THE GREY GOLD

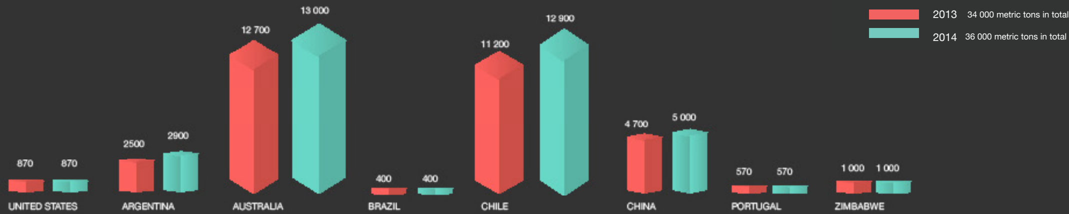
Salar de Uyuni in Bolivia is the world's largest salt flat. The salar which is Spanish for "salt lake", belongs to the Altiplano of the high Andes, the world's second-largest plateau. It is situated on an average elevation of 3,700 meters and has a surface area of approximately 10,000 square kilometers. Under the honeycombed crust of the salt flats lies more then 70 % of the world's **lithium** or roughly **9 milion tons** out of 11 tons in total

It is estimated that around 160,000 tons of lithium carbonate are produced each year from 'salt farms' all over the world.
Among the world's top lithium producer are **Australia-as a leader**, followed by Chile, Argentina, China, Zimbabwe, Portugal,Brazil and the United States.

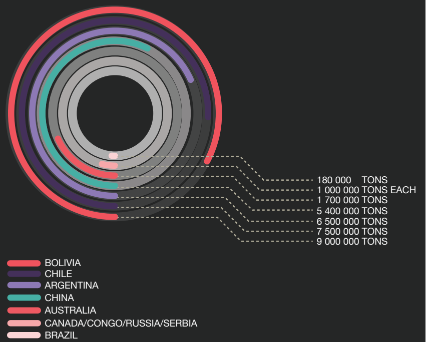
However the biggest reservers and potential for this precious metal are situatued in the so-called **lithium triangle**, comprised of **Chile, Argentina and Bolivia**. It is in these regions that the lithium it's produced from brine which is below the surface of the salt flats. In the other countries, lithium is extracted from traditional hard-rock mines with the exeption of the U.S which also uses the brine evaporation method.
Even though **Bolivia** holds the **biggest reserves of lithium on Earth**, it is the neighbouring Chile that is a leader of its production in the region. The reason for this is that **Chile** has a more developed strategy for its production, being open to **transnational** companies which have been benefiting from its reserves for over a decade.

Top countries of lithium production

Yearly production of lithium in metric tons

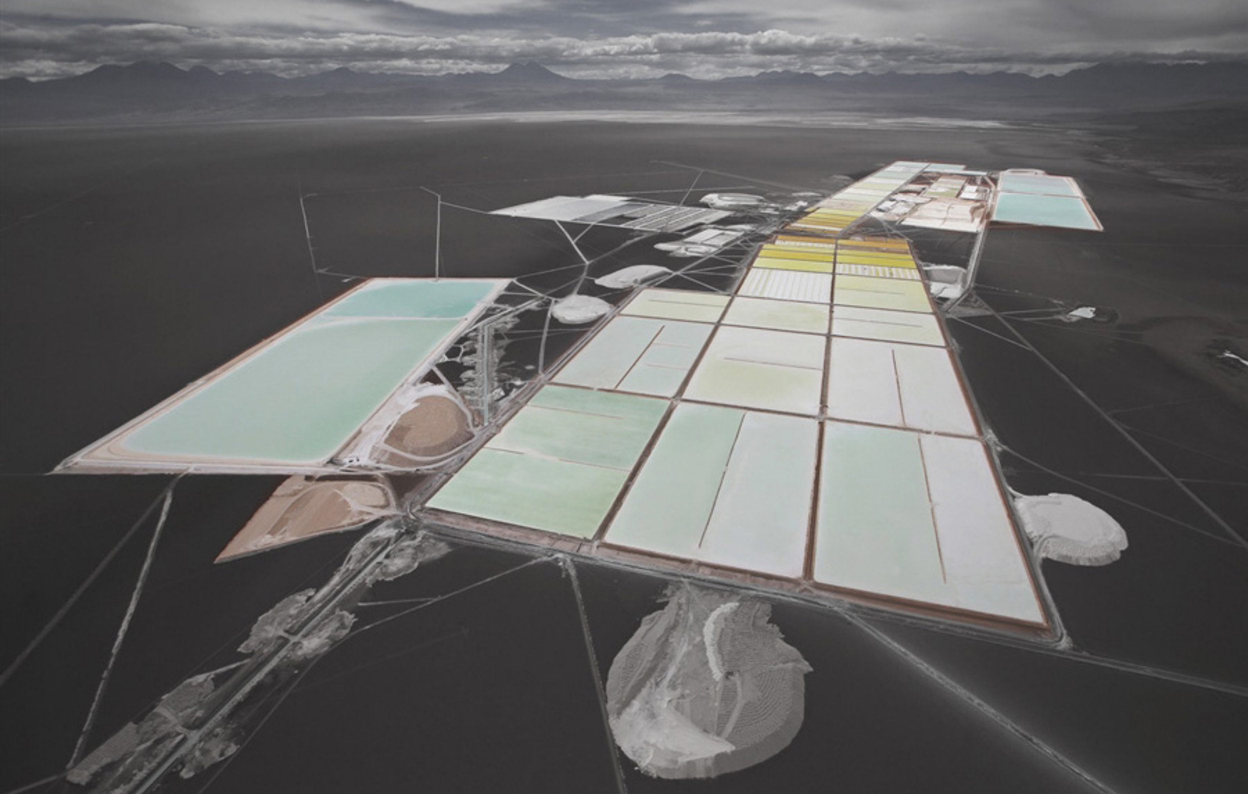


world resources of lithium

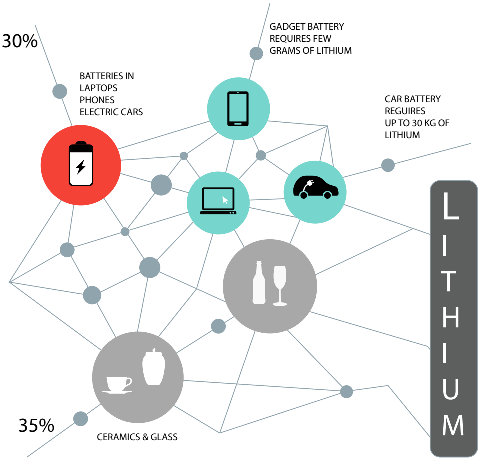


Even though Boliva is estimated to hold 9 milion tons of lihtium reserves, the US Geology survey says that roughly 5.4 milion can be extracted due to the high altitude and dificulty of accesing the material

