Structuring building monitoring and automation system data




FLORIAN STINNER[1] ALINA KORNAS MARC BARANSKI DIRK MÜLLER

RWTH Aachen University, E.ON Energy Research Center, Institute for Energy Efficient Buildings and Indoor Climate, Aachen, Germany
[1] Corresponding Author: fstinner@eonerc.rwth-aachen.de

This article describes a scheme for naming monitoring data in buildings. This standard supports the automatic analysis of the operation of technical systems.

Standardized monitoring data support automatic analysis of technical systems

Modern non-residential buildings are increasingly equipped with building automation systems. Unfortunately, these buildings rarely reach the promised energy performance indicators and functionality (Waide et al. 2014, Debusscher and Waide 2015, Fütterer et al. 2017). Errors in the programming of complex building automation systems (BAS), but also faulty components must be identified. This requires an analysis of the system. In order to achieve this within a reasonable amount of time, a standardized naming structure of the components is very helpful to quickly find your way around, even in systems that are not planned by yourself.

To achieve this, an intensive analysis is necessary. In practice, time and money for that investigation are limited. In addition, automatic analysis algorithms could accelerate this work. The basis for a reliable working algorithm is a standard for naming the system components. Many data are required for the analysis, which a building automation or an energy monitoring system could supply. Currently, however, the naming of data points is very individual. (Bhattacharya et al. 2016) System integrators or operators have their own idea of a data point naming scheme in order to integrate it into the organizational structure; the scheme of the BAS vendor is implemented, or no explicit scheme is given. After commissioning, this increases the resources (time, money, etc.) required for fault analysis and optimization of the technical systems. Companies that specialize in analyses, optimizations or novel control concepts have to prepare the data with great effort. Only then can the actual desired work begin. This leads to a high basic effort before an action takes place. Standardized monitoring data could break the vendor lock-in, which is a common complaint in building operation practice. This means that specialized and independent companies can focus on analysing building data and provide solutions for the operation of a building system.

Based on four buildings in which the naming scheme is applied, we show how it is used and what possibilities it offers. One of the buildings is currently under construction. For this purpose, we present application fields for the naming scheme.

Actual "Standardization" of monitoring data

For the development of a universal naming scheme, we have investigated different structures from practice (6 examples), norms (3 examples) and schemes (4 examples). The elements of naming are often similar. However, they usually differ in their arrangement, predefined restricted amount of characters and used vocabulary.

The scheme developed by Fraunhofer Institute for Solar Energy Systems ISE (Réhault et al, 2013) proved to be the most applicable, due to its approach of a logical structure and vocabulary, which is why we chose to develop this scheme. We have introduced additional categories and made the entire structure of naming schemes and its vocabulary consistent.

Structure of the naming schemes

The outcome of this development is a "buildings unified data point naming schema for operation management" (BUDO). It has a hierarchical structure, which consists of five categories that form the data point naming scheme: 1) system, 2) subsystem, 3) position/medium, 4) type, 5) I/O function.

An underscore character is used to separate them. A detailed naming is also possible, e. g. to distinguish a temperature sensor (SEN.T) from a volumetric flow meter (SEN.VF). A point is used for subdivision. This supports object orientation in the analysis of attachments. Additional user-specific names are important to ensure that a system integrator or operator can recognize data points. User-specific categories are also decisive for the applicability in an organization. Therefore, we allow a free text before the standardized vocabulary. This can include all additional categories required by the organization (e.g. a building number or focus of information). This text is delimited by two slashes (//) from the developed data point key. We show the structure of BUDO in **Figure 1**. BUDO allows a standardized naming of the components in the building automation systems and at the same time allows an assignment of components in the system, which makes it easier to assign the data points to a component later in the automation schema.

Translation tool

With a translation tool developed by us, the scheme can be easily applied in any construction or retrofit process. We currently implemented the tool in Excel. We planned further integrations (html, python). An application of the tool can be found in **Figure 2**.

The tool is downloadable on the E.ON Energy Research Center's website*.

