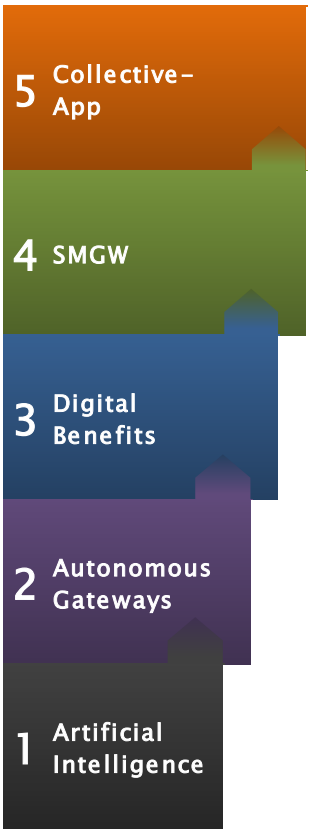
Profitability report

on pilot projects of digitisation in the housing industry

Energy-efficient residential quarter management methods for CO_2 and cost reduction

2016 to 2020



	Savings rate Thermal Heat	Description of benefit	Security	Comfort
5 Collective-App	0 %	- Secure alternative to Google & Co. - Integrated app of ERP- and free processes - Convinience-, Security- and Delivery services excite tenants	BSI-compliant Common criteria	Fully digital Communication with tenants
4 SMGW	5 %	- Implementation of highly secure CLS-interfaces - Accommodation processes for landlords and tenants according to common criteria - Telemetric transportation networks	BSI-compliant Common criteria	100 % safety & security
3 Digital Benefits	5-15 %	- Reduction of heat supply contracts or heating generator dimensions - Monitoring/Smart Meter - Energy-Management-Systems (EMS) - Predictive Load Management - Bidirectional control	Non-BSI-compliant	Interdepartmental
2 Autonomous Gateways	10-12 %	- Introduction into advanced digital world nought-investment - Self-management of warm operating costs - Heat-App for all tenants - Craftsman's steering	Non-BSI-compliant	Ready for EMS
1 Artificial Intelligence	20-30 %	- Also works without complex systems - Immediate savings - Tenants are excited - BSI-compliant - Low-investment by ALFA ©	BSI-compliant ULD-Certificate	Plug and play

Summary

The verdict of the **tenants**[1] is surprisingly clear: We were skeptical, but now we are excited. We found "Digitization" unbelievable at first, but heating cost savings now make the benefits visible. The verdict of commercial landlords[2] from municipal and cooperative housing companies and the owners of large commercial campuses is also surprisingly clear: we have learned how digitization can make us mediators of major energy efficiency processes and strengthen our active role. At last we can add significantly improved energy-saving processes to our portfolio– with low investment costs– without having to fear a landlord-tenant dilema.

Best Practice: Over the three years that the project was in operation, we collected ideas from **four different housing and real estate companies**, combined them into a testbed with representative pilot project buildings and reference buildings at different locations and anticipated the digital future in the residential quarters by means of **concrete implementations**. For the first time, we have tested new, digitally-supported business models with future potential, listed concrete questions, and **evaluated key figures to find answers**.

The data analysis[3] of the "Alliance for a climate-neutral building stock" from 2017 has now been relaunched with a gateway-oriented focus and continues on a larger scale what was started in the housing industry, among other things, with projects within the framework of the "ALFA® - Alliance for Plant Efficiency".

Thermal energy-related, digitally supported processes of the future were anticipated, tested, their key performance indicators determined and the enthusiasm of the concerned tenants evaluated. The parameters used to evaluate the current questions were:

- What effect do the results have on climate balances, energy balances in residential quarters and cities, and what options for actionable opportunities do real estate companies have?
- Can tenant loyalty be improved with clear messages about success?
- Can action and investment frameworks be identified?
- What effects do self-sufficient processes have, especially those of the new gateways?

At the beginning of the project, the Smart Meter Gateways had not yet been certified; the anticipation of this innovation proved to be one of the strongest options for action (as of Spring/Summer 2020)[4]. The digital self-sufficiency of real estate companies, which was addressed right at the beginning, also proved to be a rewarding project focus. Small and medium-sized companies in particular are asking themselves how to achieve independence from overpriced service providers.

The content of the digital project documented here does not refer to "ERP" processes, for example, where digitization is the subject of daily business in real estate companies everywhere. "Digitization" is a superordinate infrastructure topic in the project understanding. Building and system technology and data security in accordance with the new rules of the Federal Office for Information Security (BSI) also include the current understanding of data protection; indeed, it now extends this to include globally recognised rules ("common criteria").[5]

[1] Detailed statements of tenants in stage 3
[2] Detailed statements of landlords in stage 3
[3] Grinewitschus u. a. Energetic optimisation through plant engineering and user assistance in residential buildings
[4] Frank Urbansky, Smart Meter Rollout: what it brings to the housing industry, Haufe Verlag
[5] Federal Office for Information Security: common criteria

Even the older generation of tenants was very cooperative[6], according to the evaluation by the boards of the participating housing companies; clearly announced savings targets encouraged enthusiasm. The new tools of digitization were based on secure offline processes, on self-learning algorithms for individual rooms, and on gateway-led processes that provide maximum security via telemetric forwarding networks and the so-called "CLS interface" at the highest security level according to common criteria, using the now-available BSI-certified smart meter gateways.

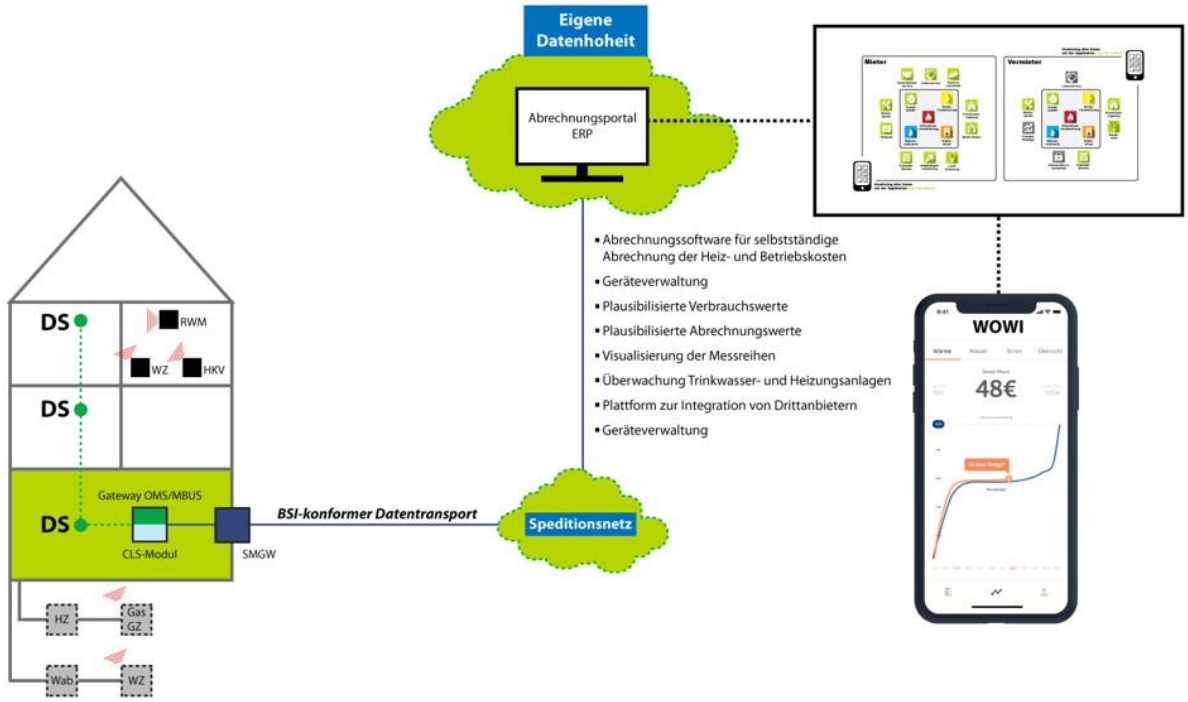


Fig. 1: Sustainable digital concept for energy efficiency in residential quarters

In accordance with the ambition of the project, future capabilities of the telemetry and collection technologies (Business-Power-Line (BPL[7]) and the use of "programmed water" to avoid system losses due to calcification[8] were also included in the field test for the first time. The decisive question here was whether and, if so, how tenants could be affected. These details were only added after conceivable impairments could be excluded.

The project's application for housing industry recognition was successful: it won the BBU Future Award 2019[9].

The major processes that had been implemented through the project and their results were put together on individual "ladder rungs," forming a "ladder of digital success" and were evaluated over the operating period of three years on the basis of invoices for warm operating costs together with housing companies and tenants. The future important interaction of so-called "digital twins" with real buildings was prepared. The most important key figures are summarized below:

[6] Lecture of the Executive Board of ABG Paradies at BBU-Workshop“ on 11.06.2019

[7] Explanation BPL (in English)

[8] Explanation video lime treatment

[9] Explanatory-Video of BBU

Stage 1: Gateway-independent "**artificial intelligence" for each part of the home in the form of self-learning individual room algorithms**: 25-30 % heat savings with daily absence of the tenants due to employment, only 0-5 % with frequent presence of the tenants (absence reduction of 4 °C cannot be effective here).

After the establishment of stage 2, which followed, all processes were managed on the basis of a gateway. Such gateways are already present in many systems; however, their performance is often inhibited by proprietary usage claims of submetering service providers. Therefore, the study focussed on establishing complete self-sufficiency for the real estate companies.

Stage 2: Self-sufficient gateways as the basis for establishing a fully self-sufficient submetering system with visualization of all heat consumption data on a centrally managed energy management system (EMS), along with simultaneous delivery of individual heating consumption data as graphics to the tenants' smartphone apps. That saved data integration from external consumption data while at the same time relieving the burden of administrative work around the tenant accounts; profits fluctuate strongly per company..

Stage 3: Fruits of digitalization: **monitoring, smart meter, energy management system (EMS) for bidirectional control of all building systems** by the technical supervisor, a 15-minute cycle of the heating generator pulses and readjustment of all burners and secondary circuits of the house connection stations (HASt) using forward-looking (predictive) algorithms, including future weather forecast data: these advances resulted in a 5-15 % reduction of the heating load.

Stage 4: Smart Meter Gateway as a BSI-compliant security basis for the protection of tenants through residential quarter software, use of the CLS interface as a secure infrastructure and highly secure telemetric forwarding networks, cost reduction of data collection in stairwells, elimination of two-wire/GSM/LORA processes, self-sufficiency vis-à-vis external infrastructure suppliers and

Stage 5: GDPR -compliant secure telemetric collective apps based on ERP data, which also map all tenant concerns from the residential quarter and the surrounding area: AAL, e-health, calendar and delivery services, security and comfort functions– a residential alternative to foreign server services with advertising-centred content.

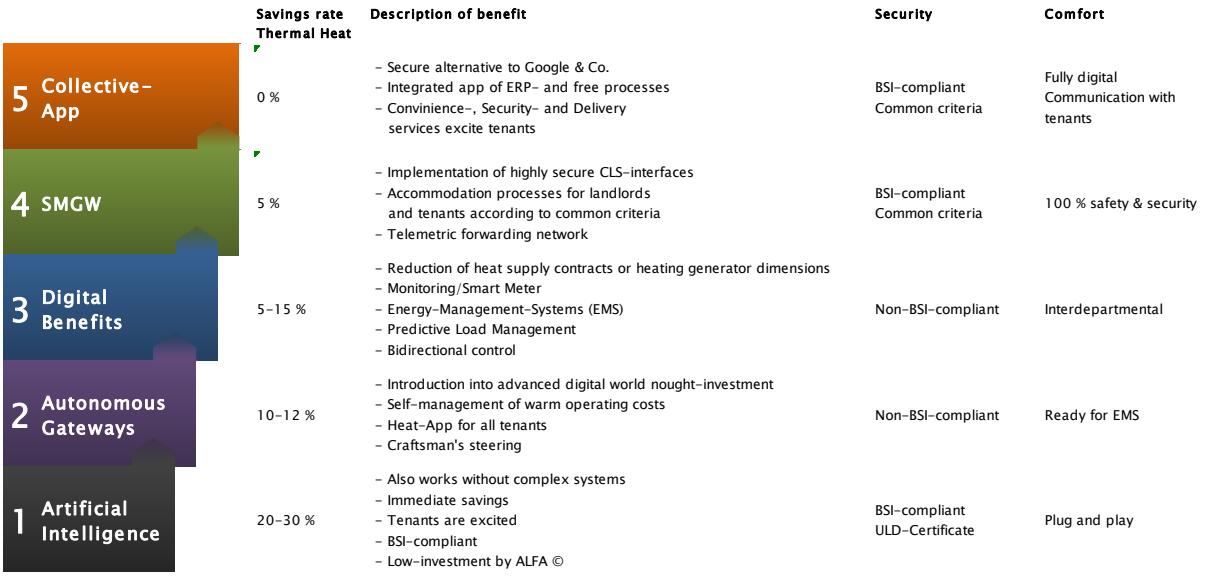


Fig. 2: The ladder to success for digital energy efficiency in residential quarters, © green with IT e.V.

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Glossary

AAL	*Ambient Assisted Living*	*Methods, concepts, (electronic) systems, products and services that support the everyday life of older or disabled people in a situation-dependent and unobtrusive manner*
ALFA	*Alliance for plant efficiency*	*BBU initiative for low invest measures to increase energy efficiency*
B2B	*business to business*	*Transactions between companies and registered traders*
B2C	*business to customer*	*Transactions between registered traders and end users (customers)*
BBU	*Berlin-Brandenburg Association of Housing Companies*	*State association in the GdW*
BPL	*Broadband via Power Line*	*High speed communication via power lines*
BSI	*Federal Office for Information Security*	*Civil upper federal authority in the business area of the BMI for IT security issues*
CLS	*Controllable-Local-System*	*Interface belonging to the HAN interface, which manages the remote access to adjustable generators*
Disruptive	*Disruptive Technologies*	*Disruptive technologies are innovations that replace an existing service and make the investments of the previously dominant market participants obsolete.*
DMZ	*Demilitarised Zone*	*Computer network with security-controlled access to the servers connected to it.*
EMS	*Energy Management System*	*Digitally supported tool for the complex management of energy-specific system components*
EPBD guidlines	*EU directive on the overall energy efficiency of buildings*	*should be implemented in German national law (GEG) by 10.03.2020*
ERP	*Enterprise Resource Planning*	*Business Resource Planning*
Gateway	*hardware and/or software*	*Component which establishes a connection between two systems*
GDPR	*General Data Protection Rules*	*European Union Regulation implementing the rules on the processing of personal data*
GdW	*GdW Bundesverband deutscher Wohnungs- und Immobilienunternehmen e.V.*	*Central Association of the Housing Industry Germany*
GEG	*Building Energy Act* *Legal force expected in autumn 2020*	*Law on the e**nergy requirements for new and existing buildings** and on the use of **renewable energies** for heating and cooling*
G.hn Standard	*Home-Grid standard based on further developed Power-Line-Communication (PLC)*	*Carrier frequency method operating at a total (gross) signal rate of one gigabit per second*
GSM	*Global System for Mobile Communication*	*Mobile radio standard for fully digital mobile radio networks introduced in 1990*
HAN	*home area network* *HAN interface = Ethernet interface, serves for the integration of the SMGw into the home network of the customer with connection option of controllable devices like intelligent household appliances or a power generator.*	*The HAN interface also includes a Controllable Local System (CLS) interface, which enables remote access to controllable generators (photovoltaic system, combined heat and power plant) and interruptible consumption devices (charging station, night storage heating)*
HASt	*House connection stations*	*Transfer station for district heating in apartment buildings, generally cellar room*
Basic IT Security	*Security catalog of the BSI*	*Proven methodology to increase the level of information security at any scale*
LAN	*Local Area Network*	*Home or company network*
LMN	*Local metrological network*	*local instrumentation network that forms the interface to smart meters* *Short-range radio interface (wireless Mbus) or serial interface for telemetric data*
LORA	*Long Range Wide Area Network*	*Low Power Wireless network protocol, opens up residential areas for telemetric purposes in submetering etc.*
MUC	*Multi Utility Controller*	*Precursor of the Smart Metzer Gateway, but without security component*
OMS	*Open Metering System*	*Cross-manufacturer and cross-divisional communication architecture for smart meters based*

		on M-Bus (field bus) in the context of smart metering
WMBUS	*Wireless M-Bus*	*Wireless version of the wired M-Bus. It is standardised in the European standard EN 13757-4*
PLC	*Power Line Communication*	*Communication via power lines*
ROI	*Return on Investment*	*Key figure for measuring return, measured by success in relation to capital employed*
Smart Meter	*Intelligent meter*	*Meter that receives and transmits digital data*
SMGW	*Smart Meter Gateway*	*central communication unit of an intelligent measuring system*
SRI	*Smart Readiness Indicator*	*Assessment of the ability of a building to interact with users and the network and to control its operation in an energy-efficient manner*
Submetering	*Collective term for units of measurement for operating costs*	*comprises the consumption-based recording and billing of heating and water costs in buildings*
ULD	*Independent State Centre for Data Protection Schleswig-Holstein*	*Issues seal of approval for data protection*
WAN	*Wide Area Network*	*IP interface/computer network which, unlike a LAN, extends over a very large geographical area*

1. Overall concept of the projects

1.1 Introduction, objectives and motivation

The verdict of the **tenants**[10] is surprisingly clear: We were skeptical, but now we are excited. We couldn't believe "digitization" at first, but saved heating costs now make the benefits visible. After three years of operation, we the clear measurable advantages have convinced us: we can participate in the important social processes of digitalization. We can actively contribute to the reduction of CO_2 pollution and save money through our reduced heating consumption. This makes digitalisation fun! More of this please!

The verdict of commercial **landlords**[11] from municipal and cooperative housing companies and the owners of large commercial campuses is also surprisingly clear: we have learned how digitization can make us mediators of major energy efficiency processes and strengthen our active role. At last we can add significantly improved energy-saving processes to our the portfolio - with low investment costs - without having to fear a landlord-tenant dilemma.

Over three complete years of operation, we combined four pilot project buildings, chosen because of specific attributes that made them representative of the housing industry as a whole, together with reference buildings to form a test bed and to anticipate the digital future in residential quarters. We tested new, digitally-supported business models with future potential for the first time. Our goal was to examine concrete, very detailed future scenarios that provide a representative cross-section of all current implementation issues of "digitalization" in residential quarters. The aim was to provide answers to the following questions:

- How concretely can the **success** of innovative digitised energy efficiency processes be measured using valid data from tenants and landlords?
- Can we turn scepticism into **enthusiasm**?
- Which valid **efficiency factors** from digitally supported residential quarter measures can be collected and how?
- Which digitally supported **business models** can emerge from this in the future?
- What **implications** might the analysed results have on economic CO_2-emissions? Assets?
- How do we **decouple** ourselves from the dominance of American servers and their data collection goals for the purpose of selling individual data relevant to advertising to third parties?
- How do we bring truly secure data infrastructures into **everyday use**?
- What degree of **disruptiveness** is required?

Further objectives

In addition to answering these questions, the aim was also to show concrete steps that can be implemented to promote self-sufficiency in all everyday housing processes. We focused on the most important housing industry processes after the "net cold rent": warm operating costs, production of heating energy, and all value-added stages of "submetering".

A further aim was to outline a step-by-step entry scenario for the digitisation of the residential quarter, which takes this most important process as its starting point. Large housing companies have long since been managing their heating and billing systems themselves via subsidiaries; small and medium-sized companies should also be given the opportunity to free themselves from proprietary constraints. At the same time, this liberation must be accompanied by an immediately implementable list of further efficiency gains, which we call "digital

[10] Detailed statements by tenants in chapter 3
[11] Detailed statements by landlords in chapter 3

fruits". These fruits hang deep, and plucking them can result in impressive progress. The main goal is: **harvest assistance**.

1.2 Simulation approach and disruptive business models

In the first period from 2016 to 2018, the first resilient digital processes were tested in the real estate industry: this affected commonplace practices in residential and commercial quarters. The everyday operation of new business models based on Smart Meter Gateways (SMGW) and other methods was then tested from 2018 onwards, although there were no certified devices for Smart Meter Gateways at that time. However, since certified so-called "Multi Utility Controllers" (MUC) are able to anticipate the operation of such SMGW in a technically mature manner, it was possible to completely simulate everyday operation until the official market rollout of Smart Meter Gateways on February 7, 2020. In addition to the collection of valid CO_2 savings data in digital test series that had never been tried out before, the project's objective was linked to the goal of convincing, involving and allowing critical end consumers to participate through positive everyday practices, thus creating the basis for a high level of social acceptance of digitisation in residential and commercial areas.

At the same time, landlords should be able to follow valid success stories, so they can experience and measure **their role** as mediators in the introduction of future-oriented digital business models. To achieve this, existing barriers had to be overcome, and in some cases even sanded down. The first barrier was the skepticism of end users, tenants and citizens.

1.3 Civic skepticism

- “They" just want to force something on me again, which will burden me more afterwards (experiences with announcements of modernization, ever-increasing additional costs, electricity levies).
- Whenever something new comes along, they reach into my wallet and afterwards everything is more expensive.
- Digitalisation means that my need for security is ignored.
- Climate change is something I cannot influence. I have no ability to actively participate.

During the development of the stages of digitisation (listed above), great importance was attached to the simplest possible handling, so-called "low cost" components (in the sense of the BBU's ALFA® strategy), the shortest possible return on investment (ROI) times, and maximum persuasiveness for the end user, without losing sight of the socially indispensable mediators of these applications, and without actively taking them along: the housing and real estate industry, i. e., the "real estate industry". i. e. municipal and cooperative housing companies, private and independent housing associations, property managers and owners, commercial property owners, managers of complex campuses.