Salar de Atacama in Chile is the equivalent of Salar de Uyuni, but due to the more arid climate, with almost no rain during the year, the concentration of lithium here is bigger
The lithium produced in Chile is then being shipped to **China, South Korea and Germany**, where its being mostly used for the electronics industry. However the usage of lithium is diverse and accounts for many different products.
Salar de Uyuni in Bolivia on the other hand has a different approach when it comes to the lithium production. The goverment has insisted on the nationalization of the resource, not allowing the international companies to overtake the market. In fact the former vice-minister of mining, Pedro Mariobo Moreno called for the state monopoly over the riches of Salar de Uyuni in order



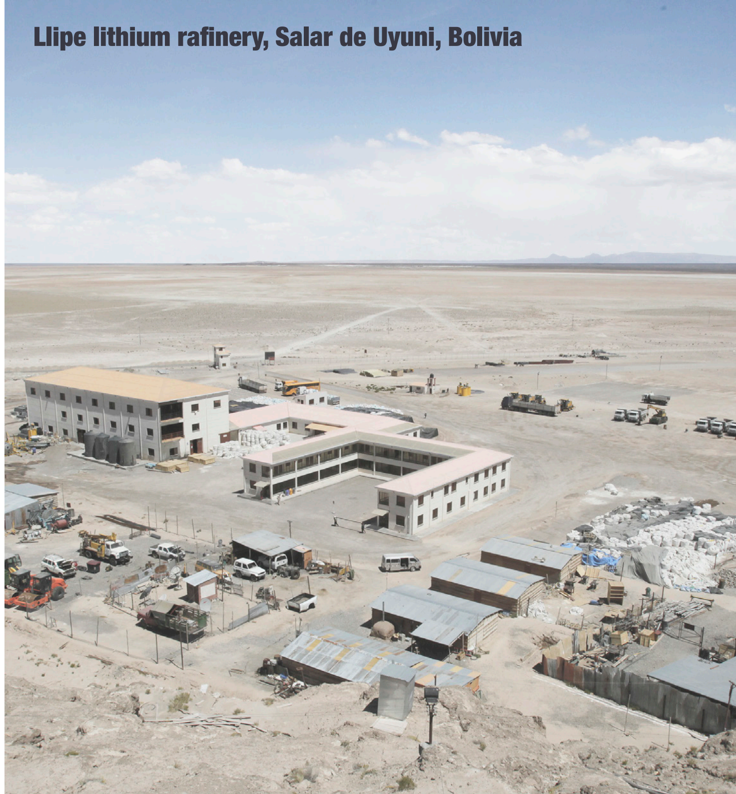
Two dominant uses of lithium



to avoid the third massive sacking of the natural resources of Bolivia, after silver and tin.In this regard the Bolivian government in 2010 decided to start up a piolot lithium refinery just on the edge of the Salar flat in Uyuni. Marcelo Castro, who is the directing the construction of this plant, sees it as an opportunity for Bolivia to recuperate its self-respect. The rafinery itself occupies 14,000 square meters of evaporation pools and Castro hopes for a further development which eventually will produce 20,000 metric tons of lithium carbonate per year.

"Our great grandchildren are going to be the ones that will really begin to enjoy the full benefits, because arguably, the quantity of lithium that we have has to make us into one of the biggest producers"

Marcelo Castro



Llipe lithium rafinery, Salar de Uyuni, Bolivia

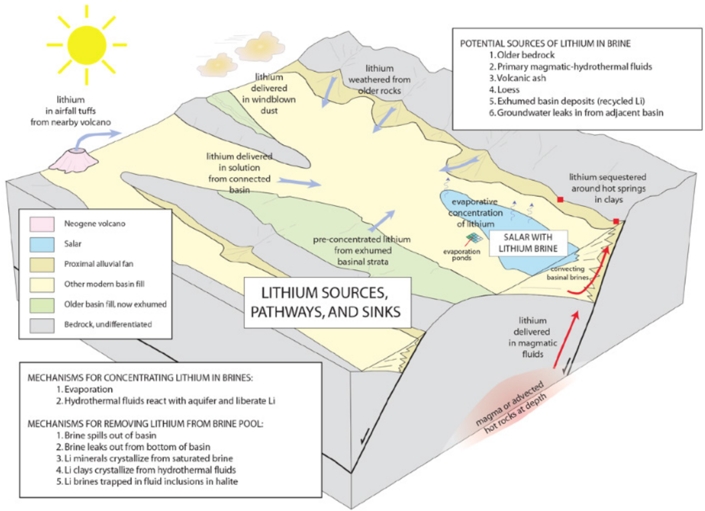
The rafinery complex at Uyuni covers 400 square kilometers of pools, more precicely 80 brine pools, which as the Bolivian experts estimate will be enough to sustain themselves for a century. The extraordinary patchwork of colours which we see here is due to the various concentrations of lithium within the pools.


Llipe lithium rafinery, Salar de Uyuni, Bolivia

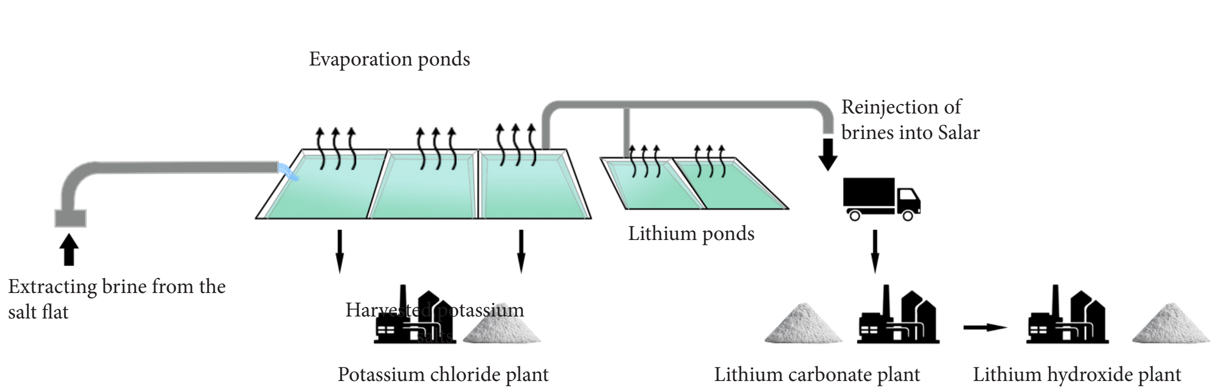
Lithium brine deposits are accumulations of saline groundwater that are enriched in dissolved lithium. This process is as follows, brine, typically carrying 200–1,400 milligrams per liter (mg/l) Li, is pumped to the surface and concentrated by evaporation in a succession of artificial ponds, each one in the chain having a greater Li concentration.

