
Utility
RECIPES
THE TOP TWELVE TECHNOLOGIES
TO TRACK (T6)
Utility
RECIPES
for meeting customer needs

New Modular Desalination

- New DOE-funded initiative ($21M) to reduce cost of desalination.
- Goal: A modular, scalable, portable and economical desalination system housed in a vehicle and transported to difficult to reach areas. The system could be powered via connection to a local grid, solar panels, or low-grade or solar heat.
- Specifically targeted to African, Middle-eastern countries with little infrastructure and severe drought.

https://today.oregonstate.edu/news/osu-cascades-researcher-awarded-2-million-research-turning-salt-water-drinking-water

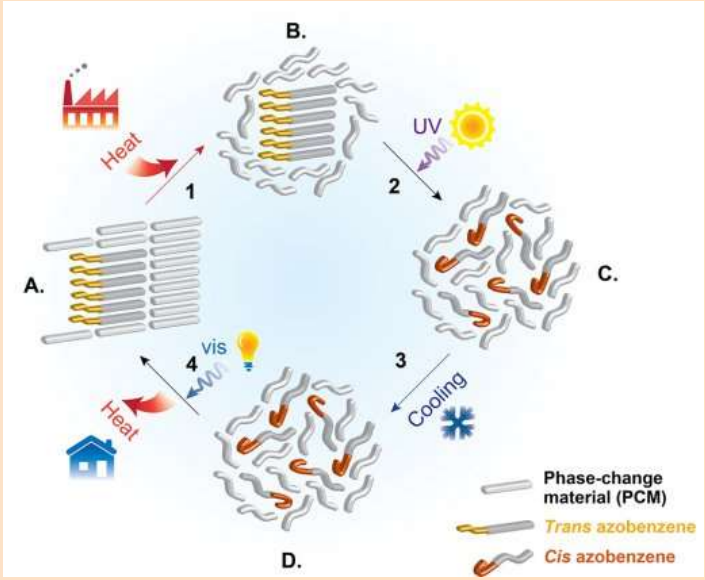
Water Supply Turbine: PGE

- Initiated in 2015, project to utilize water supply infrastructure to power a turbine in gravity-fed water pipes.
- PGE in partnership with LucidEnergy has installed turbines in Portland (*Conduit 3 Hydroelectricity Project*) with capacity of 1,100 MW/year
  - $1.7 million capital investment with ~20 year payback under PPA.
  - Must be 'neutral' energy and that limits applications to water sources that are primarily gravity fed (like Portland's Bull Run)
  - Systems also installed in Riverside CA and Johannesburg SA.
- Significant environmental benefits.

https://money.good.is/articles/portland-pipeline-water-turbine-power
https://www.citylab.com/environment/2018/01/portlands-drinking-water-is-powering-the-grid/550721

Next Generation 'Controllable' Phase Change Materials (PCM)

- More than half of all the energy used to power mechanical, chemical, and other processes is expelled into the environment as heat.
- Once melted and activated by ultraviolet light, the material stores the absorbed heat until a beam of visible light triggers solidification and heat release. Key to that control are added molecules that respond to light by changing shape from one that impedes solidification to one that permits it.
- PCMs (like wax) have thus proved a highly successful means of storing thermal energy, but getting it back out in a useful way has remained a challenge. "What we needed was a trigger that would give us control over the timing of the heat release". UV light is that trigger.



Source: MIT

- Application: De-icer/heater for EVs to reduce the battery power required. Thermal energy can be stored in a thin, transparent film as part of the glass and light would trigger a blast of heat when it's needed to melt that troublesome layer of ice.

Making water from air (and some sunlight & biomass)

- Zero Mass Water has designed a system that creates specialized solar panels that can suck water from the air even in dry areas. Water is kept clean with ozonation inside the integrated reservoir.
- A photovoltaic panel powers a fan that blows air over a desiccant that extracts water vapor. Solar thermal panels then collect heat to evaporate the water back out of the desiccant so it can be collected. No refrigerant necessary
- No pipe input. No electrical input. Up to a case of bottled water generated per day from a pair of 4x8x3.5 panels @$2000 ea. +$500 installation fee.

