



WETO Software Stack Workshop

October 28, 2024

Misha Sinner

Did you see the user workshops?

nrel.github.io/WETOStack

The screenshot shows the '2024 User Workshops' page on the WETO Software Stack website. The page includes a navigation sidebar on the left with categories like 'Workshops', 'Portfolio Analysis', and 'Resources'. The main content area features a title '2024 User Workshops', a summary paragraph, a table of workshop details, and contact information.

2024 User Workshops

This series of workshops has passed. See [Recordings and Slides](#) and [2024 Workshops Report](#) for more info.

The Holistic Modeling Portfolio Coordination Project is hosting a series of workshops in June 2024 to discuss the current state and future direction of the WETO Software Stack. Individual workshops will be held for different topic areas covering a subset of software within the WETO Software Stack. The workshops will be conducted via Microsoft Teams at the dates and times listed below, and registration is required. Anyone interested is encouraged to attend, and the target audience is current and prospective users of WETO software.

Date	Time	Topic Area	Relevant Software
June 10	7-9 am MDT	Systems Engineering	WISDEM, WEIS, WindSE, pyNuMAD, SONATA
June 12	8-10 am MDT	TEA, cost modeling	ORBIT, LandBOSSE, WOMBAT, NRWAL, CORAL
June 18	7-9 am MDT	Controls	FLORIS, FLASC, Hercules, OpenOA
June 20	7-9 am MDT	OpenFAST+	OpenFAST, FAST.Farm, ROSCO, and associated tools

Contact
Please contact Rafael Mudafort (rafael.mudafort@nrel.gov) with any questions.

Schedule Changes
• The HEM workshop (AMR Wind, Nalu Wind, ERE, OpenTurbine) originally...

youtube.com/@rafmudaf

The screenshot shows a YouTube playlist titled 'WETO Stack User Workshops 2024' by Rafael Mudafort. The playlist contains four videos, each with a thumbnail showing workshop content and a duration. The videos are: 'WETO Stack User Workshops 2024 - OpenFAST Ecosystem' (1:47:54), 'WETO Stack User Workshops 2024 - Wind Farm Controls and Analysis' (1:38:21), 'WETO Stack User Workshops 2024 - TEA & Cost Models' (1:37:17), and 'WETO Stack User Workshops 2024 - Systems Engineering' (1:52:11).

WETO Stack User Workshops 2024

Rafael Mudafort

Public

4 videos 64 views Updated today

No description

Play all Shuffle

Sort

- WETO Stack User Workshops 2024 - OpenFAST Ecosystem (1:47:54)
- WETO Stack User Workshops 2024 - Wind Farm Controls and Analysis (1:38:21)
- WETO Stack User Workshops 2024 - TEA & Cost Models (1:37:17)
- WETO Stack User Workshops 2024 - Systems Engineering (1:52:11)

Agenda

Section	Duration	Time
Intro to Holistic Modeling Project	5'	0:00 - 0:05
WETO Stack Overview	10'	0:05 - 0:15
WETO Stack Dashboard	10'	0:15 - 0:25
Best Practices	5'	0:25 - 0:30
Community Discussion	30' – 45'	0:30 - 0:45

Holistic Modeling Project

WETO Software Portfolio Coordination

US DOE & Lab-based Wind Research Projects



The Wind Energy Technologies Office invests in wind energy research, development, demonstration, and deployment activities that enable and accelerate the innovations needed to advance offshore, land-based, and distributed wind systems; reduce the cost of wind energy; drive deployment in an environmentally conscious manner; and facilitate the integration of high levels of wind energy with the electric grid.

NREL's active WETO projects

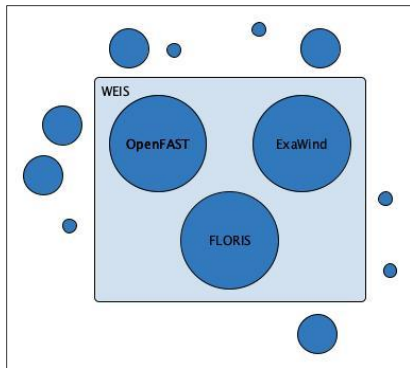
- Study on the Potential Application of Additive Manufacturing in Wind Turbine Components and Tooling
- Enabling Larger Rotors Through Modular, Customizable, Inflatable Blades
- Eagle Topic Area 3 Funding Opportunity Announcement (FOA) Support
- Co-Simulation Study and Control of a Wind Farm for Conversion Services
- Continental-Scale Transmission Modeling Methods for Grid Integration Analysis
- Atmosphere to Electrons to Grid (A2e2g)
- Fusion Joining of Thermoplastic Composites Using Energy Efficient Processes (TCF)
- Automating In-Situ Grinding and Repair for Thermoplastic Blades
- Codesign and Intelligent Approaches for Cost-Effective Operation and Maintenance of Generators and Power Converters
- Wind Power as Virtual Synchronous Generation (WindVSG)
- Modeling and Validation for Offshore Wind
- Technology Development and Innovation to Address Operational Challenges
- Evaluating Deterrent Stimuli for Increasing Species-Specific Effectiveness of an Advanced Ultrasonic Acoustic Deterrent
- North American Renewable Integration Study
- High-Fidelity Modeling
- Wind Turbine Drivetrain Reliability Assessment and Remaining Useful Life Prediction (TCF)
- Enabling Autonomous Wind Plants through Consensus Control (TCF)
- Big Adaptive Rotor
- North American Energy Resiliency Model (NAERM)
- Energy Sector Modeling and Impacts Analysis
- Floating Downwind Turbines: A Conceptual System-Level Design and Feasibility Study for U.S. Waters
- Wind Standards Development
- Multiscale Integration of Control Systems (EMS/DMS/BMS)
- Advanced Modeling, Dynamic Stability Analysis, and Mitigation of Control Interactions in Wind Power Plants
- Wind Grid Integration Stakeholder Engagement
- Atmosphere to Electrons (A2e) Performance Risk, Uncertainty and Finance (PRUF) Analysis Support
- Working Together to Resolve Environmental Effects of Wind Energy (WREN)
- High-Fidelity Modeling Toolkit for Wind Farm Development



