WETO Software Stack Workshop

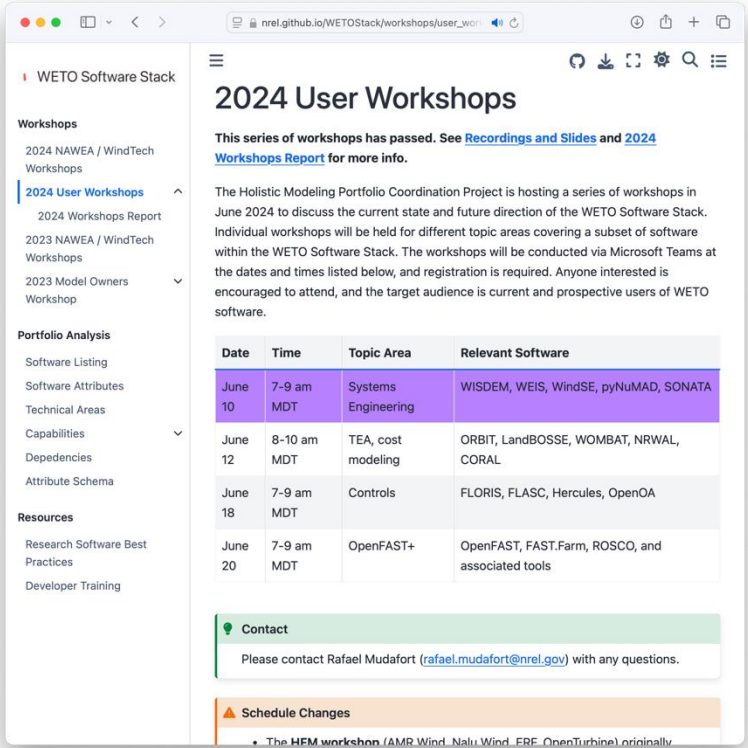
October 28, 2024

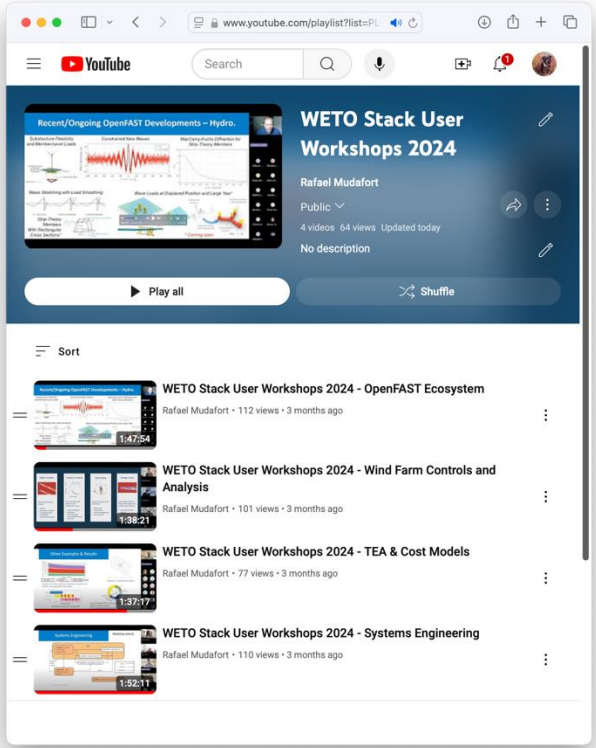
Misha Sinner

Did you see the user workshops?

nrel.github.io/WETOStack

youtube.com/@rafmudaf





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 WETO 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
Modeling and Validation for Offshore Wind
Wind Power as Virtual Synchronous Generation (WindVSG)
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)
North American Energy Resiliency Model (NAERM)
Big Adaptive Rotor
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

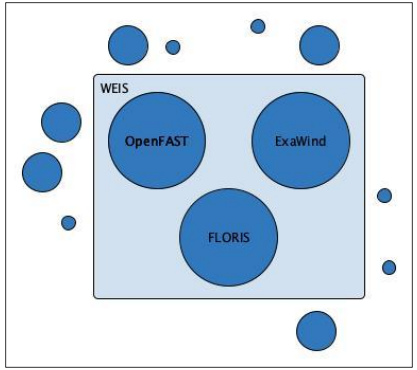
Argonne NATIONAL LABORATORY
BERKELEY LAB Lawrence Berkeley National Laboratory
Lawrence Livermore National Laboratory
NREL NATIONAL RENEWABLE ENERGY LABORATORY
Pacific Northwest NATIONAL LABORATORY
Sandia National Laboratories

