ACTIVE INTERFACES. From 3D geodata to BIPV yield estimation: towards an urban-scale simulation workflow

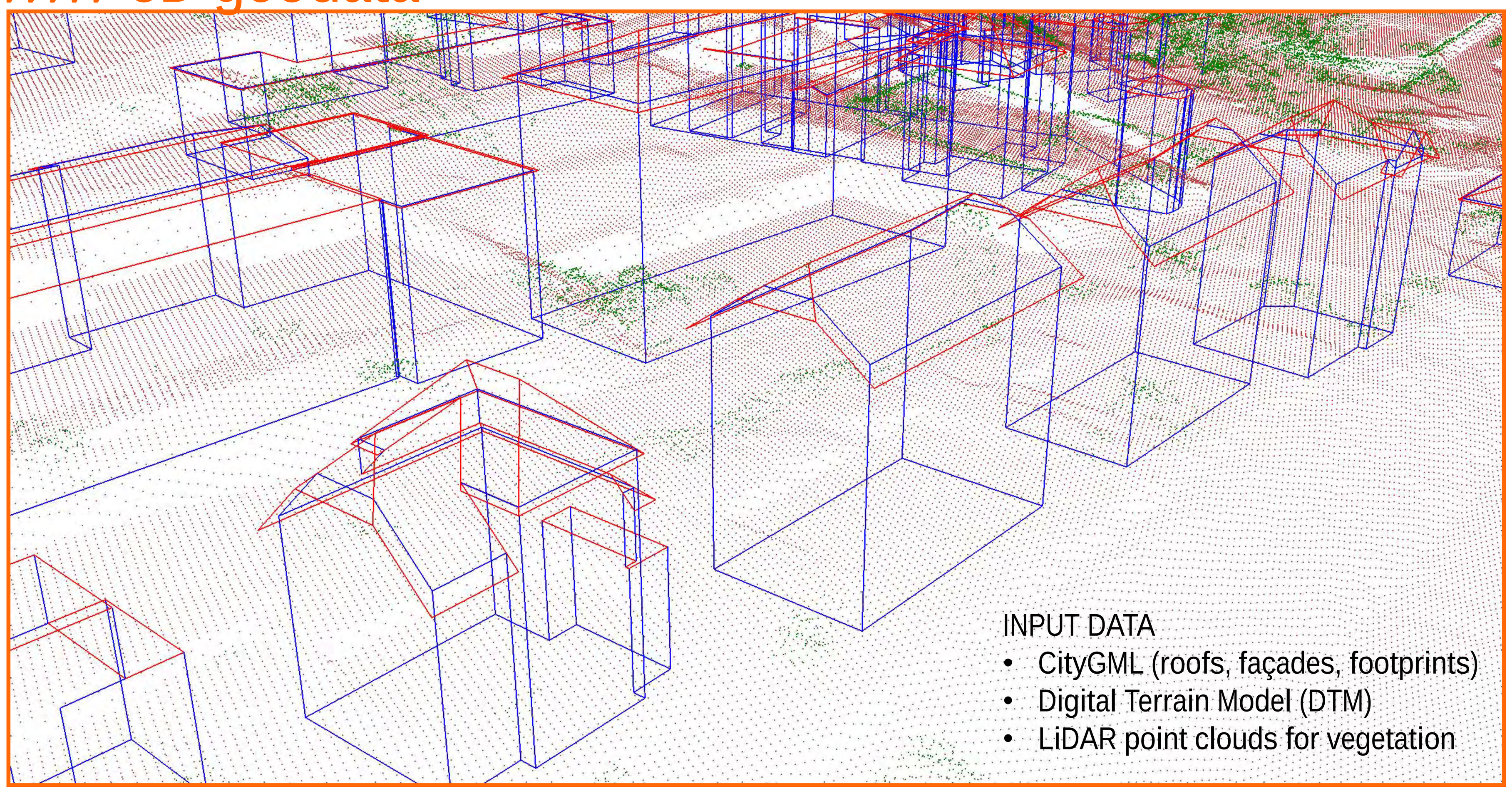
Giuseppe Peronato[1]*, Emmanuel Rey[2], Marilyne Andersen[1]

