EnergyPlus New Features Planning for FY19

Each year, the EnergyPlus development team seeks input and feedback regarding new feature development for the upcoming year. Features are selected based on impact, demand, effort, and available developer expertise. Input from stakeholders is a crucial component of this process, and selected stakeholders were polled for their priorities. The stakeholders were asked to specify up to five new features for consideration for FY19.

The new features that were suggested were considered alongside all other requests and prioritized accordingly. Most of the requests that were rated as "high priority" or "medium priority" have been assigned to one of the three laboratories (NREL, LBNL, or ORNL). This does not guarantee that the feature will be implemented since a performer will still need to be identified (from laboratory staff or a subcontractor), but every effort will be made to implement these features in FY19. A few features that were rated highly but were deemed to be too large in scope are unlikely to be implemented in FY19, but discussions will continue (see items below with a single asterisk in the assigned lab column). Items that span multiple rows (e.g. item #1) were submitted separately but were combined during the prioritization process. The numbering of the items is for organizational purposed only. Features judged to be "low priority" will not be pursued at this time. Some requests were judged to be out of scope for the new features task (e.g. defects, code refactoring, or performance improvements) but may be addressed as part of separately funded work.

High Priority Feature Requests

#	Title	Description	Requester	Assigned Lab
	Improve airside economizer modeling in VAV Changeover Bypass system	Currently VAV Changeover Bypass does not permit modeling an outdoor air economizer with the OA mixer. There is a workaround that involves setting the OA mixer OA flow to zero, adding a second OA Mixer between return zone airflow and the Bypass Mixer and modeling the economizer for that second OA Mixer. However, for cases where the bypass airflow is a significant fraction of supply airflow, this will overstate the free-cooling effect of the economizer and skew energy modeling results. Since outdoor air economizers are required by Standard 90.1 for many applications, accurate modeling of OA economizer at the OA mixer for this system type is important.	Carrier	NREL
1	Add 'load priority control' model in VAV Changeover Bypass system	Currently this system type offers “CoolingPriority” “HeatingPriority” and “ZonePriority” control options. With these options, the system tends to get "stuck" in one mode (cooling or heating) or else frequently cycles between cooling and heating modes. Actual systems have schemes for switching from cooling to heating mode at appropriate intervals to ensure one demand or the other is not neglected. A Carrier document was provided with the original correspondence (embedded at right) explaining how the mode of operation is determined by comparing the total zone cooling demand and heating demand and also considering a minimum elapsed time interval. This tends to prevent the system from staying in one mode (like cooling) all the time so it can't serve simultaneous heating demands. Adding this option would yield more accurate simulation of this type of system.	Carrier	NREL

2	Heat emissions from buildings	Heat emissions from buildings are a crucial component influencing urban microclimate, e.g., urban heat island effect and climate change. However, this component has never been reported in EnergyPlus. We propose to calculate the heat emissions from buildings with a bottom-up approach using the EnergyPlus and set them as reportable variables. The heat emissions from a building includes heat releases from four levels of building components: (1) building envelope – exterior surface convection heat transfer to the ambient air, (2) zone - exhaust air or exfiltration to ambient, (3) HVAC system - relief/exhaust air and condensers (evaporators for heat pumps), and (4) central plant – cooling towers of water-cooled chillers, gas-fired boilers and furnaces. The feature would allow users to quantify the dynamic behavior of heat emissions, and analyze their influencing factors including building use types, vintage, and climate.	LBNL	LBNL
3	Model DOAS supplying air to inlets of multiple AHUs	This feature develops the modeling and simulation approach for a dedicated outdoor air system (DOAS) connected to multiple air handling units (AHUs). Many buildings have a separate DOAS system that feeds outdoor air directly to individual AHUs on each building floor. Currently EnergyPlus can only model a DOAS delivering outdoor air directly to zones or to the inlet or outlet of zone equipment acting as terminal units. This feature will allow a single DOAS to supply air to the outdoor air inlet of multiple air systems.	LBNL, Carrier, University of Colorado	NREL
	Ability to attach DOAS to multiple rooftop units	Ability to attach one DOAS to multiple AirLoopHVAC objects would be helpful to model: DOAS connected to multiple rooftop units (or) multiple SZVAV/SZCV units	Trane	NREL
4	Intermittent fan operation, i.e., runtime fraction, during a given timestep.	EnergyPlus either cycles the coil (then the fan runs constantly) or it cycles the fan. While this behavior might be reasonable for energy use, it is unrealistic with respect to building infiltration, interzone airflow, and contaminant transport.	NIST	NREL
5	Multiyear Scheduling	Multiyear scheduling is not currently possible with schedule input objects, and this is a blocker for multiyear simulations in which schedules change from year to year (e.g. multiyear calibration). Need the ability to run multiyear (including midyear start and end dates) run periods with schedule files.	NREL	NREL