https://www.energy.gov/eere/wind/wind-energy-technologies-office-projects-map

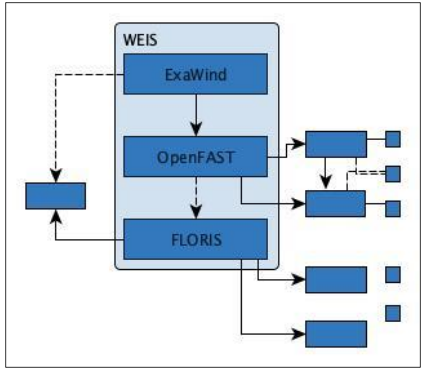
Holistic Modeling Project

Objective

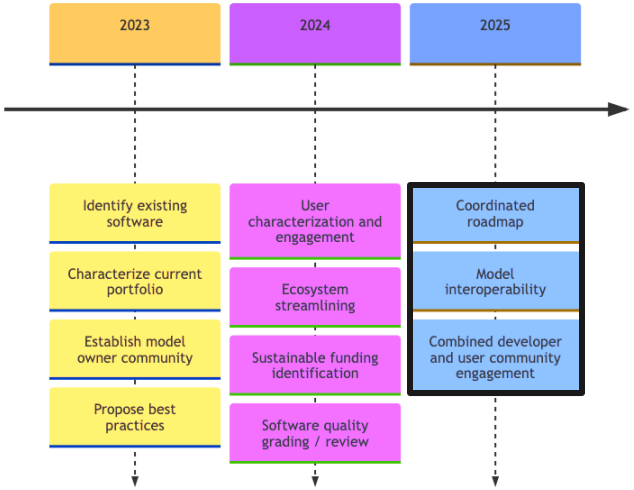
Past: Loose collection of software



Future: Cohesive software stack



Project Timeline

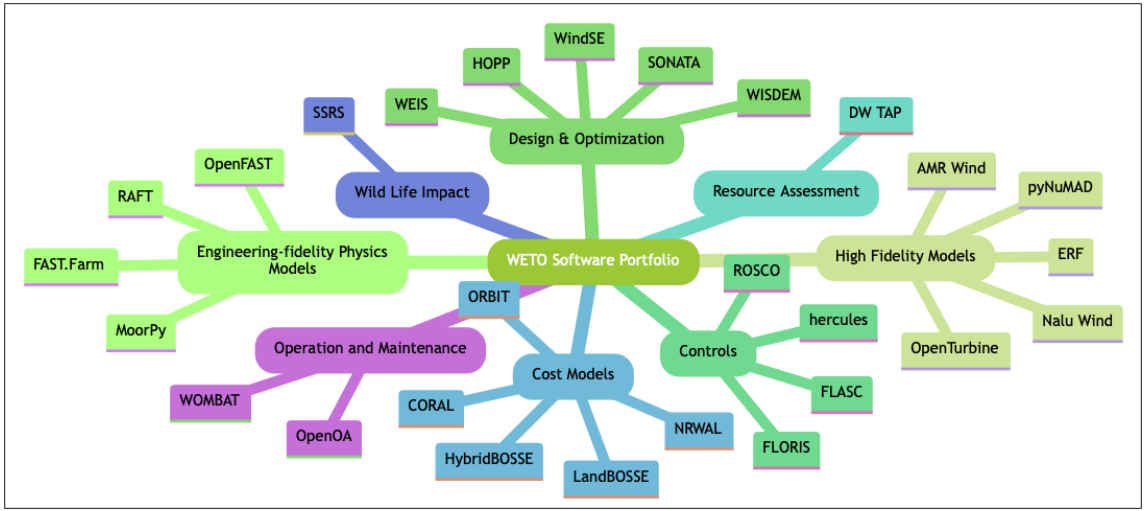


WETO Software Stack

Overview

WETO Software Stack

