Introduction to Optimization and the XENDEE Platform

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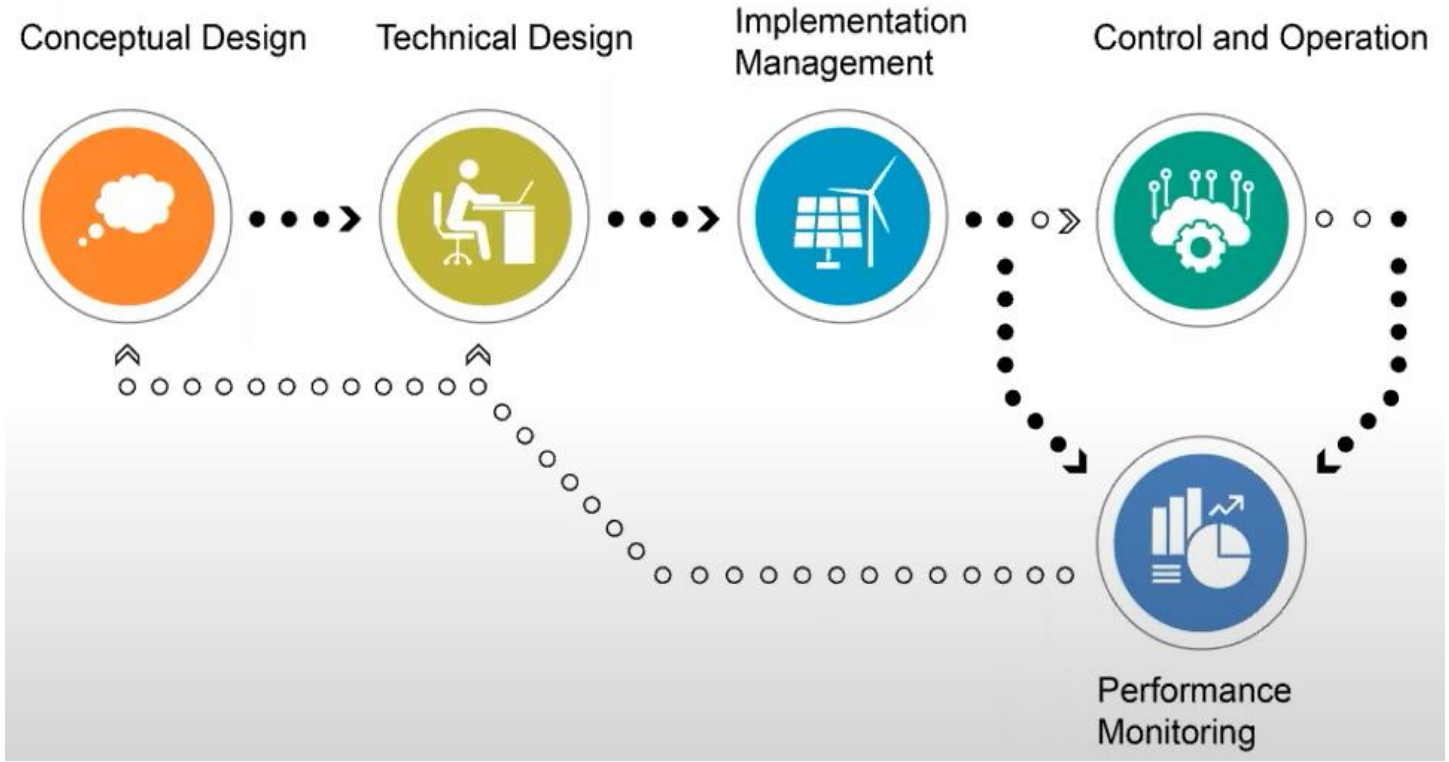
XENDEE

XENDEE Platform

XENDEE Platform

Holistic microgrid design platform primarily used for planning, operations, and financial analysis.

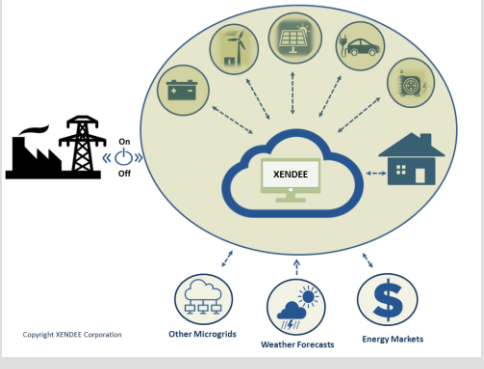


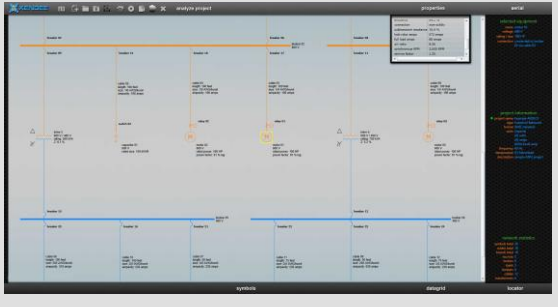
XENDEE Platform

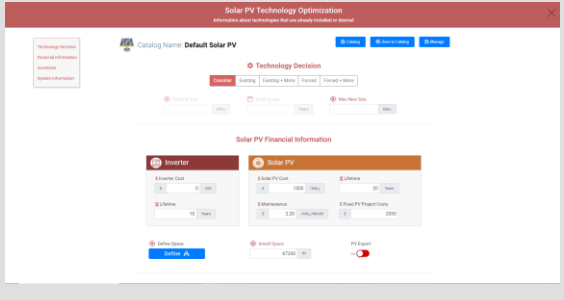
Economic Optimization (Preliminary Design)

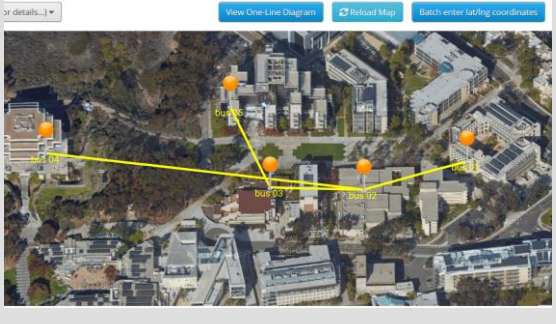
Graphical Information System (GIS)