6	Add Supplemental Heating Coil option to VRF Terminal Unit	Problem: There is currently no way to include a supplemental heater in VRF zone terminal units. Rationale: VRF systems may not have sufficient heating power during extremely cold conditions and require backup electric resistance heaters in the terminal units. Heat pump systems may experience simultaneous heating and cooling loads and when in cooling mode the zones that lost the vote for heating could still heat with supplementary heat. Other air system heat pump equipment in EnergyPlus have supplemental heaters. Solution: Include supplemental heating coil option in ZoneHVAC:TerminalUnit:VariableRefrigerantFlow object	NREL	NREL
7	System Fan Object Support with Airflow Network	Support for the new system fan object recently added. This new fan is intended to replace the older fan objects, so it is relatively important that this object be supported with Airflow Network.	NREL	NREL
8	Ground Heat Exchanger Sizing	The EnergyPlus ground heat exchanger model requires third-party tools to size the ground heat exchanger. This capability should be incorporated into the EnergyPlus so these tools are no longer required.	Oklahoma State University	NREL
9	Synchronize KIVA interior convection model with specified room model.	Replace the TARP algorithm in KIVA with a virtual function that can be set by the calling program. This allows the convection model used in KIVA to be synchronized with the convection model used by the room. For example, suppose a room is supplied by a forced air HVAC system such as VAV. The room would be modeled to use the 'ceiling diffuser' convection model since wall, ceiling, floor surfaces in the room will experience forced convection. When the room also contains ground connected elements like slab on grade floor, basement floor, or basement wall modeled via KIVA, those surfaces will automatically use the TARP model representing natural convection, and as a result will likely underestimate the convective heat flow between the surface and the room air. If KIVA could use the same convection model as used for the rest of the room, that would synchronize convection modeling between KIVA and the rest of the room and enhance the accuracy of load calculations. Allowing the calling program (EnergyPlus) to specify convection model via a virtual function allows this synchronization of convection algorithms.	Carrier	ORNL

10	Improved Infiltration Models for Refrigeration	Infiltration (doors opening and closing, flow through gaps and gasket failures, etc.) plays an enormously important role in the energy use of refrigerated cases and walk-ins, but EnergyPlus does not dynamically model the impact of the various air exchanges that are possible. This feature would be a differentiating capability and allows for the assessment of measures that reduce unwanted air movements.	NREL	*
11	Ability to model Air Wall without workarounds (**higher priority**)	Ability to place multiple air wall object without any workarounds (like glass on a small opaque surface) is very critical to industry. There should be an easy way to define air thermal boundaries in spaces to let light pass through and also account for thermal energy transfer. Air walls are very common among energy modelers.	Trane	NREL*
12	Allow evaporative coolers to cycle	Problem: Many residential evaporative cooling technologies (e.g., swamp coolers) are controlled to cycle on and off to meet the load. As stated in the I/O reference, these units cannot cycle, meaning that their pumps run continuously even when the required airflow rate is close to zero. Solution: Give zone evaporative coolers the capability to cycle like unitary equipment.	NREL	Prioritized as a defect
13	Standardize simulation outputs in XML or JSON format		Digital Alchemy	ORNL+
14	Improving output metrics for time sensitive valuation of energy efficiency in EnergyPlus	For example, including breakouts of energy use (and CO2 and cost, if possible) by peak, mid-peak, and off-peak periods; peak/off-peak cost delineations would require the application of time-of-use electricity rates or something similar to simulated energy use totals. Note that in a recent survey we conducted about time-sensitive valuation of energy efficiency capabilities in DOE tools, one user commented that these breakouts are already available in EnergyPlus, but I didn't think they were.	LBNL	LBNL
15	Add Air-to-Water Heat Pump	This is a long-standing feature request for a system commonly used in NZE building design.	NREL	NREL+
16	Updating performance curve objects on Water To Water HP models	Ability to use more advanced curves (similar to chiller reformulated model) to model WWHP.	Trane	NREL+

Key: * item is very large in scope, + item is in progress

Note: The numbering in the table is for organizational purposes only and is not related to the priority of the request.