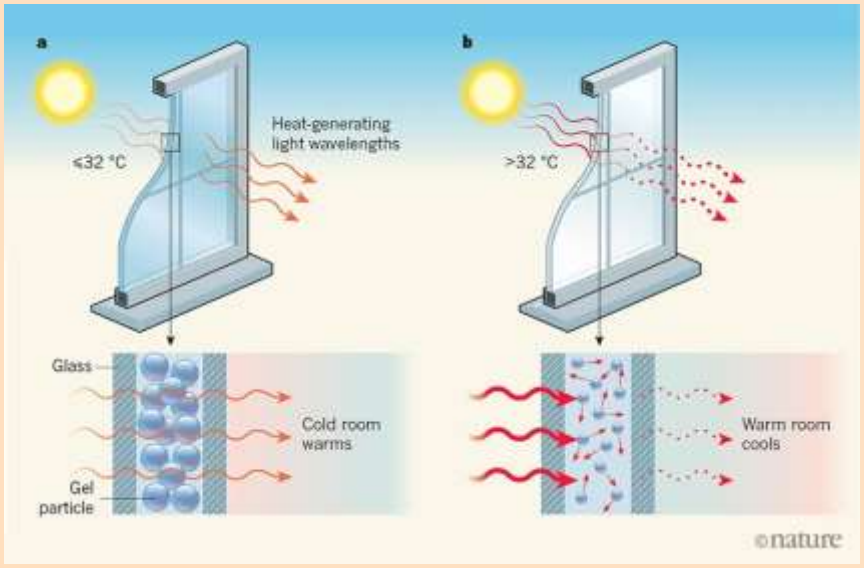
Zeromasswater.com

- A Wood-to-Energy Deployed Water System (WEDEW) creates artificial clouds inside a shipping container-sized box and then condenses them to a drinkable liquid. The system works by pulling in warmer air from outside the box and combining it with cold air inside, producing condensation.
- The system is powered by wood chips and other biomass, a renewable source of energy that has the added benefit of producing heat. The extra heat and humidity allowed the system to extract even more water from the air.
- In places where biomass isn't readily available, the WEDEW can be converted to run on solar power.
- Up to 2,000 l/day.

Islandsky.com
Forbes.com

Polymer Gel for Smart Windows

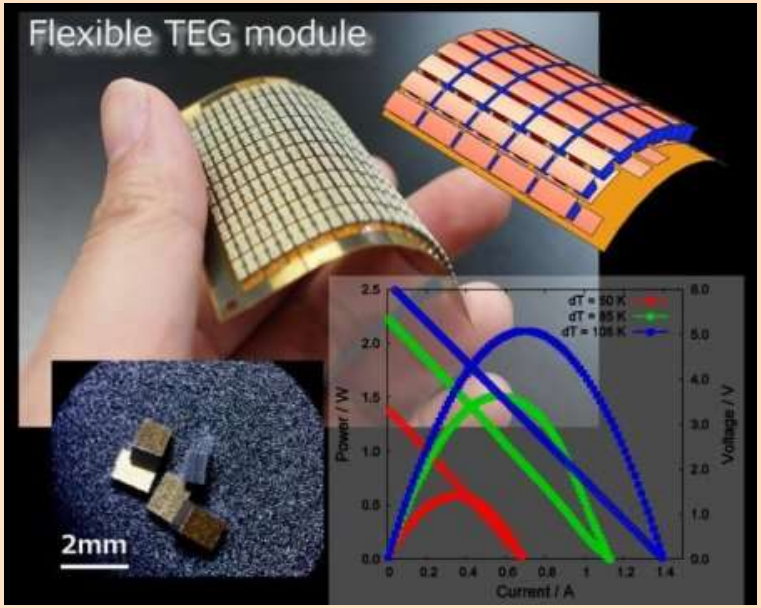
- Dynamic/smart windows emerged ~5 years ago
  - They are effective, but have several drawbacks as require the application of an electrical potential, are expensive to make, have inconsistent light-blocking are unlikely to be durable in the long term.
  - Smart polymers may replace the electrical potential. A thin layer of a concentrated solution of polymeric gel particles (microgels), trapped between two glass layers can be activated by sunlight to modulate solar gain by becoming visually opaque.
  - May be significant cost savings in manufacturer and operation.