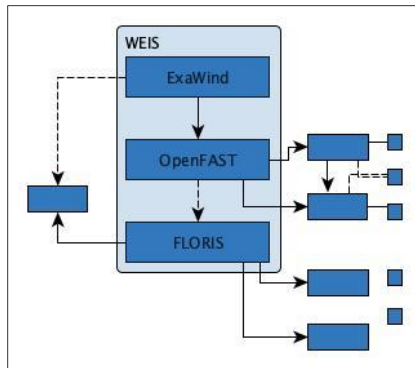
Holistic Modeling Project

Objective

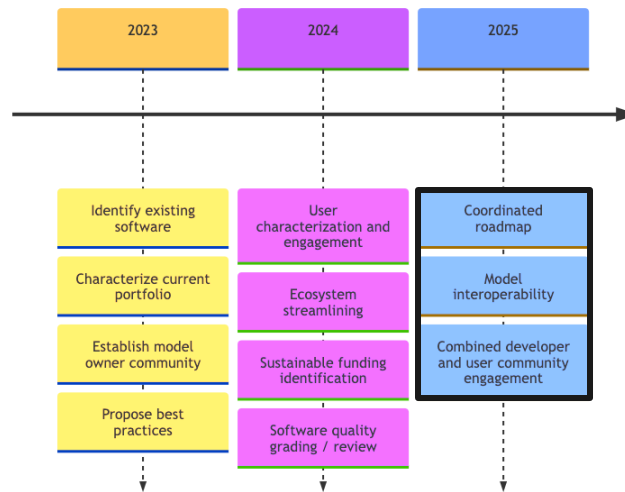
Past: Loose collection of software



Future: Cohesive software stack



Project Timeline

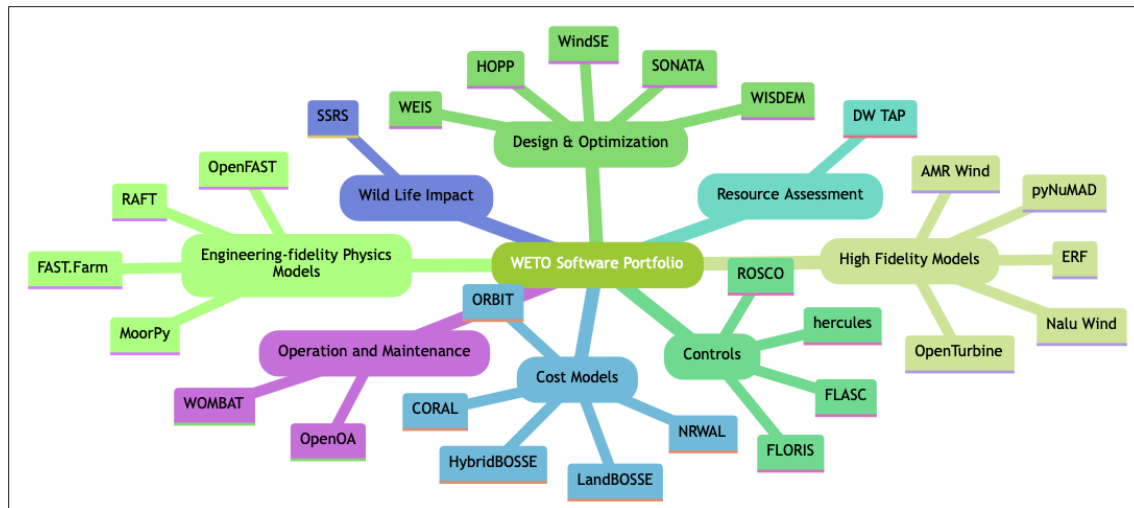


WETO Software Stack

Overview

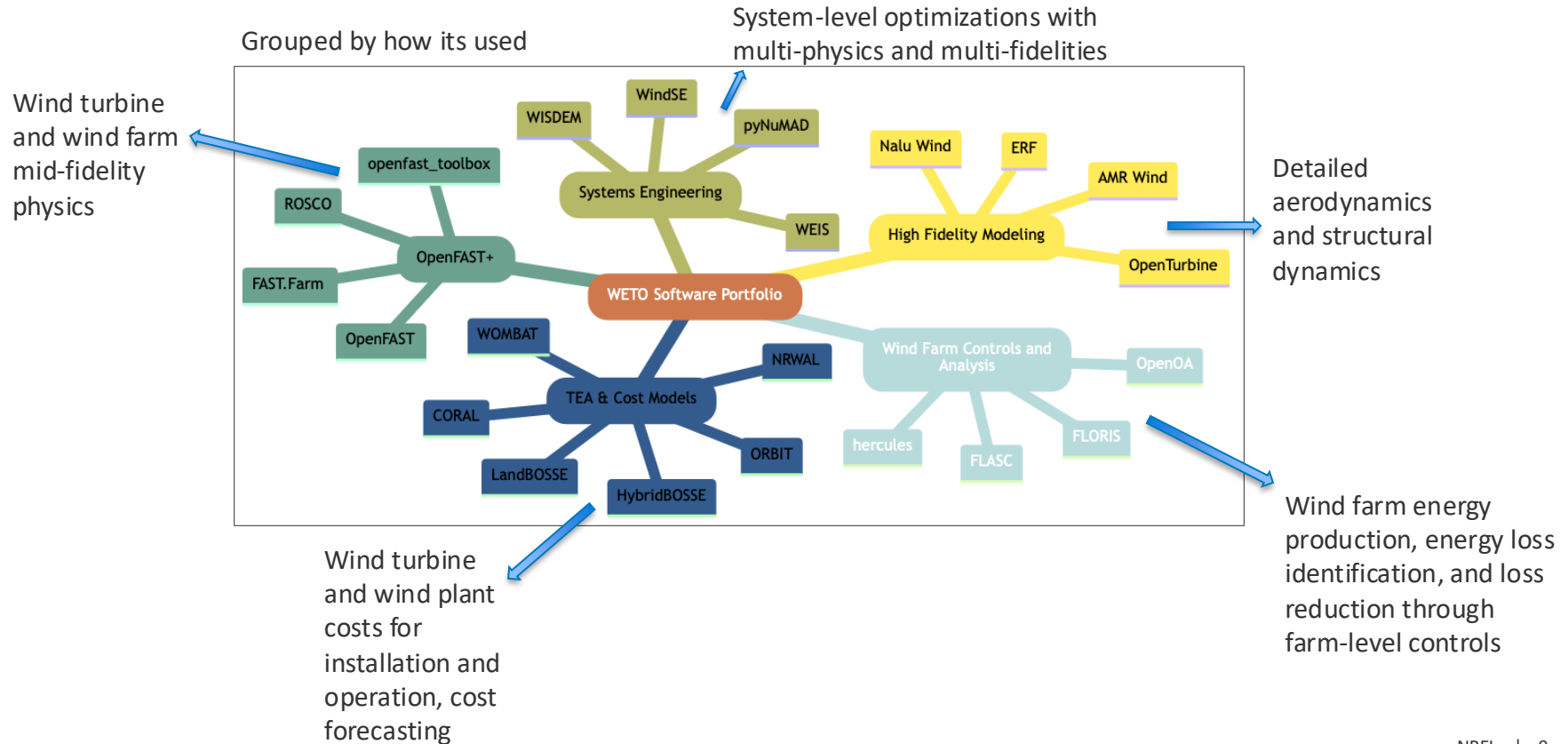
WETO Software Stack

Grouped by what it does

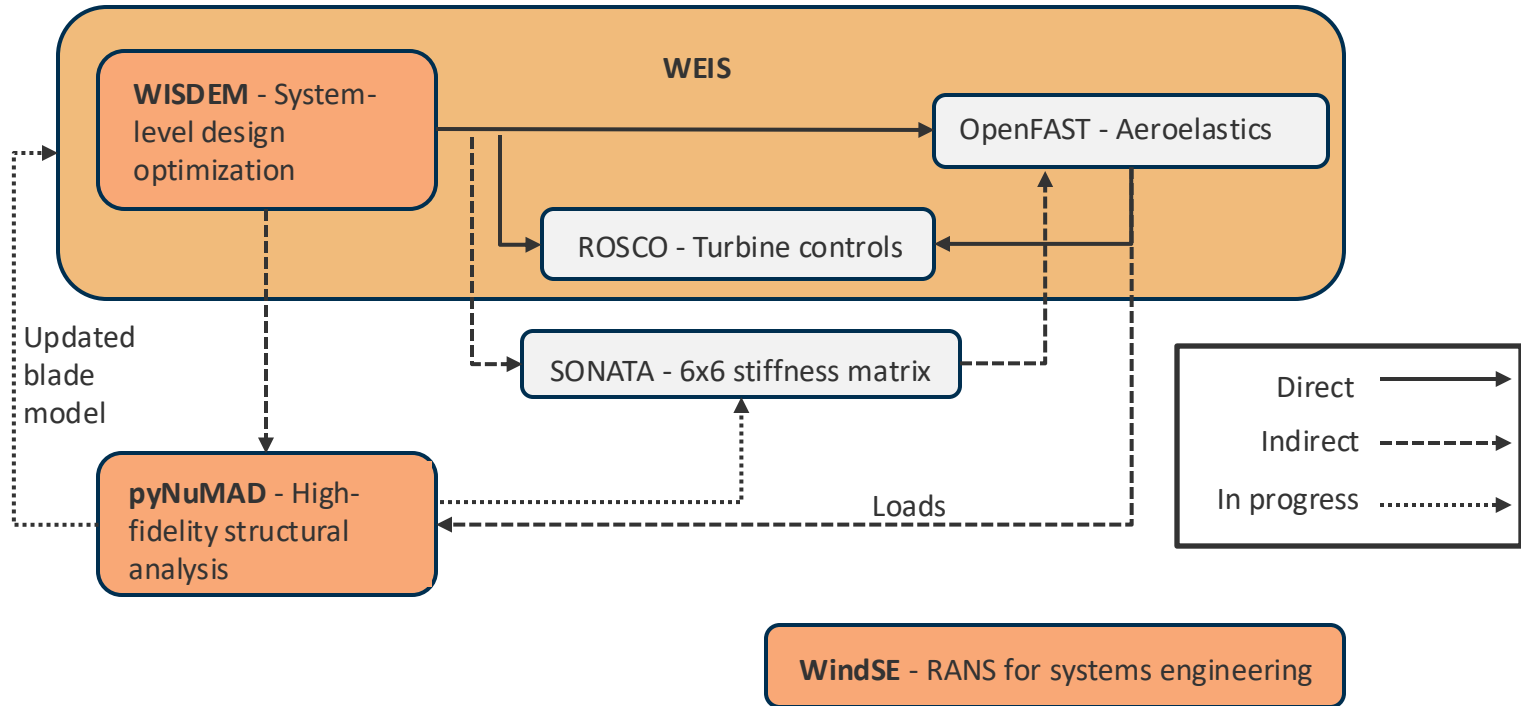


