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QuEST 2.0 – Open-source Python Platform for Energy Storage Analytics: Major Updates.

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2023 DOE Energy Storage Peer Review

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2023 DOE Energy Storage
Peer Review

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Project Objective

- Objective: develop QuEST as a platform that can provide access points to multiple independent applications, a workspace for integrating multiple apps into a work process, and data analytics tool for the characterization and visualization of large datasets.
- Methodology:
 - standardized the data and program structure of individual applications to simplify the apps' installation, operation, and maintenance,
 - developed plug-ins to seamlessly integrate of applications within a work process,
 - created an application called QuEST-GPT utilizing Large Language Modeling (LLM) to characterize and visualize large datasets.



QuEST – Background



2017

2017

START THE DEVELOPMENT OF QUEST

2018-2019

2018

RELEASE QUEST 1.0 WITH VALUATION TOOL FOR ESTIMATING REVENUE OF ENERGY STORAGE IN ELECTRICITY MARKETS

2019

RELEASE QUEST 1.1, 1.2 WITH BEHIND-THE-METER (BTM) TOOL FOR VALUATING COST SAVING BY BTM ENERGY STORAGE FOR UTILITY CUSTOMERS

2020-2021

2020

- START THE DEVELOPMENT OF ENERGY STORAGE TECHNOLOGY SELECTION TOOL
- COLLABORATE WITH QUANTA TECHNOLOGY TO DEVELOP INTEGRATED RESOURCE PLANNING TOOL

2021

START THE DEVELOPMENT OF ENERGY EQUITY AND PERFORMANCE TOOLS

2022-2023

2022

- RELEASE QUEST 1.6 WITH ENERGY STORAGE TECHNOLOGY SELECTION AND PERFORMANCE TOOLS
- RELEASE QUEST 1.8 WITH ENERGY EQUITY AND MICROGRID
- REDESIGN QUEST LIBRARY AND QUEST DESKTOP APPLICATION.

2023

QUEST 2.0 PLATFORM: QUEST APP HUBS, QUEST WORKSPACE, QUEST GPT .

Current Plan

Develop QuEST platform and expand energy storage analytic capabilities

5-year Goal

Make QuEST platform as the one-stop shop for all Sandia's and OE's energy storage analytic capabilities

QuEST – Version 1.6

QuEST 1.6:

- **QuEST Data Manager** – Manages acquisition of data.
- **QuEST Valuation** – Estimate potential revenue generated by energy storage systems providing ancillary services in the electricity markets of ISOs/RTOs.
- **QuEST BTM** – Estimate the cost savings for time-of-use/net energy metering customers using behind-the-meter energy storage systems.
- **QuEST Technology Selection** – Support storage technology selection given applications and other requirements
- **QuEST Performance** – Evaluate energy storage system performance in different climates

The screenshot shows the QuEST web application interface. At the top, there is a navigation bar with the QuEST logo on the left and links for 'home', 'about', and 'settings' on the right. Below the navigation bar, there is a central menu with five options: 'QuEST Data Manager', 'QuEST Valuation' (highlighted in blue), 'QuEST BTM', 'QuEST Performance', and 'Technology Selection'. To the right of the menu, there is a section for 'New or returning user?' with a 'Take a quick tour' button. Below this, there is a 'QuEST Valuation' section with a description: 'Estimates value for an energy storage system providing ISO/RTO services. Uses historical data to determine the maximum amount of revenue that the energy storage system could have generated by stacking multiple services/value streams (e.g., ancillary services, energy arbitrage). This retrospective analysis estimates value from future cash flows.' A 'Get started' button is located below the description. At the bottom of the page, there is a copyright notice: 'Copyright 2018 National Technology & Engineering Solutions of Sandia, LLC (NTESS). Under the terms of Contract DE-NA0003525 with NTESS, the U.S. Government retains certain rights in this software.' and the logos for the U.S. Department of Energy and the National Nuclear Security Administration.

