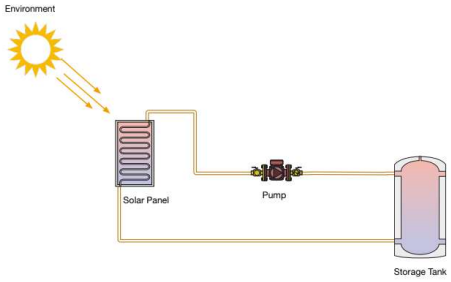
Project

Thursday, February 12, 2026 11:38 AM

Minimum Requirements

1. The system should simulate the heat transfer from a solar panel to a storage tank
2. Use whichever coding language you wish
3. We will evaluate thermodynamic correctness, code approach, and results.



Starting Notes:

This is soooo much better than anything I had hoped from a coding project interview. Seems pretty fun.

#Starting note
I am going to start by outlining my major assumptions. Ideally I would discuss these points and clarify a few things before diving too far into the modeling. For the purpose of the test I will just select several options, give my reasons for a specific selection. I tend to be thorough in making sure that I have the correct scope for a task.

#Tools
I am currently using Gemini Pro (got a free year as a student) for aided searches, and Claude for coding. I will note where I use both with a ~. I have found Gemini 3 to work great for compressing surface level info when starting, and then as an aid for finding specific projects and publications to reference. I have generally used it with github copilot in VSCode as well, but have been trying out Claude's latest this last week for coding.

My first two thoughts here are on the tech we are using here. I am assuming this would be most useful in an HVAC context, so I will act as if this is a solar panel helping with the energy load of heating a building, storing some excess heat during the day to better meet the demand during the evening and night. A lot of my projects were focused on how to leverage the industrial grade heat from nuclear, so we often worked with concentrated solar

Solar possibilities

A starting note PV: PV would not be connected to the thermal loop quite in this way. There are definitely some hybrid designs though and PV could just be immediately heating the working fluid with resistors.

Parabolic trough concentrated solar: I'm fairly familiar with this and it would probably be one of the more applicable approaches here. A trough of mirrors concentrating light onto a working fluid.

Concentrated solar (like what they have in the Nevada deserts): Probably not going to use this, typically this is just used for city scale projects.

Ok time to see if I'm out of date:
~Walk me through the best current methods of pairing solar with thermal energy storage. A full range of options will be useful, but I am mainly concerned about the scale needed to support utilities for a couple of buildings.

Looks like I was spacing on a major point.
- The reason we talked about concentrated solar in a lot of my work is because we wanted to leverage industrial heat (>200 C) which is pretty available in nuclear, but not a good approach for electrical heating.
- For commercial utilities PV works great.

~a couple more queries
I'm curious about the current state of PV vs concentrated solar in this type of application. I am aware as well of some hybrid PV applications. What is the current status on these different techs? I'm fairly curious about the efficiencies and the relative capital involved in different solutions as well.

Would PVT probably also only start to make sense if you were working on a district scale?

~Some more questions
I got a little interested in figuring out the state of tech here and went on a little research journey about material costs, degradation and common practice for heating with resistors (electric heating).

Take-aways

- PV paired with a solid state thermal battery is likely the most economic choice for this application.
- PVT is just PV with a heat exchanger on the back of the panel. More capital but makes a lot of sense for space constraints.
- Concentrated photovoltaic thermal is cool, but too much capital for anything but edge cases
- Concentrated solar is generally only remotely competitive when there is a need for process heat.

Thermal Energy storage

PCM(phase change material) or Solids(Graphite blocks, concrete, silica composite)?
- Solids have some cool advances, but mainly for high temperatures
- PCM seem to be the agreed upon go to for now for HVAC, particularly a graphite infused PCM for better conductivity and response.

I'm assuming a diurnal scale and not seasonal

Assumptions:

Purpose
I assume that we want a device to: offset part[1] of our major daily[2] HVAC heating load with solar energy for a large building.

1. If we were make solar for 100% standard operation, we would need a really high solar capacity and would need to be selling electricity back to the grid for a portion of the time (given, we'll probably be doing that sometimes during the summer)
2. Arbitrary choice between daily and seasonal here

Approach
For simplicity I'm going to assume that we are working with a PV solar panel[1], some resistors for heating, likely just purified water for the working fluid (Might switch based on the numbers), and a graphite infused PCM for the thermal energy storage[2].

1. Best value for pure HVAC at this scale from shallow research
2. Best value for reliable performance based on shallow research, maybe a modular salt hydrate unit.

Plan

MVP: Naïve models for everything except PCM and a very basic PCM. Generic demand signal (increased heating demand at night) and solar supply signal.

Note: check out DistrictLab for building load and charging thermal batteries

Thermal inertia is a big deal, (letting a building cool in prep for a hot day). Using the outside weather is a huge efficiency saver.

Waste heat recovery is really important for industrial and campus scale.

Comments: if we were make solar for 100% standard operation, we would need a really high solar capacity and would need to be selling electricity back to the grid for a portion of the time.