Due to a simple copy-and-paste of the existing name, our naming scheme can be applied very easily also on existing buildings. A user can select the appropriate vocabulary conveniently via a drop-down menu and receives a new standardized naming at the end. For a

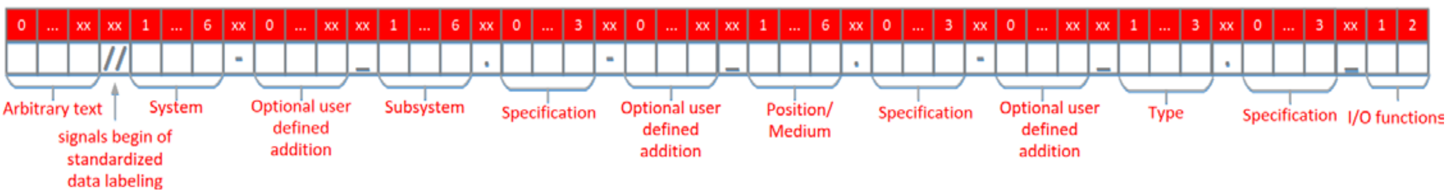

Figure 1. Structure of the unified data point naming structure BUDO.

Alter Datenpunktschlüssel	Gebäude	System	.	Spezifizg.	-	Bezeich	_	Bauteil/S	.	Spezifizg.	-	Bezeich	_
4120.H02_.DEALS01_Heizung Not-Aus	4120	Kessel				H02.1		Schalter		Not Aus			
4120.H02_.AASYY01_Ventil Kessel-1	4120	Kessel				H02.1		Ventil		Verteil		Y01	
4120.H02_.AEMWB01_Temp VL Kessel1	4120	Kessel				H02.1		Sensor		Temperatur		B01	
4120.H02_.DEBMA01_Kessel1 Betrieb	4120	Kessel				H02.1							
4120.H02_.DESMA01_Kesselsteu STO	4120	Kessel				H02.1							
4120.H02_.DASBA01_Kesselsteuerung	4120	Kessel				H02.1							
4120.H02_.DEBMM01_Pumpe K-1 Anf	4120	Kessel				H02.1		Pumpe				M01.K1	
4120.H02_.DEBMM01_Pumpe K-2 Anf	4120	Kessel				H02.1		Pumpe				M01.K2	
4120.H02_.AASYA01_Sollwert Brenner	4120	Kessel				H02.1							
4120.H02_.AEMWB06_Temp RL Kessel1	4120	Kessel				H02.1		Sensor		Temperatur		B06	
4120.H02_.DASBM01_Pumpe Kessel-1	4120	Kessel				H02.1		Pumpe				M01	
4120.H02_.DEBMM01_Pumpe Kessel-1	4120	Kessel				H02.1		Pumpe				M01	
4120.H02_.DESMM01_Pumpe Kessel-1	4120	Kessel				H02.1		Pumpe				M01	
4120.H02_.AEMWB03_Temp hydr Weich	4120	Kessel				H02.1		Sensor		Temperatur		B03	

Figure 2. Example of how to use the translation tool.

* http://www.ebc.eonerc.rwth-aachen.de/cms/E-ON-ERC-EBC/Forschung/OPEN-SOURCE/~qajk/Standardisierte-Bezeichnung-zeitaufgeloe/

building with approx. 400 data points, the renaming into the new scheme required approx. 2 hours without specialized training. This shows that the naming scheme is applicable to existing buildings. We show this below on the examples of a building in construction, an existing building, different organization structures and on the case of a building information model (BIM).

Integration into the Planning Process

BUDO can be composed of entries in the GA function list according to ISO 16484 and can therefore be easily integrated into the planning process. The assignment of the data point key to a specific position in the system makes it easier to find the data point in the automation scheme.

The complete data point consists of e.g. a building allocation or focus of information etc., the plant, the description of the data point or object and the I/O functions (see **Figure 3**). For this purpose, the corresponding categories are suitable. The building identifier can be set in the arbitrary text at the beginning. The description of the plant is stored in the system. Several parts of the naming scheme can be integrated into the description. The I/O function is used at the end of the scheme and contains information about which information type one can count on and which signal can be processed by the component. This can already be useful for debugging a system.

Table 1. Example Buildings.