https://nrel.github.io/WETOstack/portfolio_analysis/software_list.html

WETO Software Stack



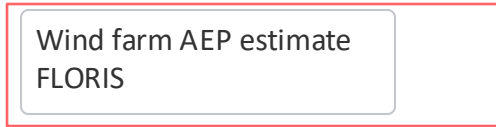
Systems Engineering



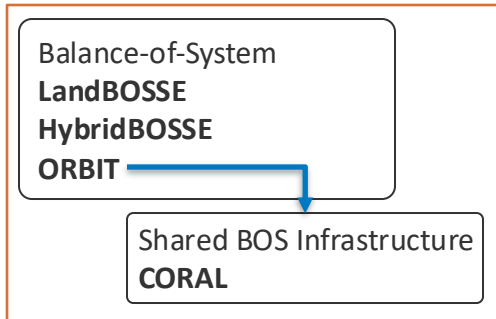
Adapted from Big Adaptive Rotor (BAR) project

Technoeconomic Analysis / Cost Modeling

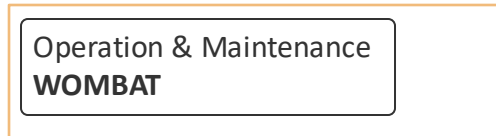
Energy Yield



CapEx



OpEx



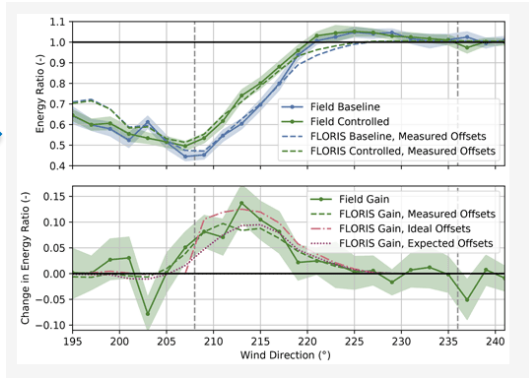
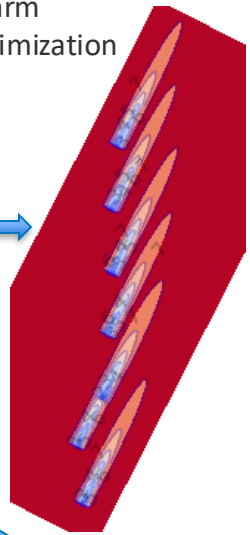
