PV STAr
LE PHOTOVOLTAÏQUE EN OCCITANIE

La Région Occitanie Pyrénées - Méditerranée

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Conception of a Global Digital Twin to Evaluate the Impact of Climate Change on the Production of Photovoltaic Power Plants

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URBASOLAR apex energies ies INSTITUT D'ÉLECTRONIQUE ET DES SYSTÈMES

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Project Funding:

- 50% Défi-clé PV-STAR
- 50% Apex Energie and Urba Solar

Project Context

Climate Change and Solar Power in the 21st Century

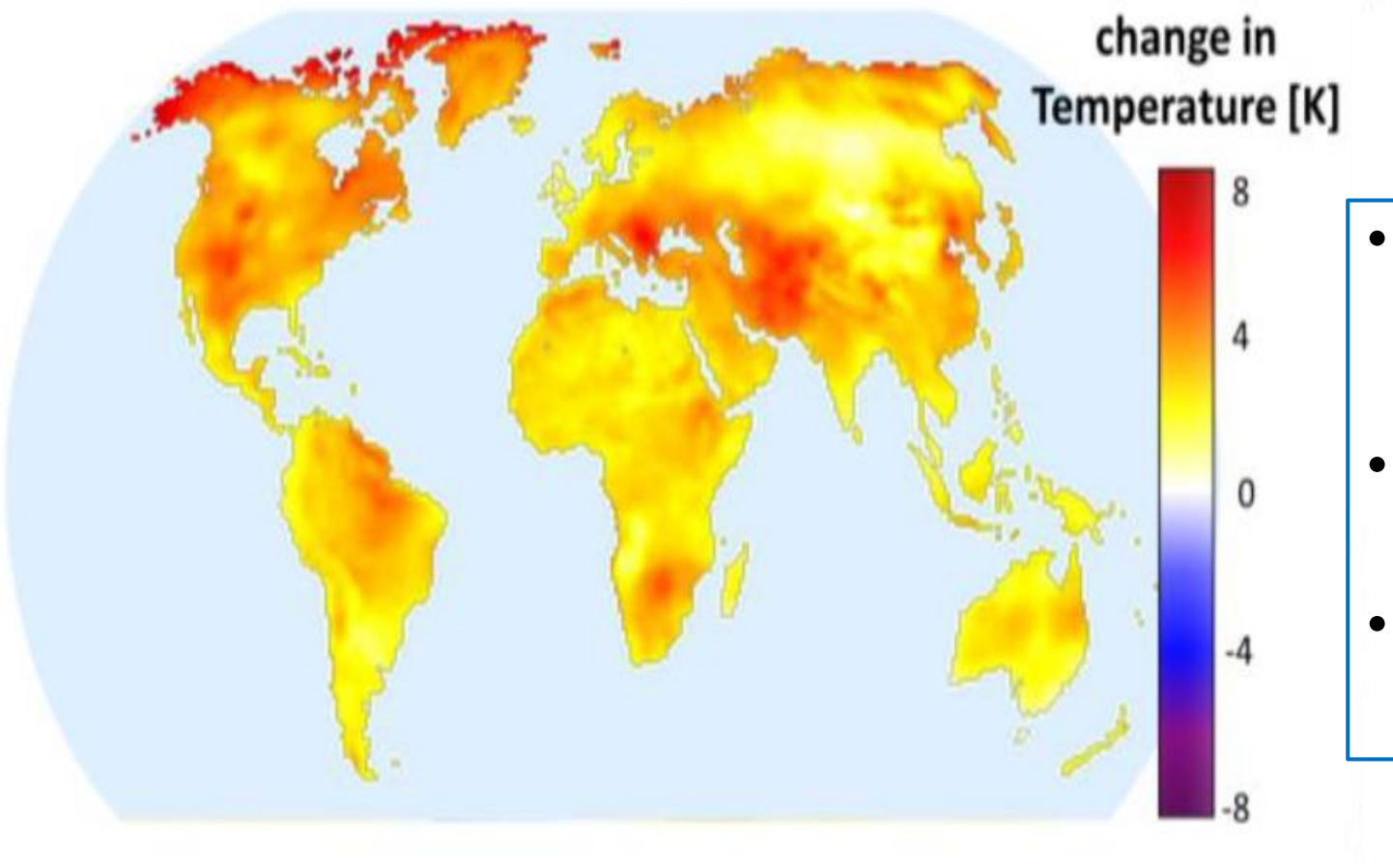
- Two developments seem very likely:
  1) the world will get warmer
  2) solar panel deployment will increase

