Power the Community: A College Design Competition
Knowledge Resources

A curated list of reference materials, inspirations, and links by Energy Mentors with suggestions from our many (and sometimes "silent") collaborators. Please submit your nominations to: info@energymentors.com

Note 1: Nothing in Knowledge Resources 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.

Contents

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I. The Energy Trilemma

- World Energy Trilemma Index | World Energy Council *"Healthy energy systems are secure, equitable and environmentally sustainable … Maintaining this balance in context of rapid transition to decentralised, decarbonised and digital systems is challenging with the risk of passive trade-offs between equally critical priorities."*
- World Health Organization: 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.
- Is Africa in position to wipe out energy poverty solely with renewable energy? Also How Africa Can Find a Balance for Its Energy Future with the Executive Chairman at African Energy Chamber, NJ Ayuk (@nj_ayuk) / Twitter, NJ Ayuk JD, MBA. | LinkedIn
- Want to learn about climate but feeling overwhelmed? See the hacks by Philip Johnston, PhD 🌍 | LinkedIn to learn the landscape quickly. Those links complement Energy Mentor's links which skew to, "How to do energy better."

II. Energy Transition – The Big Picture

Bela Hanratty has a series of Climate(Pod)Notes that provide a good perspective on the basics and the possibilities:

- It's energy, stupid. - by Bela Hanratty (substack.com)
- Energy Transition Distilled - by Bela Hanratty (substack.com)
- Energy Transition Distilled: Part 2 - by Bela Hanratty (substack.com)
- Decarbonising Electricity - Energy Transition Distilled: Part 3 - by Bela Hanratty (substack.com)

III. Benchmarking Prosperity, Energy, and Emissions

- GDP per capita vs. energy use, 2015 (ourworldindata.org)
- Greenhouse Gas Protocol | (ghgprotocol.org)
- What are scope 1, 2 and 3 carbon emissions? | National Grid Group
- IEA reports:
    - "Fossil fuel consumption subsidies rose to a record of over $1 trillion in 2022 amid the global energy crisis…"
    - "Almost all of the consumption subsidies … were in emerging and developing economies…"
    - "Governments took a variety of measures to protect consumers from the worst effects of the energy crisis. The most common, as usual, was simply to fix end-user tariffs, or to cap fuel or electricity price increases. For example, the Peruvian government decided in April 2022 to temporarily include a number of transport fuels in the State Fuel Price Stabilization Fund to curb the rise in prices. Many advanced European economies limited consumer exposure to the full impact of spiralling natural gas prices. Thailand

introduced a price cap of THB 30 (USD 0.85) per litre of diesel. Some successful subsidy reform programmes were interrupted: Egypt, for example, extended electricity subsidies, which it had previously planned to phase out by the end of the 2021-2022 fiscal year..."

IV. Business Model Innovation. Change management.

A sustainable business model is required to deliver technology to market. Sometime business model innovation is a key enabler to technology uptake. Paraphrasing Hugh E. Keough, Damon Runyon,, et. al., "Everything is not decided by a great business model, but that is the way to bet."

An example: Commercial Real Estate (CRE). Owners / developers may hesitate adopting a range of energy efficiency / technology solutions due to incremental investment cost and contractual risk. eprsquared.com (home) has three video case studies (at bottom of webpage) where technology deployments appear enabled by business model innovation (three minute video).

V. The Foundations of Design

- Integrative Design: A Disruptive Source of Expanding Returns to Investments in Energy Efficiency, Amory B. Lovins, Chairman and Chief Scientist, Rocky Mountain Institute, 14 March 2010
  Integrative Design, the great, underused lever.
- Video: Michael Liebreich with Ep68: Amory Lovins 'The Einstein of Energy Efficiency' | Cleaning Up. Leadership in an age of climate change. Some money quotes about integrative design and energy efficiency:
  - "… doing seven things may get a quarter energy reduction… fifty more may get another quarter…"
  - "Relentless patience and meticulous attention to detail …"
  - "Friction in a pipe goes down as nearly a fifth power of its diameter. But its cost goes up as a second order of its diameter… Pipes should be fat, short, and straight; not narrow, long, and crooked." So, "Bend minds, not pipes!"
  - "Most people don't think of design as a scaling vector."
  - "It's not a technology. It's a bloody design method."
- First Principles Thinking: The Definitive Guide (maray.ai) Aristotle defined a first principle as "the first basis from which a thing is known."
- First Principles: Elon Musk on the Power of Thinking for Yourself (jamesclear.com) *"Instead of buying a finished rocket for tens of millions, Musk decided to create his own company, purchase the raw materials for cheap, and build the rockets himself. SpaceX was born."*
- The 7 principles of design and how to use them While focus of this video and article is graphic design, it has great insights and thinking models.
- Plan to Zero – Part 1 and Nega-Watts. Some of fifteen "Plan to Zero" posts by Doug Houseman as of Feb 28, 2023. (It would be more accessible if they were in a Substack).
- (Crowd, please suggest better "how to" references for "Process Integration / "Pinch". See the notes below.) Optimizing Energy and Mass Flows? Process (energy and mass flow) integration (Wikipedia)[i] *"is a term in chemical engineering which has two possible meanings."*