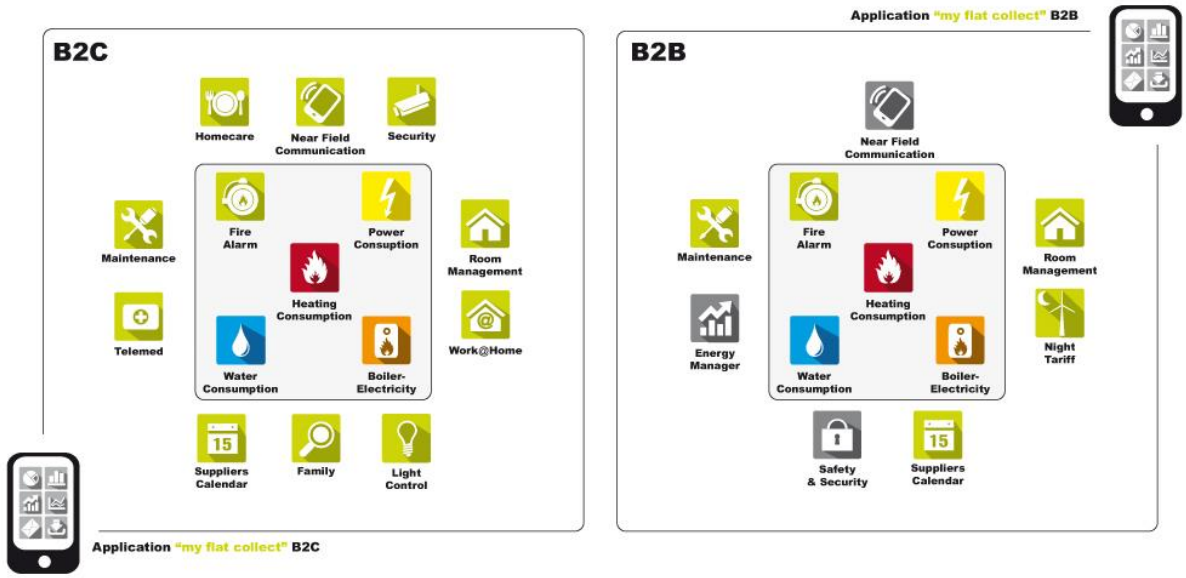


Fig. 3: Heating costs dominate end consumer interest, satellite-like, digitally supported new processes orbit this superficial sphere of interest, © green with IT e.V.

The most important individual measures were therefore differentiated according to **landlord (B2B) and tenant (B2C)** interests in order to openly address the so-called **landlord-tenant dilemma**. This is based on the fact that landlords cannot implement even socially highly effective energy efficiency measures if, for example, costs cannot be apportioned, the use of renewable energies is uneconomical or the investments remain with the landlord, or if only tenants would benefit unilaterally from savings.

It was clear from the very beginning that digitisation – with each step clearly documented – must bring profit for all. **It must be simple, clearly comprehensible, measurable, transferable to wide areas of social life, data secure, low investment, in line with the expectations of citizens and landlords**.

The positive initial experiences of the "Alliance for a climate-neutral housing stock" revealed the hurdles entailed in complex and proprietary approaches: Initial empirical data (12) showed that digital systems require an overall view. This refers to complex, gateway-led energy management systems (EMS) as a whole, as a system approach without open interchangeability of individual components. The results evaluated there meant:

- High costs without a recognizable time of amortization for landlord and tenant,
- Overuse of tenants who do not want to "program" individual rooms and
- insurmountable barriers to entry due to too-high entry hurdles.

Our biggest challenge was the simplicity of the entry system. Our developers said: "Simple is hard". Behind this is the realization that it is easier to store complicated processes with thick manuals and then "commission" the end user to implement them, or even leave them to figure the system out entirely alone. It is difficult to design the processes in such a way that:

- the end user finds everything ready to "plug and play,"
- installers can install all drivers with web support,
- the user does not experience a change in everyday usage habits, and
- the savings are automatic– they occur without the creative intervention of the end user.

The question of data security and data protection was also a central issue at the beginning of the project. After utilising the data-secure “entrance," which **elided the need for a complex**

basic system (we have referred to this here as "stage 1"), a further development takes place in stages using a cost-neutral entry component: the “gateway"!

The **assumed immediate cost neutrality** stems from the fact that all modern submetering systems either already contain a gateway or will receive one with subsequent contracts. These gateways are part of the existing apportionment costs of the accounting system of warm operating costs; they are an integral part of the system for collecting all BeKo data in the stairwell/basement. In this case, the costs of the transmission of all data, i. e. the transmission via GSM, cable, M2M, LORA etc. do not arise additionally, but are also included in the "apportioned" cost block.

Consistent focus on BSI-Grundschutz-compliant processes has not yet been achieved by any smart home provider. Therefore, the **first ULD Certification of our Stage 1 process** (algorithms for individual room control) was an important interim success, which also strengthened our own convictions that we are well ahead of the game with our processes. The aim was to convince landlords and other intermediaries that they can pass digitally-supported energy efficiency processes to their customers without hesitation and without the threat of "googlification", i. e. spying on user behaviour for marketing purposes. In the language of young people, this is now ironically disguised as „sugar mountains“.

And so we set out to test our energy efficiency processes right away, actively involving the most sceptical and demanding clientele: older, non-technically connected tenants in widely spread portfolios that are representative of the entire residential and real estate portfolio. The reason for this was simple: if you manage to convince this - currently still very widespread - crop of clientele, you will consequently have an easier time with target groups with a higher affinity for technology. But even documented "enthusiasm" and vehement support was a particularly desirable goal for all those involved in the project.

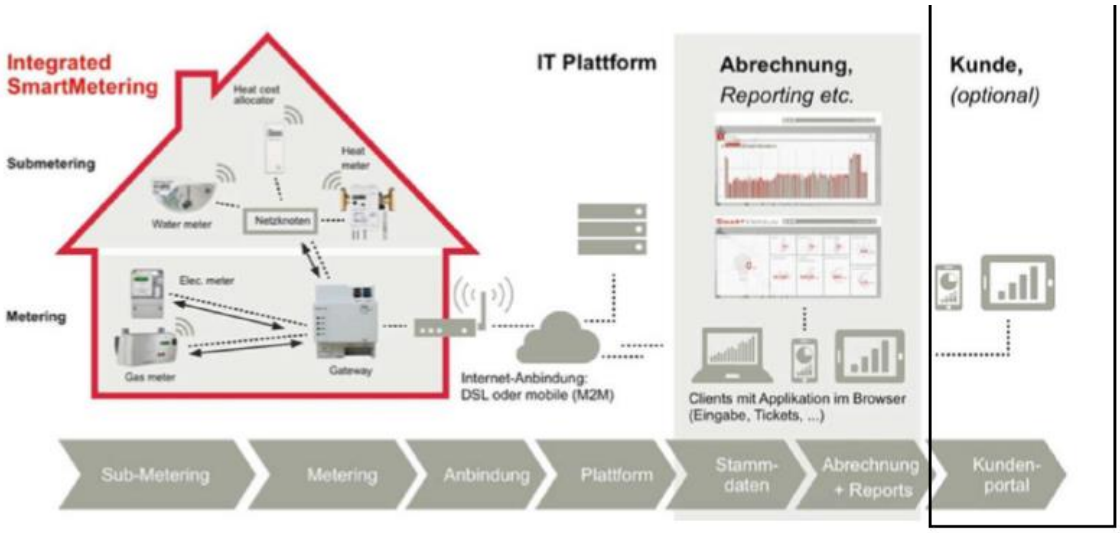


Fig. 4. Example of submetering value creation from the perspective of a housing industry customer loyalty software (ERP), source: BBU

The **disruptiveness** of our approach means replacing old habits with new processes in such a way that outdated, expensive inhibition thresholds are ground down and replaced by **maximally self-sufficient processes** at the landlord level. This is done by the new processes of digitalisation. The best example in the housing industry was, for example, the proprietary protocols of metering service providers. By rejecting the transparency of these protocols, dependencies on the electronic heat cost allocators (EHKV) were initially created, which generated special revenues up to 40 % above the usual market level. This was also communicated openly in American pension funds, so that new so-called "mergers & acquisitions"

each year would ensure additional profit on the basis of these overpriced services for the benefit of the intermediary banks. **Digitization** has now created open standards and transmission paths and promoted the **self-sufficiency of all parties involved**. Large property managers have terminated these providers and capped the oversized value added at the expense of the tenants. Instead of "buy", "make" has become increasingly widespread. Large housing companies have founded their own service providers who bring this added value into their own companies and at the same time eliminate the dependence on data supplies during the year. This practice is increasingly being adopted by medium-sized companies; small companies are currently joining together to form purchasing associations.

But parallel to this, the dependency shifts are creepingly moving towards gateways. The metering service providers are again starting with built-in "dependencies" exactly where self-sufficiency can be achieved with the simplest means. This becomes visible under point 3 of the following diagram:

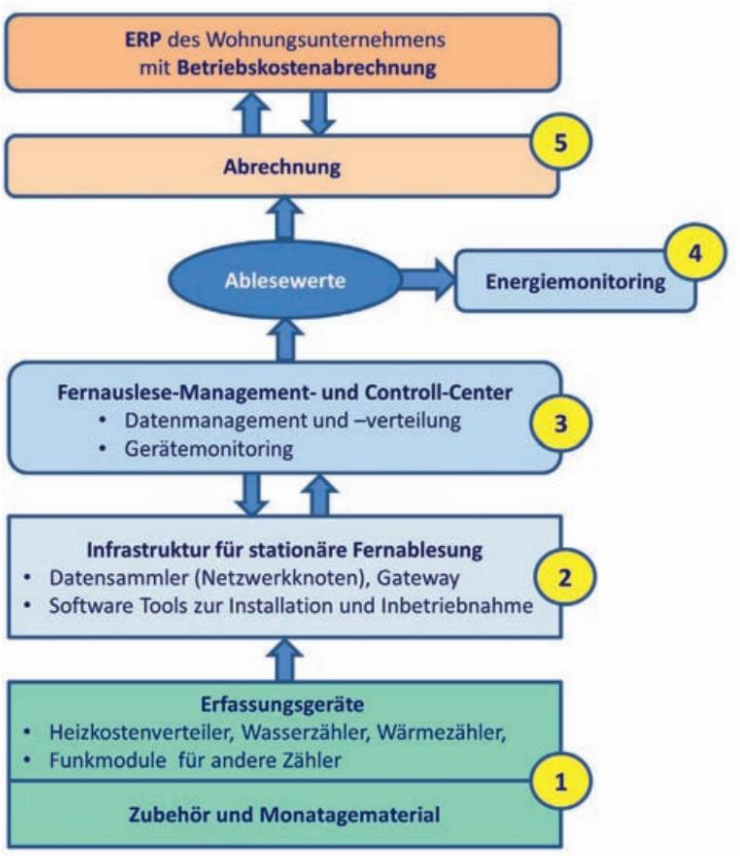


Fig. 5: Segmentation of the billing market (Source: PPR Institute Dr. Rolf Weber)

The basic philosophy of scalable digital processes **starts with the smallest unit in our project, the individual room**. The German practice of legally regulated radiator recording, documentation of consumption and its 12-fold annual invoicing on the basis of these values (from 2022[12]) is unique in international comparison, but is therefore also a technological challenge. This is where low-investment resources and data-secure processes were used. This philosophy is then transferred to the individual apartment with further digitally supported, low-investment measures, hardware and software systems, and from there adapted into the house and then into the residential quarter. Valid data is obtained in the tracking of these processes when representative pilot objects are equipped in this way and compared with identical reference objects. This is what has happened.

[12] Dr. Ingrid Vogler: How the Energy Efficiency Directive affects the Heating Costs Ordinance

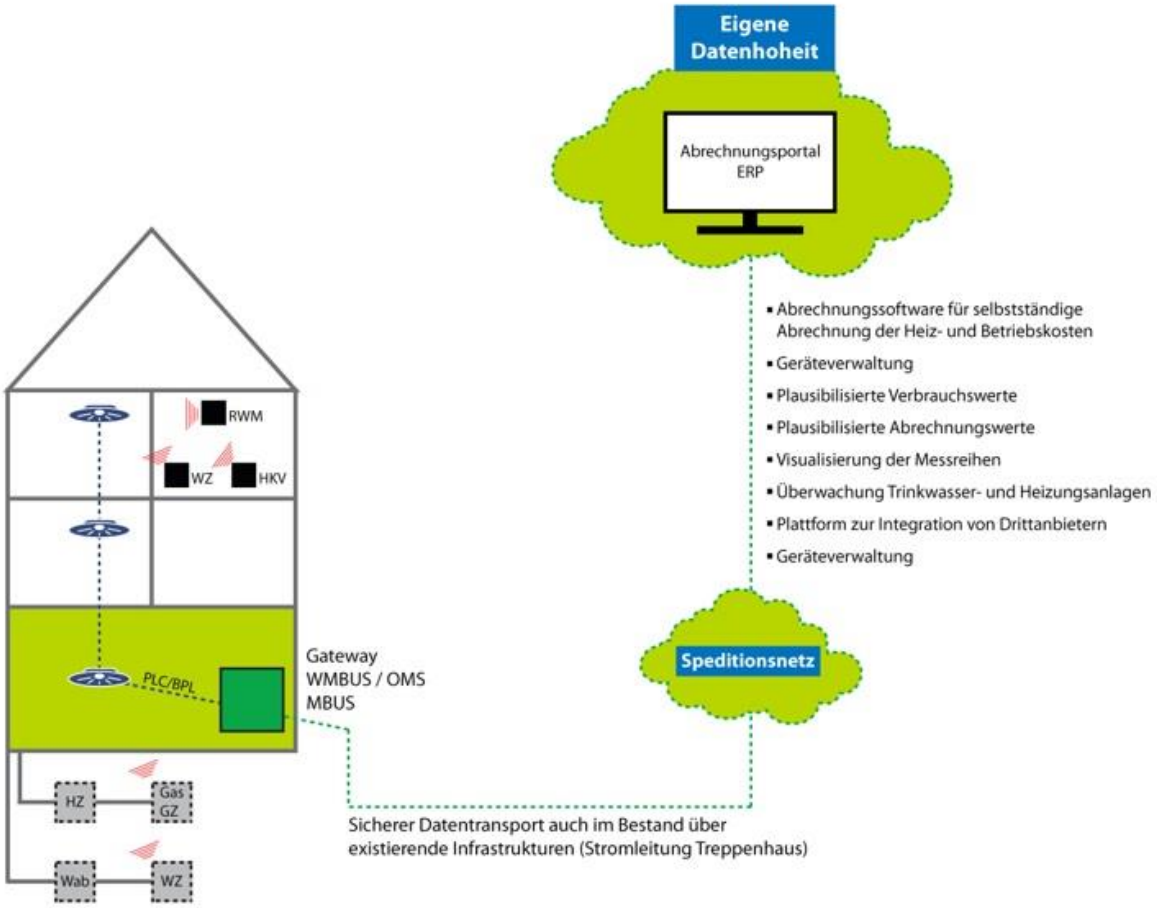


Fig. 6: Diagram of the intended digital residential quarter development B2B (landlord) and B2C (tenant) using a light-guided telemetric floor collection system© green with IT e.V.

1.4 Test-bed structure 2014-2018 - green with IT pilot measure

Application partner in the capital region:

- Two small/medium housing cooperatives
- A municipal housing association
- One commercial campus administrator (state property) with
  - · 330 Apartments
  - · 330 apartments in reference buildings
  - · 330 apartments in representative standard from 1955-1980
  - · 330 apartments represent building standards of another approx. 220,000 apartments
  - · Rental parties receive settlement of warm operating costs
  - · Landlords receive consumption data partly from service providers using proprietary protocols
  - · Invoicing of warm operating costs, generally annually on the basis of a ssupplied consumption data record
  - · no monthly calculation of consumption transparency during the year due to averaged assumed values
  - · If monthly consumption data are supplied, additional costs would be incurred by the service provider (unusual in practice)
  - · Accounting principles very heterogeneous

1.5 We start in individual rooms with Stage 1

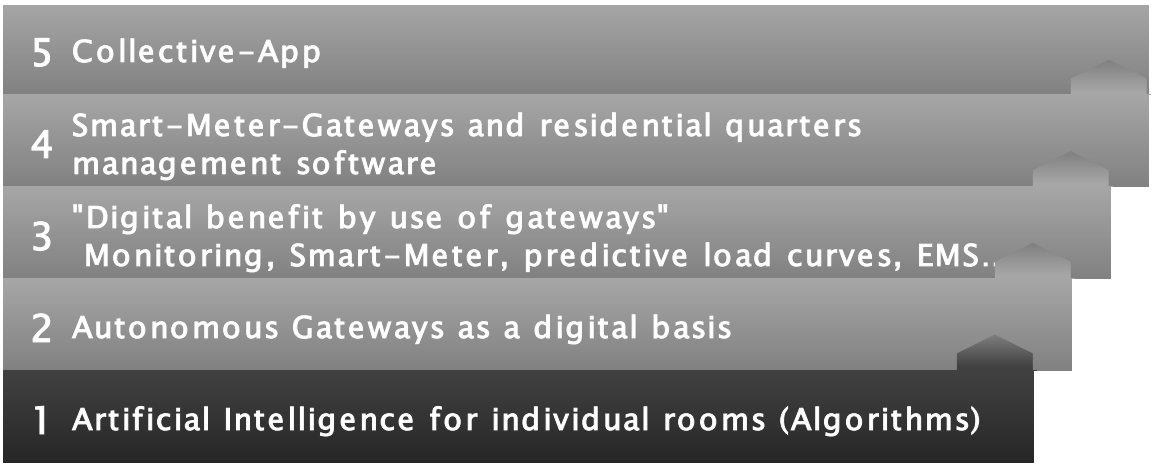


Fig. 7: Easy entry with a first self-sufficient and certified safe, allocatable process

The processes were started in **individual rooms** (as the smallest basic unit). Here, a WoWi-suitable innovation for the tenant-friendly use of "artificial intelligence (AI)" was used for the first time throughout the entire building together with applications in parallel embedded reference buildings.

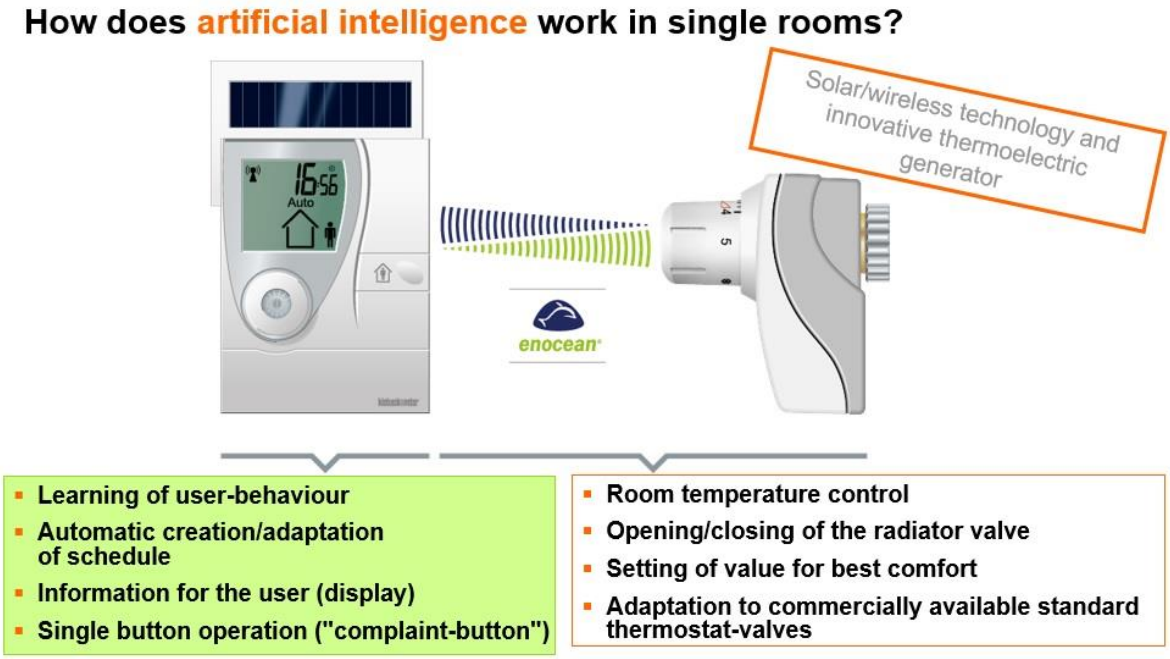


Fig. 8: "Stage 1" data secure individual room controls based on weekly algorithms, © green with IT e.V.

2. Operations - project descriptions in detail

2.1 Presentation of the objects

2.1.1 Pilot project 1 - Cooperative housing association Lübben eG (GWG)

- Project partner cooperative housing association Lübben eG.

- Pilot Project 1 is a multi-storey residential building
- Is located at Hartmannsdorfer Straße 2-5 in Lübben
- Four stairways
- DDR system construction
- As a reference block, we used Hartmannsdorfer Straße 6-9, directly opposite the test site, with the same design direction, tenant structure and heating technology
- Object is in a good condition
- Thermal insulation measures have already been carried out
- Cooperative is very open-minded about user-friendly innovations

Fig. 9/9a: Lübben residential building (left) and boiler equipment (right), source: GWG Lübben eG.

2.1.2 Pilot project 2 - Workers' cooperative Paradies e.G.

- Project partner Arbeiter Baugenossenschaft eG. Paradise in Berlin-Bohnsdorf
- Pilot Project 2 is also a multi-storey residential building \
- Located in Sausenberger Straße
- Five stairways
- Individually bricked building typical from the 30s
- As reference block, we used a building directly opposite with the same orientation, tenant structure and heating technology
- Object is in a good condition
- Cooperative is very innovative especially in the field of HKV, HF technologies etc.