- that solar cell performance is affected by:
  - Change in the solar spectrum
  - Temperature
  - Water content in the atmosphere
  - Atmospheric pollution …

How will climate change affect solar energy production in the future?

Project Context

Example: Temperature

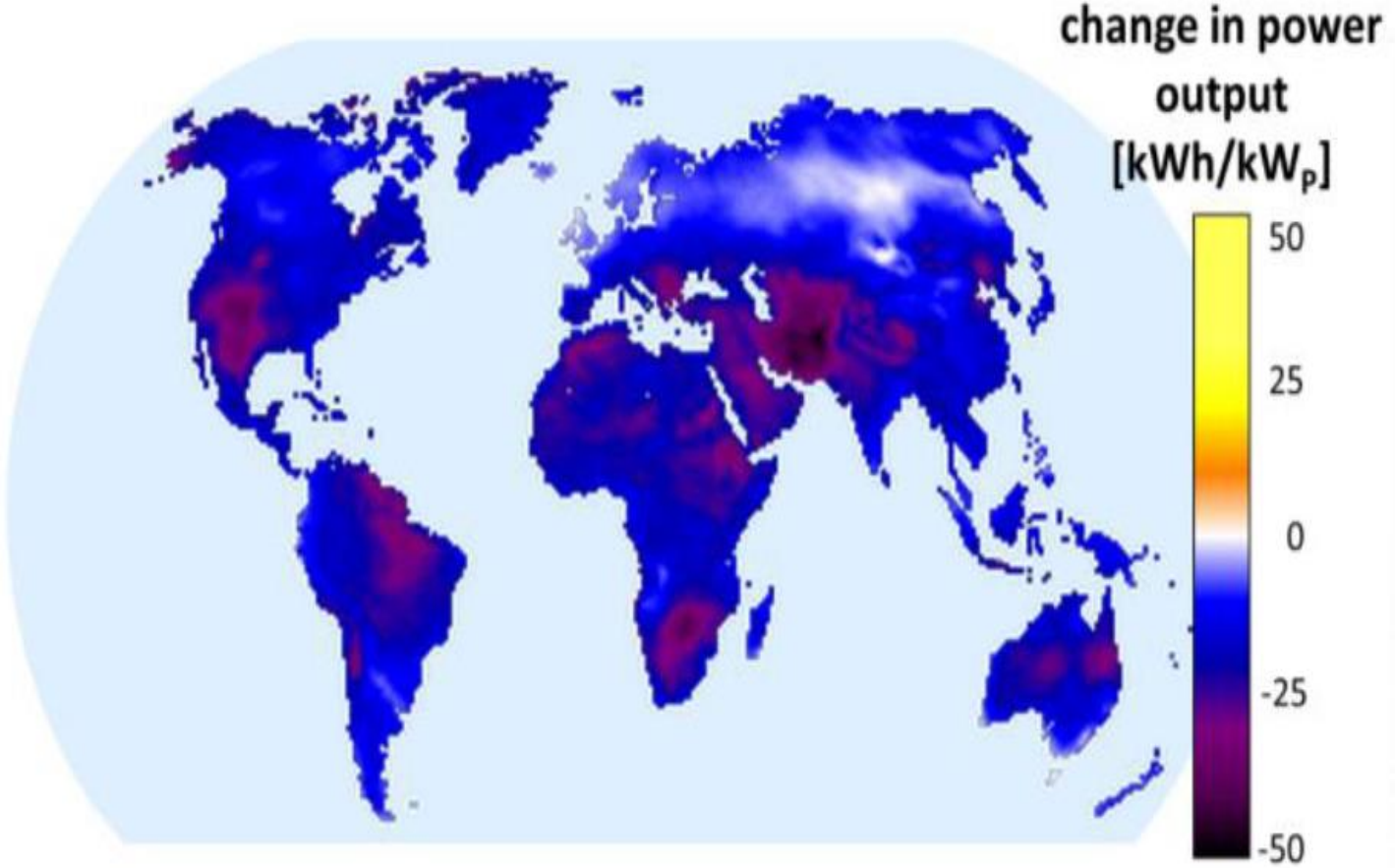


- Projected global temperature change between 2000 and 2100 according to the RCP 4.5 scenario of the IPCC
- The average worldwide temperature increase is +1.8K
- The temperature in south of France increases until +4K

Ian Marius Peters, Tonio Buonassisi, *The Impact of Global Warming on Silicon PV Energy Yield in 2100* , Massachusetts Institute of Technology, Cambridge, Massachusetts, 02139, USA

Project Context

Example: Effect of temperature on production



