Realizing the Value of Energy Storage in Urban Environments

STATEMENT

Renewable energy comes in many forms and continues to decrease in price through market expansion and new technology. However, the energy usage patterns of homes and business do not often align with the capabilities and schedules for renewable energy production. Furthermore, energy distribution infrastructure is designed for peak delivery capacity, usually assuming a small number of large production facilities. This mismatch between dispersed production, supply and distribution can be solved with energy storage but technological choices are limited and there is little or no means to monetize the benefits for Customers.

CONTRIBUTING FACTORS

There is a growing interest and a need for energy storage today both to support clean energy utilization in all classifications of buildings and the adoption of clean alternative energy in transportation including on-highway off-road, rail, marine and even aviation. The majorities of technologies developed have involved electrochemical batteries and have resulted in steady increases in storage density at a lower cost. Yet, battery technology remains inadequate to provide alternatives to building and expanding conventional energy production and distribution systems, especially in dense urban environments. Urban environments are especially challenging due to the lack of physical space, old buildings and infrastructure, a high cost of doing business, a more challenging regulatory environment and a lack of sustainable private financing. In addition, energy is often priced simply and spreads variable costs over a variety of energy applications with very varied load profiles and inherent costs. However, urban environments offer technology developers and service providers the market scale needed to quickly earn a financial return if the energy system performs well and is financially effective and the benefits can be monetized and flowed through to the ultimate user and provider.

CHALLENGE

There is a lack of retail energy storage technologies that are safe and reasonably priced. The types of energy supplies readily available include:

- Electricity
  - Conventional Grid Supply from Regional Networks (e.g. NYISO)
  - Renewable Electricity (Solar, wind, wave, tidal, renewable hydrogen or bio-fueled generation)
- Thermal Energy
  - Low polluting convention fuels (natural gas, central steam, hot water and wood)
  - Renewable Fuels (renewable Hydrogen, direct use of bio-fuels)

The types of energy storage concepts include, but are not limited to the following:

- Mechanical Energy
  - Rotational (e.g. Flywheels)
  - Potential Energy (e.g. pumped storage, compression, etc.)
- Chemical and Electrochemical (Batteries, capacitors, hydrogen, liquefaction, methanation)
- Thermal Energy (Steam, hot water, chemical (e.g. Hydrogen), salts, ceramic, phase change, etc.)

The challenge is to conceptually develop a new energy storage system or effectively utilize an existing one that is safe, reliable, clean and as cost effective as possible that provides options to better manage urban energy production and infrastructure and returns benefits to the adopters of the technology over the long term.

Can these 35-ton bricks solve renewable energy's biggest problem?

https://www.fastcompany.com/90261233/can-these-35-ton-bricks-solve-renewable-energys-biggest-problem
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Fast Company

BY ADELE PETERS 3 MINUTE READ

It's already cheaper to build a new solar or wind farm than a coal plant. But when the sun isn't shining and the wind isn't blowing, renewable electricity can still be fairly expensive to store–even though the cost of batteries is dropping. If the world shifted to 100% renewable electricity right now, we might pay more on electric bills.

A new solution that uses basic physics could cut the cost of storage in half, or by as much as 80% over the total life of the system. It makes it possible for renewable power to be cheaper than fossil fuels all day, every day of the year, everywhere. "Our solution, for the first time, will enable the world to achieve this," says Robert Piconi, CEO and cofounder of Energy Vault, the startup that developed the new system. Tata Power, the giant Indian electric utility, will be the first customer.

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[Image: courtesy Energy Vault]

Energy Vault, based in California and Switzerland, took inspiration from the way that some dams store energy–hydro plants pump water uphill when energy demand is low, and then produce energy by turning turbines as the water flows back down. The system works, but only in places where dams can physically be built; dams also harm fish, force people to relocate, and can burst and flood villages.

Like dams, the new solution–a massive tower, roughly the height of a 35-story building–relies on gravity. But it doesn't require water. When a wind or solar farm makes more energy than the grid needs, an automatic crane on the battery uses the extra electricity to lift a giant brick, weighing 35 metric tons, up to the top of the tower. "When that tower's stacked, that's all potential energy," says Piconi. When the grid needs power, the crane automatically lowers a brick, using the kinetic energy to charge a generator.

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[Image: courtesy Energy Vault]

All of this happens almost immediately. "We can have a millisecond response time," he says. The system's software takes signals from the grid to automatically control the cranes, which carefully raise and lower the giant bricks while taking into account wind and weather. The cranes lower the bricks at exactly the speed needed to provide electricity continuously.

It's cheaper than building giant lithium-ion batteries, like the huge batteries that Tesla has installed in Australia and elsewhere. In part, that's because the bricks can be made from cement that would normally be wasted. "These materials we're using are actually materials that you'd have to landfill," says Piconi. In California, for example, a construction site with concrete debris has to pay as much as $55 a cubic yard to get rid of it. Unlike lithium batteries, building the system doesn't require a specialized multimillion-dollar factory; the autonomous crane comes from another manufacturer. Mining lithium also uses huge amounts of water and risks toxic leaks.