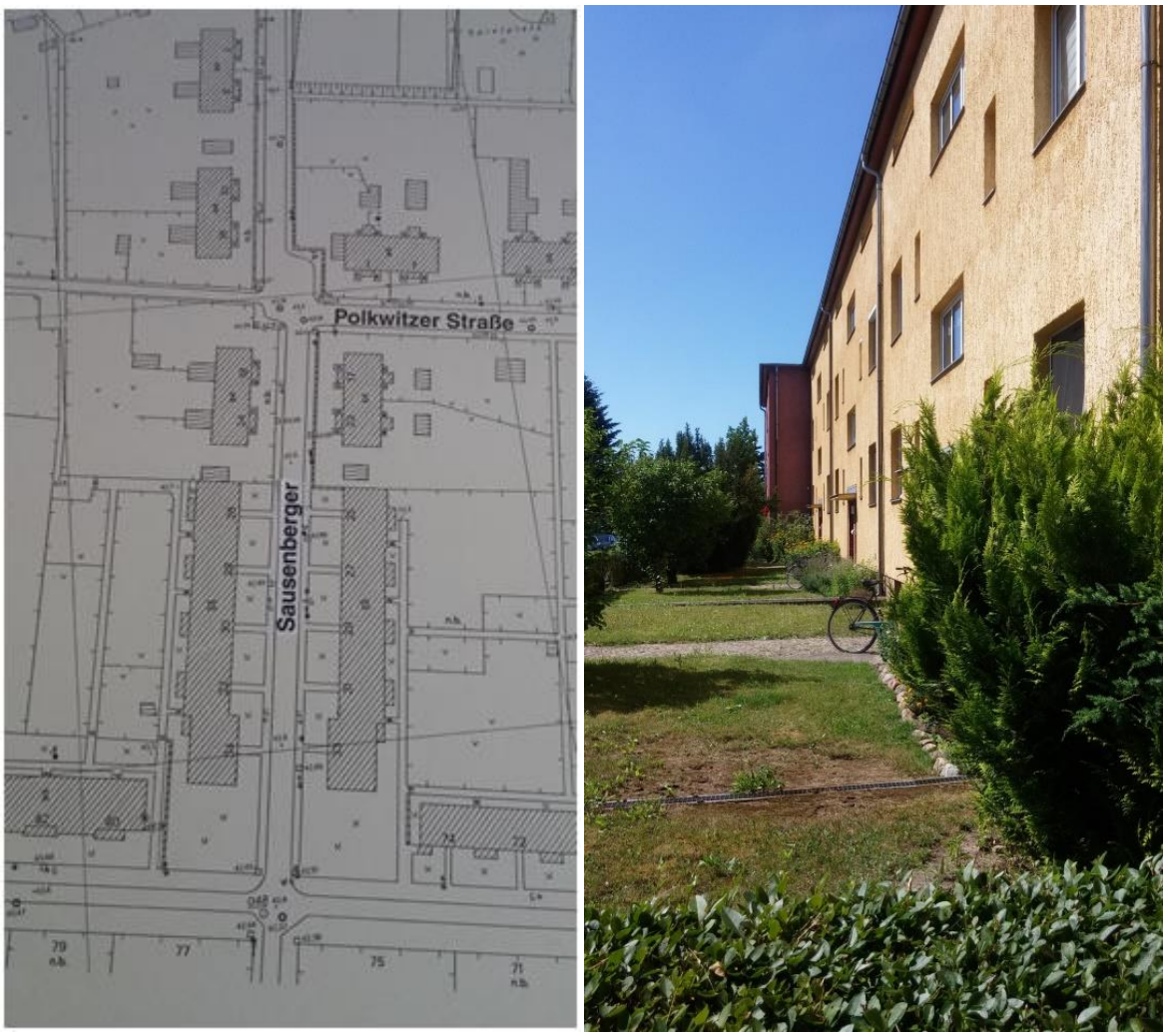


Fig. 10/10a: Site plan (left) and residential building (right), source: ABG Paradies eG.

2.1.3 Pilot Project 3 - Housing Association of Lutherstadt Eisleben mbH

- Project partner Wohnungsbaugesellschaft der Lutherstadt Eisleben mbH
- The pilot project is a multi-storey residential building
- located in Freieslebener Straße
- Two stairways
- Predecessor was a DDR construction
- As reference block, we used a building directly opposite with the same orientation, tenant structure and heating technology
- Object is in a good condition
- Company is very innovative

Fig. 11/11a: Residential building (left) and equipment "Accompanying band heating hot water" (right), source: WBG Lutherstadt Eisleben

2.1.4 Pilot project 4 - Campus Buch GmbH (BBB)

- Project partner BBB Campus Buch, Berlin public corporation since 2018
- The pilot project 4 is a multi-storey office building on campus called D85 - Arnold-Graffi-Haus
- The office building selected first - see energetic recording / energy report has turned out to be unsuitable in terms of use
  → many laboratories are warmed by external heat (computers, monitors etc.) or storage rooms in which heating is almost non-existent
- Building of the Innovation and Start-up Centre for biotechnology companies
- for scientific purposes and workplace for companies
- Three sectors per floor
- One sector of the ground floor was equipped
- The floor above was chosen as reference for the same sector
- Object is in good condition
- Management is well positioned in all technological disciplines

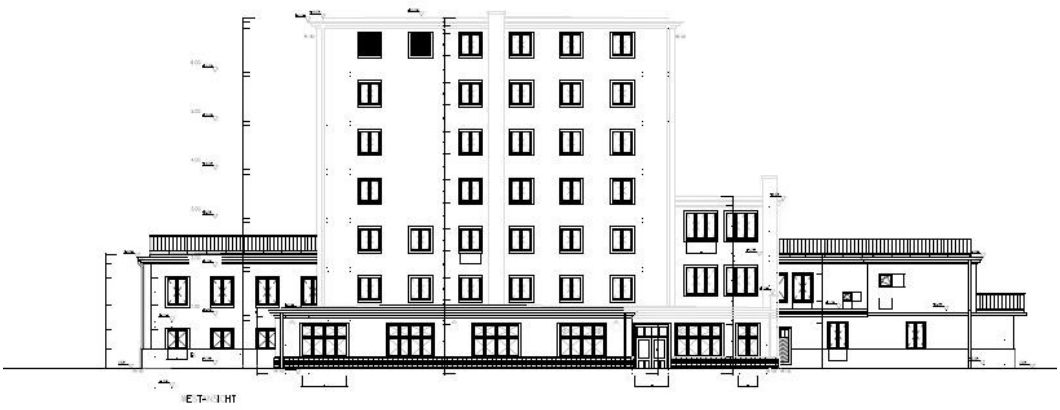


Fig. 12: Sectional view of pilot building, source: Campus Berlin Buch GmbH

Fig. 13: Floor plan of pilot building, source: Campus Berlin Buch GmbH

2.2 Preparation of the measures

From 2015 onwards, extensive preparatory measures were undertaken.

- In advance, the process was coordinated and structured in detail in team meetings with the project participants (GWG, ABG, WBG, BBB).
- The effects were also described in simulation calculations.
- A very detailed building simulation was created after extensive recording, which shows the energy saving potential for each respective object.
- After completion of the building simulation for the House 55 Campus Buch and the subsequent repeated inspection of the individual rooms, the decision was made to change the building again due to the use of the rooms (mainly laboratories with a high external heat influence and storage rooms without heat requirement) in order to better highlight the effect of the individual measures. Finally house 85, used predominantly as an office, was chosen.
- The tenants of the first three projects were informed via letters and flyers.
- There was a lively exchange with the WoWi participants in order to put the very technical view of the measures into an understandable context for the tenants. Among other things, the network's text proposals were edited by the housing companies and then published in "tenant-compatible" language (see also the following announcement by ABG Paradies).
- The prospect of getting an app-enabled visualization of heating consumption (and other consumption data) prompted some frenzied demand from tenants. From the tenants' point of view, this is highly interesting in order to be able to keep an eye on the largest item of warm utility costs.
- Older tenants with no affinity for web use were made aware by these highly interested tenants that they did not have to do this themselves, but that "the grandchild generation" could easily do this for their grandparents. This argument was accepted by the older tenants.
- The mood at the tenants' meetings was extremely positive after critical questions on data protection and the 20 % savings option had been answered satisfactorily.

Following is an example of an announcement by the landlord (see Fig. 8):

Energieprojekt in der Sausenberger Straße

Bei europäischen Innovationen ganz weit vorn: Die Sausenberger Straße

Die Meinung der Bürger ist wieder gefragt: Neue Möglichkeiten der digitalen Welt werden einem Nutzen unterstellt, der alle Mieter überzeugt: Das Senken von Kosten. Größter Posten ist hier natürlich die Heizung, gefolgt vom Strom für die Warmwasser-Erzeugung und vom Strom für alle anderen „Verbraucher" im Haushalt wie Kühlschrank, Waschmaschine usw. Wir als Genossenschaft haben uns für ein Pilotprojekt zur Verfügung gestellt. In der Sausenberger Straße wird ein Wohnblock auf Kosten des Netzwerkes mit neuester Messtechnik ausgerüstet, während der Andere im Original verbleibt. Später wird man sehen, was die neue Technik real an Einsparungen bringt.

Was ist an der „Internet 4.0"-Welt anders als heute? In erster Linie wird es Mietern ermöglicht, ohne Kabel oder Batterien neue Geräte in jedem Raum zu nutzen, die sich selbst anlernen, keinen zusätzlichen Strom benötigen und die bei Abwesenheit die Raumtemperatur absenken. Clou dabei: Die Geräte merken sich, wann die Nutzer zur Arbeit gehen und wann sie zurückkommen.

Für diese Neuerungen gibt es ein erstes Sicherheitszertifikat vom zuständigen Bundesamt, weil die dazu benötigten Daten von außen nicht eingesehen werden können. Dazu soll im Verlauf des nächsten halben Jahres nun eine sogenannte „App", also eine mieterbezogene Anwendung für Smartphones für die beteiligten Mieter erstellt werden, die in erster Linie den eigenen Verbrauch auf dem Display von TV-Geräten, Tablets und Handys anzeigt. Aber auch alle anderen wichtigen Partner aus der Umgebung sollen eingebunden werden: Apotheken für die Rezeptzustellung, Lebensmittelmärkte mit Lieferservice, warmes Essen auf Rädern usw. usw.

Ermöglicht wird dies durch Fördermittel des Landes Berlin. Ein Netzwerk aus Fachfirmen (green with IT e.V.) hat die Senatsverwaltung davon überzeugt, dass es möglich und auch notwendig ist, Bürger bei ihren Bedürfnissen abzuholen. Was liegt Mietern näher als die eigene Wohnung? Dazu soll sich diese „App" selbst finanzieren, sprich ohne Kosten für Mieter installiert werden.

Nach umfangreichen Beratungen des Vorstandes u.a. mit der Hochschule für Technik und Wirtschaft (HTW) und einer vorab angefertigten Detailberechnung durch das Netzwerk wurde in der Sausenberger Straße 26-34 ein Gebäudekomplex aus den 30er Jahren sowie ein baugleiches Gebäude für Vergleichszwecke ausgesucht. Die Installation der Grundgeräte erfolgte Anfang September. Weitere Installationen im Zusammenhang mit der Heizerzeugung, der Heizverbrauchs-Datengeräte und dazu einem sogenannten „Kieznetz" des Stromversorgers erfolgen in den nächsten Wochen und Monaten.

Erste Ergebnisse werden im Sommer 2017 erwartet. Doch welcher Nutzen soll sich einstellen? Zunächst einmal wird unterschieden in denjenigen Nutzen, den die Mieter selbst erzeugen können: Das automatisierte Absenken der Raumtemperatur bei Abwesenheit bringt mit nachweislich ca. 20% die größte absehbare Einsparung bei den Heizkosten. Dann gibt es weitere, sehr wichtige Einsparungsmöglichkeiten, die der Vermieter seinen Mietern erschließen kann: Verbesserte Informationstechnik bringt Informationen an den Heizkessel und seinen Brenner, so dass hier – wie bereits im Einzelraum – eine Vorhersage der Nutzungsgewohnheiten, aber auch des zu erwartenden Wetters erfolgt.

Ganz zuletzt sollen diese Daten dann in ein zentrales Kiezmanagement einfließen, so dass hier alle für eine Senkung der Heizverbräuche wichtigen Anwendungen zusammen fließen. Damit dies stattfinden kann, werden für jede Mietpartei „intelligente Stromzähler", sogenannte Smart Meter, eingebaut und zu einem zentralen Knotenpunkt (dem „Smart

Fig. 14: Article from the member newspaper of ABG Paradies (first section), source: ABG Paradies eG.

Energieprojekt in der Sausenberger Straße

Meter Gateway) zusammen gefasst. Dies wäre eigentlich eine „normale“ Maßnahme, zumal die alten Stromzähler reichlich „dumm“ sind. Doch dafür gibt es noch kein verpflichtendes Gesetz, so dass die Investitionen dafür ausbleiben.

Erst 2025 ist mit einer flächendeckenden Einführung solcher Managementsysteme zu rechnen.

Nicht so bei uns. Wir nehmen die Zukunft vorweg und probieren zusammen mit der Senatsverwaltung neue Dinge aus, die unsere Genossenschaft in der Innovationskraft stärken, ohne dabei Risiken einzugehen. Gewinnen können nur unsere Mieter. Aber auch unsere Genossenschaft beweist hier einmal mehr, dass unsere Organisationsform genau richtig ist, wenn neue Formen des Miteinanders, der Kommunikation ausprobiert werden. Spielereien und Spinnereien bleiben draußen. Nützliche Technik ist so aufgebaut, dass ein erkennbarer Nutzen entsteht und die Kosten überwiegt. Apropos Kosten:

Unsere Mieter zahlen für die beschriebenen Ausbaustufen nichts. Das wird durch die Mittel des Landes Berlin sichergestellt. Aber wir werden auch messen, wie schnell sich die Geräte lohnen würden, wenn diese voll bezahlt werden müssen. Sollte sich der Nutzen klar heraus stellen, so werden wir unseren Bestand entsprechend aufrüsten. Möglicherweise kann auch noch eine zweite, größere Ausbaustufe, diesmal mit Mitteln der EU, umgesetzt werden. Aber das wäre erst im nächsten Jahr der Fall, wenn ein weiterer Förderantrag in Brüssel entschieden wird. Bürger- und Mieterbeteiligung kommt bei den Regierungsstellen immer mehr an.

Fig. 15: Article from the member newspaper of ABG Paradies (second section), source: ABG Paradies eG.

2.3 Implementation measures

2.3.1 Hydraulic balancing

The originally planned measure of the old familiar "hydraulic balancing" did not meet with the approval of the WoWi partners, since in some cases there were reliable findings available which proved that no positive effect could be definitively proven. For this reason, the implementation did not take place in any of the projects after the application partners agreed.

2.3.2 Flow Limiter

In the interest of all project participants, the flow limiters were not used because the effort required for their use was not satisfactory.

→ Problems: a high investment of time and effort
- Ice up or
- Complete water extraction in the system.
- This would have meant that all tenants would have had to be on site on the day of installation.
- Cannot be guaranteed 100 % or is not practicable, as this is partly is perceived as a danger by the tenant.

2.3.3 Stage 1: Self-learning "energy-harvesting" individual room control as an introduction

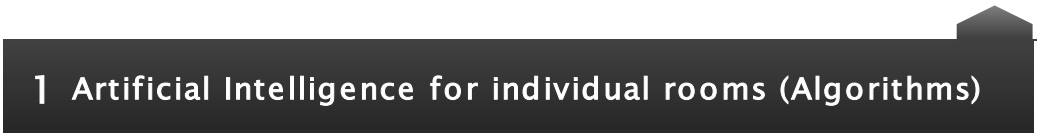


Fig. 16: Level 1 Success quotients of digitisation as ladder rungs, © green with IT e.V.

Fig. 17: Self-learning single-room control system from competence field 2, © green with IT e.V.

The first central measure to reduce heating energy consumption was the individual room control system (ECR) with self-learning algorithms described in Fig. 16. The system permanently learns usage behaviour and creates an energetically sensible heating profile from this. During the time of use, the temperature set by the user is maintained and in their absence the temperature is automatically reduced by max. 4 K (degrees Celsius as temperature difference) [13].

Details were extensively explained in parallel building simulations and are summarised briefly here: it is a "low investment" measure in the sense of the BBU's ALFA philosophy; simple installation because no cables have to be pulled or holes drilled; batteries are not needed because of the energy harvesting of the components; ISO-standardised EnOcean wireless technology is used, which can be extended by its open standard and is particularly low-radiation, so it can also be used in hospitals, for example; increased comfort for users because the standard comfort temperature is already provided in advance for use; intuitive operation, so no changeover is necessary for users. **Embedding in a complex central system is not necessary here in our pilot approach.**

This entry took place in all four pilot project quarters and was therefore subjected to an initial interim review before the more complex steps that followed began.

[13] Definition Kelvin

3. The tenant as an opinion leader - promising design frameworks in cooperation with the landlord

3.1 Individual evaluation Stage 1 Project 1: GWG Lübben

General Information

- Hartmannsdorfer Straße 2 - EZR in the living rooms
- Hartmannsdorfer Straße 3, 4 and 5 EZR in all living rooms, children's rooms, bathrooms and bedrooms

Installation individual room control

- Date of Installation 04.11.2016

Number of installed devices

- 33 apartments
- Mainly 2-room apartments
- 94 Room sensors
- 94 Valve controller
- No adapters
- Three apartments without installation → not found
- Caretaker installed in these apartments, since the practical training of the caretakers had taken place during the installation phase.

Booking of consumption data for evaluation purposes (applies to all subsequent pilot projects)

- Booking of the defined WE from 2015 could take place immediately. The accounting period 2015 to 2017 was available to the users and could be delivered anonymously (GR numbers). Before publishing individual results, the formal GDPR declarations of consent were obtained from tenants.
- The expected data can be extrapolated to the entire portfolio
- A return on investment model can be generated from the tenant's perspective using a formal, apportionable "mod" measure
- CO_2 savings quotas can be extracted and extrapolated to quarters, districts and municipalities

The savings ratios - as the most important component of project success - are listed in the last column of all subsequent graphics:

Presentation of selected apartments of long-term tenants (moving in before 2015)

WE NR	HMD-STR	ETAGE	2015	2017	Entwicklung [HKV-Einheiten]	Entwicklung [%]
023.06	2	2. OG re	3486,38	2290,04	268,32	-34,31
023.09	3	EG li	2190,31	1368,99	-411,59	-37,50
023.16	3	3. OG re	1809,89	1452,32	275,55	-19,76
023.32	5	3. OG li	7427,15	5810,68	-1176,99	-21,76

Table 1: Representative savings rates at pilot project 1 - GWG Lübben, © green with IT e.V.

These apartments were then compared with the projected reference apartment in terms of results. In the following diagram, we have directly assigned each apartments to one of two blocks placed one below the other, so that a clear reference to the reference building can be documented:

WE NR	HMD-STR	ETAGE	2015	2017	Entwicklung [HKV-Einheiten]	Entwicklung [%]
023.06	2	2. OG re	3486,38	2290,04	268,32	-34,31
024.14	7	2. OG re	1480,19	1427,30	-1,89	-3,57
023.09	3	EG li	2190,31	1368,99	-411,59	-37,50
024.18	8	EG li	3954,60	4471,29	1348,96	13,07
023.16	3	3. OG re	1809,89	1452,32	275,55	-19,76
024.25	8	3. OG re	1861,69	3882,69	1660,10	108,56
023.32	5	3. OG li	7427,15	5810,68	-1176,99	-21,76

Table 2: Comparison of reference apartments at pilot project 1 - GWG Lübben, © green with IT e.V.

3.1.1 What the landlord says:

"GWG Lübben, together with the network green with IT e.V., has tested possibilities of digitising housing industry processes in a pilot project in Hartmannsdorfer Straße in Lübben and on a similar building. We presented and explained in detail how the new technologies work in information letters and a tenant meeting. Individual concerns, especially those of the older residents, were dispelled in this way. The targeted savings in heating costs were analysed and evaluated over a three-year project period. Under the conditions of an FTTB network, which has covered our entire residential portfolio in Lübben since January 2018, new digital possibilities will arise for us in the future. We support all options for tenant participation in the reduction of warm and cold operating costs. We will be happy to be available again for future pilot projects produced by the network".

Nicole Jaegers
Board of Directors GWG Lübben

Jürgen Busch
Board of Directors GWG Lübben

3.1.2 This is what the tenants said in an interview:

Karl-Heinz Sauerbrei
My name is Karl-Heinz Sauerbrei, I am a tenant with the GWG in Lübben. My landlord has installed digital devices in my apartment, which I viewed sceptically at first. In terms of living comfort, nothing has changed for me. I take care that the heating costs remain as limited as possible. So it is self-evident for me that, for example, I still turn down the thermostats when I am absent and of course raise them again by 2 strokes after returning to the apartment. I hear some of the automatic changes to the actuator, but I don't find that annoying.

My warm operating costs were 379 € in 2015, in 2016 this was reduced to 313 € and settled at 336 € in 2017. All in all, I welcome the tendency to have to less heat and, of course, lower costs.

However, despite digital support, I continue to keep a close eye on my heating energy consumption, monitor the consumption values and thus ensure that I always have my warm operating costs under control.

My comfort temperature is between 20 and 22 °C.

Birgit Gnädig
My name is Birgit Gnädig, I am a tenant of the GWG in Lübben. I cannot imagine an apartment without the operation of the installed individual room control system. My daughter and I get on well with the simple operation - I always call it the “Little Man". Our motto is: Push the Little Man, and everything will be well-timed. I have a clear conscience when I am absent, because then my room temperature is not unnecessarily high. Of course this saves me money, but making a small contribution to limiting climate change is also a plus. The important thing for me is: when I come home, the apartment is warm!

My warm running costs have been at a very good, i. e. low, level since 2016. I would also like it to stay that way and I am happy to help further. My comfort temperature is between 21.4 °C (living room) and 24 °C (bathroom).

Ms. Gnädig also made these statements herself in a *film which won the Future Award 2019* (featured in the last part of the film).

Andreas Fischer
I am a tenant at the GWG in Lübben. My apartment is part of a series of experiments on how to help tenants save on heating costs. For this purpose, devices were installed in my apartment.

I was curious from the beginning whether I could actually detect lower consumption by installing the devices. The installation was quick and easy– much better than with most such systems, where you would have to program endlessly first. I was very positively surprised that I actually saved heating consumption and costs. The bottom line for me was € 50,- less than in previous years.

I am happy to try out other worthwhile methods, if it is of any use.

My comfort temperature is 24°C in the bathroom and living room.

3.2 Individual evaluation stage 1

General Information

- Sausenberger Straße 24, 26, 28, 30
- Reference: Sausenberger Straße 25, 27, 29, 31

Installation individual room control

- Date of installation 07.09.2016

Number of installed devices

- 17 apartments in which en:key is used.
- 53 room sensors
- 53 Valve controller
- Adapters used: approx. 35
- Installation in living rooms, kitchens and bathrooms
- Bedrooms were left out
- Subsequent installation of two more apartments in October

Later installation Smart meter gateway simulation, MUC, HKV devices, open metering SystemConnection [14]

- Date of installation Autumn 2016

Presentation of selected apartments of long-term tenants (moving in before 2015)

Sausenberger Straße	Name	2015	2017	Entwicklung [HKV-Einheiten]	Entwicklung [%]
28	anonym	13.280	10.318	-2.962	-22,30
28	anonym	4.565	2.480	-2.085	-45,67
28	anonym	3.521	1.469	-2.052	-58,28
34	anonym	6.844	5.103	-1.741	-25,44

Table 3: Representative savings rates at pilot project 2 - ABG Paradies, © green with IT e.V.

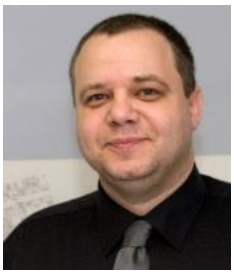
Further evaluation details can be found in the appendix of this report.

3.2.1 What the landlord says:

“ABG Paradies Berlin has tested various possibilities of digitising housing industry processes together with the network green with IT e.V. in a pilot project at Sausenberger Str. 26-34 and on a similar building. There were only minor concerns on the part of our cooperative tenants. Our oldest tenant, who is 102 years old, also coped well with the installation of digital measures in her individual rooms. In the field of residential quarter management, we worked with a local utility company to implement the requirements for extensive Smart Meter processes by replacing all the old meters and joining them together to form two gateways. The first area of application is to be self-determined and database-managed heating consumption data, in order to achieve a certain independence from service providers as an option. We were very pleased to be involved in these new digital fields of activity and look forward to helping shape further pilot projects.”