www.nature.com/articles/d41586-019-00084-2

Thermoelectric Energy Generation from Waste Heat

- Recovering waste heat from industrial processes and HVAC equipment cost-effectively has vexed scientists and engineers for generations.
- An inexpensive large-scale ***flexible*** thermoelectric generator (FlexTEG) module with high mechanical reliability for highly efficient power is under development in Japan.
  - Thermoelectric conversion technology directly converts thermal energy to electric power, and vice versa. Since it allows for energy conversion according to temperature difference even if the difference is small, this next-generation technology will contribute to energy harvesting, a process that captures small amounts of energy that would otherwise be lost.
  - By mounting small thermoelectric (TE) semiconductor chips on a low-cost flexible substrate at high packaging density, the researchers achieved reliable and stable adhesion with electrical contacts between the chips and the flexible substrate, realizing efficient recovery (thermoelectric conversion) of waste heat.



www.sciencedaily.com/releases/2018/12/181218100416.htm

- All of the top electrodes were integrated in parallel on the chip, providing flexibility when bent in any uniaxial direction. This reduced mechanical stress on chips, improving mechanical (physical) reliability of the FlexTEG module.
- No cost information provided!

Dandelion Geothermal Retrofits

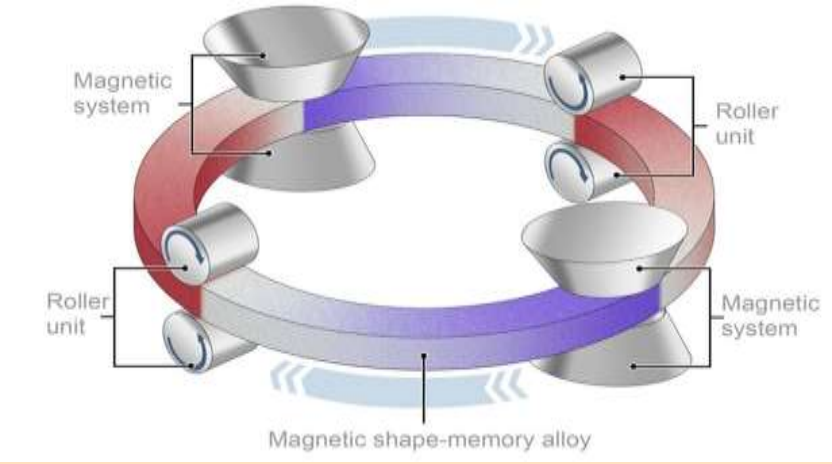
https://dandelionenergy.com

- A typical geothermal retrofit system costs between $10,000 and $40,000 to install, depending on the size of a home, the makeup of the soil in your yard and whether there is ductwork for the heat pump*.
- A New York-based startup has developed its own ground-contact geothermal heat pump, called Dandelion Air. It was built in partnership with AAON and comes in four different sizes. Dandelion is able to make and sell the pump at a fraction of the cost of what has been available on the market before, which contributes to its aggressive pricing plans.
- Dandelion will install the system under a 'performance-type' contract thus reducing the up-front cost. They also take advantage of available incentives and tax credits.
- Barrier of cost of drilling for the loops has been overcome using custom machinery that has a vibrating head that causes the soil to act more like a liquid. It makes the ground easier to cut through and also accelerates the installation of supportive casing for the ground loops. Remediation costs are also reduced.
- Dandelion is working with municipalities to install and own a widespread system of ground loop pipes. Residents would then have the option to connect their home and switch away from expensive fuel oil or propane. The mass installation would be cheaper for Dandelion and also set the company up as a sort-of energy provider for the area.
- Installations are in the 'tens' with goals for the 'hundreds' in the coming year.

