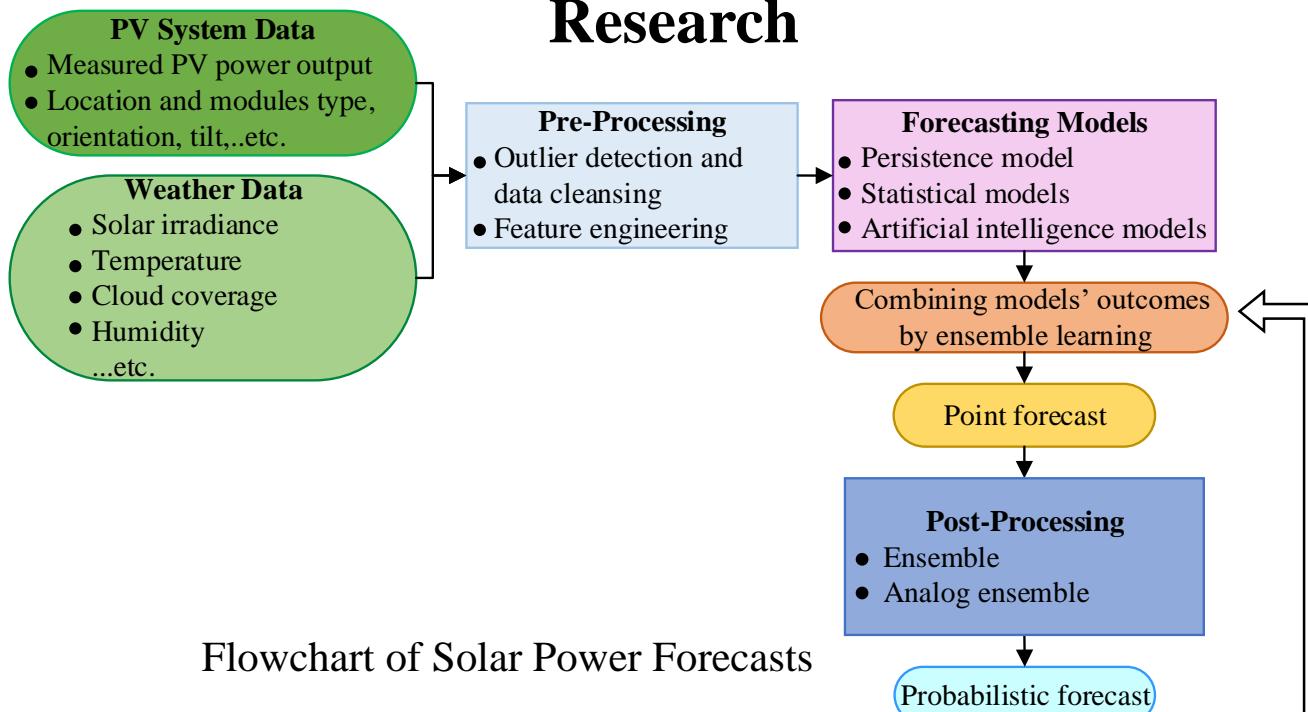
Transmission / bulk level:

- Trading & dispatching the operating reserve.
- Managing the ramp capability / system flexibility with high-level of renewable energy integration.

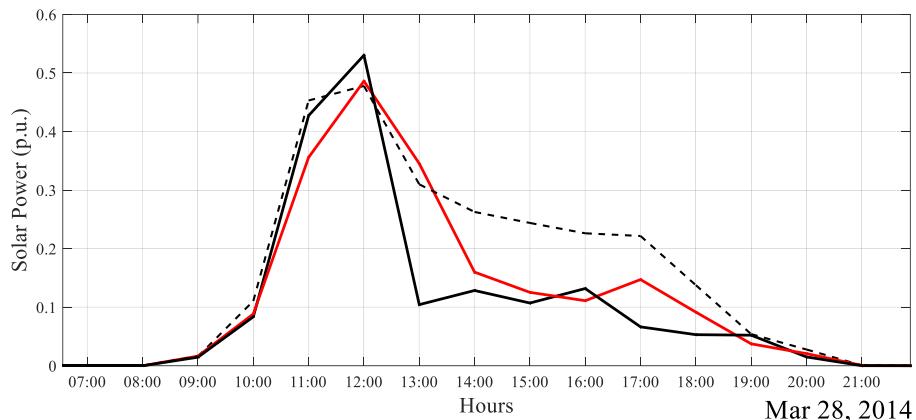
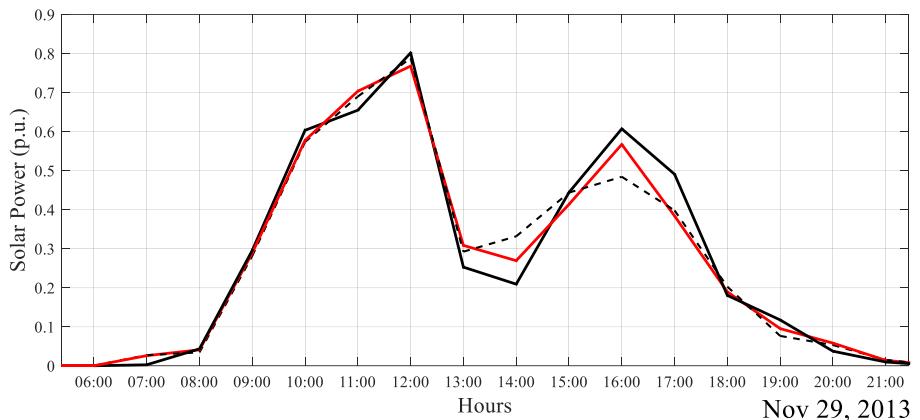
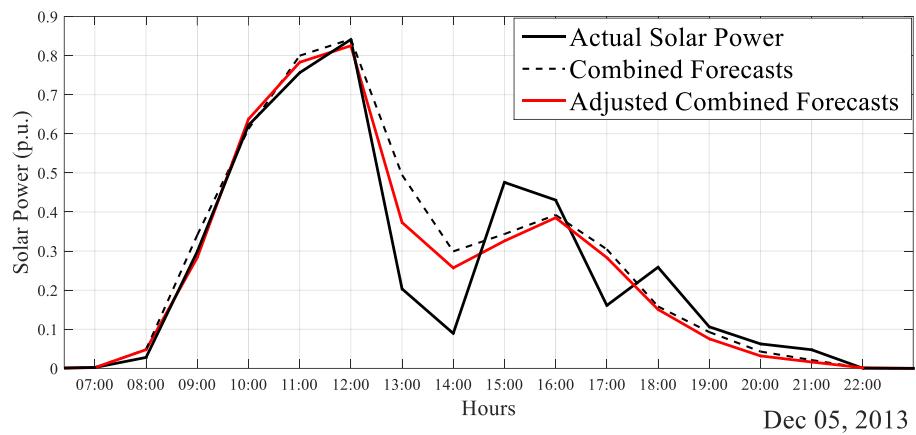
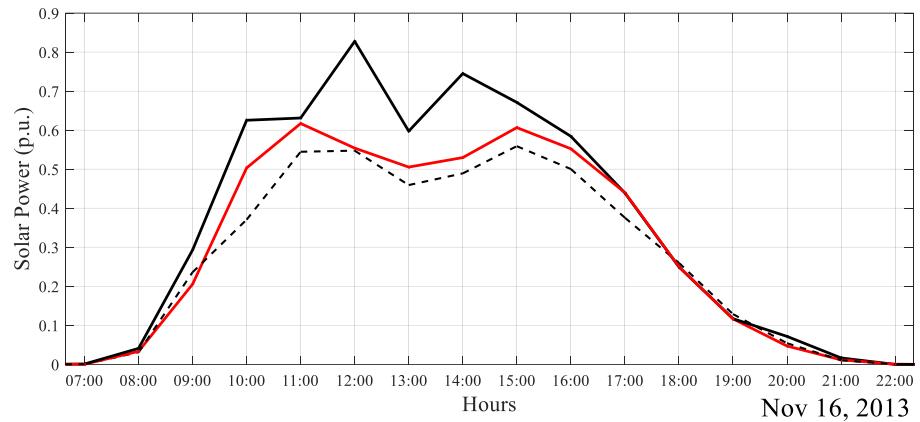