The detailed presentation of the first project results took place at the IHK conference „Wärmewende-Energieeffizienz-Erfolge made by IoT“ on 01.03.2018.

[14] Definition OMS



Daniel Schulz
Chairman of ABG Paradies e.G.

3.3 Individual evaluation Stage 1 Project 3: WBG Eisleben

General Information

- Equipment placed in Freieslebenstraße 7 and 8
- Freieslebenstraße 5 and 6 as reference building
- Equipment placed in the living rooms, children's rooms, kitchens and bathrooms
- Bedrooms were not equipped, as the heating activity is usually not very high there
- Reference object is located on the other side of the street with the same equipment and orientation

Installation individual room control

- Date of Installation 06.09.2016

Number of installed devices:

- 18 apartments
- 66 room sensors
- 72 valve controllers
- No adapters required
- Caretakers were able to install in a few apartments after successful practical training

Difficulties during installation

- None
- Caretaker accompanied the installation
- Watched the assembly and commissioning and was able to install for the tenants who were not initially present

Presentation of selected apartments of long-term tenants (moving in before 2015)

Freieslebenstraße	Etage	Lage	Name	2015	2017	Entwicklung [HKV-Einheiten]	Entwicklung [%]
7	EG	M	anonym	5.165,37	4.161,78	-1.003,59	-19,43
7	1OG	R	anonym	3.898,33	2.885,73	-1.012,60	-25,98
8	EG	M	anonym	5.068,88	4.415,91	-652,97	-12,88

Table 4: Representative savings rates stage 1 at pilot project 3 - WBG Eisleben, © green with IT e.V.

Representation of selected apartments from long-term tenants to the reference apartment in the reference building

Freieslebenstraße	Etage	Lage	Name	2015	2017	Entwicklung [HKV-Einheiten]	Entwicklung [%]
7	EG	M	Kaltofen, Walter	5.165,37	4.161,78	-1.003,59	-19,43
5	EG	M	Referenz 1	125,73	27,39	-98,34	-78,22
7	1OG	R	Dienemann, David und Maria	3.898,33	2.885,73	-1.012,60	-25,98
5	1OG	R	Referenz 2	3.821,58	4.830,90	1009,32	26,41
8	EG	M	Wüsthoff, Reinhard	5.068,88	4.415,91	-652,97	-12,88
6	EG	M	Referenz 3	2.805,01	3.710,64	905,63	32,29

Table 5: Comparision of reference structures stage 1 at pilot project 3 – WBG Eisleben,© green with IT e.V.

The reverse trend is especially noticeable in the last two pairs of apartments (each with EZR and reference): If savings are made in the apartments (all long-term tenants) with individual room control, the heat demand in the reference increases.

3.3.1 What the tenants say:

Reinhard Wüsthoff

My name is Reinhard Wüsthoff, I am a tenant with Wobau Eisleben. In my apartment my landlord has installed digital devices, which I observe with great interest in everyday life. I believe that there could be some improvements for the everyday use.

Personally, I take great care to keep heating costs as limited as possible. So it was all the more pleasing to see that I receive noticeably higher repayments after the installation of the devices.

My warm running costs were €645 in 2014 and then rose to €716 in 2015, before the year of installation. After installation, the next operating year was 2016, where I saw a reduction to €531, which levelled off at €571 in 2017.

One of the reasons for this is that I also go to sports at fixed times, for example, and am otherwise supported by the built-in technology, probably in the sense of limiting heating costs. However, I am not letting up in my efforts to keep this limitation in mind myself.

Despite initial skepticism, I regard the built-in technology - with small suggestions for change - as very positive and can only encourage the administration to use it everywhere.

My comfort temperature is 24 °C in the bathroom and 22 °C in the living room.

Maria Dienemann
I am a tenant of Wobau Eisleben. My family's apartment was part of an attempt to save heating costs with new appliances.

At the beginning I was a little skeptical as to whether the promises about future savings would be true. However, our family became familiar with the technology within a month. It was also important that the technology became familiar to us without us having to do anything. I found it very positive that we are automatically supported in our savings efforts. We no longer have to turn down the thermostats when we leave the apartment.

I particularly liked the fact that we saved a lot of money. My initial skepticism has evaporated. We are happy to accept even more of such new support.

3.4 Individual Evaluation Project 4: Campus Berlin Buch

General Information
- House 85, commercial buildings (in contrast to residential buildings projects 1-3)
- One wing on the ground floor (office use) was completely equipped
- A reference on the 1st floor
- Both floors have a heat meter, therefore no (superfluous) individual radiator recording
- For evaluation, the two floors are placed opposite each other and cleaned up with the help of the heating profiles
- Intermediate results can be read and compared more flexibly in terms of time

Installation individual room control
- Date of installation 04.11.2016

Number of installed devices:
- 35 room sensors
- 25 valve controllers

Due to the fact that in this commercial property the data basis was not provided by EHKV but by heat meters, the results could be simplified in the form of a compared floor (application on the ground floor, reference on the first floor). The presentation of the results was therefore also simplified, which documented the different development and the immediately saved heating energy quantities:

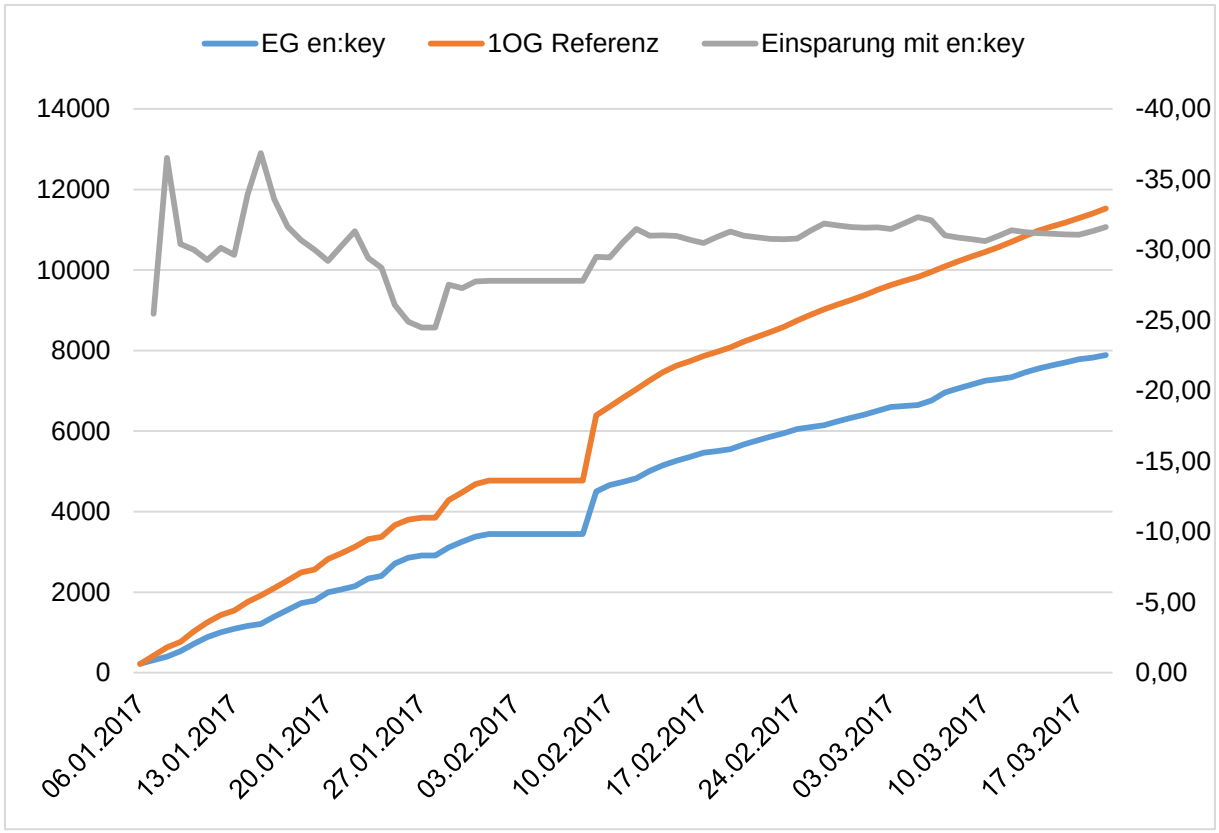


Table 6: Representative savings rates level 1 in pilot project 4 - Campus Buch GmbH, © green with IT e.V.

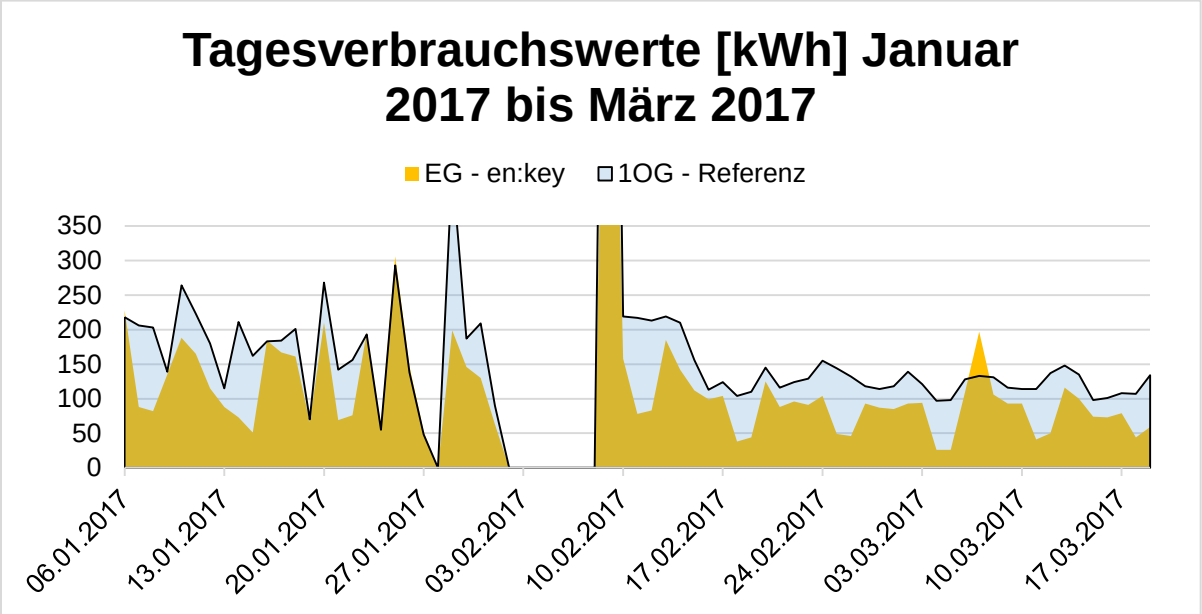


Table 7: Quantitative-graphical comparison of the savings achieved, © green with IT e.V.

From the conceivable measures mentioned above, priorities for the actually feasible implementations were developed. The goals were

- the quantity of district heating purchased, which is to be further streamlined,
- increased internal transparency,
- increased transparency also for external dissemination in the district.

The correct values were determined in a follow-up project "DITRAC" based on the actual consumption in 2018. Here, the **priorities of a commercial manage**r are to be viewed in

contrast to the **priorities of the housing industry**. The expected effect was critically evaluated and included in an assumed savings ratio. The reduction calculation can thus only ever be based on the reduced actual value of the previous ones. The data validated in the subsequent project are not directly related to this report, but should not be left unmentioned in this context.

Here are the priorities and assumptions adopted in the follow-up project:

1. A reduction of the consumption of the static heating system after a **hydraulic adjustment** was calculated conservatively at 5 % as Measure 1, since the heating networks on the campus had been tightly managed for many years and a contract adjustment had already been made in advance. In the overall context, the result was a saving of 2 %. The new starting point is 98 %.

2. The night reduction, in conjunction with

3. The weekend reduction and

4. The summer switch-off are three interlinked measures requiring a high level of communication activity with all users. However, the combination of the measures mentioned above was considered to be successfully implementable because communication with the other users is at a high level and oriented towards efficiency maximisation. Therefore, a combined benefit of 20 % in total for the static heating was included. From 98 %, **89 %** now remain.

The first four measures all follow the accepted rules of technology and can be achieved with - albeit significantly increased - in-house resources and staff. In the comprehensive step-by-step evaluation of all projects, these steps were named but not included in the general context of the documentation of results. In the uniform report on the results, only those measures listed below are based on digital support and are regarded as the **"low-hanging fruits" of digitisation**, so to speak. Since the "smart meters" are now installed in all HASt, and the primary energy values of the district heating are delivered resiliently by the supplier via an app within a new customer portal, the conditions are right for a worthwhile harvest of these fruits.

5. The control engineering adjustment of the heating curves can now be carried out on the basis of newly supplied information qualities of the load curves. Whereas 1-h cycles were previously the norm, 15-minute values can now be obtained and processed in adapted heating curves. Matching” with the outside temperature values during the course of the day is particularly important in order to bring a valid fine adjustment to efficiency maturity.

6. This is now to be further optimised by a forward-looking consideration of valid weather forecasts. The secondary controller can automatically learn that, for example, high solar radiation can be expected in a near time profile. Consequently, the controller will predictively lower the room temperatures before the expected solar radiation occurs. For the Measures 5 and 6, a conservative 10 % reduction is set for the static heating, so that starting from 89 %, a roughly estimated value of **86 %** results compared to the basic approach.

7. 30 % heating energy could be saved by individual room presence detection in offices. This is achieved through the use of artificial intelligence, which sets room profiles for each individual day of the week and reduces the thermostat's heating preset by 4 de-

grees Kelvin when there is no one present. The measured lowering rate was 30 %. Since the office space shares can only be estimated (high volatility due to permanent conversion by tenants), conservatively only a possible third of the total space is considered here. Consequently, the reduction effect is assessed at 10 % overall. This leaves 86 %, which is still roughly **82 %** compared to the basic approach.

8. The "cleaning" of all heating registers and generators in the heating and hot water systems in one of the two so-called "mirror houses" (houses 79 and 80) was implemented in order to check how large this predicted effect is. This is a pilot measure whose effect is all the greater the hardness of the domestic hot water. A corresponding table has already been attached to the report. Conservatively, we assume that an improvement of 2 % will be achieved in the applied house 79, which will be continuously checked by means of the incoming meter values of the heating and hot water consumption. However, a general reduction of the entire household is not included in this calculation.

9. Hydraulic decoupling (district heating and air conditioning) of the primary from the secondary side of the heat transfer has the advantage that the secondary side would be operated at lower operating pressures and lower temperatures. This would also create the possibility of hydraulic balancing. A saving of the AHU share of the total budget can be conservatively estimated. However, we adjust this rate to a conservative overall savings assumption of **76 %** of the original budget. This is followed by other measures, all of which relate to the budget heading "Electricity" and follow the accepted rules of technology.

In addition, individual measures to check for implementation opportunities were considered and will soon be examined internally for prioritisation in the above-mentioned ranking as an option:

- Optimisation of the heat recovery rates in the entire AHU
- Partial replacement of the supplied district heating by third parties with their own geothermal energy gains from deep geothermal energy in coordination with GFZ Potsdam

3.4.1 What the landlord says:

“In the past heating periods, Campus Berlin-Buch GmbH, together with the network green with IT e. V., tested in a pilot project in order to determine to what extent digital processes can help to reduce heating energy.

In one of our buildings, the heating of the rooms on one floor was synchronised with the presence of the employees using self-learning algorithms. The savings effect surprised even us. On average, 30 % of the heating energy could be saved compared to a reference floor with comparable use. We are now planning to install these devices not only on the other floors of the building, but also in other buildings in the biotechnology park.

A second joint and much larger project will be the analysis of the energy consumption of the entire campus with an area of 32 ha and currently 45 buildings with different uses and sizes. To this end, we intend to establish a comprehensive monitoring of consumption in order to identify and exploit further savings potential. The aim is to establish a campus-wide energy management system.”

A detailed report on project 4 can be downloaded here.

Dr. Christina Quensel
Managing Director Campus Berlin Buch GmbH

3.5 Additional information from individual projects in connection with Stage 1

3.5.1 Soft factors

Frequently asked questions by the tenants, which were always answered satisfactorily:

- Do I have to freeze now?
  → The fact that all use habits with thermostats can be kept unchanged was convincing here.
- How much energy can I save?
  → The experience values of 20-30 % were explained, as well as the connections with why mainly tenants who are regularly absent during the day can save
- Am I being monitored?
  → The certified data protection situation was explained in detail; fears were assuaged.
- Are we the test subjects?
  → Yes, but not "guinea pigs". In the test phase, all installations are free of charge for tenants; there can be no deterioration.
- Questions about functionality could always be answered satisfactorily.
- As a tenant, do I now have to pay for the electricity for the individual room control units from my private electricity supply contract?
  → No, the devices do not need electricity, batteries or cable runs.
- The availability of a central contact person from the network was important.

3.5.2 The scalability of the first measure was important for the landlords:

- Option to extend to the whole residential quarter (level 2) as a "gateway solution": as the tendency is to use open standards more and more, this was assumed here..
- Option for integration in a "self-sufficient gateway" to be installed later (as a moderately secure solution) is thus given, as is a transfer to the "smart meter gateway" in the cloud (under BSI basic protection conditions as a highly secure solution); this would allow, for example, the delivery of heating consumption data to tenants' smart phones.
- It is important here to consider data security. Individual security "islands" can also be developed. For example, the individual room control of the type described cannot be controlled from the outside, but manages all variables via the presence of the users. This presence of the users is not communicated to the outside. This was the reason why **this system was awarded the certificate "Data Protection Compliant" by the ULD certification body.**

Scalability as an important energy policy element for harvesting ripe efficiency fruits was explained by the network at many events between 2015 and 2020:

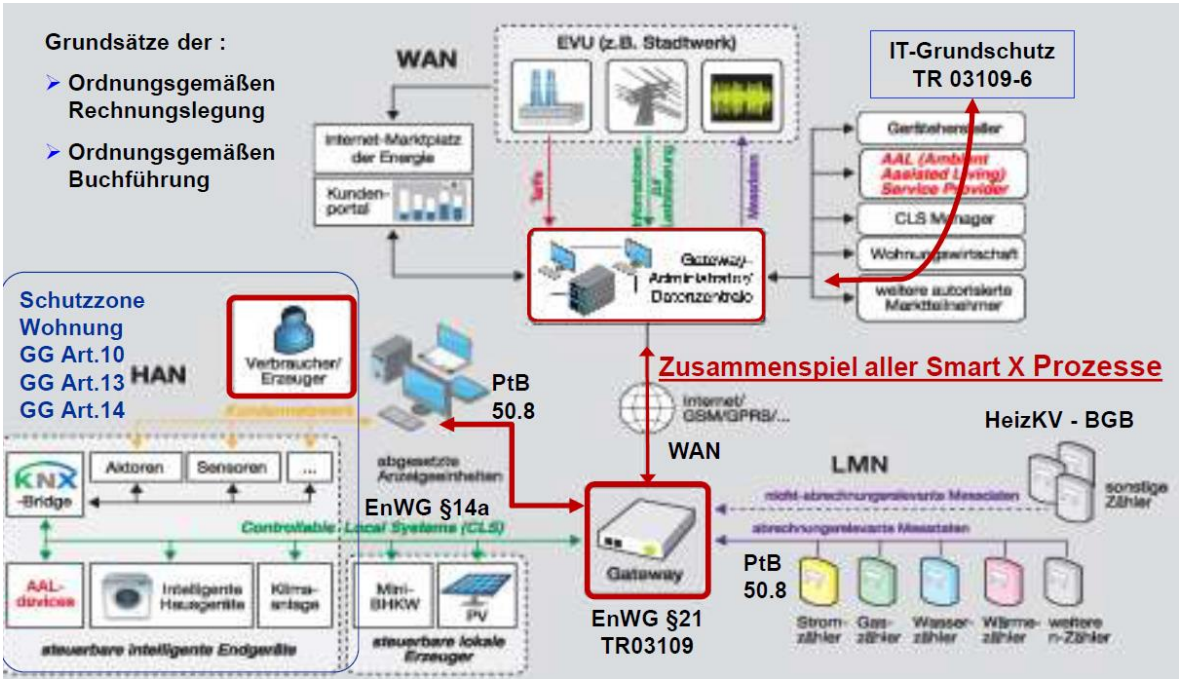


Fig. 18: Smart Meter Gateways, usage levels in the building and data protection, Source: Rolf Uhlig

For example, the individual room regulation (EZR) fulfils the requirement to ensure data protection and privacy for tenants. This is important because it is also the landlords' primary responsibility not to allow third parties (such as Google or Facebook) to access tenants' data.

4. The landlord as intermediary - consideration of the accompanying B2B processes

4.1 Data security in the infrastructure

In order to use and apply digital services in a value-adding manner, a solid and valid database is required in addition to the necessary tools. The raw material basis of digitisation is data!

In order to collect this data, not only are the corresponding data sources and points of data collection necessary, but above all corresponding transport routes and infrastructures on which data can be exchanged securely and with high availability. Only with the help of such infrastructures can locally collected information be digitalized and thus used in a really secure way. The range of digital infrastructures extends from small local solutions to globally available networks.

In this fundamental role, communication infrastructures have a central responsibility. With the growing demands for data security data protection and availability, this responsibility will in future assume central importance for the digitization of our society and, above all, its acceptance.

This key position of communication infrastructures is also reflected in national and international legislation. Examples are the EPBD guidelines or the various BSI guideline decrees.

In the field of building and real estate management, gateway-led services such as

- the establishment of a technical monitoring system,
- active bidirectional operational management and optimisation,
- the active energy management according to ISO50001, or
- a fully automated recording and billing of energy consumption data

are the first applications, which urgently require digitalisation and communicative networking of building services systems and trades.
Many other applications, e.g. from segments such as telemedicine, care, mobility, user service, energy supply, comfort, etc. are already beyond the status of verification and validation and are being implemented.

The "raw materials" - i. e. data - required for these applications vary in their sensitivity, from personal, to critical, to harmless. But all of these characteristics have one thing in common - the use of a secure and reliable infrastructure.

4.2 B2B process secure integration of intelligent metering systems (electricity) using existing infrastructures

4.2.1 Secondary objective “electricity”

Even though this is not in the direct focus of the landlords (B2B), as electricity contracts are concluded directly between end users and tenants, this is an important approach for the tenants, in order to ultimately obtain an overview of their entire spectrum of all service charges.
Within the scope of the project work, therefore, the automated recording of **electricity consumption data from intelligent consumption measuring devices (smart meters)** solutions are developed, which transmit decentralised measurement data collected on the basis of existing infrastructures to a central server in a secure and highly available manner.
This is followed by a dedicated transfer to the application servers/computers for the provision of central services, such as the preparation of energy bills or real-time consumption visualisation.