Building No.	Explanation
1	Office Building with mixed utilization
2	Test Hall
3	Canteen
4	Battery Storage System

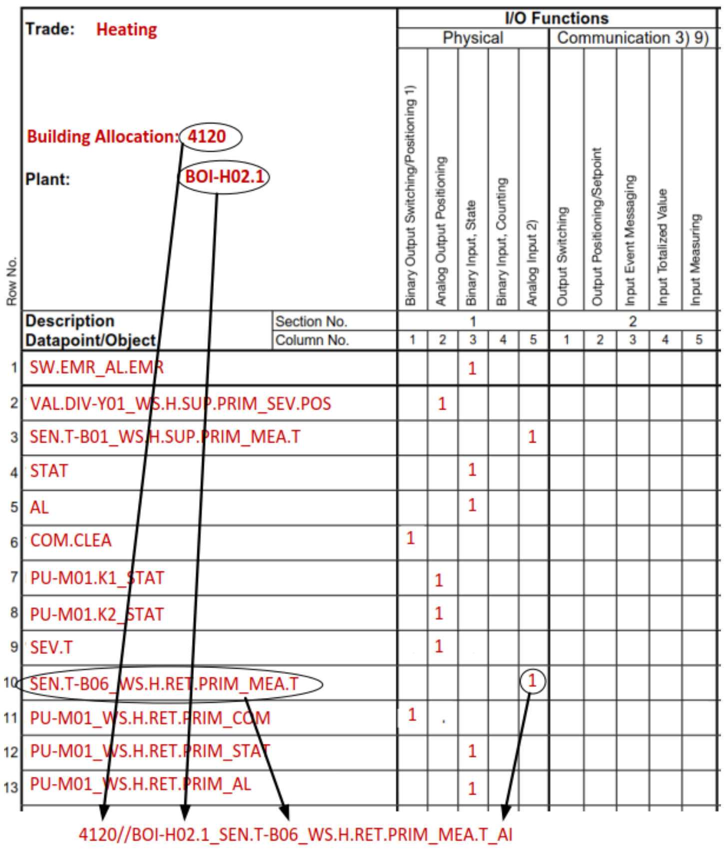

Figure 3. Assembling the data point label from the function list of ISO 16484-3.

Table 2. Data label of BUDO.

System	
BOI	Boiler
CHP	Combined Heat and Power Unit
CCA	Concrete Core Activation
Subsystem	
PU	Pump
SEN	Sensor
SW	Switch
VAL	Valve
Position/ Medium	
HYDS	Hydraulic Separator
STO	Storage
WS	Water System
Type	
AL	Alarm
COM	Command
MEA	Measurement
SEV	Setpoint Value
STAT	Status
I/O Function	
AI	Analog Input
AO	Analog Output
BI	Binary Input
BO	Binary Output
SAO	Shared Analog Output

Specifications	
BOT	Bottom
CLEA	Clearance
CTRL	Control
DIFF	Differential
DIST	Distribution
DIV	Diverting
EMR	Emergency
H	Heat/Hot
LT	Low Temperature
MAIN	Maintenance
MAX	Maximum
MID	Middle
MIN	Minimum
NROT	Number of Rotations
OPR	Operation
POS	Position
PRIM	Primary
RET	Return
SEC	Secondary
SUBS	Substitute
SUP	Supply
T	Temperature
TOP	Top
VF	Volume Flow

Case Study 1: Concrete Core Activation (Test hall, in Construction)

We have integrated the developed key into a building process in a test hall currently under construction. This way, the previous theoretical considerations on the applicability of the key can be examined. The labels of data points in the concrete core activation are located in **Figure 4**. It shows that particularly more complex systems, such as a pump, have significantly more data points than a simple valve. The choice of vocabulary should be consistent. This means that if a component has been named with a certain name once, this name is also used for all subsequent designations.

Case Study 2: Boiler (Office Building with mixed utilization)

Table 2 shows the vocabulary needed to understand the data label in **Figure 5**. It shows a system with two boilers and a hydraulic separator as located in the case study office building. Typical data labels of