EPEX: European power exchange spot trading

Research

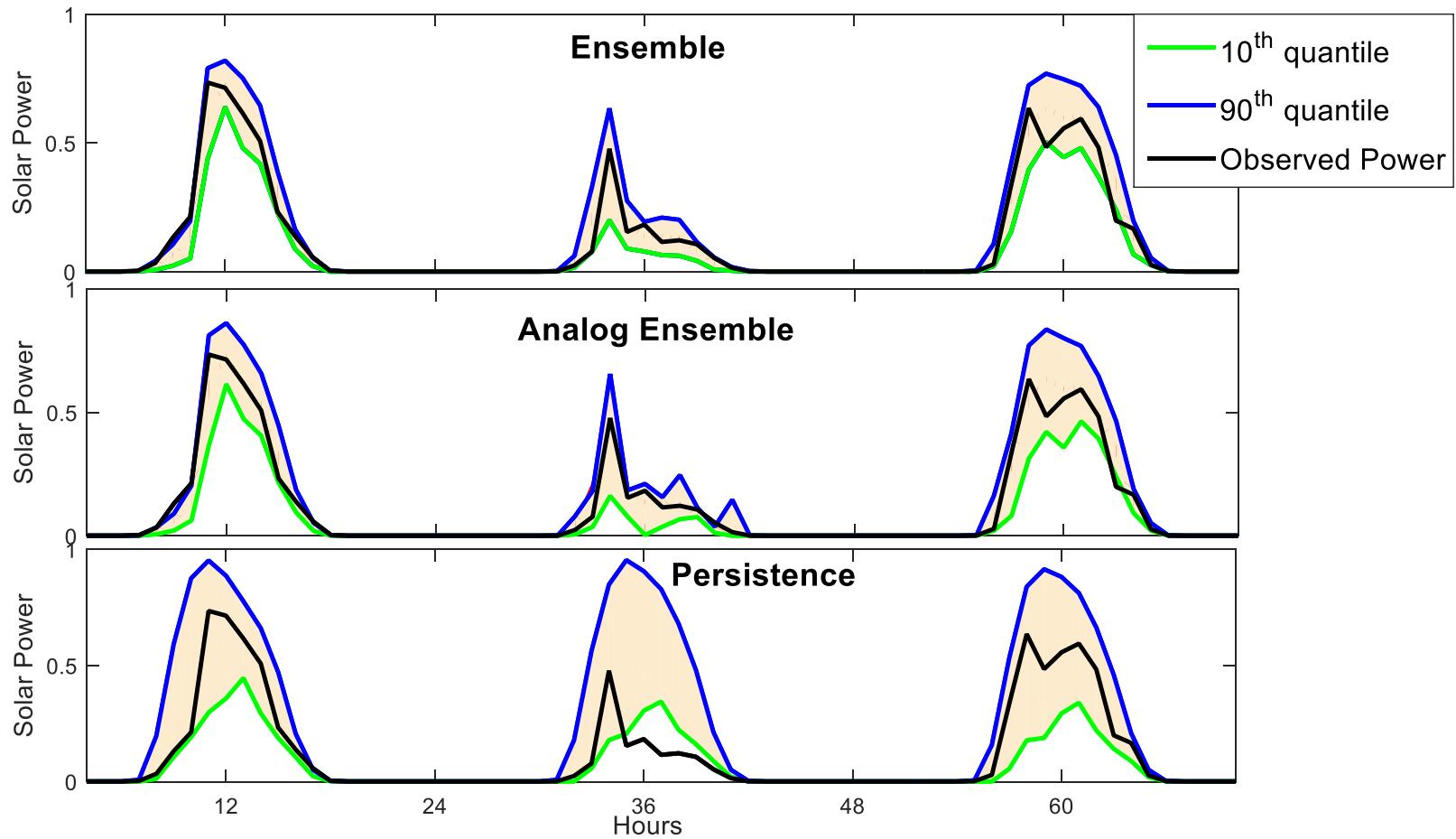


Research



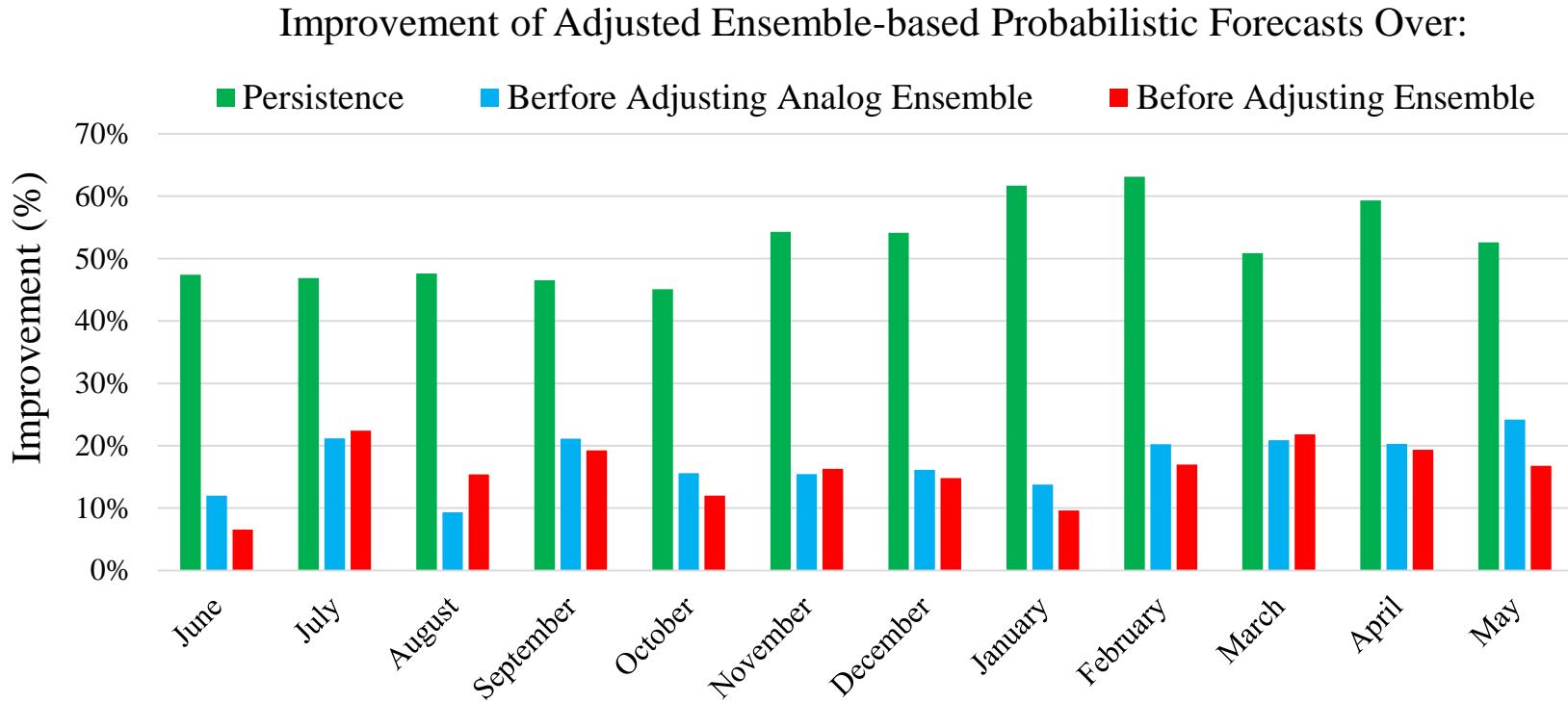
Combined forecasts of solar power for cloudy days before and after applying the adjusting

Research



Graphs of the probabilistic forecasts of the three methods for three days

Research

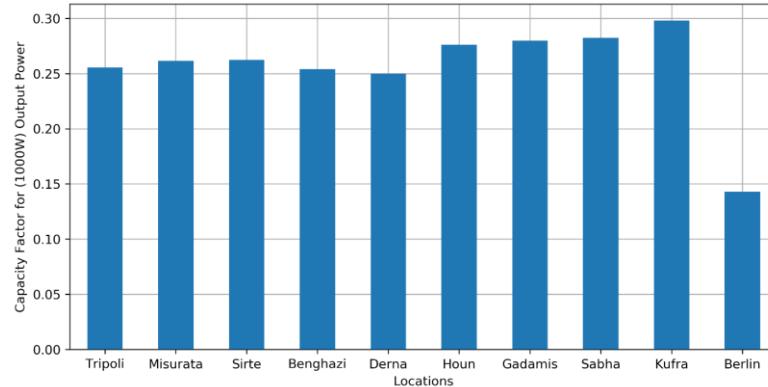
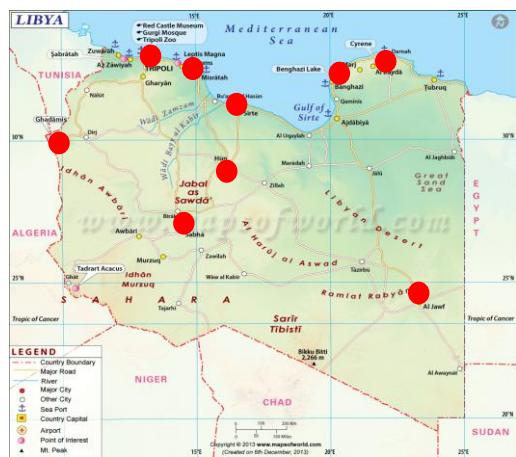


$$Skill\ Score\ (\%) = \left(1 - \frac{Metric_{method}}{Metric_{reference}} \right) * 100$$

Research

Planning and Analysis for Solar Energy in Libya

9 Locations for Comparison of Solar Energy Modeling and Analysis: Tripoli, Misurata, Sirte, Benghazi, Derna, Houn, Gadamis, Sebha, Kufra
 Typical Meteorological Year (TMY) data represents the weather for a "median year". <https://developer.nrel.gov/>