*Note air-source heat pumps also are suitable for 'cold climates' (https://www.rmi.org/insight/economics-of-zero-energy-homes/).

Magnetic Cooling

- Basic refrigerator technology hasn't changed much in decades. They still chill your milk by way of chemical refrigerants and compressors; although they are significantly more efficient.
- Researchers in Europe have shown promising early results with an experimental cooling system that uses magnetic fields and shape-shifting memory alloys. Magnetic cooling systems work by exploiting the magnetocaloric effect – which basically means that certain materials will change temperature when exposed to a magnetic field.
  - The technology has been around almost as long as conventional fridges, but has never really taken off because device complexity can ruin energy efficiency. The problem is often the superconducting magnets used, which require their own electric cooling system that defeats the efficiency gains.
- A unique combination of magnets and special alloys. The magnets contain the rare-Earth metal neodymium, as well as iron and boron. The alloy is a mixture of nickel, manganese and indium. That combination is key to making the system practical. Those magnets are the strongest permanent magnets currently known, capable of generating magnetic fields 40,000 times stronger than that of the Earth. That particular alloy, meanwhile, will cool down when exposed to a magnetic field and, in addition, it can return to its original shape after being deformed.



https://newatlas.com/magnetic-cooling-shape-shifting-alloy/56379

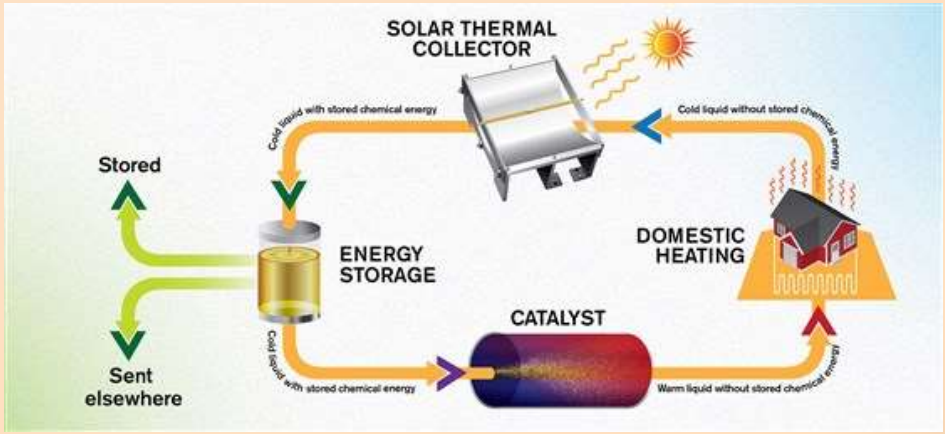
Energy Storage: The Holy Grail

- For a low carbon/renewable future, cost-effective energy storage must be a part of the equation. Several exciting developments have created excitement that we are not far away. Here is a summary:
  - **Tesla Powerwall/Powerpack**. In Australia, a series of battery units provided 129 MW of storage to the Neoen's Hornsdale Wind Farm, supplying enough power for 30,000 homes.
  - **Redox flow battery**. "Old' technology. Costs have come down and round-trip efficiency increased.
  - **Lithium ion battery**. The benchmark LCOE for grid-connected lithium-ion batteries has fallen by 35 percent, to $187 per megawatt-hour, since the first half of 2018. This precipitous decline has outpaced the continuing slide in LCOE for solar PV and onshore and offshore wind power. cost-competitive alternative to natural-gas-fired power plants across a number of key energy markets.
