Power the Community: A College Design Competition
Framing Your Efforts

Note 1: Nothing in this suggested Framing is binding on the judges of the "Power the Community" competition. This document is provided by the Organizing Committee solely as a resource to competing teams. It may perhaps provide the right mindset to teams so they can consider how to strike balance when considering trade-offs for their efforts and final designs.

Contents

I. Intro: Loose Rules. Helpful Resources.

Some consistent feedback during the vetting of the proposed competition "Power the Community" was along the lines of,

> *"Cool contest, yet what will make a winning design? What does good look like?"*

Who is a better judge of that for your communities? Perhaps it is you who live there and possesses local knowledge.

Energy Mentors opted for modest approach to this design competition,

> *How about student propose what good may look like in their community?*

It will be suggested to the judges that they consider such framing was shared with the design teams.

And the role of Energy Mentors? We will try to connect you with resource and give you a platform to make your case. The resources include:

- Frequently Asked Questions (link)
- Links and other Knowledge Resources Link)
- Thought for Framing Your Efforts (below)

How will this all turn out? We are optimistic:

- This is a contest of creativity.
- We believe you are up to the challenge.
- The opportunity space is large.

Why do we know better answers are out there? The philosophers of U2 nailed it:

> I Still Haven't Found What I'm Looking For (Official Music Video)

After all, if we had found strong energy infrastructure designs that can power the communities of the future, why would we be sponsoring a design competition?

II. Mindset: First and foremost, "It's all about the customer!"

What should guide your design choices? Here is one suggestion, "It's all about the customer!"

Jeff Bezos, the founder of Amazon, preached a relentless attention to the needs of the customer. What will add value to the customer? What will make her or his quality of life better?

How does such relate to this competition? When faced with a design decision, do not think what the judges may think. Think about the families, that is the customers, in your community. What do they value? What can they afford? Most importantly, ***what are they willing to pay for and what are they willing to do without***.

Better than thinking, go to talk to some prototypical customers. They are out there. Ask them!

Remember, rarely is there one global solution. Often it is better to seek local improvements: in quality of life, in sustainability, in prosperity. In different locales, in a community energy context, "good" and "awesome" may look different.

- In a region where all neighborhoods come grid connected to gas and electricity then then next step-change may be to make a home super-efficient (well insulated, good ventilation yet low leaks) and "smart" (instrumented and connected).
- In a region where grid electricity is available yet unreliable a local microgrid with a mix of distributed power generations (e.g., renewables and high efficiency fossil fuels) may be a step change improvement in energy reliability and resiliency.
- In a village with no electricity then a PV solar array pulled out of a shipping container which can charge a mobile phone is a step change improvement, even with charging limited to daylight.

For what will your neighbors, that family with a schoolteacher and a nurse and two children say, be willing to commit their time and earnings month in and out for their long-term housing and living?

A definition of Engineering that once appeared in Tau Beta Pi magazine went something like this.

> **Engineering is the skill to make the most improvement with the least amount of input.**

Think about that. For your design, viewed through the lenses of your neighbors, your customers, "What does "good" look like?" In your finished design, what may achieve the most improvement for energy affordability, sustainability, and resiliency for the least amount of materials, environmental disturbance, and capital?

Drive to render that design.

And don't worry about the rest. Trust the judges understand this:

Your design should meet the needs of the people in your community.

After all, it was also the approach Steve Jobs and Apple took on the iPhone,

> **"We're sending CUSTOMERS a message… we are going to try to serve their needs. We went around and asked a lot … what they wanted. And that's where we got our list from. We did not make it up ourselves."**

III. Community Needs

Your second deliverable is, "A statement of the most important needs of the community supported by references." How might you go about creating this deliverable?

First the easier part, the second half of the requirement, the references. Similar to how we handle Links, search out and cite just as a typical Wikipedia article does:

- Links to government and NGO reports
- Links and or references to news accounts
- Links and or references to other published sources
- Citing comments from interviews and focus groups

Now to the heart of the matter. What might the needs of the community be? Consider back to basics: clean water, sanitary sewage systems, indoor or outdoor air pollution, reducing energy costs, reducing energy supply chain constraints, sourcing cooking fuel, refrigeration, heating, cooling, lighting, communication, transportation, GHG emissions / carbon emissions, low outage power delivery, etc. All these basic needs either require or are associated with energy use and efficiency.