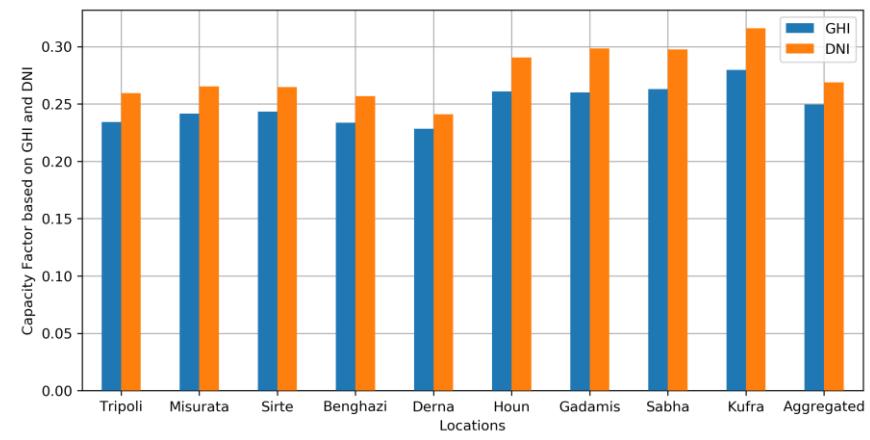
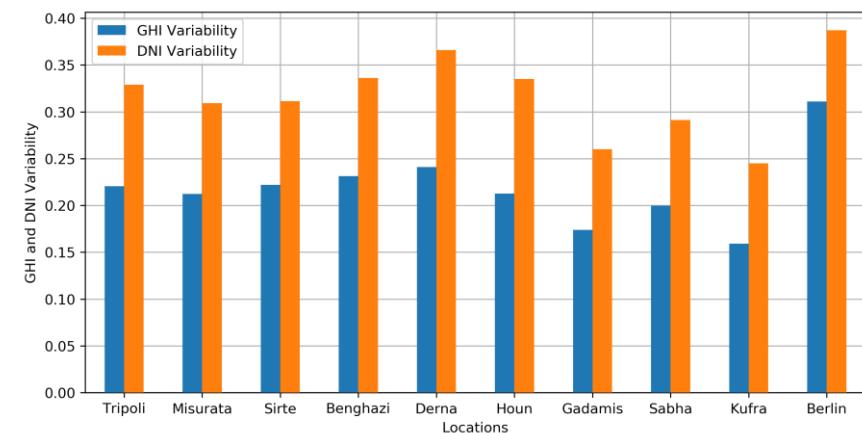
Solar Energy Modeling

Capacity Factor of Solar Energy Resources

Variability of Solar Energy Resources

Aggregation of Solar Energy Resources

The Capacity Factor is calculated based on Output power (PWac).
 The Rating of Solar PV System =1000W during an entire year = 8760 hours.

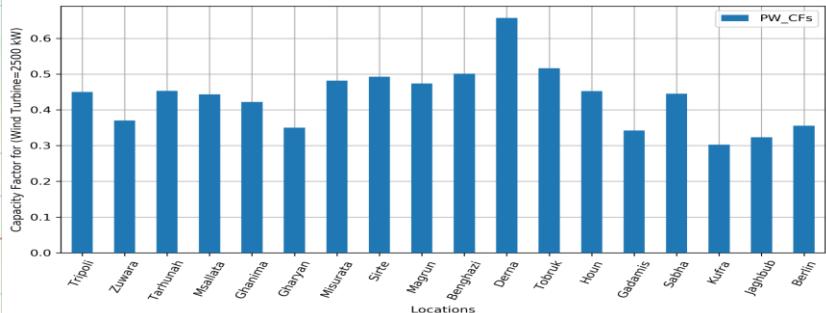
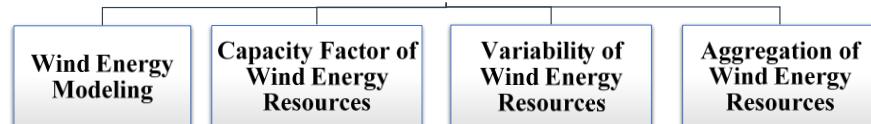
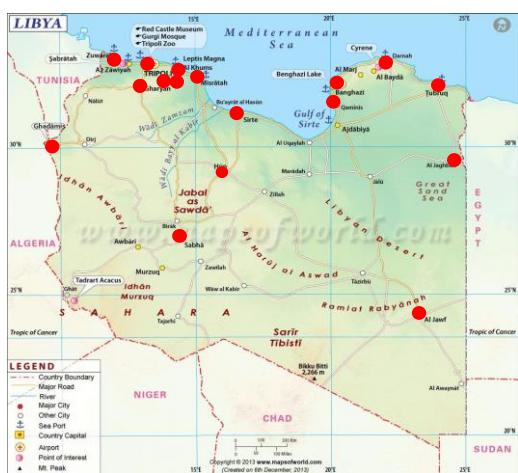


Research

Planning and Analysis for Wind Energy in Libya

Tripoli, Misurata, Tarhunah, Ghanima, Msallata, Zuwara, Gharyan, Sirte, Benghazi, Magrun, Derna, Houn, Gadamis, Sabha, Kufra, Tobruk, Jaghbub

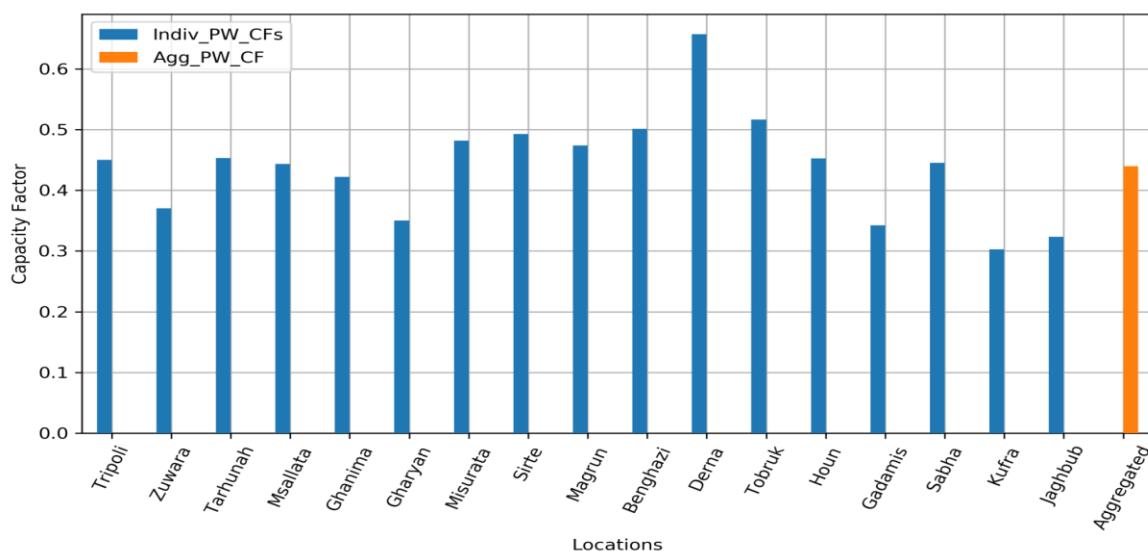
Typical Meteorological Year (TMY) data represents the weather for a "median year". Data are retrieved from NREL's Developer Network:
<https://developer.nrel.gov/> Comparison of Monthly Average Wind Speed (m/s) at Height of 10m



The Capacity Factor is calculated based on Output power (PWac).

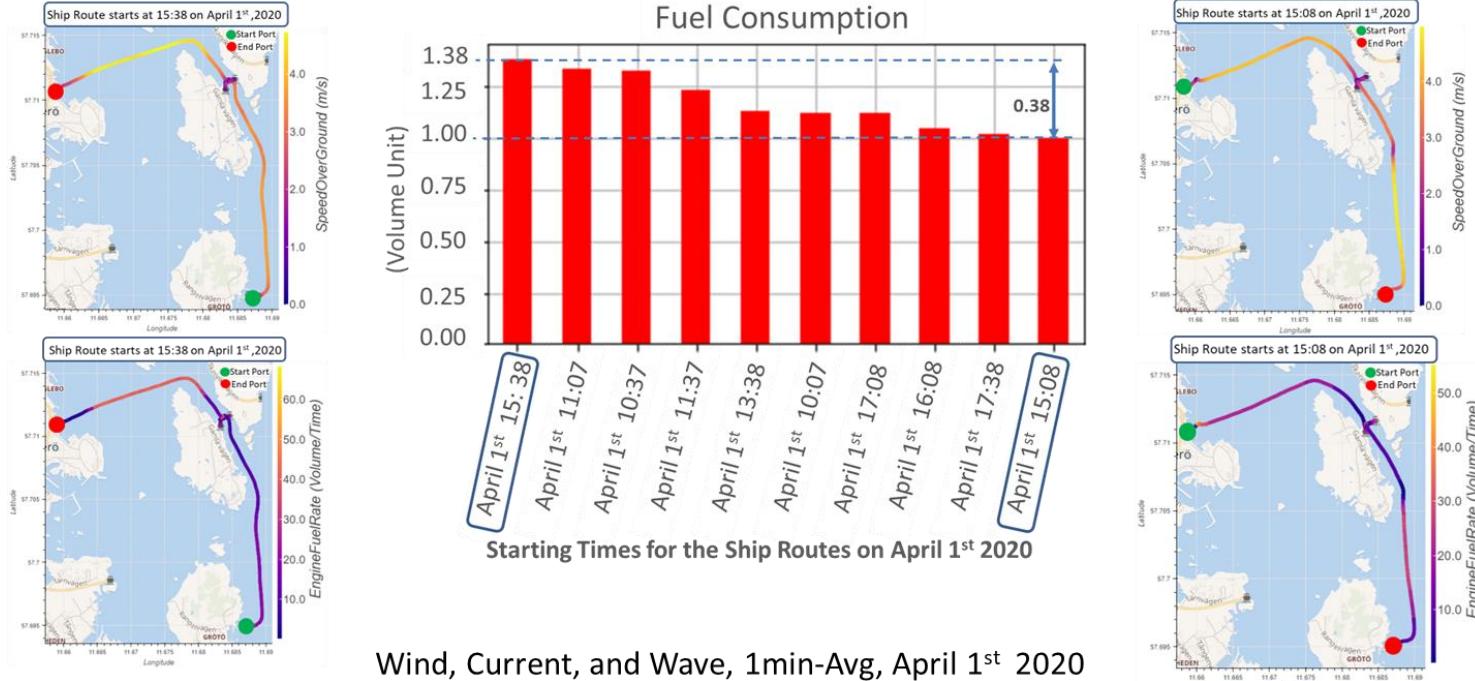
The Rating of Solar PV System =1000W during an entire year = 8760 hours.