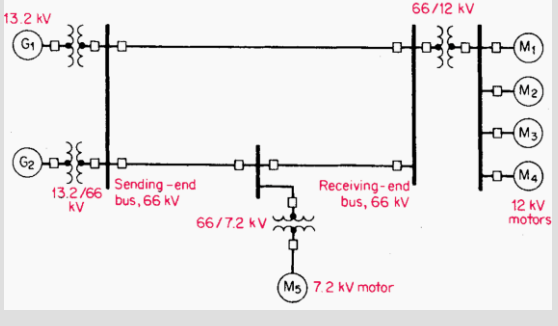
Power Engineering





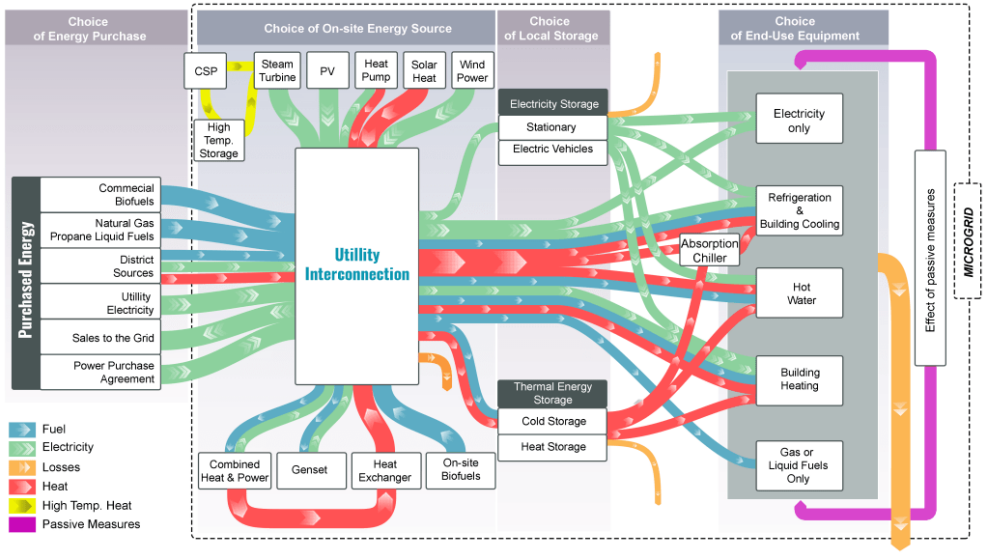


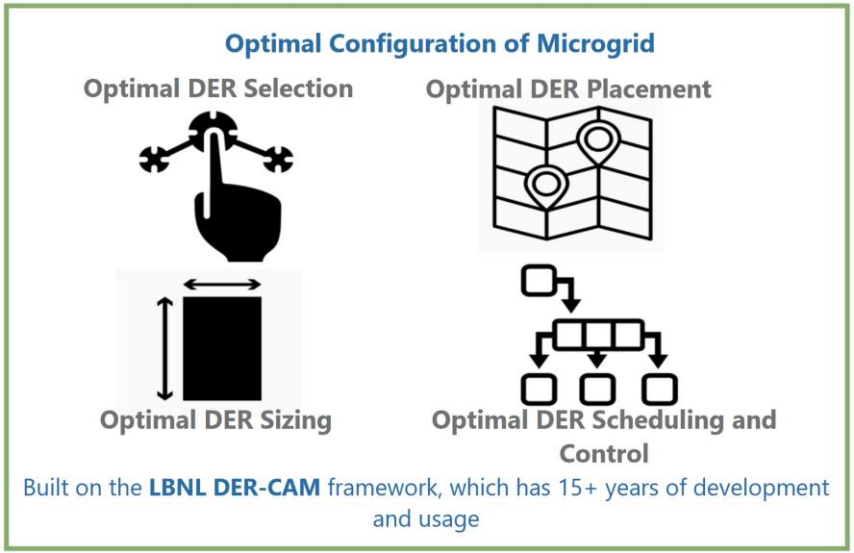




Economic Optimization

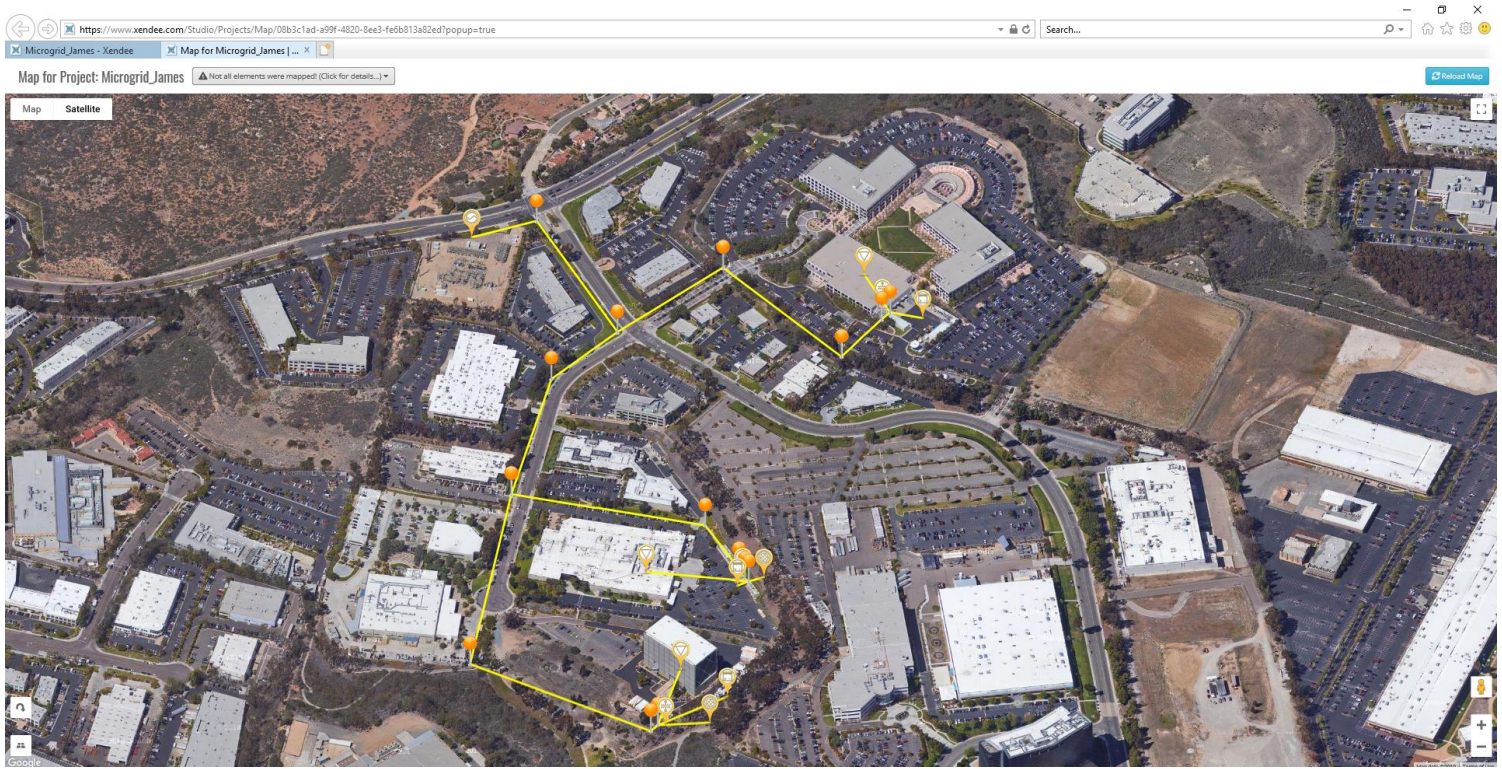
The XENDEE economic optimization suite provides users with a design and implementation tool that optimizes selection, sizing, dispatch, and placement of technologies for Microgrid, Mini-grid, and Distributed Energy Resources projects.





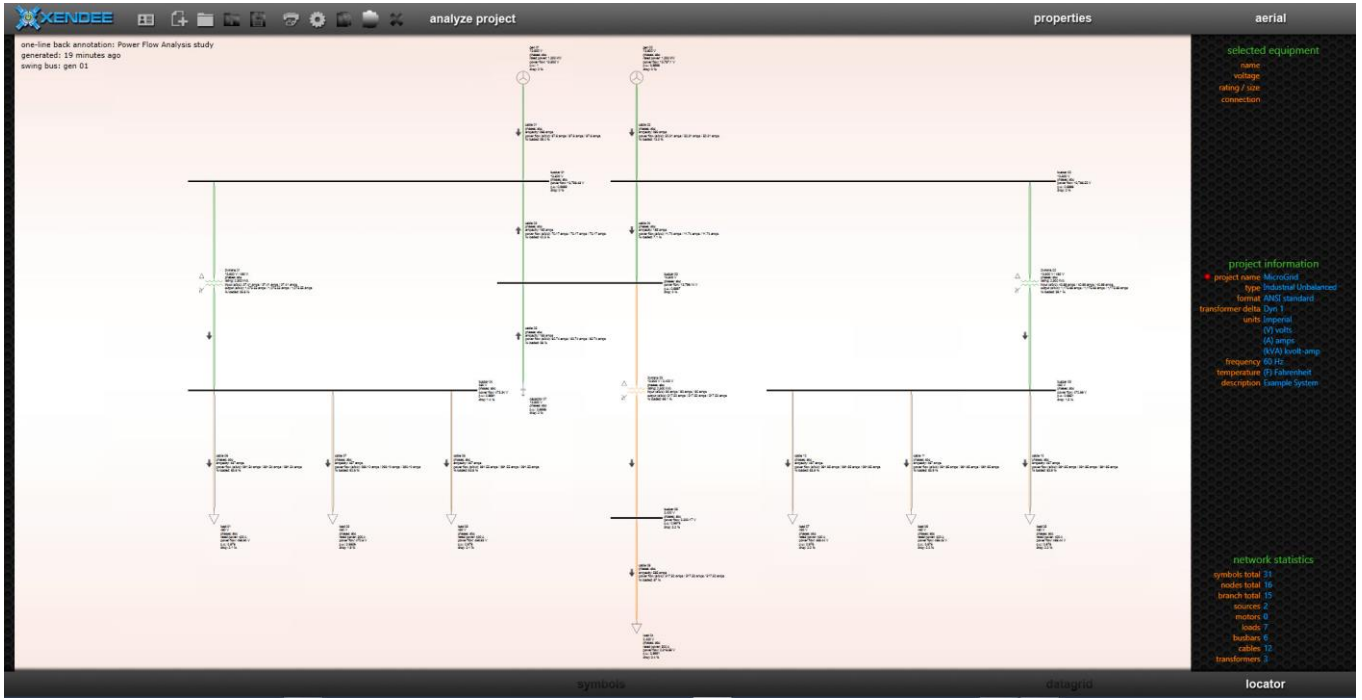
Graphical Information System

The XENDEE graphical information system (GIS) allows users to easily input geographical locations of system assets on a project site for accurate power flow studies and easy visualization.