After a few months to about a year, depending on climate, a concentrate of 1 to 2 percent Li is further processed in a chemical plant to yield various end products, such as lithium carbonate and lithium metal

SOURCES OF LITHIUM AND WAYS OF EXTRACTION



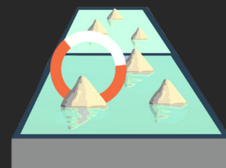
THE PROCESS OF LITHIUM EXTRACTION BY BRINE EVAPORATION



In the late 1990s, subsurface brines became the dominant raw material for lithium carbonate production worldwide because of lower production costs compared with the mining and processing of hard-rock ores These unique deposits are also:

66%

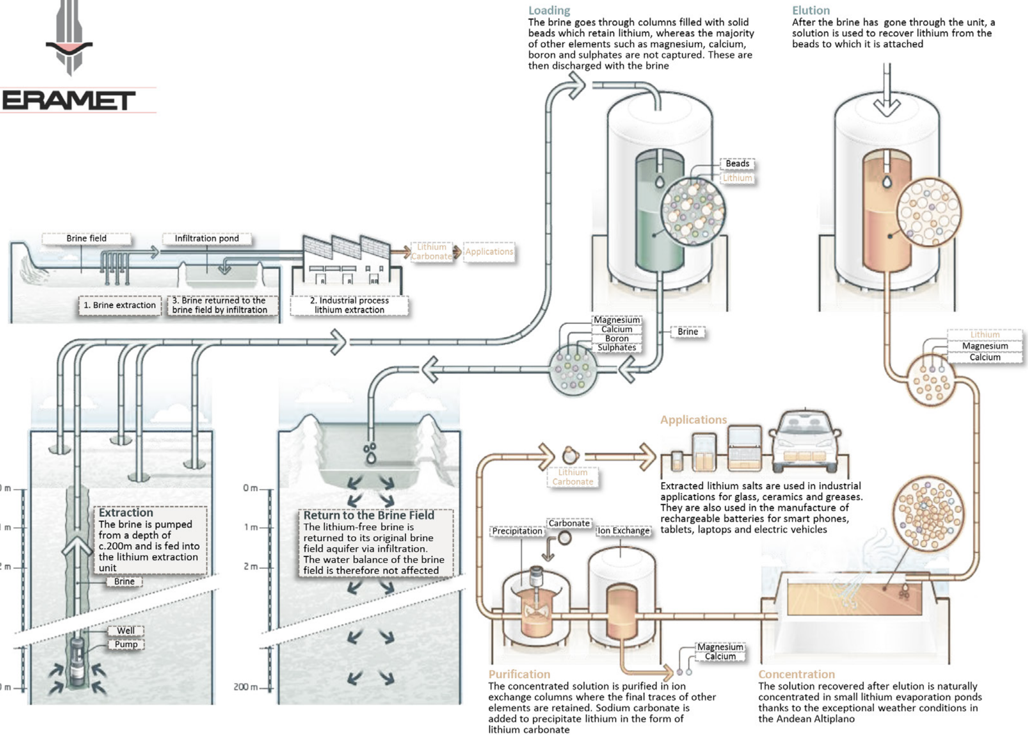
of global lithium reserves are found in such instances Lithium salts get more and more concentrated in the brines which causes the different colorations into them



RECHARGEABLE BATTERIES AND THE ELECTRIC CARS INDUSTRY

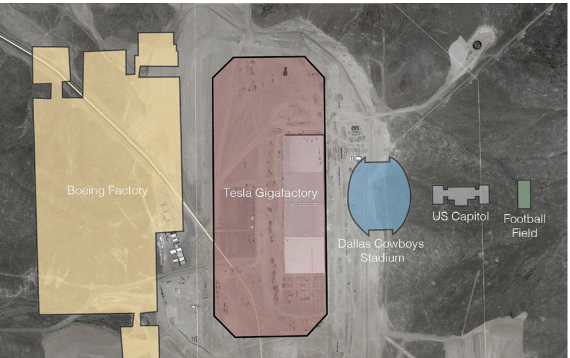
Rechargeable batteries was the largest potential growth area for lithium compounds. Demand for rechargeable lithium batteries exceeds that of other rechargeable batteries. Lithium-ion batteries are the default choice for most personal electronics and most electric cars today because they have a higher energy density than other technologies. The lithium-ion battery revolution began in earnest in the early 1990s after Sony and several other companies released the first commercial version of the new battery technology. . Automobile companies were developing lithium batteries for electric and hybrid electric vehicles. . Automobile companies were developing lithium batteries for electric and hybrid electric vehicles.

ERAMET


Loading
The brine goes through columns filled with solid beads which retain lithium, whereas the majority of other elements such as magnesium, calcium, boron and sulphates are not captured. These are then discharged with the brine
Elution
After the brine has gone through the unit, a solution is used to recover lithium from the beads to which it is attached
Brine field
Infiltration pond
Lithium Carbonate
Applications
1. Brine extraction
3. Brine returned to the brine field by infiltration
2. Industrial process lithium extraction
Beads
Lithium
Magnesium
Calcium
Boron
Sulphates
Brine
Lithium
Magnesium
Calcium
Applications
Lithium Carbonate
Extracted lithium salts are used in industrial applications for glass, ceramics and greases. They are also used in the manufacture of rechargeable batteries for smart phones, tablets, laptops and electric vehicles
0 m
1 m
2 m
200 m
Extraction
The brine is pumped from a depth of c.200m and is fed into the lithium extraction unit
Brine
Well
Pump
0 m
1 m
2 m
200 m
Return to the Brine Field
The lithium-free brine is returned to its original brine field aquifer via infiltration. The water balance of the brine field is therefore not affected
Precipitation
Carbonate
Ion Exchange
Magnesium
Calcium
Purification
The concentrated solution is purified in ion exchange columns where the final traces of other elements are retained. Sodium carbonate is added to precipitate lithium in the form of lithium carbonate
Concentration
The solution recovered after elution is naturally concentrated in small lithium evaporation ponds thanks to the exceptional weather conditions in the Andean Altiplano

A leading electric car manufacturer announced plans to construct an immense lithium-ion battery plant in the United States capable of producing up to **500,000 lithium-ion vehicle batteries per year by 2020**.

The size of the gigafactory compared to other existing structures-when built, it will be one of the largest buildings by foot print and square footage



The plant-**Tesla Gigafactory** was expected to be vertically integrated, capable of producing finished battery packs directly from raw materials. The building's current footprint is 800,000 square feet, with 1.9 million square feet of manufacturing space in four stories. With an assumed average capacity of 65 kilowatt-hours per vehicle (taking into account both the smaller battery of the expected Model S and the larger batteries like those in the P85 and P85D), 500,000 65-kilowatt-hour batteries per year would require, at about 10 kilograms of lithium per battery, 5 million kilograms (5,000 metric tons) of refined lithium per year.Tesla's expected lithium demand per year by 2020, at full production, is about **8,000 metric tons**.

Tesla Gigafactory, Reno, Nevada

Now that lithium-ion batteries are the predominant choice for many applications, particularly electric vehicles, questions about the global supply of lithium are timely.
In short, can lithium-ion batteries scale up with increased demand?

Let's suggest that the world will see 100 Tesla-size battery production factories by 2040. This is enough to produce about 100 million EVs per year, plus a ton of stationary storage.If this is the case, and the basic battery requirements don't change too much, the world would need about **800,000 metric tons of lithium by 2040**. And that's just for battery production and doesn't include the many other uses of lithium.