Grouped by what it does



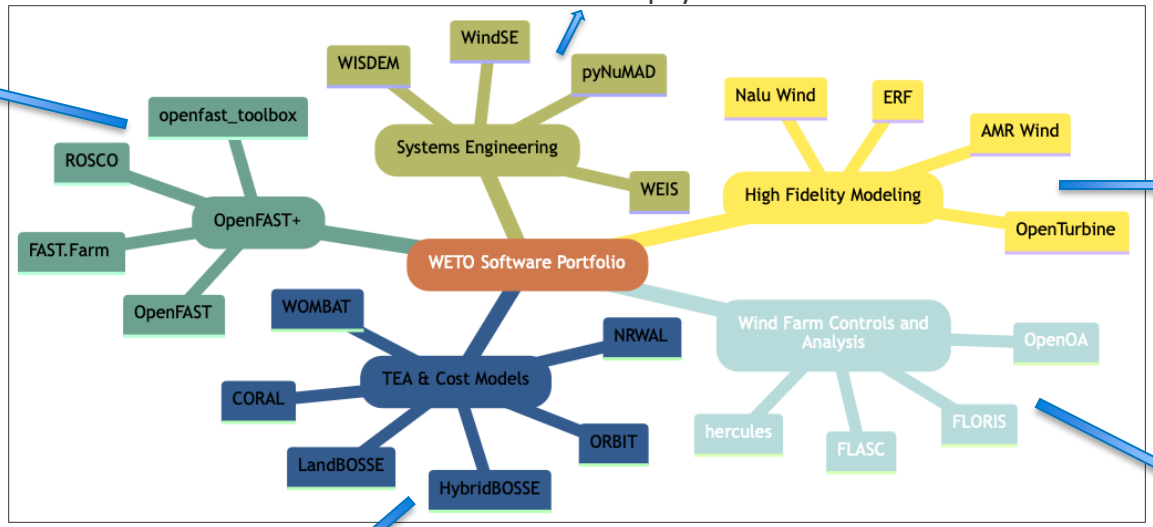
https://nrel.github.io/WETOStack/portfolio_analysis/software_list.html

WETO Software Stack

Grouped by how its used

System-level optimizations with multi-physics and multi-fidelities

Wind turbine and wind farm mid-fidelity physics



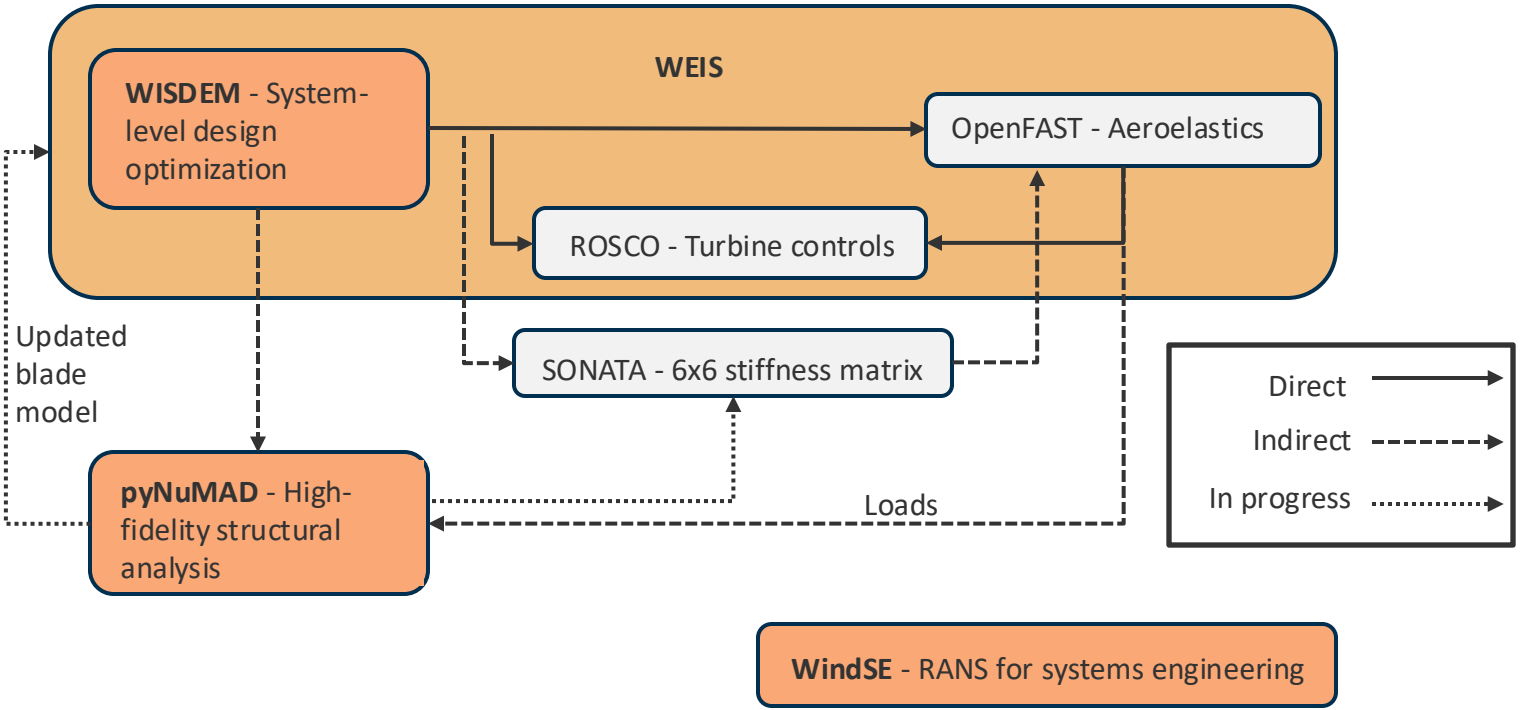
Detailed aerodynamics and structural dynamics

