Dear reviewers and editors,

Thank you for your review work. We have taken into account your concerns and have revised the manuscript accordingly.

The first reviewer seems to express doubts regarding the scientific contribution of our work. We strongly believe that there is a clear contribution, which is elaborated below. Furthermore, in a previous review round one of the reviewers has strongly recommended our work as "Since it could reduce significant engineering costs to develop MPC for buildings, and it can be used for several different purposes, I believe that this paper matches to the interests of the Journal of Building Performance Simulation. In addition, the paper is well organized and presents a thorough description. Therefore, I strongly recommend publication of the paper but after a minor revision." Therefore, we would like to clarify the contribution of our work, primarily by starting from the arguments of the first reviewer. Where possible we have also modified the manuscript to alleviate any ambiguities that may exist.

Reviewer 1

On short:
The paper treats a chain of software tools for developing model predictive control of the energy in buildings. Since the subject is very connected to existing software tools, the paper is not archival. Most probably these tools will change or disappear in time which will render this paper outdated. Therefore, the paper may be of interest for a MODELICA conference. Besides this, there are scientific issues.

We don't understand the first part of this argument. The reviewer seems to suggest that the further development of existing software tools cannot be archival, by definition. It is certainly more useful than reinventing the wheel by developing software from scratch. Furthermore, to the authors best knowledge, there exists no decent software tool for MPC in buildings that includes the translation of a building simulation model into a controller model for optimization.

This paper does not merely describe a combination of software packages. It is about solving a real problem: that there exists a large amount of MPC research that is not being valorized in practice at all, quite likely due to problems related to algorithm scalability and usability of MPC by non-experts. We propose to solve the usability problem by using an intuitive, object-oriented approach such that the MPC complexity is offloaded to the component models, which thus have to be very generic, often using more equations and state variables. This enlarges the first problem regarding scalability (computation time and convergence). To counter this, we propose a new problem formulation for which the NLP computation time does not scale with the number of states, which certainly does have a lasting value. Existing research mostly uses LPs and QPs. Our more detailed NLP approach allows for solutions that come much closer to the optimum since our models tend to represent reality more accurately by incorporating more detail. Furthermore, it avoids the need of post-processing, which again increases the usability. Finally, other computation time improvements are described such that other researchers can implement these into their research.

MPC is about gaining efficiency through system integration. Existing research however tends to focus on small, academic problems, touching only upon specific parts of the MPC toolchain without considering their place in the larger system, and therefore often neglecting important aspects of the bigger picture, such as usability. This paper lays the foundations for a more integrated development approach with the ultimate goal to support any HVAC device, multiple objectives and automated code generation in a single coherent software package.
In a follow-up paper we demonstrate that this toolchain solves a model with more than 1000 state variables, 92 control points, pressure driven flows, frequency-controlled fans, heat pumps, etc in about 5 seconds, which demonstrates the viability of our approach.
We hope that this clarifies the value of our work, not only for research, but for our whole society by creating REAL impact.

A few comments on large:
Some errors:
p. 8/29, line 11: not clear what is a "rule based controller" and why it is considered "classical".
This has been rephrased into "New buildings are therefore harder to control using Rule Based Control (RBC) systems that use control logic such as hysteresis controllers, PI(D)s and heating curves, which do not inherently integrate system delays and forecasts.".

p. 8/29, line 21-22: The use of P-controllers is the usual solution. The phrase "This may cause conservative set points …" is incorrect.

Since the reviewer does not clearly describe why the statement is incorrect, we added an example that motivates the statement:
"E.g. when using return water temperature controlled 2-way valves for a set of parallel concrete core activation (CCA) circuits, an increase in the supply water temperature demand for one CCA slab, will increase the heat delivered to all CCA slabs."

p. 8/29, line 22-23: "Backup systems my automatically compensate … " is technically wrong. simultaneous heating and cooling may be in double-duct systems but this control error is not compensated by backup systems.
This seems to be an issue of terminology. In our case we consider the concrete core activation to be the primary system, while an air-based system is used for the supply of fresh air, and as a supplementary heating/cooling device when the primary system does not achieve the set point. Perhaps the use of 'secondary system' is more appropriate here. This has been revised.

p. 10/29, line 36: what is the use of integer optimisation? The values are numerical (floating point), but not integers.
As the reviewer mentions correctly, we use floating point optimization variables that can take any real value between an upper and lower bound. In some cases, such optimization variables do not reflect reality. For instance, on/off pumps are either on or off, there is nothing in between. I.e. their control signal is either 0 or 1 and a real control signal between 0 and 1 is not a valid control signal. Such optimization problems can be solved through the use of integer programming (see e.g. https://en.wikipedia.org/wiki/Integer_programming). However, JModelica currently does not support the concept of an 'integer optimization variable'. As such, integer programming is currently not supported.