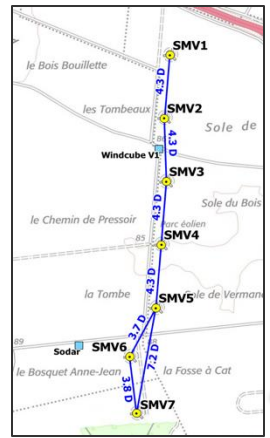
NRWAL: Offshore wind system cost and scaling model



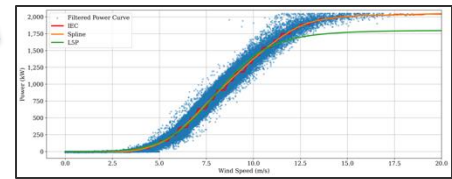
Wind Farm Controls and Analysis

FLORIS: Steady-state modeling, farm controls optimization

FLASC: Validate FLORIS model with SCADA, compare control methods



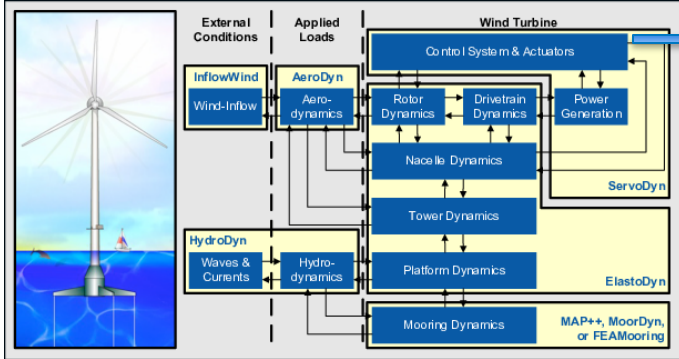
Hercules: Realtime high-fidelity simulator for hybrid power plants with a specific focus on wind farm controls.



