

# Presentation

# Mohamed Abuella

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كلية التقنية الصناعية\_ مصراته  
The College Of Industrial Technology\_Misurata



# **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** Who knows!

# 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](#).

The image shows a word cloud centered around the word "energy". Other prominent words include "modeling", "renewable", "solar", "wind", "weather", "storage", "system", "utility", "research", "service", "pv", "ramp", "solar", "spatio-temporal", "wind", "forecasting", "meterology", "post-processing", "monitoring", "measurements", "iso", "grid", "integration", "learning", "market", "approach", "data", "day-ahead", and "forecasting". The words are in various sizes and shades of blue, set against a white background with a thin gray border.

# 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.

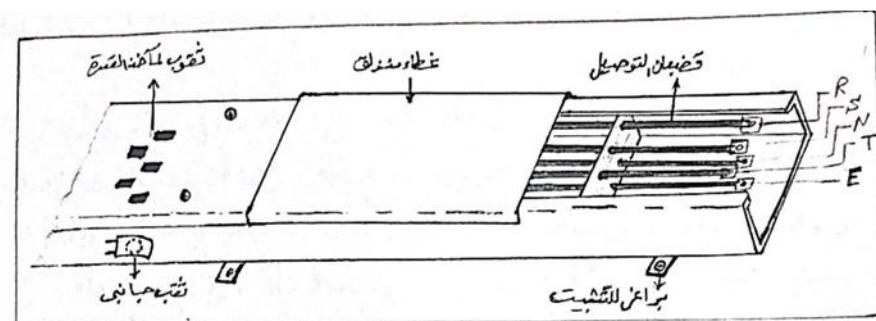
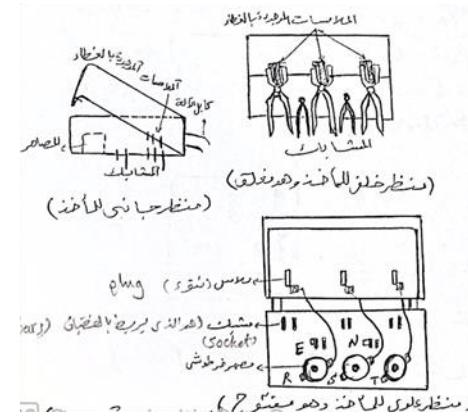
# Research

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

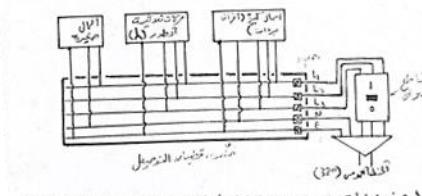
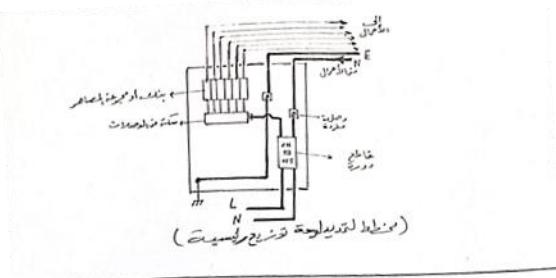
[https://www.researchgate.net/publication/344772515\\_Technical\\_report\\_of\\_maintenance\\_and\\_operation\\_internship\\_at\\_shoes\\_factory\\_in\\_Misurata\\_Libya](https://www.researchgate.net/publication/344772515_Technical_report_of_maintenance_and_operation_internship_at_shoes_factory_in_Misurata_Libya)

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

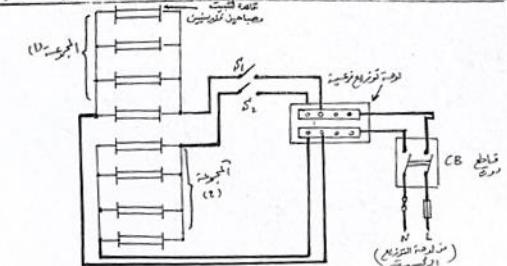
Electrical Operation & Maintenance for fulfilling requirement of the Higher Diploma



(مقدمة طولى به قصبة التوصيل)



(مخطط لتغذية صناديق التبديل التوصيلية بـ كهربائية (كتل طبل))



(مخطط لتغذية إثاث في ساحة المختبر الزراعي)

# Research

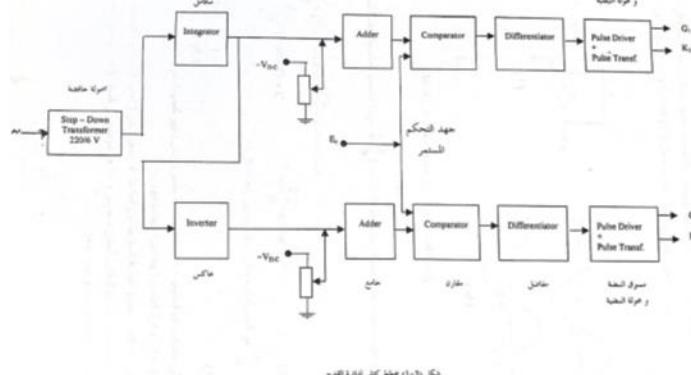
## Triggering Circuit for SCR Thyrists of an AC-DC Converter

[https://www.researchgate.net/publication/277109663\\_Triggering\\_Circuit\\_for\\_SCR\\_Thyristors\\_of\\_an\\_AC-DC\\_Converter](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

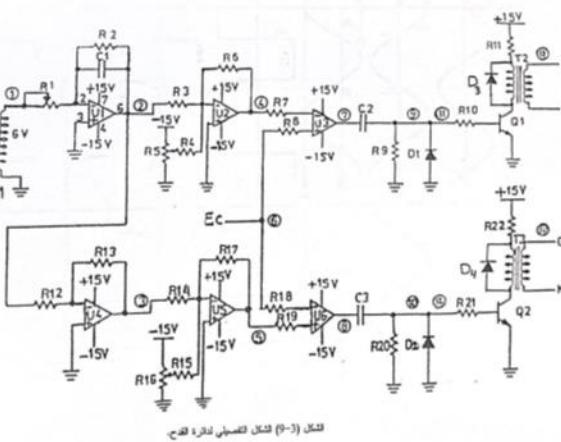
**Acquired Expertise:** Electrical Wiring & Installations, Maintenance & Operation



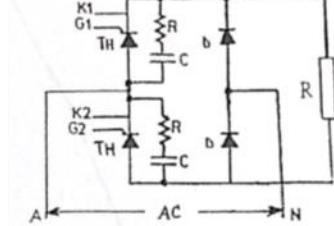
Scanned with CamScanner



Number: 277109663  
Status: Production  
Page: 1 of 14  
Type: TO-48 (14)  
Circuit Type: DISCRETE  
Designation: DOD-14  
Doc. No.: 30000  
Product: SCR Phase  
Line Control  
(discrete)  
FDD # 30000



Parameter	Limit	Units	Condition	Value
VDRH	MIN	Volts	NA	1200
IT(RMS)	MAX	Amperes	NA	35
IT(av) comp. (a)	MAX	Amperes	NA	22
@ TC	—	°C	NA	85
ITSM (50Hz)	MAX	Amperes	NA	335
ITSM (60Hz)	MAX	Amperes	NA	355
Vgt	Max	Volts	NA	2
Igt	Max	mAAmperes	NA	60
VTM comp. (a)	MAX	Volts	NA	1.7
@ ITM comp. (a)	—	Amperes	NA	70
DV(GT)	MAX	Volts	NA	300
Rth(JC)	MAX	°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](https://www.researchgate.net/publication/277110587_Study_of_NEPLAN_Software_for_Load_Flow_and_Short_Faults_Analysis/stats)



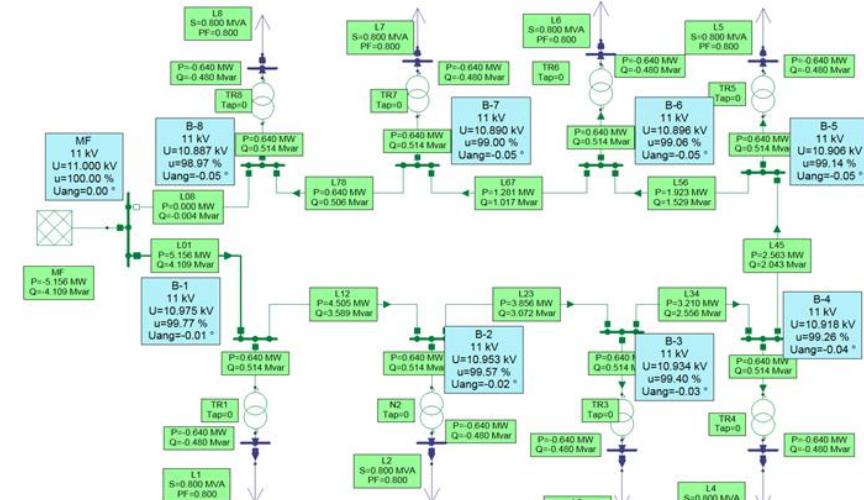
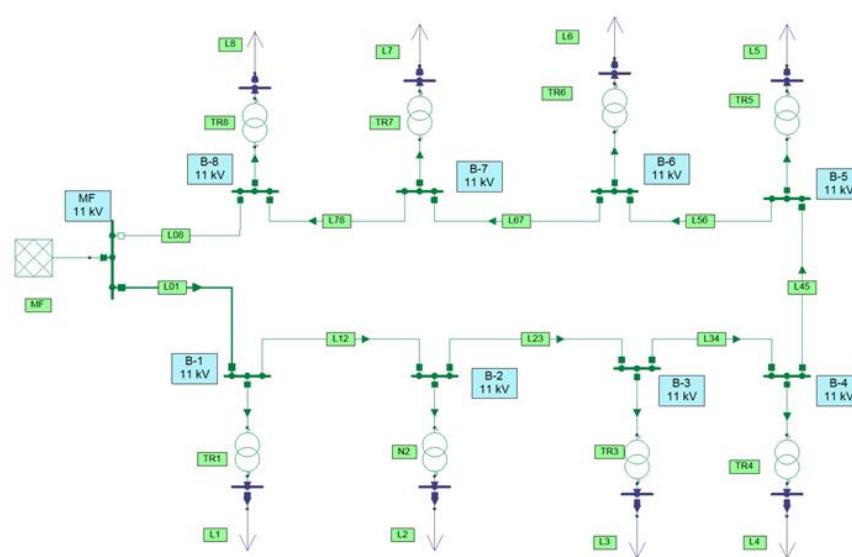
B.Tech Project, 2008 at College of Industrial Technology, Misurata, Libya

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

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

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

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

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

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

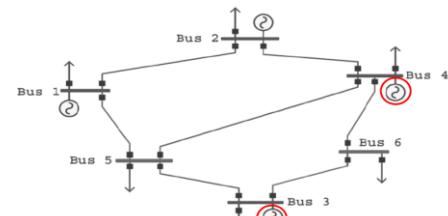
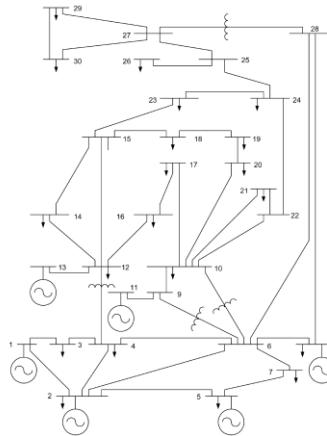
$$C_{r,i} = k_{r,i} \int_0^{w_i} (w_i - w) f_W(w) dw \text{ (overestimation)}$$