Power Engineering

XENDEE provides an easy to use graphical user interface (GUI) to create, modify, and analyze power flow studies. The GUI connects to EPRI's OpenDSS tool as a physics engine. OpenDSS is a validated and industry accepted power flow algorithm environment.



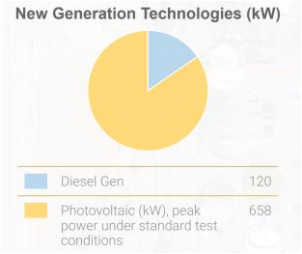
What is Optimization?

Optimization

Optimization: an act, process, or methodology of making something (such as a design, system, or decision) as fully perfect, functional, or effective as possible

Must serve an average 20 kW load

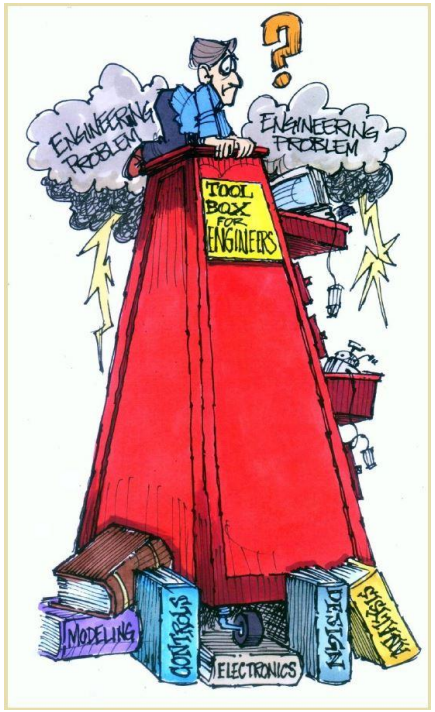
$$0 = P_{dg} + P_{sol} - P_{load}$$



Engineering Requirements + Mathematics → Optimized Solution

Why Optimization

Optimization is a tool in an engineers tool box used to solve problems that can be formulate to either minimize or maximize a function.



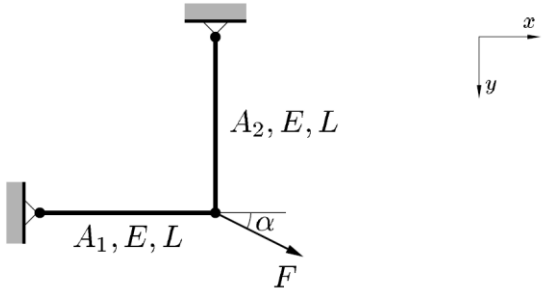
Minimize

Find the cross-sectional areas that minimize weight under stress constraints.

$$f(A_1, A_2) = (A_1 + A_2)\rho L$$

$$\min_{A_1, A_2} \quad A_1 + A_2$$

$$\text{s.t.} \quad \begin{cases} A_1 \geq \dfrac{F\cos\alpha}{\sigma_0} \\ A_2 \geq \dfrac{F\sin\alpha}{\sigma_0}, \end{cases}$$



Maximize

Let x be the number of tables of type T1 and y the number of tables of type T2. Profit P(x , y) = 90 x + 110 y

$$\begin{cases} x \geq 0 \\ x \geq 0 \\ 2x + 4y \leq 7000 \\ x + 2.5y \leq 4000 \\ 2x + 1.5y \leq 5500 \end{cases}$$

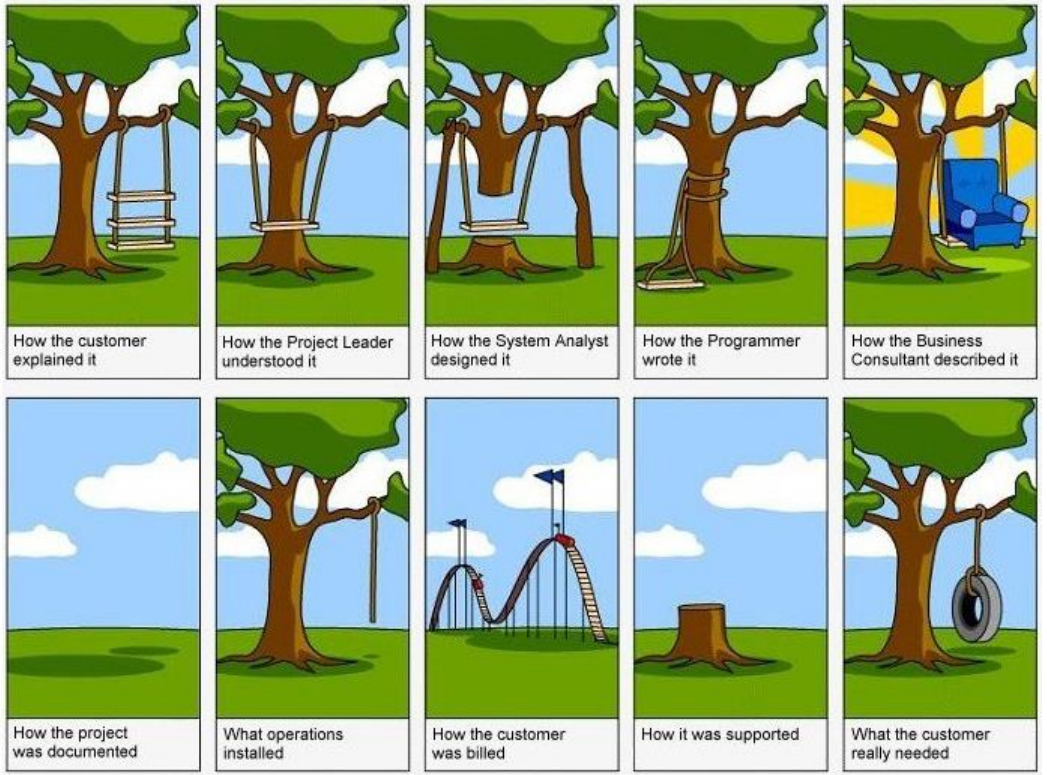
Engineering Requirements

The process of understanding qualitative requirements and creating quantifiable metrics for design and testing.