OpenOA: Characterize plant performance and quantify sources of operational loss

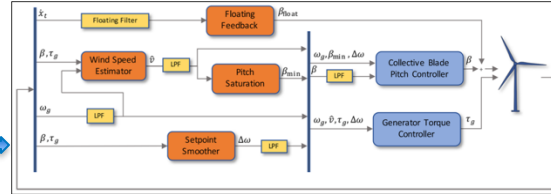
OpenFAST+

OpenFAST



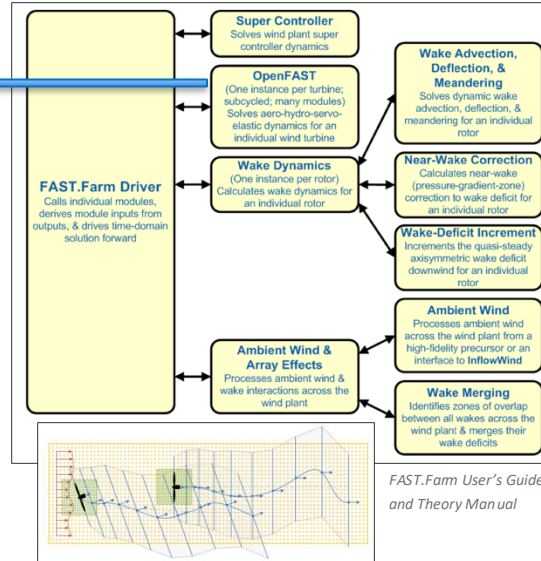
OpenFAST v3.5.3 documentation

ROSCO



N. J. Abbas et al.: A reference controller for wind turbines

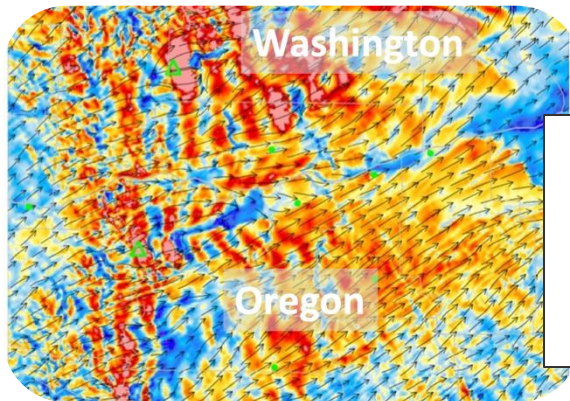
FAST.Farm



openfast_toolbox

High Fidelity Models

ExaWind



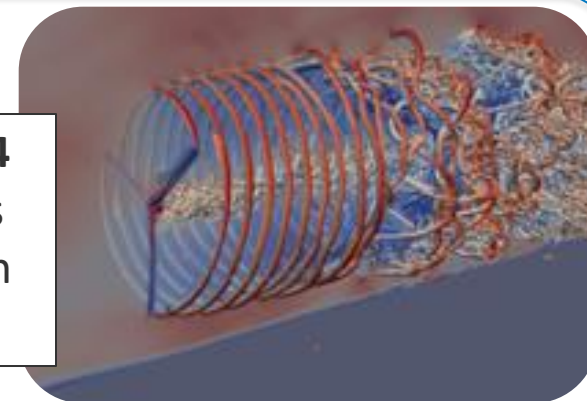
Mesoscale: ERF

- Regional scale weather
- **Scales 10 km to 1000 km**
- WRF numerics & models, built on AMReX
- GPU compatible
- Compressible

Upcoming workshop November 14
 WETO Stack + High Fidelity Models
 HFM-specific community discussion
<https://nrel.github.io/WETOStack>

Microscale: AMR-Wind

- Atmospheric boundary layer
- **Scales less than 10 km**
- Large Eddy Simulation built on AMReX
- GPU compatible
- Structured grid with refinement zones
- Incompressible



Turbine scale: NALU-Wind

- Turbine, rotor, tower, nacelle
- **Scales less than 1 km**
- Unsteady Reynolds Averaged Navier Stokes
- GPU compatible
- Unstructured grid, geometry resolving
- Incompressible

WETO Stack Dashboard

WETO Stack dashboard will provide the following information:

- The WETO-supported tools that enable a given task
- The state (maturity, stability) of included software
- The state of the WETO-support portfolio of software
- The current and future capabilities
- Updates and community-focused materials

WETO Software Stack

Intent & Contents

nrel.github.io/WETOStack

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Current Contents:

- Workshop recordings and reports

The screenshot shows a web browser displaying the 'WETO Software Stack' website. The page title is '2023 NAWEA / WindTech Workshops'. The left sidebar contains a navigation menu with sections: Workshops, Portfolio Analysis, and Resources. The main content area includes a search bar, a list of workshops (2024 NAWEA / WindTech Workshops, 2024 User Workshops, 2023 NAWEA / WindTech Workshops, 2023 Model Owners Workshop), and a section for 'WETO Software Stack Overview + Community Discussion'. Below the text, there is a link to download slides and a video player showing a thumbnail for 'NAWEA 2023 Workshops - WETO Software Stack WETO Software Portfolio'. The video player has a red play button and a share icon. At the bottom of the video player, it says 'Active funding, active development: 30 projects + 20k?'. The URL in the browser is 'nrel.github.io/WETOStack/workshops/nawea_2023.html'.

Intent & Contents

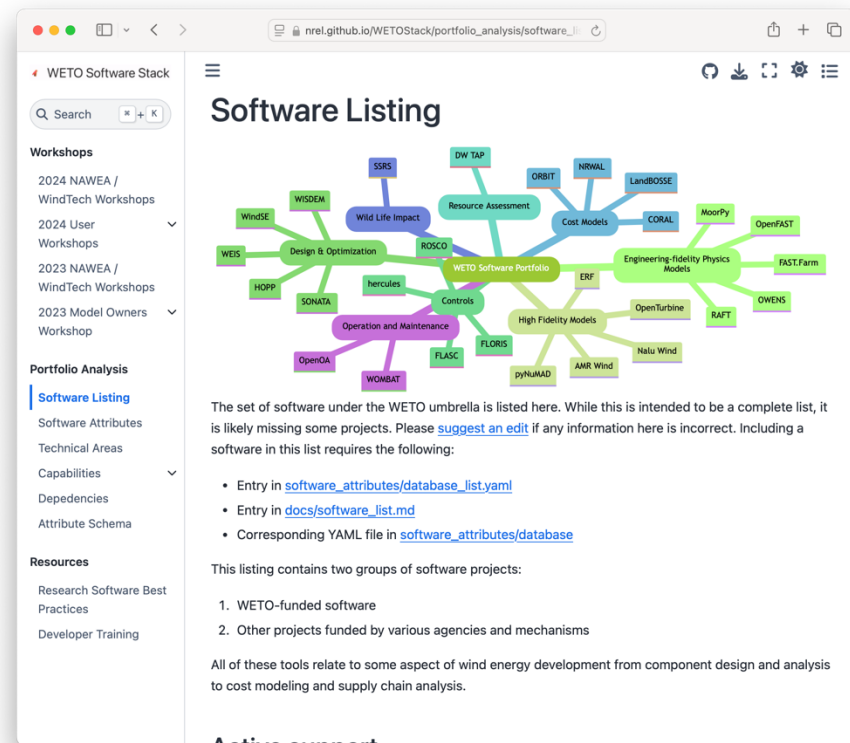
nrel.github.io/WETOStack

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Current Contents:

