Sustainable Design:

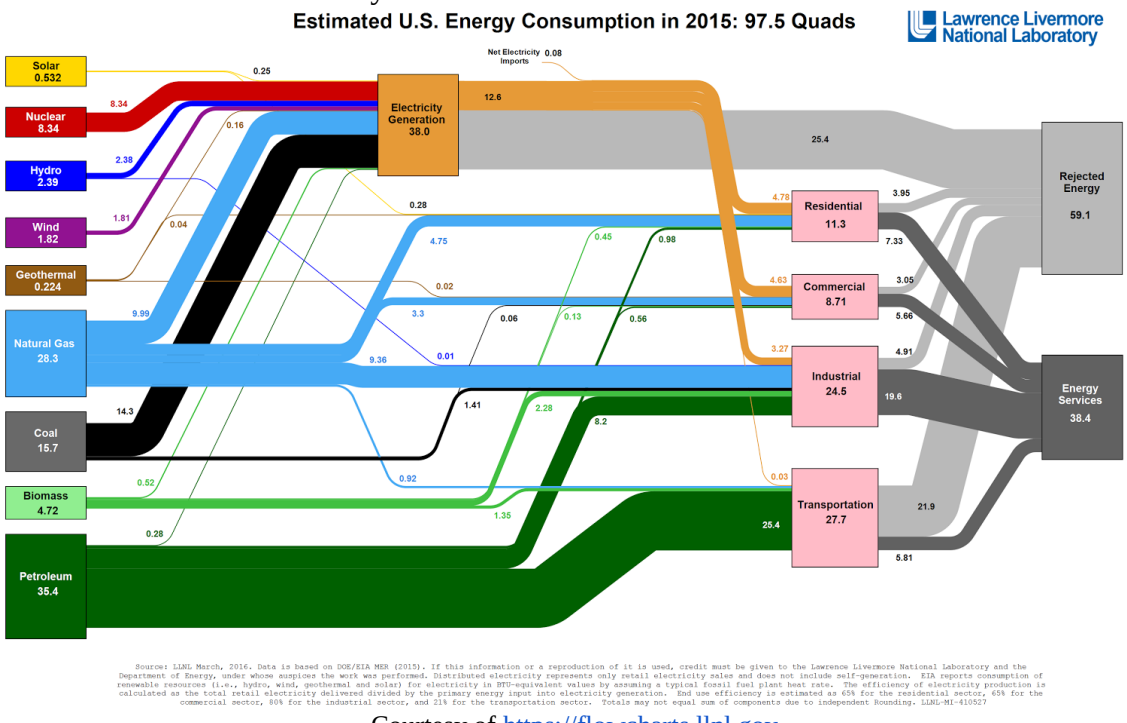
2030 marks the turning point of our planet. We've expanded past our means, and we've suffered in the wake of our own ignorance. We have taken and taken from our planet until it decided to fight back, and fight back it did. The sea has engulfed our coastlines, more and more with every passing storm, and millions of people have fled their homes that now sit below the rising tide. Thousands have died, millions have moved, and by now everyone has been effected.

But then we fixed it. We stopped polluting our atmosphere and accepted our roles as tenders and gardeners of nature, instead of being an overlord and master. We taught our children that if we respect nature, nature will respect us. We learned we can't reverse most of what damage we have done, but we can stop it from getting worse and we can start to mend it by living within our means and the means of the planet. We developed, and are continuing to develop, technological systems that celebrate the planet's changing tides, and allow us to live within dynamic nature. These systems are founded in a sustainable attitude of the relationships between man and nature. Below are some examples of these sustainable technologies that help the planet balance back out.

The pluralistic approach to living within the means of nature was divided into four parts: stopping current contributors to Global Warming, technological systems that assist us in living within the means of the new system, innovations that allow for us to leave the planet, and efforts to reverse the negative impacts of our industrialization and the years of living environmentally dangerously.