The U.S. Geological Survey produced a reserves estimate of lithium in early 2015, concluding that the world has enough known reserves for about 365 years of current global production of about 37,000 tons per year. The 100 Gigafactories scenario could come true. And if that happens, the 365-year supply would be less than a 17-year supply

New Local Renewables
Wind and Solar
x 100 ?
13.5 MT of reserves/800,000 = 16.9 years

THE ENVIRONMENTAL IMPACT OF RESOURCE MINING

While mining enables us to power our civilization up, at the same time it leaves unrepearable scars on the face of Earth. In order to sustain our evergrowing need for power we have started destroying our enviroment and therefore sawing the branch we are sitting on

Cant we find a better way of simply drilling Earth's crust, stripping it off its materials one after another? Going from one resource dependency to another untill there is no more? Meanwhile leaving **epmty wholes** in the surrounging landscape as **witnesses of our destructivness as a specie?**

The photographs show some of the ongoing mining around the world, such as diamond and copper mining.Large scale projects like these are quite rewarding for the monetary systems and generally improve the lives of the people in those countires but it all comes with a high cost. Potential desctruction of the natural ecosystem in the process. **The question remains-are we ready to continue paying that cost?**

ARE OUR MINERAL RESOURCES TRUELY LIMITED ?

A resource is defined by its usefulness at a given point in time. This fact must be borne in mind when envisaging solutions for the sustainable use of mineral resources.
A rock, mineral or metal that meets a requirement today **may be considered useless tomorrow**

The debate on the depletion of the planet's mineral resources feeds on the confusion between the **concepts of resources and reserves**. The latter, which encompass the accessible supplies whose extraction is considered economically viable at a given time, depend solely on technical parameters, combined with economic and political strategies. Setting aside the technical, environmental, geopolitical, regulatory and industrial factors that influence the supply of mineral products, **the Earth's total mineral resources certainly exceed the needs of humankind over the duration of its existence**

Where will tomorrow’s metal reserves be found?

Provided that effective recycling techniques are developed, **cities** can be expected to become real **“urban mines,”** where **today’s waste could become the valuable ore deposits of tomorrow.**

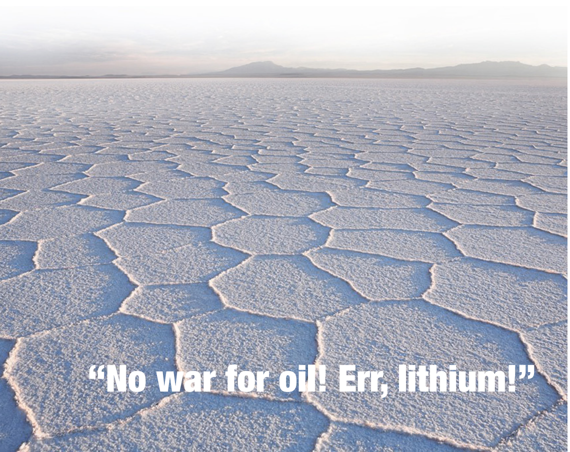
Protecting the future?

It mostly depends on the energy, environmental and societal price that humankind is willing to pay in order to access them. In this light, the question arises as to **whether it is truly sensible to try and preserve resources for future generations.**

Such reasoning is based on a static view of society and technologies. It would be more relevant to rely on **dynamic reasoning**, taking into account the inevitable—evolution of society’s needs and therefore resources. In concrete terms, rather than saving a certain amount of current petroleum supplies for our descendants, it would make more sense to **enable them to produce the energy necessary to meet their needs** regardless of the resource to be used

The scarcity of mineral resources is ultimately neither physical nor geological, but rather political, economic and environmental.

The green revolution could make lithium one of the planet's most strategic commodities
But there is simply nowhere near enough currently mined to fuel the world's 900 million cars.



According to William Tahil, research director with technology consultancy Meridian International Research, 'to make just 60 million plug-in hybrid vehicles a year containing a small lithium-ion battery would require 420,000 tons of lithium carbonate -or six times the current global production annually.

Exchanging one energy dependency for another
One of the big pushes behind "green" vehicles is the goal of reducing the country's energy dependence. Consequently, when considering battery-powered vehicles that rely on lithium, **it's important to ask where the lithium comes from?**


TESLA

DESTRUCTION OF THE BOLIVIAN LANDSCAPE

The extraction of lithium has **significant environmental and social impacts**, especially due to water pollution and depletion. In addition, toxic chemicals are needed to process lithium. The release of such chemicals through leaching, spills or air emissions **can harm communities, ecosystems and food production.** Moreover, lithium extraction inevitably harms the soil and also causes air contamination.

Apparently half of the world's lithium is beneath the Bolivian desert.In order to improve the difficult economic situation, Bolivia is faced with the dilemma of extracting lithium on a big scale, therefore risking the depletion of its landscape.But like other countires before, Boliva seems to feel that the environmental value of the salt flats is **worth less** than the **enormous monetary wealth** mining will bring. The large scale mining of lithium can only lead to destruction of the Salar ecosystem.

"Like any mining it is invasive, it scars the environment, it destroys the water table and it pollutes the local wells. This is not green solution, its not solution at all"


We should accept that the destruction of this piece of land is a small price for much good. Not only will the atmosphere benefit from the electric car, but Bolivia too?!

In the parched hills of **Chile's northern region** the damage caused by lithium mining is immediately clear. As you approach one of the country's largest lithium mines the white landscape gives way to what appears to be an **endless ploughed field.**

Huge mountains of discarded bright white salt rise out of the plain. The cracked brown earth of the site crumbles in your hands. There is **no sign of animal life anywhere**. The scarce water has all been poisoned by chemicals leaked from the mine.
Huge channels and tracts have been cut into the desert, each running with heavily polluted water. The blue glow of chlorine makes the water look almost magical, but these glistening pools are highly toxic. The chlorine used to water down the potentially carcinogenic lithium and magnesium compounds that are commonly found in the water table around lithium deposits.

A Chilean delegation recently visited Salar De Uyuni to warn locals of the problems of lithium mining. According to the delegation's leader, Guillen Mo Gonzalez, **the unique landscape of the salt plateau would be destroyed within two decades.**

The increasing **water scarcity** around the Chilean mines has also accelerated the decline of the region's subsistence agriculture. An entire way of life is disappearing as families leave their near-impossible existence in the mountains and head for the cities.

'It is hard to show how much water mines are using,' says Gonzalez.

'What's undeniable is that communities are facing severe water shortages. We are seeing patterns of rural subsistence **farmers simply giving up** and taking their families to horrendous living and working conditions in the cities.

BACK IN BOLIVIA-FARMERS PROTEST

Colchani is a small village of salt farmers just on the edge of the Salar de Uyuni. Francisco Quisbert, 67, the leader of Fructas, a farmers' collective, says, 'We want political power because as Morales says we have a right to our own land.