Berlin in Germany has been added just for sake of comparison.

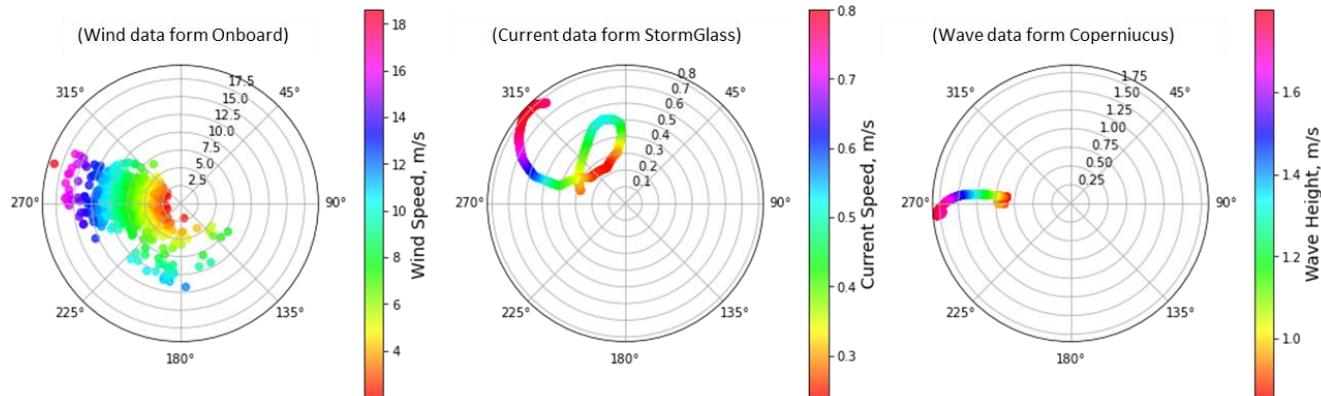


Research

Research Work for Improving the Vessel's Energy Efficiency



Wind, Current, and Wave, 1min-Avg, April 1st 2020



Research

Data Analytics for Improving the Vessel's Energy Efficiency

Descriptive Modeling

Input: Data of vessel's operational and environmental data, from onboard and external sources.

Outcome: Dataset for training and validation the predictive and prescriptive models.

Predictive Modeling

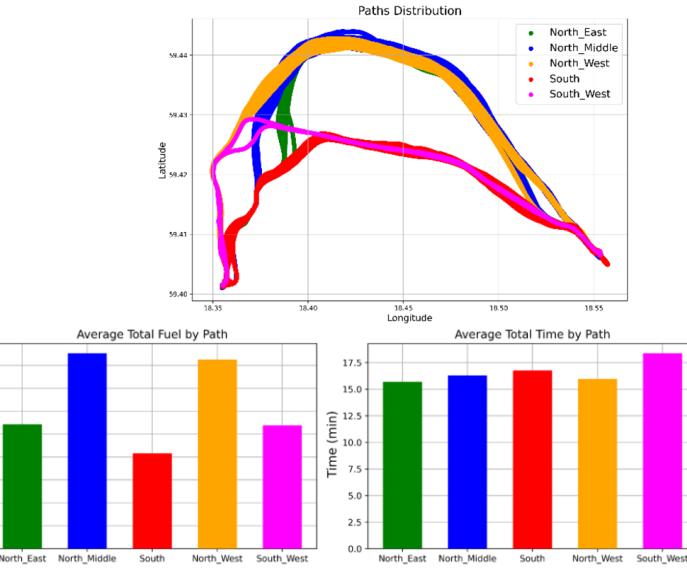
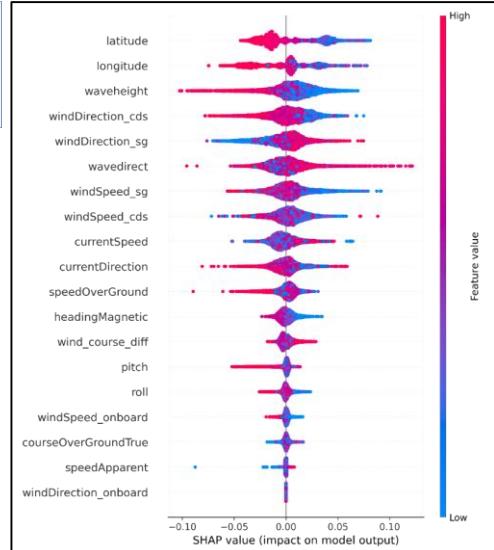
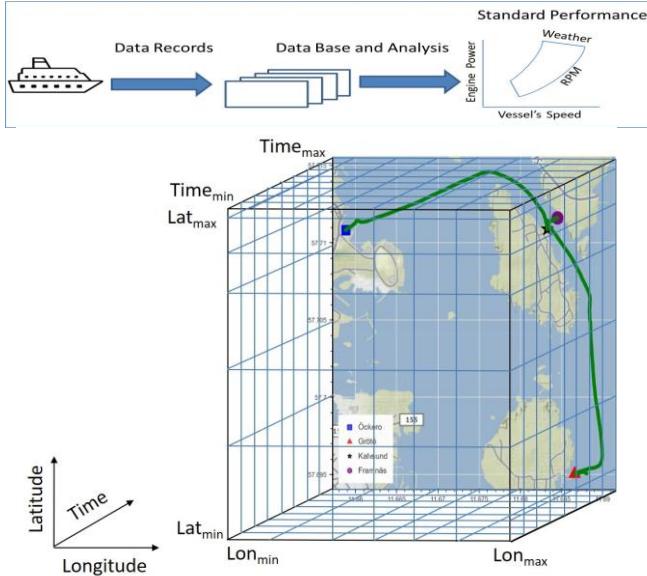
Input: Preprocessed data include operating and weather variables, such as vessel's speed and course, wind, wave, current, etc.

Outcome: Validated predictive models for fuel, distance and time.

Prescriptive Modeling

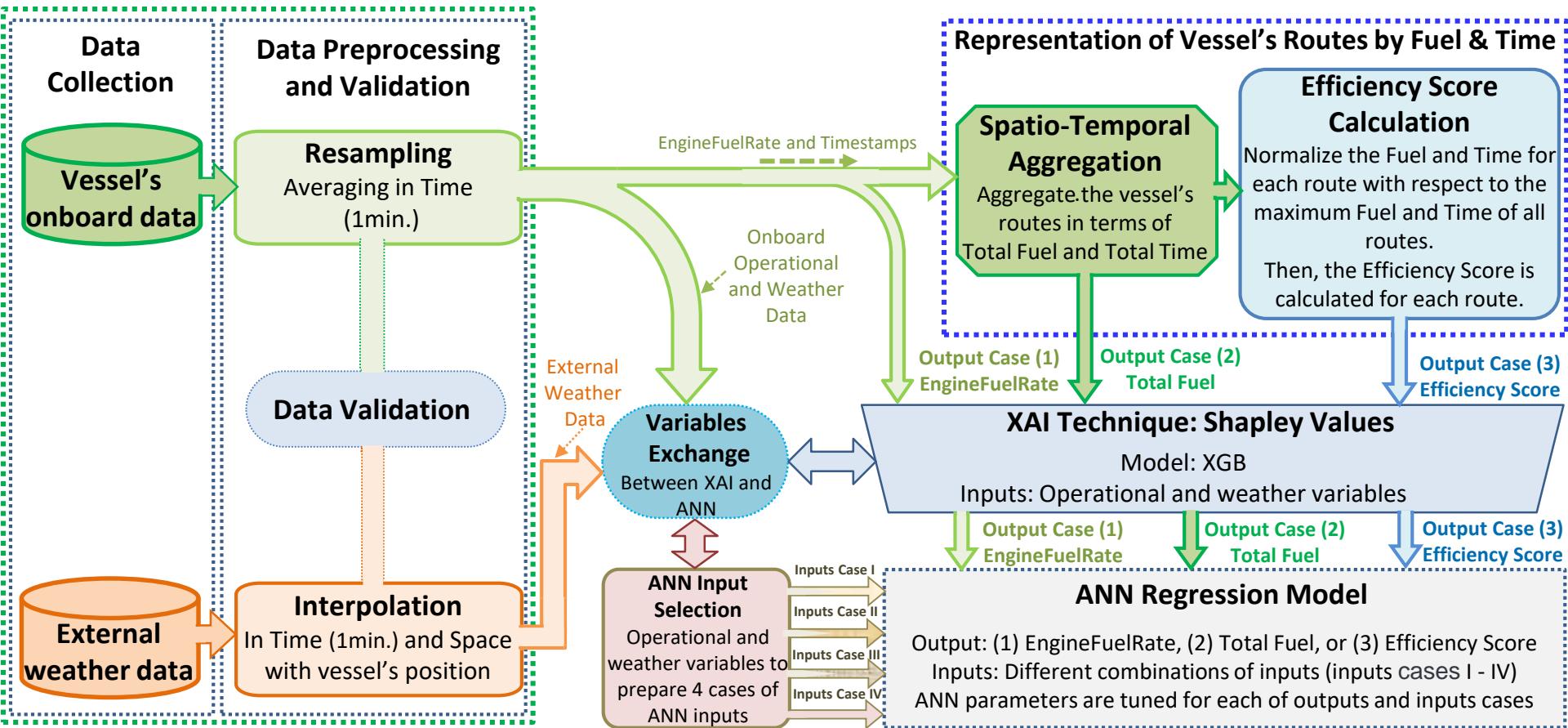
Input: Using solving algorithms, with control variables, such as vessel's speed and course, to find the optimal fuel and time.