Wind turbine and wind plant costs for installation and operation, cost forecasting

Wind farm energy production, energy loss identification, and loss reduction through farm-level controls

Systems Engineering

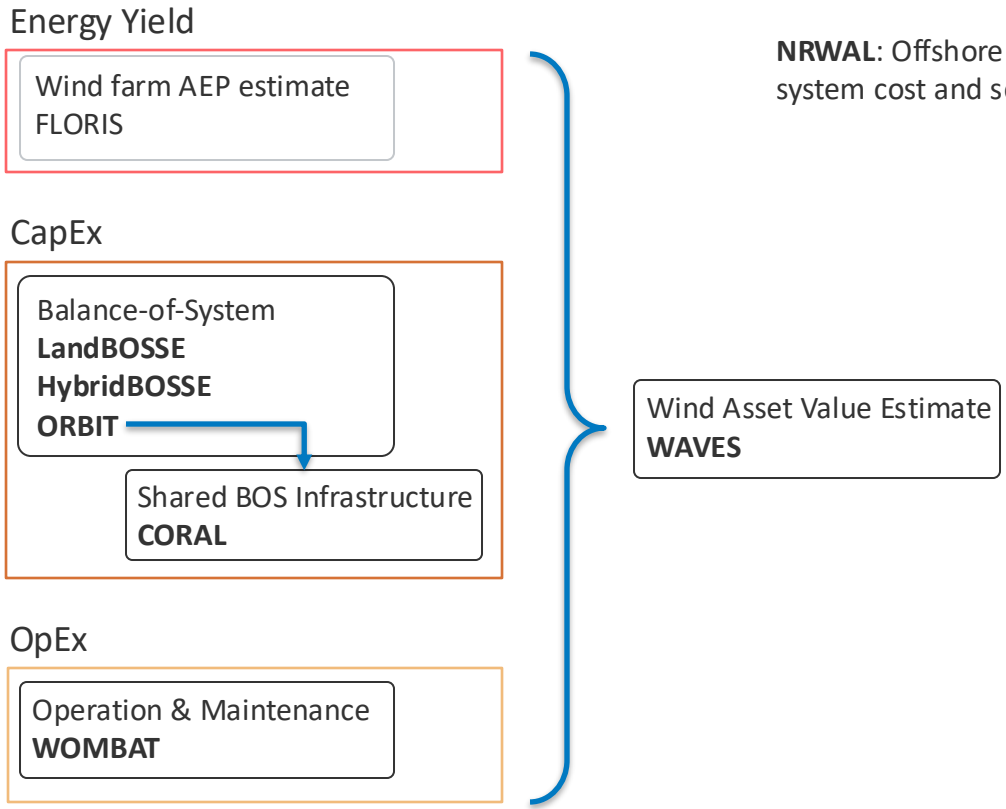
pietro.bortolotti@nrel.gov



Adapted from Big Adaptive Rotor (BAR) project

Technoeconomic Analysis / Cost Modeling

matt.shields@nrel.gov

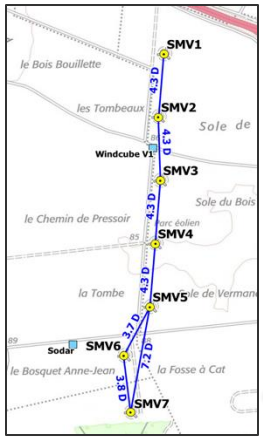


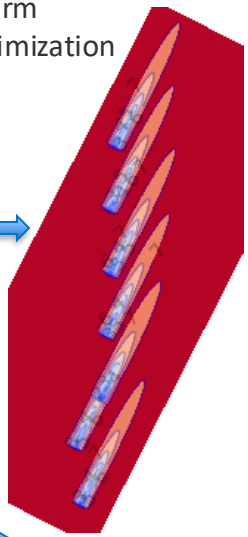
NRWAL: Offshore wind system cost and scaling model

