Humans have benefited from the energy of the sun ever since the dawn of civilization. From hunter gatherers that used it to see their pray, select their berries and keep their bodies warm, to farmers who converted it into wheat, maize and rice that fuelled the biggest civilizations of all time. Sunlight has influenced humans in apparently subtle but crucial ways, from killing bacteria and drying our food to fuelling the winds that allowed us to sail the world and propelled us to the modern era. But the sun gives out so much more than we will ever gather, that is why we never cease to invent and devise new methods to harvest its energy in ever more efficient ways. And one of the most efficient ways we have found to harvest the sun’s energy is through Photovoltaics.

Photovoltaic technologies pose a new and interesting way to harvest the energy that has been lighting our way since the dawn of humanity. An almost magical technology that immediately converts the sun’s light into the electricity that powers practically everything we need to thrive as a society. This simplicity and effectiveness are probably one of the main reasons why solar power is one of the most promising renewable technologies nowadays. But before we dive into the world of photovoltaics I would like to introduce the field of “solar energy” with a much wider scope than usual.

1.1 Why Solar?

If we stop to think about it, in our biosphere, there is actually very little that is not at all related to the sun’s energy. From oceanic currents and algae blooms, to the washing down of mountains and the growth of the densest forests, most of the energy that we use as living beings comes directly or indirectly from the sun.

We could argue that one of the most important steps for life in this planet has been to master the art of capturing the sun’s energy. Our little friends, the cyanobacteria, discovered how to harvest its enormous power (probably by mistake) over 2.3 billion years ago, and even though we might have gotten a little rustier after that, that discovery radically changed the energy landscape for life on earth. No longer did we depend on chemical gradients or simple redox reactions to obtain energy, we tabbed a much bigger energy source. That led to a rapid growth in the variety, size and amount of species, which the earth had never seen before and that it would never see again.

Sadly, humans do not share common ancestors with photosynthetic species, so we had to go through other routes to gather the sun’s energy. At first, we gathered its energy through wild plants, that grew fruits which we ate, and by oxidizing their sugars we obtained chemical energy to survive. A few million years later, we took a small leap into a more concentrated source of solar energy: Animals. Which we could eat to extract all the solar energy they had harvested for years from either other animals or plants.

Probably one of the most important leaps of humankind was to realize that we could, systematically, extract the power of the sun in a much more efficient way if we planted certain crops on a land field. That led to the agricultural revolution and can be considered the first time humans harvested solar energy intentionally on a large scale. Besides, with this extra energy we harvested we could feed animals to perform all sorts of different tasks that were too energy demanding for humans alone. Some centuries later, we began harvesting solar energy in the form of wind. Even though we did not know it was powered by the sun at the time, we started using wind as an energy source for a variety of applications, from pumping water or grinding grain to sailing through the oceans. That form of energy harvesting propelled humanity to a whole new stage, globalization. Simultaneously, we started extracting the solar energy that powered rivers, and creeks by using watermills that moved our seesaws to build even bigger ships and our grain mills to produce even more food.

That is until we discovered the biggest solar energy reserve we could ever imagine to unveil, Coal. Once again, we had rediscovered the easiest and most efficient way to harvest solar energy, plants. The only difference was that the energy harvesting had already been occurring in the past, for millions of years (citation needed) and it ended up being beautifully concentrated for ourselves to enjoy. It seemed almost too good to be true, an energy source which we did not need to maintain, or wait for it to collect, and that could be directly fed into our furnaces and our steam locomotives to travel the world faster than ever before, manufacture goods with better quality than ever before all the while keeping us warm in the winter. Could this get any better? Well, we know it could because around one hundred years later gas and oil came along, and in that moment, we just exploded as a society.