- Version 1.6 available on GitHub
 - <https://github.com/sandialabs/snl-quest>



QuEst – Main Challenges

For users:

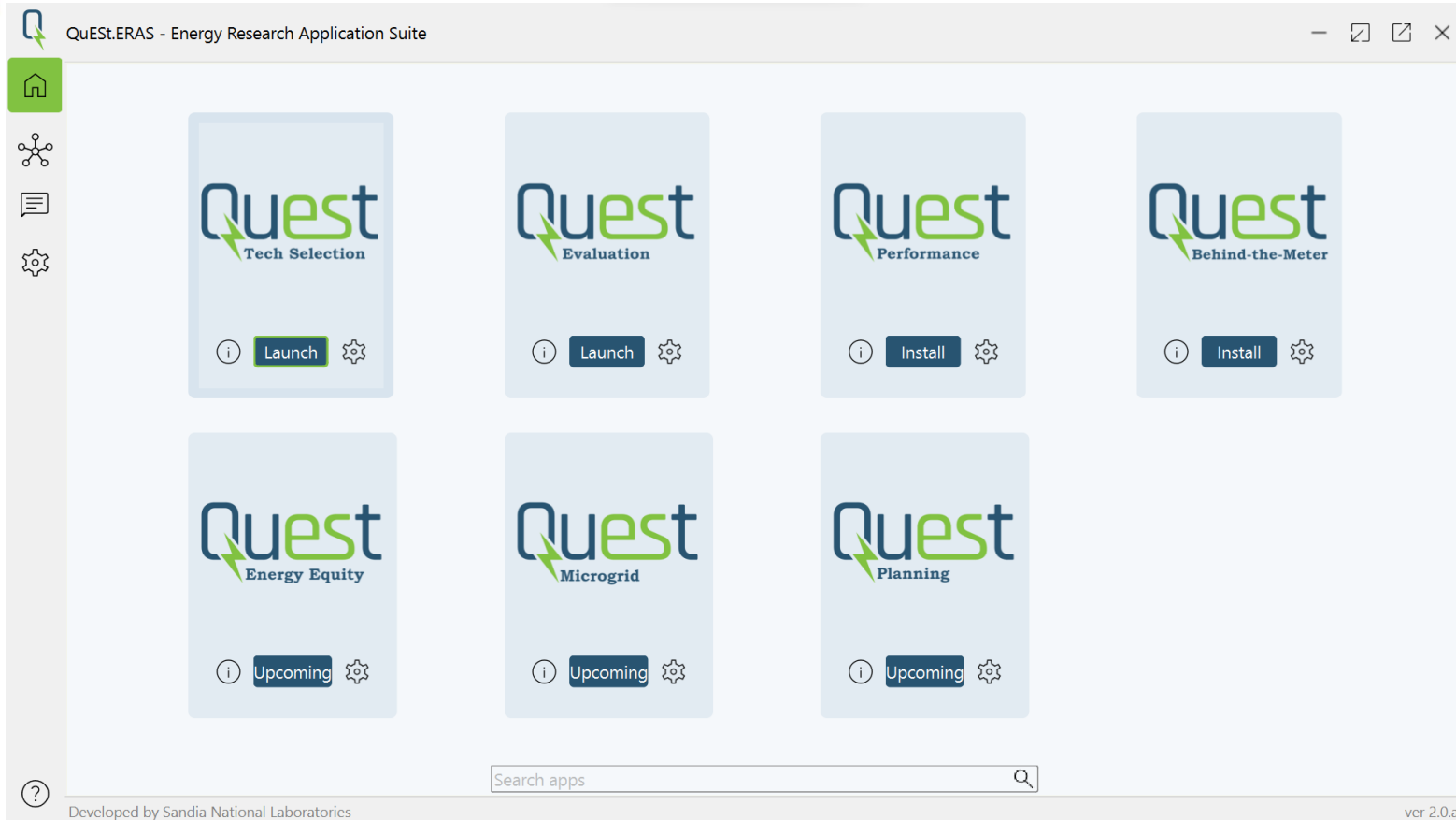
- Unable to install (50%):
 - Many dependencies: kivy, pyomo, solvers, ...
 - Users might only one application but have to install all.
- Program crashes due to unknown errors (45%):
 - APIs are not stable
 - Adding applications causes version control issues of libraries.
- Other issues (5%):
 - Unable to adjust window size.
 - Unable to generate reports

For developers:

- Difficult and time consuming to develop a new app:
 - Data, utilities, GUIs are well glued in one package
 - developers must understand the code very well to integrate a new element.
 - developers cannot work in parallel.
- GUI development is the bottle neck