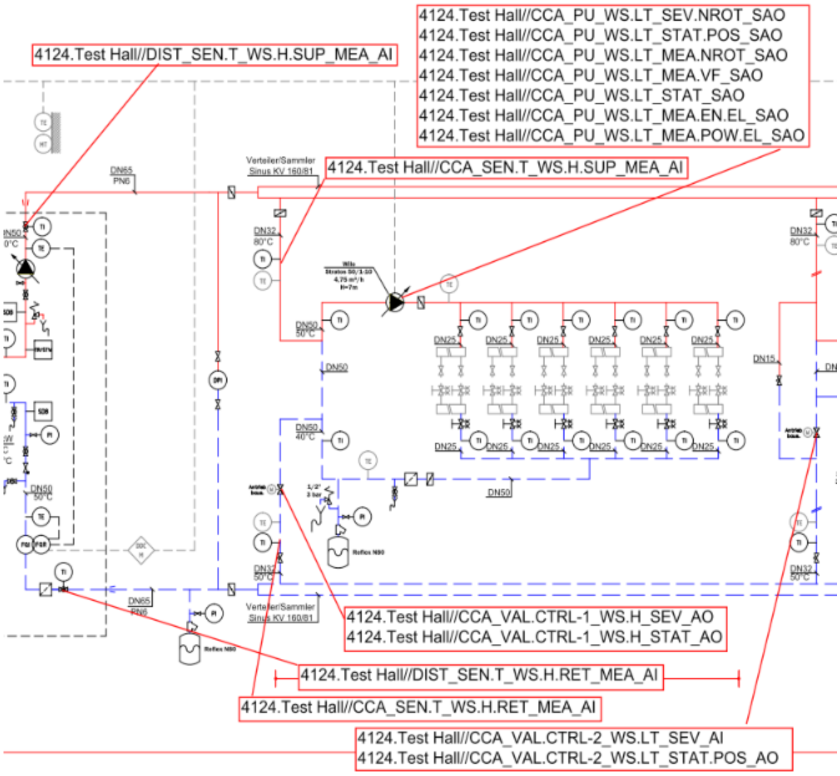

Figure 4. Examples of BUDO in a Concrete Core Activation of a building in construction (test hall) (source: DEERNS B.V.).

