TITLE: **Hybrid Fuzzy Model Predictive Control for Smooth Transition of Voltage Source Inverters under Harmonics and Unbalances**		DATE: 05.02.2024
Object under Investigation (OuI) The OuI are the following: -Active Power Controller -PV in RTS -LCL filter in RTS -Converter in RTS -Inverter in RTS -Grid in RTS -Real Loads	**Test Objectives** A Voltage source inverter (VSI) based power generation system which consists of PV system inverter, LCL filter and grid connection is presented in this proposal. - - Expected outputs - Compensated line voltages at PCC under unbalanced load. - Provide a smooth transition between islanding and grid connection	**System under Test** (SuT): The specific test case is concerned with the performance of microgrids in terms of power balancing. A microgrid is usually connected to a Transmission/Distribution grid via a VSI. In the specific test case we consider a microgrid consisting of PV array , VSI, LCL filter controllable loads. At the Point of Common Coupling we have considered that the requirement is to balance the PV, production with the local consumption, thus minimising the power interchanges. To this end, a control system that controls the active power of loads in order to provide a smooth transition between islanding and grid connection. Overall, the SuT is depicted in -PV array in RTS -inverter in RTS -Grid in RTDS -Active Power Controller -Controllable loads
Function(s) under Investiga-tion (FuI) The specific FuI uses algorithm for synchronizing the load voltage with the grid voltage. This algorithm starts by calculating the phase and amplitude of the grid voltage vector and the load voltage vector. Then it compares the phase of the load voltage with the phase of the grid voltage as the reference phase. If the phase difference is within the acceptable range (usually around 0.1 degrees), the system will be connected to the grid and the	**Purpose of Investigation** (PoI) A smooth transition between grid connection and islanded mode that provide by control system Overall, the PoI is the characterisation of the controller's (FuI) and voltage -frequency flactuation performance (OuI).	**Functions under Test** (FuT) The function that is regarded as FuT in this TC is the voltage and frequency Controller. This function is a controller that uses the value of the measured grid voltage and frequency to provide a smoot transition.

power transfer will start. Otherwise, the system won't be allowed to connect to the grid until the phase difference is reduced. If the grid voltage phase leads the load voltage phase, the controller increases the load frequency; if the grid voltage phase lags the load voltage phase, the controller decreases the load frequency. Therefore, the phase difference between the grid voltage and the load voltage will be reduced before connecting to the grid		
Domain under Investigation (DuI)**:** The domains that are involved in the TC as DuI are the following: -Electric power domain -Primary source domain -Control domain The electric power domain is related to smoothing of voltage and frequency during transition between grid connection and islanding or vise-versa. As a matter of fact, most interactions of the system happen in this domain. The primary source domain plays a very crucial role in the performance of the smooth transition between two modes. Last but not least, the control domain is related to the connection of the control strategy to the loads in order to achieve the reference voltage and frequecny.	**Test criteria**: The test criteria for the success of the specific test are the minimization of the deviation of frequency and voltage during transition in the microgrid.	**variability attributes** (test fac-tors): In the specific TC the varying parameters are related to the Primary Source domain. Specifically, reference value of frequency and voltage which, in turn, specify the set-point for the load control. therefore they were considered important controllable variability attributes. The values that these parameters should assume are the following values: -Load deviation 0.2pu - -In terms of faults, the system should be subjected to sudden variations of the frequency and voltage as well as discrepancies in the load consumption.
target metrics (criteria) Comparison of reference frequency and voltage according to standards. In particular, the deviation of frequency and voltage show system performance. To this end, the deviation of frequency and voltage should be monitored and recorded every second for both quantities.	**quality attributes** (thresh-olds): The overall deviation of the frequency should not exceed %10 Instantaneously, the voltage should not differ more than 10% of the reference value.	