Section 1: Solving Global Warming

The national energy system looks very different in 2030 than in 2016. The flowchart below does best to describe the system as of 2015:



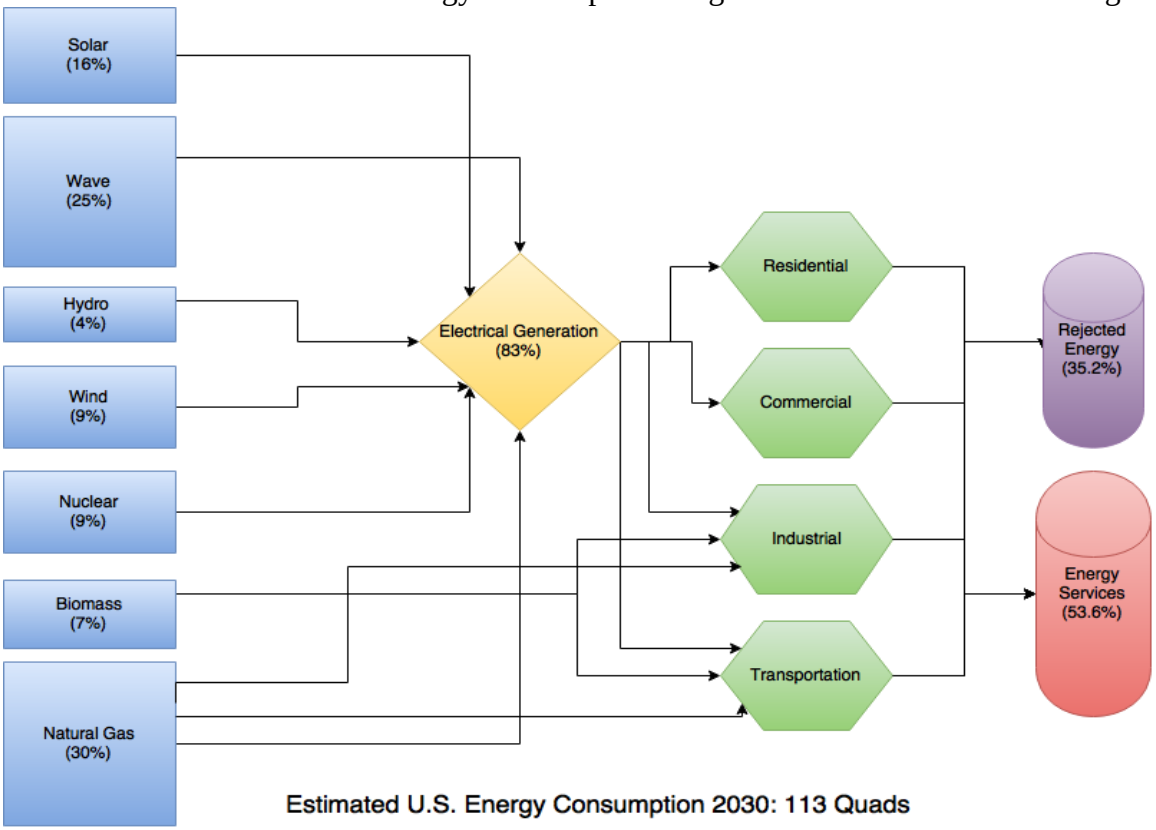
Source: LLNL March, 2016. Data is based on DOE/EIA MER (2015). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 80% for the industrial sector, and 21% for the transportation sector. Totals may not equal sum of components due to independent Rounding. LLNL-MI-410527

Courtesy of https://flowcharts.llnl.gov

Petroleum accounts for 35.4% of the national energy produced and coal accounts for 15.7%. In 2030, both of these sources (~50.1%) of energy are negligible and account for less than 1% of the total energy production. In their stead are a combination of alternative energy sources, specifically wave energy collection systems (now 25%) and the expansion of solar (16%), wind (9%), biomass (7%), and nuclear (9%). The cost barrier of entry in the solar industry was dramatically reduced over the 15 years with the advent of better photovoltaic technology. The safety procedures for nuclear power plants are more precise and thus the margin of error for failure is miniscule; making nuclear an appealing option. The usage percentage remained relatively constant over the 15 year change. Transportation changed from being driven largely by petroleum products (2015) to electricity generated by renewable sources (2030). Also, the total percentage of rejected energy dropped from 59.1% to 35.2% which was a byproduct of using efficient power sources and more efficient power grids that developed.

