Since the last 30 years, the photovoltaics (PV) industry has grown exponentially. Unfortunately, this growth isn't fast enough to prevent global warming. The time is lacking to transform our energy system toward sources with low greenhouse gas emission. Among the emerging energy production technologies, metal halide perovskite solar cells (PSCs) have attracted extensive attention from both academia and industry as their power conversion efficiency (PCE) has increased from 3.8% to a certified 25.5% in a decade using low cost solution processing technology. In this context, the photovoltaic community seeks to accelerate the development of this technology that could speed up of the large scale deployment of photovoltaics as energy source and thus reducing the impact of global warming. The main remaining challenge for the commercialization of PSCs lies in their limited lifetime due to a low stability of the material and devices. This is challenging because the understanding of the fundamental chemical reactions and electrical processes at the origin of the device degradation is complex and ageing tests are time consuming. Degradation in PSCs is mainly caused by the effect of moisture, oxidation and thermal stress. But other degradation processes are caused by mobile ions in the perovskites.

These degradation can be partially reversible increasing the complexity of stability tests and posing challenges for characterization and simulation of the operational principle of devices in general and during aging. Many strategies have been followed successfully to improve the device stability and studies exist showing less than a few per cent degradation of the performance, when devices are tracked for 1000 hours under operation. Despite the progress in improving the stability, reported values are still far from what is expected from a PV technology. Therefore, a lot of research is necessary on the sources of degradation within solar cell devices under operation. To speed up this research, it is of the utmost importance to get a better understanding of the degradation pathways, from a fundamental point of view, and to find ways to accelerate ageing tests and obtain rapid feedback which is the goal of this project.

In more detail, the described problem leads us to the following research questions:
- Which are the best stress factors for accelerated aging?
- How can degradation be monitored by non-destructive in-situ measurements, also considering the peculiarities of perovskite solar cells such as slow reversible effects?
- How can the observed changes be attributed to distinct physical parameters?
- How can acceleration factors be identified from the degradation patterns and be used to predict lifetime under operation?

Associated with these questions are the following research goals:
- Design of tailored experiments for accelerated aging and identification of the most suitable stress factors and their parameter range
- Development of suitable in-situ characterization based on opto-electronic measurements that allow distinguishing changes in charge transport and recombination
- Application of numerical device simulation based on drift-diffusion models to identify the most likely source of performance changes during aging and attribute it by quantification of material parameters
- Development of predictive models that based on the acceleration factors allow lifetime estimations for given operating scenarios and ambient conditions

To answer these questions and achieve our goal we are going to combine degradation studies on a statistically relevant sample size with in-situ characterization and paired with device modeling to identify degradation patterns and their underlying physical cause.

We anticipate that the results from our experiment will allow us to improve the knowledge regarding degradation mechanisms of perovskite photovoltaic device and lead to an establishment of fast, reliable and cost-effective stability measurement standards which will be applicable by the whole research community. On the long run, these outcomes should facilitate a faster development of stable perovskite-based PV helping this technology to penetrate more easily the energy market. This would help to accelerate the decarbonization of the economy, thus reducing the disastrous impact of global warming on our society.