- Projected global change in energy output for a silicon PV installation between 2000 and 2100 for the temperature changes
- As temperatures raise nearly everywhere on the land mass of our planet, energy output is reduced everywhere
- The median reduction is approx. 15 kWh/kWp
- Some regions reaching up to 50 kWh/kWp

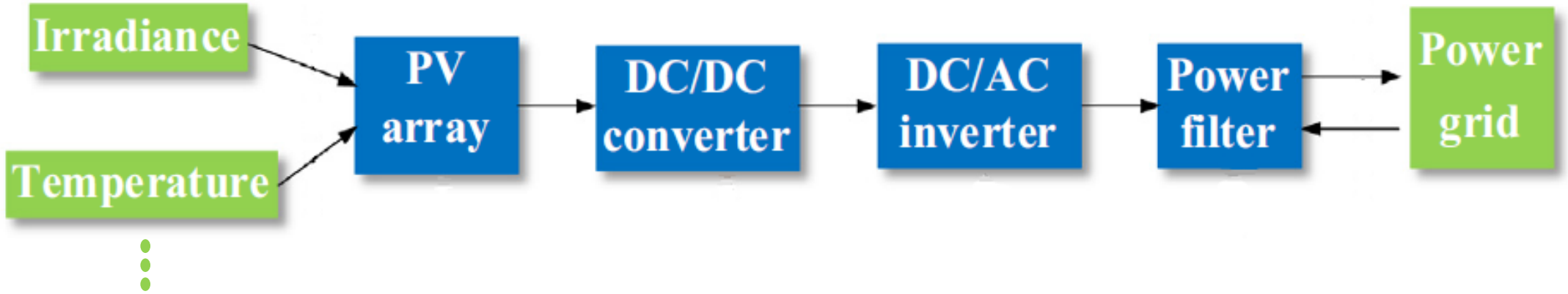
Ian Marius Peters, Tonio Buonassisi, *The Impact of Global Warming on Silicon PV Energy Yield in 2100* , Massachusetts Institute of Technology, Cambridge, Massachusetts, 02139, USA

Project Goal

Develop a global numerical model (digital twin) to evaluate the overall performance of a PV power plant with sufficient accuracy to cover current and future economic and climatic challenges