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

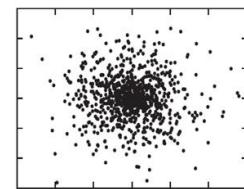


$$C_i = a_i P_i^2 + b_i P_i + c_i$$

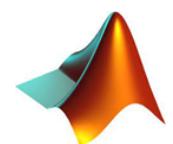
$$C_{w,i} = d_i w_i$$



Gen. No.	a (SMW <sup>-2</sup> .hr)	b (SMW.hr)	c	P <sub>G_low</sub> (MW)	P <sub>G_high</sub> (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



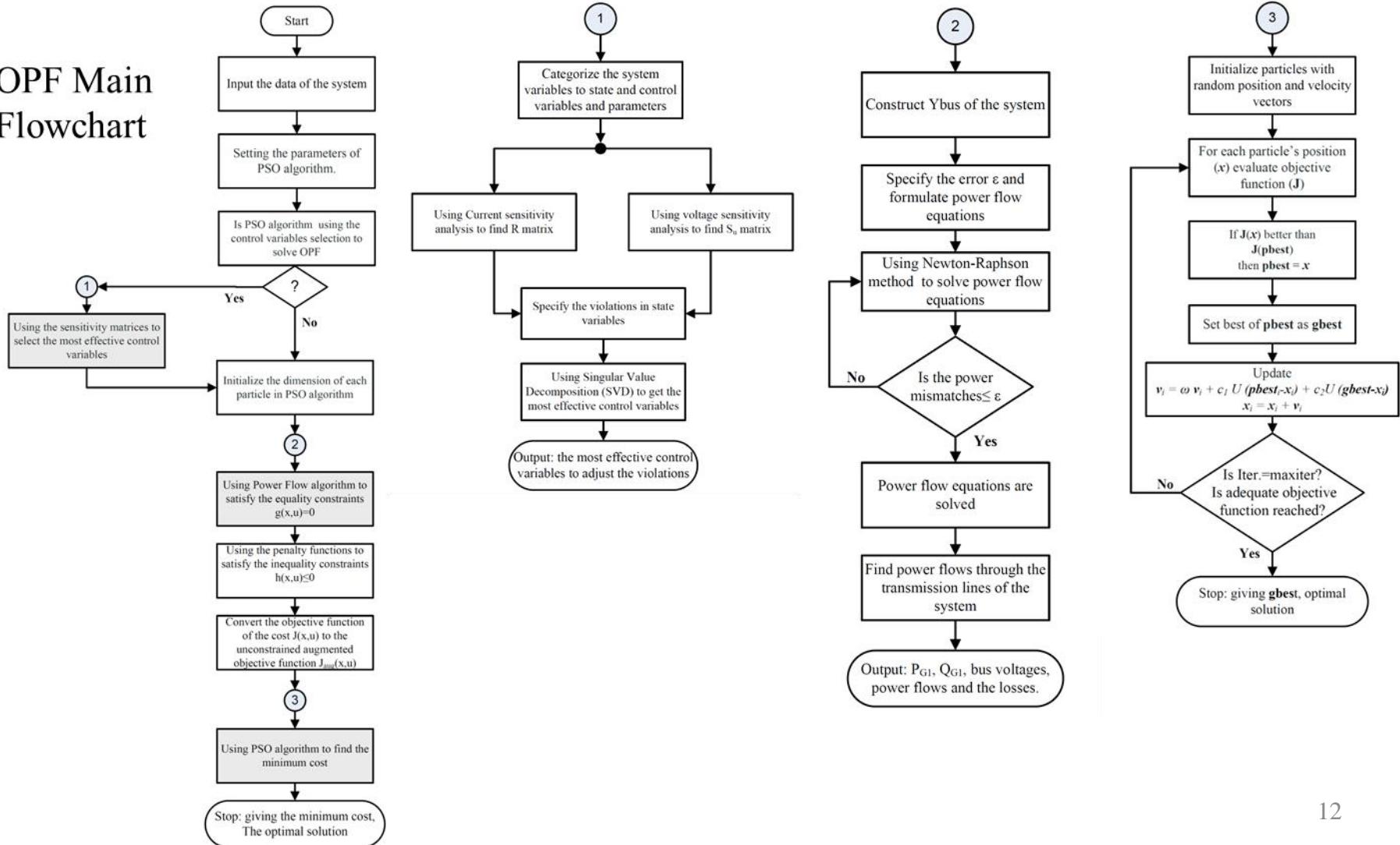
Particle Swarm Optimization (PSO) algorithm is used for solving this optimization problem.



# 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

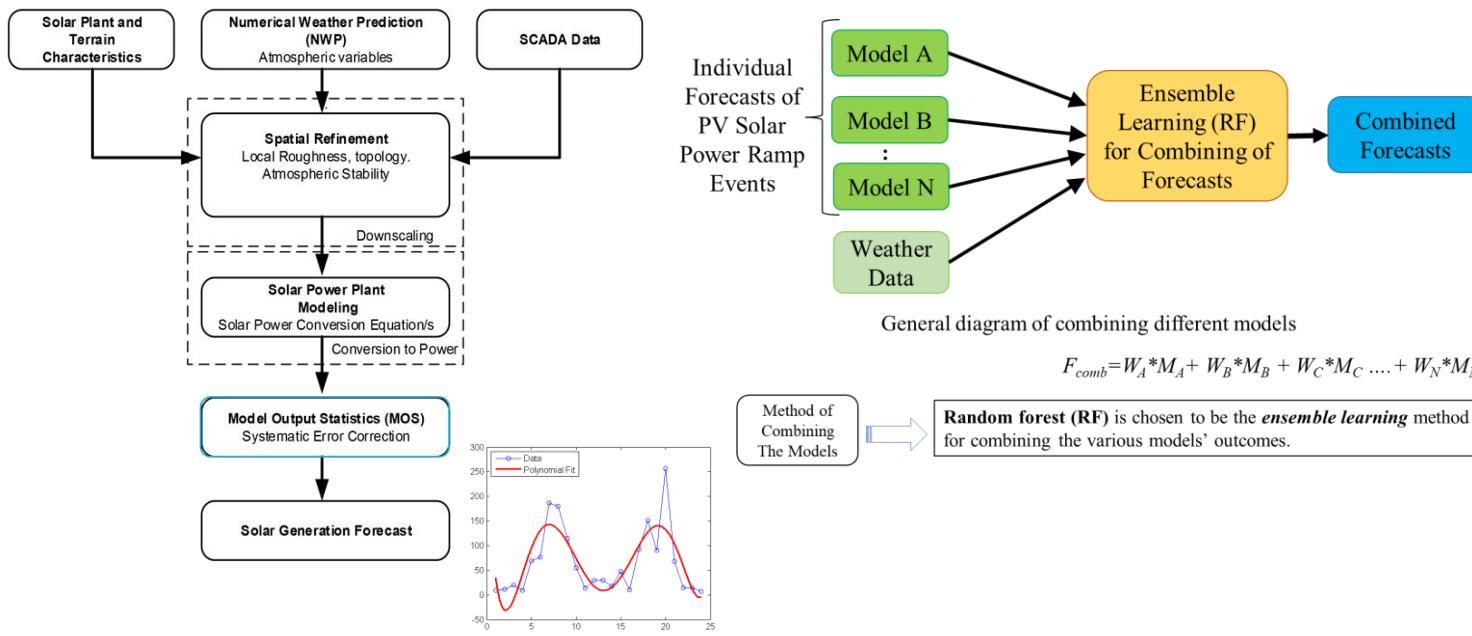
<https://www.proquest.com/openview/42049145119c7760f93ea736b37a0930/1.pdf?pq-origsite=gscholar&cbl=18750>

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

Advisor: Badrul Chowdhury



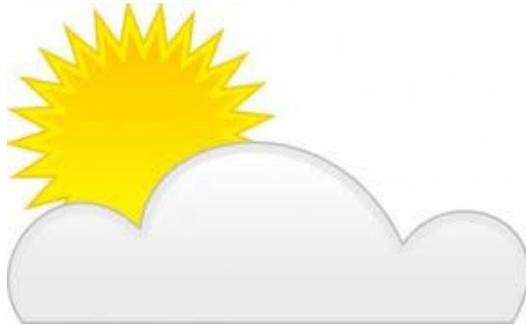
**Acquired Expertise:** Energy Analytics, Energy Markets, Renewable Energy Integration, Asset & Supply Chain, Time Series Analysis & Modeling, Risk & Uncertainty Quantification, Machine Learning, Big-Data Processing, Research Publishing & Peer Reviewing, Software Tools including SAS, R, and Python



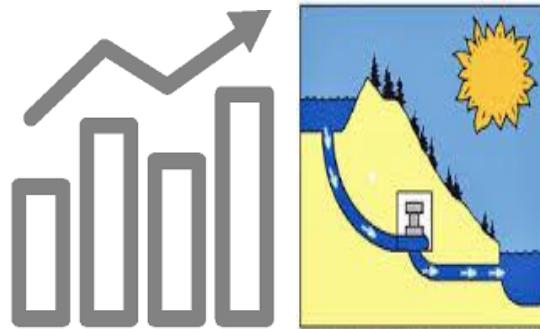
# Research

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

**PV Solar Power Generations are Too Variable**



**Coordination with Operating Reserves and Energy Storage Systems**



**Reducing Cost and Pollution**

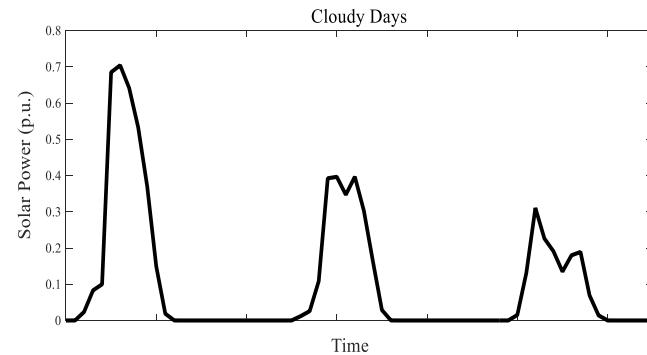
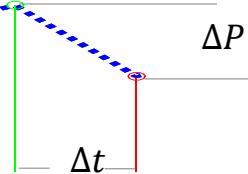


Illustration of the motivation of PV solar power forecasts

# Research

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

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



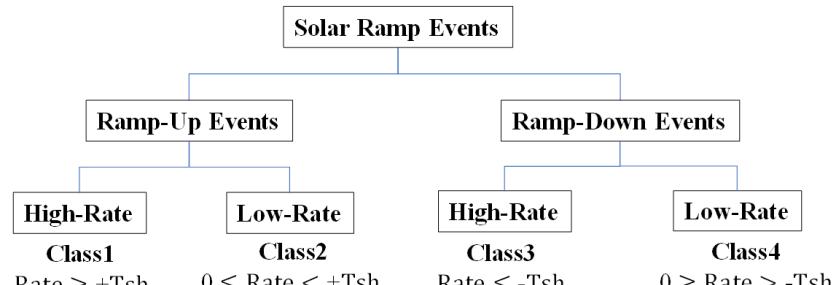
where  $P(t)$  is the solar power of the target hour, it can also be its forecast  $F(t)$ ;  $D$  is the time duration for which the ramp rate is determined.

