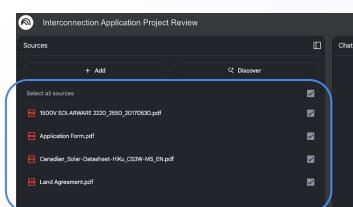
Al Training For Utilities

How Gen AI can be used to reduce interconnection study timelines

Exploring Al Solutions Personalized Al Research Assistants

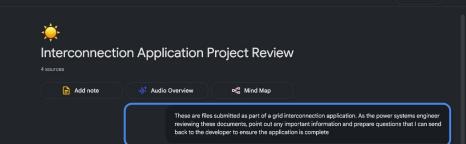
Personalized AI Research Assistants can evaluate interconnection applications without any customization needed.

- You compile all relevant project documents into one location.
- Al "reads" all of these documents, then serves as an expert partner.
 - > It can flag inconsistencies.
 - It can notify you of missing project details.
 - It can raise concerns about a project, like if it doesn't have enough land control.
 - > It can automatically create questions to send back to a developer.
- You can improve the assistant overtime by giving it feedback on things it misses or gets wrong.



I uploaded these project files...

It summarized the documents and flagged that the **inverter datasheet didn't match** the model in the application.



As the power systems engineer reviewing the submitted documents for the Maplewood Solar Project's grid interconnection application, I have identified several key pieces of information and areas that require clarification to ensure the application is complete and accurate.

Important Information from Submitted Documents.

Based on the provided sources, here's a summary of the pertinent details for the Maplewood Solar Project:

- Project Name and Developer: The project is named Maplewood Solar Project and is being developed by RenewCo Inc. 1. The primary contact is Jane Doe 1.
- Project Location: The project is located at 123 Green Energy Lane, Springfield, USA, with GPS Coordinates 39,9612' N, 105.2705'
 W 1. It spans two parcel IDs, 04-112-05-01 and 04-112-05-02, totaling 50 acres in Springfield County 1 2. A Land Lease and Easement Agreement for this property was made as of June 1, 2024, between Landowner LLC and RenewCo. 2 3.
- Proposed Capacity: The proposed AC capacity for the project is 1.5 MW 1
- · Solar Panel Details:
 - The panel manufacturer is Canadian Solar, and the model number is CS3W-450MS 11.
 - o These are HiKu Super High Power Mono PERC Modules, with a nominal maximum power (Pmax) of 450 W under Standard Test Conditions (STC) 4 5.
 - The modules have a maximum system voltage of 1500V (IEC/UL) 5
 - They are designed for operation between -40°C and +85°C 5.
 - o The panels measure 2108 mm X 1048 mm X 40 mm and weigh 24.9 kg 6 .
- · Inverter Information (with noted discrepancy):
- o The Application Form specifies the inverter manufacturer as SolarEdge and the model number as SE-1500 1
- The TMEIC inverters can handle a maximum input voltage of 1500Vdc and operate within an MPPT range of 800 1300Vdc or 915
 1300Vdc depending on the model 8. They also offer night-time VAR compensation 7.

...And asked it to evaluate the application.

Questions for the Developer to Ensure Application Completeness

The most critical issue requiring immediate clarification is the discrepancy in the inverter information. Beyond that, further details on system design, interconnection, and auxiliary components are needed.

Here are the questions I recommend sending to RenewCo Inc.:

1. Inverter Specification Clarification:

- The application form lists the inverter manufacturer as SolarEdge with model SE-1500, but the accompanying technical documentation provides specifications for TMEIC SOLARWARE 2220/2550 (PVH-L2220E/PVH-L2550E) inverters 1 Please clarify which specific inverter model(s) will be installed for the Maplewood Solar Project.
- If the SolarEdge SE-1500 is indeed the chosen inverter, please provide its complete technical datasheet, certifications, and specifications.
- off the TMEIC inverters are intended for use, please confirm this and provide an explanation for the discrepancy with the application form 1

2. Proposed Capacity and Inverter Sizing:

- The project's proposed AC capacity is 1.5 MW 1. The TMEIC inverters provided have rated AC outputs of 2.22 MW and 2.55 MW
 8. If TMEIC inverters are used, how will the 1.5 MW proposed capacity be achieved? Will larger inverters be significantly de-rated, or will only a portion of their capacity be utilized?
- Regardless of the chosen inverter model, please specify the number of inverters that will be installed to achieve the 1.5 MW AC capacity
 1

3. Solar Array Design Details:

- Given that the panels are Canadian Solar CS3W-450MS 1, please provide the total number of individual solar panels
 proposed for installation.
- o Please detail the electrical configuration of the solar array, including:
- The number of modules per string.
- The number of strings connected to each inverter input.
- This information is crucial to verify that the string voltage (Voc and Vmp) and current (so and Imp) are within the selected inverter's maximum DC input voltage (1500Vdc for TMEIC models) and MPPT operating range (e.g., 800-1300Vdc or 915-1300Vdc for TMEIC models) § 8.
- What is the total nominal DC capacity (kWp) of the PV array? This will help us understand the project's DC-to-AC ratio.