Light weight -> Weigh less than 50 kg

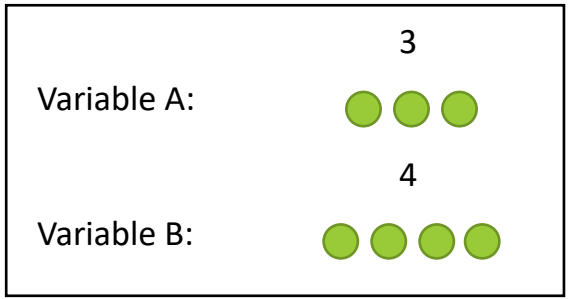
Inexpensive -> Manufacture cost less than $100

Small -> Volume less than 2 m^3

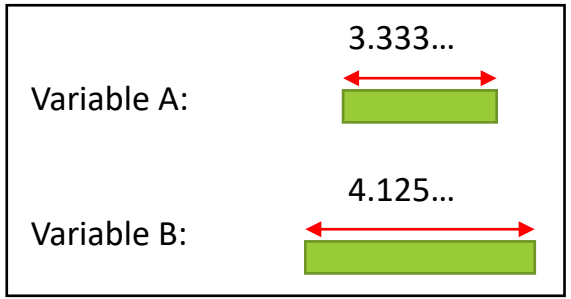


High Level Classifications

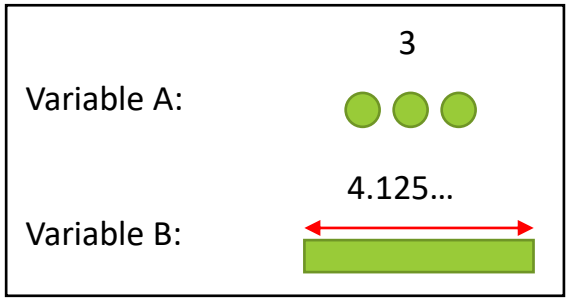
- **Discrete** – Model only contains variables that take on values from a discrete set (often integer or binary)
- **Continuous** – Model contains variables that can take on any real value
  - Tend to be easier to solve because of the smoothness of the functions
- **Mixed Integer** – Model contains both discrete and continuous variables



Discrete



Continuous



Mixed Integer

XENDEE Economic Optimization Assumptions

“All models are wrong, but some are useful.”

Single node – During preliminary design, the distribution network constraints are neglected. All technologies are assumed to be connected to a single infinite bus.

Representative design days – 24-hour profiles, three for each month, represent typical weekdays, typical weekends, and extreme days. Monthly and annual quantities are determined by scaling up the daily variables using the number of days each representative profile occurs within a month.

Linear technology operational characteristic – All operational characteristics of considered technologies must be of a linear form to accommodate the classification of the optimization solver.

“Garbage in, garbage out.”

Technology economic parameters – Best available data is used for estimating the capital and O&M costs of technologies. Once a project is financed capital costs can vary dramatically. O&M costs can vary depending on usage and climate conditions

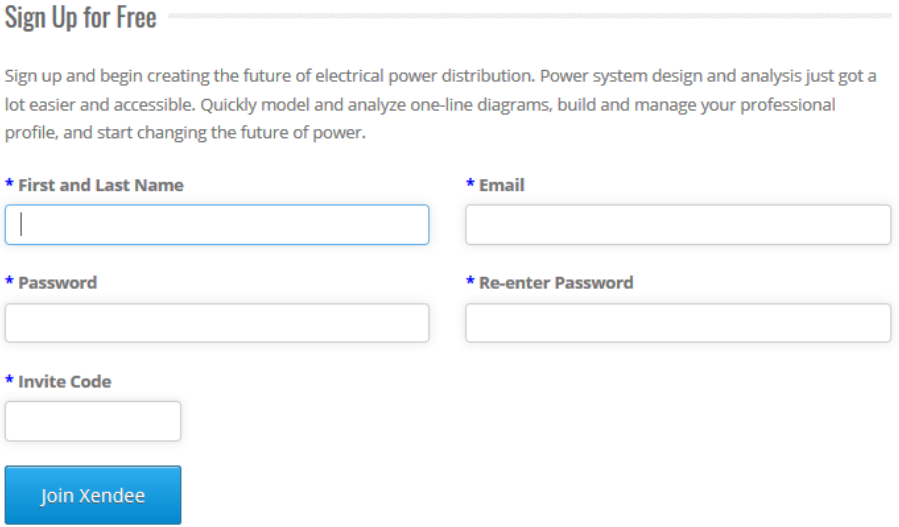
Electricity providers contractual agreements – XENDEE allows for hourly time-of-use energy and demand charges to be modeled for two seasons of the year. Some complex rate structures may not be able to be directly modeled.

Your First Visit to XENDEE

Making a XENDEE Account

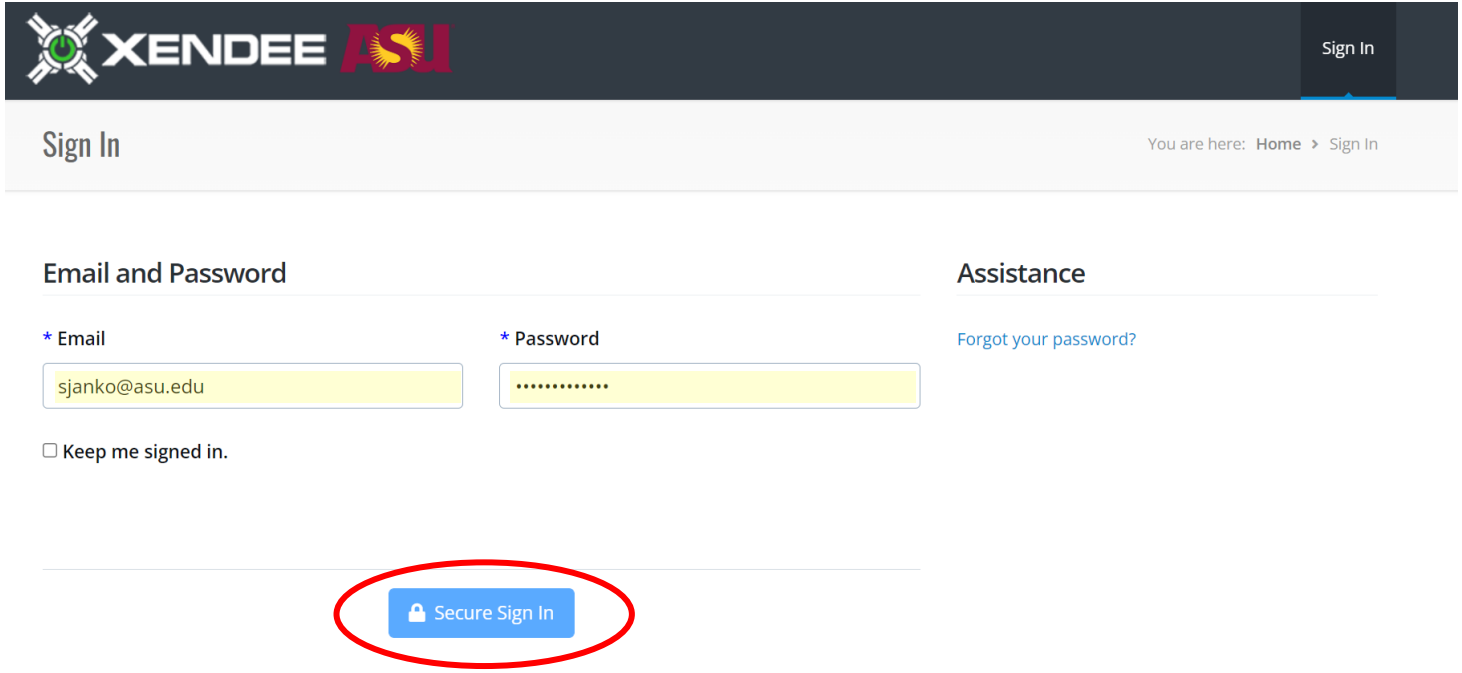
If you have not made a XENDEE account, please follow these steps:

1. Open a web browser and go to https://asu.xendee.com/JoinNow
2. Input the requested information
3. Use invite code **PACASU**