For the illustrated cloudy day below:

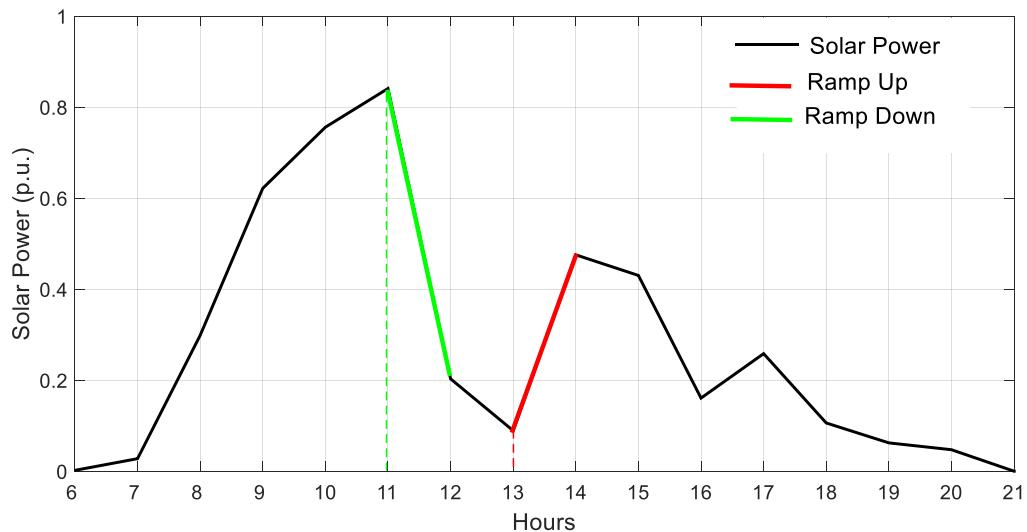
$$\text{Ramp rate, } \frac{\Delta P}{\Delta t} = \frac{0.2 - 0.85}{12:00 - 11:00} = -0.65 \text{ (-65%) ramp down of its normal capacity, (pu/hr)}$$

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

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



Distribution of the classes of solar power ramp events



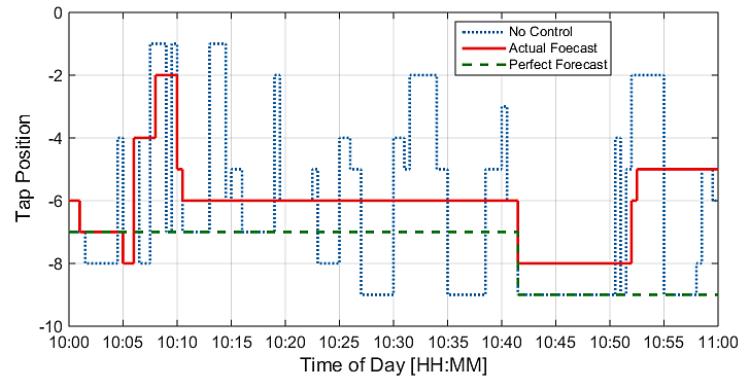
Ramp Events During a Cloudy Day

# Research

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

Distribution level:

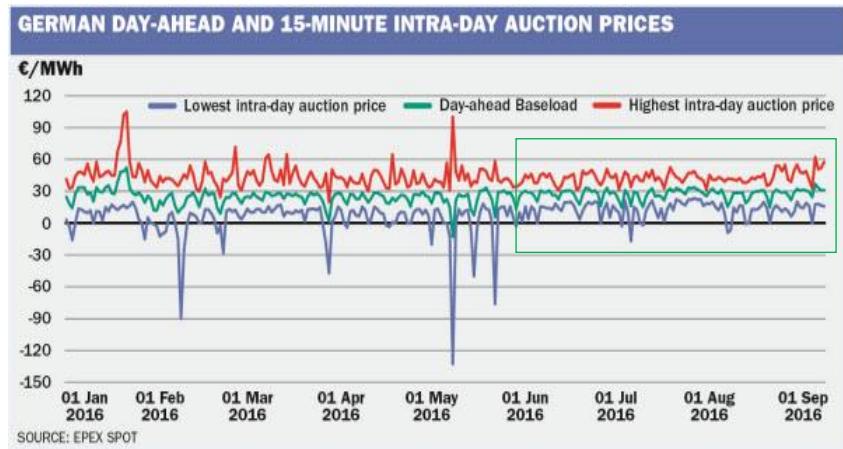
- Optimizing the voltage regulation equipment.
- Control schemes of energy storage systems.



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

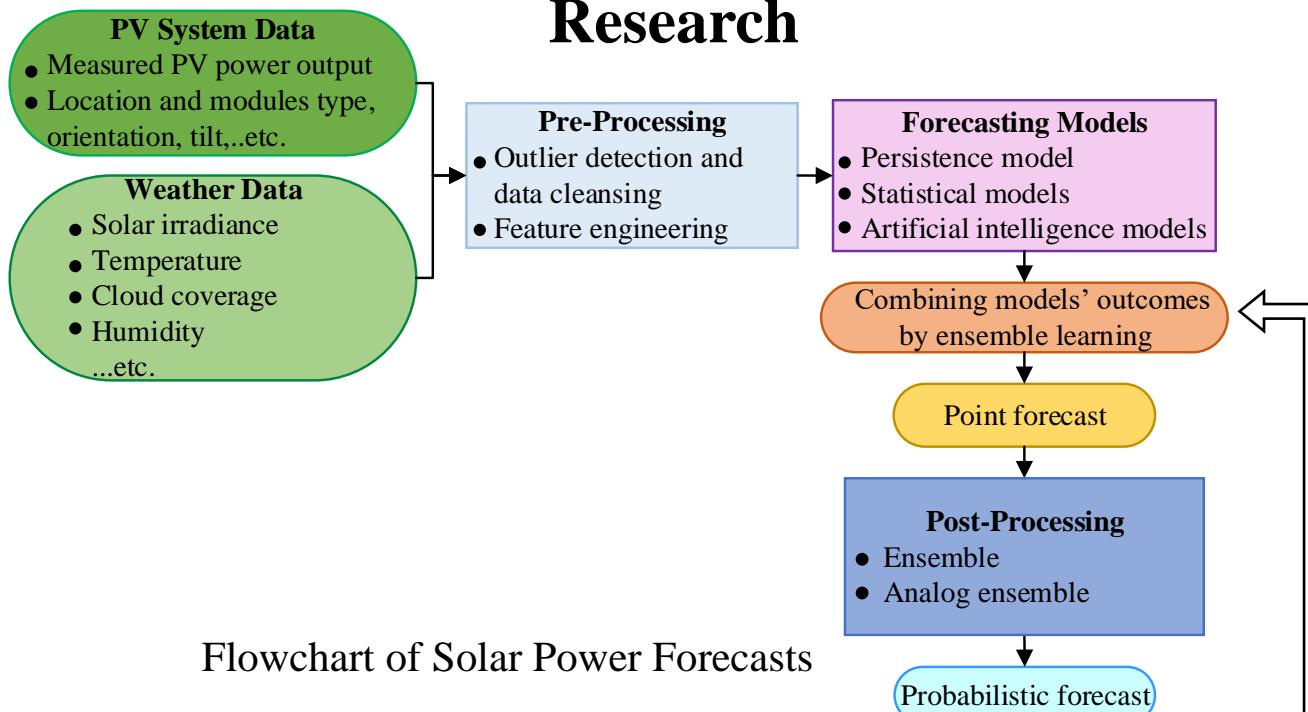
Transmission / bulk level:

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

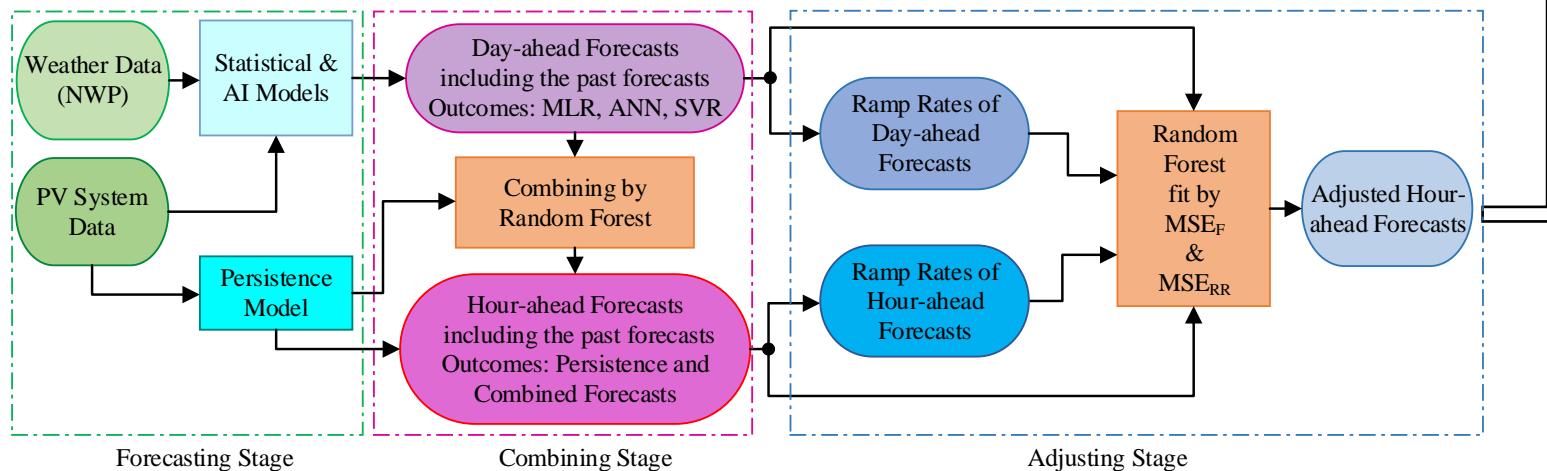
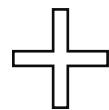