Major environmental changes

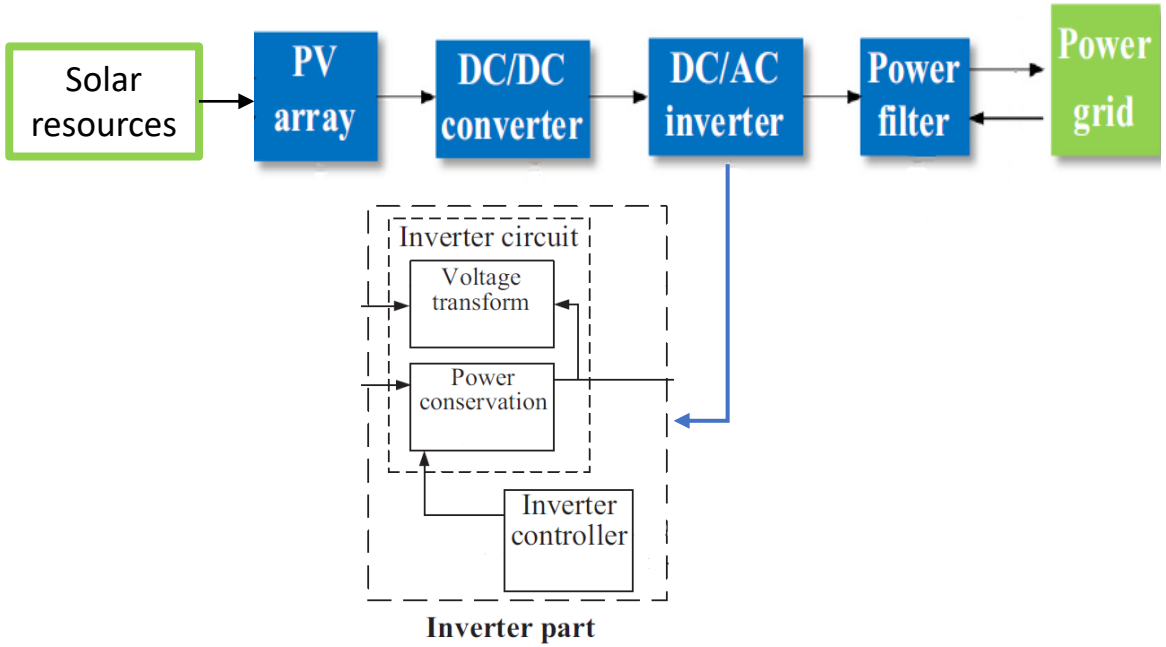
Power plant components



Model specification

Multi-scale modelling using physical models

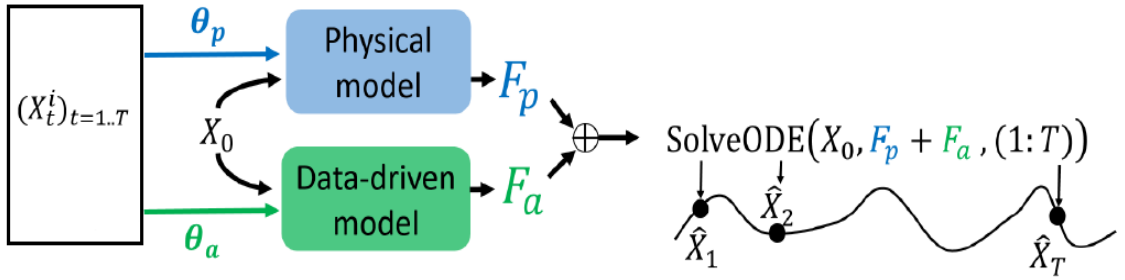
It will be built from **physical blocks**, the proposed digital twin should eventually make it possible to assess the impact of each of the plant's constituent blocks on its overall behavior



The globality of the model means a huge amount of data

This creates parameters that are not given for calculations in the physical model

The idea is to use a **hybrid model** (machine learning type) to interpolate these parameters in order to obtain accurate results



Challenges

- Modeling these large-scale, complex systems is not easy using traditional methods based on pure physical representation
- Difficult to integrate the necessary data in this complexity
- High precision with reasonable calculation times
- Validation of model