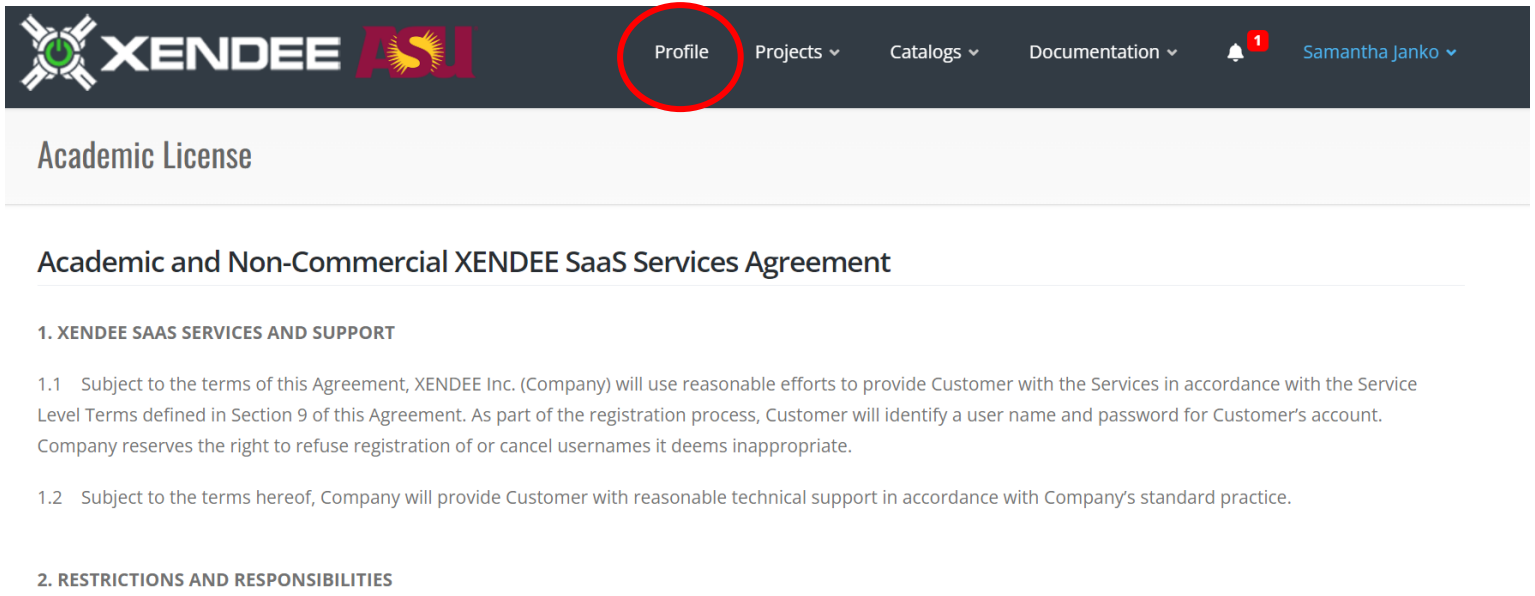
Making a XENDEE Account

4. Log in with your new XENDEE account: https://asu.xendee.com/Account/SignIn



Making a XENDEE Account

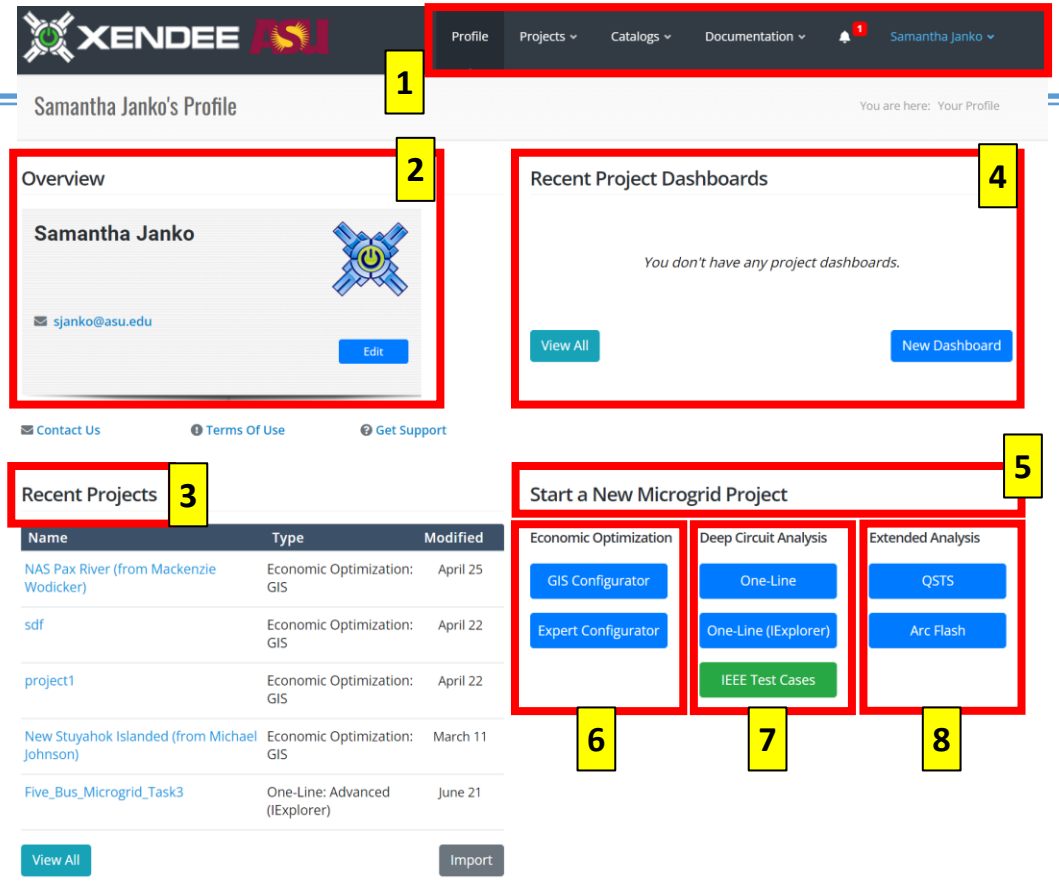
5. Click “Profile” at the top of the page



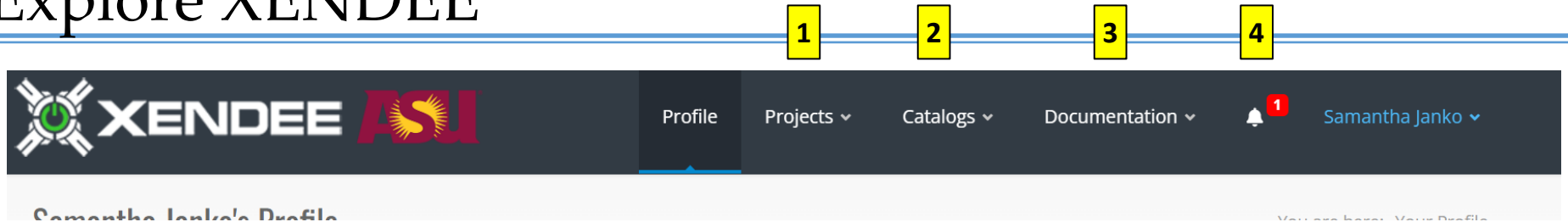
Explore XENDEE

6. Find and identify the following key items on your profile:

1. Menu
2. Overview
3. Recent Projects
4. Recent Project Dashboards
5. Start a New Microgrid Project
6. Economic Optimization
7. Deep Circuit Analysis
8. Extended Analysis