Wave power rose in popularity as the tariffs on non-renewable energy increased. Seatricity Ltd. (a London based company) produced *Oceanus II*, one of the first high-efficiency point absorber buoys (in which the rise and fall of swells drive hydraulic pumps and generate electricity) in 2023 and became the industry standard worldwide. Environmentalist groups in the UK protested the expansion of Seatricity Ltd.'s *WaveHUB* site until a 2024 study concluded that buoy generators have minimal impact of fish, marine mammals, and low-flying birds.

Below is a modified U.S. Energy Consumption Diagram that illustrates these changes:



Estimated U.S. Energy Consumption 2030: 113 Quads

Source: www.crawfishenergystudies.com
Courtesy of www.draw.io for Diagram Software

Section 2: Systems That Mediate New Relationship with Planet

In the wake of Hurricane Drumpf and other similar superstorms, countries around the world, especially the United States, began to realize that climate change had become a pressing matter in everyday lives. Thus, to quickly spur each country into action, their respective governments began a series of policy changes to combat the effects of the rising tide. The first of these changes was the mandatory implementation of Next Generation Science Standards (NGSS) in schools for grades K-12 across the United States. This program worked to introduce students to the relationship between people and nature in the form of the weather, renewable energies, biodiversity, and much more. This program had already been in effect in ten states in 2016, but the new education reform policies sped up the process of state uptake. The goal of better education was to prepare the children for the task of combatting global warming once they grew up. The next policy change occurred around the world with each country opting to declare a large portion of their beaches as national parks. While this decision was met with much outrage by beach-goers, we can now see the importance of that decision in allowing the shorelines to change naturally in the wake of storms and further rising sea levels. Ten years after the President of the United States declared the New Jersey shore a national park, geologists and environmental scientists were happy to find that the wetlands had started to reform and the shoreline had eroded slightly which indicated that Long Beach Island had begun the process of rebuilding its dunes and maintaining its status as a barrier island. Just last year, the army corp of engineers declared that the natural beach replenishment had been effective and began plans to open up some of the shore to visitors once more. They plan to open five miles of the Jersey shore for day visits in a matter of months. While many are still upset at the loss of their ability to spend weeks at houses they owned along what is now the Jersey Shore National Park, most people are just happy about the renewed availability to spend time at the beach. For people located in areas that are further than a day trip to the shore, there are seasonal water parks open in many areas around the world that work just as well. By 2020, around the world, parks began to crop up that made use of rainwater collection and frequent flooding from storms and sea level rising. Many of them were modeled off of the Qunli Stormwater Park that was built in Haerbin, Heilongjiang, China in 2010. These parks were more nature oriented and had floating walkways that would allow patrons to continue to enjoy the park even after the water had risen. Other parks were modeled off of the Waterplein Benthemplein in Rotterdam, Netherlands which took a more urban approach to excess water. This park had three basins that would collect runoff water from buildings and streets during heavy rainfall and then allow them to drain again after the storm had passed. Thus, during the rain, the park was home to three ponds. However, when it is not raining, the basins served other purposes including basketball courts, a small stage, and otherwise places to sit and enjoy the day.

The combination of policy changes, proved extremely important in our current success in combatting rising sea levels. While it is true that we had to move inland and sacrifice constant access to beaches and beachfront property, we all agree that the new wetlands and natural barrier islands have made a noticeable difference in protecting us from the brunt of hurricanes and other large storms.

Section 3: Technological Innovation That Allows Us to Go to Mars

Mars seems so far away and physically it is, but conceptually, we are already there. It may seem quite childish and irresponsible to just leave this earth but it might be the break we

need. The Earth cannot sustain us, at least not all of us, and that is why the colonization of Mars is crucial. Today is the day we pass a milestone, sustaining the only interplanetary civilization ever to be developed. Using the information we acquired back in 2016 was nice but the leaps and bounds we have come from that is “out of this world”

The first of the astronauts laded on Mars with little to no problems. The development team has some major breakthroughs with the long term survival of humans on Mars. The sustainability of these developments is what makes them a huge benefit to the human race. The living quarters on Mars have gone through many design plans and, due to the harsh weather of Mars, are usually placed underground. This also allows the engineers to access the water that is stored under the surface. The technology for this feat is similar to fracking but a little different; the CO_2 from Mars’ atmosphere is condensed, heated and pressurized and finally pumped down into subsurface ice to melt it and push water back up to the surface. This process is called Marking, in reference to Mars-fracking.