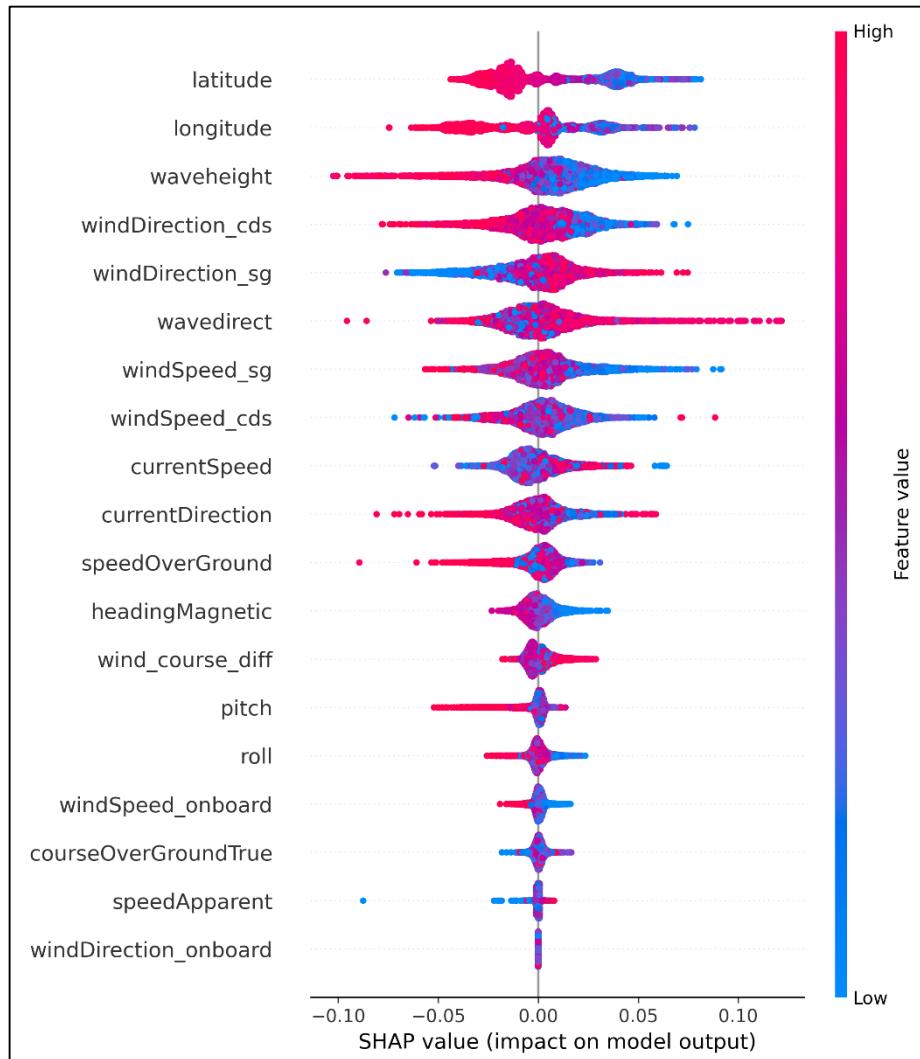
Outcome: Improving fuel consumption and meeting the operational conditions



Research

Workflow of Applying XAI for Improving the Vessel's Energy Efficiency

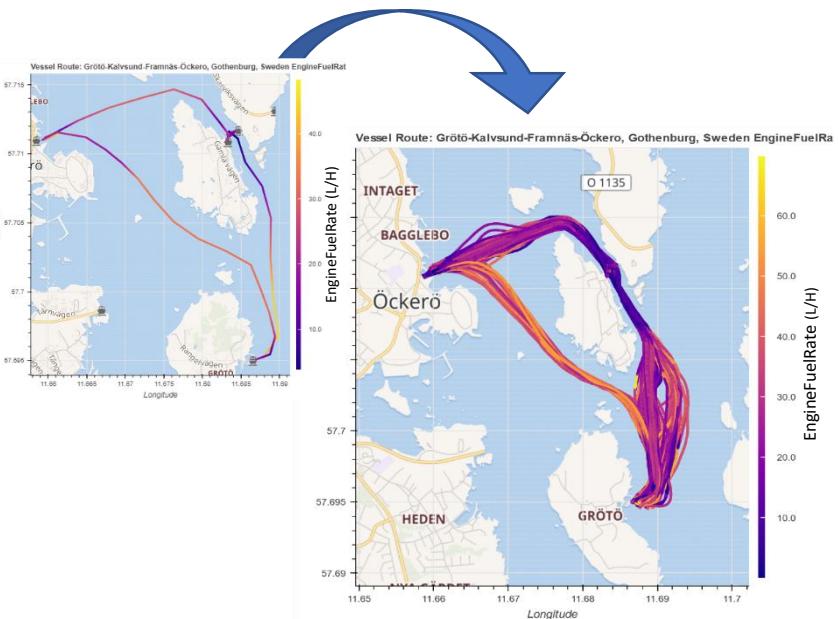




Shapely values for Regression of Eff-Score (Global, where Fuel and Time are normalized based on
The spatio-temporal aggregation and using the efficiency score (Global) leads to the **causality**

Efficiency Score

It is calculated once for the entire route.



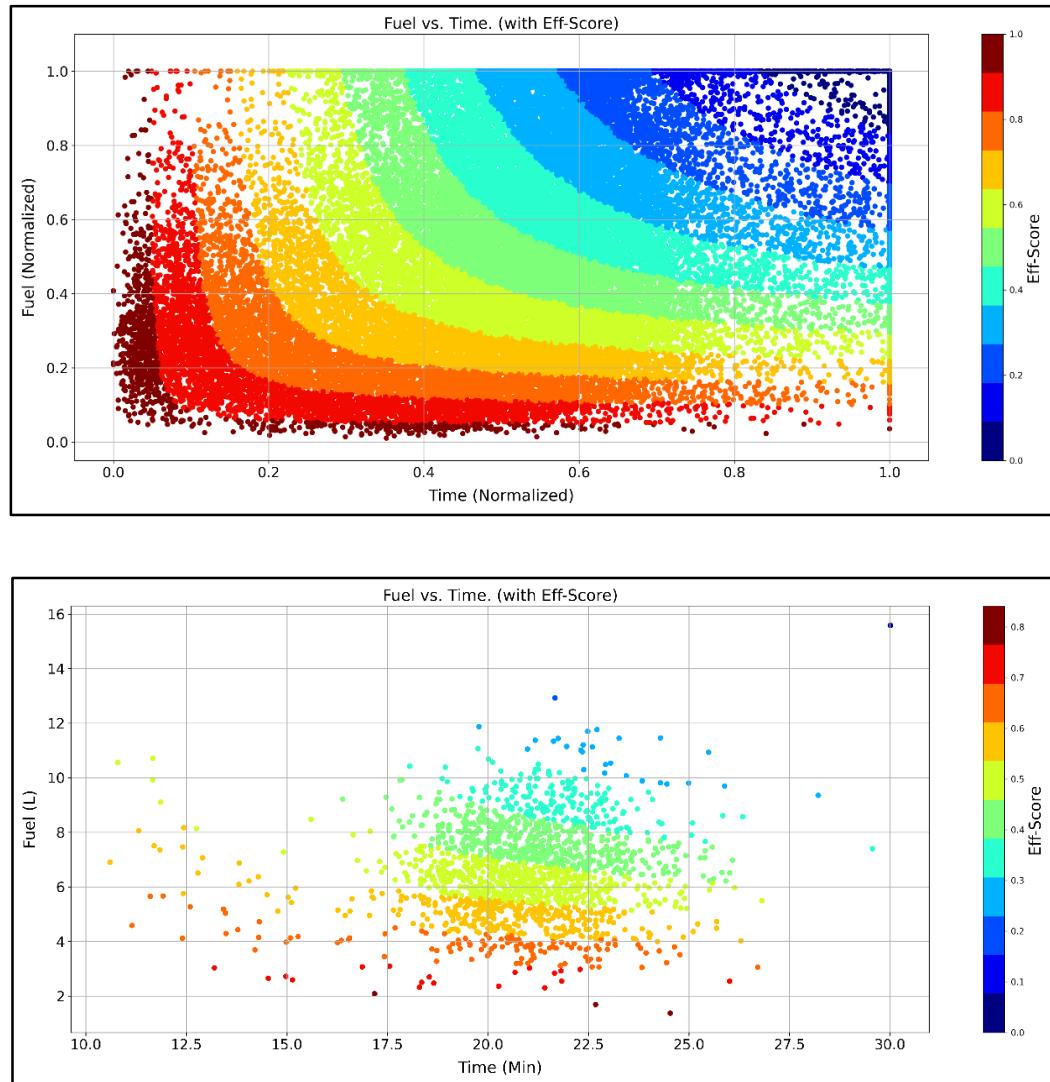
1754 sequences (Routes)