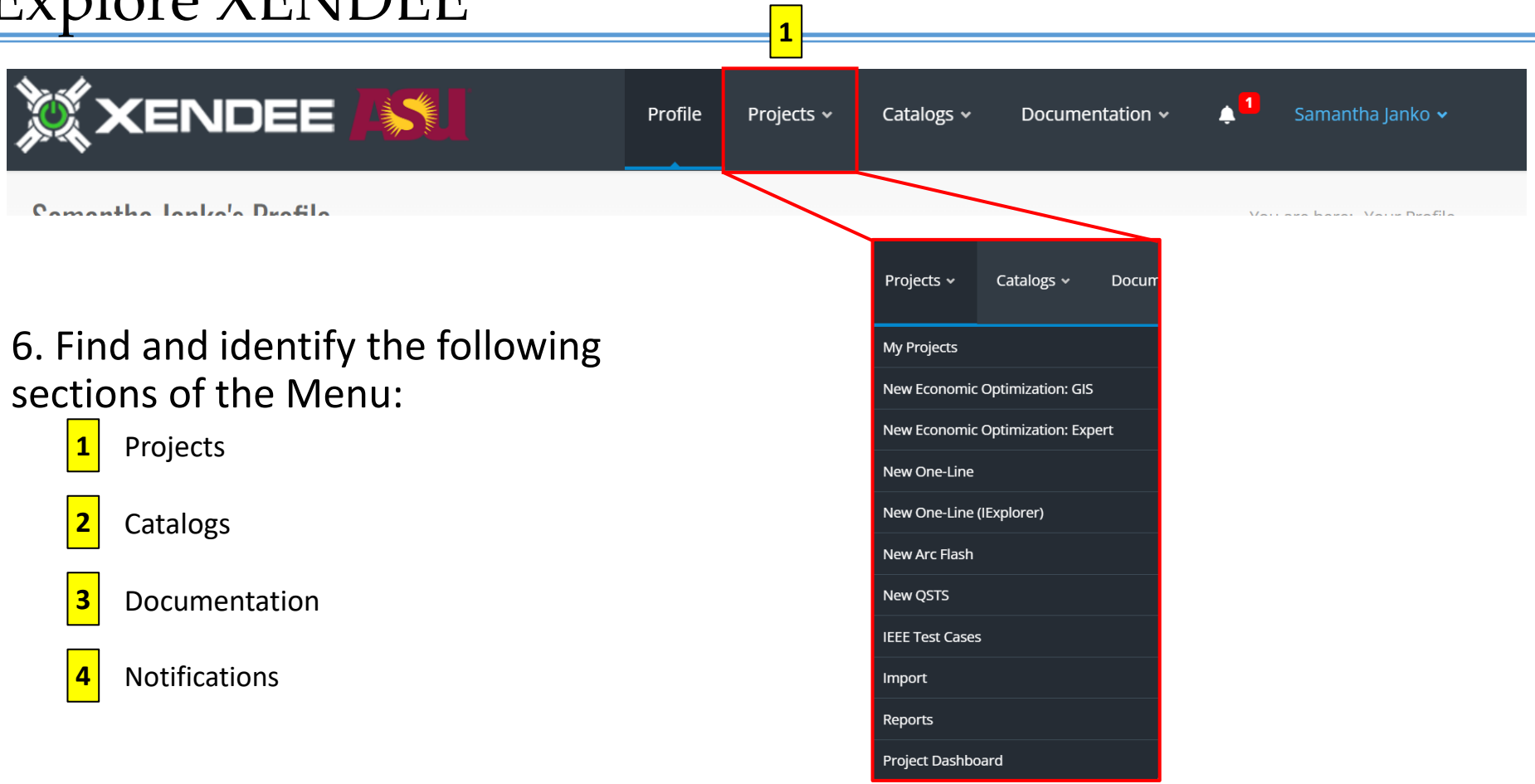
Explore XENDEE



6. Find and identify the following sections of the Menu:

1. Projects
2. Catalogs
3. Documentation
4. Notifications

Explore XENDEE



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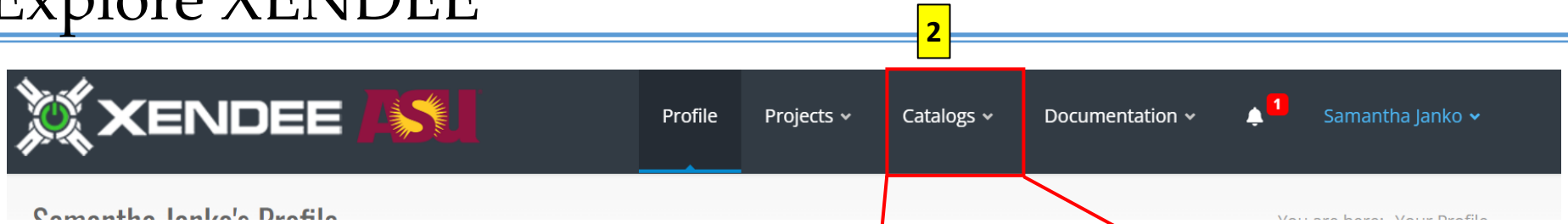

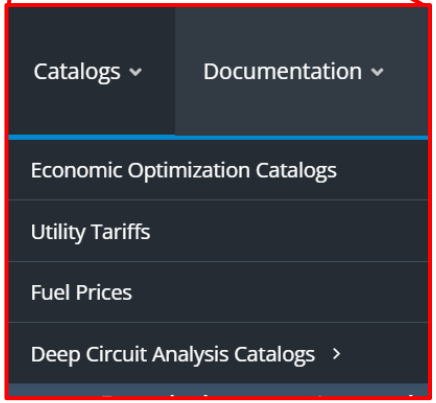

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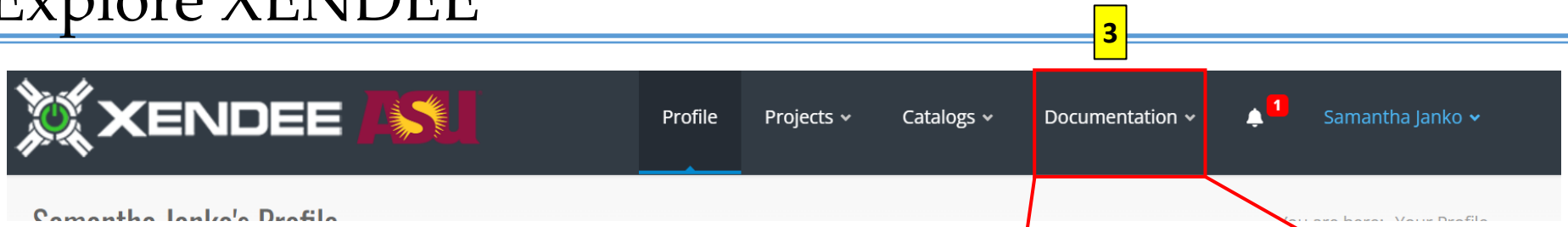

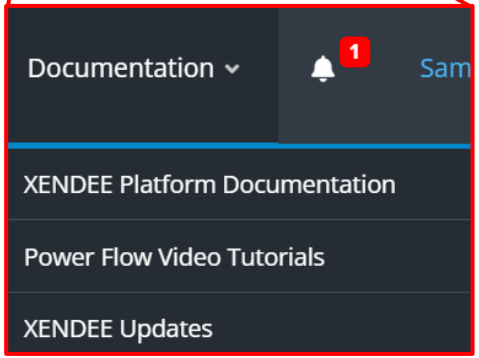

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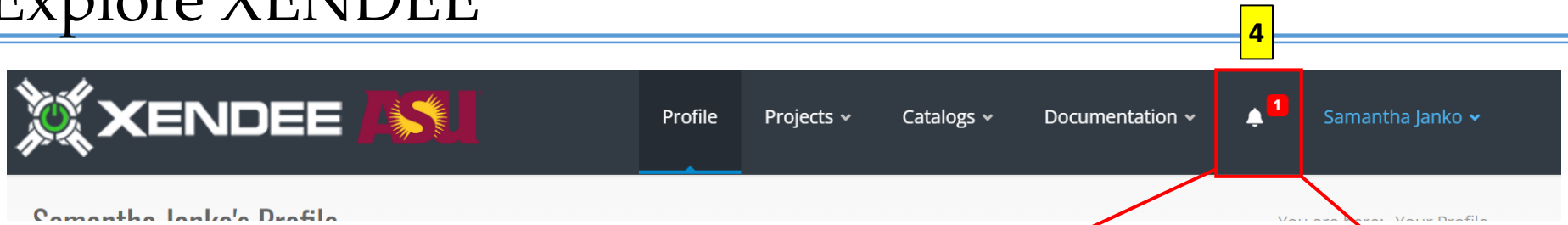