Wind Farm Controls and Analysis

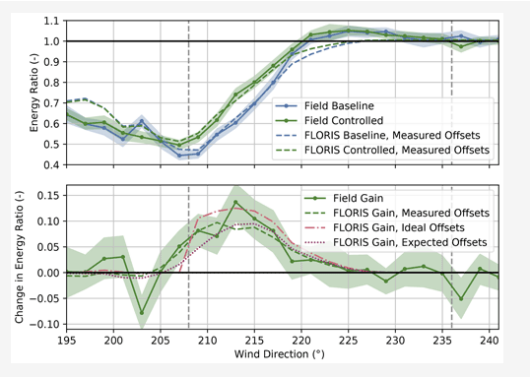
paul.fleming@nrel.gov

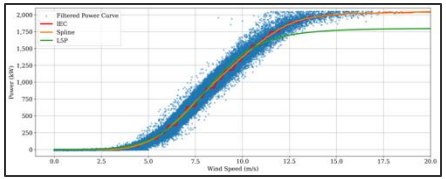
FLORIS: Steady-state modeling, farm controls optimization





FLASC: Validate FLORIS model with SCADA, compare control methods





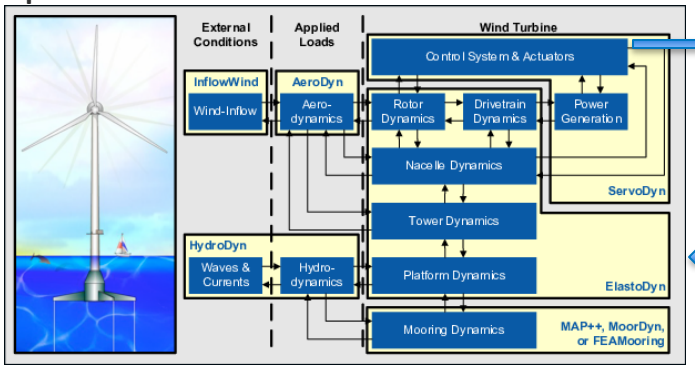
OpenOA: Characterize plant performance and quantify sources of operational loss