Medium Priority Feature Requests

#	Requester	Title	Description	Requester	Assigned Lab
17	LBNL	Sky radiant cooling using materials with selective spectral properties	New materials are emerging that can radiate heat to deep sky even under the sun. This new feature request will enable EnergyPlus to model this type of materials with selective spectral properties of emissivity and absorptance. Two such technologies are Radi-Cool and SkyCool.	LBNL	LBNL
18	ORNL	Hygrothermal Modeling Improvements	Additional tasks are needed for first class performance including critical air leakage paths with an envelope, surface heat and moisture transfer values, precipitation absorption and intrusion, ASHRAE 160 mold growth, condensate, and storage.	ORNL	ORNL
19	University of Colorado	Add ability to model ice rinks	Problem: Ice rinks are not common, but they do have significant energy implications that are not captured in EnergyPlus. This would probably require indoor vs. outdoor objects (like swimming pools). There's a PhD dissertation from CU Boulder that did provided details on how to implement an indoor ice rink thermal model into EnergyPlus.	University of Colorado	NREL

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Low Priority Feature Requests

Title	Description	Requester
Co-simulation value delay	Co-simulation values passed to EnergyPlus by CONTAM are not used until two time steps later. This was reported to LBL, but apparently there is no way around this issue.	NIST
Enhanced GroundHeatExchanger:Pond Model	Current EnergyPlus pond heat exchanger model does not support freezing of the water body. This is physically possible, and systems exist today where this behavior occurs. OSU has collected experimental data from pond heat exchangers where freezing on the coil occurred. They have also developed models for this behavior.	Oklahoma State University
Offer equal functionality between platforms (DOS/Mac/Linux)	EP-Launch is almost done, may need more improvements. Finishing up IDF Editor and possibly adding JSON support would be the next big thing.	GARD
Support BTO GEB (DR flexibility, TSV, MELs)	BTO has a new initiative GEB which will improve interactions between buildings and their serving electric grid, considering the dynamics and flexibility of energy supply, demand as well as storage. Sensing and controls are critical to enable GEB at the individual and group of buildings. This new feature request will enable EnergyPlus to support the modeling of GEB related technologies and strategies.	LBNL, University of Colorado**
Improving representation of MELs in commercial prototype models	We are improving the granularity of MELs end use representation in Scout (https://scout-bto.readthedocs.io/en/latest/); it would be helpful if EnergyPlus outputs represented MELs end uses of particular interest. As I understand it, MELs can be represented as equipment/plug load objects in EnergyPlus but specific MELs are not necessarily broken out in results for prototype buildings.	LBNL++
Model a chiller with multiple compressors	Right now, E+ can't model a chiller with multiple compressors, because the chiller reference capacity has the linear relationship with chiller power. The engineering output shows the equation as: Pchiller = QrefChillerCapFTemp/COPrefChillerEIRFPLRChillerEIRFTempChillerCycylingRatio. Actually, it is very often to see the chillers with multiple compressors in the real building. Unluckily there is no good alternative way to model it right now. As every modeler knows, the chiller consumption occupied a huge energy ratio in a building, which means the importance of modeling a chiller accurately.	University of Colorado++
Ability to Put All Coils Directly on AirLoops	Coil:Cooling:WaterToAirHeatPump objects cannot be placed directly on an Airloop branch; these heat pump coil objects must be set up differently than other coil objects and we believe they should instead follow the standard practice	Bractlet
More EMS Actuators and Sensors	EMS is a powerful part of E+ and allows us to provide maximum benefit to customers thorough optimization of their current systems; ideally, all object fields would be usable as both a 'sensor' and an 'actuator'	Bractlet

