CLAIMS

1. A method for generating a model for determining a baseline energy efficiency of a Heating, Ventilating, and Air Conditioning (HVAC) unit, the method comprising

- receiving a plurality of sets of training measurement values of operational parameters of the HVAC unit, wherein the operational parameters comprise
- electrical powers of a plurality of chillers of a chiller assembly of the HVAC unit,
- a temperature of chilled water being supplied from the chiller assembly (CHWS_T),
- a temperature of the chilled water being returned to the chiller assembly (CHWR_T), and
- a flow rate of the chilled water (CHW_F) in a chilled water loop of the HVAC unit,
- computing a value of efficiency of the HVAC unit for each set of the operational parameters, the value refers to a ratio of a sum of the training measurement values of the electrical powers of the chillers to a total cooling load (RT) of the HVAC unit, wherein the total cooling load (RT) refers to a product of
- a constant value,
- a difference between a training measurement value of the temperature of the chilled water being supplied from the chiller assembly (CHWS_T) and a training measurement value of the temperature of the chilled water being returned to the chiller assembly (CHWR_T), and
- a training measurement value of the flow rate of the chilled water (CHW_F) in the chilled water loop of the HVAC unit,

- performing an analysis between the computed efficiency and the operational parameters to determine a correlation coefficient of each operational parameter,
- selecting operational parameters, wherein the correlation coefficient of each selected operational parameter is larger than a predetermined selection value, wherein the selected operational parameters consist of the electrical powers of the chillers, the temperature of the chilled water being supplied from the chiller assembly (CHWS_T), the temperature of the chilled water being returned to the chiller assembly (CHWR_T), and the flow rate of the chilled water (CHW_F) in the chilled water loop,
- providing a plurality of training sets, each training set comprising training measurement values of the selected operational parameters and a corresponding computed value of the efficiency,
- training a model based on the training sets to generate a trained model, the model comprising a machine learning algorithm, wherein the trained model is adapted to provide a baseline efficiency according to the training measurement values of the selected operational parameters.

2. A method for detecting an anomaly in energy efficiency of a Heating, Ventilating, and Air Conditioning (HVAC) unit in real time, the method comprising

- capturing operational measurement values of selected operational parameters of the HVAC unit,

wherein the selected operational parameters consist of

- electrical powers of a plurality of chillers of a chiller assembly of the HVAC unit,

- a temperature of chilled water being supplied from the chiller assembly (CHWS_T),
- a temperature of the chilled water being returned to the chiller assembly (CHWR_T), and
- a flow rate of the chilled water (CHW_F) in a chilled water loop of the HVAC unit,
- computing (a value of) an operational efficiency of the HVAC unit, the (value of the) operational efficiency refers to a ratio of a sum of the operational measurement values of the electrical powers of the chillers to a total cooling load (RT) of the HVAC unit, wherein the total cooling load (RT) refers to a product of
- a constant value,
- a difference between an operational measurement value of the temperature of the chilled water being supplied from the chiller assembly (CHWS_T) and an operational measurement value of the temperature of the chilled water being returned to the chiller assembly (CHWR_T), and
- an operational measurement value of the flow rate of the chilled water (CHW_F) in the chilled water loop of the HVAC unit,
- generating an operational baseline efficiency of the HVAC unit according to the operational measurement values of the selected operational parameters based on a trained model,
- computing a difference between the operational baseline efficiency and the computed operational efficiency, and
- sending a warning signal if the difference is larger than a predetermined deviation value.

3. The method according to one of claim 1 or 2, wherein the selected operational parameters further consist of a

temperature of condenser water being supplied to the chiller assembly (CDWS_T), a temperature of condenser water being returned from the chiller assembly (DWR_T), a flow rate of the condenser water (CDW_F) in a cooling tower loop, a wet-bulb temperature, and a dry bulb temperature of the HVAC unit.

4. The method according to one of claims 1 to 3, wherein the trained model is adapted to provide the baseline efficiency according to a configuration of the chillers comprising at least one operating chiller and at least one non-operating chiller.

5. The method according to one of claims 1 to 4, wherein the trained model comprises a machine learning algorithm, wherein the machine learning algorithm refers to a regression tree algorithm.

6. The method according to claim 5, wherein the regression tree algorithm refers to a random-forest algorithm.

7. The method according to one of claims 2 to 6, wherein the predetermined deviation value is 10 percent.

8. The method according to one of claims 2 to 6 further comprising executing a fault detection and diagnostic algorithm to identify causes of the warning signal.

9. The method according to claim 8 further comprising providing a remedial action plan.

10. A controller for operating a Heating, Ventilating, and Air Conditioning (HVAC) unit, wherein the controller comprises interfaces for a plurality of sensors that are provided for capturing operational parameters of a chilled water loop, of a

cooling tower loop, and of a chiller assembly comprising a plurality of chillers of the HVAC unit,

wherein the controller is adapted to issue signals to the interfaces for receiving the operational parameters, and

wherein the controller is adapted to perform steps of a method according to one of claims 2 to 9 to detect an anomaly in the energy efficiency of the HVAC unit.

11. The controller according to claim 10, wherein the chilled water loop comprises at least one electric chilled water pump, wherein chilled water is circulating in the chilled water loop.

12. The controller according to claim 10 or 11, wherein the cooling tower loop comprises at least one cooling tower with at least one electric condenser water pump, wherein condenser water is circulating in the cooling tower loop.

13. The controller according to one of claims 10 to 12, wherein the chiller comprises a thermodynamic refrigeration cycle that interconnects with the chilled water loop and with the cooling tower loop such that heat is transferred from the chilled water to the condenser water.

14. A HVAC unit comprising a controller according to one of claims 10 to 13.