PAPER TITLE: **SIMULATION BASED SOLAR WATER HEATING SYSTEM OPERATION IN RESIDENTIAL ENVIRONMENT**

AUTHORS: *To be added upon potential acceptance of the manuscript*

SUBJECT: **APPENDIX 4 - *Experiment and Verification model concepts***

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1. Physical experiment concept

A hardware solution in terms of decentralized multi-channel stochastic (temperature, relative humidity, atmospheric pressure, irradiance, etc.) and process (flow) variables data logger which will serve as a real-time thermodynamic data processor is shown in the Fig. 1.

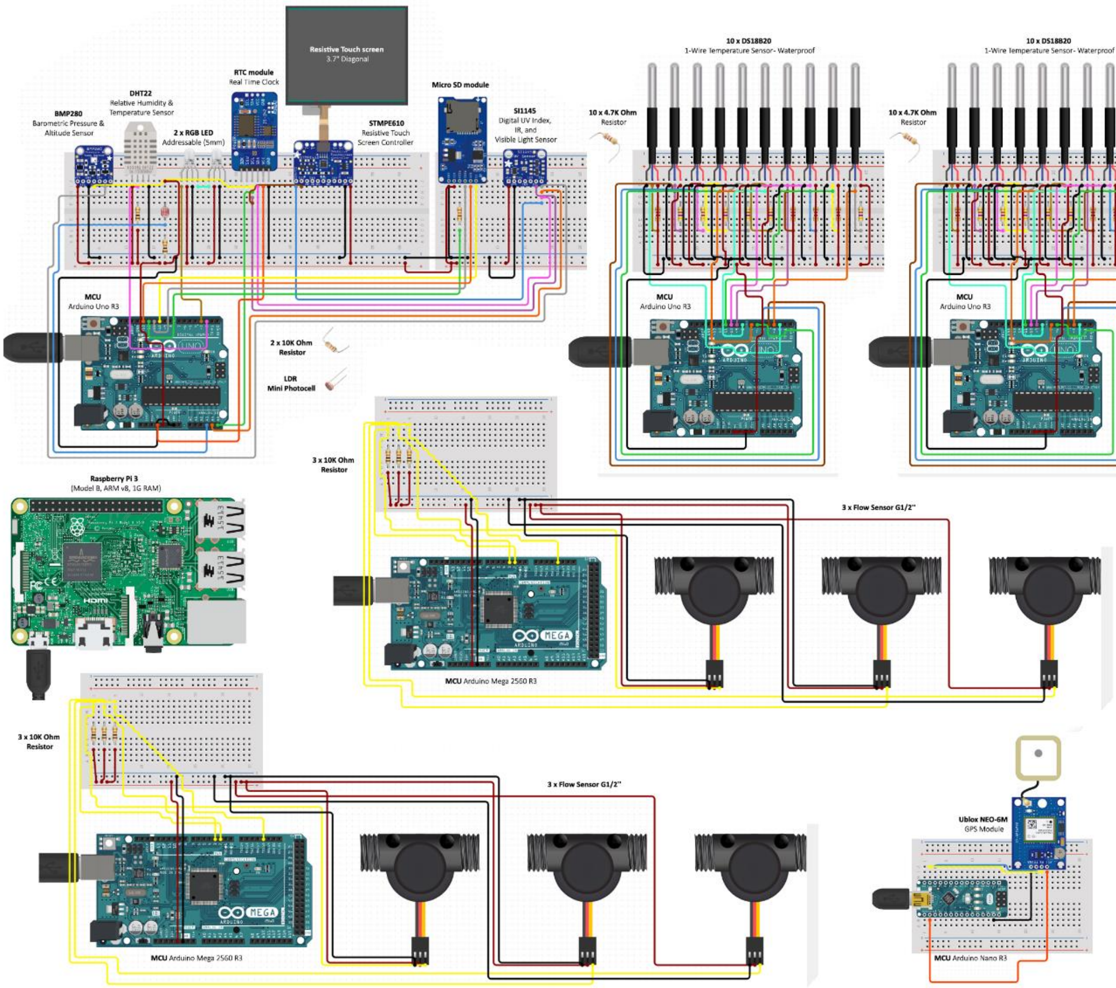

Fig. 1. Conceptual solution of thermodynamic data processor for physical experiment conduction

This network of devices are planned to be an integral part of the physical experiment setup, while the obtained data are subjected to a simulation procedure as given in Appendix 1 of this manuscript with small modification regarding tank temperatures data aggregation. This experimental setup disposes of 20 waterproof temperature probes, 6 flow sensors, Psychrometric set (Relative humidity, dry bulb temperature, and atmospheric pressure sensors), IR, UV and visible light sensors (for indirect irradiance estimation) accompanied by necessary modules for data localization, visualization, manipulation, preservation and time-step association.