"We have been here before, with the Spanish, who came and plundered our gold and silver and enslaved our people"

'**This time we are in control, it is our land, no outsiders will be tolerated**. There will be blood spilled on this white earth if they arrive to take what isn't theirs. People tell us Bolivia can become the Saudi Arabia of lithium. But it cannot be done at the cost of our homes and environment.' The men who gazed at Salar DeUyuni from the Moon will never forget what they saw that day. If the Americans return to the Moon in 20 years' time they may no longer see the salt plain from space. Is the world's need for a green solution to transport worth the **destruction of this unique environment and the ancient way of life that lives on it?**

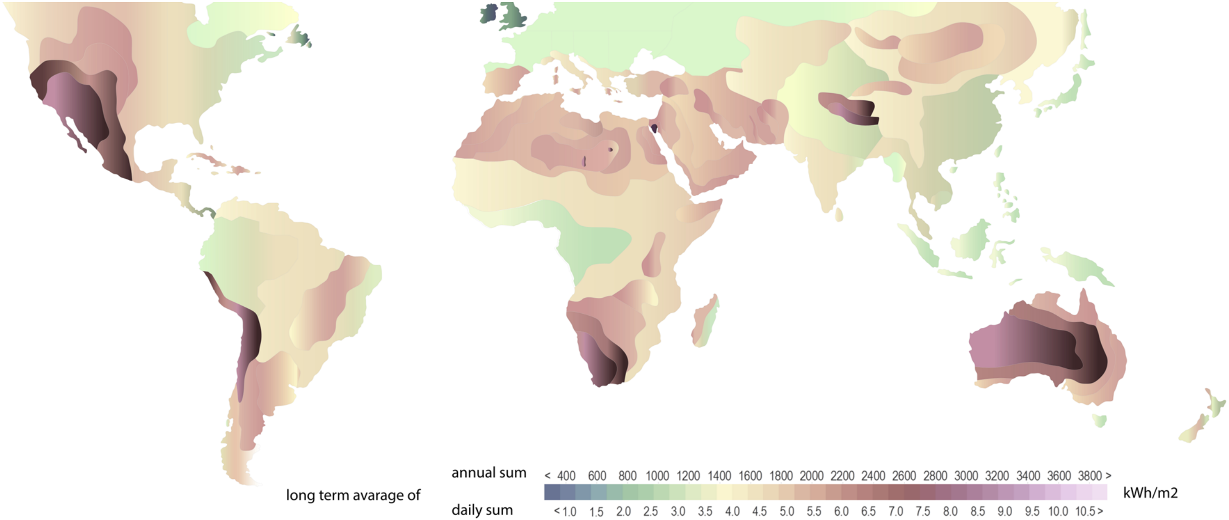
“It is impossible to continue these kinds of mining practices.” The new law must “enforce a more rational and efficient use of these resources”

NATURAL RESOURCES MANAGMENT FOR A BETTER FUTURE

Given all the possibile negative effects of massive mining and resource extractions around the world, in order to satisfy our neverending need for power, maybe its time for us to finally hold on and ask ourselves-**can’t we do better than this?**

Nature has given us endless potential and its up to us to harnes it in the right way without damaging the land we live on with our short-term strategies

In this regard, we can try considering **the power of the Sun** which is basically endless. The sun produces more energy every hour than the entire energy needs of human civilization from the beginning of time In addition, using the sun **doesnt pollute the environment** and gives **zero-emissions**.

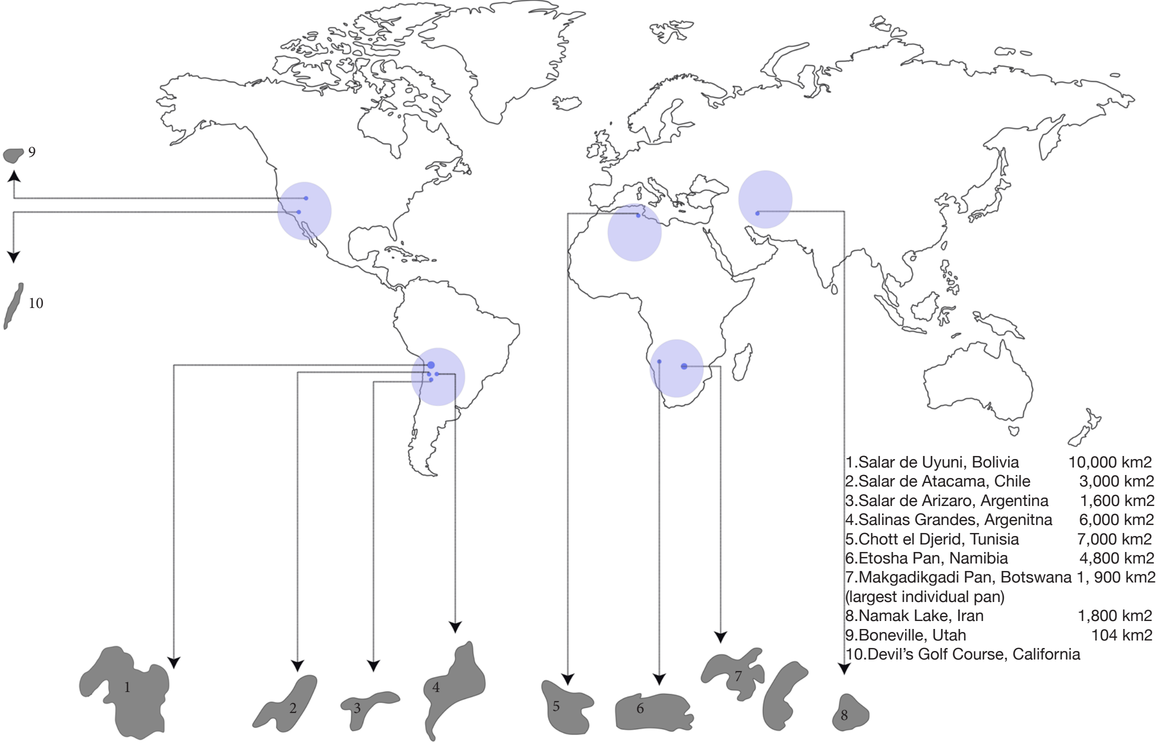


Direct normal irradiation is solar radiation that comes in a straight line from the direction of the sun at its current position in the sky
In the map above is shown data about received solar radiaton per square meter per year/day

However we should find a soultion that comines the two without leading to their depletion As a matter of fact, we can already see projects around the world that use the Sun energy to power up nearby cities. These are the so called- **solar power plants**

Chott el Djerid, Tunisia

Unfortunatelly most of those places are so called ‘baren landes’, deserts with non-human living conditions
More specifically we are focusing on places like Salar de Uyuni in Bolivia, **salt flats which have double potential-great number of sunny days during the year and the precious lithium.**
We could imagine a scenario where these two power sources are generating new communities within extreme landscapes.The power plants are not anymore just isolated energy producers for faraway cities , but they are actually the focus point of new settlments This gives us oppportunity to explore new architecture that can coexist with this sustainable technologies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1
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4
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6
7
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1.Salar de Uyuni, Bolivia 10,000 km2
2.Salar de Atacama, Chile 3,000 km2
3.Salar de Arizaro, Argentina 1,600 km2
4.Salinas Grandes, Argenitna 6,000 km2
5.Chott el Djerid, Tunisia 7,000 km2
6.Etosha Pan, Namibia 4,800 km2
7.Makgadikgadi Pan, Botswana 1, 900 km2
(largest individual pan)
8.Namak Lake, Iran 1,800 km2
9.Boneville, Utah 104 km2
10.Devil's Golf Course, California

SOLAR POWER PLANTS AND THEIR TECHNOLOGY

Solar power plants are being built extensively all around the world in the last years. Spain dominates the market as it accounts for the largest number of built power plants.