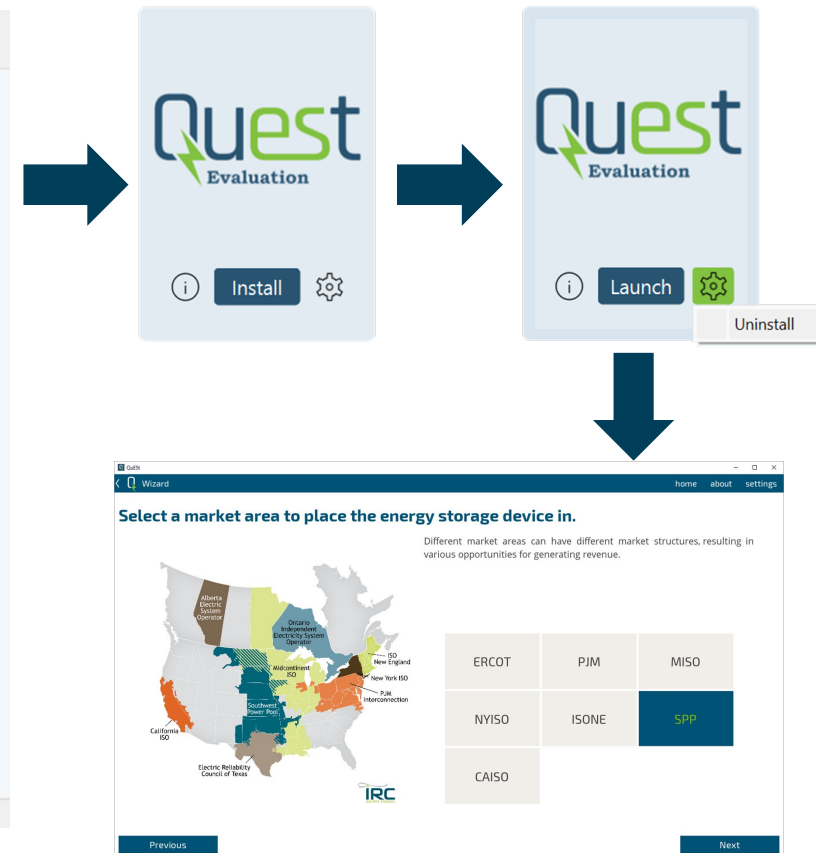
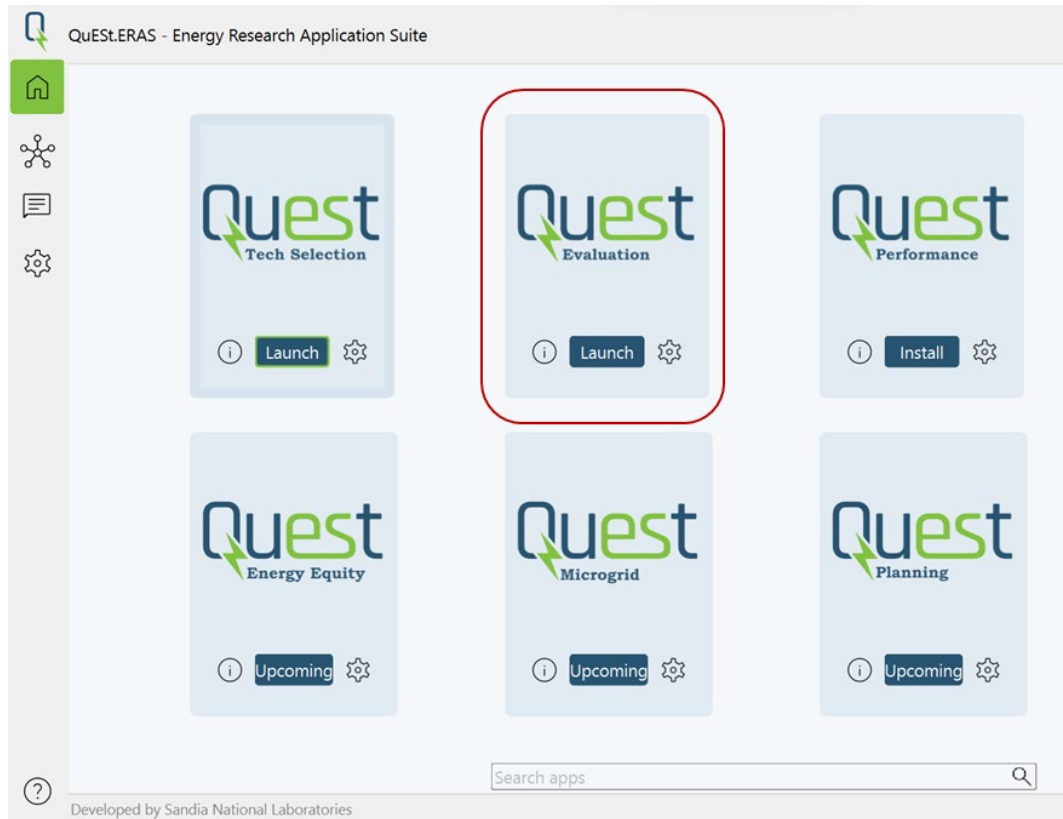
QuEST 2.0 – Major Updates