In a small town near its headquarters in Switzerland, Energy Vault built a small prototype of the device–72 feet tall, instead of the usual 393. (The system also works at a small scale, but the company is focused on the largest market, utility-scale customers; it's also less efficient and less disruptive in terms of cost at a smaller scale.) The company is now beginning to build its first units for customers around the world. It's also in talks with some customers who have been considering constructing huge new dams. "We can do that at a quarter of the cost, without the environmental problems, and have something that would deliver more on the performance side," says Piconi.

The solution can scale up quickly. "We don't need to rely on manufacturing or large investments," he says. It's a needed step as more states and countries move toward 100% renewable electricity.

ABOUT THE AUTHOR

Adele Peters is a staff writer at Fast Company who focuses on solutions to some of the world's largest problems, from climate change to homelessness. Previously, she worked with GOOD, BioLite, and the Sustainable Products and Solutions program at UC Berkeley.
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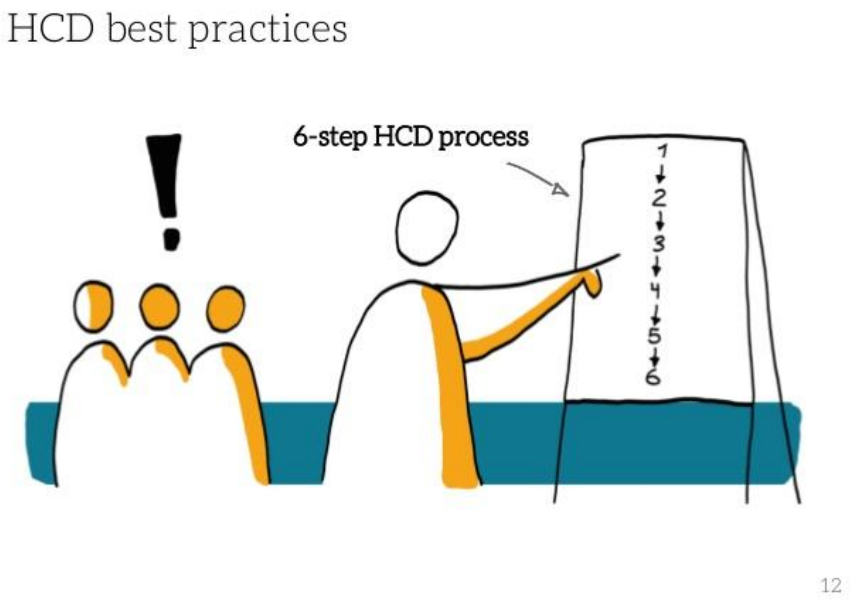
6 steps in Human Centered Design Process

- Identify
- Immerse
- Reframe
- Ideate
- Build
- Test



Identify

Goal: Defining the targeted problem space you will tackle.

Outputs: 4-5 broad questions that define the problem spaces to research.

Key Questions:

- What are the facts, assumptions, and problem space you can identify about the larger problem?
- What local organizations and mentors can you work with to help tackle this challenge?
- What are 2-3 initial How Can We's that will help focus research in your problem spaces?

Immerse

Goal: Empathize with end-users (stakeholders) and uncover insights to deeply understand your problem spaces.

Outputs: Empathetic stories of stakeholders. 2-3 key insights along with visual representation.

Key Questions:

- What are interesting facts, stories, themes and existing solutions from your secondary research that you are excited to explore further?
- Who are stakeholders within your problem spaces? Organizations? Places?
- What are 2-3 key insights along with visuals to explain those insights?

Reframe

Goal: Define the change you want to make in the world and what your solutions needs to accomplish to get there.

Outputs: 3-4 Design Goals defining desired solutions qualities.

Key Questions:

- Based off of your teams research and insights, what qualities does your solution need for it to be effective? (These are your Design Goals)
- What end results will indicate that future solutions impact your users' lives? (These are your measures of success)

Ideate

Goal: Generate a variety of ways that make change and explore many alternative solutions.

Outputs: List of 10+ different ideas. 2-4 well-considered concepts..

Key Questions:

- What are some of your wildest ideas? Safest ideas? Easy to implement ideas? Difficult to implement ideas?
- What are themes or categories that your different ideas begin to explore?
- Based on alignment with your design goals and measures of success, what 2-4 concepts are you going to build?

Build

Goal: Make a variety of tangible prototypes to communicate your ideas.

Outputs: At least 2 built prototypes of every concept you're moving forward with for user testing and feedback. A list of important questions to learn about each concept..

Key Questions:

- What are at least 2 different ways you are prototyping each concept?
- What are the simplest ways that you can prototype your concepts to quickly get user feedback?
- What are the important questions you have about each of your concepts that you need to learn as you build your prototypes?

Test

Goal: Get feedback to uncover insights and develop next steps to improve a solution.

Outputs: 4-5 user/expert quotes about your solution. 2-3 insights to inform next steps.

Key Questions:

- How are you ensuring that your tests will help you answer the important questions you have for each concept?
- What quotes and stories from users and experts stood out to you during testing?
- What insights from testing are directing further research and ideation?