Some concepts that do not have the general agreed meaning
p. 8/29, line 38: "MPC is a control strategy that optimizes a system's control inputs". In control theory, the MPC optimizes the command given to the system.
To the authors, these two phrases indeed mean the same, although the former formulation is more specific about what is controlled (which is one of the strengths of the approach described: optimizing the real control inputs (such as pump frequency, valve opening …) instead of e.g. a thermal power that needs some post processing to be converted into a control input) and as such should be easier to understand for the readers of the paper.

p. 9/29, line 22 "qualitative measurement data". Qualitative values are, for example, "large", "very large".
Thank you for pointing out this ambiguity. This is indeed not how we intended the use of this word. We reformulated 'qualitative data' into 'data of high quality'.

It is not clear what is the time step: p. 16/29 line 36: 1 hour, p. 19/29 line 25: weather data set 2 min, p. 20/29: 1s
The first time step is the duration of a single control interval l_c: the time during which the control variables stay constant. The second interval is the resolution of the weather file that is used. This weather data reader linearly interpolates between the weather data points at the points in time corresponding to Equation (12). As such it is much more detailed than required, but this is simply the file that we have available. The time step of 1 second is used as an accurate discretization for computing the matrices \hat{A}, \hat{B} and \hat{C}, which correspond to the control interval duration l_c. The manuscript has been modified such that this discussion is clearer by referring to the correct variables. The use of the variable Δt was also not consistent and has been changed to further clarify the discussion.

A few non-archival, technical, points
Does the reviewer mean that these points should be removed?

p. 10 / 29 IDEAS and JModelica are not archival issues.
The use of the IDEAS library is important since its models have been specifically developed to be compatible with this toolchain. Not mentioning this would wrongly give the impression that we support any model.
The JModelica framework lays the foundations for our toolchain and as such it should be included in the discussion. As soon as other model libraries with the same characteristics as IDEAS, and solver frameworks with the same capabilities as JModelica, are available the methods described in this paper can be applied by using these alternatives too.

p10/29: reference to CasADI 3.1
We build upon existing open-source software tools. Not referencing this earlier work would raise questions about the details of the implementation and would incorrectly suggest that we have developed the CasADi functionality ourselves.

p 12/29, line 9: why is it important the FMU (Functional Mockup) from a scientific point of view?
FMI is an open standard that has been developed for many years. Implementing it in our toolchain enhances interoperability and facilitates the implementation of new functionality when it becomes available in the standard and in JModelica. Furthermore, such aspects should be mentioned only for the sake of clarity when discussing how the software is implemented.

p. 12/29: the name of functions such as CombiTimeTable or of attributes of optimica
We feel that these names are important, though they do not tell that much to readers who are unfamiliar with Modelica. I.e. the CombiTimeTable is a well-known data reader in the Modelica Standard Library. The fact that this component can be used out of the box is non-trivial and it greatly enhances the usability and flexibility of the toolchain, which is one of the main motivations for our work.
Similarly, the attribute 'free=true' indicates what concepts are used to define the optimization problem. This is again important with respect to the usability. Furthermore, not mentioning it would create a lot of unclarity with respect to these aspects.

p. 21/29 line 44: "super-linear"
This term is indeed not commonly used. The sentence has been rephrased to use 'more than linear' instead of 'super-linear'.

Reviewer 2
The authors have taken into account the comments formulated during the first review process. References have been added which makes the reading much easier.
Thank you for your feedback!

Please note my first "more detailed comment " from the first review was concerning line 16 (and not line 11, apologies for the mistake).

The original comment of the reviewer on line 16 of page 2 was:
"it is not so obvious that MPC decreases the energy consumption. This heavily depends on the cost function"

While the line itself contains:
"It then typically minimises the energy use or energy cost of the building, while enforcing constraints such as technical constraints and comfort constraints."

We agree that MPC does not always decreases the energy use This is why we included 'typically' in the original sentence. We clarified this further by adding ", but other cost functions are possible too.".