- Workshop recordings and reports
- [Software Listing](#): active, inactive, and “other status” software



The screenshot shows a web browser displaying the 'WETO Software Stack' dashboard. The main content area is titled 'Software Listing' and features a central mind map diagram. The mind map has a central node 'WETO Software Portfolio' with several branches: 'Design & Optimization' (including WINDSE, WISDEM, WES, HOPP, SONATA, hercules, ROSCO, Wild Life Impact, SSRS, DW TAP, Resource Assessment, ORBIT, NRWAL, LandBOSSE, Cost Models, CORAL, MoorPy, OpenFAST), 'Engineering-Fidelity Physics Models' (including FAST.Farm, OWENS, RAFT, OpenTurbine, Malu Wind, AMR Wind, pyNUMAD, FLORIS, FLASC, WOMBAT, OpenOA), and 'Operation and Maintenance' (including WOMBAT, FLASC, FLORIS). Below the mind map, there is a text block explaining that the list is intended to be complete but may be missing some projects, and it includes a link to 'suggest an edit'. Below that, there are three bullet points: 'Entry in software_attributes/database_list.yaml', 'Entry in docs/software_list.md', and 'Corresponding YAML file in software_attributes/database'. At the bottom, there is a section titled 'This listing contains two groups of software projects:' followed by a numbered list: '1. WETO-funded software' and '2. Other projects funded by various agencies and mechanisms'. The footer of the page says 'All of these tools relate to some aspect of wind energy development from component design and analysis to cost modeling and supply chain analysis.'

Intent & Contents

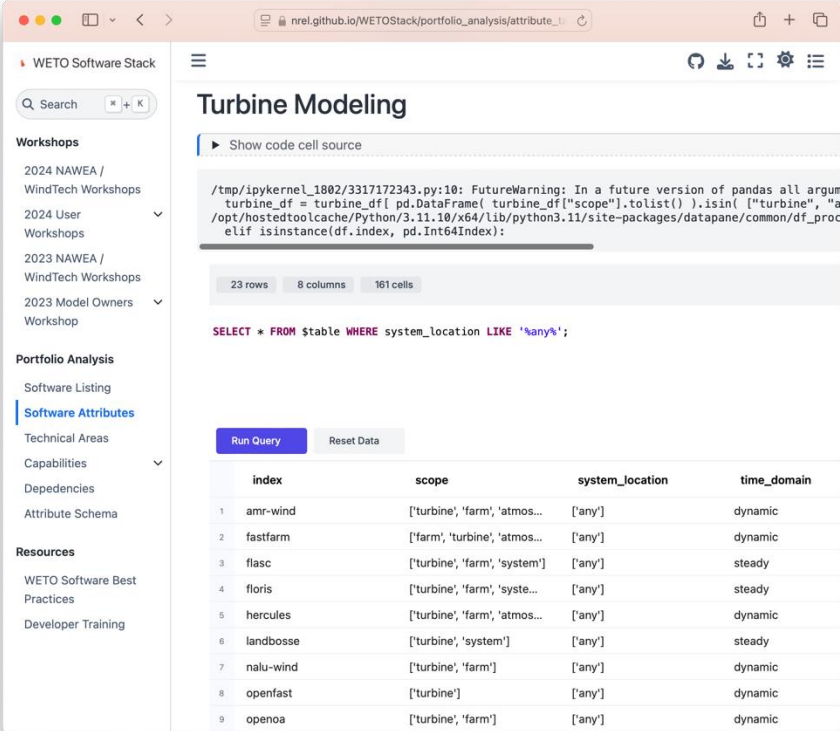
nrel.github.io/WETOStack

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Current Contents:

- Workshop recordings and reports
- [Software Listing](#): active, inactive, and “other status” software
- [Software Attributes](#): tabulated data describing each software, defined by an [Attribute Schema](#)



The screenshot shows the WETO Software Stack dashboard. The main content area displays a query result for "Turbine Modeling". The query is: `SELECT * FROM stable WHERE system_location LIKE '%any%';`. The result is a table with 9 rows and 4 columns: index, scope, system_location, and time_domain.

index	scope	system_location	time_domain
1	amr-wind	['turbine', 'farm', 'atmos...]	dynamic
2	fastfarm	['farm', 'turbine', 'atmos...]	dynamic
3	flasc	['turbine', 'farm', 'system']	steady
4	floris	['turbine', 'farm', 'syste...]	steady
5	hercules	['turbine', 'farm', 'atmos...]	dynamic
6	landbosse	['turbine', 'system']	steady
7	nalu-wind	['turbine', 'farm']	dynamic
8	openfast	['turbine']	dynamic
9	openoa	['turbine', 'farm']	dynamic