Overview

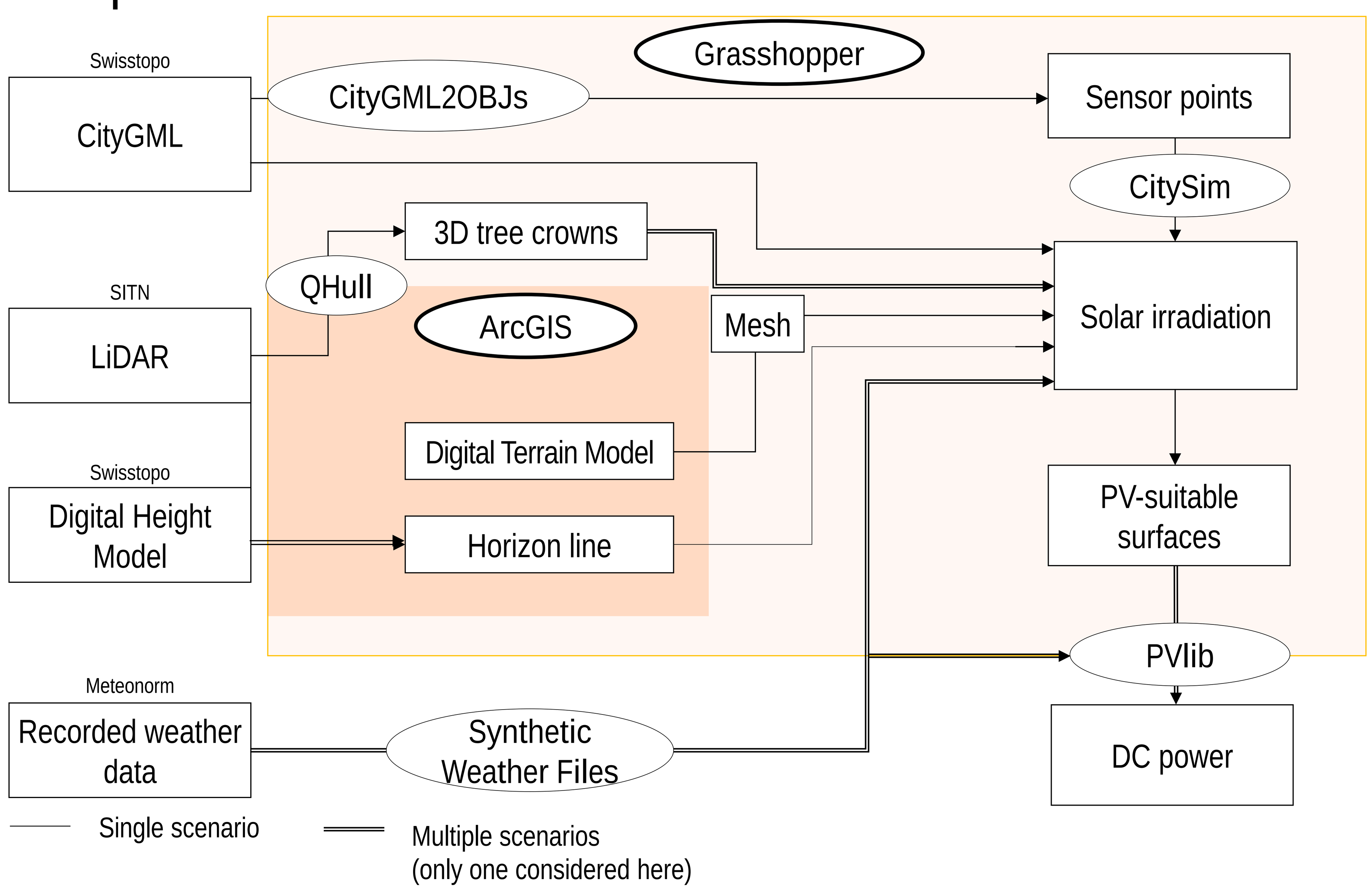
In order to meet the requirements of the Energy Strategy 2050, there is the need for a large-scale energy retrofit of the current building stock combined with the use of solar active systems, in particular BIPV. However, existing tools to assess the potential solar energy yield, such as solar cadasters, present some limits. For instance, they usually consider only rooftops and do not include inter-reflections, neglecting or underestimating the potential for façade-applied systems. To overcome some of these limits, we present here a simulation-based workflow for the assessment of the BIPV potential in urban areas. Advanced solar radiation and PV-modeling tools are applied to detailed 3D city models, derived from 3D geodata that are (or will be soon) available for all of Switzerland.