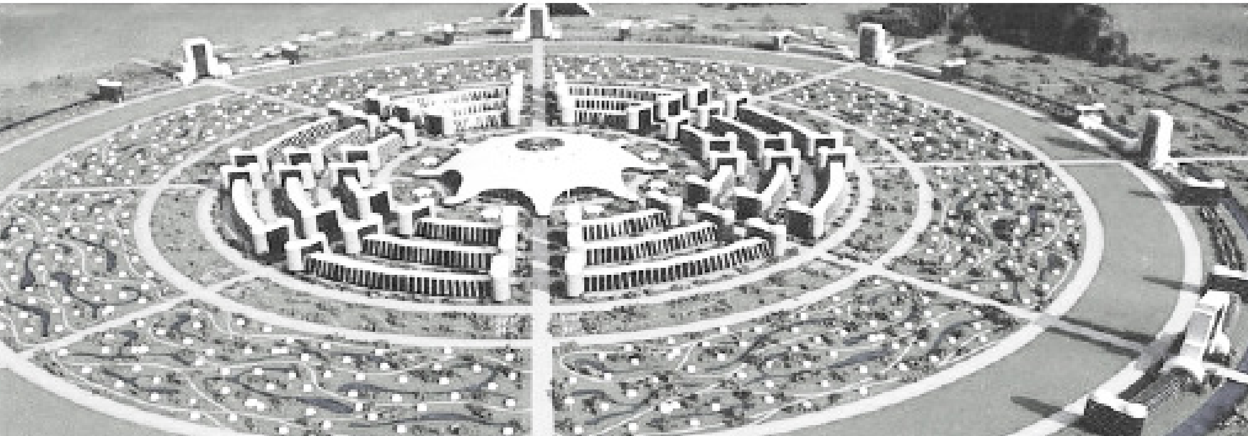
It is interesting to mention that along most of the plants we can see some forms of agriculture developments and even settlments which kinda suggest the above mentioned scenario.People are trying to ‘colonize’ the environments with non-human conditions with the help of technology. Therefore we can see green crop fields in the middle of what seems to be an arid, dry land

Another interesting thing is the shape itself of these kind of factories-we can see couple of tower cores within a box that are endlessly streching along the deserts. It is easy to immagine whole cities being inter connected in this way-cities spanning around a central axis with strongly defined borders

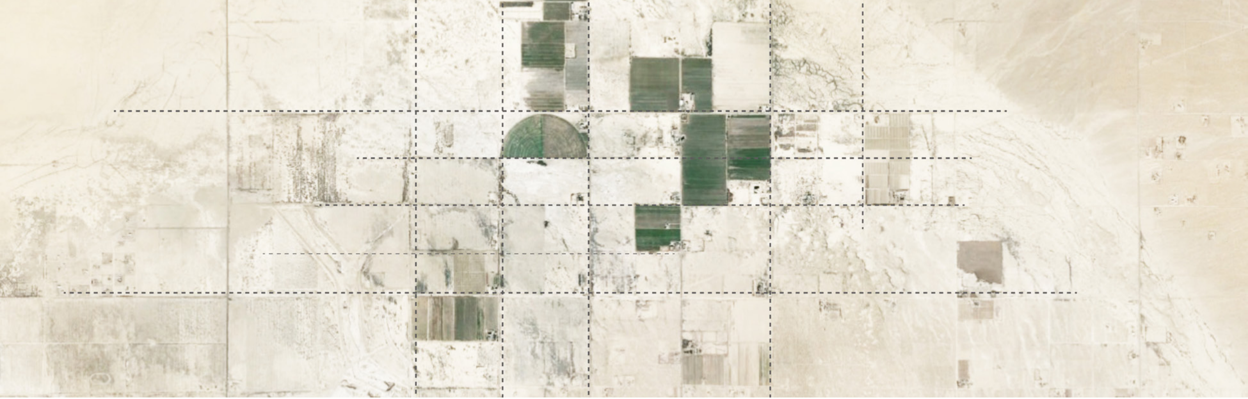

SPAIN
USA
PERU
SOUTH AFRICA
Spain is obviously the leader with 30 operational power stations and many more to be build in the next years. Right after follows USA-California with 12 stations . Peru has 3 power stations planned to be build whcih is important due to its vicinity to our location-Uyuni Salt flat
OPERATIONAL SOLAR POWER STATIONS

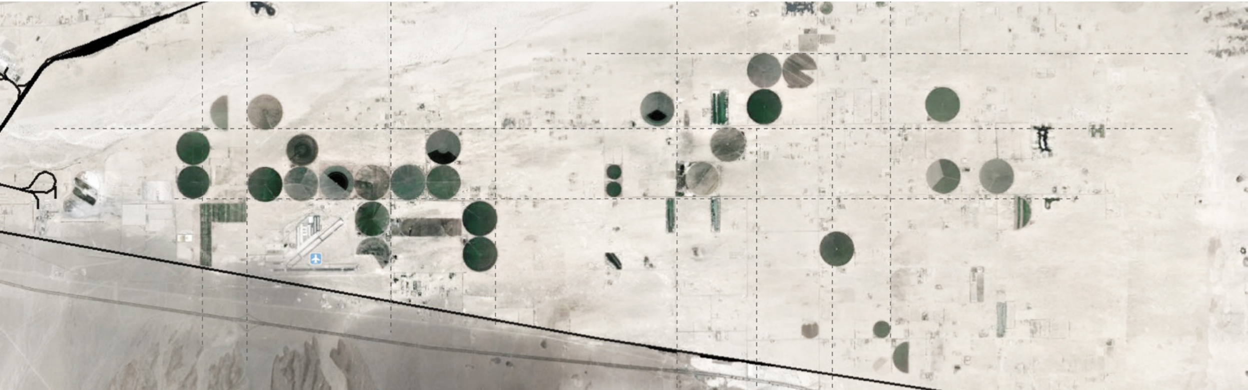
In the photo below we can see the plan of the Venus project by Jacque Fresco that exemplifies the idea of ‘limited’ cities with central core which are futher connected between themslves.