  - **Compressed air energy storage**. In the first project of its kind, the Bonneville Power Administration teamed with the Pacific Northwest National Laboratory and a full complement of industrial and utility partners to evaluate the technical and economic feasibility of developing compressed air energy storage (CAES) in the unique geologic setting of inland Washington and Oregon. CAES can be designed for several hours to several days of generation. Two large compressed air plants were built decades ago, one in Huntorf, Germany and the other in McIntosh, Alabama. Both are still working extremely well.
  - **Thermal energy storage**. Most common is a sensible heat system using PV that uses a liquid or solid medium. Water, sand, rocks or molten salt are either heated or cooled to store collected energy. SolarReserve's Nevada Crescent Dunes project is an example of utilizing a TES system, which uses molten salt to store 1,100 MW of power in two massive thermally shielded metal tanks, and can store that energy for 40 years (in theory) with no significant degradation.
  - **Pumped hydro**. The Australian National University (ANU) has completed an audit of 22,000 potential sites across Australia for pumped hydro energy storage, which can be used to support a secure and cheap national electricity grid with 100% renewable energy. Australia only needs a fraction of these sites to support 100% renewable.
  - **Salt/nano-coated material.** Vattenfall (Sweden) has initiated a pilot project at a plant in Germany to test the storage in salt of electricity from solar plants and wind turbines. Vattenfall's pilot program will use a technique developed by another Swedish firm, SaltX Technology (http://saltxtechnology.com/). SaltX's system uses salt crystals coated in a nano material, which can be heated up with electricity (from renewables), then release the heat (@500 ^{o}C) when they are discharged.
  - **Solar/thermal fuel**. See next slide!

Solar Energy Absorption Fluid

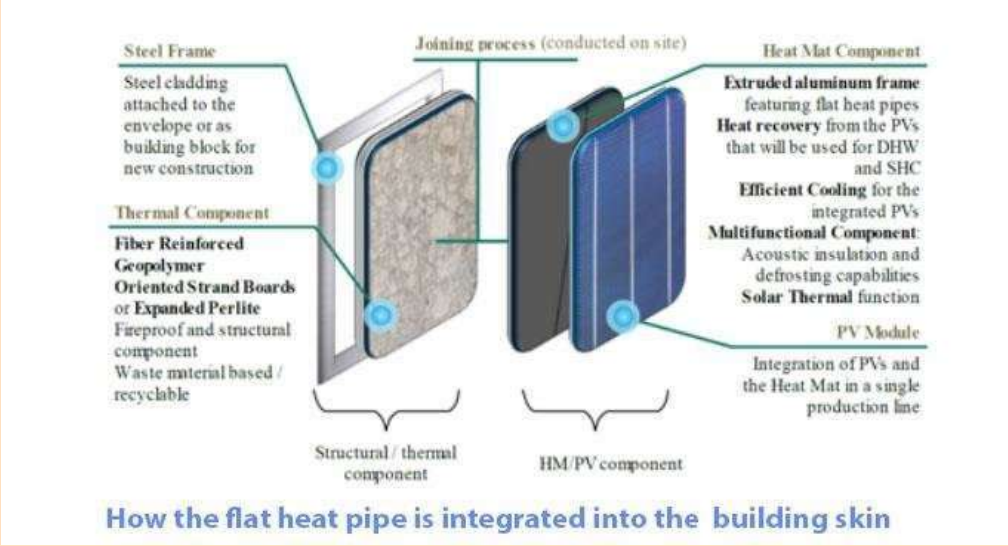
Solar Thermal Fuel

- A Swedish research team believes it found the breakthrough renewables was looking for, a solar thermal fuel that can store the sun's energy for up to 18 years.
- As an alternative to batteries, the specialized solar thermal fluid can hold the sun's energy for long periods of time and expel that energy on demand. Unlike batteries, which discharge electricity, the solar thermal fuel emits heat when activated through a catalyst. This means the fluid would be ideal for heating residential and commercial homes.
  - The fuel is composed of carbon, hydrogen and nitrogen molecules. When these molecules are hit by sunlight, some of the bonds between atoms are rearranged to form quadricyclane, a highly stable compound that traps energy when formed.
  - To release the energy, the molecule is passed through a catalyst, which rearranges the chemical bonds back to pre-rearranged state and with it releases quite a lot of heat…as much as 113F. Enough to heat a room (via a heat exchanger) to 70F. Higher heat release is possible to perhaps generate electricity.