EPEX: European power exchange spot trading

# Research

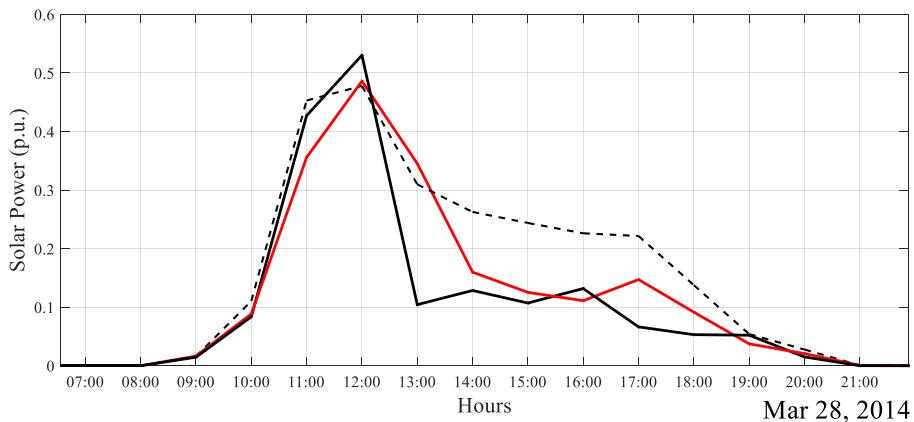
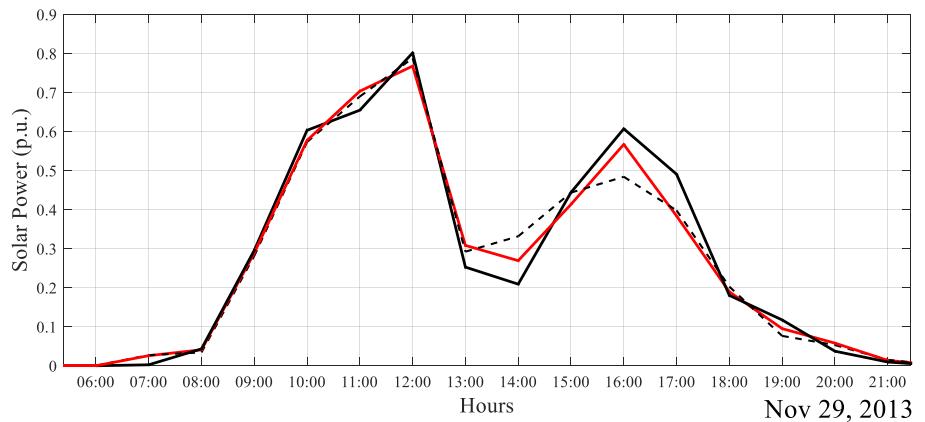
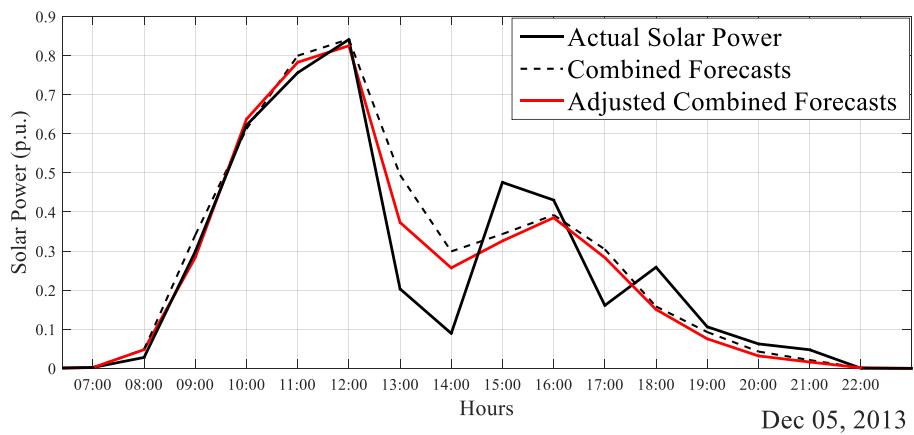
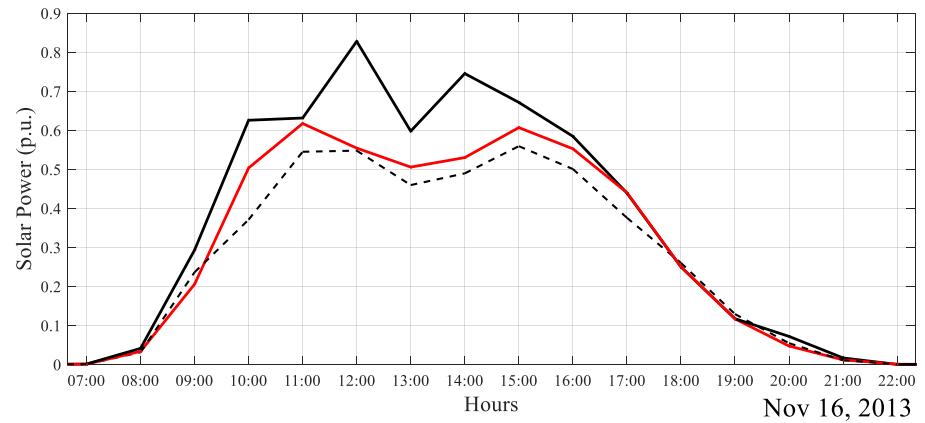


Flowchart of Solar Power Forecasts



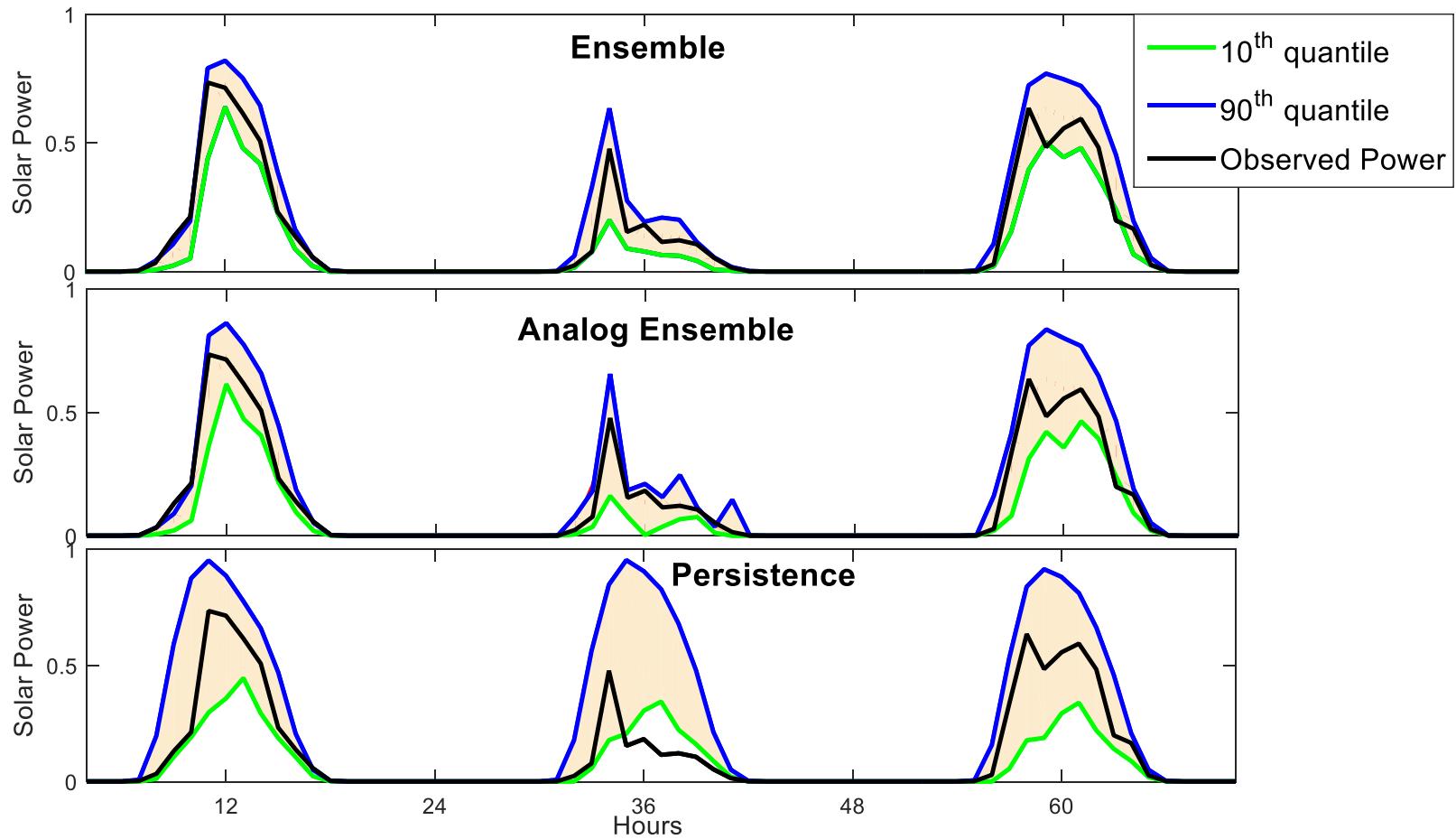
Block diagram of the adjusting approach

# Research



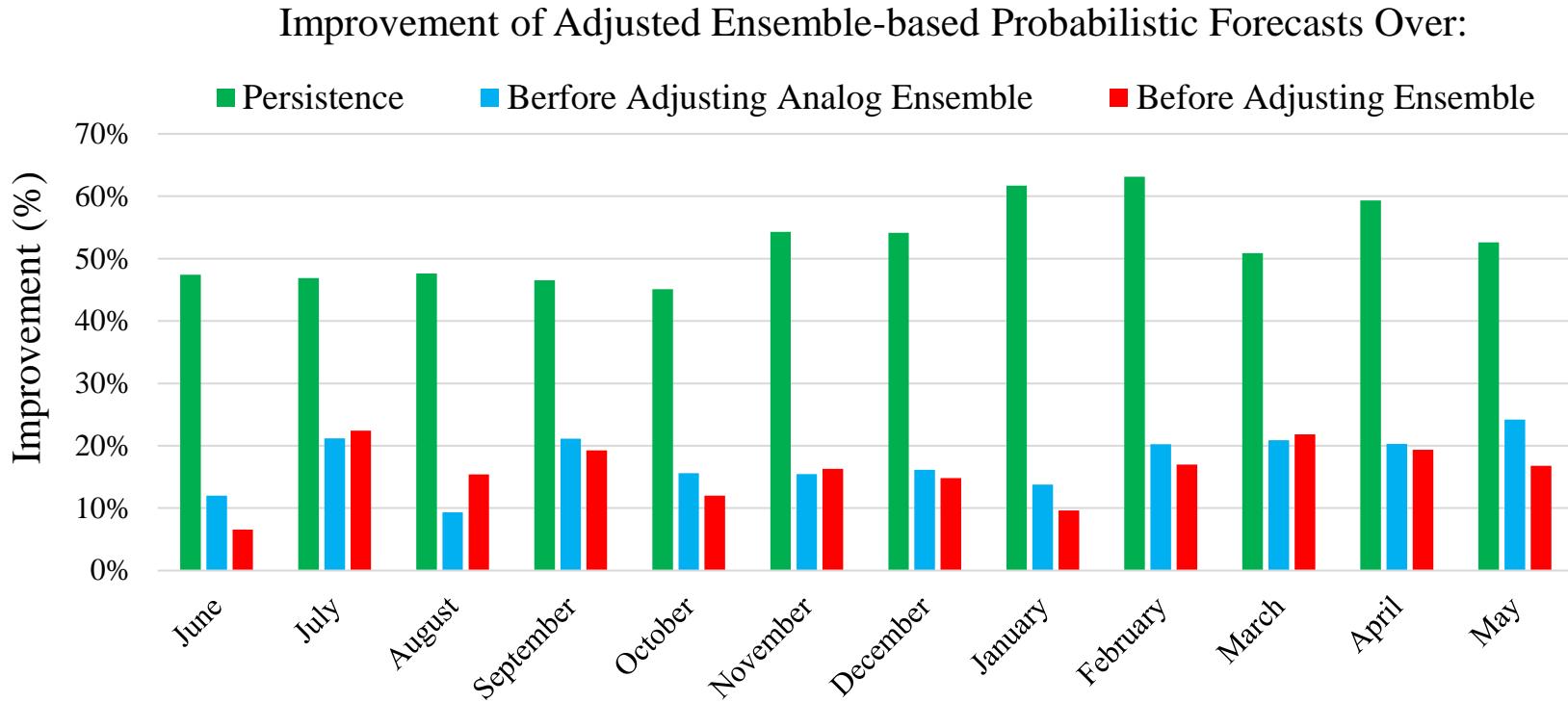
Combined forecasts of solar power for cloudy days before and after applying the adjusting

# Research



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

# Research

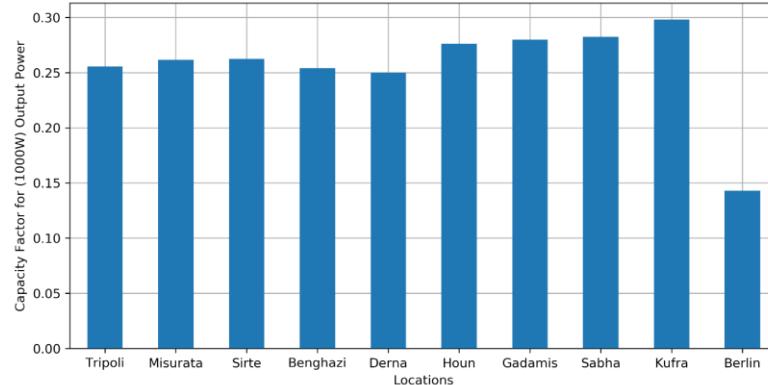
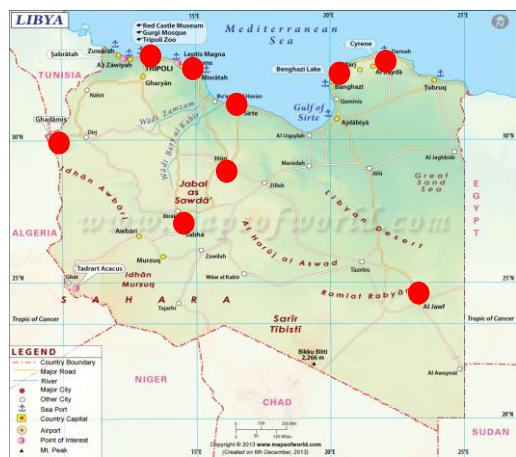


$$Skill\ Score\ (\%) = \left( 1 - \frac{Metric_{method}}{Metric_{reference}} \right) * 100$$