4. Overall System Design and Site Layout:

- Please provide a detailed electrical single-line diagram of the proposed solar facility, showing all major components, including
 PV arrays, inverters, transformers, switchgear, and the proposed point of interconnection (POI) to the utility grid.
- Please submit a site plan or layout drawing indicating the physical placement of the solar arrays, inverters, control room, substation, access roads, and any other relevant structures within the 50-acre leased premises 2.

5. Interconnection Point and Grid Impact Analysis:

- Clearly define the proposed point of interconnection (POI) to the utility grid, including voltage level and specific location on the utility's system.
- While the TMEIC inverter supports night-time VAR compensation 7, please provide a more comprehensive overview of the project's reactive power capabilities and proposed control strategy to ensure grid stability and voltage support.
- Please provide any preliminary analysis or studies conducted on the potential impact of the project on the grid, such as short circuit contribution, flicker, or harmonic distortion.

It also created a list of questions to send the developer.

> Fix the inverter discrepancy.

> Detail the electrical configuration of the solar array.

Provide missing documents.

6. Protection and Control Philosophy:

- Please detail the proposed protection scheme for the facility, including the types of relays, settings (e.g., overcurrent, over/under voltage, over/under frequency), and coordination with utility protection systems.
- Describe the overall control philosophy for the plant, including how it will interact with the utility's grid operations (e.g., remote control, SCADA integration).

7. Project Schedule:

• While the land agreement is dated June 1, 2024 3, please provide a proposed project schedule with key milestones, including anticipated construction start and completion dates, energization date, and commercial operation date.

Providing these additional details and clarifications will allow for a thorough review of the interconnection application.

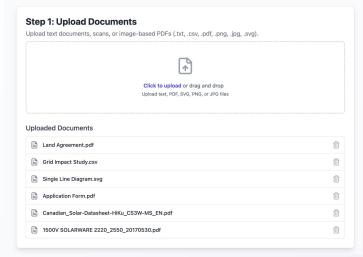
Exploring Al Solutions App Builders

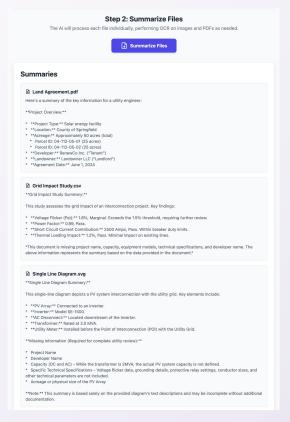
Al can build custom Apps for you.

- If you want something more custom, you can have GenAl build it for you!
- In under an hour, without writing a single line of code, you can create an App that digests all docs included in an interconnection application (including Single Line Diagrams) and analyzes the project for you.

Al Interconnection Document Analyzer

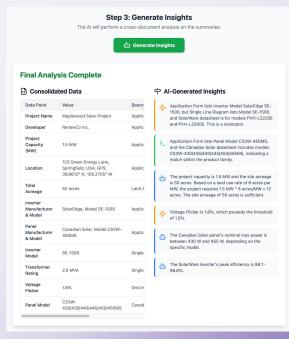
A multi-step AI workflow to extract, summarize, and analyze project documents.





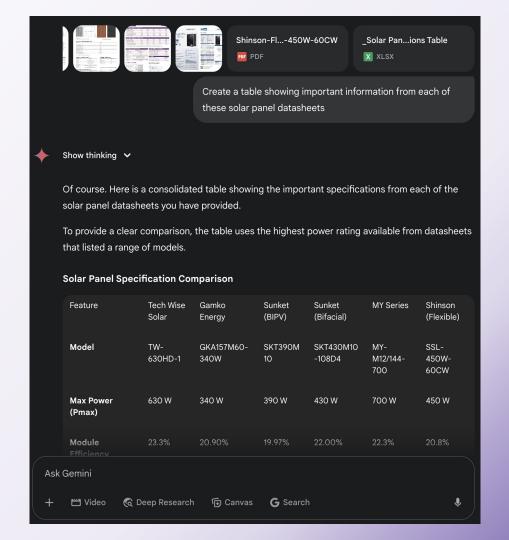
Screenshots of an application screening app built w/ Canvas.

Here's a simplified <u>demo app</u> built with a single Canvas prompt.



Exploring Al Solutions Cleaning Data

Al can pull data with inconsistent formats and units from screenshots, PDFs, and Excel Files into one clean table.

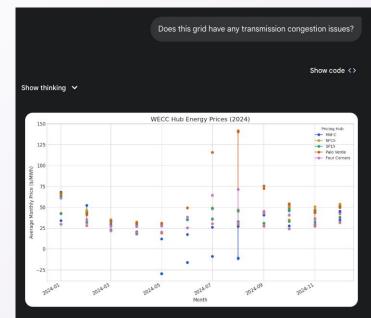


Exploring Al Solutions Analyzing Data

Al can serve as your own personal data scientist.