Lego-Style Hybrid Solar Panels

- A flexible PV system that generates both heat from hot water and electricity.
  - The hybrid ‘snap-together’ solar panels combine PV cells with flat heat pipes. Heat pipes transfer unwanted heat away from surfaces and is used for hot water.
  - A surprising problem the hybrid system solves is that the more sunlight solar PV panels suck up and the hotter they get, the less efficient they are at converting energy. That means the sunnier it is, the more energy they produce, but less is converted into electricity. Heat pipes move that generated heat away from the PV panel and use it to produce the building's hot water.
- The solar panels are PV coated for the most southerly-facing aspect of the roof and are designed to **clip together** as a weather-tight roof as simply as clicking together Lego or laminate flooring.



How the flat heat pipe is integrated into the building skin

https://phys.org/news/2018-09-lego-style-solar-panels-energy-bills.html

Eco-Snap High Performance PTAC

- Window air conditioners/PTACS are generally ugly, inexpensive, inefficient, noisy, often unreliable, and difficult – if not impossible – to repair.
- NREL has been working on a solution to all these issues for the last few years. It received an R&D 100 award.
- A 2-piece high efficiency (like a ductless heat pump) system that 'snaps' together through a relatively small opening.
- Goal is availability in 'big box' stores for consumer purchase & installation.

www.hpac.com/around-web/nrels-ecosnap-ac-aims-shake-market?PK=UM_Top5&elqTrackId=394951545bb04a489ee5569de98446

Quick…Odds and Ends

Clocky Update!!!

Clocky!

- A shag rug-covered clock for people who have trouble waking up!
- When "clocky" goes off, the sleeper must locate *IT* to turn *IT* off since clocky moves to a safe hiding spot
- Smart chip allows clocky to find a new hiding place every day!

MIT Media Lab

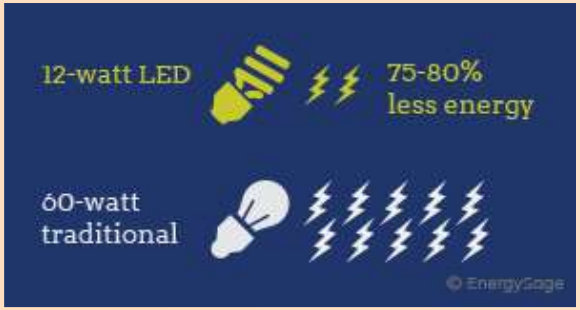
Utility Energy Forum

U.S. Department of Energy
Pacific Northwest National Laboratory

What is Wrong with this Article?

Energy efficiency 101: What is energy efficiency?

Last updated 12/13/2018



At its most basic, energy efficiency refers to a method of reducing energy consumption by using less energy to attain the same amount of useful output. For example, an energy-efficient 12-watt LED bulb uses 75-80% less energy than a 60-watt traditional bulb but provides the same level of light.

Efficient energy use has been a rising trend in the United States due to increasing energy costs and the environmental problems caused by greenhouse gas emissions. This green energy trend is evident in the products and appliances for sale to consumers, many of which become more energy-efficient from year to year. The trend also extends to homes: a growing number of prospective homeowners are starting to request energy ratings before deciding to purchase property.

https://www.energysage.com/energy-efficiency/101/what-is-ee

Before the Tesla was the 'Tango'

- Introduced in 2007; made in Spokane, WA
- 108 inches long 39 inches wide—like a tandem bike
- 0 to 60 in 4 seconds
- Originally 40-100 mile range depending upon lead-acid or lithium battery. New battery has a 300 mile range.
- Building to order (1 at a time)
- $108K - $150K ($2007)
- A total of 12 have been built with George Clooney the 1st buyer!!
- Waiting for additional capital for mass production…and it may be awhile…