The implementation of the above project content was carried out with consistent consideration of and orientation towards the three main project objectives defined in advance:

- Ensuring data protection and data security for all process stages and participants.
- Use also of broadband powerline communication (PLC) as an immediately usable alternative infrastructure for integration into the network management.
- Contribution to technical and process-related standardisation.
- Transparency for the end consumer or tenant through consumption visualisation.

The installed remote readable intelligent measuring equipment was operated in combination with communication units, which, among other things:

- have standardized communication protocols,
- enables interoperability between all meter types (formerly proprietary),
- work with internal security routines,
- enable IP-based, bidirectional communication with one or more control panels.

To enable a benchmark between generations of communication units, the project was divided into two implementation phases.

1st project phase: Use of a Multi Utility Controller (MUC)
2nd project phase: Use of a Smart Meter Gateway (SMGW)

4.3 Further project objectives

In addition to the modular concept described above, the focus of the project was extended to include the transfer of the meter data to a scientific institution (University of Applied Sciences, HTW Berlin) or other network partners after a declaration of consent from the tenants, in order to

- enable the scientific processing of the data
- carry out an end-user-oriented visualisation.

The secure transmission concept implemented for the collection of electricity consumption data and measured values was transferred to other media and with extensive use of the same communication infrastructure/technologies in the further course of the project in order to burden the approach of sharing secure communication infrastructures by different media/services/providers both technically and economically. As an example, this was done for the data transfer of heating cost allocators (from Stage 2) from the individual residential units to central application servers.

4.4 Project participants

1. Arbeiter-Baugenossenschaft Paradies e.G = property management of the property
2. Tenant = final consumer, owner of the data
3. Netcom CS GmbH = Telecommunications network operator of the ICT infrastructure (Broadband PLC)

in cooperation with

4. Stromnetz Berlin GmbH = metering point operator and service provider
5. Innotas GmbH = EHKV manufacturer in-house production
6. Kugu Home GmbH = self-sufficiency in all data processes

4.5 Project scope from Stage 2

The project was carried out and validated in the property of the Arbeiter-Baugenossenschaft Paradies in Sausenberger Straße 26-34 in Berlin-Bohnsdorf. The property consists of five stairways with four to five residential units each. The meters are centrally located in the basement of each staircase.

Preparation for Stage 2 " Autonomous Gateways"

These measures were **scaled up** for Stage 2. The approaches and their actually measurable implementation were closely monitored, documented and compared. Landlord processes were also described in detail and the disruptiveness of individual processes was identified so that follow-up projects could be easily designed.

In order to find a basis for a self-sufficient residential quarter approach, the dependency on proprietary gateways, two-wire, Cat7 or Lora networks had to be reduced and replaced by a simple, open and purely current-based solution. All that is needed is the power cable in the stairwell. This "infrastructure" is already available everywhere:

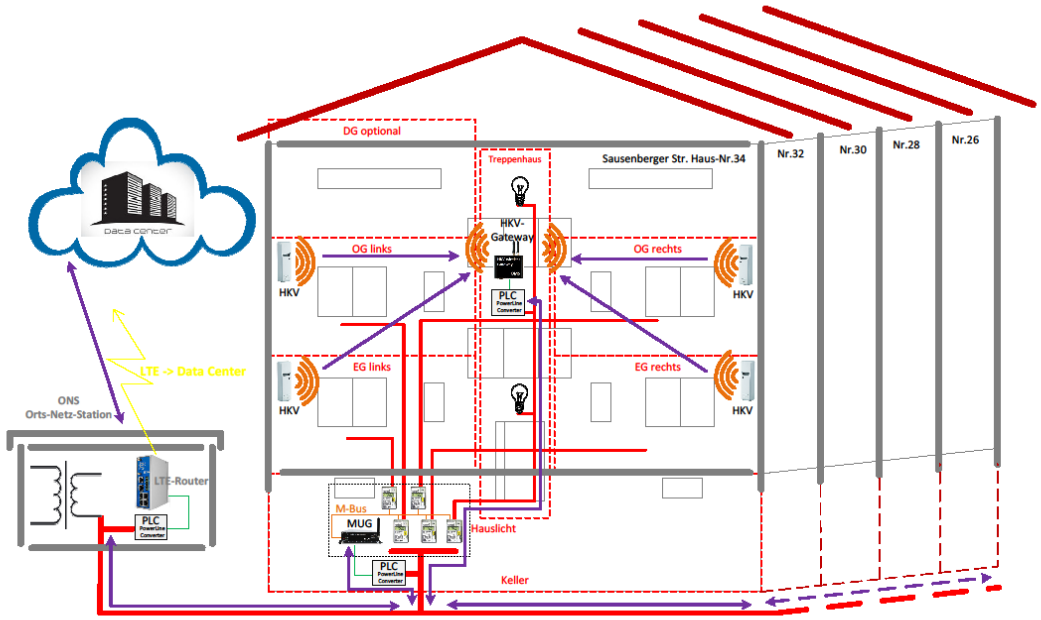


Fig. 19: Level 2 residential quarter approach based on electricity, © green with IT e.V.

In the case of pilot measures, there is the creative freedom to question old familiar processes. The prerequisite here is to precisely describe the new processes, to reveal the gaps that still need to be filled until certification, and to document “old vs. new” comparisons in a scientifically sound manner. Our developers and project engineers have succeeded in this. Experts from research and development, product and project management have joined forces in our fields of expertise to form interdisciplinary test bed designers.

We described the other project components in detail (description of the project approaches) and also evaluated them individually. The data from the individual evaluations were then combined into an overall evaluation. The graphic representation of all further steps from stage 2 onwards follows in the course of the detailed descriptions.

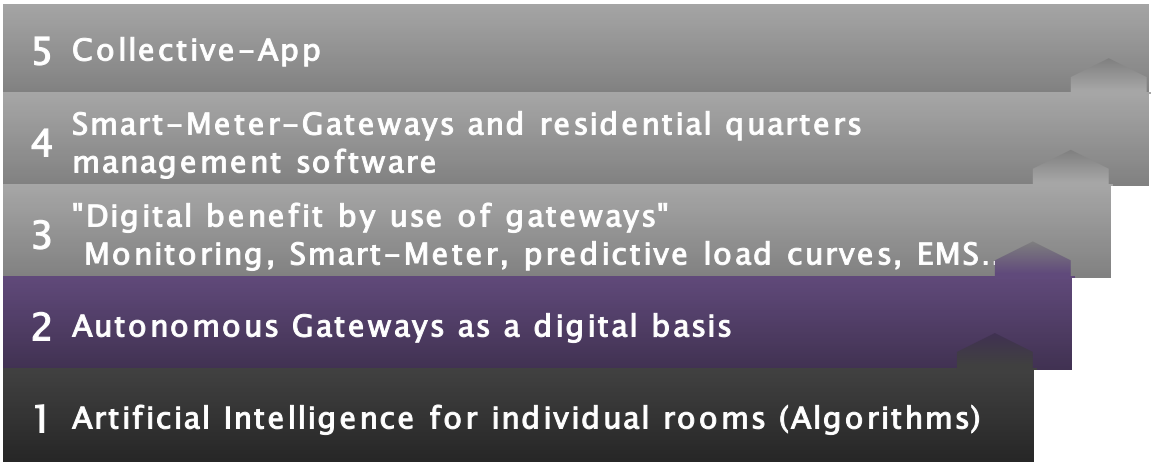


Fig. 20: Success quotients of digitisation as ladder rungs, level 2 © green with IT e.V.

Building blocks of the project scope: Start of Stage 2, further development

- Conversion of the concept into detailed planning phase and execution of the planning services
- Stage 2 Procurement and commissioning of a self-sufficient gateway
- Stage 2 Use of gateway Procurement, exchange and commissioning of a measuring device Submetering, subsequently further development
- Stage 3 Use of gateway to harvest further "digital fruits": predictive load curves, smart meters, monitoring, energy management systems, tradesmen's steering, bidirectional Driving operation of heating generators, automated error management...
- Procurement, replacement and commissioning of electricity measuring equipment
- Provision of a communication path from the measuring point to the local network station (last meter)
- Operation, monitoring and maintenance of the PLC network
- Integration into the systems of Stromnetz Berlin GmbH
- Remote readout at defined intervals
- Stage 4 Procurement, installation and commissioning of the communication units Smart Meter Gateway; broadband PLC modem "BPL", CLS interface
- Stage 4 Added value Provision of a data secure customer portal (residential quarter app) for consumption visualisation
- Collective app according to BSI basic protection

The **already existing submetering gateway** often originates from the **contractually connected submetering supplier**, who places this in the context of all contractual obligations. However, the WoWi customer is not provided with the resulting manifold process options. The gateway is to be restricted artificially to pure submetering data in the contractual context. But this means that **only part of the gateway's capability is being used**; it could do much more. But this is where the absurdity of this contract interpretation begins: these service providers do not provide further quartering processes, or additional data from the gateway operation such as monthly readout intervals. After all, the use of this data opens up entire residential quarters and their management. Instead of self-sufficiency, an additional service is charged for all data and processes that go beyond the annual data delivery. Often the housing companies are not even aware of the digital fruits that can be harvested here without any additional investment (the gateway has already been paid for).

4.6 The technological concept of Stage 2

While the housing industry added value can now be created immediately using **autonomous** gateways as described above, the next concept, the next gateway, is already appearing on the horizon. If all processes that can be mapped via the standard gateways are still equipped with a low level of data security, the smart meter gateway achieves the level of BSI-compliant data security according to common criteria. But first we'll take a look at the standard gateway:

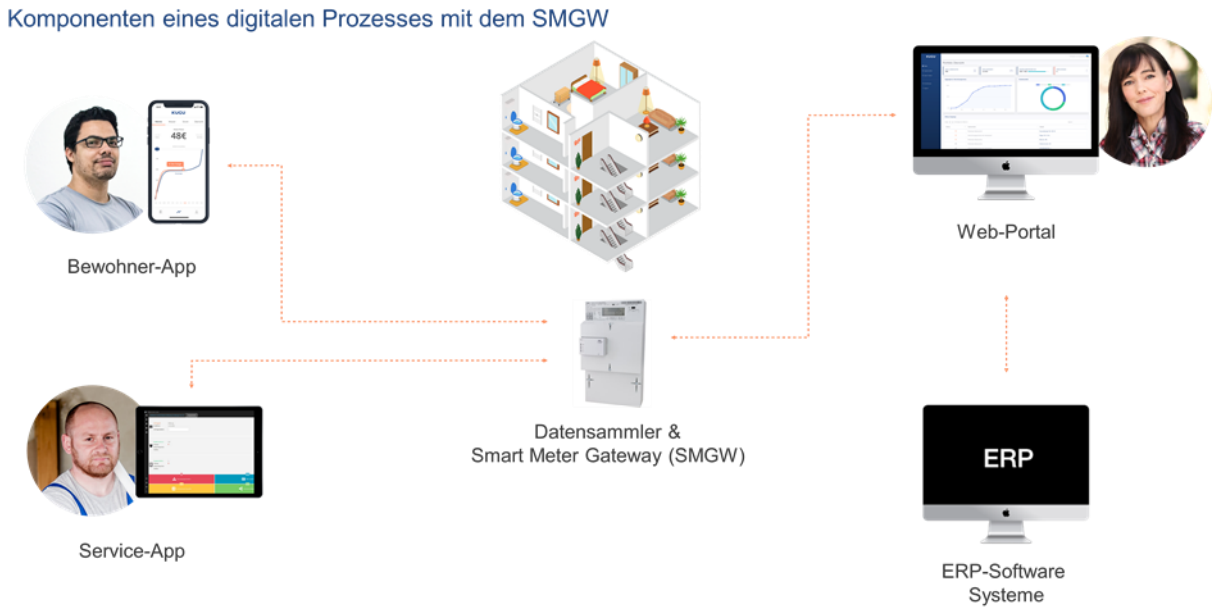


Fig. 21: The gateway is already there: what operations can be added to the standard process? © green with IT e.V.

4.7 Stage 2 Autonomous gateways as digital foundation

The apportionable cost block of the submetering service providers includes the described "gateway", which is used to transfer all relevant submetering data. However, this gateway - shown here in a not yet fully self-sufficient expansion stage - could do much more with conceivable applications for tenant communication, bidirectional system control, etc.

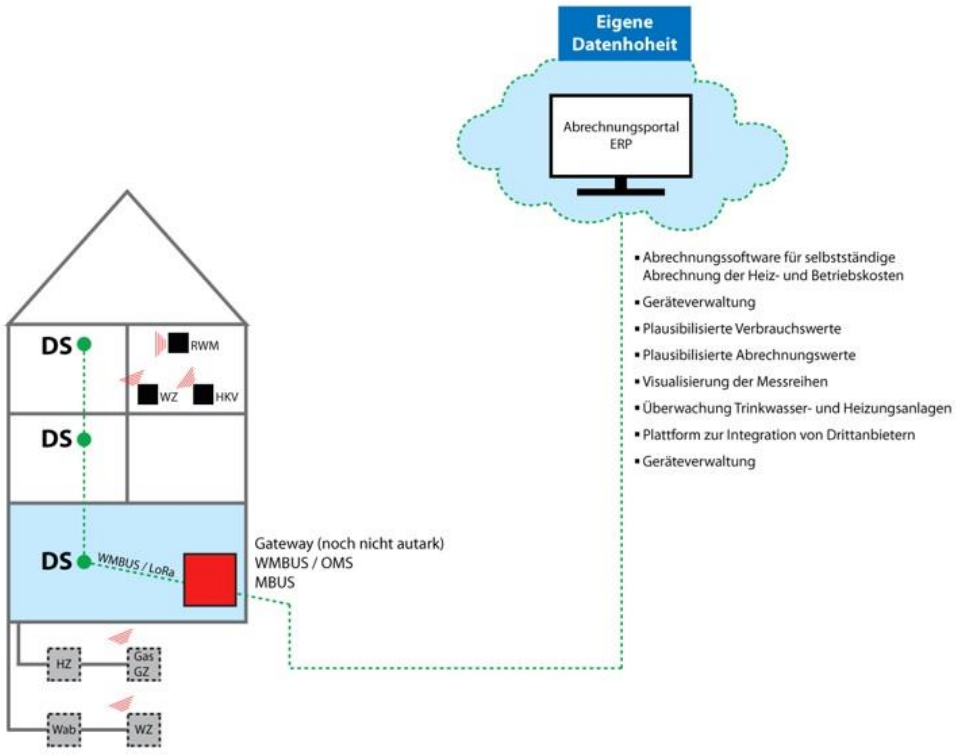


Fig. 22: Level 2 Currently still widely used gateway solution with limited self-sufficiency (service provider is still data holder), © green with IT e.V.

Many housing companies still shy away from taking the decisive step towards **freeing themselves from this dependency**, because this would mean that a very simple package solu-

tion consisting of hardware (EHKV, heat/water meters, in-house transmission technology, gateway) and software would have to be operated with their own resources in future. This is suspected to be more expensive than purchased apportionable packages. However, this is not the case:

The traditional billing of heating and water costs via a service provider ties up a lot of resources at housing companies every year. Ideally, the administrations have to provide the billing information, invoices, tenant changes, etc. in online portals and check the plausibility of the final bill after receiving it. As soon as errors occur, several coordination and correction rounds are not uncommon.

In the case of a self-determined accounting, an invoice can be created for a property within five to 10 minutes with the help of software. By means of many automated plausibility checks, errors can be detected and corrected immediately, so that an invoice is always available when you need it.

You can still leave the device service to external service providers. In this case a continuous transmission of the collected data should be agreed upon, so that one can react quickly even in case of errors and can still use the advantages mentioned below. Alternatively, this business area can also be built up independently with your own personnel or with regional service providers, which can increase further sales potential.

4.8 Harvesting digital fruits: further gateway uses - Stage 3

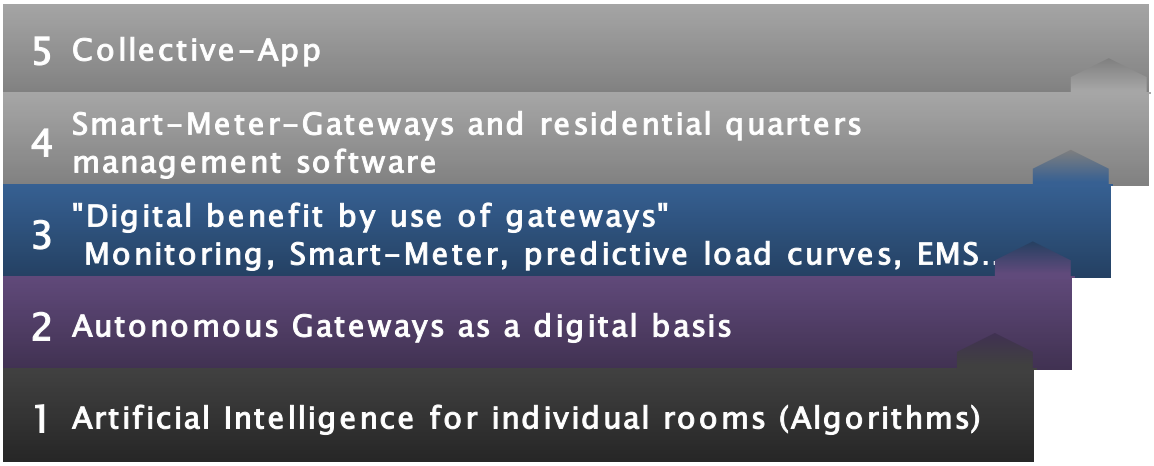


Fig. 23: Success quotients of digitisation as ladder rungs, © green with IT e.V.

Submetering in focus

In principle, stage 2 already included the entire submetering value chain. Currently, this process is carried out with a wide variety of gateways/technologies. The choice of the gateway is usually decided by the service provider, who includes this in his allocatable cost pool. In the following stages this submetering process does not change in itself. However, with the d**ecision for self-sufficiehnt management the data sovereignty** changes radically. Here, the process of submetering, which has so far been the sole focus of the project, is now embedded in a whole series of new, open processes.

Only when **the gateway is fully self-sufficient** can the required gateways be used to their full potential. The consequence is a **multitude of possibilities** for the digital management of buildings, such as the monitoring of heating systems, vacancy management, legionella detection and many other applications. In the case of continuous monitoring of heating systems, faults or defects can be detected and rectified at an early stage. In addition, self-learning algorithms detect inefficiencies, such as missing night set-back, poorly adjusted

heating curves or inefficient pumps. With the implementation of this digital operation management, heating energy savings of up to 12 % can be achieved without having to replace the system.

In the following example, we have deliberately incorporated a collection technology that is being used for the first time. All data from the apartments is collected via new LED corridor lights, which contain a permanently energized telemetric data collector for each floor, and is then forwarded via powerline technology.

For example, the gateway could now be used for monitoring, for setting up an energy management system (EMS) or for controlling a weather forecast-controlled optimisation of the burner and heating-up devices. This is known as a "predictive load curve" and is able to drastically reduce connected loads or power values immediately.

This gateway-controlled energy saving effect is essentially based on the fact that the heating phase is delayed on the basis of the predicted consumption curve until the optimal switch-on point is reached and the burner runs for a maximum combustion duration. This avoids or prevents start-up losses and loss-related burner cycling (connected loads in heating networks are reduced). In addition, a low-temperature storage tank with a lower charge will generate fewer inherent losses. Storage tanks have a large surface area and the temperature difference in normal operation to the environment is often greater than 50 °C. Despite good insulation, the storage tank gives off heat to the environment at these temperature differences. In general normal operation (without a gateway), the burner would always compensate for this heat difference and generate unnecessary start-up losses even during the heat-up phase.

In combination with a data-supported weather forecast, an average of 30 % of the existing connection or boiler output values are saved in large districts.

4.8.1 Other gateway uses:

Equipment of the object with remote readable measuring devices (electricity)

In the first project phase the pilot objects were equipped with the necessary hardware, i. e. procurement and replacement of the measuring equipment for electricity as well as procurement and installation of the MUC as a communication unit. The installed devices were put into operation and then connected to the systems of Stromnetz Berlin GmbH. Furthermore, the provided modems for broadband PLC were installed.

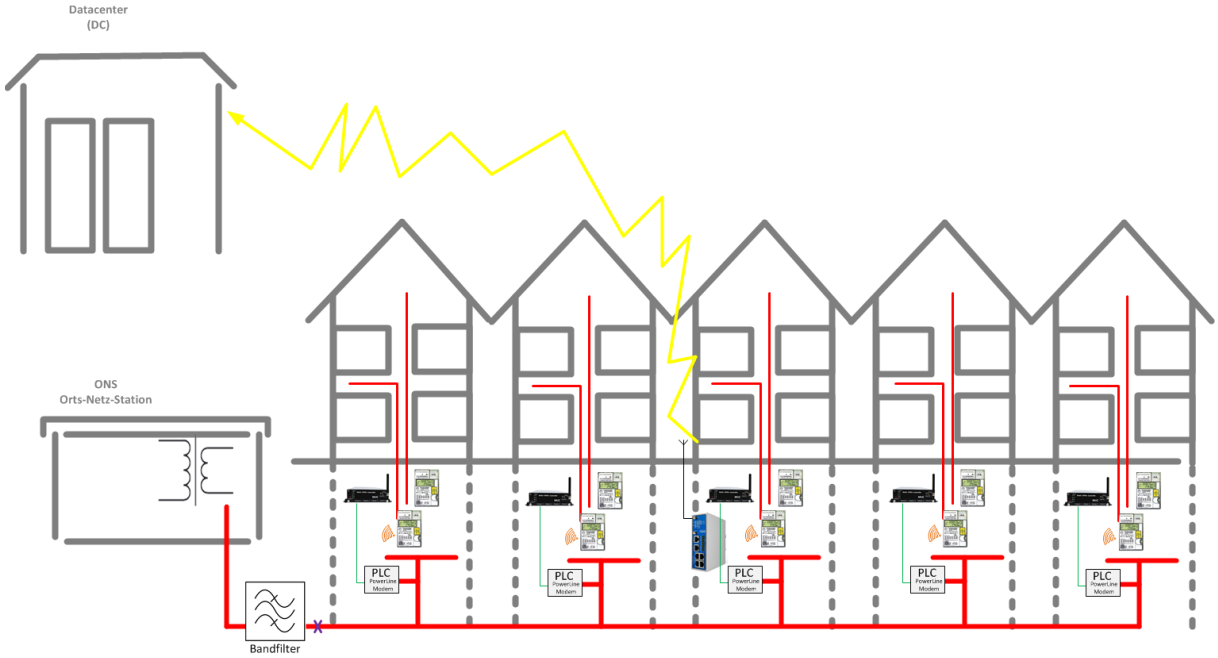


Fig. 24: Installation location PLC headend and WAN interface, © green with IT e.V.