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

OpenFAST+

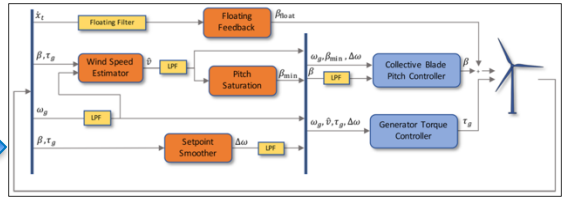
jason.jonkman@nrel.gov

OpenFAST



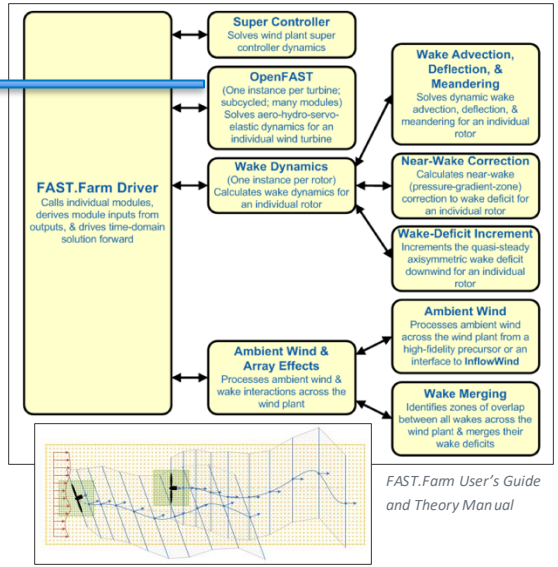
OpenFAST v3.5.3 documentation

ROSCO



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

FAST.Farm



FAST.Farm User's Guide and Theory Manual

openfast_toolbox

High Fidelity Models

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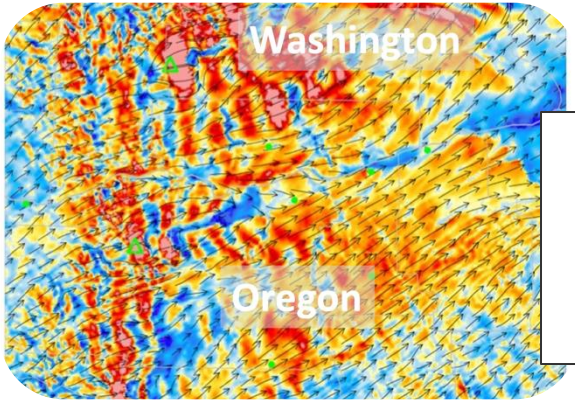
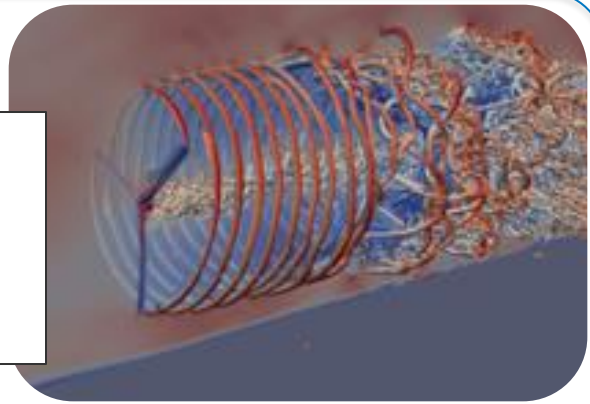
ExaWind



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



Mesoscale: ERF

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

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

Intent & Contents

nrel.github.io/WETOStack

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

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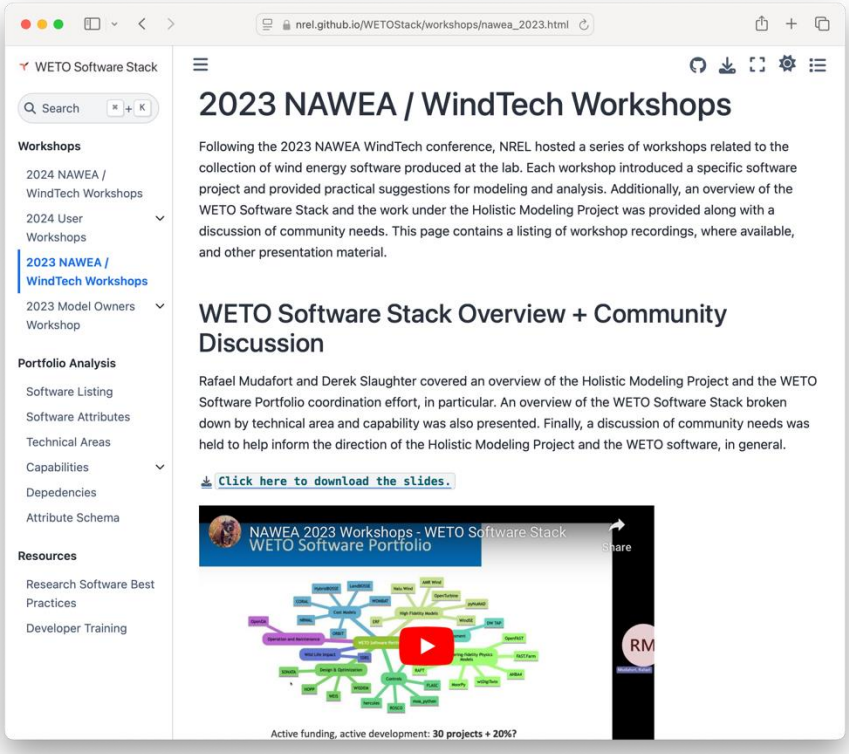
Current Contents:

- Workshop recordings and reports



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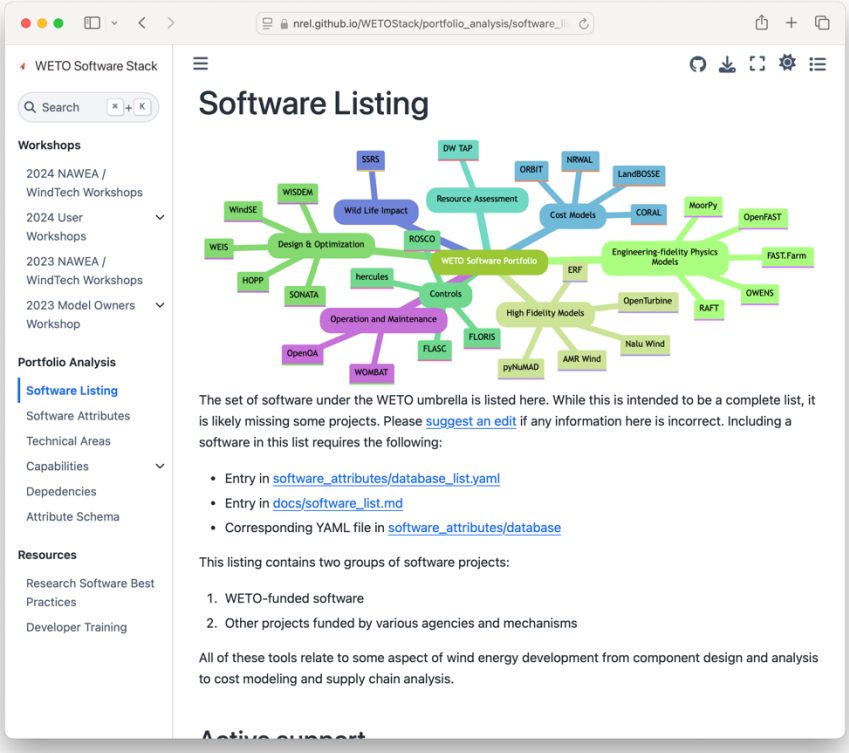

