CLAIMS

What is claimed is:

1. A method for scheduling a heating, ventilation and air-conditioning (HVAC) system, wherein the HVAC system comprises an air conditioning plant, at least one air handling unit (AHU) in connection with the air conditioning plant, and the at least one AHU is configured to serve a plurality of zones, the method comprising:

obtaining zone environmental information including a zone temperature, a zone air quality indicator and zone set-points for the plurality of zones, the zone set-points for the plurality of zones comprising zone temperature set-points and zone air quality set-points;

obtaining conditioned air temperature and conditioned air quality indicator of conditioned air associated with the at least one AHU and fresh air temperature of fresh air configured to mix with return air of the conditioned air to form pre-conditioned air; and

determining, for the at least one AHU and for a prediction horizon, a minimum conditioned air supply rate and a return air ratio based on a conditioned air function of parameters including the zone temperature, the conditioned air temperature, the fresh air temperature, the zone air quality indicator and the conditioned air quality indicator so as to collectively meet the zone set-points for the plurality of zones,

wherein the at least one AHU comprises a damper opening configured to vary the return air ratio by adjusting positions of the damper opening,

the method further comprising:

determining an average return air ratio across the positions of the damper opening, and determining differences between the return air ratio when the damper opening is at each of the positions and the average return air ratio.

2. The method of claim 1, wherein the conditioned air quality indicator is determined by an air quality indicator of the return air, an air quality indicator of the fresh air and the return air ratio.

3. The method of claim 1 or claim 2, wherein the zone air quality indicator includes zone carbon dioxide (CO_2) concentration data, wherein the zone carbon dioxide (CO_2) concentration data at a succeeding time period within the prediction horizon is determined by a carbon dioxide (CO_2) concentration dynamic model as a multi-component function including a plurality of components relating to zone parameters selected from a group of air volume, air density, carbon dioxide (CO_2) generation rate of occupant(s) and/or equipment(s) of a respective zone of the plurality of zones.

4. The method of any of claims 1 to 3, wherein the zone temperature of a succeeding time period is defined as a temperature linear function of the zone temperature of a present time period within the prediction horizon, a zone air conditioning load, a mass flow rate of conditioned air supply in a respective zone of the plurality of zones and the conditioned air temperature.

5. The method of claim 1, further comprising:

setting a lower bound and an upper bound for an air conditioning load associated with the at least one AHU,

wherein the lower bound is set when the return air ratio is at a maximum and the upper bound is set when the return air ratio is zero,

wherein the air conditioning load is set between the lower bound and the upper bound.

6. The method of claim 5, further comprising:

(i) obtaining a parameter relating to a coefficient of performance of the air conditioning plant;

(ii) determining the parameter relating to the coefficient of performance of the air conditioning plant to be a first parameter if the air conditioning load associated with the at least one AHU is less than or equal to a first predetermined threshold;

(iii) determining the parameter relating to the coefficient of performance of the air conditioning plant to be a second parameter if the air conditioning load associated with the at least one AHU is less than or equal to a second predetermined threshold and greater than or equal to the first predetermined threshold; and

(iv) continuing step as described in (iii) until the air conditioning load associated with the at least one AHU is greater than a last predetermined threshold, and determining the parameter relating to the coefficient of performance of the air conditioning plant to be a last parameter.

7. The method of claim 6, further comprising:

optimizing the return air ratio based on an optimization function of the determined parameter relating to the coefficient of performance of the air conditioning plant and the differences between the return air ratio when the damper opening is at each of the positions and the average return air ratio.

8. The method of claim 7, further comprising:

mapping a conditioned air coupling based on a zone damper opening for the plurality of zones and a fan supply air pressure for the at least one AHU to a mass flow rate of conditioned air supply for the plurality of zones.