4.8.2 Next expansion in Stage 3:

Autonomous metering point operation and metering service

Autonomous metering point operation and metering service

Now the **hourly** remote readout for the heat consumption visualization was set up and put into operation. The measured values "electricity" (1/4h load profiles) were transmitted via the secure IKT WAN forwarding network to a computer center of Stromnetz Berlin GmbH, where they are stored and processed. Stromnetz Berlin GmbH checks the data records for completeness. Substitute values are created for incomplete or incorrect billing-relevant data. Furthermore, a fault management system is set up and operated.

In parallel, all telemetric data was transferred to a neutral server at the Berlin University of Applied Sciences (HTW); at the end of the project, the data was read out and fed into a fully economic process in accordance with HeizKVo, i. e. proprietary data was visualised and integrated into the WoWi-CRM (here: Wodis).

Fig. 25 : Annual curve of submetering files, © green with IT e.V.

4.8.3 Consolidation of the HKV topic representative for all other projects

In order to be able to evaluate the results of all tested HVAC technology measures in as much detail as possible, all radiators in the "test apartments" of AGB Paradies in the I/II quarter of 2017 were additionally equipped with modern electronic heat cost allocators EURIS II - parallel to the existing, billing-relevant, heat cost allocators. Daily consumption reports for the individual rooms were generated from the measured heat consumption data and transferred to a central database, the Point of Presence, for further processing, e.g. in the app system "My apartment", as shown in Fig. 31. For this purpose, we developed a gateway that enables remote transmission of the WMBUS16 data via Powerline. Parallel to this, a GPRS transmission of the HKV data to a central server is carried out in order to further develop the HKV remote transmission system during the project. In addition to efficient remote reading of the heat consumption distribution relevant for billing as part of the operating cost billing, the aim was to make the tenant's **heating consumption per room available to him per app on a daily basis** in the future and thus motivate him to optimise consumption more strongly than is currently possible with annual billing.

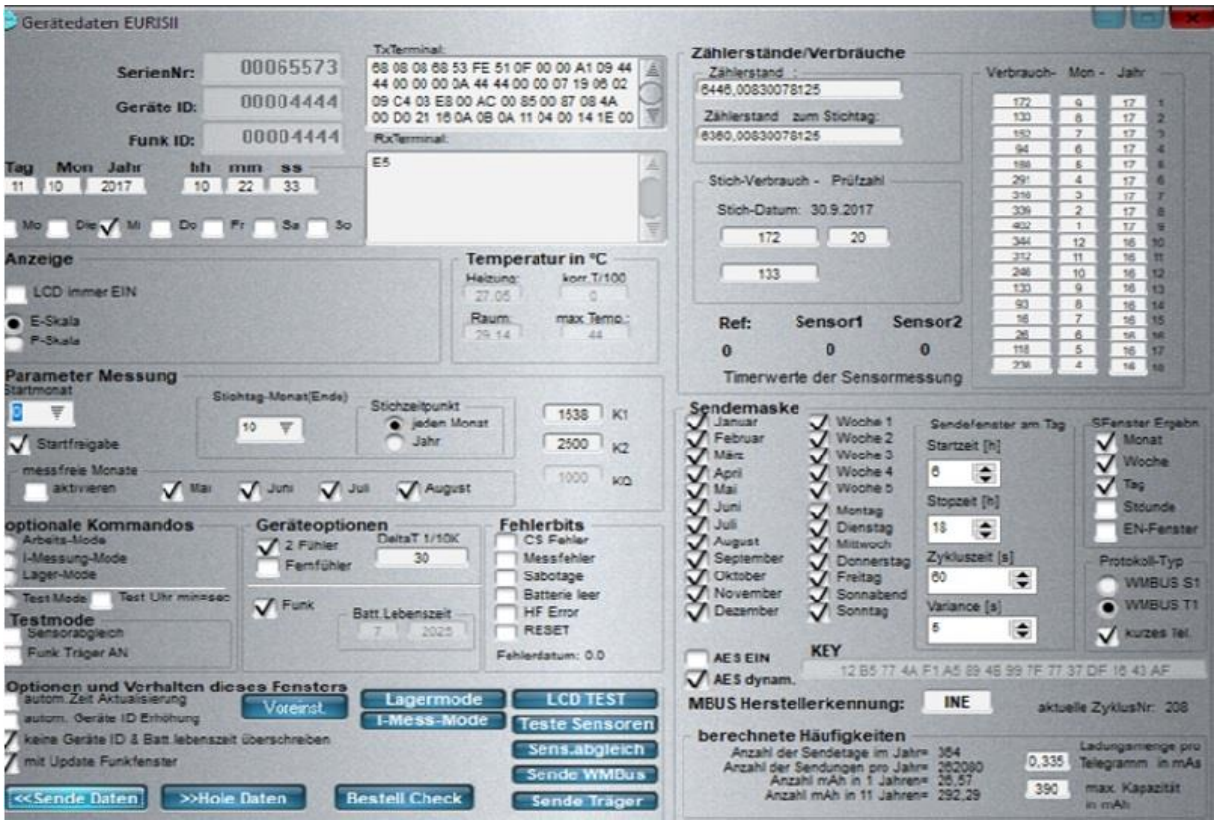


Fig. 26: Illustration of submetering details in the housing industry ERP, here: wodis, source: ABG Paradies eG

4.9 B2B process network sharing - secure integration of intelligent metering systems (electricity) and heat metering systems via common, existing infrastructure

HKV technology for disruptive use in PLC-controlled networks

HKV file transport via the IKT forwarding network

The described measures for data transport have been extended. In order to enable the transport of HKV files cost-effectively and securely via the WAN- IKT forwarding network, a **further pilot project** was planned.

The solution described for the communication of electricity consumption data was extended by the existing communication infrastructure, transporting the consumption values of the me-

dium "heat" in parallel via a common and secured communication network and supplying applications for the provision of central services and services.

The following objectives were defined:

- Reduction of the monthly data transmission costs via mobile radio
- Avoidance of SIM card handling
- Avoiding reception problems from the mobile network
- Use of the BSI-compliant (certified) infrastructure of the SMGW

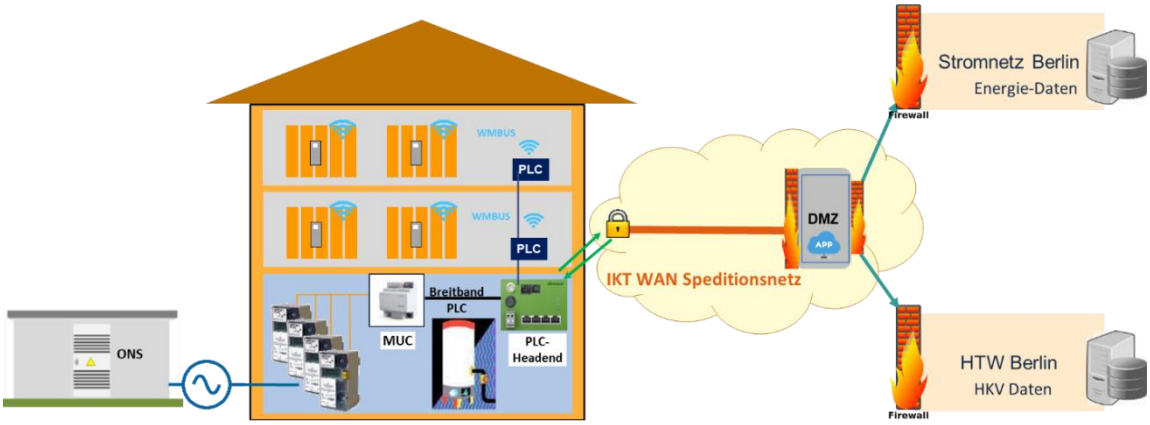


Fig. 27: Communication concept pilot objects Sausenberger Straße 26-34; 1st evaluation level with MUC and standard PLC communication, © green with IT e.V.

Development of a cost-effective pull service for the transmission of daily updated consumption data

The positive prerequisites were demonstrated on the basis of the submitted in-house, standards-compliant hardware and the thematic proximity of the HKV hardware to the issues of "water meter readout and visualization" and "smoke detector integration" was coordinated. ABG confirmed the market relevance both from a technical and a price point of view and integrated this process into the Smart Meter Gateway.

<u>Milestones of the project plan</u>

- Insert HKV
- Installation of WMBus gateways (WMBUS/PLC) in floor distribution boxes
- Installation /Integration in PLC-Head End in the boiler room
- Communicative connection of the floor distributor boxes to PLC Head End
- In-house connection to the WAN infrastructure /IKT-WAN forwarding network of Netcom CS GmbH
- Enhancement of file transfer via IKT-WAN forwarding network to the DMZ
- Secure IT coupling DMZ/application server for APP development

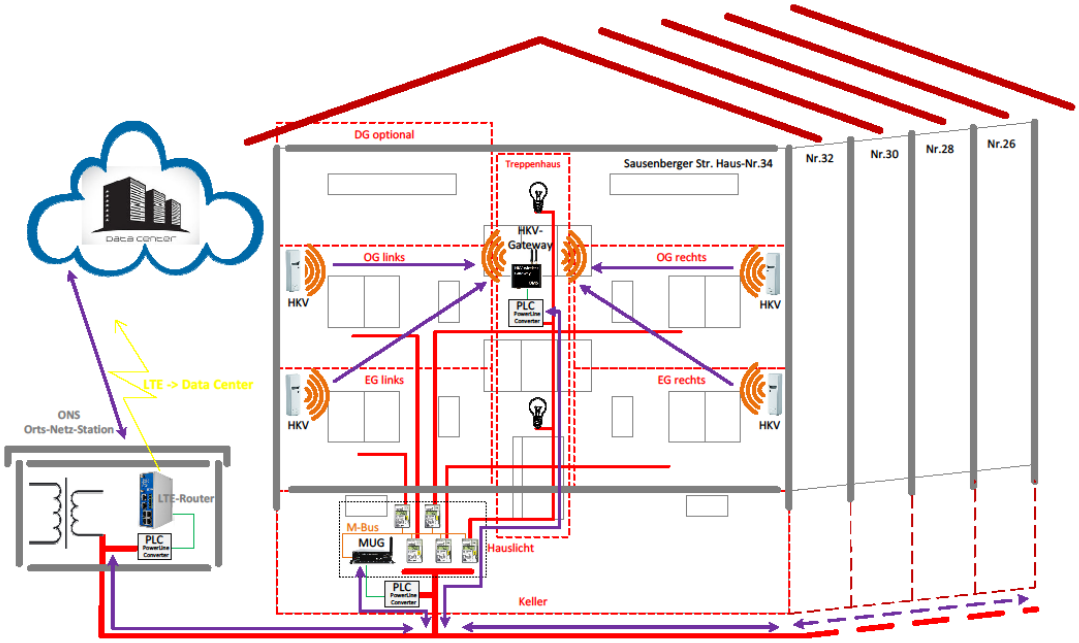


Fig. 28: Communication concept HKV data transmission via IKT-WAN forwarding network, © green with IT e.V.

In addition, with regard to the Internet of Things (IoT) the aim is also to investigate technical solutions for the efficient use of **cross-media in-house gateways** and shared transmission paths and databases and the intelligent services based on them (Big Data).

The following preparatory steps can be used for this:

A "basic server package" has been created, which performs the task of collecting, processing, storing and subsequently forwarding the data from the various sources once a day. Since data is already stored here, the data can also be output via a web client at this point. Here, however, it is important to ensure that the tenant account -> housing unit <- sensors (HKV, water and electricity meters) are linked in compliance with the GDPR.

A separate interface/service has been created on the server for each data source. As an example, the HKV data is downloaded from an FTP server and then stored in a MySQL database. The data is directly uploaded to the server via the Netcom forwarding network using FTP and read in once per hour by a service. Data that have already been processed are marked to prevent them from being read in again.

An FTP client downloads the newly added data from the provider's server and stores it in a "working" directory. After that the connection to the FTP server is terminated by the script. In an interval of one hour, all CSV files in the working directory are processed chronologically, so that the last downloaded file is processed last. The values are written to a database ("MariaDB") in the same format as the CSV files. This makes it possible to provide the data in any form via interfaces later on. The implementation of the interfaces was realised in the prototype via a JSON interface. The format can be adapted and extended depending on the desired interface.

The data is sent via JSON arrays, which are interpreted by the target. The data is then datestamped in the local database as sent.

4.9.1 Included in stage 3: Heat transparency

Consumption visualisation
Stage 3 simultaneously offers landlords and also end users or tenants a ready-made portal solution for consumption visualisation. The "Meter Online" online portal displays the individual consumption for different time periods (daily, monthly, weekly and yearly view) and offers various analysis options to create transparency and identify energy potential.

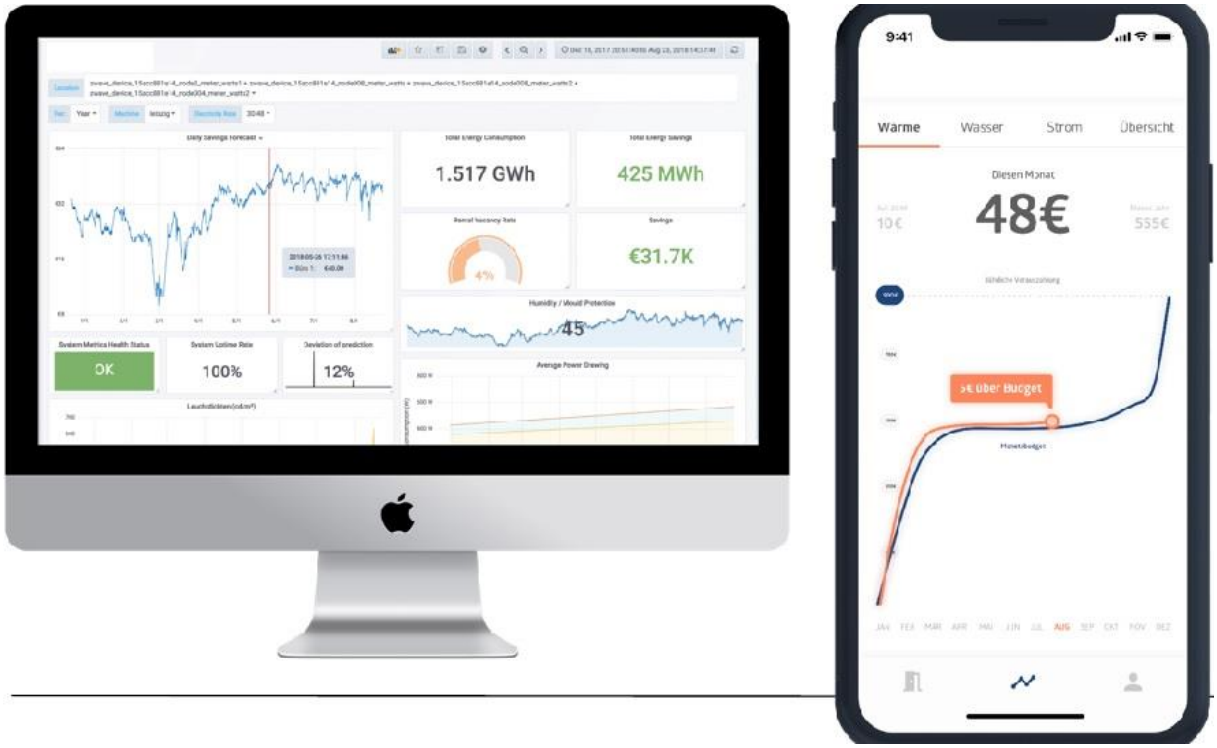


Fig. 29: B2B portal for the landlord and B2C information for tenants in conformity with the HeizKoV, © green with IT e.V.

A prerequisite for the implementation of this concept is a declaration of consent by the tenants to read the measured values hourly by remote control and to visualise them via an online portal. This is guaranteed by the tenant's consent during the first registration process on the online portal. In addition, a declaration of intent was drawn up with Arbeiter-Baugenossenschaft Paradies e.G.

Important! Future-proof as regards the new heating cost regulations!

From the end of 2020, all heat consumption values must be delivered every six months, and from 2022 probably every month. The above solution saves the effort of paper delivery if the tenants agree. Experience has shown that the paper-saving argument is very persuasive, as it immediately offers an option for relieving the burden on the environment. Compared to the obligation to issue a receipt and the associated paper flood, this option is very convenient.

In order to preaggregate the decentralized data and to reduce the number of WAN interfaces, the two key components - the central PLC headend and the associated WAN router - are installed at a central location in the pilot system. The communication units (MUC; SMGW) installed in the test objects terminate at this installation location. Both function together in the functional unit as the central "data turntable" in the communication concept. The local network station of Stromnetz Berlin GmbH belonging to Sausenberger Straße or optionally a "public" technical room in the test objects was considered as the central installation location.

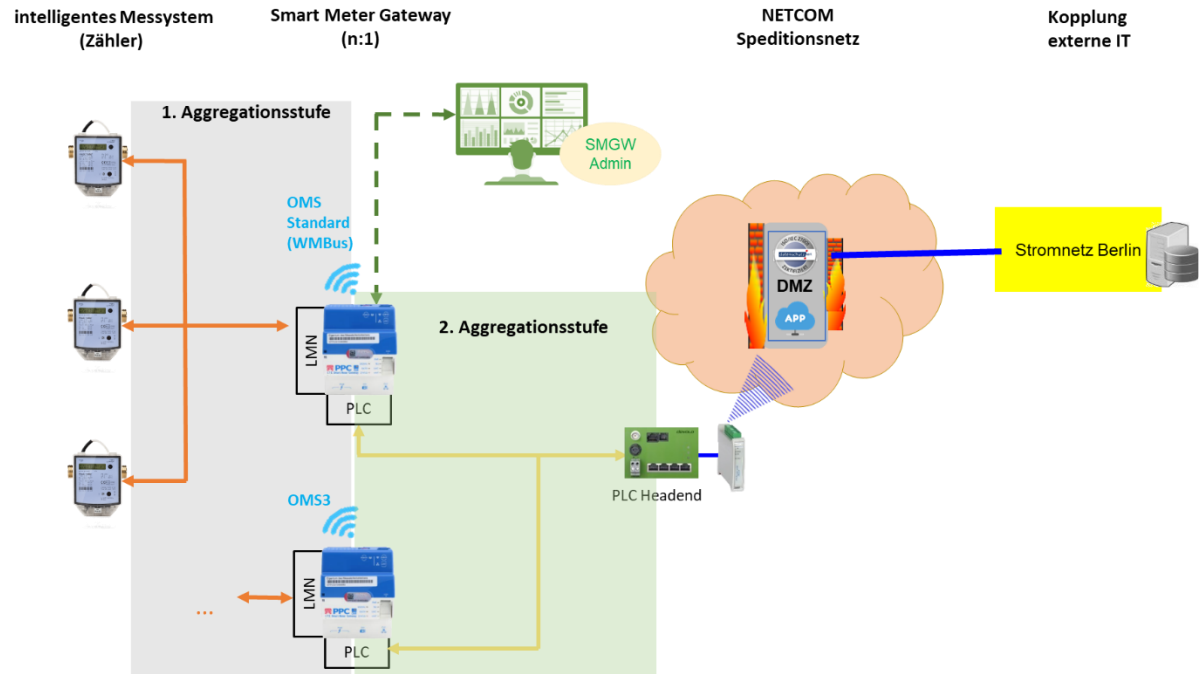


Fig. 30: Two-step aggregation model shown by the example of Sausenberger Str., © green with IT e.V.

Connectivity from the headend to the intelligent measuring points in the test objects is achieved by broadband PLC technology. Connectivity to Netcom's secure ICT WAN forwarding network and the integrated so-called "demilitarised zone" (DMZ) is provided via the WAN router. From the DMZ the data is directly transferred to the server of Stromnetz Berlin GmbH and stored there.

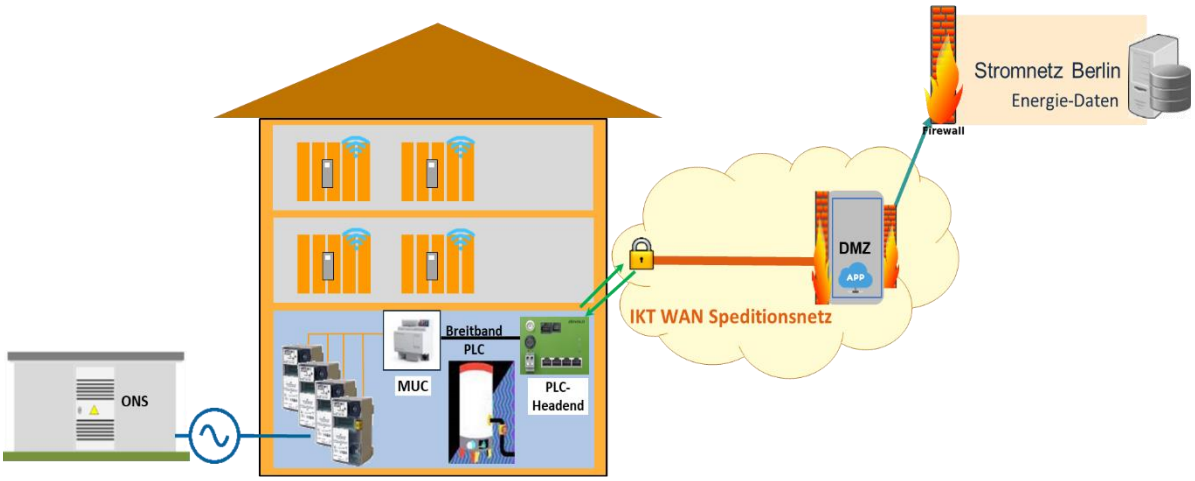


Fig. 31: Communication concept pilot objects Sausenberger Straße 26-34; 1st evaluation level with MUC and standard PLC communication, © green with IT e.V.

4.9.2 Added value in stage 3: The ICT WAN forwarding network

The success and market penetration of digital services and services depend to a large extent on a necessary degree of availability and security of the underlying communication solution. To this end, the legislature has formulated special requirements for data security based on the requirements of the German Federal Office for Information Security (BSI), which have been incorporated into the "Law on the Digitisation of the Energy Sector".