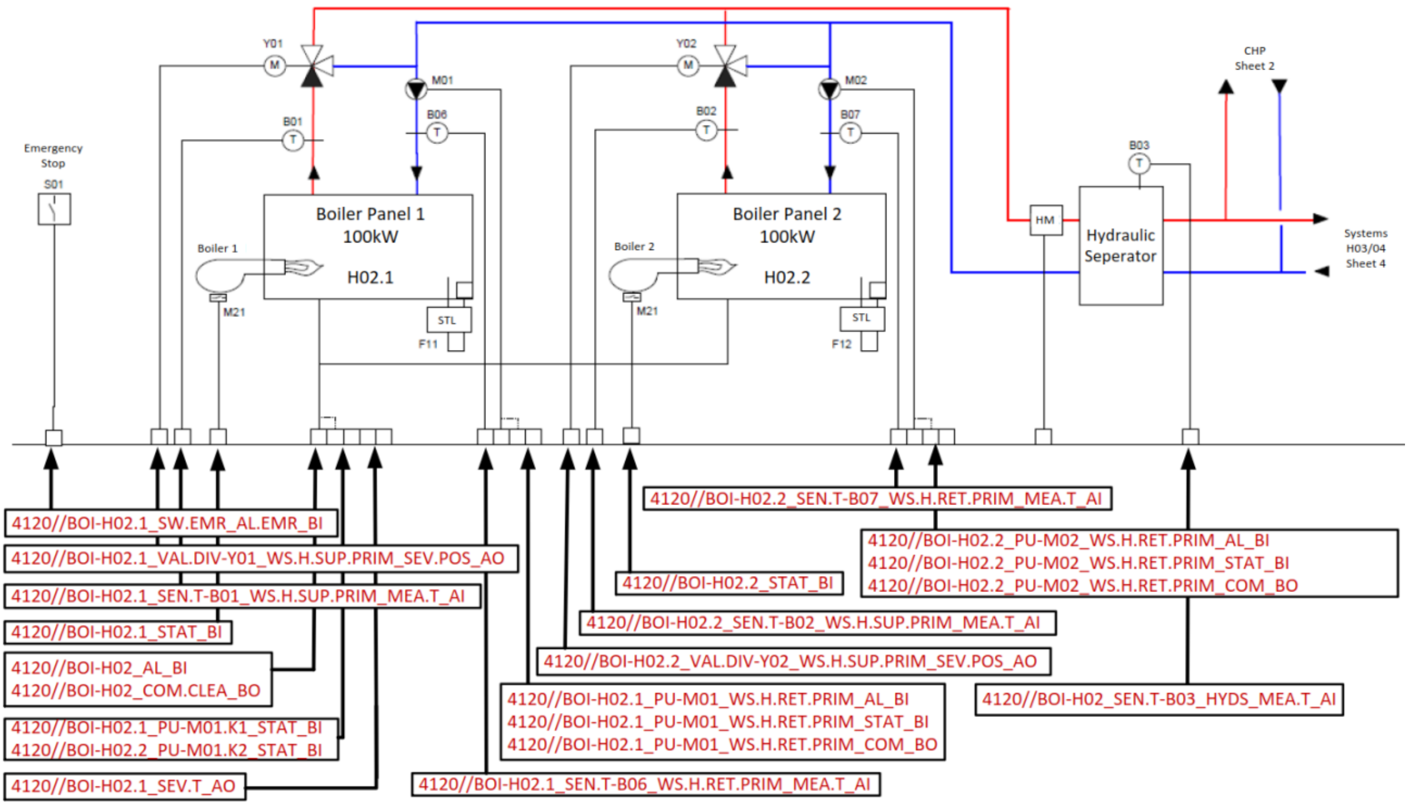

Figure 5. Boiler in case study 2 (office building) (source: Johnson Controls International Plc).

components used in such a system like a thermal energy storage, pump, valve and temperature sensors either to measure the temperature or to watch a maximum or minimum set point of a temperature difference are named according to the BUDO.

Case Study 3: Integration into different organization structures

As we show in **Figure 6**, there are no restrictions in the usage of BUDO at the Cologne Bonn Airport. We integrated the building, trade and room in front of the standardized part of the label. User-specific attributes are also applicable here. The system is integrable in the standardized part. BUDO completely maps the data point designation.

In the case of the city of Frankfurt/Germany (**Figure** 7), we have to depict the street code, house number, building, floor and type of costs. BUDO does not map these parts in a standardized way. Therefore, they must be inserted before the separator (//). For each unstandardized type, we recommend using an underscore as a separator. For the rest, we used the standardized part of BUDO.

Case Study 4: Usage in Building Information Model

The integration of data labels that are named after the developed naming scheme into a building information model (BIM), whose de facto standard is ISO 16739 (IFC4) was successful. We have implemented this in an existing building (see **Figure 8**). Here the description of objects offers the possibility to integrate the new label into BIM. The planning information can be added to BUDO according to the level of development in BIM. For example, if it is not yet clear which boiler type will be implemented, BUDO can initially contain the boiler information (BOI) only and the information of a condensing boiler (BOI.COND) can be supplemented later. If installations are subsequently changed in the planning process, the data point keys can also be adapted automatically by BUDO, thus avoiding errors in the planning process. BUDO therefore supports the workflow and benefits from BIM.

Conclusion

We have developed an easy-to-apply data point naming scheme. It can be easily integrated into existing organizational structures and helps to develop new standardized products for the analysis and optimization of buildings. If everyone would name or rename their building automation system accoring to BUDO, a lot of time spent on finding one's way around in a building automation system could be saved, and it could provide the basis for algorithms for an automatic evaluation of building automation in the future.

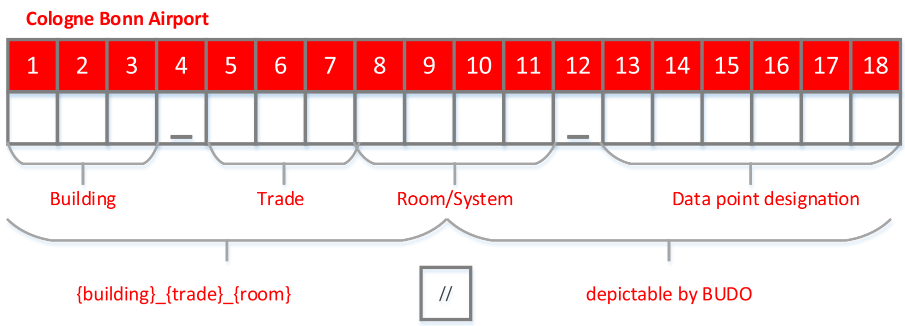

Figure 6. Example of integration into organization structures of the Cologne Bonn Airport/Germany.

