left to the tool vendors. By separating the implementation from the knowledge base the testing criteria can be stated clearly and agnostic of programming languages and vendor specific mechanics. A wiki or the BCL are a good choices for hosting the libraries of tests and test scripts. They provide a publically accessible and updatable format for sharing and updating test ideas, for hosting scripts that are implementations of the tests, and APIs for automated interactions. A useful public example of a similar system can be seen in the Rosetta Code Project (rosettacode.org , 2015) which is a public repository of instantiations of common computer programming functions in every programming language. For instance, on the page that demonstrates a simple for loop there is a description written that describes a for-loop, how it should function, and how to demonstrate that is it working correctly, followed by canonical examples of for-loops in 148 different programming languages.

Specification of tests should be standardized so that searching and references to tests are repeatable. Each test should have at minimum the following attributes:

1. Unique Identifier: a uuid or ID number
2. Label: a few words to help users understand what it does
3. Test Level: Object, System, Whole Building.
4. Description: A paragraph explaining what the test is, how it is performed, and what the expected ranges and test / fail criteria are, along with any references or backing documentation.
5. Technical Description: A description written as pseudo code of the test written as a specific recipe that could be implemented in a specific language but that not language specific.
6. Implementations: Downloadable scripts that are specific implementations of this test.

CONCLUSION

The RMI Energy Modeling Summit identified the importance of model QA/QC, and many individuals and organizations since have taken steps forward to build infrastructure for executing model QA/QC. However, an overall vision and strategy for coordination of resources to prevent duplicate and competing efforts appears is lacking. Achieving a future where energy modeling predictions are accepted by a broad community of users as the best available technology for determining energy usage will require improvements in developing and automating model QA/QC processes. Any broadly accepted open source project requires that there is a person or entity that takes on the responsibility of parenting the project as it is built and as it grows. This project requires a home and long term support more than most. Possible candidate organizations include ASHRAE, as a QA/QC process for BEM support is similar to a published standard, but maintenance of live databases and websites has not been much adopted by ASHRAE. If in the BCL framework, it is possible that DOE could take a leading role. IBPSA, as a well trusted and neutral resource, would be a prime candidate for leading the way in the development and hosting of a BEM QA and QC system.

Examples of a QA and QC specification:

ID	6da56f4f-d2d1-4b84-a6c6-d657527d2c4d
Label	Chilled water loop minimum loop temperature
Level	System
Description	Unless an ice storage system is attached to the loop, a warning is triggered if the specified minimum chilled water loop temperature is less than 41 [F]. An error is triggered if the minimum loop temperature is less than 36 [F]. If attached ice storage systems are detected, the warning limit is reduced to 25 [F] and the error limit is reduced to 20 [F].
Technical Description	Check Model: is there an attached ice storage system? Check Model: what is the water loop minimum temperature setpoint? If: there is no ice storage system and the setpoint is less than 41 [F] send a warning. If: there is no ice storage system and the setpoint is less than 36 [F] send an error. If: there is an ice storage system and the setpoint is less than 25 [F] send a warning. If: there is an ice storage system and the setpoint is less than 20 [F] send an error.
Implementation	6da56f4f-d2d1-4b84-a6c6-d657527d2c4d.rb 6da56f4f-d2d1-4b84-a6c6-d657527d2c4d.py 6da56f4f-d2d1-4b84-a6c6-d657527d2c4d.params

ID	800f7e62-0168-440f-9eba-330898e8dab3
Label	Pump motor to whole building energy ratio
Level	Whole Building
Description	Check if the sum of energy consumed by all heating and cooling pump motors divided by the whole building electric energy consumed meets reasonable criteria. Only be applicable to models having both central chilled and hot water systems. If pump energy to whole building energy use is greater than (0.0000141*HDD65) + (0.0000284*CDD50) a warning is triggered. If pump energy to whole building energy use is greater than (0.0000159*HDD65) + (0.0000326*CDD50) and error is triggered.
Technical Description	Check Model: Central chilled and hot water systems present? If: both systems are not present send Not Applicable message and end test. Check Model: What is HDD65 and CDD50 Check Simulation Results: What is total pump energy divided by total building energy use? If: total pump energy divided by total building energy use greater than (0.0000141*HDD65) + (0.0000284*CDD50) trigger a warning. If: total pump energy divided by total building energy use greater than (0.0000159*HDD65) + (0.0000326*CDD50) trigger an error.
Implementation	800f7e62-0168-440f-9eba-330898e8dab3.py 800f7e62-0168-440f-9eba-330898e8dab3.rb 800f7e62-0168-440f-9eba-330898e8dab3.params

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