$$Eff_{Cost} = \frac{2 * (Fuel\ Total_{norm} * Time\ Total_{norm})}{(Fuel\ Total_{norm} + Time\ Total_{norm})}$$

$$Eff_{score} = 1 - Eff_{Cost}$$

Research

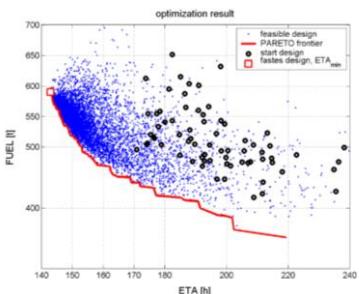
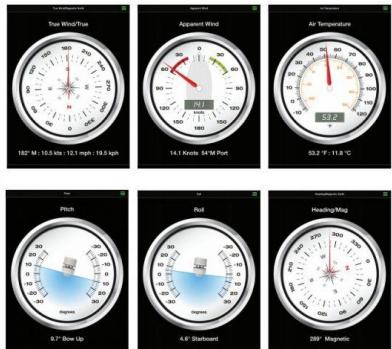
Predictive Analytics



Research

Problem Formulation

Objective Function:
Minimizing the fuel consumption



Solutions Finding

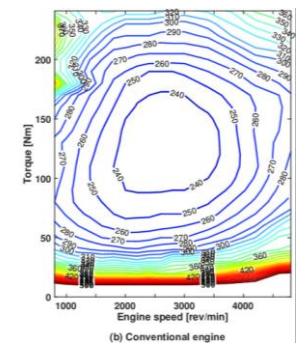
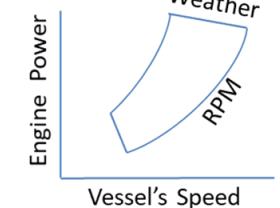
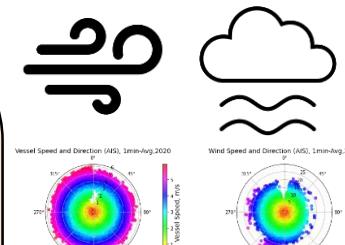
Solving algorithm:

Modeling and managing the engine power at any weather conditions by using a fuel estimation model

Control variables:
Ship's speed and course

Constraints:

Arrival time, geographic, safety, route smoothness, the ship's roll, and the engine power

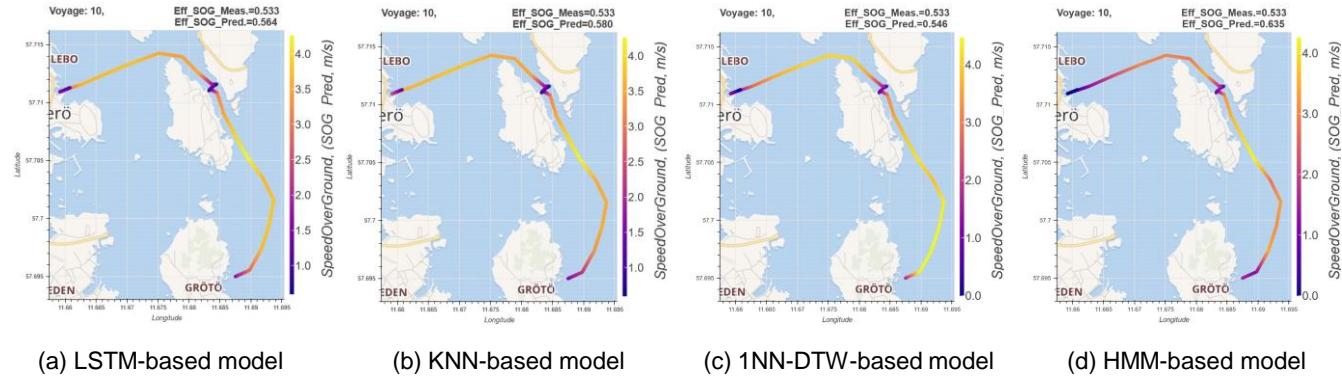
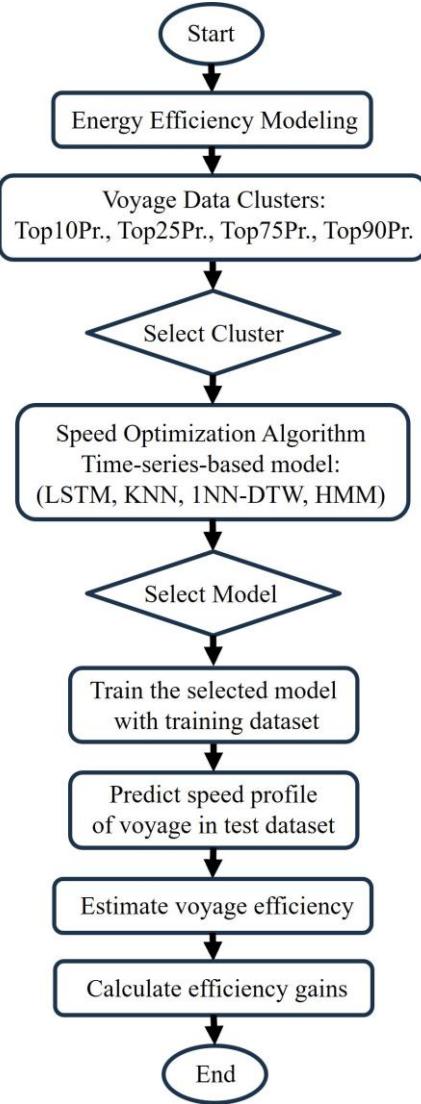


Objective:
Minimum fuel consumption

Research

Predictive Analytics

Framework of vessel voyage optimization



Cluster	Efficiency Score	LSTM	KNN	1NN-DTW	HMM
Top10Pr	Eff. Gains (%) IV Count (#)	2.61 134	2.13 114	3.20 127	6.05 139
Top25Pr	Eff. Gains (%) IV Count (#)	2.38 129	1.58 107	3.23 128	1.30 107
Top50Pr	Eff. Gains (%) IV Count (#)	0.97 100	0.98 106	2.58 117	7.34 140
Top75Pr	Eff. Gains (%) IV Count (#)	-0.84 60	0.50 93	2.28 119	9.31 141
Average	Eff. Gains (%) IV Count (#)	1.28 105.75	1.30 105.00	2.82 122.75	6.00 131.75

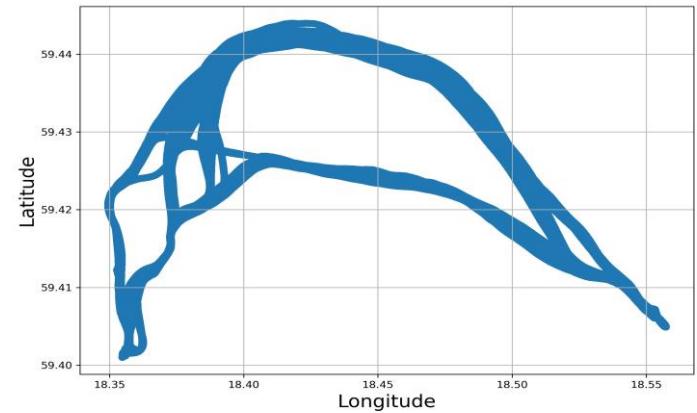
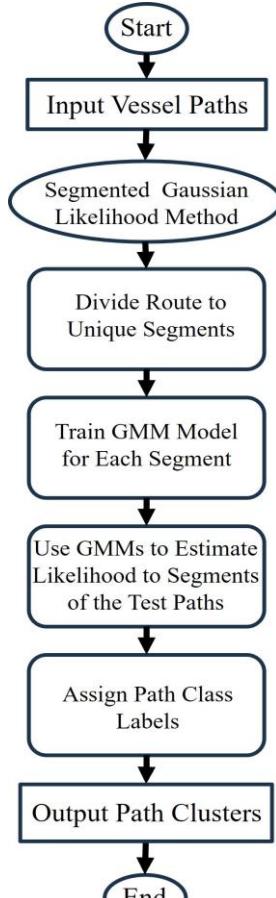
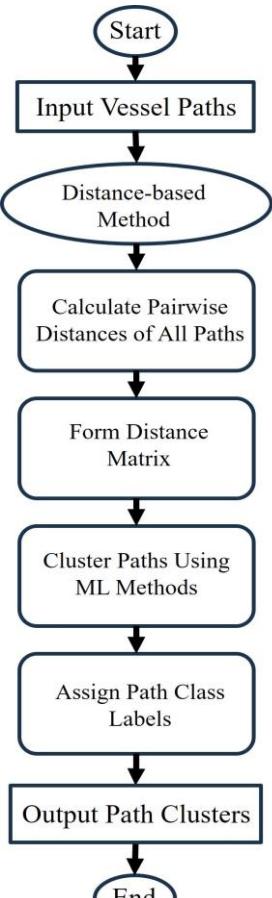
where,

$$Eff.Gain = \frac{Eff.Score_{Pred} - Eff.Score_{Meas}}{Eff.Score_{Meas}} \times 100$$

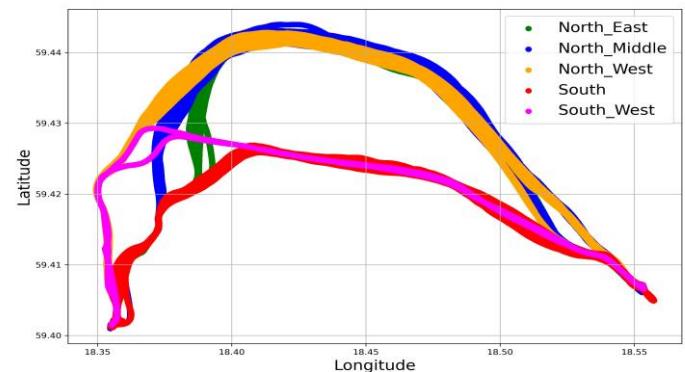
Counts of improved voyages (IV Count#) out of 162 voyages in the test dataset

Research

Spatial Clustering Approach for Vessel Path Identification



The vessel route



Main classes of path

Framework of vessel path identification.