In the workflow, all building surfaces are first regularly subdivided according to a given PV module size. For each sub-surface, the POA irradiance is then calculated using weather data from Meteonorm and the software CitySim. We finally apply the Sandia cell temperature model and the De Soto "Five Parameter" model to calculate the DC power of the system.

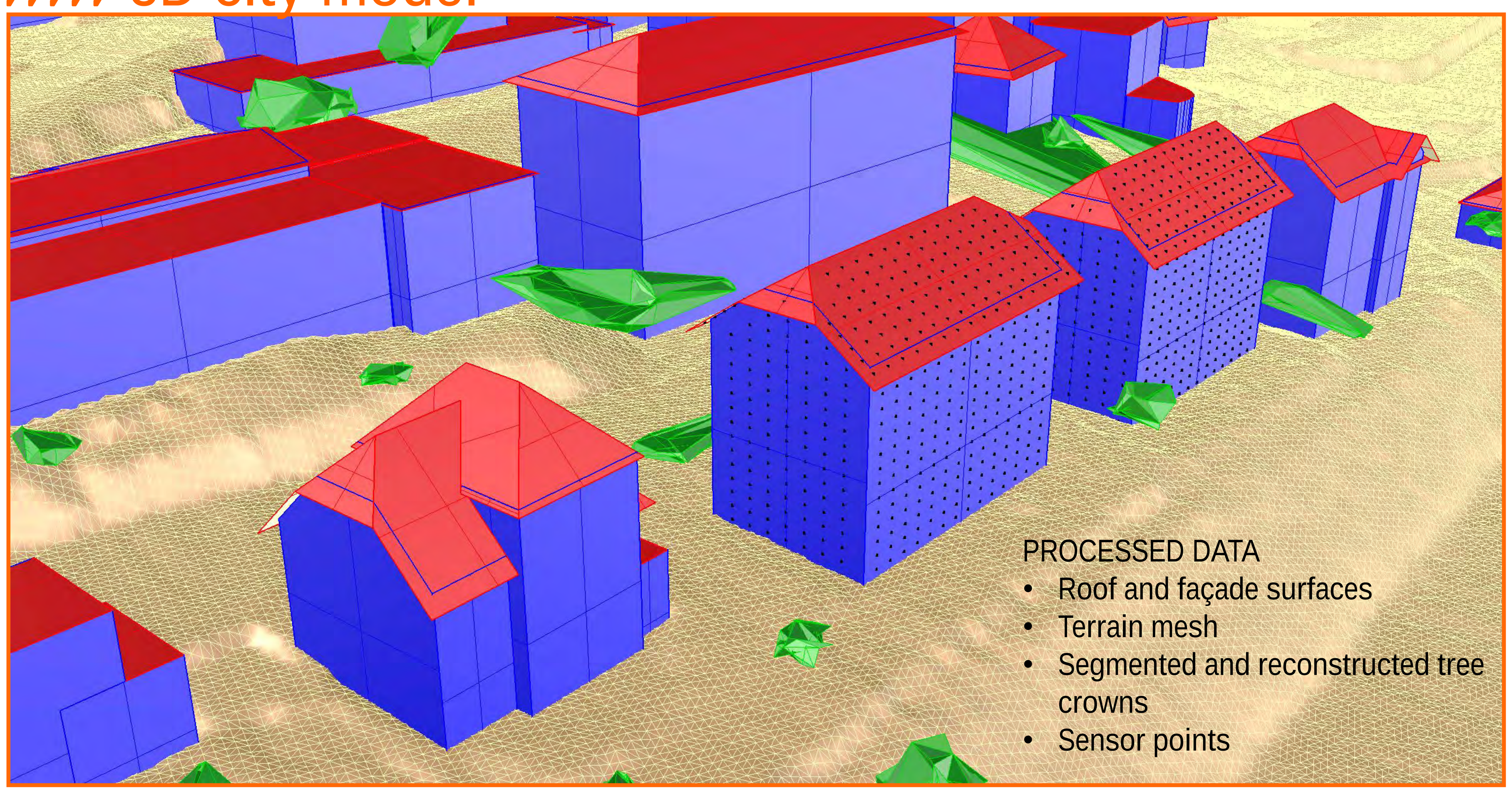
///// 3D geodata



Proposed workflow



///// 3D city model



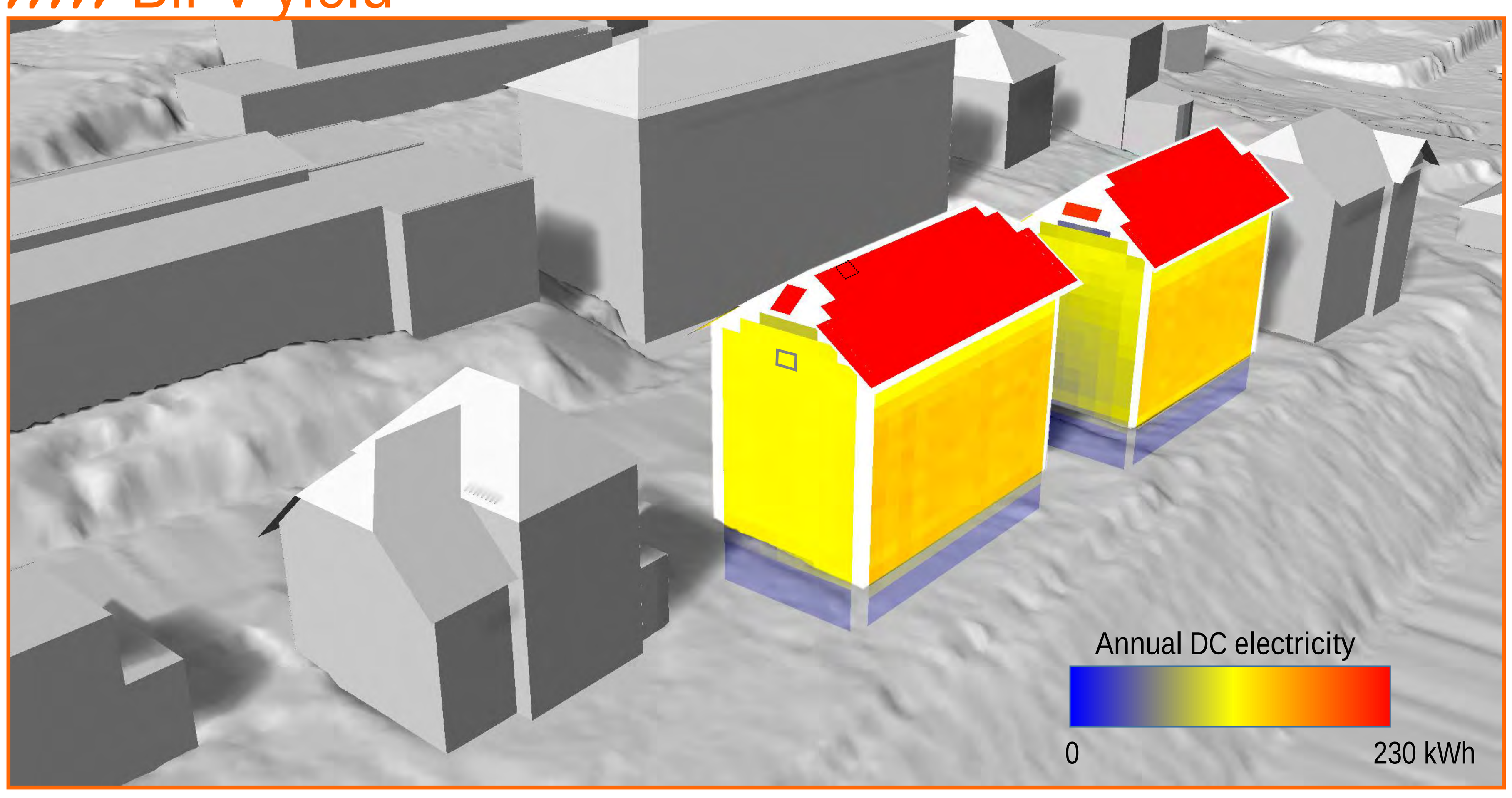
Simulated BIPV module

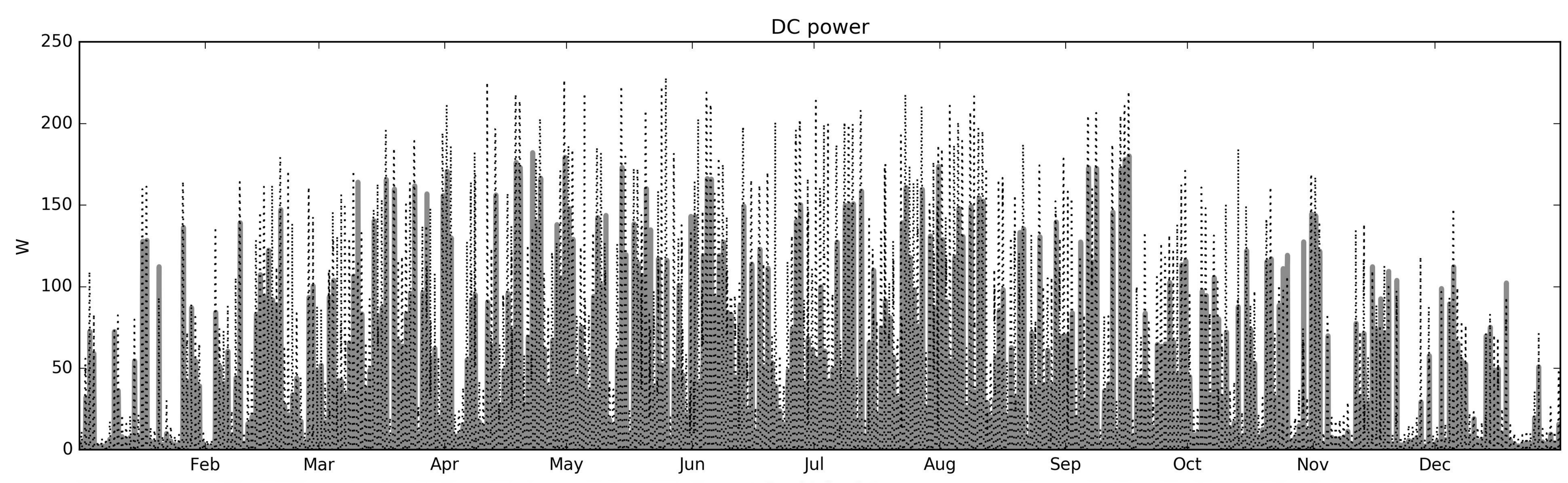
Dimensions	1300 x 875 x 6.5 mm

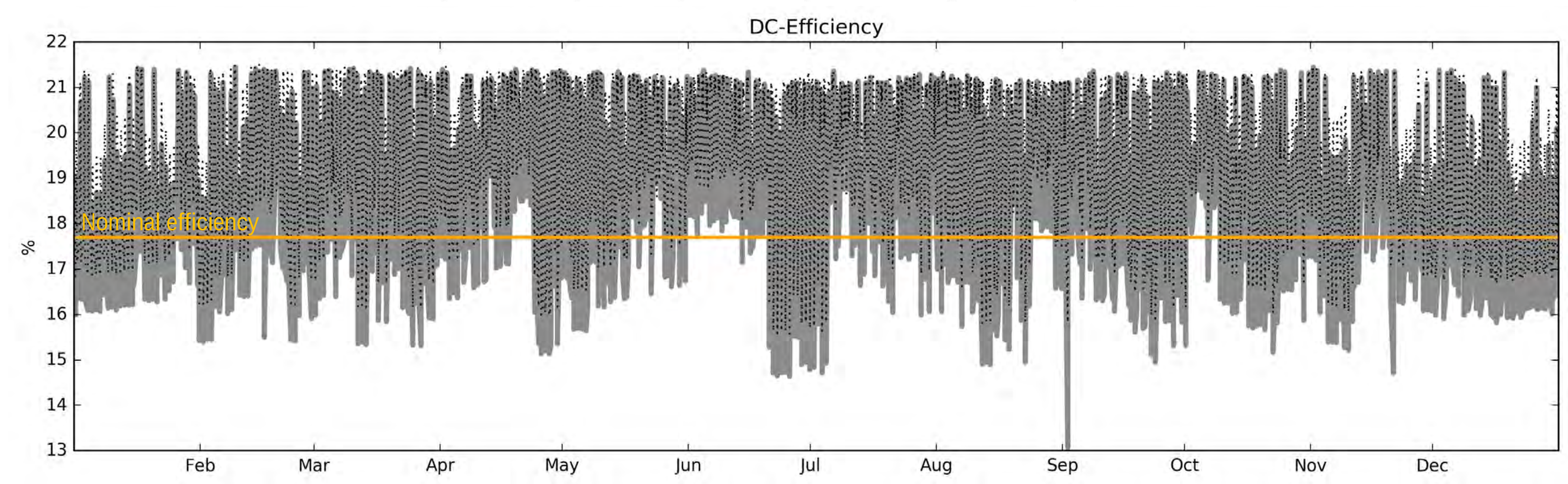
Specifications at STC	Value
Nominal efficiency	17.7%
Nominal output	185 Wp
Voltage U_{mpp}	21.8 V