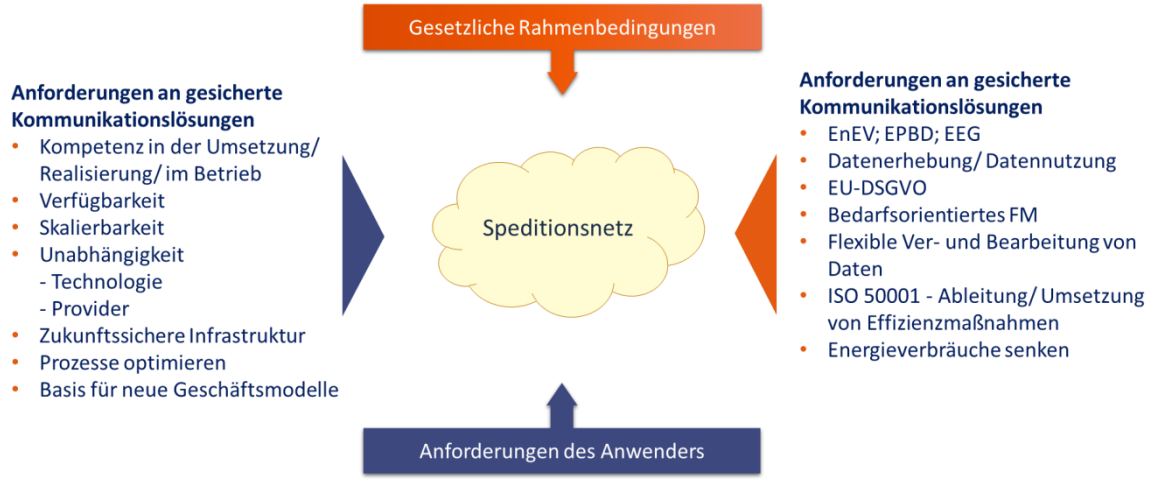


Fig. 32: Legal framework, © green with IT e.V.

To this end, the legislature has formulated special requirements for data security based on the requirements of the German Federal Office for Information Security (BSI), which have been incorporated into the "Law on the Digitisation of the Energy Sector".

In order to meet these requirements and, at the same time, to be able to act flexibly and independently of technology, special communications infrastructures are required, which are characterised by the "area of conflict" between legal framework conditions and user requirements as summarised below.

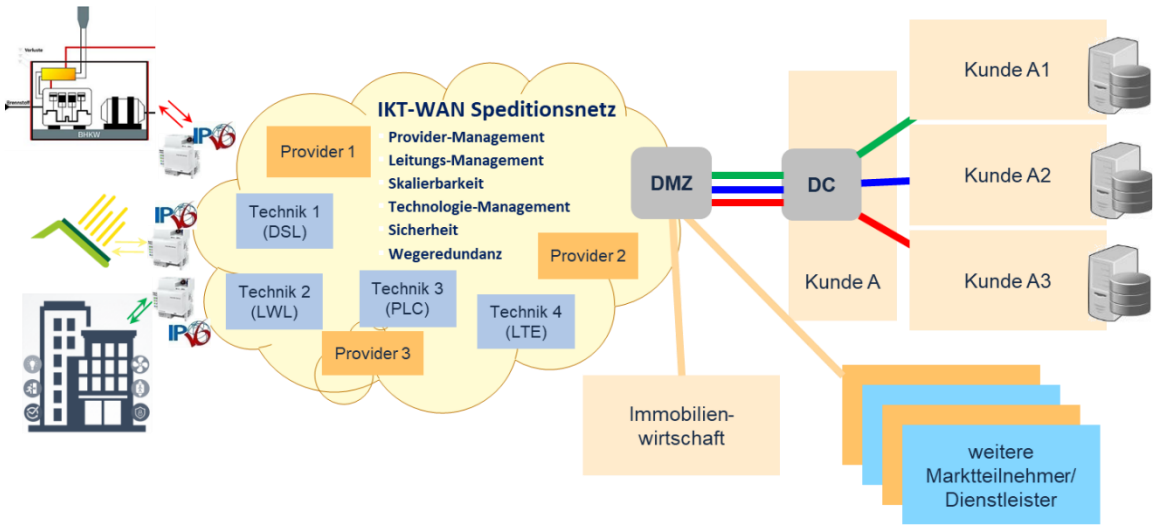


Fig. 33: IKT-WAN Forwarding network, © green mit IT e.V.

The comprehensive and at the same time flexible security approach in the freight forwarding network structure and the freight forwarding network servers/data centers is reflected in a 24/7 network management according to ISO 27001 certified processes and the possibilities for integration/coupling of external systems (third-party providers/value-added services).

With the IKT- WAN forwarding network, the network provides a communication solution that meets the above-mentioned requirements for secure, non-public, customer- or application-specific data transport. The data communication via the IKT-WAN forwarding network ensures that the transmission data are transmitted securely and reliably without restrictions in so-called "closed user groups", regardless of their individual structure and significance, via a wide area network (WAN) throughout Germany.

In the future, this offer of a secure and shielded communication solution will extend to the building infrastructures themselves and thus realise secure data transmission from the build-

ings, e.g. apartments via closed user groups into a DMZ (Demilitarised Zone) - parallel to the classical communication connections of public providers.

4.9.3 IKT-WAN forwarding network - additional data security considerations

The stronger the data flow in large "machine-2-machine" (M2M) networks, the more important and technically demanding the implementation of IT security, information security, data protection and mass data communication becomes. The challenge is to control the data flow in a large number of systems to be connected while at the same time ensuring the necessary security and availability of the overall solution.
The security of the IKT-WAN forwarding network begins with customer-specific network engineering, includes protected access to properties and extends to protected communication networks, application hosting in the DMZ and secure data exchange between the gateways at the individual measuring points and the central application. By means of unique, non-public Access Point Names (APN), the IKT-WAN forwarding network enables data transfer via a closed network independent of the Internet. Secure data transmission by means of encryption during the transmission of consumption data ensures the necessary integrity and confidentiality.

Technical solutions for decentralised communication connections can vary greatly, especially in regional areas. Typical technologies that can be used are mobile radio connections (e.g. GPRS, UMTS, LTE) or fixed network solutions (e.g. cable/DSL, fibre optics, power lines/PLC). The IKT-WAN forwarding network enables the use of the best technology for each location with the open-technology approach and to meet application-specific security and availability requirements.

All these security structures are not yet a legal standard in building telemetry, heating and tenant processes of the so-called HAN, WAN or LMN processes. This leads to the next stage of this report: the "**Smart Meter Gateway**".

4.10 Level 4 - The Smart Meter Gateway (SMGW) and residential quarter software

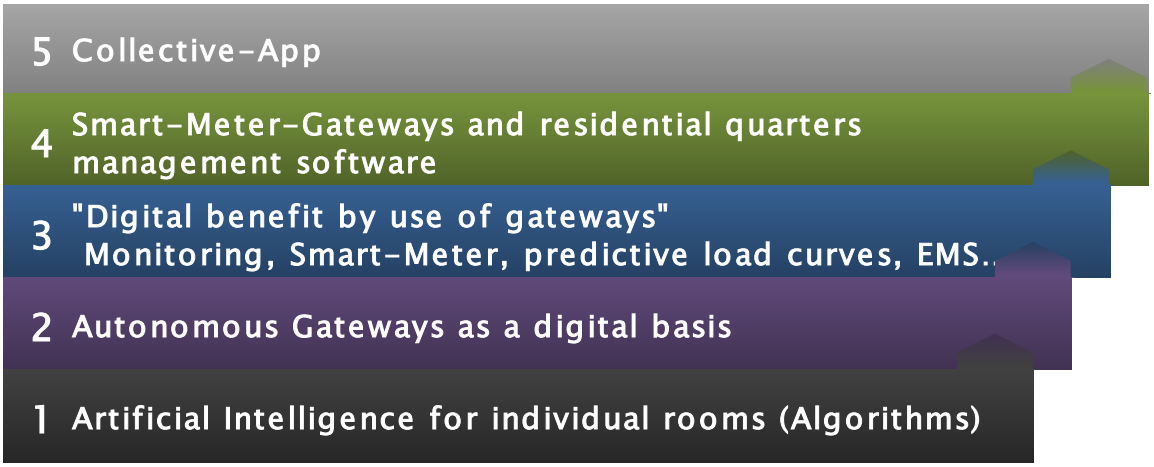


Fig. 34: Success quotients of digitisation as ladder rungs, © green with IT e.V.

The adoption of the law on the digitalisation of the energy system transformation [15] paved the way for the rollout of intelligent metering systems (iMSys). The rollout was announced on 07.02.2020. Our preliminary planning in terms of content based on the MUC (from 2015) now met the legislative reality:

[15] BMWI Law on the digitization of energy system transformation

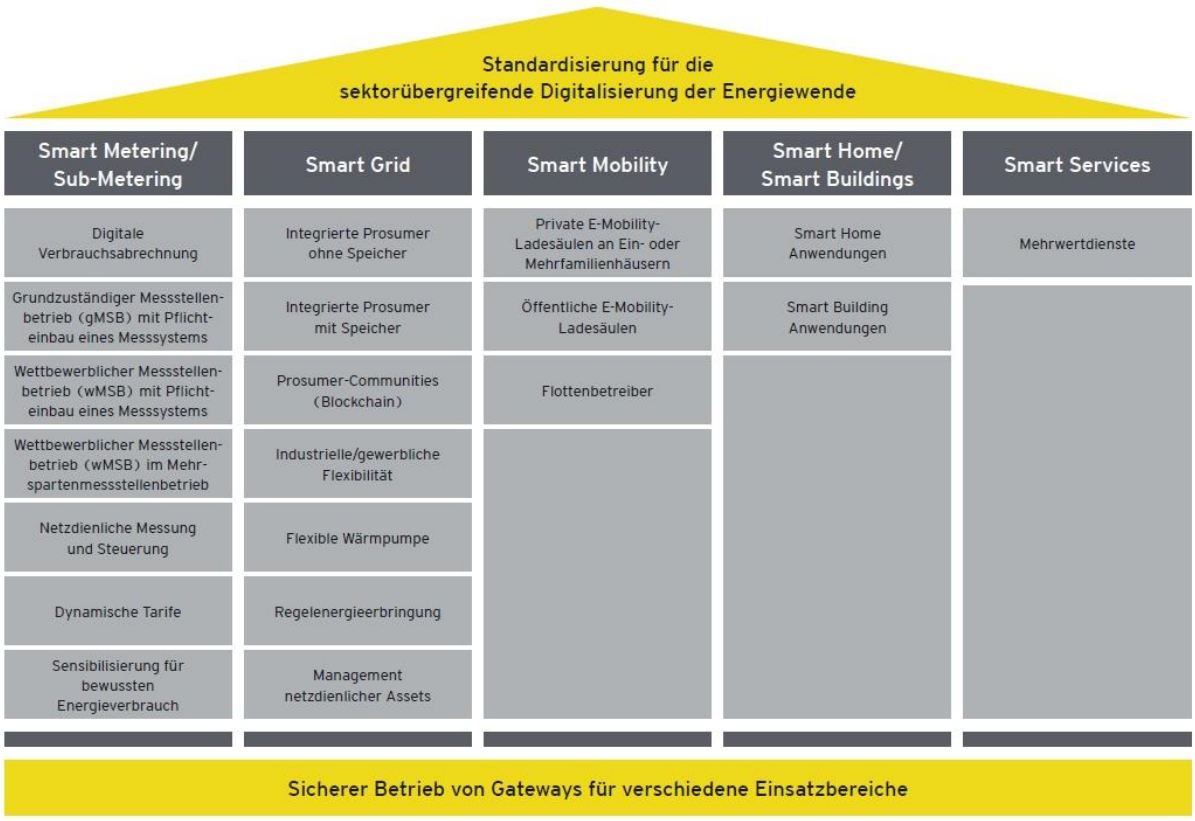


Fig. 35: Highly secure energy industry applications of the Smart Meter Gateway, source: BMWi/EY

The use of smart meter gateways will be legally required for a transition period to electrically powered processes in an initial rollout phase of three years. So why think about the cross-sector use of smart meter gateways as early as 2020 if this is not a legal requirement?

Argument 1: Fit for the future - self-sufficient protection of WoWi's own telemetric data
In principle, all the above processes can also be designed with "conventional" gateways. But nothing is as secure as the BSI basic protection.

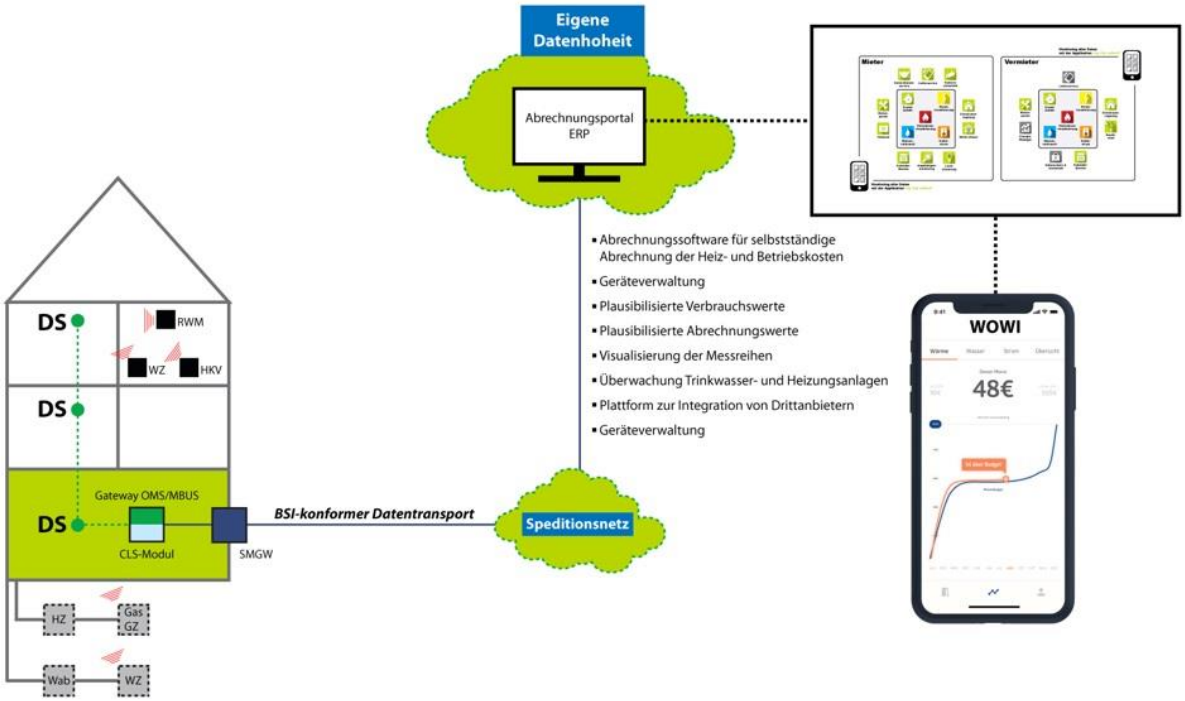


Fig. 36: Self- sufficient value creation including gateway and SMGW in the housing company, here already with BSI-compliant data security according to common criteria, heating app for tenants, prepared for comprehensive WoWi app, © green with IT e.V.

Argument 2: Data security service "Protection of tenants"
Those who additionally design the HAN processes using a smart meter gateway have (initially) a unique security feature due to the automatically embedded BSI basic protection, compared to all current commercially available smart home solutions that cannot offer this basic protection. Landlords can now offer their tenants secure processes that no DIY store or KNX product can provide.

Argument 3: Ready for the future
In the long term, there is no way around smart meter gateways. Furthermore, in the next EPBD[16] step, buildings will have to be described with a (currently still voluntary) so-called „Smart Readiness Indicator“[17] similar to the well-known "Triple A Refrigerators". Smart Readiness means that intelligent building automation and gateway solutions will reduce the need for building physically structured renovation approaches ("insulation boards") and will be given a higher legal status. This will be incorporated into the new versions of the Building Energy Act. The GEG will then look completely different than in 2020.

[16] EPBD Directive
[17] Smart Readiness Indicator according to EU implementation plan

The BMWi has outlined this future viability with a cross-sector graphic representation in an expanded thematic context:

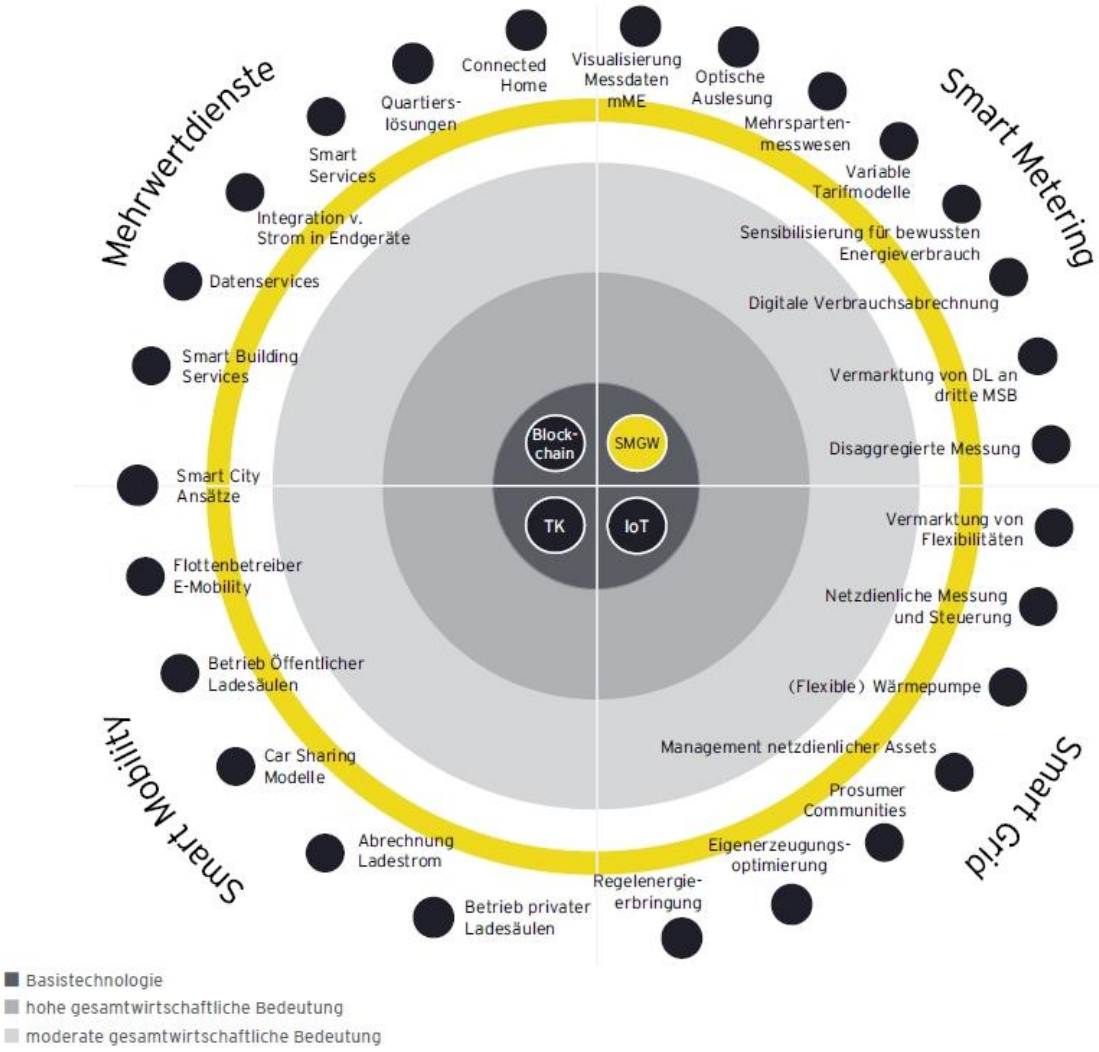


Fig. 37: SMGW business areas: Classification of the BMWi, Source: BMWi/EY

From all of the “conceivable” business areas, the BMWi has referenced the first topics that embed and map housing preferences:

Connected Home	Smart Building Services	Quartierslösungen	Smart City Ansätze
▸ Angebot von Smart-Home Lösungen innerhalb eines Wohnbereichs (Wohnung oder EFH) ▸ Lösungen basieren i. d. R. auf Sensoren zur Steigerung von Energieeffizienz, Komfort, Sicherheit etc. ▸ Heute sind bereits Lösungen verbreitet	▸ Energiemanagement für komplette Gebäude bzw. Gebäude-Komplexe, z. B. MFH, Büros oder sonstiges Gewerbe ▸ Der Fokus des Energie-managements von Gebäuden ist vor allem die Reduktion der Energiekosten	▸ Durchführung der gesamten Energie-versorgung und -verteilung in einem Quartier ▸ Quartiere können Wohnbezirke oder Gewerbeparks sein, Quartierslösungen sind heute in einigen Pilotprojekten bereits zu beobachten	▸ Messung, Konzentration und Verwertung von Daten mit dem Ziel der Optimierung von Städten ▸ Eine vergleichsweise verbreitete Anwendung im Bereich Smart City ist die intelligente Steuerung der Straßenbeleuchtung (Smart Light)

Fig. 38: SMGW business areas: Classification of the BMWi, Source: BMWi/EY

In particular, the energy-related topics, primarily the topic of heating, have been focussed on here. The view of the most urgent fields of action is sharpened accordingly; the first results of the pilot projects in neighborhoods have an effect. Frameworks of action become recognisable and open up concrete design cornerstones around the topic of “Smart Meter Gateway”.