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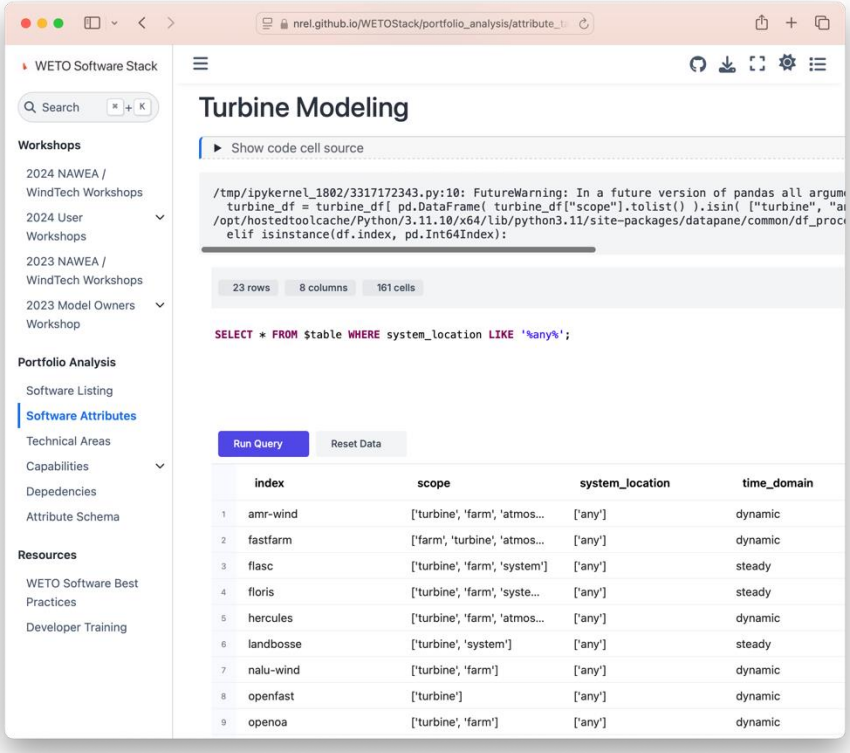

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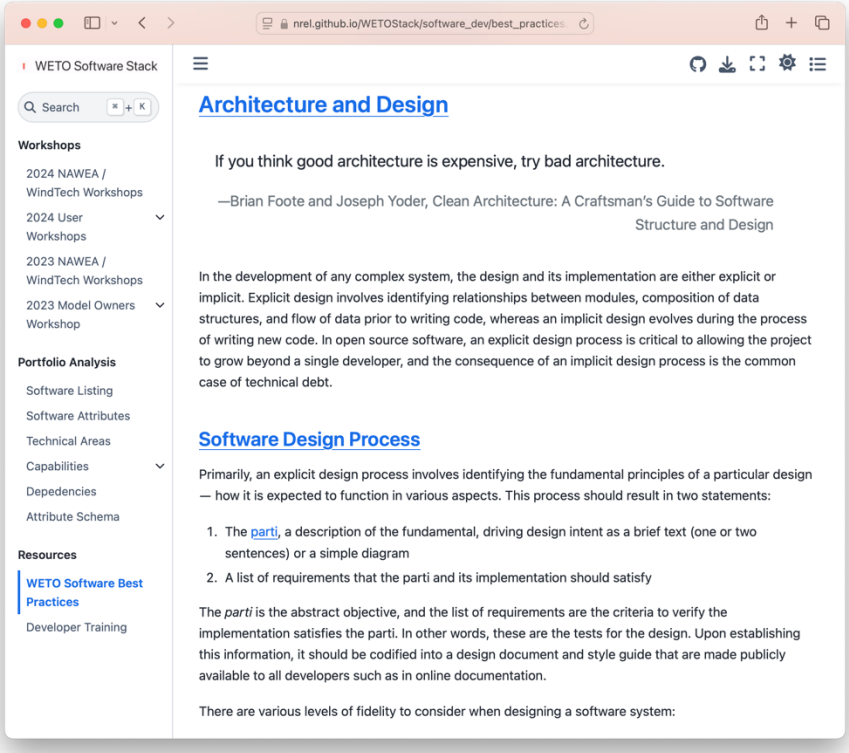
Current Contents:

