



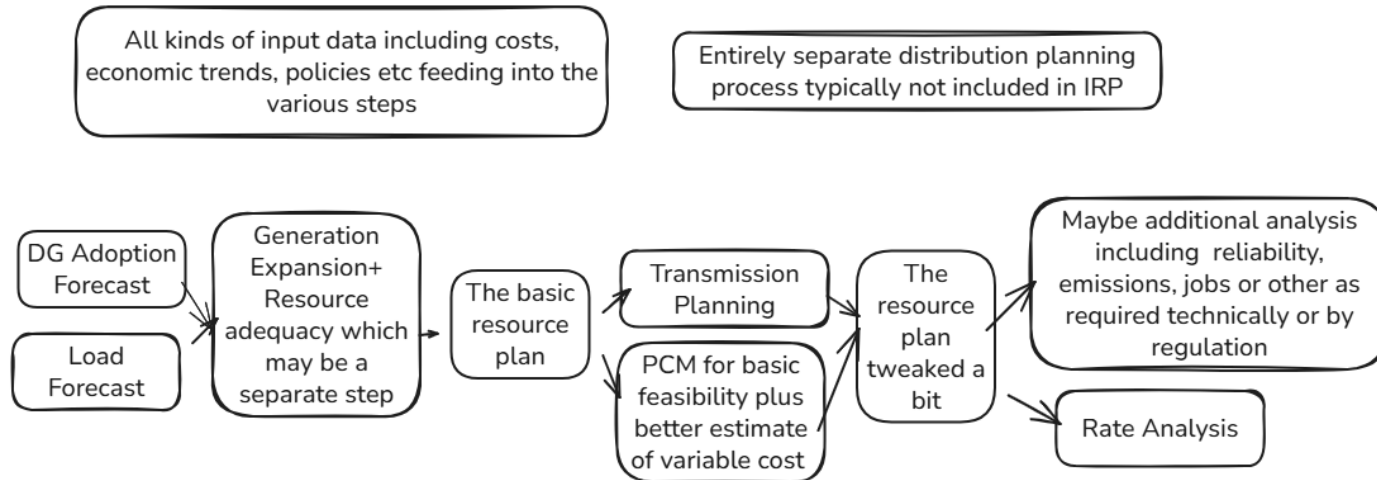
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# What's Broken, What's Getting Better, and What Might Not Really Matter: A Perspective on Power Systems Modeling

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# Context For This Discussion: “Classical” Power System Planning..

- What mix of resources provides the least-cost mix of resources while maintain reliability?
- What are the operational aspects of different resource mixes (what we used to call “integration studies”)



## Some Caveats

- These are largely personal observations based on 20 years of modeling, primarily PCM (UC/ED) but also capacity expansion and some steady-state power flow
- I am not speaking on behalf of any DOE program.

# What is (In My Opinion) The Main Challenge?

- The overall process of performing this type of study is still very difficult, time consuming and expensive, required extensive domain expertise.
  - This means we still cant do all of the types of analysis we want/need to do.

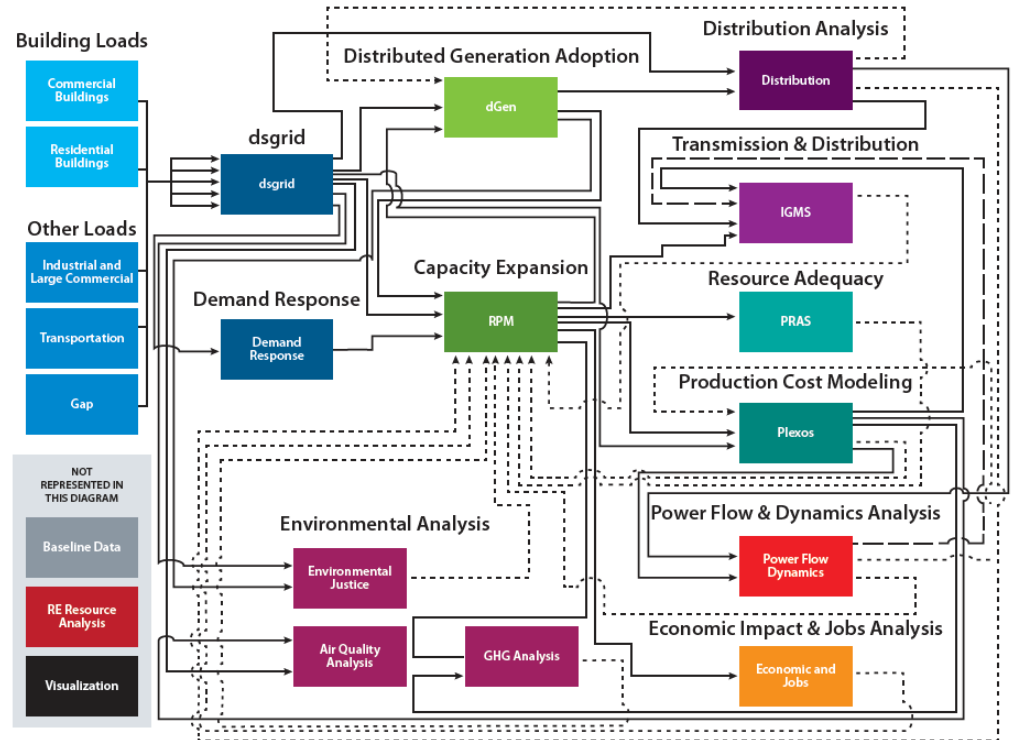
# Dividing This Into Three Parts

- “Interoperability” – Making the models and data sets work together
- Model capability – Do they have the features needed and can they actually solve?
- Interface and process - The overarching framework of how we do these studies.