Consider this example where energy intersects with basic human needs. The World Health Organization reports Household air pollution was responsible for an estimated 3.2 million deaths per year in 2020, including over 237 000 deaths of children under the age of 5. (28 November 2022)

- "Around 2.4 billion people worldwide (around a third of the global population) cook using open fires or inefficient stoves fueled by kerosene, biomass (wood, animal dung and crop waste) and coal, which generates harmful household air pollution..."
- "Women and children, typically responsible for household chores such as cooking (and) collecting firewood, bear the greatest health burden from the use of polluting fuels and technologies in homes."
- "It is essential to expand use of clean fuels and technologies to reduce household air pollution and protect health. These include solar, electricity, biogas, liquefied petroleum gas (LPG), natural gas, alcohol fuels, as well as biomass stoves that meet the emission targets in the WHO Guidelines."

In some ways your design is about lessening energy poverty and enhancing energy prosperity. Can we design communities to help families save money by increase energy efficiency, source lower-cost energy, or preventing illnesses associated with either lack of access to affordable energy or current energy usage?

Can you enable:

- "A penny saved is a penny earned."
- And, "A carbon saved is a carbon earned."

IV. Build your team for the competition:

- Teams can decide for themselves the number of teammates.
    - It is suggested competing teams could be a handful or two of undergraduate and graduate students across multiple disciplines.
- Teams may draw on the knowledge and advice of faculty, graduate students, and working professionals without limit though such people should not work to produce results / deliverables.
- Helpful hint: It may be desired to include disciplines outside engineering and architecture! Consider recruiting cross-discipline team mebers who can contribute in:
    - Electrical Engineering
    - Power/Mechanical/Process Engineering
    - Architect
    - Land Planning
    - Public Policy, Legal, Regulatory and Permitting
    - Business and Economic Analysis
    - Cost Estimating
    - Construction Disciplines

V. First-principles scrutiny

- Your conceptual design must figuratively and literally “stand up” to first-principles scrutiny.
- A design audit per se is not a burden we are placing on the judges.
- Do recognize the judges probably have the “pattern recognition” to spot potentially unworkable solutions and to quickly test such hypothesis. And perhaps the capability to do quick analysis to double check a potential hole in the design premise.

VI. Deliverables: Managing time and expectations

To participate in the competition, your design submission should include a number of deliverables. And they will require some investment in time. So how to balance expectations and manage time? Should you go:

- Bold and innovative?
- Compound improvements for step change?
- Conceptual?
- Very Deep and Detailed?

The following sections gives some – actually a lot! – of considerations on many things.

First, if you are designing for your community, it may be that you need to but identify one or two big, unmet needs and but come up with one or two matching solutions that you illustrate can be practically rendered.

All you may render something in awesome detail that strikes the fancy of the judges.

Where to stop? Well, you are students with other studies so you will have to use judgment to strike a balance. Also ponder the value proposition to you. Are you in this to learn? Are you in it to win it? To score a cash prize? Or to start you on a path of developing your capabilities by putting in the discipline of designing "strong elements" and "awesome" features and approaches? You may actually want to try to pilot what you came up with!

There is good news for the majority of you competing students. Younger people tend to be more innovative and have more "agile intelligence" than those who have had careers of 20 plus years. That is what this competition is trying to catalyze, innovative ideas rendered into "strong elements" and "awesome" features and approaches!

Now yes, it is true, ideas have to be molded around practical methods and real world constraints. For example, no violating the Laws of Thermodynamics. And what if you are not "practiced" in economics, design, and engineering? Might that be intimidating? So what! Every thing in life has a learning curve. The only way to get over it is to seek a mentor / advisor and to start practicing a capability.

Ever see someone try to kick a football or swing a tennis racket for the first time? They will probably not do it well … the first time. But with some hours of practice, some learning of technique and perhaps the assistance of a good coach that person will get better.

Perhaps consider turning on its head, "Anything worth doing is worth doing well." When you are just starting out, you will not do it well. Yet with effort and repetition and feedback you can do it well. Accept that the first few tries might not be done well, yet over time you will improve. And perhaps along the way you may surprise others, and even yourself.

So will you get started and crack up your agile intelligence?