The next major development was an advancement of our thinking along with our technology. The living quarters us Martians have built in 3D printing models allowed us use certain materials that are beneficial to our sustainability mission. This development allows for reuse of previously deemed unrecyclable material on Mars or Earth. This doesn’t seem like much but, coupled with the consistent care packages that are sent to the Mars, citizens there seem to gather a large amount of unusable plastics in the packaging that is use in the space travel of perishables resources. The engineers designed a method of melting down the unusable material to the point of extreme deformation through extreme heat and pressure. The shapeless material is then stored in a 3D printer model that could be used to make useful tools and structures for space survival. This breakthrough of technology is designed to be helpful and resourceful without leaving any scraps or trash.

Along with the breakthrough in 3D printing, there have been large breakthroughs in the cultivation of agriculture on Mars. The soil on Mars is very unforgiving but has the potential to be quite useful to us. The use of the local rock as a growing medium by adding sufficient minerals and additives was the first step to producing food on Mars. However, by adding a small amount of heat along with a large amount of pressure, the minerals in the Martian soil form a stronger bond with the additives and produce a much higher yield of crops. This discovery enabled food production in a large controlled area called a Biosphere. This structure controls the climate and humidity to allow the plants to grow in the most optimal conditions.

The next major advancement of NASA is the physical path to get there: advanced propulsion systems. Six months is the current optimal time for space travel to Mars. The vehicles we use to get there are much different from old space shuttles, with a new and improved ion propulsion system that allowed for quicker and smoother space travel. This worked with and against our mission, making it easier and quicker to get to Mars but making the trajectory much more difficult to project. We want a six month travel time to harness as much gravitational forces as possible to conserve fuel.

Section 4: Reversal of Negative Impact Due to Industrialization

In June 2025, the Crawford Foundation began efforts to superfeed phytoplankton to increase the size of the carbon sink in our oceans. The EPA determined this approach acceptable after a 7 year study analyzing the effects of increased plankton population in the world oceans, specifically the Southern Ocean. As of 2025, phytoplankton absorbed a quarter of the total CO2

released by man; this number is up to 65% by April 2028 and 83% by 2030. The phytoplankton convert CO2 into sugars which they use as energy and tissue. To fertilize these blooms, the Crawford Foundation pumps iron and nutrient-rich water over the plankton. Iron is often the limiting factor in plankton population growth, and therefore the blooms grow to upwards of 80% larger after artificial feeding. The plankton actually also produce a chemical called dimethylsulfide (DMS) which promotes cloud formation directly above the blooms. Much like our cloudbusting solution option, these clouds cool the Earth by reflecting sunlight off the planet. As to be expected, this bio-technology solution was met with hostility by the more adamant environmentalist groups, but the extent of EPA study proved enough to quieten the environmentalists.

Another technological system we implemented in an effort to decrease the negative impacts of industrialization is the restructuring of our cattle feed-system. In 2009, a study in Bangor University measured the methane produced by cattle in specially designed polytunnels. With the data from these polytunnels, the study determined 30% of the harmful methane gases produced by cattle can be eliminated with a change of diet that focuses on huskless oats and garlic. This diet in turn is proven to increase milk production and meat yield. By the time of the President's plan, research succeeded in proving the change in diet has little to no effect on the taste of the meat, and so the President suggests the change of diet to farmers. Much of the rest of the socio-technical cattle-feed system has remained unchanged, and so we have not included a diagram of the system.

Conclusion

Although this future has its obstacles, we still have found a way to cope and thrive within our newfound limitations. No one today in 2030 looks back with fondness to wastefulness and ignorance of 2016, or idealizes the “good ol’ days” of seemingly unlimited resources. Environmental responsibility has a cost, but it is a cost we must pay to ensure the stability of our future. We all make choices, but in the end, our choices make us.