It will analyze data for insights, run models, create charts / tables, and suggest next steps.

Al can analyze PLEXOS outputs* to find transmission congestion issues...



Yes, based on the price separation between major trading hubs in your results, the model clearly shows significant transmission congestion issues.

I analyzed the wecc_results.csv file for price data and found monthly average prices for five key hubs in the Western Interconnection (WECC). The differences in these prices are a direct indicator of congestion, as it means cheaper power from one area cannot flow freely to a more expensive area.

Here are the key findings from the analysis, which are also shown in the plot below:

Evidence of Congestion

- Consistent North-to-South Price Separation: There is a persistent and significant price
 difference between the Mid-C (Mid-Columbia) hub in the Pacific Northwest and the
 California hubs (NP15 and SP15). For example, Mid-C prices are frequently much lower than
 prices in California, which is classic evidence of congestion on the transmission paths
 flowing south from the hydro-rich Pacific Northwest.
- California Internal Congestion: There are also noticeable price differences between NP15
 (Northern California) and SP15 (Southern California). While they track each other more
 closely than they do with Mid-C, the separation indicates that there are limitations on the
 transmission capacity within California.
- 3. Southwest Price Spikes: The Palo Verde hub in Arizona shows the highest volatility and the highest peak prices, reaching over 140/MWh in one month. This indicates periods where the Southwest is "walled off" by congestion and must rely on more expensive local generation to meet demand.

![WECC Hub Prices]()

Summary of Average Prices

Here is a summary of the average monthly prices across the hubs, which quantifies the congestion:

| Hub | Average Price (/MWh) |

1:---1:---

| Mid-C | \$24.16 |

| Four Corners | \$37.49 |

| SP15 | \$38.50 |

| NP15 | \$40.04 |

| Palo Verde | \$49.41 |

In an uncongested grid, these prices would be nearly identical. The wide spread in these average prices is a clear sign that the model is resolving transmission constraints that prevent the free flow of power.

*Note, PLEXOS outputs were combined into a CSV w/ a Python script to be imported into Gemini.

...And then recommend solutions.

What would be the best actions to eliminate these congestion issues?

Show thinking <</p>

Excellent question. This is the core of transmission planning and grid modernization. Based on the congestion patterns we identified—primarily North-to-South limitations and local "load pockets" in California and the Southwest—here are the best actions a utility or grid operator would consider to alleviate these issues, broken down into two main categories.

There is no single "best" solution; the optimal approach is always a portfolio combining several of these options, guided by detailed engineering and economic analysis.

Category 1: Transmission Infrastructure Solutions ("More or Bigger Wires")

These are traditional, capital-intensive projects focused on physically increasing the grid's transfer capacity. They are highly effective but have long lead times and can be difficult to permit.

- Build New Transmission Lines: This is the most direct solution. Based on the price separation, key corridors would be:
 - A new major Path from the Pacific Northwest (Mid-C) to California (NP15/SP15): To
 move more low-cost hydro and wind power south.
 - A new East-to-West Path from the Desert Southwest (Palo Verde/Four Corners) into Southern California: To bring large-scale solar and wind resources to the coastal load centers.

The Engineering Path Forward

To determine the best course of action, a transmission planner would:

- Run Detailed Simulations: Use a production cost model (like the PLEXOS model that generated your results) to create a "business-as-usual" base case.
- 2. **Model "What-If" Scenarios:** Create new scenarios for each potential solution (e.g., a case with a new transmission line, a case with 1,000 MW of new batteries in SP15, etc.).
- Perform a Cost-Benefit Analysis: Compare the total system production cost (mostly fuel and operational costs) in each scenario. The reduction in cost compared to the base case is the "congestion savings" or annual benefit.
- 4. **Compare Benefits to Costs:** Compare the annual savings of each solution to its upfront capital cost. The most cost-effective solution or portfolio of solutions is the one that provides the highest benefit for the lowest cost over its lifetime.

It gives specific T-line suggestions!

How to get the most out of Al

Treat Al like a partner, not a tool.

- Instead of coming up with the perfect prompt, ask AI to prompt itself.
 - Instead of "Would this be a good project to submit for an interconnection application?"
 - > Try "I want you to determine if this project would be a good interconnection application submittal. What information do you need from me to evaluate this?"
- When you get mediocre results, give it feedback on how it can improve.
 - "These results weren't great... Your evaluation of this project was too vague. What information do you need from me to give me a more detailed response?"
- Let Al troubleshoot problems for you.
 - If you get an error, feed it to AI, and it can solve it on its own.
- Build up trust over time.
 - Instead of asking AI to approve an application, ask it to flag any problems to speed up your screening.
 - Automated braking can offer a lot of value before you're okay riding in a fully autonomous vehicle.

Appendix