(a) Flowchart of distance-based method.

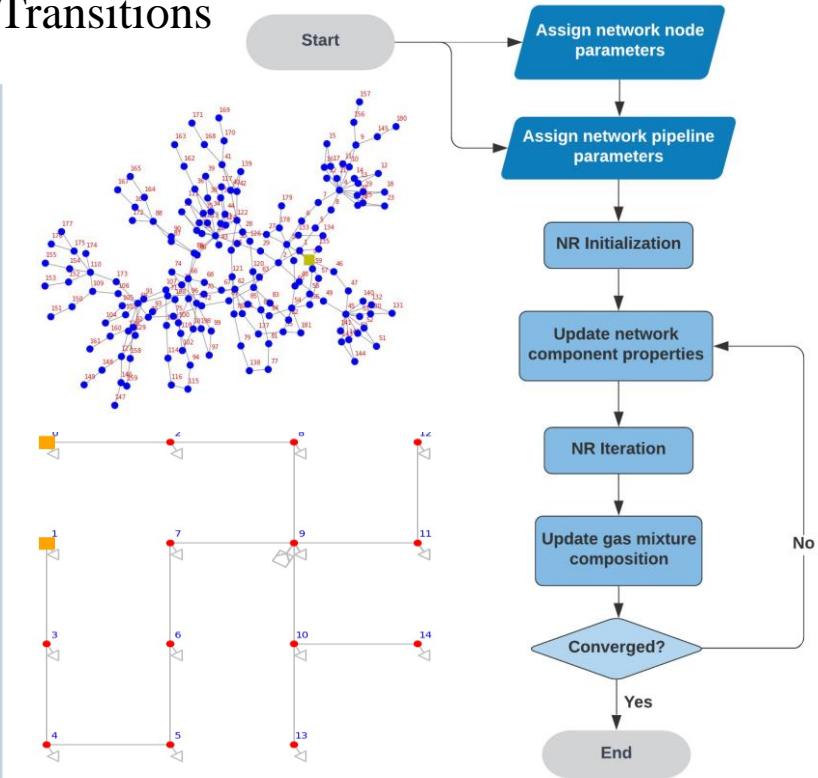
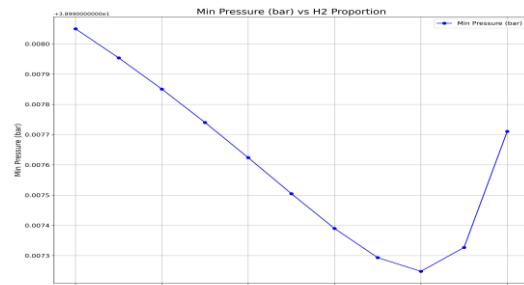
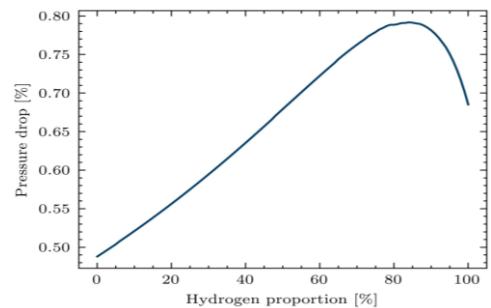
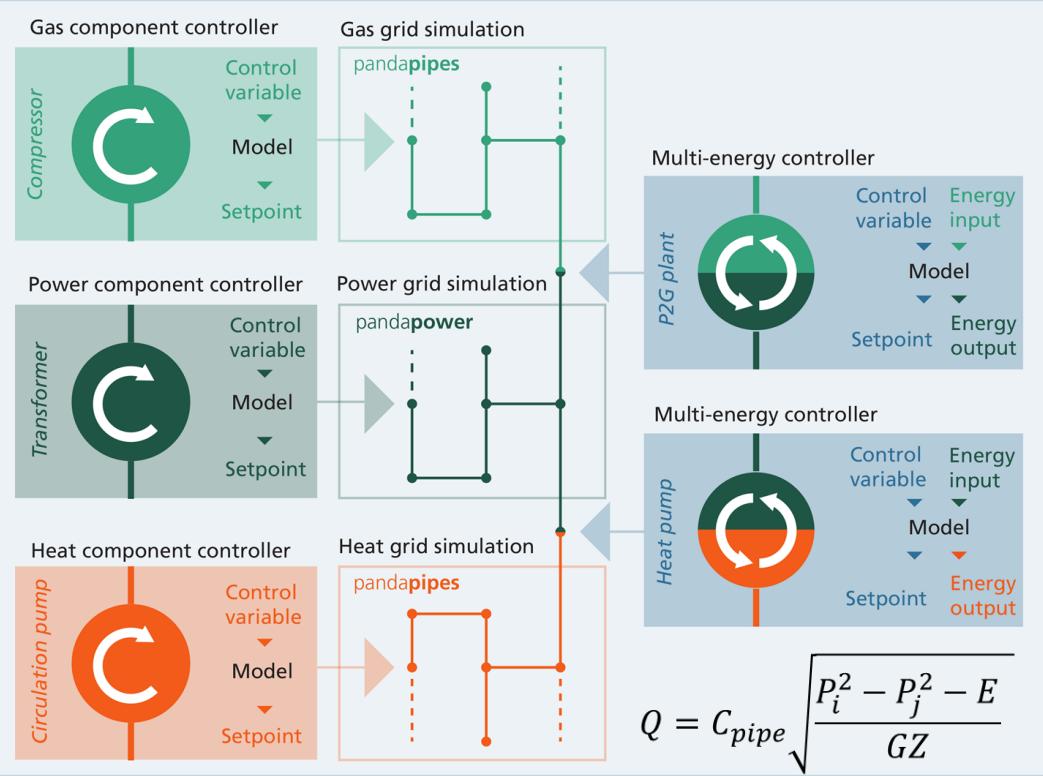
(b) Flowchart of segmented Gaussian likelihood method.