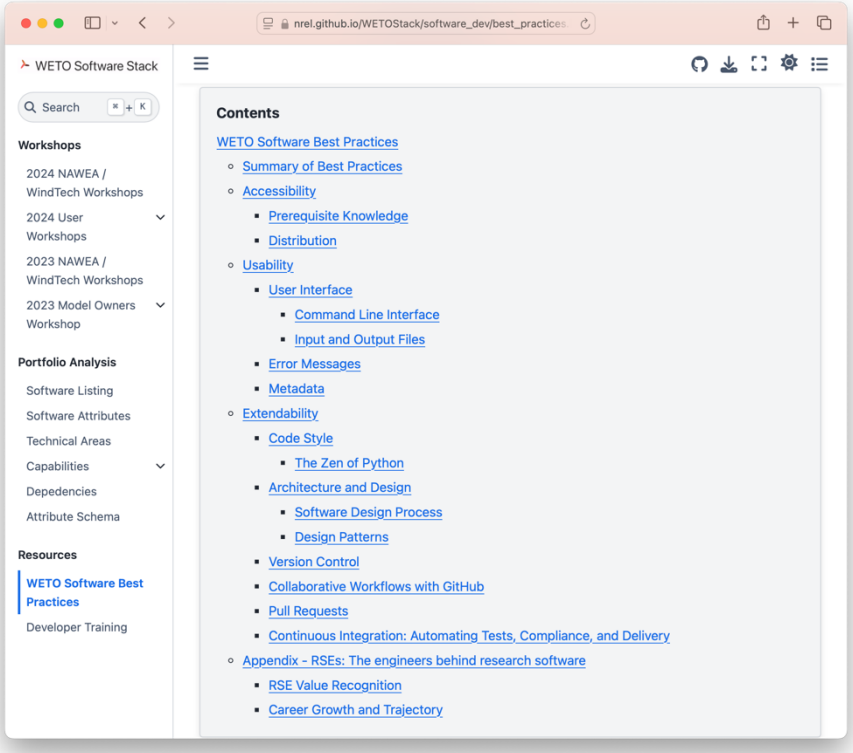
- Workshop recordings and reports
- Software Listing: active, inactive, and “other status” software
- Software Attributes: tabulated data describing each software, defined by an Attribute Schema
- Best Practices: guidance for creating software within the context of WETO and the research environment



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!

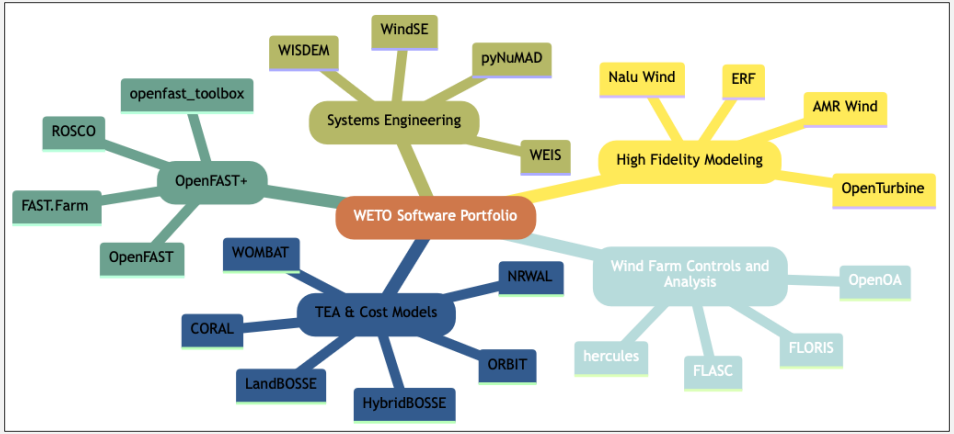
- Repository: https://github.com/nrel/wetostack
- Issues: https://github.com/NREL/WETOStack/issues
- Pull requests: https://github.com/NREL/WETOStack/pulls
- Discussions: https://github.com/NREL/WETOStack/discussions

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/WETOStack

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NREL
Transforming ENERGY

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Asdf