- QuEST 2.0 includes 3 main components:
 - QuEST App Hub works like an apps store that provides access points to multiple apps.
 - QuEST Workspace provides an environment for integrating multiple apps into a work process
 - QuEST GPT is a data analytic tool for the characterization and visualization of large datasets using LLM.

In Version 2.0, QuEST has been transformed from a software to a software platform.

QuEST App Hub

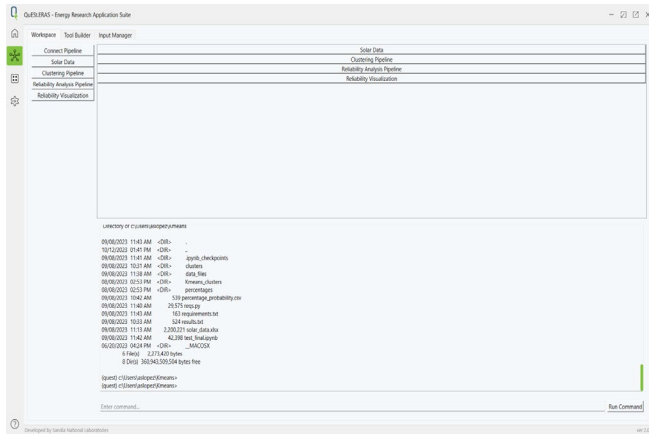


- Main features:

- Users can find and install applications that suite their needs.
- Installation initiates the creation of an isolated environment.
- Each application runs in an isolated environment
- Multiple applications can be installed and run simultaneously.

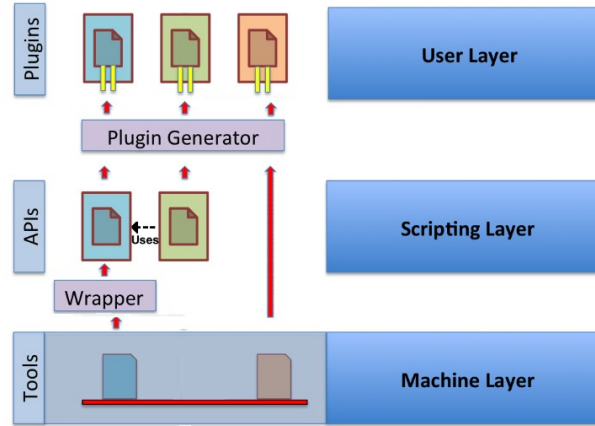


QuEST Workspace



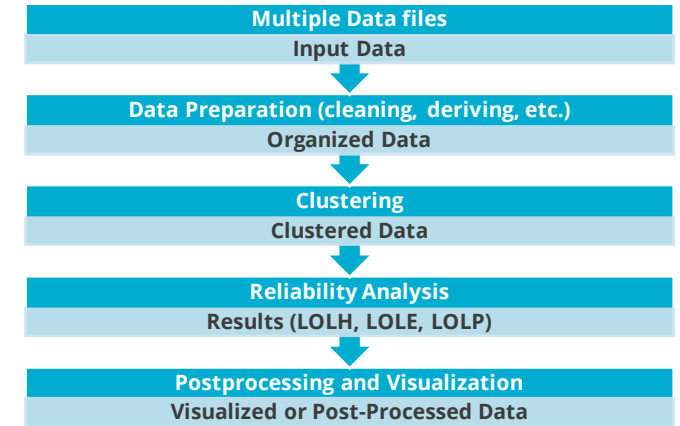
Workspace Overview

Workspace is where users can create work processes that integrate multiple apps by assembling pipelines using plugin extensions (Apps).



Conceptual Design of PluMA

Python, Perl and R plugins interface to the scripted layer of PluMA. Compiled plugins in C++ or CUDA to the computational (machine) layer.



Pipeline Example

Each stage in PluMA gets executed sequentially, with the output of a specific stage serving as input to a later stage of the pipeline.