# 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/>



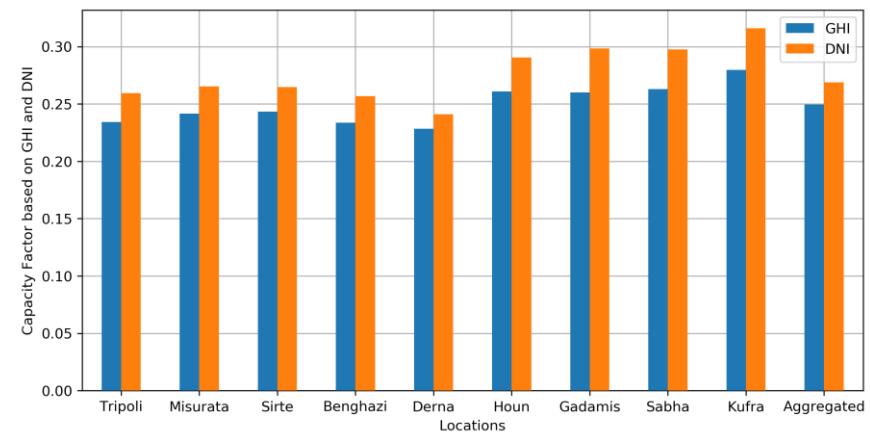
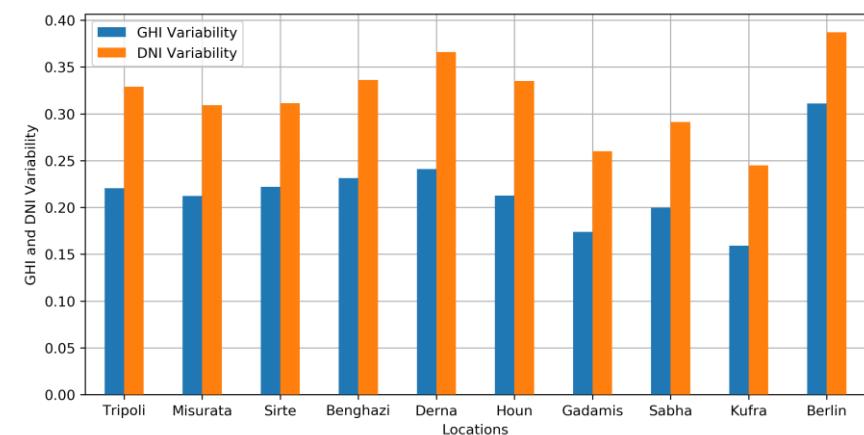
Solar Energy Modeling

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.



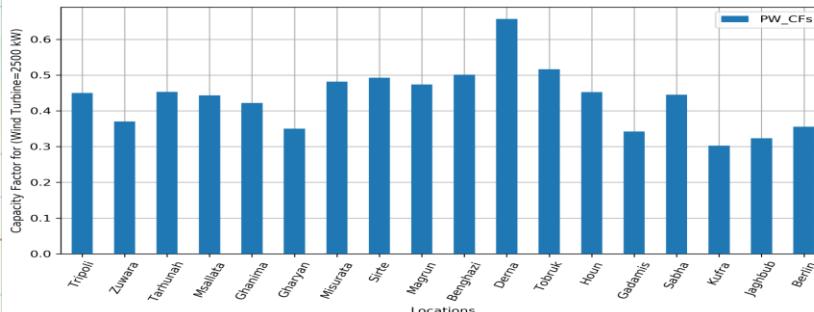
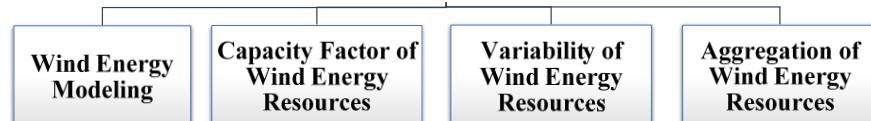
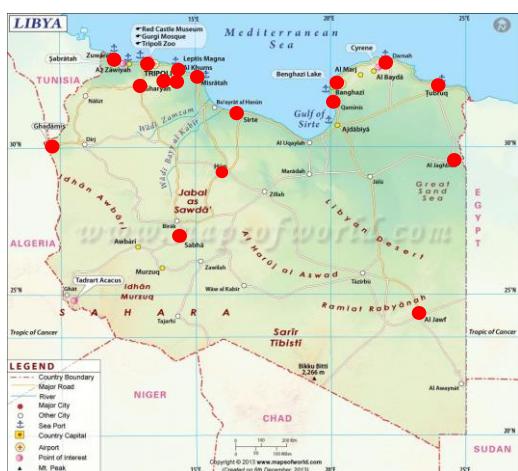
# Research

## Planning and Analysis for Wind Energy in Libya

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

Typical Meteorological Year (TMY) data represents the weather for a "median year". Data are retrieved from NREL's Developer Network:

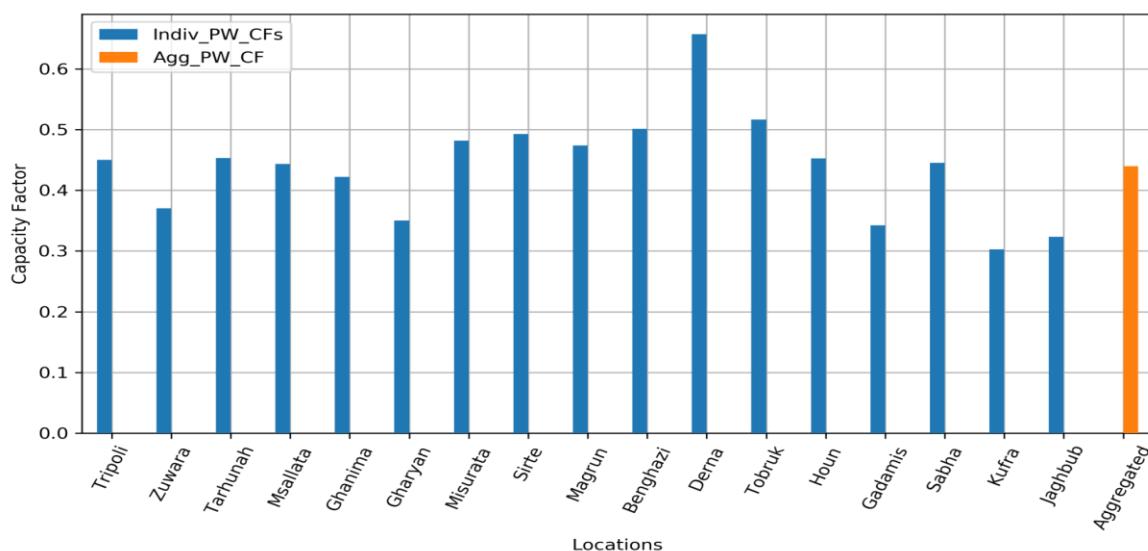
<https://developer.nrel.gov/> Comparison of Monthly Average Wind Speed (m/s) at Height of 10m



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

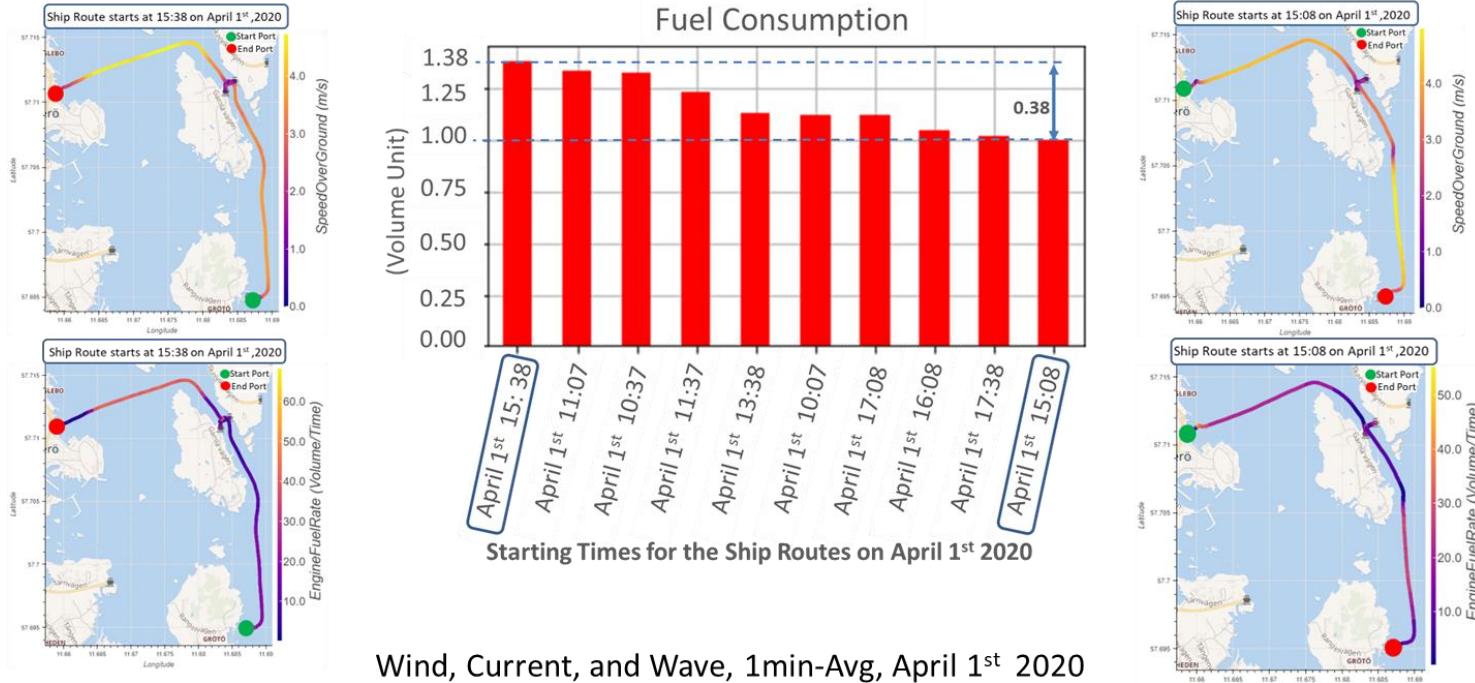
The Rating of Solar PV System =1000W during an entire year = 8760 hours.