Research

Multi-Energy Model

HI ACT: Hydrogen Integration for Accelerated Energy Transitions

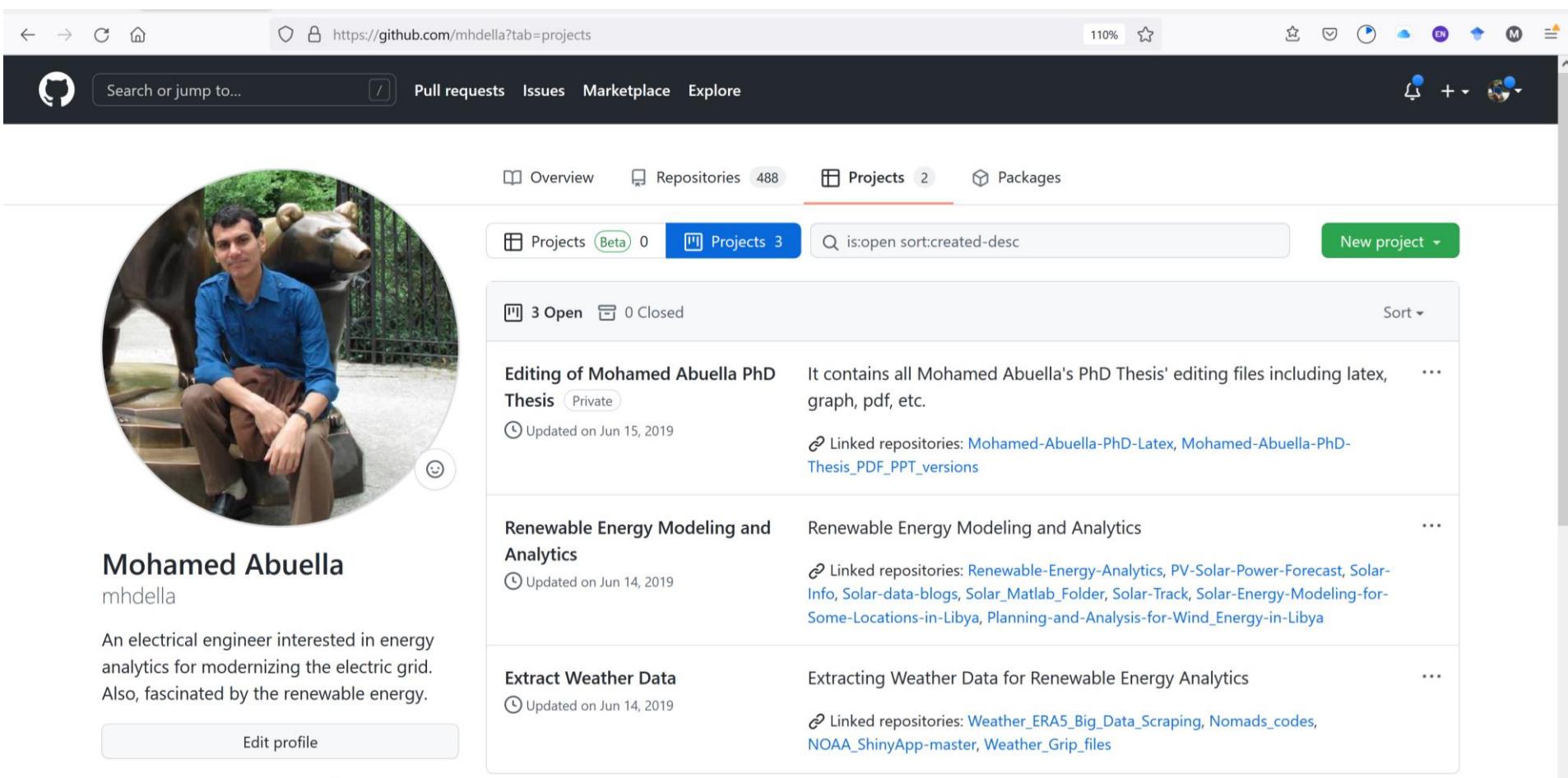
Multi-energy grid simulation



H2_prop	Total_cost	Optimal_q_g	qg_h2	qg_gas	mdot_h2	mdot_gas	source_mdot
0	10442.183	2.219	0.000	2.219	0.000	0.152	0.152
0.1	10442.671	2.269	0.080	2.190	0.002	0.150	0.152
0.2	10443.262	2.330	0.176	2.154	0.004	0.147	0.152
0.3	10443.994	2.405	0.296	2.110	0.008	0.144	0.152
0.4	10444.925	2.501	0.448	2.053	0.011	0.140	0.152
0.5	10446.147	2.627	0.648	1.979	0.016	0.135	0.152
0.6	10447.824	2.799	0.922	1.877	0.023	0.128	0.152
0.7	10450.266	3.050	1.321	1.729	0.034	0.118	0.152
0.8	10454.152	3.450	1.956	1.494	0.050	0.102	0.152
0.9	10461.302	4.184	3.124	1.061	0.079	0.073	0.152
1	10478.799	5.983	5.983	0.000	0.152	0.000	0.152

Research (Miscellaneous)

Some other Projects in GitHub: <https://github.com/mhdella?tab=projects>



The screenshot shows a GitHub profile page for a user named Mohamed Abuella (mhdella). The profile picture is a circular photo of a man sitting next to a large golden bear statue. The bio text reads: "An electrical engineer interested in energy analytics for modernizing the electric grid. Also, fascinated by the renewable energy." Below the bio is a button labeled "Edit profile". At the bottom left, it shows "47 followers · 584 following · 267 stars". The main content area is the "Projects" tab, which lists three open projects:

Project Name	Description	Actions
Editing of Mohamed Abuella PhD Thesis	It contains all Mohamed Abuella's PhD Thesis' editing files including latex, graph, pdf, etc.	... Linked repositories: Mohamed-Abuella-PhD-Latex, Mohamed-Abuella-PhD-Thesis_PDF_PPT_versions
Renewable Energy Modeling and Analytics	Renewable Energy Modeling and Analytics	... Linked repositories: Renewable-Energy-Analytics, PV-Solar-Power-Forecast, Solar-Info, Solar-data-blogs, Solar_Matlab_Folder, Solar-Track, Solar-Energy-Modeling-for-Some-Locations-in-Libya, Planning-and-Analysis-for-Wind_Energy-in-Libya
Extract Weather Data	Extracting Weather Data for Renewable Energy Analytics	... Linked repositories: Weather ERA5_Big_Data_Scraping, Nomads_codes, NOAA_ShinyApp-master, Weather_Grip_files

Research (Miscellaneous)

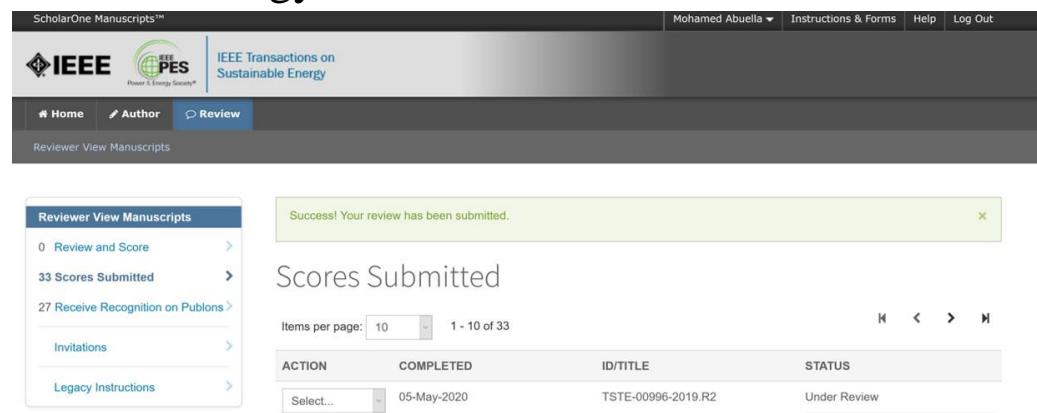
Blogs

Keep up some blogs on : <https://mohamedabuella.github.io/blog/>

- 24 Mar 2024 » [Blog iHelm Project: Data Analytics for Improving Energy Efficiency in Short Sea Shipping](#)
- 05 Feb 2024 » [Blog Tools for Energy Systems Modeling and Analysis](#)
- 23 Dec 2023 » [Blog Systematic Analysis of Mendeley Documents with ChatGPT as a Coding Utility](#)
- 06 Dec 2023 » [Blog iHelm Project: Data Analytics for Improving Energy Efficiency in Short Sea Shipping](#)
- 06 Dec 2023 » [Blog Data Analytics for Vessel Path Planning in Short-Sea Shipping](#)
- 06 Dec 2023 » [Blog Data Analytics for Improving Energy Efficiency in Short-Sea Shipping](#)
- 15 Dec 2021 » [Blog Using pandapower for Modeling and Analysis of Energy Systems](#)
- 01 Sep 2021 » [Blog Planning and Analysis for Wind Energy in Libya](#)
- 19 Jul 2021 » [Blog Planning and Analysis for Solar Energy in Libya](#)
- 11 Dec 2019 » [Blog Reading and Reflection on a Book of Solar Energy](#)
- 19 Aug 2019 » [Blog Does the Educational Curricula Keep the Pace with the Advancements in Energy ..?](#)
- 09 Aug 2019 » [Blog Wind and Solar Energy Resources Modeling and Analysis](#)
- 30 Jul 2019 » [Blog Net Load Forecasting for Microgrid Resiliency](#)
- 29 Jul 2019 » [Blog How a Subtle Lack of Knowledge Could Lead to Catastrophic Consequences](#)
- 23 Jun 2019 » [Blog Reading a Big-picture Book after a While of Focusing on Elaborate Technical Stuff](#)
- 17 Jun 2019 » [website Website Launched](#)

Research (Miscellaneous)

- Power System Flexibility and DG resources management, I have been working on Forecasting and Machine Learning approaches, since 2014
- Techno-economic analysis of HOMER, NREL SAM, and PVLib Toolbox for Python.
- Writing using Latex (Eqs, Biblio.), Mendeley (~10000 docs, tags), Evernote (organize notes, share them), Dropbox, Google Drive (clouds to back up), iCalendar, etc.
- Research Outreach and Knowledge Dissemination: depending extensively on the online tools, such as Blogs on personal website, LinkedIn, Twitter, Researchgate, Newsletter from relevant groups of interest (ESIG, AI in Smart Grids, ISES, WEMC, etc.)
- Review of IEEE Transactions on Sustainable Energy



The screenshot shows the IEEE ScholarOne Manuscripts interface. At the top, there are logos for IEEE and IEEE PES, and the title "IEEE Transactions on Sustainable Energy". The navigation bar includes links for Home, Author, and Review, with "Review" being the active tab. A dropdown menu shows the user is logged in as "Mohamed Abuela". Other options in the header include "Instructions & Forms", "Help", and "Log Out".

In the main content area, a green success message box says "Success! Your review has been submitted." Below it, a section titled "Scores Submitted" displays a table with one row:

ACTION	COMPLETED	ID/TITLE	STATUS
Select...	05-May-2020	TSTE-00996-2019.R2	Under Review

On the left sidebar, under "Reviewer View Manuscripts", there are several links: "Review and Score", "33 Scores Submitted", "27 Receive Recognition on Publons", "Invitations", and "Legacy Instructions".

Thanks for Your Listening

Any Question?

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mhdabuella@gmail.com



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Energy Production and Infrastructure Center (EPIC)



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