A. The Pitch Video

- A “pitch video” of about 10 -12 minutes (max 15 minutes).
    - The pitch is to a family of informed buyers who want better living and bring along relatives who are engineers and architects. The pitch should go beyond aspirations and holistic living considerations and explain how the design and construction of the infrastructure and the housing unit underpin more affordable energy supply, delivered reliably, with better environmental sustainability.
    - Remember that the community should be a desirable place to live. Bring it alive in the pitch. Your video may be “your best opportunity to make a good first impression.”
    - The pitch video must be in English language or subtitled in English.

B. Design Musings: The Community

In this competition you will not have the time to render a "professional" design. But you should know what it may comprise so you can decide what may or may not be worth the effort.

Here are some elements of a community professional design.

- The community should be great place to live… and maybe even work also!
- A list of applicable regulations and codes.
- Plot plans and general arrangements.
    - The location of fixed assets, e.g., buildings, built-up roads & corridors, etc.
    - "Corridors" for the flow of people, transport, energy, other utilities, precipitation run-off, etc.
    - Non-residential real estate can be indicated as a "black box" with a realistic (e.g., benchmarked) footprint and utilities consumption.
- Community electrical one lines
    - All external connections of power import to the community
    - All local ("distributed") power generation and energy storage
    - All community power (microgrid) distribution down to the connection to the housing units
    - All community utility flow diagrams (water, liquid and or gaseous fuels, sewage, district heating and or cooling fluids)
- Energy and emissions profiles should have cases of highs, lows, and likely averages on both an annual basis and daily basis, each for two seasons (e.g., warmer & cooler; wetter & drier).
    - Energy infrastructure must anticipate the range of annual, local weather conditions.
    - The community design of course must provide and integrate the utility and energy systems demands of the commercial real estate into the overall master design.
    - At least one typical residential unit must have been developed an internal floor plan and a basis of design that sets the overall utilities consumption. If not detached housing it must be shown how that unit is arranged into a larger building.
- Utility flow diagrams with system wide mass and energy balances / inputs / consumptions / outputs
    - The community's unit's energy consumption profiles.
    - The community's cumulative emissions from energy, including particulates, carbon (scope 1 and scope 2), and other emissions.

- Design basis and materials of construction for the interconnecting infrastructure, especially as it affects energy.
- Before launching into detail design, the design should be completed to a level of conceptual engineering.
- Integrative design should enable constructability and execution assurance and thus cost assurance.

C. Design Musings: The Housing Units

In this competition you will not have the time to render a "professional" design. But you should know what it may comprise so you can decide what may or may not be worth the effort.

A typical housing unit design might be based on:

- A list of applicable regulations and codes.
- A floor plan and general arrangements.
- General materials of construction for major components. Highlight major design and construction features that drive energy consumption.
- A list of energy sources made available to the residences.
- A list of the residence's energy consumers.
- The housing unit's energy consumption profiles.
- The housing unit's cumulative emissions from energy, including particulates, carbon (scope 1 and scope 2), and other emissions.
- Energy and emissions profiles should have cases of highs, lows, and likely averages on both an annual basis and daily basis, each for two seasons (e.g., warmer & cooler; wetter & drier).

A typical housing unit design might include:

- floor plan
- Major design and construction features especially those that drive primary energy consumption
- Energy consumption list: Annual, seasonal if applicable, daily.

- Do consider how materials of construction, structural design, HVAC, ventilation and airflow, window selections, etc., all may impact utilities consumption.

- The housing units should consider approaches to and or affordability of:
    - Lighting
    - Power
    - Cooking
    - Food refrigeration
    - Potable water
    - Sewage
    - Solid refuse holding means and disposal access

  - Heating
  - Cooling
  - Broadband Internet
- Family and community energy delivery should be affordable, sustainable, and robust / resilient to extreme events (weather, seismic, etc).
- Consider scenarios and mitigation to avoid common cause failures that can interruption of community power, fuel supply, utilities, etc.
- Consider not only energy but other utilities infrastructure synergy (e.g., water, broadband, garbage, sewage).
- Construction completion and move in of first units shall be within four years of project approval, notionally before year end 2030.
- Etc.