QuEST Workspace – Workflow

1

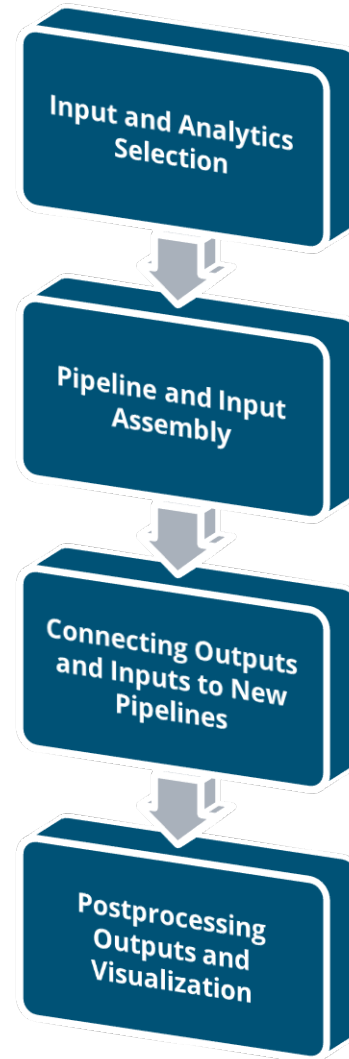
Selection

The Workspace's selection process allow users to choose the most suitable inputs and tools for their data analytics requirements.

3

Connections

The Workspace allows users to feed the outputs of smaller pipelines into new pipelines or tools transforming extensive pipeline strings into an easy-to-follow sequential workflow.



2

Assembly

The assembly process of the Workspace enhances data usability and the efficiency of analytics tools

4

Postprocessing

Beyond the interconnection of inputs, outputs, and pipelines, the system also allows for post-processing of data, preparing it for either visualization or subsequent utilization.

QuEST Workspace – Tool Builder

QuEST.ERAS - Energy Research Application Suite

Workspace | Tool Builder | Input Manager

Name	Size	Type	Date Modified
gpt-test-by-parts.py...	7.09 KiB	Jupyter note...	7/31/2023 10:09 AM
gen_doc.py	3.44 KiB	Python script	8/30/2023 9:24 PM
Function_calling.ipynb	30.59 KiB	Jupyter note...	7/31/2023 11:35 AM
Checker.ipynb	2.14 KiB	Jupyter note...	8/1/2023 9:19 AM
GPT-4 API		File Folder	7/14/2023 9:33 AM
gpt_outputs		File Folder	8/10/2023 1:35 PM
codebase		File Folder	8/15/2023 5:55 AM
mod_utilities.py	12.01 KiB	Python script	8/10/2023 1:54 PM
mod_renewables.py	4.77 KiB	Python script	8/10/2023 1:54 PM
mod_plot.py	852 bytes	Python script	8/2/2023 8:10 AM
mod_matrices.py	1.63 KiB	Python script	8/2/2023 8:10 AM
mod_data.py	4.28 KiB	Python script	8/2/2023 8:10 AM
main_MPL.py	6.18 KiB	Python script	8/5/2023 8:13 PM
main.py	7.01 KiB	Python script	8/6/2023 5:07 PM
._DS_Store	6.00 KiB	unknown	8/14/2023 1:10 PM
PSAppDeployToolkit		File Folder	8/24/2023 12:07 PM
Pictures		File Folder	7/11/2023 5:56 PM

Generated Items:

- File Input Solar Data {
C:/Users/aslopez/Kmeans/data_files/Solar_Sites_PNM.csv
C:/Users/aslopez/Kmeans/data_files/FTM_solar_generation_1998_2020.csv
C:/Users/aslopez/Kmeans/data_files/FTM_solar_clear_sky_1998_2020.csv
}
- Pipeline Clustering Pipeline {
C:/Users/aslopez/Downloads/KMeans_Final.py
C:/Users/aslopez/Kmeans/reqs.py
}
- Pipeline Reliability Analysis Pipeline {
C:/Users/aslopez/Python-Projects/codebase/mod_utilities.py
C:/Users/aslopez/Python-Projects/codebase/mod_renewables.py
C:/Users/aslopez/Python-Projects/codebase/mod_plot.py
C:/Users/aslopez/Python-Projects/codebase/mod_matrices.py
C:/Users/aslopez/Python-Projects/codebase/mod_data.py
C:/Users/aslopez/Python-Projects/codebase/main_MPL.py
}
- Visualization Reliability Visualizer {
C:/Users/aslopez/Python-Projects/GPT-Functions-Test/gen_doc.py
C:/Users/aslopez/Python-Projects/GPT-Functions-Test/validation_functions.py
}

