Geophysical Research Abstracts
Vol. 18, EGU2016-15294, 2016
EGU General Assembly 2016

Linking top-down and bottom-up approaches for assessing the vulnerability of a 100 % renewable energy system in Northern-Italy

Marco Borga (1), Baptiste Francois (2), Benoit Hingray (2), Davide Zoccatelli (1), Jean-Dominique Creutin (2), and Casey brown (3)

(1) Università di Padova, Dip. Territorio e Sistemi Agro-Forestali, Legnaro, Italy (marco.borga@unipd.it), (2) CNRS, Laboratoire d'étude des Transferts en Hydrologie et Environnement, Grenoble, France, (3) Department of Civil and Environmental Engineering, University of Massachusetts Amherst, Amherst, Massachusetts, USA

Due to their variable and un-controllable features, integration of Variable Renewable Energies (e.g. solar-power, wind-power and hydropower, denoted as VRE) into the electricity network implies higher production variability and increased risk of not meeting demand. Two approaches are commonly used for assessing this risk and especially its evolution in a global change context (i.e. climate and societal changes); top-down and bottom-up approaches. The general idea of a top-down approach is to drive analysis of global change or of some key aspects of global change on their systems (e.g., the effects of the COP 21, of the deployment of Smart Grids, or of climate change) with chains of loosely linked simulation models within a predictive framework. The bottom-up approach aims to improve understanding of the dependencies between the vulnerability of regional systems and large-scale phenomenon from knowledge gained through detailed exploration of the response to change of the system of interest, which may reveal vulnerability thresholds, tipping points as well as potential opportunities.

Brown et al. (2012) defined an analytical framework to merge these two approaches. The objective is to build, a set of Climate Response Functions (CRFs) putting in perspective i) indicators of desired states ("success") and undesired states ("failure") of a system as defined in collaboration with stakeholders 2) exhaustive exploration of the effects of uncertain forcings and imperfect system understanding on the response of the system itself to a plausible set of possible changes, implemented a with multi-dimensionally consistent "stress test" algorithm, and 3) a set "ex post" hydroclimatic and socioeconomic scenarios that provide insight into the differential effectiveness of alternative policies and serve as entry points for the provision of climate information to inform policy evaluation and choice.

We adapted this approach for analyzing a 100 % renewable energy system within a region in Northern Italy. The main VRE available in the region are solar and hydropower (with an important fraction of run-of-the river hydropower). The indicator of success is the well-known 'energy penetration', defined as the percentage of energy demand met by the VRE power generation. The synthetic weather variables used for building the CRFs are obtained by perturbing the observed weather time series with the change factors method. A large ensemble of future climate scenarios from CMIP5 experiments are further used for assessing these factors for different emission scenarios, climate models and future prediction lead times. Their positioning on the CRFs allows discussing the risk pertaining to VRE penetration in the future. A focus is especially made on the different CRFs obtained from daily to seasonal time scales.