D. Energy Systems Design Trade Offs

What could be the trade offs under various scenarios for various home configurations? Components to consider:

- Battery Storage (e.g., Tesla Power Wall)
- Solar Photovoltaic
- Concentrated Thermal Solar
- Natural Gas Generator
- Cold Weather Heat Pump / AC
- Conventional AC with Natural Gas Heat, both with circulating blower
- Natural Gas convection fireplace(s)
- Wind Turbine
- Advanced Windows
- Designed Air Exchange for interior
- Advanced roof designs for winter / summer energy management
- AC versus DC home components / circuits

Observation: 80/20 rule! Most of the benefit comes from only a few things, not everything.

Considerations: Steady State

- Capex
- Opex
- Power usage
- Grid power cost: different for nights and weekends from peak?
- Loan interest rates for Capex
- Loan duration for Capex (years)
- Government Tax credit
- Return on Investment

Risk Management:

- August midday: no / low midday wind, AC load is max. High solar intensity carrying over daylight
- February: No / low wind (not there, freeze ups). Max grid electric draw so rolling black outs. Natural Gas supply chain collapses (electric compressors, pipeline components freeze up) so no / low gas.
- Hurricane: Power out for a week plus. Some natural gas? No natural gas. Solar panels damaged?

Possible Aapproaches to High Risk Scenarios:

- Cut loads to extend battery life?
- High efficiency: cold weather heat pump. Gas heat plus circulating blower
- Passive energy systems: heat storage? Insulation?
- Smart*N*Secure(TM) energy management. (Google, Tesla, or Amazon don't own or get your private info. Local Optimization.)
- Citizen control of supply and demand decisions, not central agency (government, utility, expert system, remote control)
- Trade-offs: Where to provide investments for security of supply (closest to power users) versus economy of scale (centralization) versus economy of manufacturing.
    - Batteries and energy producers at neighborhood or house level?
    - Home microgrids integrated into Neighborhood minigrids with smart interconnect with regional utility grid
- Interactions with other utilities:
    - Fresh, potable water supply, buffer storage for human use
    - Grey water supply for non-human use
    - Natural gas supply
    - Natural Gas storage?
    - Sewage treatment
    - Solid waste collection and disposal
    - Rainwater collection and storage?
    - Thermal storage?
    - Storm water retention?
    - Above versus below ground power lines
    - Fiber Optic / broadband connectivity

VII. Benchmarking: Why? How to use to inform design?

The design competition intent is to promote energy prosperity and sustainability along a "Think Global. Act Local." impetus. The question arises, "Versus what?"

- Benchmarks: comparisons of improvements in living for your community versus those living in the region. Can be in any number of dimensions: energy cost resuctions, energy "availability" (e.g., percent of time, # incidents of supply disruption per year), GHG intensity and other emissions, etc.
- Resiliency, Prosperity, and Sustainability benchmarks, including:
    - A cost estimate for the total community development and a cost estimate for the prototypical housing unit.
    - Benchmarking energy and emissions for the family in the housing unit versus nearby populations. Minimum benchmarks include:
        - Housing and energy costs and affordability.
        - Energy availability (e.g., online %, # outages per year).
        - Emissions, indoors and outside.
        - Carbon intensity per unit household annual salary (a stand-in of GDP).

    - Minimum benchmarks:
        - Housing affordability
            - All-in capital cost per square meter of housing (including land, community utilities, etc.)
        - Monthly costs versus household salary
            - Housing amortization
            - Energy costs
            - Other costs (local taxes, non-energy utilities, etc.)
        - Interior air quality:
            - Particulates (PM25 for example)
            - CO
            - NOx

- Energy flow outages:
  - % of annual time each energy source is available to power the residences.
  - Number of incidents per year
- Carbon intensity per unit household annual salary (a stand-in of GDP)

- Prosperity, Resiliency, and Carbon Intensity benchmarks.
  - Precision should be appropriate to the decision making of a typical citizen. In some cases only one significant digit may be required. In others, perhaps two.
  - All benchmarking must be made in comparison with nearby populations. Nearby is to be considered either:
    - The population to the nearest city of greater than 100,000 persons.
    - Populations in the surrounding 200 km (120 miles) if the design is for a less populous region.
  - Powered Community and Nearby Population benchmarks minimums:
    - Carbon intensity per unit household annual salary (a stand-in of GDP)
    - Interior air quality (to one significant digit): parts per million for:
      - Particulates (PM25 for example)
      - NOx
    - Power outages:
      - % time
      - Number of incidents per year
    - Housing affordability
      - All-in capital cost per square meter of housing (including land, community utilities, etc.)
      - Implied Costs
        - Upfront
          - Down Payment
          - Other
        - Monthly payment
          - Mortgage if financed.

