The goal of the state of the art is to establish an inventory of the existing technologies and to see their underlying potential of their utilization in the project.

== PV ==

The solar cells generate electricity by absorbing sunlight thanks to the photovoltaic effect.

In space at Low Earth Orbit, the sunlight is not filtered by the atmosphere. The efficiency of a solar panel depends of the wavelength of the photons that it can absorb. Therefore, in a space context with a larger wavelength of photons available than at Earth, the technology used for the solar cells has to be able to absorb the maximum amount of photons. More, since the area available of the solar panel is strongly limited on the CubeSat (each side size 100 cm², and has to integrate solar cells but also sensors and wires). The triple junction technology solar cells have a layer well adapt to a large wavelength area with an absorption wavelength from 300 nm to 1700 nm. This option but also other types of technology have been study in the State of the Art document.

[[File:Quantum efficiency-0.JPG|centre|thumb|410x410px|Wavelength absorption depending on the layer material]]

== BAT ==

The energy produced by PV panels has to be stored partially to deal with the eclipse period in which there is no more sunlight, and so no more electricity production.

Batteries are generally the preferred method of energy storage for CubeSats. There are several factors to consider when choosing the dimensions and technology.

- The nominal voltage has to be line with the buses voltage required by the modules supplied by the battery.

- The energy density determines the size of the battery compared to the needed energy

- The maximum discharging current limits the maximum number of modules running at the

same time. This also limits the maximum consumption of any single module.

- The self-discharge will affect the battery capacity, so it must be taken into account when deciding the total capacity.

- The charging time of the battery minus the oversize part cannot be longer than the sunshine time, or else it will be a lack of electricity during the eclipse.

- The thermal charging and discharging range are linked to the spacial conditions, and must be line with the thermal regulation modules to provide optimal or minimal operating conditions

- The maximum number of cycles depends on the length of the space mission. As the capacity of the battery diminishes over time, one can choose to over-size the battery or to choose a type which has a higher number of maximum cycles.

Many kinds of 1U batteries already exist. The power stored in each of these batteries is about 10 to 30 Wh.

The ECE3SAT team considered different type of battery technology, including chemical batteries. The maximum energy density and watt-hour per kilogram rate with a correct price are the Lithium batteries (in the chemical battery technology). This technology is usually the one which is used in CubeSats.

The lithium batteries (Li) can be divided in two categories. Lithium Polymer or Li-Po, and Lithium Ion or Li-Ion. These two categories have both advantages and disadvantages comparing with the other.

{| class="article-table" style="margin: auto; border:5px double black;"

! style="text-align:center;"|

! style="text-align:center;"|Lithium Polymer

! style="text-align:center;"|Lithium Ion

|-

| style="text-align:center;"|'''Strengths'''

| style="text-align:center;"|Different tiny forms

| style="text-align:center;"|Different Tiny forms

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| style="text-align:center;"|Low weight

| style="text-align:center;"|Low weight

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| style="text-align:center;"|Safest batteries

| style="text-align:center;"|Highest power saving

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| style="text-align:center;"|'''Weaknesses'''

| style="text-align:center;"|Less energy stored

| style="text-align:center;"|Shortest life cycle

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|

| style="text-align:center;"|More expansive

| style="text-align:center;"|Can cause bypass

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| style="text-align:center;"|Regulated charge

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== PCC ==

When the electricity has been generated by the solar panels. It has to be manage by the PCC modules. The PCC has to distribute the electricity, to the battery to store it or directly to the modules to use it. PCC has also to protect modules against over-current and reverse-current. To do so, a microcontroller, several MPPT modules and regulators will be integrate in the circuits.

Microcontroller has to fit with the need of communication with the [http://ece3sat.wikia.com/wiki/On\_Board\_Computer\_(OBC) OBC] thanks the I2C buses, of electricity distribution control with digital outputs for the electronic switchs and of measure of battery level of charge using sensors.

== Architecture ==

There is two main architectures for CubeSats which are centralized and distributed.

Each one has several advantages and disadvantages. According to a survey on 25

CubeSats led by university or affiliated university whose purpose was to

determine what type of architecture was implemented, 80% of the CubeSats used

centralized architecture while 20% used distributed architecture.

== Download the State Of the Art - EPS ==

[[File:State\_of\_the\_art\_2016-2017\_EPS\_VF.pdf|State Of the Art EPS]]

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