Generate CSV hourly output directly from EnergyPlus (deprecate ReadVarsESO)		Big Ladder
Improve EnergyPlus geometry model	a) Center line representation of building elements - reduces accuracy by 3% to 5% b) Curved surfaces - common in modern buildings - are not easily represented in E+ c) Concave surfaces - should be supported as they generate hundreds of warnings d) External surfaces at center-line or inside face reduce accuracy of shading results	Digital Alchemy
Piping heat loss and heat recovery for district energy systems	The new feature request will consider the thermal energy loss in the piping network, which can be 5% to 15% of the distributed energy of district energy systems. The feature also considers heat recovery between the hot and the cold water loops.	LBNL
Improvements to the EnergyPlus simulation engine to better support utility-scale load shape analyses	1) Load profiles are highly sensitive to stochastic variations in occupant behavior; need an efficient way of running a large number of EnergyPlus models to capture this behavioral diversity and its impact on load shapes, 2) EnergyPlus is more focused on energy consumption than energy demand; doesn't represent cycling of equipment well, as load is averaged across a given time interval (e.g., 15 minutes). 3) EnergyPlus doesn't currently model power factor, though short-term fluctuations in power factor are meaningful for certain types of control (e.g., at 1-5 minutes or less time scale). 4) Improve computational efficiency of running EnergyPlus at short time intervals for utility-scale analyses.	LBNL
Single-Duct System Auto Heat/Cool Setpoint Manager	A single central setpoint manager to control heating, cooling, humidity, and account for fan heat could eliminate the need for 3, 4 or more setpoint manager objects that often can cause battling heating/cooling coils.	GARD
Food Product Models for Refrigeration	Food safety requirements are typically formulated on the core temperature of the food product, not on the temperature inside the case. A detailed dynamic model of the food products (e.g. based on data in the ASHRAE Handbook of Refrigeration) would allow EnergyPlus to model what is actually important (product core temperature) rather than a crude proxy and would allow for the promotion of energy efficiency with large supermarkets and similar (e.g. Walmart) using physics-based models of the real problem they need solved.	NREL

Key: ** identification of individual features that support GEB will be prioritized, ++ possible with current capabilities

Other Requests

Title	Description	Requester	Category
Bug - Unitary multi-stage heating coil simulation problem	Two Issues: 1. Scenario: "Coil:Heating:Fuel" object with user specified capacity (not autosized) is used in an "AirLoopHVAC:UnitarySystem" with staged air flow, and the heating is one stage. Problem: For some time steps that the zone is predicted to have no need for cooling or heating, the unitary system mixed air node temperature is not correctly calculated. The mixed air temperature is much lower than what it should be. 2. Scenario: A “Coil:Heating:Gas:MultiStage” object is used in an "AirLoopHVAC:UnitarySystem" with staged air flow, and the heating is one stage. Problem: In the unitary system, the supply fan is specified to run continuously during occupied period. However, in the simulation result, it is observed that when the zone is predicted to have no cooling or heating need, the unitary system fan shuts off rather than running continuously as specified.	Carrier	Defect
Bug - Chilled water cooling coil dehumidification control problem.	Scenario: A chilled water cooling coil is used as the cooling coil in an air loop with dehumidification control. Problem: When the coil inlet humidity ratio is higher than the outlet humidity ratio setpoint, the dehumidification control overrides the cooling coil outlet temperature setpoint and uses the dew point temperature as setpoint instead. It then determines the corresponding humidity ratio at this dewpoint temperature. Because the coil outlet state is usually not in reality saturated, when the reheat coil heats the air back to dry bulb setpoint, the air loop outlet humidity is below the setpoint humidity. This overstates both the cooling coil load and the dehumidification reheat load and causes excessive energy use. Note that when a DX cooling coil is used in the same system configuration, this error does not occur.	Carrier	Defect

Support for dependent properties in E+ data model	Many properties in the E+ data model are dependent on others. 3rd party vendors must deal with this individually. A proper schema would include relationships between these properties such that their interpretation is consistent.	Digital Alchemy	Out of scope
Automatic Hardsizing	Once a model is autosized, it is often useful to copy the sized values into the objects so that the model is hard sized. OpenStudio currently does this by parsing the outputs of E+ to fill in (most) sized values but with limited precision. This operation should be facilitated by writing out the data in a better form for reuse, either by standardizing on a file format or actually writing out the sized objects.	NREL	Refactoring
Fix height issue in Large Office	Fix height issue in Large Office idf file downloaded from energycodes.gov. The height is currently 10m too short based because the elevation of the mid floor zones and top floor zones are not input correctly. I had email exchanges with PNNL in 2016 about this, but not sure it was ever resolved. If the IDF would be corrected and available for public download, I could release an infiltration correlation for it.	NIST	Out of scope
Significant Speedup of Core Processing Tasks	Even when using cloud computing resources and distributed time-parallelization of a single E+ run, we still are required to make tradeoffs between model fidelity (# of zones) and total run time; an order-of-magnitude decrease in run time would open up numerous possibilities for optimization, such as real-time running and comparison between an E+ sim and actual building data	Bractlet	Performance
Improve Simulation Run Time (running 1 instance) / Memory management when multiple instance of E+.	Ability to run simulations faster than the current run time for medium/bigger buildings (say min 50 zones) using most common input idf objects. Also, ability to support better cpu/memory allocation when multiple instance of E+ are used (e.g. 5 large size files around 200 zones running simultaneously).	Trane	Performance
Advanced EMS	Advanced EMS capabilities to better support GEB-related grid interactions involving HVAC controls and greater accuracy on timing of energy use.	ORNL	Alternate funding