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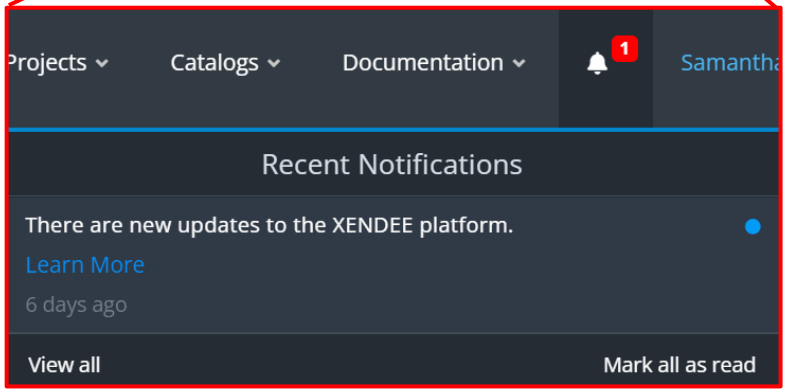
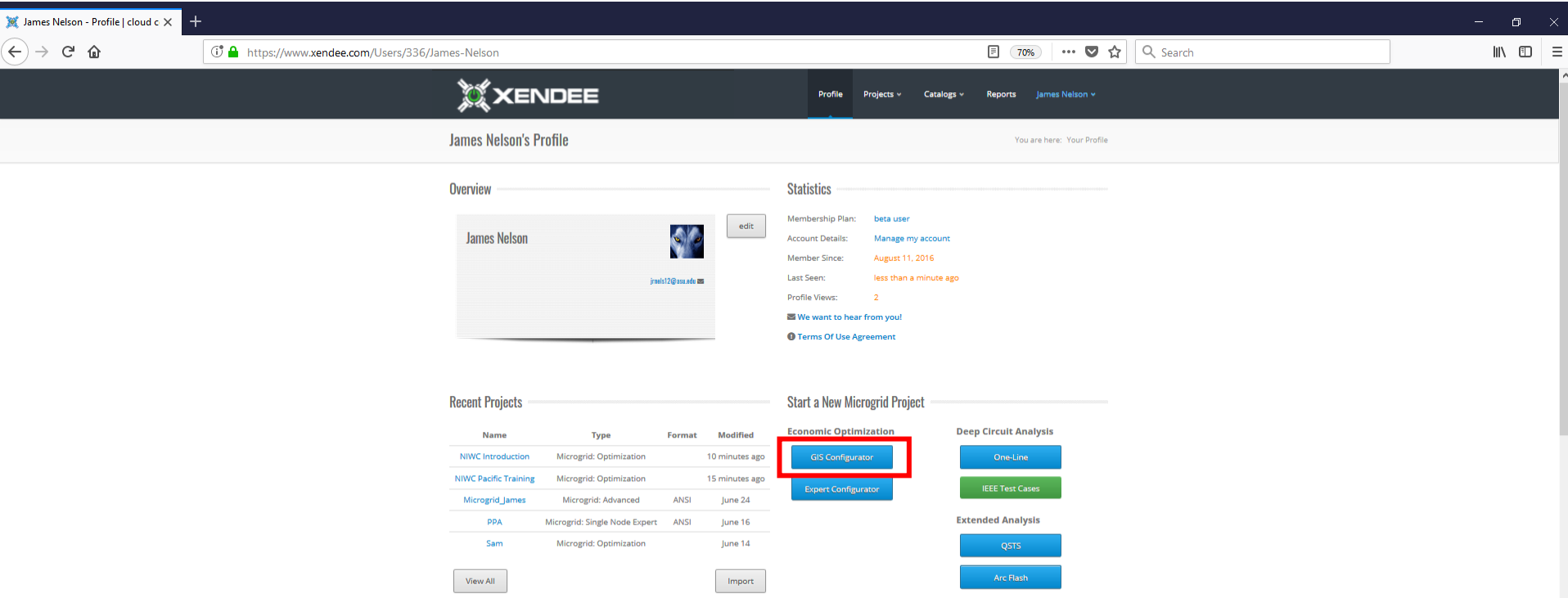


Creating a XENDEE GIS Economic Optimization Project

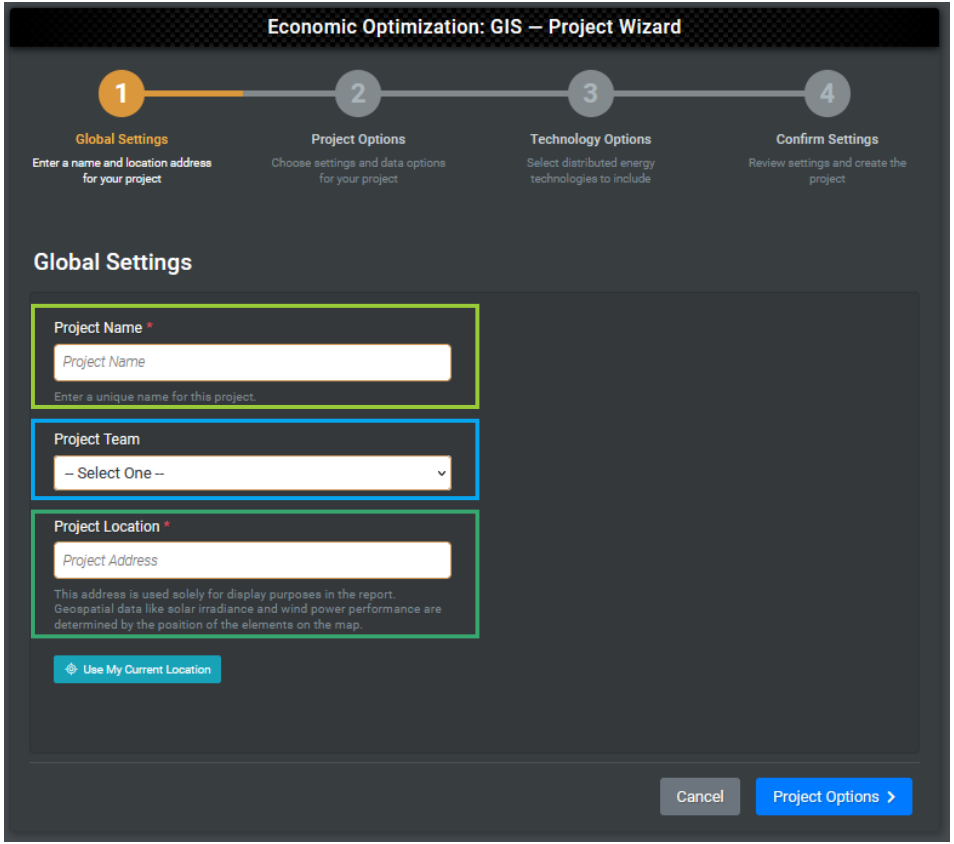
Starting a Project

Sign in and click on “GIS Configurator” to start a new Economic Optimization Project.



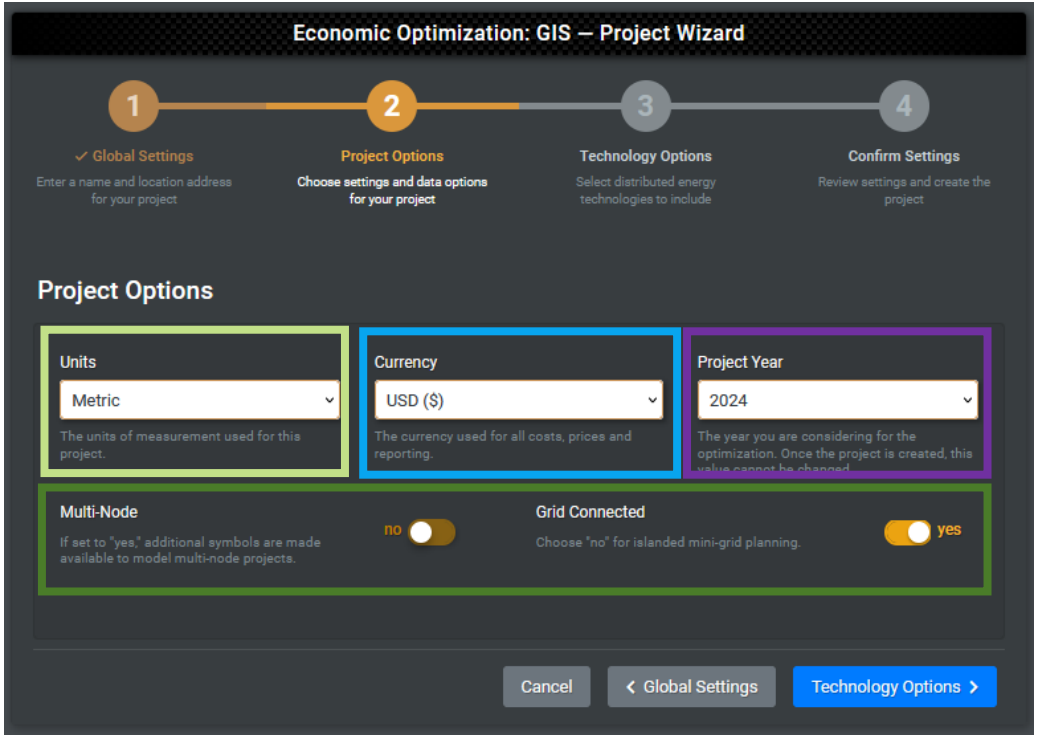
Smart Energy Project Wizard – Global Settings

- **Project Name** – A name that you can recognize and is relevant to your preliminary design.
- **Project Team** – Allows you to share the project with members of unique teams. *If your account is not associated with multiple teams, you will not see this option.*
- **Project Location** – The address closest to your project location. A map will appear once an address is defined.