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

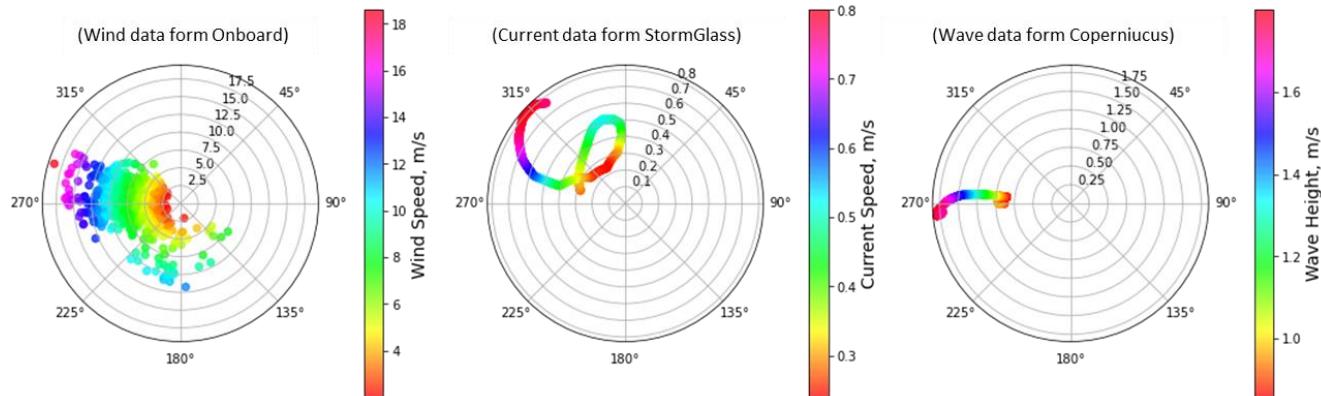


# Research

## Research Work for Improving the Vessel's Energy Efficiency



Wind, Current, and Wave, 1min-Avg, April 1<sup>st</sup> 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

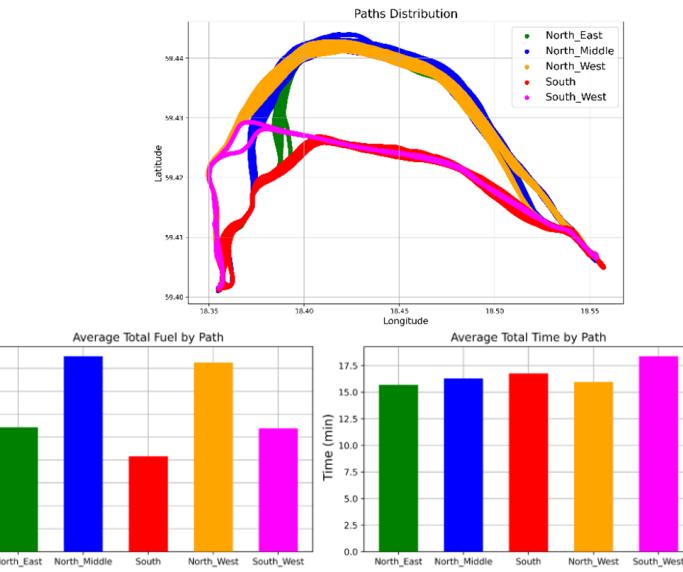
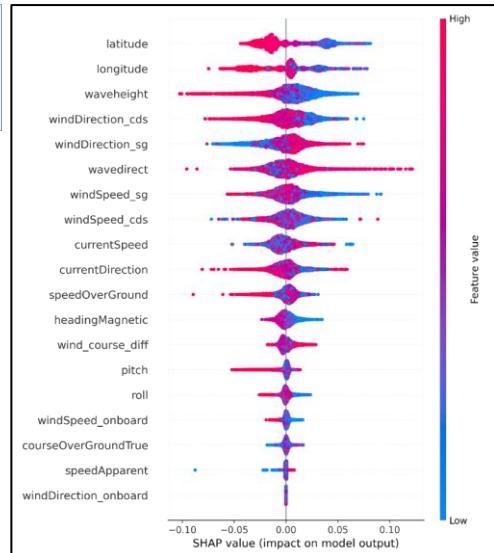
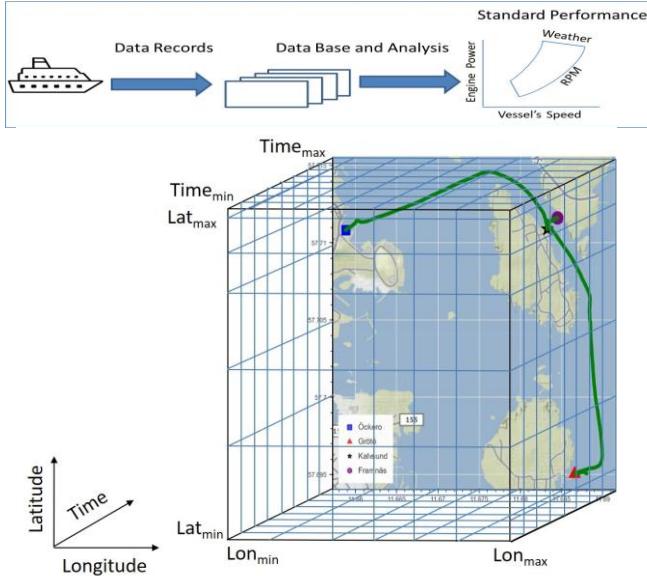
Input: Preprocessed data include operating and weather variables, such as vessel's speed and course, wind, wave, current, etc.

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

### Prescriptive Modeling

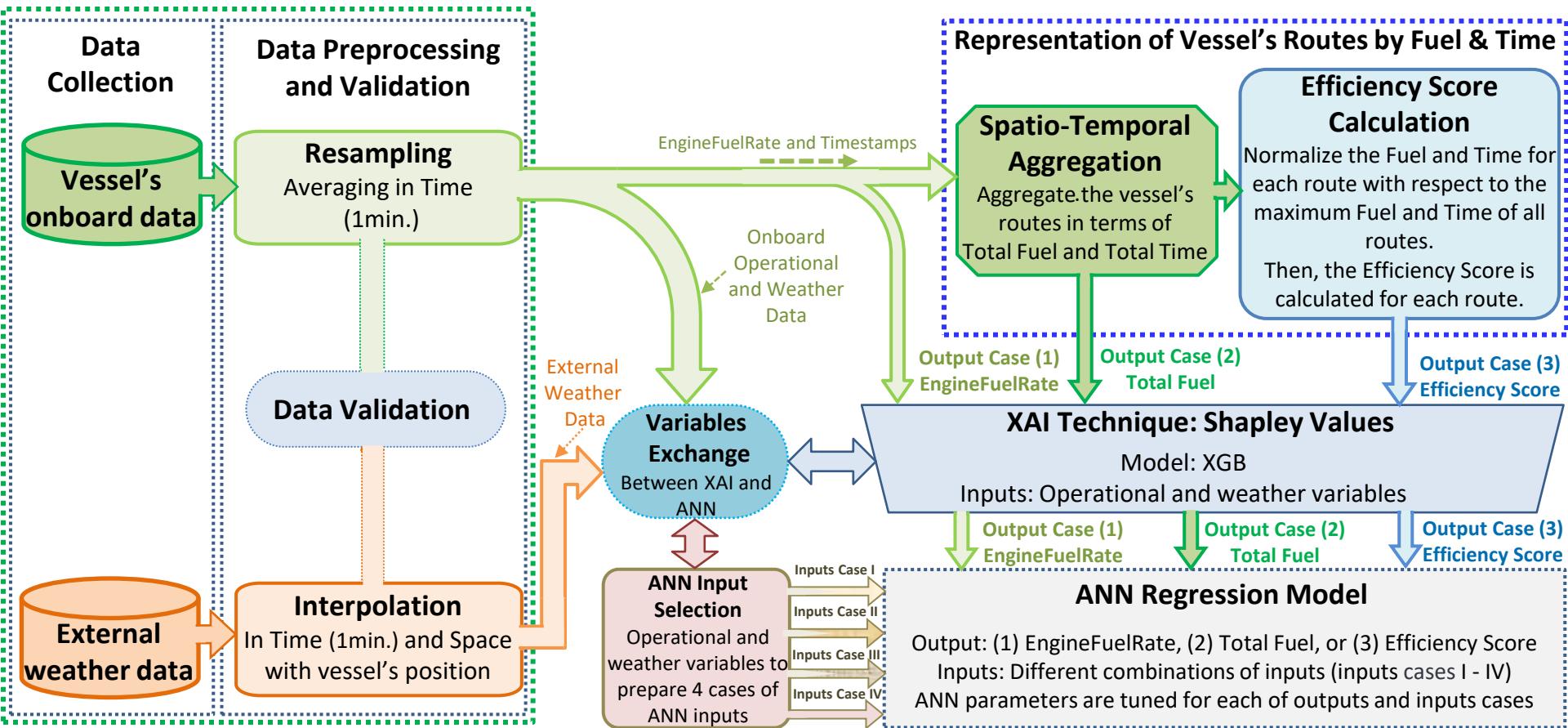
Input: Using solving algorithms, with control variables, such as vessel's speed and course, to find the optimal fuel and time.

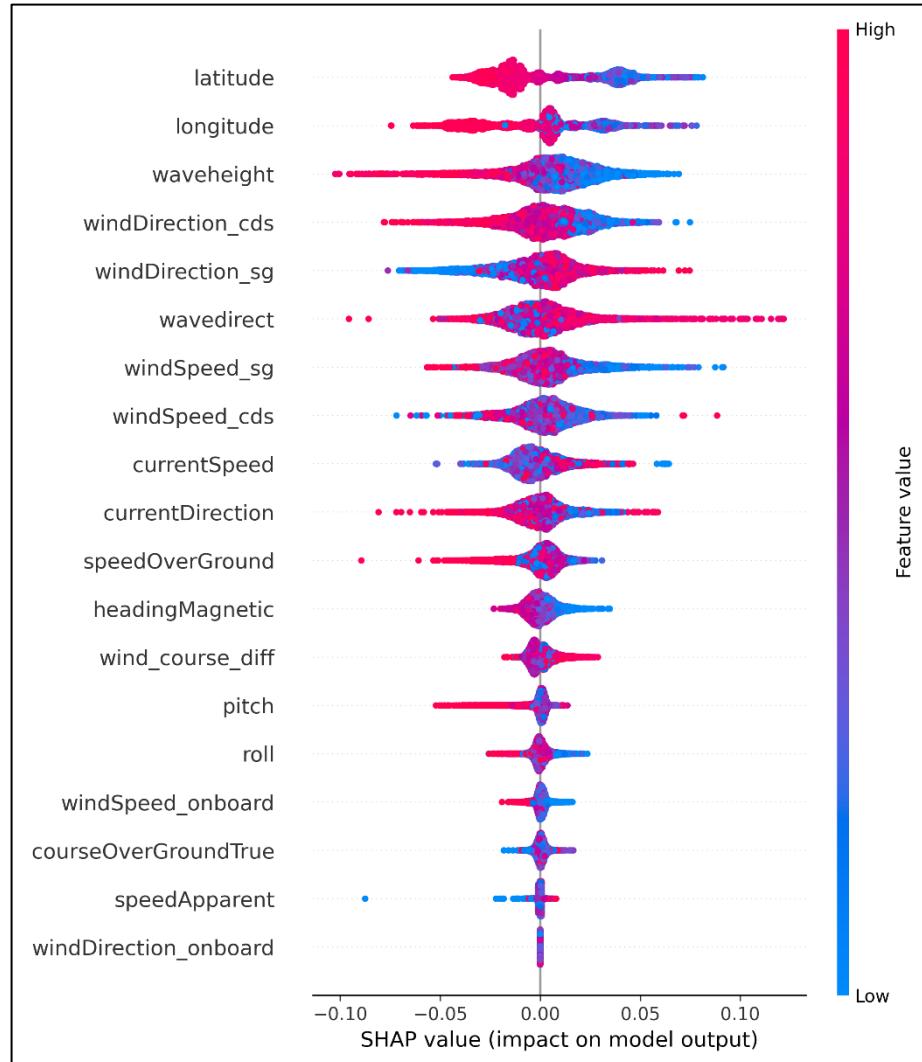
Outcome: Improving fuel consumption and meeting the operational conditions