Therefore we can try to explore the possibilities this technology gives us by combining architectural developments and landscape design in order to create human settlments in apparently ‘undesirable’ land



In these photos we can see some of the agricultural projects that are being developed around the solar power plants. For example in United States near the Mojave desert, we can see crop circles arranged along a grid system. They are using the center pivor irrigation system, that pumps water from underground aquifers. In other cases we can see even attempts of settlments comprised of residential buildings and entertaiment-camel racing, such

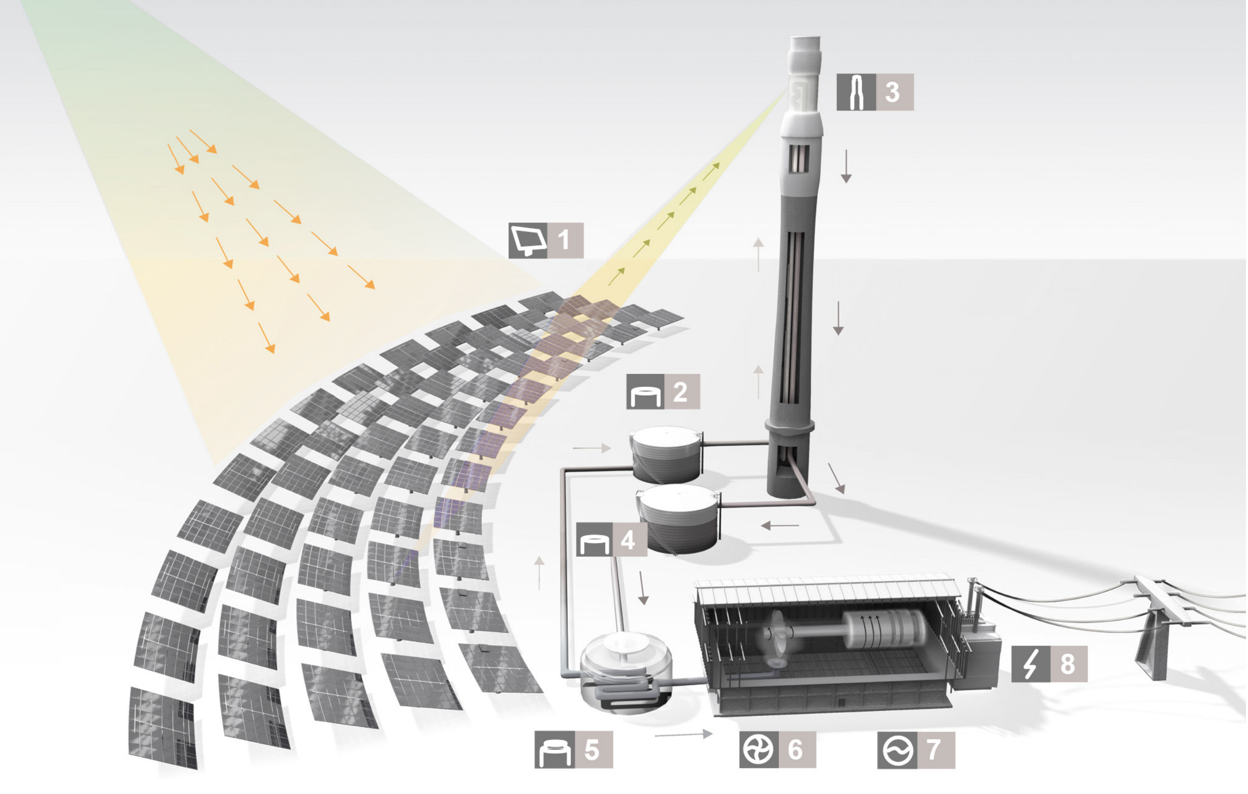




HOW DOES A SOLAR POWER PLANT WORKS?

Most of the solar power stations we have seen are using heliostats- mirrors whcih are reflecting the sun energy by following the sun movement throught the day. The reflected energy is being sent to a receiver located on the top of a tower.

Some of these towers use molten salts which are being heated by this energy before being sent to a salt tank that stores them. Futher on the molten salts are being delivered to a steam generation system where they transfer their heat to the water, therefore reducing their temperature. This transfered heat transforms the water into high pressure which then turns the steam turbine. In this way electrical power is being produced which is ready to be inserted into the power grid. However there is another type of solar plants that dont use the heliostats but are working on the principle of heated air.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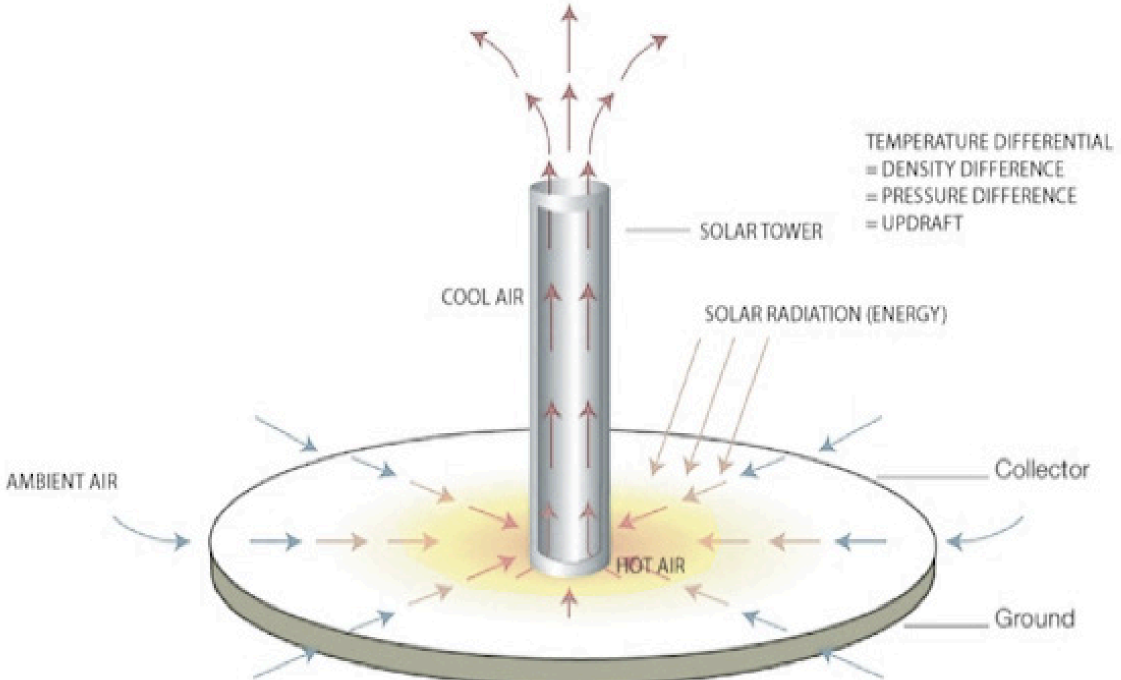
These are the so called updraft solar power plants. This 'solar chimney' utilizes a combination of solar air collector and central updraft tube to generate a solar induced convective flow which drives pressure staged turbines to generate electricity.The tower 'draws' the air from a covered area of a transparent membrane. An important side effect of placing a large transparent membrane over an area of land is the capture of evaporated ground water and its return back to the topsoil. This localized increase in land moisture can make the soil underneath the collector suitable for agricultural uses, through the effective creation of a partial greenhouse.