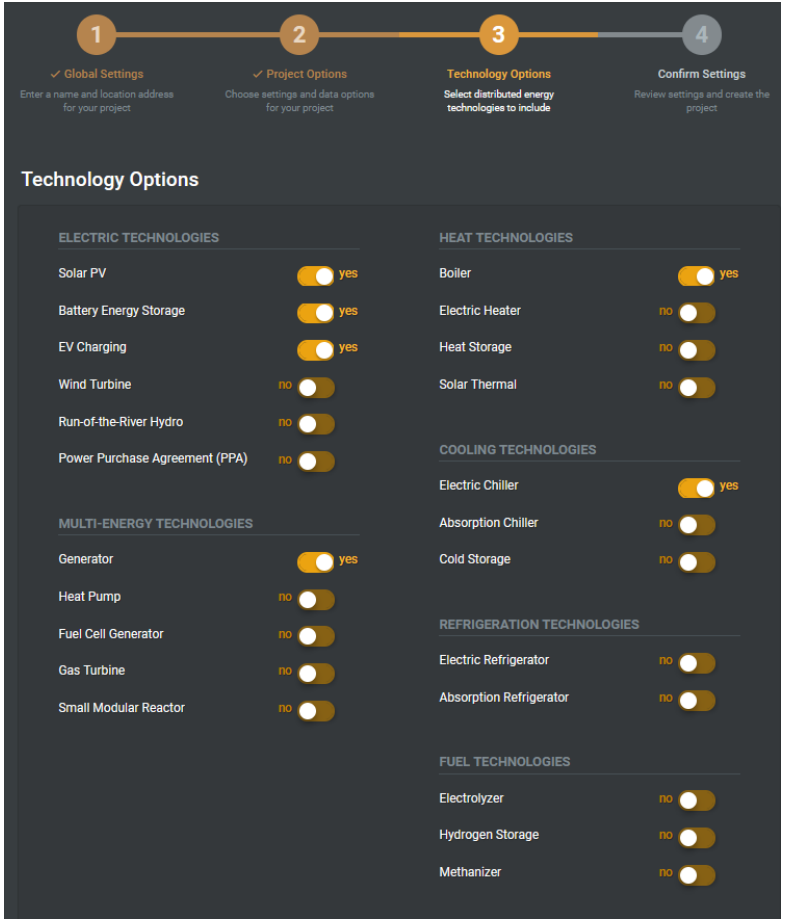
Smart Energy Project Wizard – Project Options

- **Units** – Define if metric or imperial units will be used in input fields.
- **Currency** – Define the currency for all costs, pricing, and reporting.
- **Project Year** – The year being considered for optimization.
- **Project Type** – Define project type such as grid connected and multi-node.



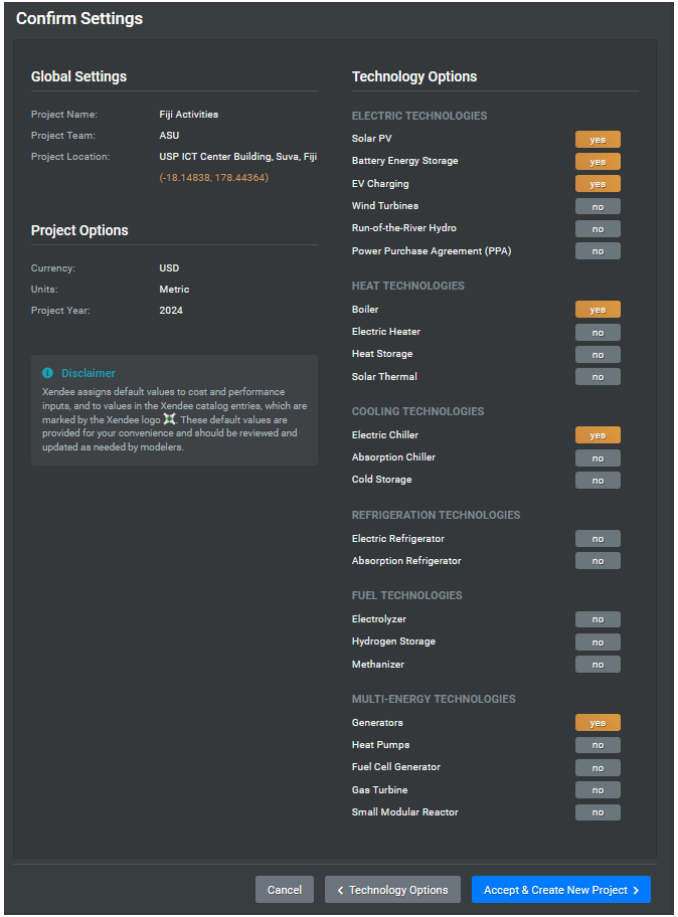
Smart Energy Project Wizard – Technology Options

- **Technologies –** Select the technologies to be selected and sized for the optimized microgrid portfolio.

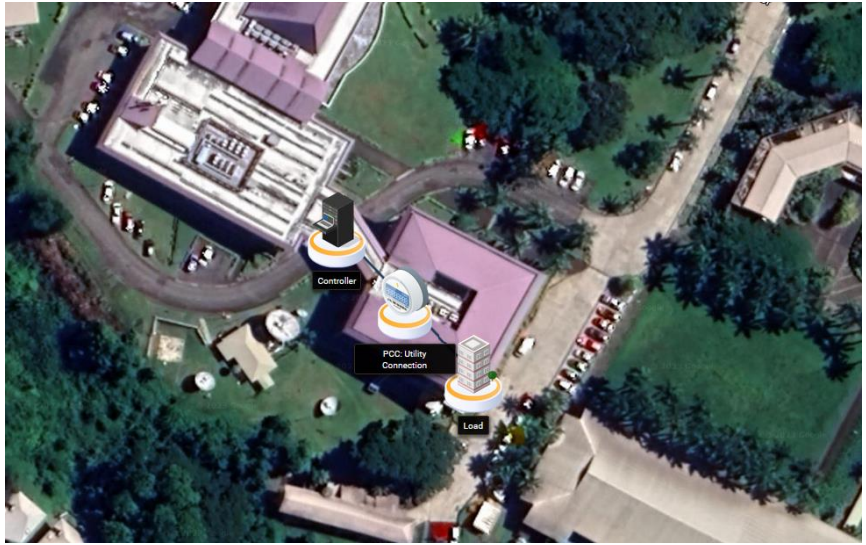


Smart Energy Project Wizard – Confirm Settings

- **Project Information –** Ensure that the correct information and options were inputted. (These can be changed later if necessary)



Create Your First XENDEE GIS Project

Follow the previous process to create a project with the following specifications.

- Project Name – Fiji Activities
- Project Team – Pacific Islands Workshop 2023 (if prompted)
- Project Location – Japan-Pacific ICT Centre, Fiji
- Units – Metric
- Currency – USD ($)
- Project Year – 2023
- Multi-Node – No
- Grid Connected – Yes
- Technologies Enabled – Solar PV, Battery Energy Storage, and Generator. Ensure all other options are “no”.
- Confirm settings and click “Accept &Create New Project”