# Research

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



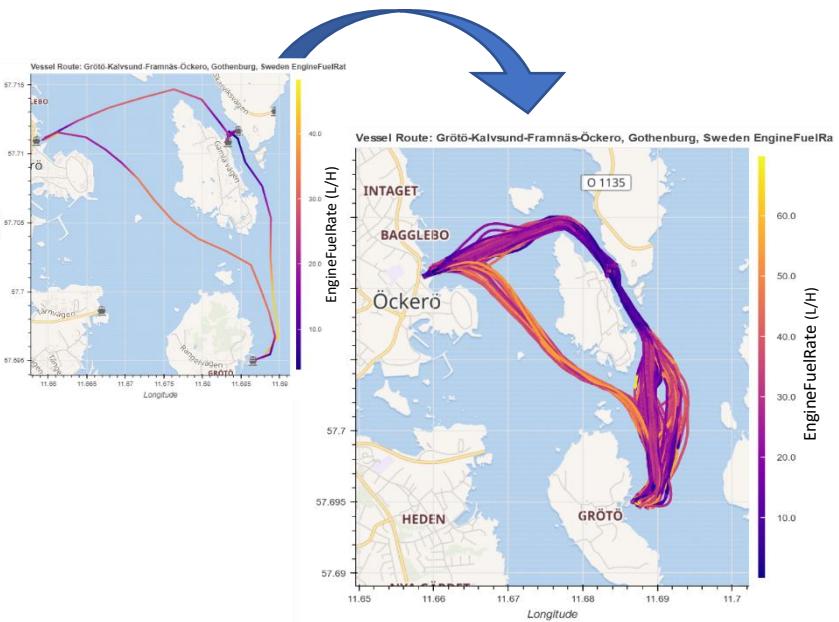


**Shapely values for Regression of Eff-Score** (Global, where Fuel and Time are normalized based on values of all routes)

The spatio-temporal aggregation and using the efficiency score (Global) leads to the **causality**

## Efficiency Score

*It is calculated once for the entire route.*



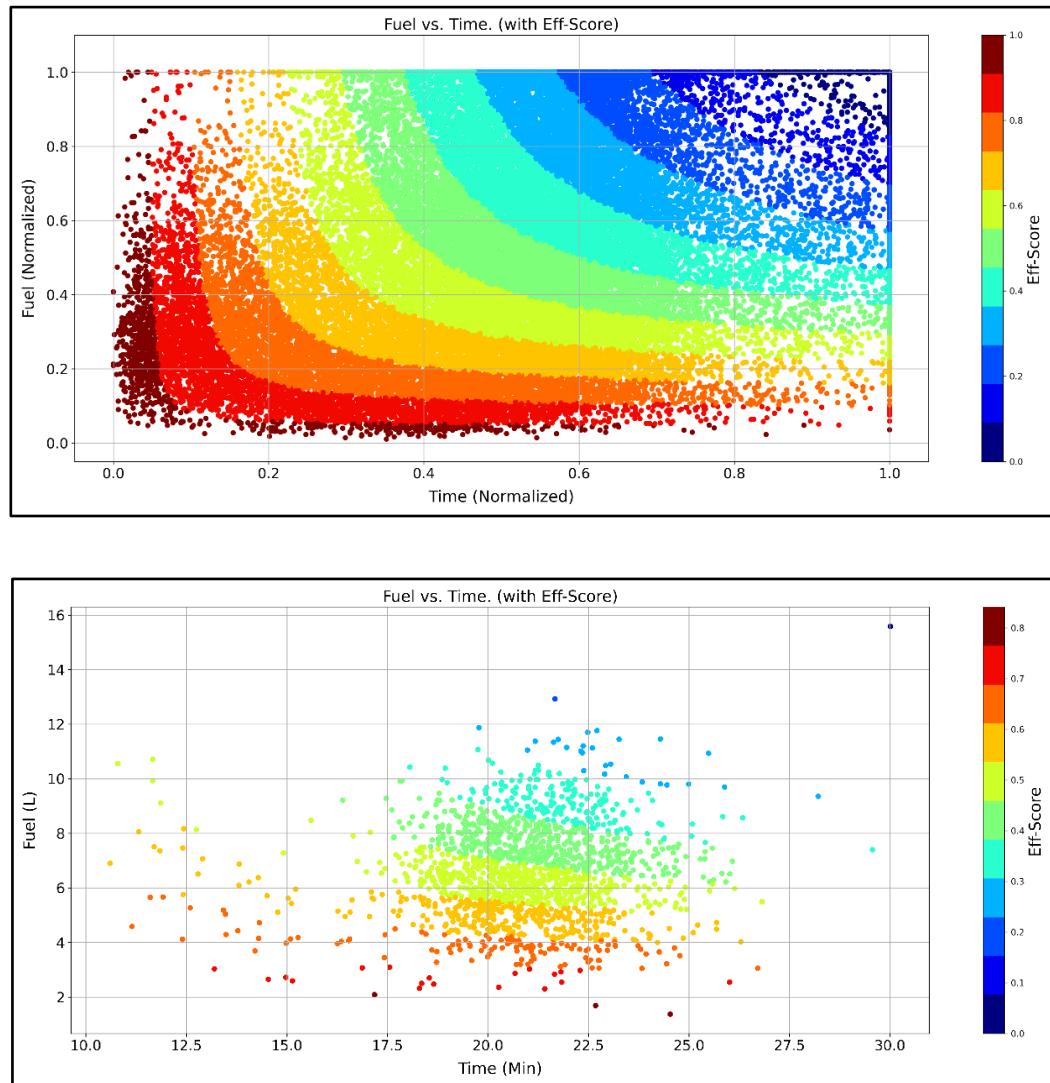
1754 sequences (Routes)

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

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

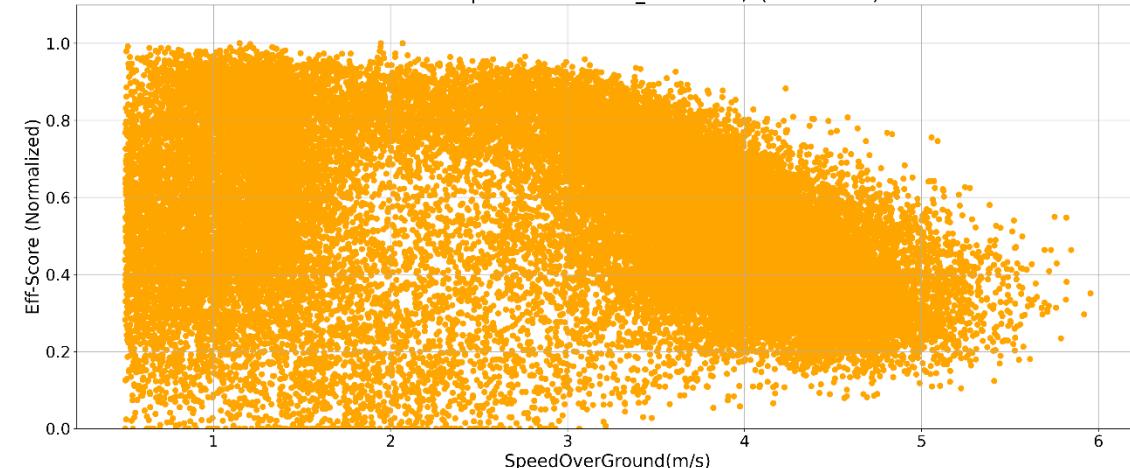
## Research

## Predictive Analytics



### Eff-Score vs. Control Variables

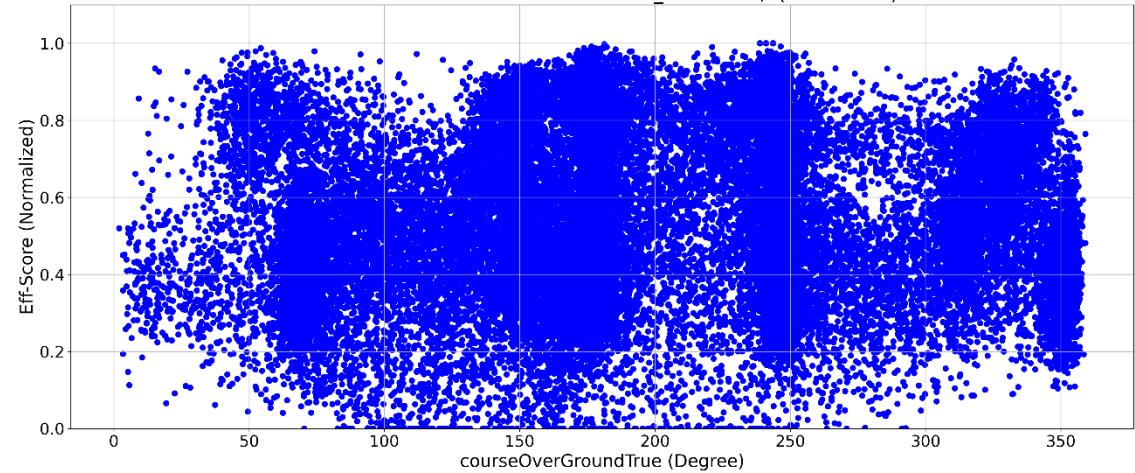
Eff-Score vs. speedOverGround\_measured, (All Dataset)



*For each route out of 1754 routes, it is calculated at every leg (waypoint) of the route.*

*39193 datapoints (Resolution: Min.)*

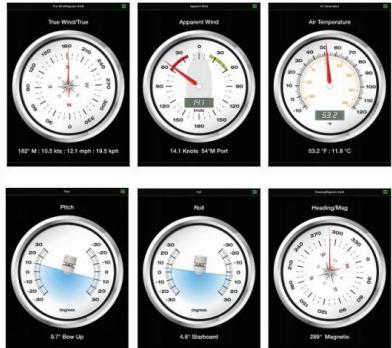
Eff-Score vs. courseOverGroundTrue\_measured, (All Dataset)



# Research

## Problem Formulation

*Objective Function:*  
Minimizing the fuel consumption



## Solutions Finding

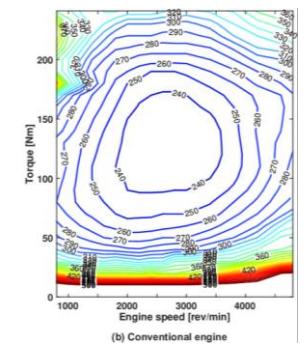
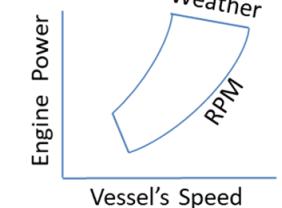
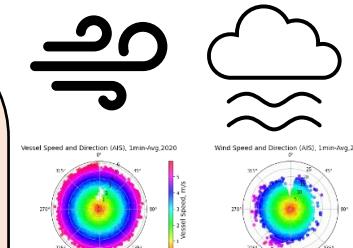
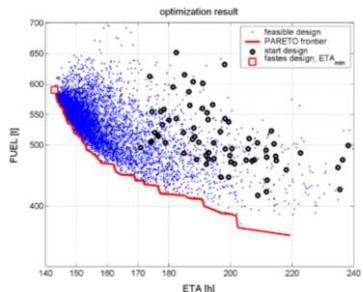
*Solving algorithm:*

