Tutorial on using IPV definition to scale models

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Introduction

Simulations of complex buildings demand considerable computing resources and, more importantly, considerable staff resources. Increases in the number of zones and surfaces or patterns of use (controls & occupancy) are costly in terms of QA. Sometimes it is useful answer a question about annual performance without having to run a simulation at a ten minute timestep over a whole year. Sometimes it is useful not to have to represent all the intermediate floors of a office block.

Astute practitioners have often created abstract simulation models which represent a design with limited geometric complexity. Reducing simulation assessment resources by scaling short period simulations to seasonal performance has also been possible. In both approaches, practitioners have been confronted by the need to scale portions of the model or apply multipliers to results.

New facilities associated with the creation of Integrated Performance Views (IPV) in the climate module and the project manager should allow practitioners greater flexibility to scale their models and performance results. Here is a summary of what is now available:

clm module

The climate module has extended facilities for defining seasons (3 or 5) and then searching for "best fit" weeks in each season (based on user-supplied criteria) and reporting on multipliers for heating and cooling demands as well as time-based demands.

project manager

The project manger now scans the current climate database as well as the ‘climatelist‘ file (using the same method as the climate module) and use this to set up sets of simulation parameters (which are used to automate simulation assessments).

The facilities for defining an IPV have been revised to allow more flexibility on how assessments are undertaken, the performance metrics included and how information can be transformed into annual whole-building performance predictions.

Integreated Performance Views

The definition of an IPV has been revised to allow different assessment approaches: an annual simulation, three assessments (winter/transition/summer) or five assessments (winter/spring/summer/autumn/winter).

The definition of an IPV now includes user definable performance metrics (currently zone resultant temperature, zone dry bulb temperature, zone relative humidity, zone infiltration loads, zone casual gains, solar entering and solar absorbed in a zone). Each metric is associated with a list of zones and has an associated scaling factor. For example - demands found in one actual zone could be scaled to the demands of a larger portion of the building.

The existing concept of energy demand sets (i.e. a list of zones which are treated in aggregate) has been expanded to allow up to ten different energy demand sets, each with an associated list of zones and a scaling factor.

The reported performance metrics include the seasonal multipliers as well as the zone scaling. That saves lots of calculator and/or spreadsheat time.

Seasons

Seasons can represent either observed patterns in the climate (for example Spring tends to be rather short in Ottawa) or be set to represent seasonal usage patterns in the building (which might have little to do with what is happening outside).

Information on seasons and best fit weeks is now held in the ‘climatelist‘ file (but at this point a text editor is required to update this file for each new climate file).

In the northern hemisphere the five seasons are: winter starting in January, spring, summer, autumn and winter ending in December. For three seasons the multipliers combine the two winters and combine spring and autumn.

Best weeks

The concept of a best-week is based on a determination of the heating and cooling degree days in each season as well as the available solar radiation. Each week is scanned in turn to find one with the least difference in these parameters.

Tests indicate that seasonal demands predicted by this approach can be within a few percent of that predicted by simulating each day of the season - if degree days correlate well with the performance of a particular design.
Although the automated process assumes weekly assessments, the user is free to user other periods and supply other multipliers (for example, to ensure that capacity issues are addressed).

The descriptive process

The extension of a model description required to support zonal scaling and seasonal multipliers requires several steps.

planning
: Begin with a clear idea of what types of model scaling and seasonal multipliers are relevant to the current model. You might, for instance have created a model with a pair of zones which are typical of corner offices on five floors, an office which is typical of west-facing mid-facade conditions, a typical corridor and a number of one-off rooms. You have the option to create a number of sets of performance metrics (e.g. comfort in corner offices vs comfort in one-off rooms) as well as the option to define several energy demand sets in order to arrive at whole-building predictions.

setting context
: In the project manger choose Model Definition -> model context -> primary energy conversions. This facility defines the relationship between demands (heating/cooling/lighting/fans/small power/hot water) and primary energy supplies. These figures can include a factor for seasonal efficiency should such information be available.
: The facility also allows you to define the emissions (g/kWh) for each kWh of primary energy. This supports the testing design variants for lower emissions.

setting distributed demands
: Within the ‘Site information‘ menu is an entry for dispersed fans/lifts/DHW demands. If the normalised performance of a building is dependant on casual gains which are not directly attributable to a thermal zone, this is the place to supply such schedules (either absolute Watt or on a per mˆ2 basis).