- Other monthly costs (local taxes, utilities, etc.)

VIII. Other Considerations: What to not fret. What to Sweat.

Do not conform to what may be expected.

Precision should be appropriate to the decision making of a typical citizen. In some cases only one significant digit may be required. In others, perhaps two.

IX. Getting Your community built: The next competition?

Perhaps Community Construction and Execution can be the next competition!

Change Management is often a major inhibitor to innovation adoption. Many and sometime just about all actors in a supply chain may have to do something different to deliver the innovation. If they are not so informed and retrained, then through no fault of their own points in the supply chain can stay in a "business as usual" mode. Expectations have to be made know and new capabilities taught.

Points in the supply chain to consider when rendering innovation into a community design may include:

- Component suppliers. What is the availability of components in the quantities desired? Can they be manufactured at enough scale for: cost effectiveness, secure supply of spare parts?
- Cadre of "EPC" specialists: Design (engineering), Procurement, Construction. Have proforma, existing contract been modified to enable and then drive the innovation implementation? Have commercial terms been altered likewise?
- Training the trades! Need the right work force and leadership at the workface. Think like a military campaign: at the point of attack it's all about the NCOs and the soldiers. Developing, training, growing: companies, construction superintendents, laborers in how to install properly.
- Construction Erection Sequence: from before the slab to occupancy
- Operability: make it easy on the occupant.

X. Networking and forging professional relationships.

Nascent thoughts:

- “Networking. Job offers / exposure”
- Can professional org do webinar? Community design? Electrical?
- Can they present at AICHE? IEEE? Etc.? Allow poster sessions, presentations, etc.

XI. More Commercial and Legal Considerations

- Submitting your designs to the competition website is explicit agreement and acknowledgement that design is not proprietary, confidential, etc. If the drawings are marked with such classification the act of submitting them to the competition makes such null and void.
- Your design will be publicly posted so any innovations will become public domain at the time of submittal if not preceded by patent application.
- You grant Energy Mentors the right to display and promote your entire design or parts of your design. Such will be done giving recognition to Team Name and Location.
- Team members must be listed as part of the submittal. The default is team members names will not be publicly associated with the Team result unless explicit permission is given.
- Likewise a Team may submit an optional team picture that can be displayed or they may opt not to submit a Team Picture.
- Submitters are responsible for their own Intellectual Property (IP) obligations and compliance. Energy Mentors does not assume any IP obligation of the submitters to any third party.
- You are free to include team members' patented or "patent pending" innovations with your submissions as long as the innovation can be fully rendered with components available in the market place. Energy Mentors does not assume any IP obligation with such a submission.
- You are free to sell your design to the property owner. And or buy or take an options on the land for which you are designing. Why not profit from your value-add ideas?

XII. A Mentor's Journey

Before suggesting how the Design Teams could think about the "Power the Community" competition, perhaps it may help to share in one page my journey to promote the competition.

Since 2018 a formal part of my employment was to broadly formulate societal solutions for energy prosperity / access, resiliency, and sustainability. A catalyst to my thinking was experiencing Winter Storm Uri which knocked out power to my and the homes of many Texans in February, 2021. There were many common cause contributors to the widespread electricity outages. One of many observations included,

> *Master planned communities being built nowadays around Houston, Texas, USA, tend to have the same energy infrastructure as communities built half a century ago.*

What are the odds that design practices a half century old are as efficient and good as they could be?

Of course, a good energy infrastructure solution in Texas may not be a priority in meeting the needs of family life in, for example,

- Bengaluru, India
- The Okavango Delta, Botswana, or
- Bojonegoro, Indonesia

When I retired after a 40-year career I wished to share my modest energy knowledge and promote innovation deployment. I wished to direct my energy to catalyzing actual improvement in people's lives and our environment. As one person puts it, "Outcomes, not ideology." Therefore I formed Energy Mentors and proposed the "Power the Community: A College Design Competition."

On the bottom of my emails for my last decade of employment was the catch phrase, "Connect Global. Act Local." I wonder if any in a rising generation across continents will take on the design challenge, "How can we best power energy prosperity, resiliency, and sustainability for the people in our local communities?"

Don Victory