These ancient solar power reserves fuelled, and keep fuelling up to this day, an unprecedented economic and human growth. From the beginning of the industrial revolution we have experienced an incredible 700% increase in world population (citation needed), and even though the growth rate is slowing down there are 35 million humans more every year. But of course, good things do not last forever, and we, scientists, are usually the first to come ruin the party. I guess that is part of our job after all. We discovered that fossil fuels caused severe health problems, environmental pollution, acid rain, water contamination, land degradation, ocean acidification and the most feared of them all, Climate Change. (Citation needed for each and every effect)

Climate change is not something new, at least not for the earth we stand on. The climate has been changing for as long as there has been a climate, from the atmosphere suddenly turning into an extremely oxidizing environment to full on snowball earth where the snow covered an important percentage of the world threatening to freeze everything to death. However, the difference, between those climate changes and our Climate Change, is that the term suddenly is usually used in geological terms, where it generally means something happened over millions of years. However, when we say nowadays that the climate is changing suddenly, we mean it is changing over the curse of decades or centuries at most. We have a 3-4 order of magnitude difference to overcome. This does not mean that the earth has not experienced radical and instantaneous climate changes, it has. But the dinosaurs were not happy with the change, so we humans, might not end up being happy with ours either.

I like to think that humans, overall, are clever enough to avoid self-extinction. The only thing we need is to, once again, change the way in which we extract energy from the sun, or find a completely alternative source altogether. Of course, we are already working on it. We have devised plenty of mechanisms to extract the power of the sun. We have built wind power turbines, hydroelectric power stations, biomass incineration facilities. We have also invented completely new ways of producing energy, like extracting the heat of the earth’s interior with geothermal power plants. Or extract the rotational energy from the Moon with Tidal power generation. We even discovered how to extract energy from dead stars. Bombarding the ultra-heavy atoms that were formed when they died billions of years ago (we could say it is one of the most bizarre ways to extract power from the sun, even if it is not our own sun). We are not quite there yet, but we are also fiddling with the possibility of creating our own sun by using nuclear fusion.

While all these energy generation methods are really interesting, they come with certain disadvantages. All of them involve moving parts, except in very specific scenarios. Nuclear Fission Power plants produce radioactive waste that has to be managed safely and buried for thousands of years. Hydropower plants have a huge impact on the ecosystem and massive construction costs, as well as huge CO2 emissions while being constructed because of the extensive use of concrete, problem which they share with Nuclear Fission Power plants. Biomass also emits a significant amount of CO2, because it is basically burning organic matter. You see where I’m going with this, they all have certain drawbacks to a certain extent. And most of them are, in one way or another, extracting power from the sun.

But, maybe, the simplest way to extract energy from the sun could be to directly convert what we receive from it, light, into what we use to power our society, electricity. And trying to do so in the most efficient and direct method we can, without intermediate steps or complicated systems. Finally, we arrive at what we usually refer to as “solar energy”, or the part of it which is within the scope of this work: Photovoltaics.

Falta introduir mes dades, i alguna taula o esquema?

Falta dir que totes están be, es a dir que no tenim perque barallarnos sino que totes les renovables unides poden salvar el mon, pero es necesita que totes i cada una d’elles sigui lo més eficient posible.

1.2 Photovoltaics

Photovoltaics consists basically in the conversion of light power into electrical power. This phenomenon occurs thanks to the photoelectric effect, where a photon is absorbed within a semiconducting material and the energy of the photon is transferred into an electron which is promoted to an excited state. This electron starts moving along the semiconducting material leaving a positively charged atom behind. The valence electrons from neighbouring atoms can transfer to the positively charged atom. This “effective movement” of the positive charge is treated as a positive quasi-particle called hole. Depending on the nature of the semiconducting material the electron and the hole will be tightly bound together or almost completely independent. If left alone these electrons and holes will eventually find each other and the electron will fill the empty valence state in the positively charged atom, a process we usually refer to as recombination. In order to extract the energy of the electron hole pair we need to prevent recombination within the semiconductor. If we manage to concentrate all the electrons on one region of space and all the holes on another we can extract the charges by connecting one electrical conductor to each region and placing a load in between the conductors. In this way the recombination will occur somewhere within our load and we will be able to extract the light power in the form of electricity.