Name: mod_renewables.py
Path: C:/Users/aslopez/Python-Projects/codebase/mod_renewables.py
Size: 4884 bytes
Is Directory: False
Docstrings:
Pulls and modifies renewable energy data for the resource adequacy model
This function extracts the solar data and modifies it for the MCS.
The solar data is stored in a 4D ndarray where the dimensions are: [cluster, day, hour, site]. The clusters are created using the K-means clustering algorithm. Similar days of solar generation are put in the same cluster.
This function extracts the data for the probability of each type of solar day
This function is used to collect all parameters and data associated with wind except the transition rates.
This function collects the transition rates for all sites and stacks them together.

Developed by Sandia National Laboratories | ver 2.0.3

- The Tool Builder serves as the hub for both selection and assembly processes.
- Through the file explorer, users can select files, tools, and programs for use.
- These selected files or programs can then be loaded into pipeline tools, which are displayed in the workspace toolbar.
- In the details section of the Tool Builder, users can view the inputs and features of the selected programs.



QuEST GPT

QuEST.ERAS - Energy Research Application Suite

QUEST CHAT

You: What is the distribution of projects by country?

What is the distrib

1400
1200
1000
800

New Visualization

Data Analysis

Data Visualization

Zoom out on plot by 10%. Change title to Number of GESDB Projects by Country.

Developed by Sandia National Laboratories

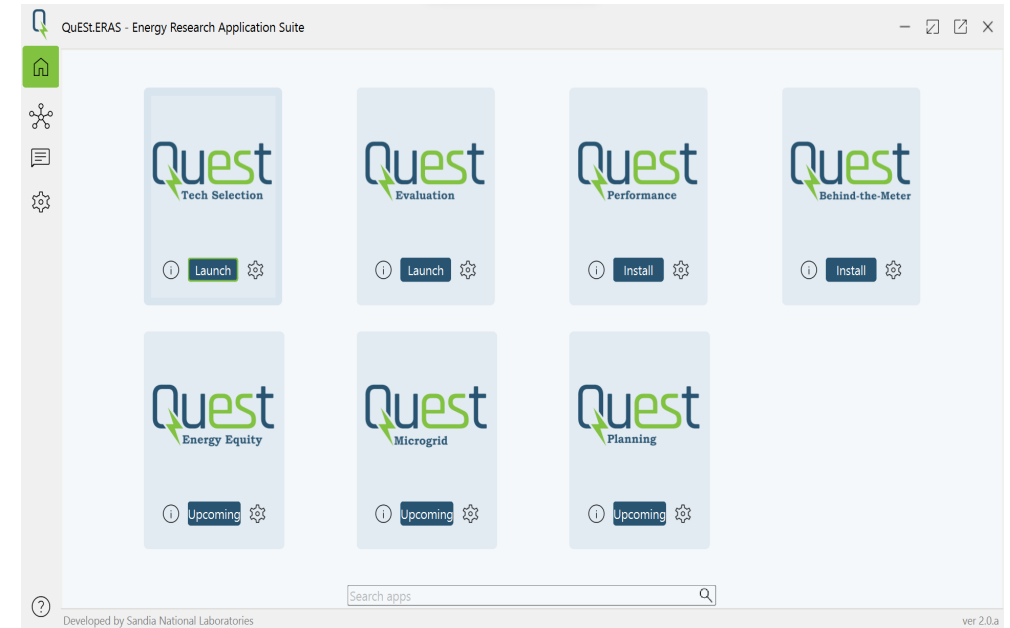
ver 2.0.a

- QuESTGPT allows users to select the dataset they want and ask questions about the data.
- QuEST GPT utilizes OpenAI's core engines to characterize users' data.
- QuESTGPT knows the data only by column names and some example data points, so make sure to refer to data by its proper name.



QuEST – Future Work

- Release QuEST 2.0 on github by the end of 2023.
- Collect users' feedback and improve platform functionalities:
 - Workspace: automate plugin creation and add drag drop tool.
 - GPT: improve GUI and data visualization.
- Expand QuEST capabilities: increase the number of apps
 - QuEST Microgrid 2.0
 - QuEST Equity
 - QuEST Planning
 - QuEST Reliability



QuEST platform – the store front for all Sandia's energy storage analytic capabilities



Acknowledgements

QuEST Team

Platform Developers

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Tool Developers

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