Intent & Contents

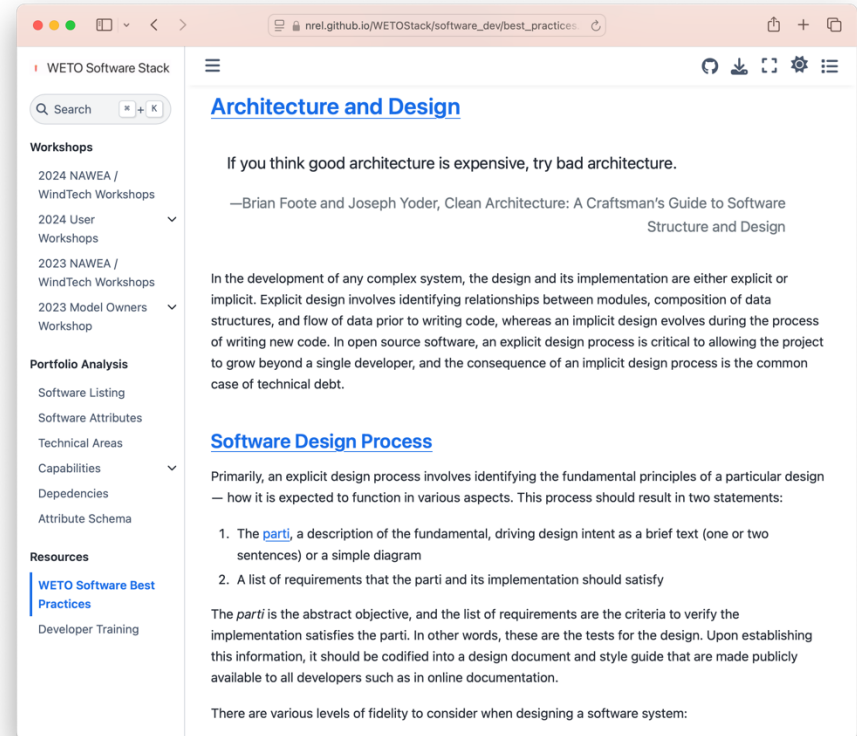
nrel.github.io/WETOStack

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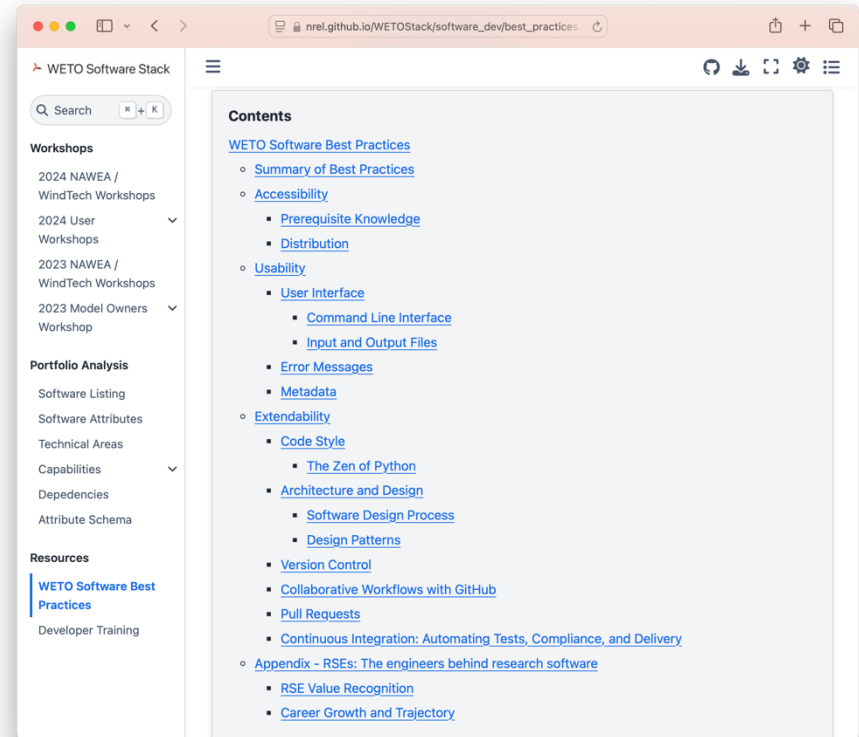
- Workshop recordings and reports
- [Software Listing](#): active, inactive, and “other status” software
- [Software Attributes](#): tabulated data describing each software, defined by an [Attribute Schema](#)
- [Best Practices](#): guidance for creating software within the context of WETO and the research environment



WETO Software Best Practices

nrel.github.io/WETOStack

- **Accessibility:** How to obtain and integrate the software into your work
- **Usability:** How to get up to speed and become proficient at executing the software and understanding the results
- **Extendability:** How new features, bug fixes, and general maintenance are incorporated into the software by regular developers as well as new developers



Ideas?

Tell us your thoughts!

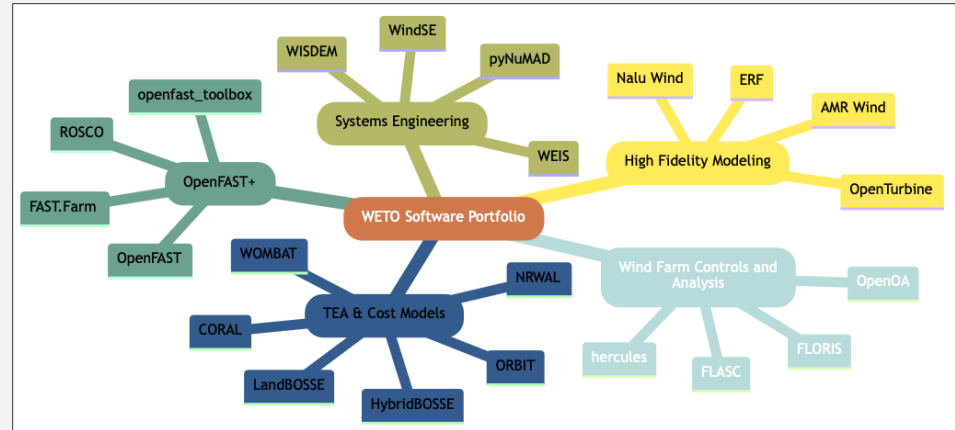
- Repository: <https://github.com/nrel/wetostack>
- Issues: <https://github.com/NREL/WETOStack/issues>
- Pull requests: <https://github.com/NREL/WETOStack/pulls>
- Discussions: <https://github.com/NREL/WETOStack/discussions>

WETO Software Stack

Open Discussion

WETO Software Stack

- What's missing?
- What works well?
- Is there a particular capability or topic that you'd like to elevate?
- What have been your primary pain points or bottlenecks?



