Hello… uh, I'm Cooper, as you now know. Um, I'm a senior Mechanical Engineering student with a minor in Innovation, and obviously a Grand Challenge Scholar, and today, I'm going to talk to you about energy. Uh, before I do, um I'm gonna talk about my story and kind of how I got here, and how I got into engineering. So, um, in high school, I felt a little bit like, uh, Michael Scott, from "The Office" in the sense that I knew what I wanted to do, but really, I had no idea what to do. So, um, I knew I liked Physics, and I went and talked to my high school physics professor – teacher – and asked him, "what should I study?" And he said, "well, you can study physics." Ok. Fair enough. "But how would I do something more 'hands-on'?" So, he was like, "well, can do, uh, mechanical engineering." And I was like, "ok, works for me, I'll do that." So, for the next four years I decided to study mechanical engineering, um, but, before… Or no… so that's what got me into UP. And then, freshman year at UP is when I really focused in on renewable energy, so and then I said "okay, this is what I want to do – I'm gonna go make renewables and what-not…" So, um, that leads us to today, um, with energy independence. That's what I'm gonna talk about – is energy dependence and diversity - which - energy and diversity, I mean, which kinda go hand-in-hand. And so, what energy independence is, is basically when a country, or a city, or a building, or even a person is, um, able to produce all the energy that they use. Um, so there's a few advantages to this. One of them is, um, that it eliminates the financial incentive to support aggression, and what do I mean by this? Well, as most of us know, there is a big conflict going on in Russia and Ukraine right now. And the EU has sanctioned Russia, but, um… um, but a lot of the EU is also dependent on Russian gas, so. Like, Germany, for example, is really dependent on gas. So, it kind of presents a dilemma in that it puts power in the hands of the aggressor. So, for example, on April 1st Vladimir Putin signed a decree, uh, forcing all foreign purchasers of Russian gas to, um, pay only rubles which raises the value of the currency, the Russian currency, um, which kind of goes against the whole point of sanctions in the first place. So, um, illuminating, er, increasing, uh, energy independence kind of removes the strongarm to support, you know, <inaudible>. And so, keeping it on the topic of Europe, um, when I studied abroad in Austria, I noticed a lot of wind turbines, er <inaudible> solar panels on the rooves of houses. Um, and I asked an engineering friend of mine, "why is there so many of these on the house <inaudible>, there're so many!" And, apparently, there's a financial incentive to do so. So, in Germany, if you a solar panel on the roof, you can get a 4-times the rate to produce energy, the rate that is paid to, um, coal power plants in Germany. And part of that is because we are really starting to shift into greener energies, and so if you create your own green energy, then, that works for them. Um, so, the current model of our energy grid is where a bunch of energy is produced in a central location, whether it's the dams, or wind turbine field, or a nuclear plant, whatever. It is generated in one place and then sent to houses and buildings, and whatnot. But what if we can replace that sort of structure with hamster power – no I'm just kidding. Um, but if we could supplement, sort of, the large-scale industrial power generation with local power generation – so whether that'd be solar panels on your rooves, for example – then, it would remove us from the, kind of, ebbs and flows of energy prices, and we would also need to, you know, individually buy less energy, 'cause we're creating it. And, it would lower the strain on industrial, large-scale power plants. And so, and also, um, as a little added bonus is that if you create local energy, um , it would somewhat mitigate the, um, energy storage problems that we're running into today. If we just generate it locally and use it. So, over the summer, um, I interned for a engineering non-profit called Burn Design Lab, and what they do, is they make, um, energy efficient stoves, with, in partnership with co-ops from developing nations – primarily in sub-Saharan Africa. This was one of their stoves. This is a picture from their website. Um, and one of the things that became really apparent to me really quickly was, um, that energy usage and efficiency is a daily consideration in these co-ops and villages. Because

most of the time, at least in the places where we work with, um, they have no – they're off the grid – they have no central power plant that delivers their energy. So everything they do industrially needs to be powered on site. So, the common way they did that was a solar panel on the roof. But what I found more interesting – and I couldn't find a picture – but some of the machines that had direct access to sunlight were actually, powered themselves with a solar panel on the machine itself. So, completely self-sufficient in… regarding no exterior sorts of energy. And this small-scale energy generation can fill a big role here, like if we had, like if you imagine every building, or every machine even, being able to power itself? Then, that would be, in theory, a really stable model of our electricity grid. If one, um, energy source were to fail for some reason, then it would be no big deal, <inaudible>, more self-sufficient. Um, so I don't talk a lot about solar panels on rooves, but there's a lot of other methods of small-scale energy generation. So, for example, this is my favorite, kite energy. It's basically where you have two kites that are attached to, uh, via tether to a generator and they constantly alternate like this. They have little robots that control the angle of the kites, and so one rises while the other falls. That coils in and coils a, you know, a tether attached to a generator. And there're some advantages to this. Like, the first one is these things can reach a lot higher than wind turbines can, and as a general rule of thumb, the higher you go, the faster the wind is, and you get more energy from that. Another one is that with a wind turbine you have to… part of the struggle is that the bigger you make them, and uh – so you want them to be bigger because you want the higher wind speed up high above, and the bigger you make it the more you have to support the force against the bending moment that the wind induces on the wind turbine. And so that's expensive and hard to do, but with these, the main stresses are mostly in the tether itself, so if something's going to break, it'll be the tether, which is relatively cheap compared to a wind turbine structure. And then you can go find it on the ground somewhere and re-set it up. Um, also these are portable – you can fit these on the bed of a truck – I wish I had a real picture on here, but I don't – we can look it up. Um, we fit these on the bed of a truck and deliver them basically anywhere and set them up in like less than a day, so it could be a viable option for disaster relief situations. Um, and the next one is actually the topic of my capstone project which is called an 'oscillating water column.' And the way this works is you have a chamber somewhere on the ocean and the wave fills this chamber with water, and so the air inside the chamber exits through a hole, which is usually in the top, and then as the wave falls down, that empties the chamber and creates a vacuum that sucks the air back in. And you put a generator where that hole is, then you get power. And there's actually a really complicated equation that we use <inaudible> so bear with me – here it is. But this is our capstone actually. These are our CAD files. And, so the end goal would be to put our turbine on a buoy of sorts and make it float in the ocean. There's a lot of application for this. So, for example, weather beacons, GPS beacons, um, cautionary buoys all use power. And, if you can generate that power locally – if you can generate some power and be energy independent, then you don't need to be hooked up to the grid and it's a lot cheaper <inaudible> to do that. Um, but, yeah, so there's a lot of other applications. This concept can be applied to basically anything. If you imagine a world where every machine can power itself, that'd be great, but obviously not very feasible to attach, you know, solar panels to every bit of machinery we have. Um, that said, I think, the main point I want to make, is that there's a place in this world for small-scale energy, and I think it's important to, um, continue the research and development of small-scale energy, and if possible renewable energy more specifically, and then, yeah, that's pretty much it. Thank you very much.