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

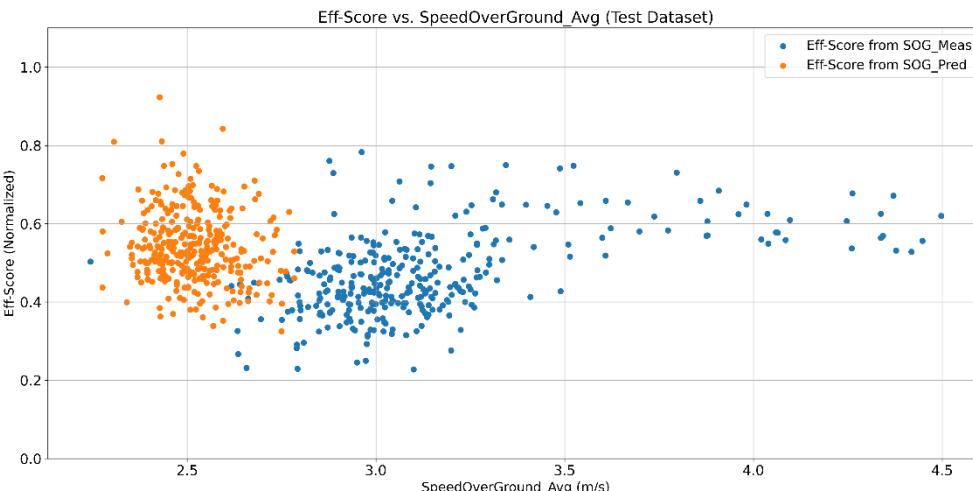


*Objective:*

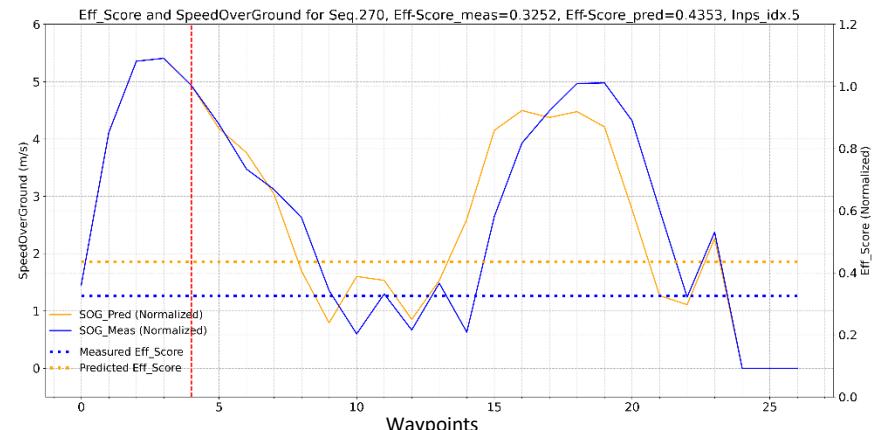
Minimum fuel consumption

## Research

### K-Nearest Neighbor Using Dynamic Time Wrapping (KNN-DTW) and LSTM for Analysis of Vessel's Routes

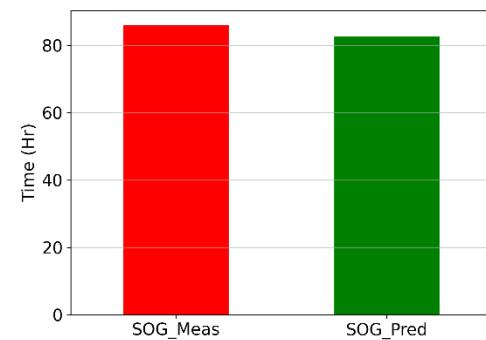
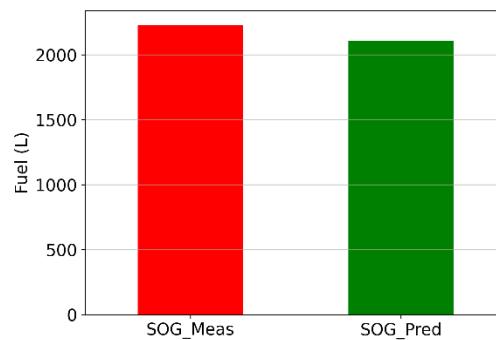


Train data that have Eff\_Score > Q<sup>75th</sup>  
to Predict SOG  
 $Q^{75th} = 0.5360$



334 routes as test data

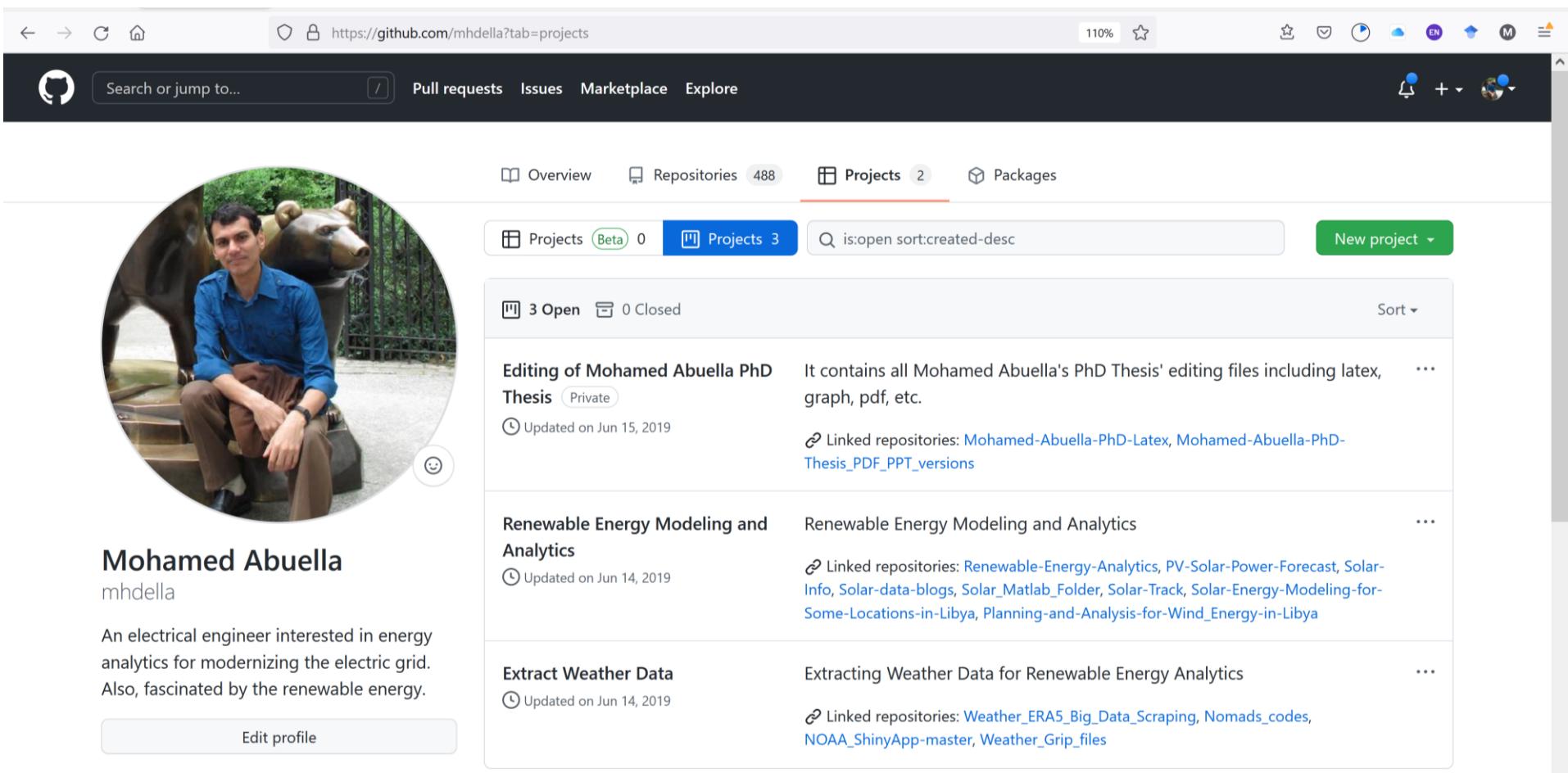
	SOG_Meas	SOG_Pred	Improve
Fuel	2228.28	2105.21	5.52
Time	85.96	82.57	3.94
Distance	1125.82	1082.77	3.82
SOG(avg)	2.4	2.52	-4.65



	Improved Routes	Not-Improved Routes
Count	283	51
Percentage(%)	84.73	15.27

# Research

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



The screenshot shows Mohamed Abuella's GitHub profile page. On the left, there is a large circular profile picture of him sitting next to a large bronze bear statue. Below the picture, his name "Mohamed Abuella" and GitHub handle "mhdella" are displayed. A bio states: "An electrical engineer interested in energy analytics for modernizing the electric grid. Also, fascinated by the renewable energy." A "Edit profile" button is visible. At the top of the page, the URL "https://github.com/mhdella?tab=projects" is shown in the address bar, along with browser controls and a 110% zoom level. The main navigation bar includes "Pull requests", "Issues", "Marketplace", "Explore", and a search bar. Below the navigation, tabs for "Overview", "Repositories 488", "Projects 2", and "Packages" are present, with "Projects" being the active tab. A sub-header for "Projects Beta 0" and "Projects 3" is shown, along with a search bar containing "is:open sort:created-desc" and a "New project" button. The "Projects" section lists three open projects:

- Editing of Mohamed Abuella PhD Thesis** (Private) - Last updated on Jun 15, 2019. Description: 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** - Last updated on Jun 14, 2019. Description: 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** - Last updated on Jun 14, 2019. Description: Extracting Weather Data for Renewable Energy Analytics. Linked repositories: Weather\_ERAS\_Big\_Data\_Scraping, Nomads\_codes, NOAA\_ShinyApp-master, Weather\_Grip\_files.

47 followers · 584 following · 267 stars

# Research

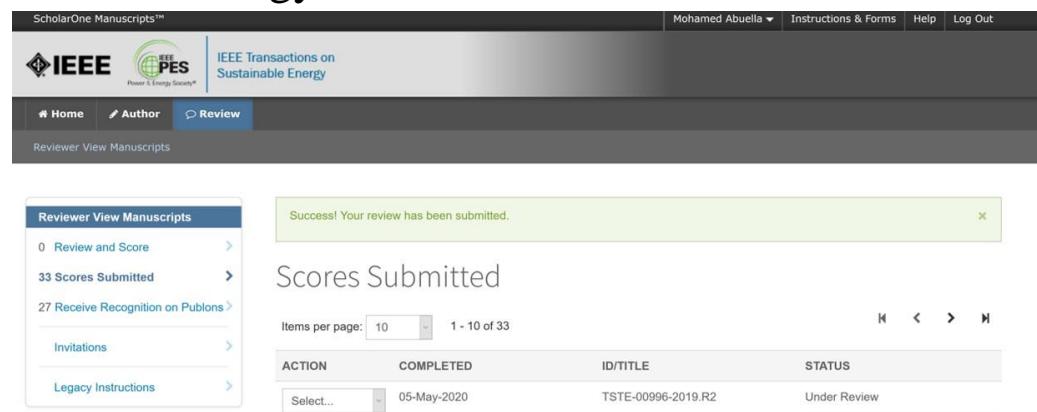
Keep up some blogs on : <https://mohamedabuella.github.io/blog/>

## Blogs

- 01 Jun 2023 » [Blog Data Analytics for Vessel Path Planning in Short-Sea Shipping](#)
- 20 Dec 2022 » [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 Technologies?](#)
- 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 Launched](#)

# Research

- 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. On the left, a sidebar titled "Reviewer View Manuscripts" lists options: "Review and Score", "33 Scores Submitted", "27 Receive Recognition on Publons", "Invitations", and "Legacy Instructions". A green success message box displays the text "Success! Your review has been submitted." In the main content area, the heading "Scores Submitted" is shown above a table. The table has columns for ACTION, COMPLETED, ID/TITLE, and STATUS. One row is visible: "Select... 05-May-2020 TSTE-00996-2019.R2 Under Review".

# Thanks for Your Listening

## Any Question?

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[mhdabuella@gmail.com](mailto:mhdabuella@gmail.com)



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The College Of Industrial Technology\_Misurata



 UNC CHARLOTTE  
Energy Production and Infrastructure Center (EPIC)