- "A holistic approach to process design which emphasizes the unity of the process and considers the interactions between different unit operations from the outset, rather than optimising them separately…"
- "Pinch analysis, a technique for designing a (heating and cooling systems) to minimise energy consumption and maximise heat recovery…" [ii]

VI. Community Design Visions & Lessons

- We really want to be living in Strong Towns. Yes? Strong Towns explores design approaches …
- A books on architecture and community planning is "A Pattern Language" by Christopher Alexander et al, Center of Environmental Structure: https://www.amazon.com/Pattern-Language-Buildings-Construction-Environmental/dp/0195019199. Hat tip: Bill Conlon
- Our Built Environment | Coby Lefkowitz | Substack Because we want to enjoy where we live …
- Out of the box thinking? "Lennar is building communities of tiny homes in San Antonio because they are legal there. They should be legal everywhere." https://twitter.com/taupeavenger/status/1602749161484345345?s=51&t=Emh8e5juT_gn3IDmug3z8Q

VII. Lessons from Extreme Events

- A Winter's Tale: "Ask an Engineer." Texas Electricity Crisis: Engineers Explain What Went Wrong | National Review
- A Summer's Tale: Extreme Heat (example required how a community energy system performed, or not)
- A Hurricane's Tale: "An ounce of prevention…" Babcock Ranch, Florida:
  - How Forward Thinking Prevents Disaster - Friday Forward (#352) (robertglazer.com) *"The community was designed specially to account for global warming and natural disasters such as Hurricane Ian."*
  - Florida community built to weather hurricanes endured Ian barely scratched. Jennifer Languell, sustainability engineer who helped design Babcock Ranch, explains, *"The things that we do, you don't see. The strength of the buildings, or the infrastructure that deals with stormwater, or the utilities. You don't see that stuff… Which is good, because most people don't need or want to think about it."*

VIII. Power Grid Primers

- Microgrid Knowledge Do you want to know the latest of what is available for community power grids?
- There may be more co-innovation required all around (independent developers, utilities, regulators, etc.) to enable decentralized, distributed grids if this report is representative. Hat tip: Bill Conlon

- Suppliers:
  - Smart Grid Solutions for Electricity Companies | Schneider Electric Global (se.com)
  - Smart grids – driving energy intelligence | Energy Topics | Siemens Global
  - Smart Power solutions for Microgrids | ABB

IX. Electric Grid Architecture:

- (Crowd: please source some more primers for this category)
- AC vs. DC. Tesla/Westinghouse Vs. Edison. Case closed. Or is it?
  - Purdue's DC nano grid house. More Efficient. Lower Cost. Powered by solar panels, batteries or local utility. See 3-minute video.
  - Digital DC Networked Electricity. "Villages throughout the world without access to electricity are now afforded the opportunity for independence by building and managing their own infrastructure. Open the crate, plug the components together, and hours later multiple homes will have sufficient power for lights, fans, a small refrigerator, TV, and communal water purification. And with our "pay-as-you-go" platform, electricity is affordable and accessible to all citizens of the world!"
  - Tesla versus Edison: lessons from the AC/DC war – Physics World

X. Building Tech

- High Performance Buildings
- Retrofitted Net-zero Energy House. See 2-minute video.
- GENIUS Smart Panels - KOBEN (kobensystems.com)
- (Crowd: please source some more candidates for this category)