Engage with us!

- WETO Stack: <https://nrel.github.io/WETOStack>
- Need help with a particular problem?
 - GitHub Issues or Discussions pages for any of the software
 - NREL User Forum (for NREL models): forums.nrel.gov
- Feedback, question: Rafael.Mudafort@nrel.gov



Thank you!

<https://nrel.github.io/WETOSStack>

Michael.Sinner@nrel.gov

Rafael.Mudafort@nrel.gov





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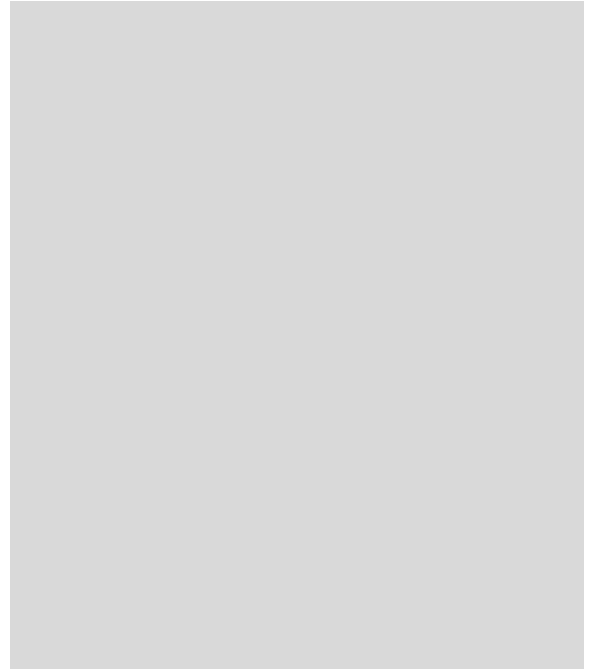
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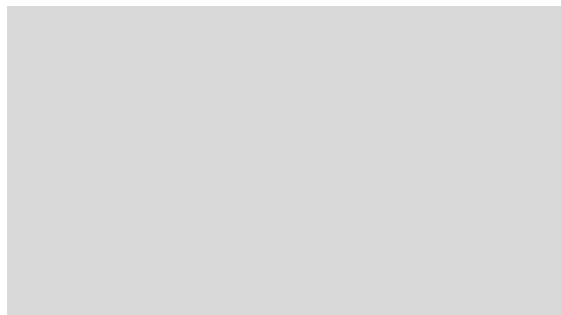
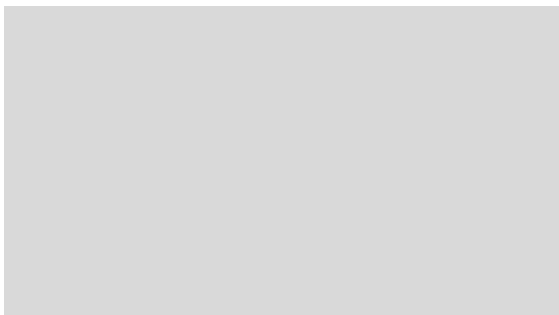
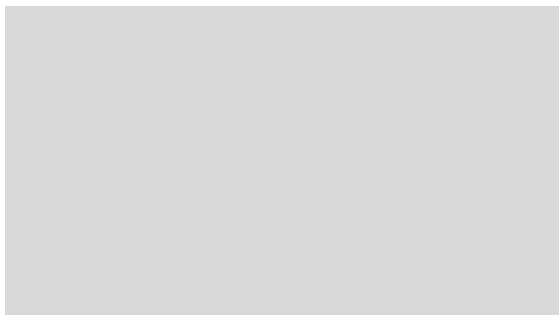
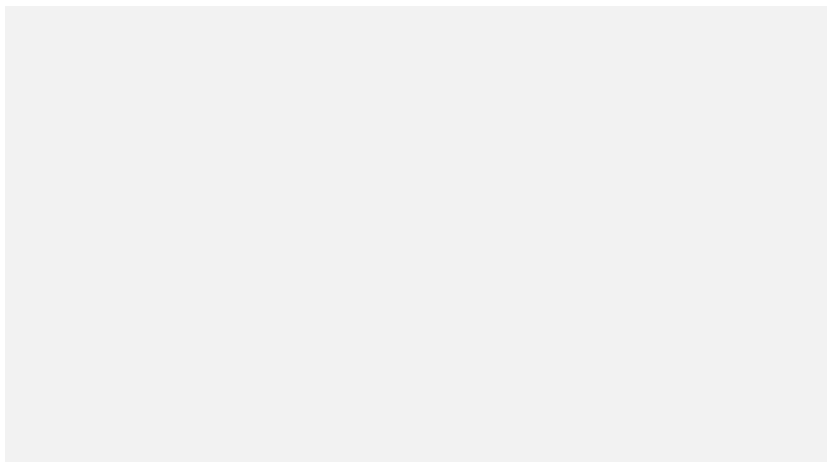
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Asdf



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