Outdoor Air Summary report improvements	Users often find it difficult to compare the outdoor air delivered for proposed vs baseline simulations, especially with economizers and zone equipment.	GARD	Alternate funding
Correct E+ Outputs When Equipment is OFF	When a plant loop (or section of a loop) is not running (no flow), temperature outputs rapidly change to an unexpected number. This makes interpreting results difficult and can cause concern from both a modeler and customer perspective	Bractlet	Defect
Rooftop PV	A part my research focus over the past several years has been on thermal interactions of rooftop PVs with the building and urban climates. We've had some interesting results with respect to potential benefits of PV's. For example, our recent measurements on a test building at ASU show that PV's on top of white roofs can have a cooling energy penalty even though they shade the roof. Since this is mainly due to the longwave radiation exchange, these sorts of observations cannot be replicated by EnergyPlus. In fact, EnergyPlus predicts the exact opposite (a cooling benefit) as it only considers the shade from incoming shortwave radiation. So far, we have been mostly using workarounds, such as modifying the sky temperature based on measured data (the attached paper as an example). But in general, the prevalent approach in the published literature is to ignore this effect.	Arizona State University	Defect

Enhanced Occupant Behavior Modeling	The current EnergyPlus modeling for occupant behavior relies on static pre-defined schedules to define the behavior in terms of presence in specific spaces, lighting use, equipment use, and temperature settings, and operation and controls of heating and cooling systems and other energy systems. The EnergyPlus user has to define or adjust in their input file the schedules specific to all the energy systems (i.e., lighting, appliance, heating and cooling) based on the desired occupant behavior. A new native feature to EnergyPlus will be developed to allow the user to automatically select occupant behavior settings including but not limited to (i) turning lights on/off, (2) adjusting thermostat setting using setback or set-up desired levels, (3) turning on/off a set of appliances and equipment, and (4) turning on/off heating/cooling systems. The user has the option to select one or combine all these occupancy behavior settings based on an input menu to switch on or off occupancy-based schedules for various energy systems. An object-oriented (OO) module will be developed for the implementation of this approach. The module can be native to EnergyPlus or implemented through an external module (i.e., MATLAB). Moreover, the module will be tested for various building types and occupancy schedules using EnergyPlus sample input files.	University of Colorado	In progress
Autozoning	Add capabilities to procedurally generate or copy/paste thermal zones and space types from one building to another (with different geometry). NREL and LBNL have varying approaches which may benefit from pros/cons co-publication or standard method of test for evaluation (and consensus development) of an autozoning methodology.	ORNL	Out of scope
Reduce the number of object class sub-categories		Digital Alchemy	Refactoring
Base class design	Create a base class that is the basis for all objects as well as a base class for the containers of all objects.	Big Ladder	Refactoring

Better and more consistent utilization of new input processor	The JSON input processor is much easier to work with, but it could still use some utility functions to make processing input even better (e.g., access to filed names and default values).	Big Ladder	Refactoring
Remove redundant 'Branch', 'BranchList', and 'ConnectorList' objects		Big Ladder	Refactoring
Deep refactoring of peripheral objects	Refactor curves, schedules, materials, weather data. These objects have few dependencies and must be tackled before any of the larger more complex objects can be thoroughly refactored.	Big Ladder	Refactoring
Add model options to WeatherProperty:Sky Temperature	As an outcome of ASHRAE Std 140 comparisons with other software, it has been suggested that the Martin-Berdahl (1984) sky temperature algorithm may be a better model than the current one in EnergyPlus, Clark-Allen (1978).	GARD	Alternate funding
Allow alternate simulation initialization (warmup) options	Other programs offer different initialization methods, such as a user-specified number of days to simulate prior to the simulation start date. Recent comparisons related to ASHRAE Std 140 development have shown that the impact on results in the first simulation month can be significant.	GARD	Alternate funding
Binary Timeseries Output Format	We desire output formats that are smaller file size and faster to read for applications like ResStock.	NREL	Refactoring