XI. District Heating and Cooling

- (Crowd: please source some candidates for this category)

XII. Solar: Photovoltaic, Passive, Concentrated

- Solar Power | Schneider Electric Global (se.com)
- PowerField Energy: Because it is not just about the cost of the solar panels. It's also about the cost of supporting and installing them. See time elapsed installation on the home page.
- (Crowd: please source some more candidates for this category)

XIII. Wind Turbines

- Distributed Wind Resources:
  - Distributed Wind Energy Association | Our Wind, Our Power, Our Future with its 2023 Conference: Distributed Wind 2023 Agenda | Distributed Wind Energy Association
  - Home - Bergey Windpower Co.
  - Crossflow Energy | Affordable, Low maintenance & Clean energy solutions
- Big Wind Resources
  - Wind turbines and services I Siemens Gamesa
  - Wind Energy Power Systems & Solutions | GE Renewable Energy

XIV. Grid Energy Storage

- Storing renewable electricity on the grid of the future (updated for 2023), by Kit Fitton | LinkedIn
- Pumped hydro key to meeting storage demand (pv-magazine.com)

XV. Community Energy Resiliency Resources

- Local Generator Power Back-up: Microgrids Solutions in TX | Natural Gas Microgrids | Enchanted Rock
- Industrial Battery Power Storage: Grid Energy Storage Systems | Energy Management Systems | FlexGen
- Local Gas Storage: Gas Virtual Pipeline in Operation since 2014 to Madeira Island, Atlantic Ocean: LNG Virtual Pipeline - YouTube
- Thermal Energy Storage to Power: Pintail Power – Transforming large-scale thermal energy storage into flexible dispatchable power systems

XVI. Building Materials

- Smart Windows can be used:
  - Smart Windows for Smart Buildings | View Smart Windows
  - Smart Windows Cost - How Much for Smart Glass? - Modernize
- Transparent solar panels that can be used as windows though should not be used in your in competition submission unless they come to market. As of Feb 2023 they are not available best we know but one day... https://www.freethink.com/hard-tech/transparent-solar-panels-43983
- (Crowd: please source some more candidates for this category: windows, walls, building materials, etc)

XVII. Home Systems

- Heat Pumps: This has to get easier. Real life lessons, by Tom Gosling | LinkedIn
- (Crowd: please source some candidates for this category: Heat Pumps, Cold Weather Heat Pumps, HVAC Systems, etc.)

XVIII. Fuel Choices

- Diesel, Solar, Wind, Natural Gas, Hydrogen, etc.
- (Crowd: please source some candidates for this category: Heat Pumps, Cold Weather Heat Pumps, HVAC Systems, etc.)

XIX. Carbon Capture

- (Crowd: please source some candidates for this category)

XX. Hydrogen

- The Clean Hydrogen Ladder [Now updated to V4.1] | LinkedIn, by Michael Liebreich
- Liebreich: Separating Hype from Hydrogen – Part One: The Supply Side | BloombergNEF (bnef.com)
- Liebreich: Separating Hype from Hydrogen – Part Two: The Demand Side | BloombergNEF (bnef.com)
- ExxonMobil awards FEED for world's largest low-carbon hydrogen facility

XXI. "It's the customer, stupid."

- Jeff Bezos, the founder of Amazon, preached a relentless attention to the needs of the customer.
- 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."**

[i] Pro Tip: Get to the source. While peer review journals disqualify references to Wikipedia, sometimes it is a good place to start the search for tracking down sourced, foundational references.

ii Curator's Note: Two "pinch analysis" articles by Bodo Linnhoff in Chemical Engineering Progress in perhaps the late 1980's and early 1990s tooled me to use first principles to render or correct system energy integrations in one

swoop. The first article gave the principles and the methods. The second article was recognition of the 80/20 rule. My takeaway was, "If an absolutist approach is taken to efficiency, then in the real world there can be unintended consequences, like overly complex operations, impractical start-up sequences, and overinvestment in capital." Ironically, once I understood the first principles, I never needed to do a rigorous pinch analysis per se. For example, it is possible to "see" gross thermodynamic efficiency violations by identifying wide temperature approaches in individual heat exchangers. And in cryogenic design most simulators have the approaches built into their complex heat exchanger models. (If anyone can provide the references to those Bodo Linnhoff articles it would be appreciated.)