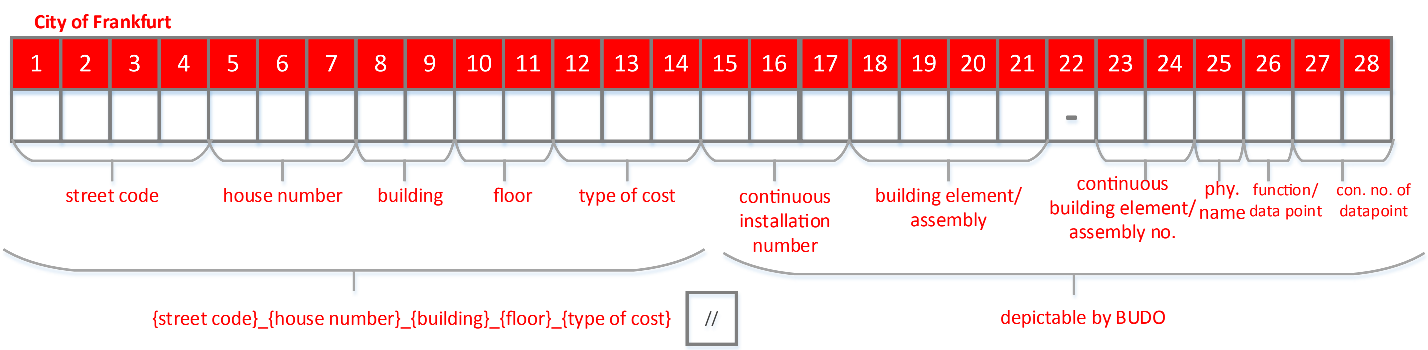

Figure 7. Example of integration into organization structures of City of Frankfurt (Main)/Germany.

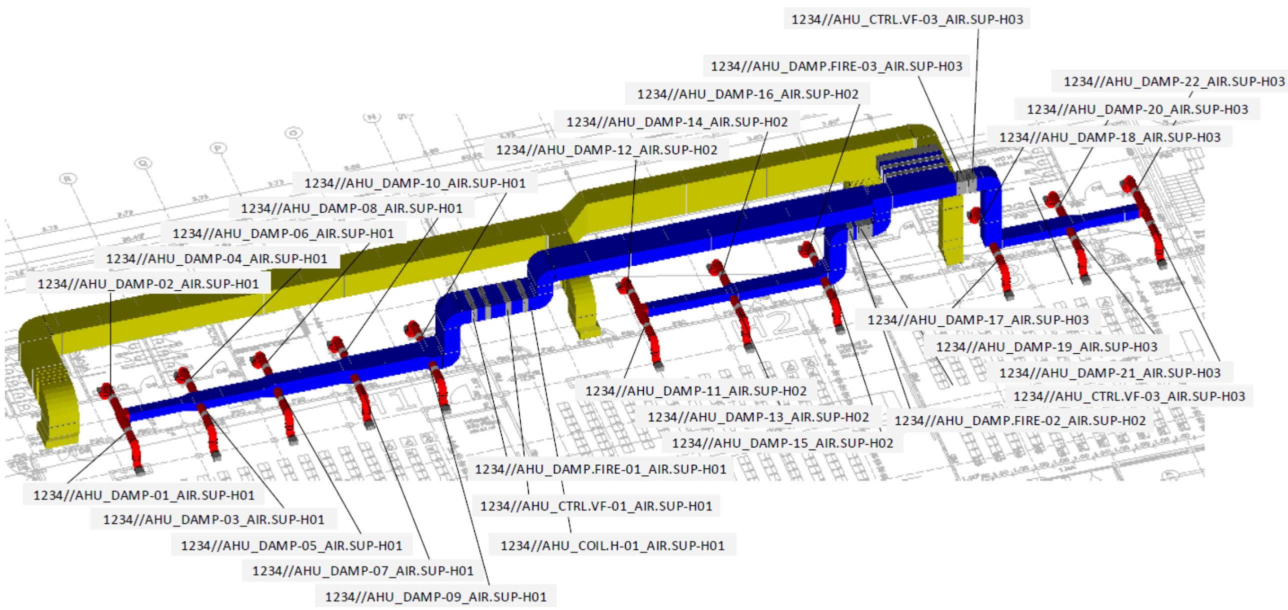

Figure 8. Example of integration of BUDO into IFC4 (Building Information Model).

We showed that the naming scheme can consistently name data points in existing buildings and in buildings under construction. The naming scheme could facilitate the application of innovative analysis and control concepts in the future. ■

Acknowledgements

The authors would like to acknowledge the financial support of the German Federal Ministry of Economic Affairs and Energy within the funded project 03ET1022A and "OOM4ABDO" (03SBE0006A).

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