2. Model for simulation verification, validation and justification

Upon data generation through experimental setup it would be possible to verify, validate and preferably justify the simulation results. For that purpose a simple data-centric model was designed and conceptualized in the Fig. 2.

The model is based on Python but developed in Anaconda environment which makes it suitable for further integrations and modifications regardless of which programming language is being used for further deployments.

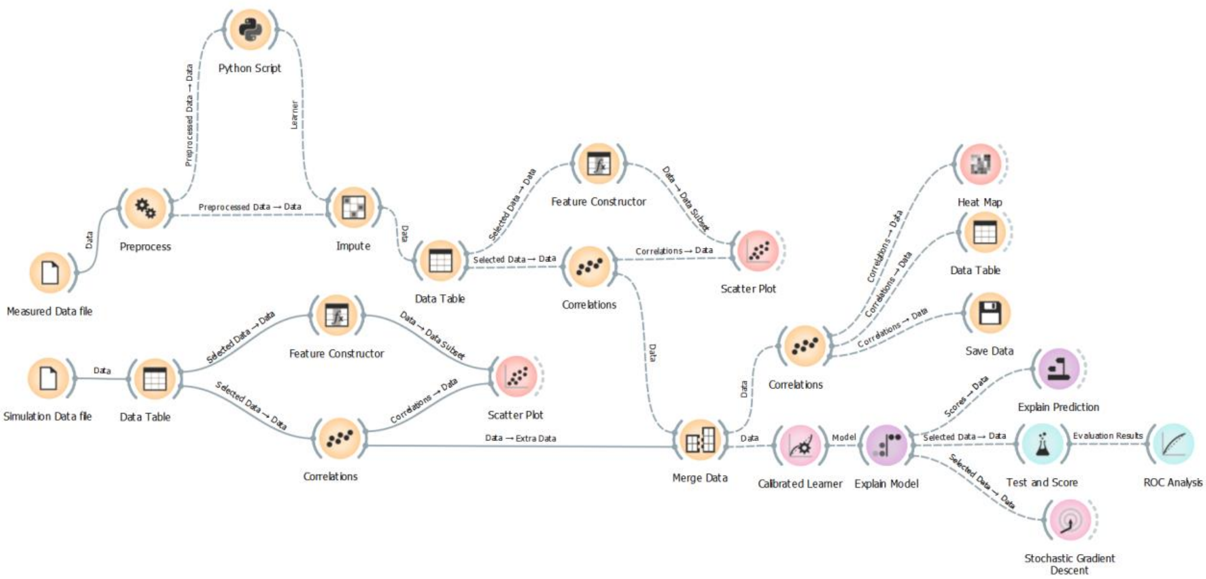

Fig. 2. Model for simulation verification, validation and justification

The model processes both, measured (based on calculation method given in the Appendix 1 generates data as in the simulation procedure) and simulation data (weather data and data generated through simulation process), allowing scripting, constructing, visualizing, etc., throughout the model data flow with aim to combine both data streams at one point (Merge Data) and subject them to classical correlation procedures at one, while simultaneously builds a calibrated learner model (a model that calibrates the distribution of class probabilities and optimizes decision threshold), evaluates it, tests it and returns model scores at the other hand.

Moreover, the model is capable to explain predictive model it generates in terms of which attributes and which values of those attributes are important, as well as which attributes contribute to the decision when making predictions. In situations with large data sets (as is the case in this study), the Stochastic Gradient Descent could be deployed to minimize a chosen loss function with a linear functions in which algorithm approximates a true gradient by considering one sample at a time, and simultaneously updates the model based on the gradient of the loss function. Finally, the ROC (results of testing classification algorithms) analysis can be used for comparison between observed models.