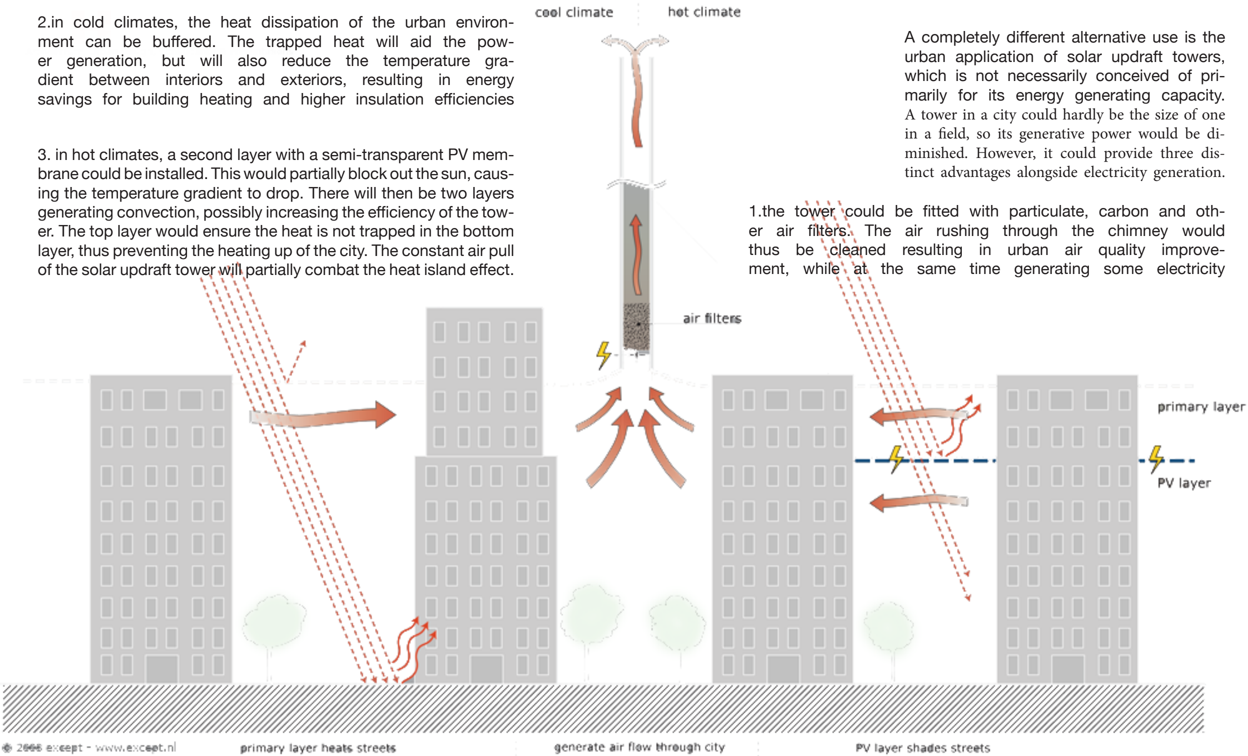

TEMPERATURE DIFFERENTIAL
= DENSITY DIFFERENCE
= PRESSURE DIFFERENCE
= UPDRAFT
SOLAR TOWER
COOL AIR
SOLAR RADIATION (ENERGY)
AMBIENT AIR
Collector
HOT AIR
Ground

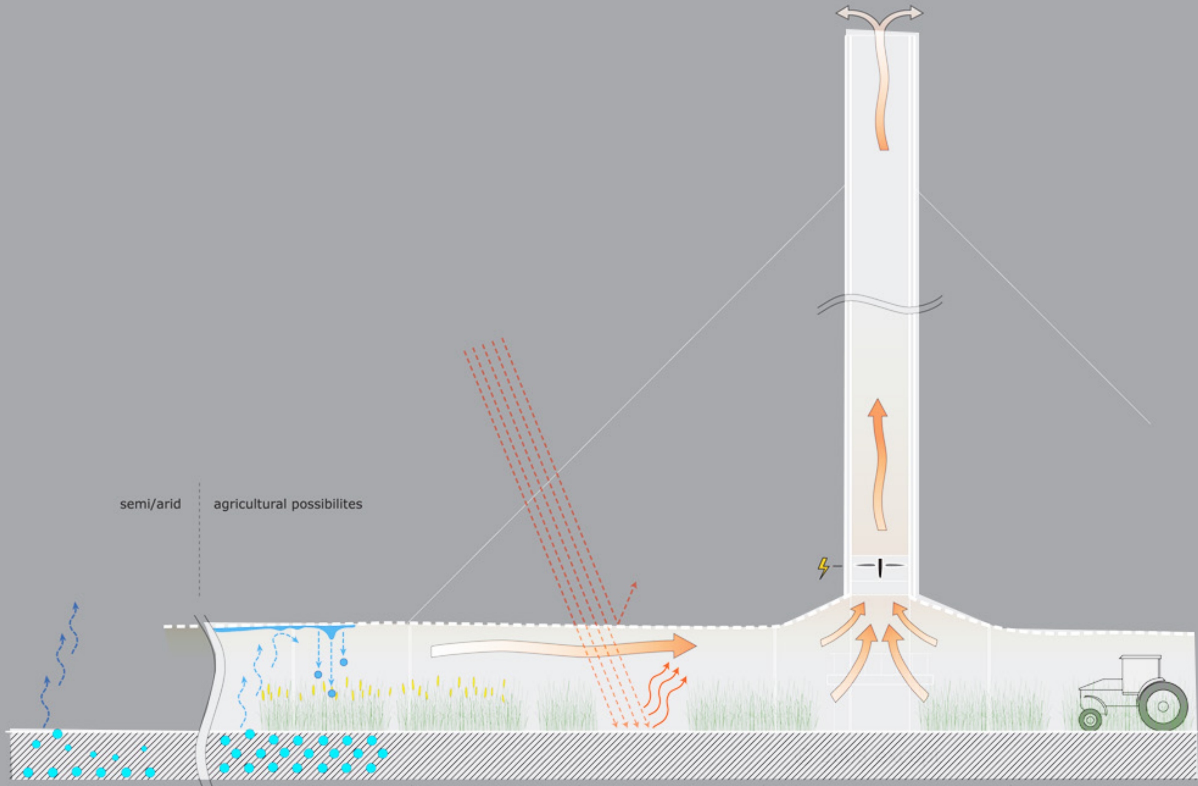
2.in cold climates, the heat dissipation of the urban environment can be buffered. The trapped heat will aid the power generation, but will also reduce the temperature gradient between interiors and exteriors, resulting in energy savings for building heating and higher insulation efficiencies

3. in hot climates, a second layer with a semi-transparent PV membrane could be installed. This would partially block out the sun, causing the temperature gradient to drop. There will then be two layers generating convection, possibly increasing the efficiency of the tower. The top layer would ensure the heat is not trapped in the bottom layer, thus preventing the heating up of the city. The constant air pull of the solar updraft tower will partially combat the heat island effect.

A completely different alternative use is the urban application of solar updraft towers, which is not necessarily conceived of primarily for its energy generating capacity. A tower in a city could hardly be the size of one in a field, so its generative power would be diminished. However, it could provide three distinct advantages alongside electricity generation.

1.the tower could be fitted with particulate, carbon and other air filters. The air rushing through the chimney would thus be cleaned resulting in urban air quality improvement, while at the same time generating some electricity




semi/arid
agricultural possibilites

DIFFERENT KIND OF FARMING