# The Interoperability Challenge

- Very large number of data handoffs across at least 10 different models written in GAMs, Julia, Python, and others.
- Multiple interface types including everything from command line interface to GUI.
- Data stored in multiple data formats
- Significant domain-specific expertise required to run and interpret data sets
- Significant effort to communicate across modeling teams.

Example model and data flow from the LA100 study.



# Our Approach in LA100

- For LA100 we had a dedicated data manager who put a huge amount of effort into getting the teams able to pass data across models

# Example: Our Attempt to Deal with The Nightmare of Dealing with Time-Series Data Sets

- We created a timeseries standard and required all team members to respond in writing
- We sent out periodic reminder emails, to hopefully catch new members of the team

## **\*\*Your Immediate Action Items\*\*:**

I need every member of this team doing technical work (leads/analysts/coders) to reply to this email (or respond in a separate email) saying that you:

1. You understand that we are using a la100 project-wide timeseries format for the LA100 project,
2. You understand the requirements of the format which are that all model handoffs and data transfers be in PST, hour-beginning format, and if it is an 8760, that 12/31 be dropped for all leap years and the first index value (index 0) be set to 00:00 (12:00 AM) PST, and
3. You promise to adhere to this LA100 project wide format for all handoffs and movement of timeseries data from one LA100-subteam to another.

In addition, please include in your email response your answer to the following: “Do you think there might be DST shifts hiding in your data currently?”. If yes, please say where they might be. If no, please explain how your timeseries data is handled for your current model. If you do not know, please respond saying what your uncertainties are/might be. We will document these so we can address these uncertainties.

# And it mostly worked...but at what cost?

- About 2 years into the project we found some legacy data sets that dated back to the Western Wind and Solar 2 project that used a “work around” to address leap year. This resulted in a loss of time-synchronism in one year of data 2040.
- We found this error, and fixed it, but the amount of time trying to pre-empt this kind of problem, time spent looking for errors, and time spent fixing error takes way from what we are actually trying to do when we model the power system.
- This isn't scalable, but...

# Some Optimism – “What’s Getting Better”

- There has been significant integration of the CEM, RA, PCM components in commercial, lab, academic tools
  - Fewer data handoffs
  - Closer to co-optimized solutions
- Automated data checking and identification of errors using LLM tools
  - Time series example – LLMs have the potential to rapidly and accurately identify time series errors in each step.
  - For example - LLM tools can very accurately look for discontinuities during DST shifts, extra leap years, and weird stuff that sometimes happen at midnight. Compare time stamps to solar noon, traditional load peaks.

# And I Still Want Better Tools

- Lots of opportunities for improving models
- I want more features, faster run times
- I want true generation and transmission co-optimization.
- I want analysis of the cost optimal deployment of GETs
- I want to be able to model tradeoffs between DERs and central generation.
- And of course, I want tools that can quickly perform interconnection analysis
- Etc<sup>n</sup> where n is large

# But Lets Consider How We Design and Use the Tools...

- A lot of those features I want makes the tools even more complex. Especially as so much planning moves into more technically complicated issues (dynamics, IBRs).
- Will this increase barriers to use.?
- Leads me to the question of how much we should be thinking about improving transparency, accessibility as we develop or models and modeling processes.
- Are we appropriately serving key stakeholders including regulators, policymakers, developers and the general public?

# Some General Questions

- Can we design our modeling tools, techniques and studies to avoid some of the challenges we are now seeing in the narrative around power system evolution?
- Can we develop better tools that can prevent the use of simplified metrics that can create false narratives about how the power system works?
  - (Can we get rid of LCOE once and for all...? Can we show that the grid is a system?)
- Can we help address the asymmetry of knowledge between the utility industry and stakeholders such as intervenors?
  
- Lets get specific

# 1) Will natural language interfaces create new opportunities to reduce barriers to use?

- Until we get to “slider bar” type models (which I don’t see happening anytime soon) we will still be running complex models with significant barriers to use.
  - GUIs may not be sufficient to get to where we want
- Natural language models for input and output handling, analysis, runs.
  - ***Can we get to the point where PUC staff or intervenors can re-run utility IRPs using natural language interface?***

## 2) Will reduced barriers improve our ability to summarize complex issues in a transparent manner?

- Automated data processing, run management makes it easier to generate a large set of runs. This means:
- A larger array of cases instead of the normal “preferred option” (with a few alternatives which are often perceived as suspect)
- Ability to show how resource mixes fit in the “surface space” of options.
  - Explain how resources with low to zero ELCC can still be part of the least cost mix that maintains reliability
  - Demonstrate the tradeoffs between cost and reliability of different resource mixes.
  - Show what actually happens if you build “too much” or too little of a given resource

### 3) Can we use our models to improve how we train the next generation of power system engineers and analysts?

- Can we turn our better tools into better tool users?
- All this is under the shadow of how increased use of AI/LLMs creates new challenges and new opportunities (like everywhere else)
- At a minimum LLM tools can help us codify many of our tricks and best practices for data processing and analysis.
- I think this is another opportunity for institutions like ESIG ....

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