9. The method of claim 8, further comprising:

communicating the optimized return air ratio to a scheduler;

receiving, at the scheduler, the optimized return air ratio and energy efficiency data of the air conditioning plant;

balancing the optimized return air ratio against the parameter relating to the coefficient of performance of the air conditioning plant for a subsequent time period;

calculating an air supply strategy based on the balancing, the air supply strategy comprising a conditioned air supply allocation for the plurality of zones in the subsequent time period to minimise energy consumption of the air conditioning plant while aiming to meet the zone set-points; and

delivering the air supply strategy to the plurality of zones.

10. A system for scheduling a heating, ventilation and air-conditioning (HVAC) system, wherein the HVAC system comprises an air conditioning plant, at least one air handling unit (AHU) in connection with the air conditioning plant, the at least one AHU is configured to serve a plurality of zones, the system comprising:

a zone module configured to obtain zone environmental information including a zone temperature, a zone air quality indicator and zone set-points for the plurality of zones,

the zone set-points for the plurality of zones comprising zone temperature set-points and zone air quality set-points;

an input module configured to obtain conditioned air temperature and conditioned air quality indicator of conditioned air associated with the at least one AHU and fresh air temperature of fresh air configured to mix with return air of the conditioned air to form pre-conditioned air; and

a scheduler, for the at least one AHU and for a prediction horizon, configured to determine a minimum conditioned air supply rate and a return air ratio based on a conditioned air function of parameters including the zone temperature, the conditioned air temperature, the fresh air temperature, the zone air quality indicator and the conditioned air quality indicator so as to collectively meet the zone set-points for the plurality of zones,

wherein the at least one AHU comprises a damper opening configured to vary the return air ratio by adjusting positions of the damper opening,

wherein the scheduler is further configured to determine an average return air ratio across the positions of the damper opening, and determining differences between the return air ratio when the damper opening is at each of the positions and the average return air ratio.

11. The system of claim 10, wherein the conditioned air quality indicator is determined by an air quality indicator of the return air, an air quality indicator of the fresh air and the return air ratio.

12. The system of claim 10 or claim 11, wherein the zone air quality indicator includes zone carbon dioxide (CO_2) concentration data, wherein the zone carbon dioxide (CO_2) concentration data at a succeeding time period within the prediction horizon is determined by a carbon dioxide (CO_2) concentration dynamic model as a multi-component function

including a plurality of components relating to zone parameters selected from a group of air volume, air density, carbon dioxide (CO_2) generation rate of occupant(s) and/or equipment(s) of a respective zone of the plurality of zones.

13. The system of any of claims 10 to 12, wherein the zone temperature of a succeeding time period is defined as a temperature linear function of the zone temperature of a present time period within the prediction horizon, a zone air conditioning load, a mass flow rate of conditioned air supply in a respective zone of the plurality of zones and the conditioned air temperature.

14. The system of claim 10, wherein the scheduler is further configured to:

set a lower bound and an upper bound for an air conditioning load associated with the at least one AHU,

wherein the lower bound is set when the return air ratio is at a maximum and the upper bound is set when the return air ratio is zero,

wherein the air conditioning load is set between the lower bound and the upper bound.

15. The system of claim 14,

wherein the input module is further configured to:

(i) obtain a parameter relating to a coefficient of performance of the air conditioning plant;

wherein the scheduler is further configured to:

(ii) determine the parameter relating to the coefficient of performance of the air conditioning plant to be a first parameter if the air conditioning load associated with the at least one AHU is less than or equal to a first predetermined threshold;

(iii) determine the parameter relating to the coefficient of performance of the air conditioning plant to be a second parameter if the air conditioning load associated with the at least one AHU is less than or equal to a second predetermined threshold and greater than or equal to the first predetermined threshold; and

(iv) continue step as described in (iii) until the air conditioning load associated with the at least one AHU is greater than a last predetermined threshold, and determine the parameter relating to the coefficient of performance of the air conditioning plant to be a last parameter.

16. The system of claim 15, wherein the scheduler is further configured to:

optimize the return air ratio based on an optimization function of the determined parameter relating to the coefficient of performance of the air conditioning plant and the differences between the return air ratio when the damper opening is at each of the positions and the average return air ratio.