Voltage I_{mpp}	8.5 A
Open circuit voltage U_{oc}	26.3 V
Short circuit current I_{sc}	9.0 A

Parameter for the De Soto model		Unit	Value
Modified diode ideality factor parameter at reference conditions	a_ref	A	1.2
Light-generated at reference conditions	I_L_ref	A	9
Diode reverse saturation current in amperes at reference conditions	I_o_ref	A	$1.02 \cdot 10^{-10}$
Series resistance at reference conditions	R_s	Ω	0.18
Shunt resistance at reference conditions	R_sh_ref	Ω	2200

///// BIPV yield







Conclusion / Outlook

The proposed method allows an early assessment of the BIPV potential of all building surfaces, taking into account shading and reflections from the urban context. The BIPV model considers the effective DC power due to cell temperature and irradiance effect. In the simulated case, we can see, for instance, that the efficiency is generally greater than at STC.

We showed a test application of the proposed workflow for some sample buildings in the city of Neuchâtel considering one single scenario, which includes, for instance, a typical meteorological year (TMY) and the absence of vegetation (e.g. as in winter, assuming deciduous vegetation). However, the workflow can be extended to include multiple simulation scenarios, which can provide confidence intervals so as to allow decision-makers account for the uncertainty of the simulated results.

Since the workflow is entirely automatized and based on standard geodata, we argue it can be applied up to the city-scale, allowing an estimation of the BIPV potential for urban planning applications. Future work include the application of the method for the whole city of Neuchâtel with multiple scenarios.

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

[1]Interdisciplinary Laboratory of Performance-Integrated Design (LIPID)
[2]Laboratory of Architecture and Sustainable Technologies (LAST)

Ecole polytechnique fédérale de Lausanne (EPFL)
*corresponding author: giuseppe.peronato@epfl.ch

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70 NRP Energy Turnaround National Research Programme

FNSNF Swiss National Science Foundation

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