IPV definitions

Within the ‘Site information‘ menu is an entry for Integrated Performance Views. Select this and fill in the title, version and synopsis (which will help clarify reports if there are several variants).

IPV metrics
: Below the general information is an entry ‘performance metrics‘. Selecting this will open a new menu where you can add new metrics or delete existing metrics. To edit an existing metric select it and you will be presented with:

a) a list of available metrics,

b) a list of zones to associate with this metric. Remember you can select this metric several times, each with a different set of zones,

c) you will be asked to confirm the total floor area of zones included in the list,

d) you will be asked which casual gain to associate with occupancy (i.e. comfort might only need to be tested during occupied periods),

e) check the metrics by requesting a listing.

demand sets

Demand sets are defined via the ‘demand set‘ option. A demand set is a list of zones for which a standard set of performance metrics (statistics/timestep data/frequency bins) are created. You may create up to 10 demand sets. You will be asked:

a) a logical name for the demand set,

b) a list of zones associated with the demand set,

c) the floor area of the zones associated with the demand set,

d) a multiplier to be applied to predictions - e.g. to have the performance of this set of zones represent the performance of a larger portion of the building. This multiplier should have been defined in the planning stage above.

e) There is a toggle ‘timestep aggregate ON/OFF‘ which will include or exclude timestep reporting of the aggregate (normalised) predictions for all the defined energy demand sets.

The ‘IPV simulations‘ section takes a user directive for the number of assessments to be carried out and revises the interface to report on the seasons associated with the current climate database (assuming that the ‘climatelist‘ file has been updated to hold this information).

A single assessment would typically be a literal year, however a shorter period could be defined if, say only cooling was an issue in the design. The choice of three or five assessments depends on how similar spring and autumn are and whether the winter in, say November - December is rather different than winter in January - February.

Assuming the user toggles to five simulations each of the simulation periods will be displayed along with a logical name (which should not be edited).

display days

The entry display days defines a list (up to 10 separate days) on which detailed (timestep) data will be produced for each of the demand sets and performance metrics. Check that these days actually fit within the assessment periods.

ratios

One section of the IPV interface relates to the ratios between the period assessed and the whole season for heating, cooling, lighting, small power, fans and DHW. At the bottom of this section is a option ‘rescan‘. Recan work in two phases, the first scans the climate list for seasons and the second derives heating degree day ratios, cooling degree day ratios and time ratios. You will be asked:

a) to confirm the base temperature for heating and cooling,

b) the degree days and radiation will be reported for each of the seasons

c) next confirm the weightings for heating degree days, cooling degree days and solar radiation. Initially these are all set to unity (each has the same importance). To ignore solar radiation its weighting would be set to zero.

d) for each season the best fit week will be presented. This is a shortened version of the report in the climate module. If you want to know more about other weeks that were not selected then use the climate module.

At this point the main IPV menu will be presented, updated for the ratios. This concludes the definition of an IPV, when you exit this a compatible set of simulation parameter sets will have been defined.

Simulation and recovery

In the Actions section of the project manager ‘Model definition‘ menu, both the simulation and results analysis facilities will now be able to take into account the information held in the IPV and the directives setup

in the simulation parameter sets.

simulation
: selecting the simulation option will present a menu that already includes five simulation presets (based on the earlier IPV definitions).

integrated performance view
: The option at the bottom of the ‘simulation controller‘ menu named ‘integrated performance view‘ allows you to invoke all of the required simulations as well as extract the report for the metrics and energy demand sets defined in the IPV. Typically, simulations will be run in ‘silent running mode‘ rather than ‘run interactively‘.

extract results
: After assessments are run, re-select the IPV menu and choose ‘extract results‘. Again you will typically want to do this in ‘silent running mode‘. You will then be asked if you want to extract intermediate results, extract an annual summary from the intermediate results or do all. Typically you can do all at one time. Note: only one report file is generated, regardless of the number of assessments that were run. You will be asked one question about the output format - select the ‘comma separated‘ option.

The report that is generated is a compromise between begin machine-readable and human-readable. There is a java display tool which is under development which should take the report file as its input.