The BMWi presents the macroeconomic context, differentiated as follows:

Fig. 39: Macroeconomic criteria within and outside the energy industry: Classification of the BMWi, Source: BMWi/EY

The BMWI differentiates the activity levels in the future action areas according to B2B and B2C priorities. Interestingly, WoWi-related topics are very high up here, and so-called “soft” topics such as raising awareness among tenants are also thematically embedded here. The BMWi imagines this as follows:

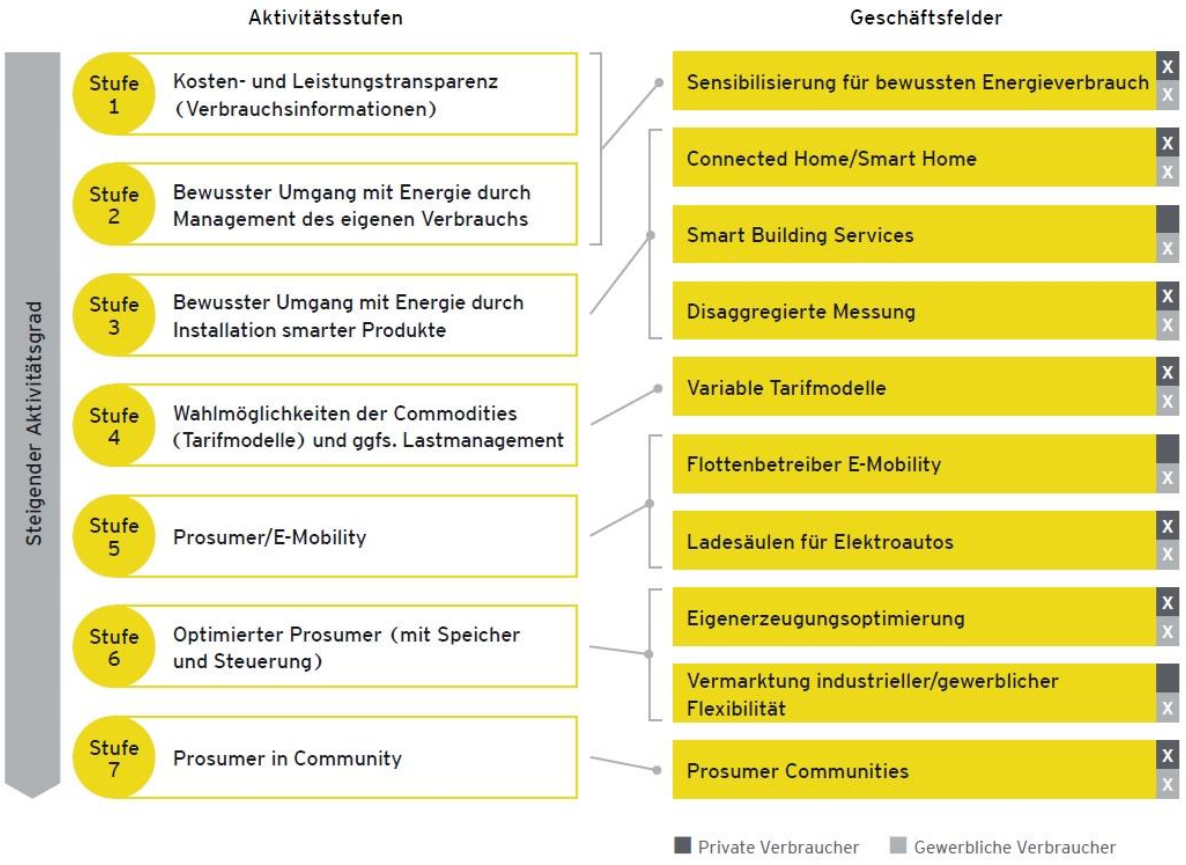


Fig. 40: Increasing level of activity in various business areas: Classification of the BMWi, Source: BMWi/EY

The resulting preferences rearrange all of the market's influencing factors. Of course, these preferences include all conceivable business areas in all everyday businesses in the district and all everyday topics of the tenants. Here, too, an attempt is made to focus the market relevance more concretely; the topic of "submetering" is always at the forefront:

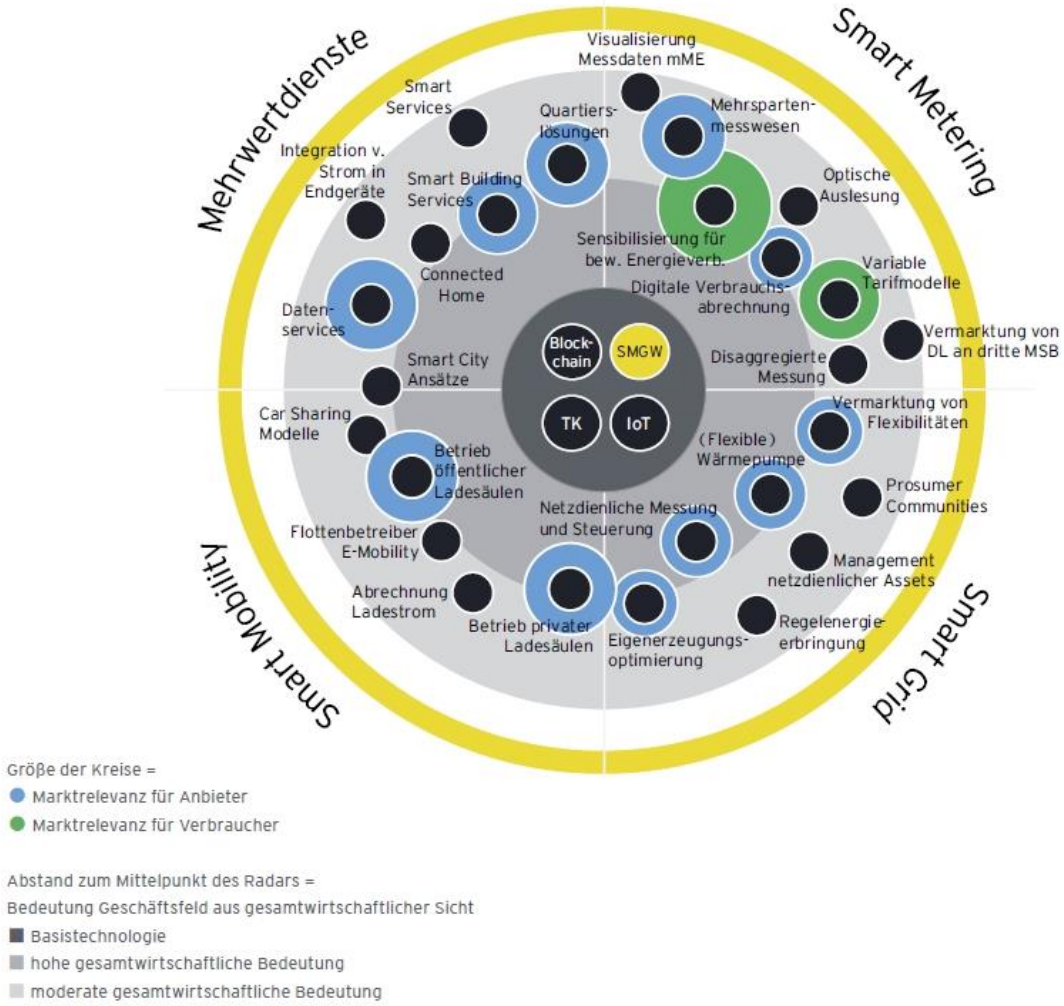


Fig. 41: Business segments sorted by preferences: Classification of the BMWi, Source: BMWi/EY

Such a goal was foreseeable well in advance. That is why pilot project 2 (ABG Paradies) in Sausenberger Str. was equipped with intelligent measuring systems in 2017 and provided with an SMGW precursor. In addition to the heating data, the aim was to make the consumption data for electrical energy available to the tenant via an app and to harvest additional digital fruits.

For this purpose, the network and Stromnetz Berlin GmbH participated in the pilot project ABG Paradies with the provision for construction of intelligent meters and communication infrastructure for the transport of meter data.

The communication infrastructure - the so-called ICT freight forwarding network - is set up by Power Line Communication (PLC) from the measuring point to the local network station and from there is transmitted to the data center via a backbone network.

At the same time, this central communication infrastructure should be used as an inexpensive, secure and stable communication platform for all smart applications.

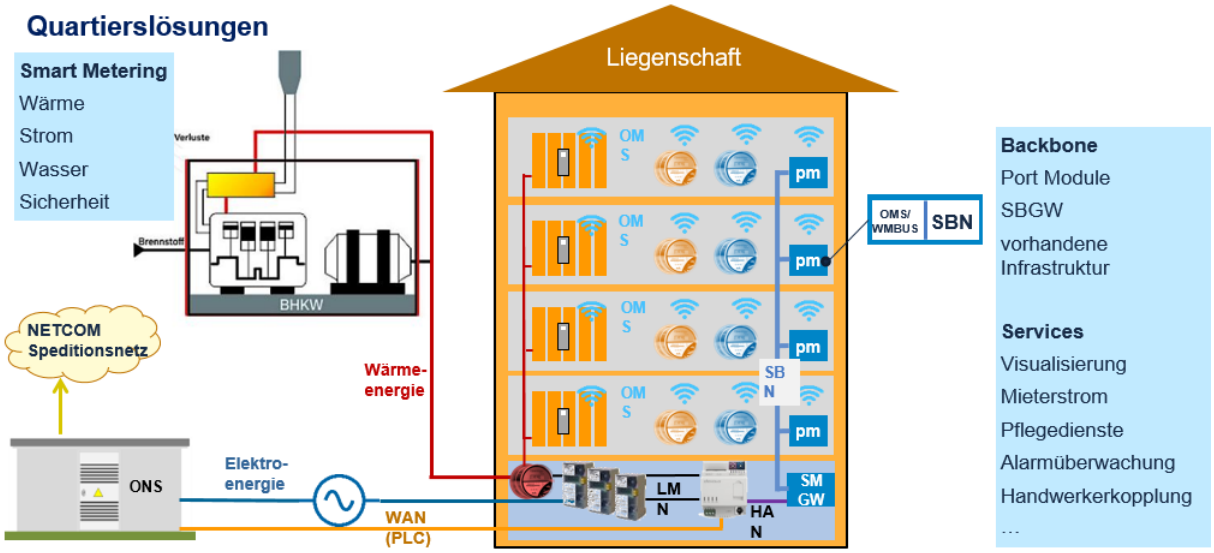


Fig. 42: Representation of the ICT forwarding network with illustration of new business areas, © green with IT e.V.

Residential quarter Software: "My Apartment" App

The former exclusive focus on "basic security" in processes related to "electricity" and "gas" was abandoned in the basic concept of the Smart Meter Gateway. After lengthy discussions amongst ministries, chambers and associations, science and company experts, the key points were defined. This took some time, as additional end user processes were now to be included. The quality of basic provision should not suffer under any circumstances. This development was also foreseeable early on, but discussions in the technical committees dragged on for four years.

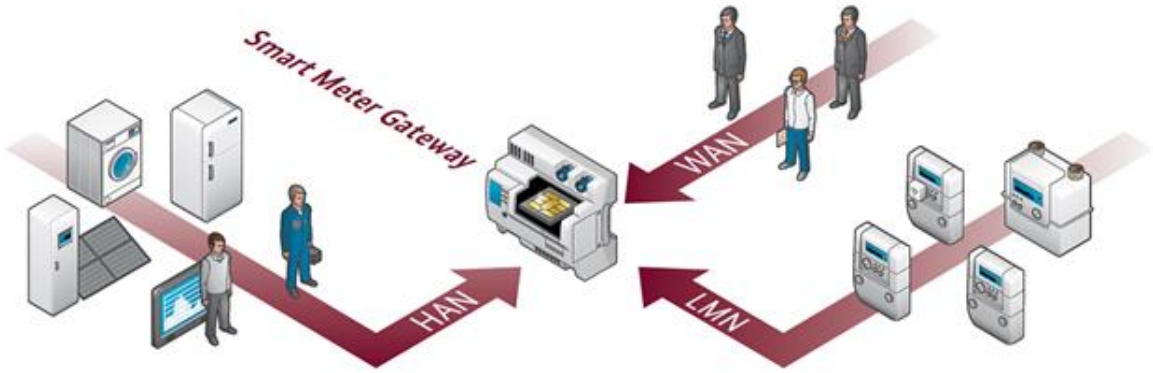


Fig. 43: Smart meter gateway relationships in buildings of the future, Source: Federal Office for Information Security BSI

This graphic illustrates the power of the "owner" of this data. For this reason, the BSI has also established corresponding task forces to structure the open use of this highly secure data in the form of a "communication platform":

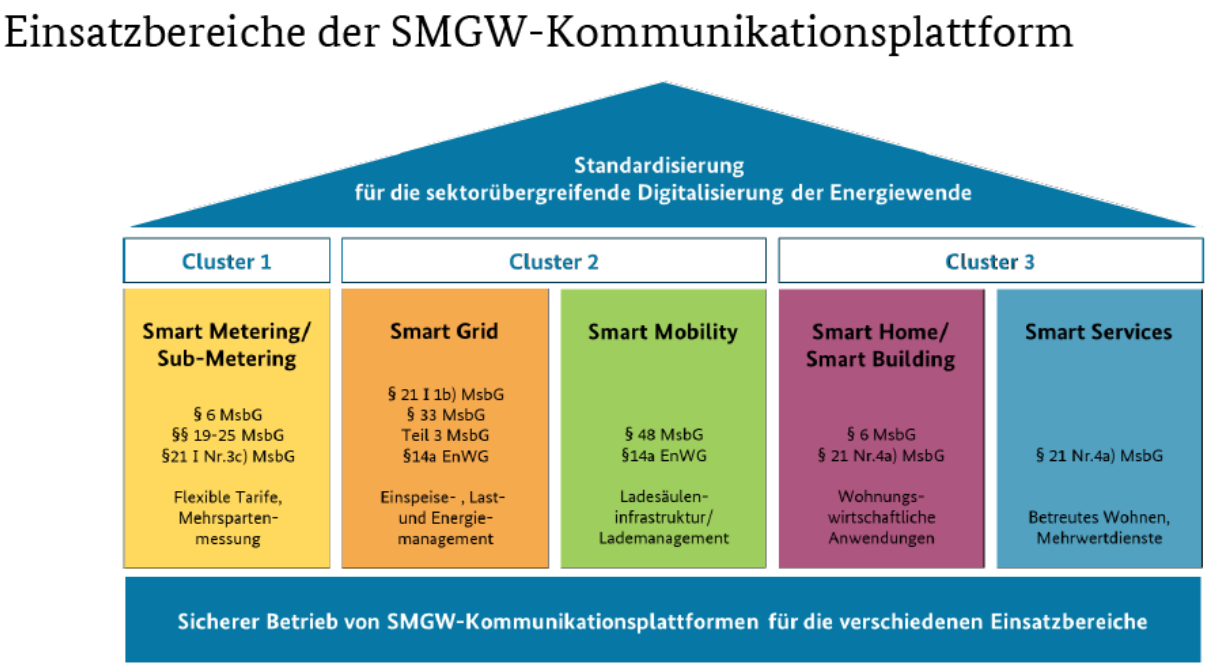


Fig. 44: Smart Meter Gateway Task Force and the significance of the topic of "submetering" in Cluster 1 as of spring 2020, source: BMWi

At each point along this roadmap, all conceivable processes in the residential quarter can now be subjected to the high security requirements of the BSI. Of course, the topic of "submetering" is at the top of the agenda here, as this process is the heart of the real estate industry.

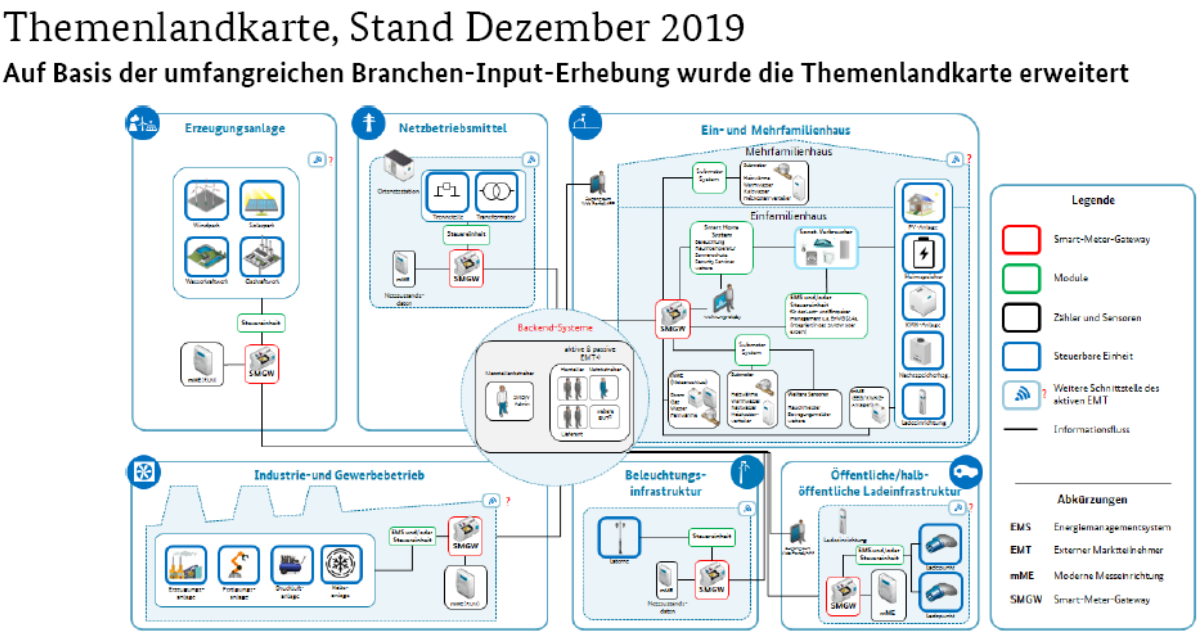


Fig. 45: Architecture of data security according to common criteria: the CLS interface is gaining importance, Source: BMWi

If the "submetering" processes are now added at the top, a tenant app will look completely different compared to apps currently on the market. All processes, shown here with their own “icons," are subordinated to the central presentation of the most important point from both the tenant and landlord's point of view: the warm operating costs! As already described in the previous steps this process is already completed and therefore already “built in" in a future tenant app.

Centrally displayed here, the other points of the service charges are structured around this heating-heat display: electricity, water, boiler power, etc.

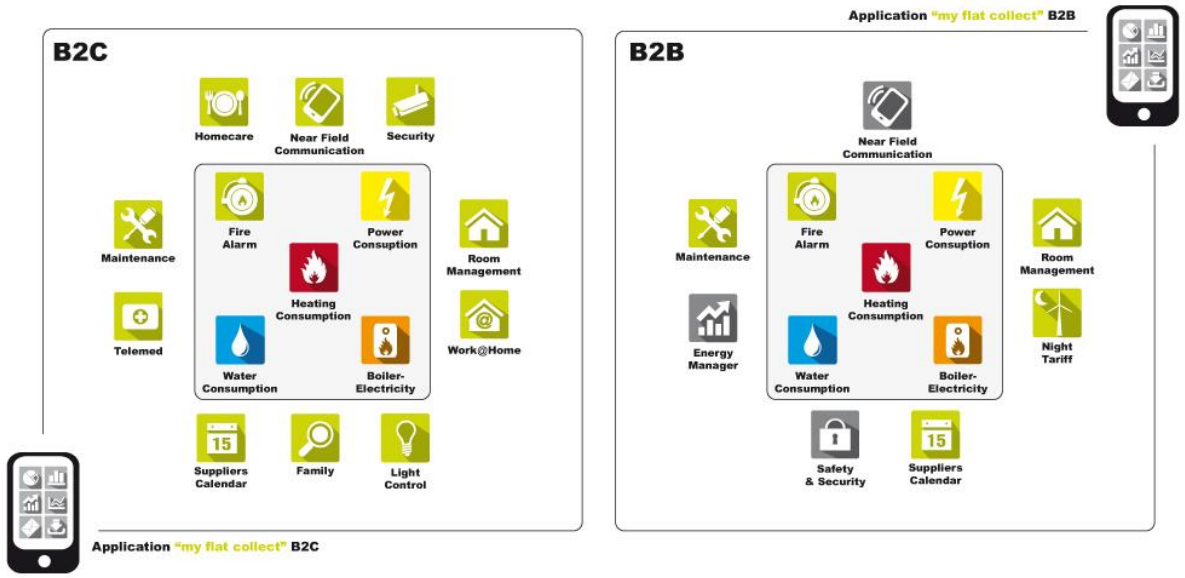


Fig. 46: Concept graphic "MeineWohnung", © green with IT e.V.

4.11 Stage 5: The "Collective App"

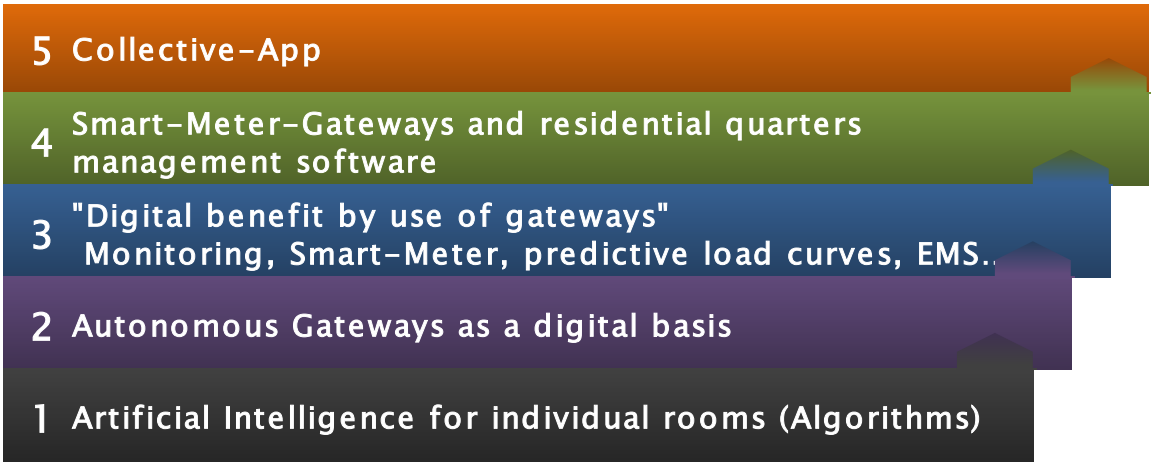


Fig. 47: Success quotients of digitisation as ladder rungs, © green with IT e.V.

In Stage 5, which includes the app "My Apartment," the API available in the network is used to customize a full mobile tenant environment portal on Android and IOS. The resources are also available in the network for this purpose. In each case, a large residential area is required as an example district, which can then be used as a template residential area for further use in more distant districts.

Core modules of the app, in order of prioritisation:

- Further visualisation of consumption
- Connection of an existing API basis (module camera security, lighting control,...).
- Contact possibilities with the landlord (tradesmen's coupling, chat, ticket system,
- or similar).
- Scheduler (announcements & events, emptying the trash cans, etc.).
- "Print on demand" for paper invoices.

Fig. 48: Recognizable core modules tenant app, © green with IT e.V.

Second step of implementation:

- Integration of “third party services” (pharmacy, delivery services, nursing services, etc.) – Work@home
- Telemed
- Monitoring of dependents
- Further 28 business model fundamentals

The basic requirements for such a "tenant app" are the design, **development and operation of a platform** for communication between tenant and landlord. These steps are carried out independently of all CRM systems, but can subsequently be connected to the CRM. The integration work is not carried out by the CRM provider, but by an external service provider, who can usually offer significantly lower prices. An Android and IOS app is available as a basis for this. A "modular construction kit" is made available, with which the individual adaptation to the individual housing company can be carried out. As a counterpart to the tenant app, there can be landlord portals, for example. Here the landlord can manage his residential units/tenants, for example by managing the QR codes that the tenant finds in his rental agreement and through which he can access the tenant app.

The expenditure for this portal depends very much on how many functions and interfaces have to be provided. In the pilot project, the expenditure could be identified in detail and quantified for implementation. There are two steps to this:

a. Preliminary stage "Web client": Here, detailed data can be generated in the buildings and delivered and further processed as described under "HKV integration". Investments of WoWi are not or only to a very small extent necessary for this purpose, as the telemetric use of Power Line Communication (PLC) eliminates the otherwise usual bidirectional contracts with communication providers (telecom, cable). Everything is already there.

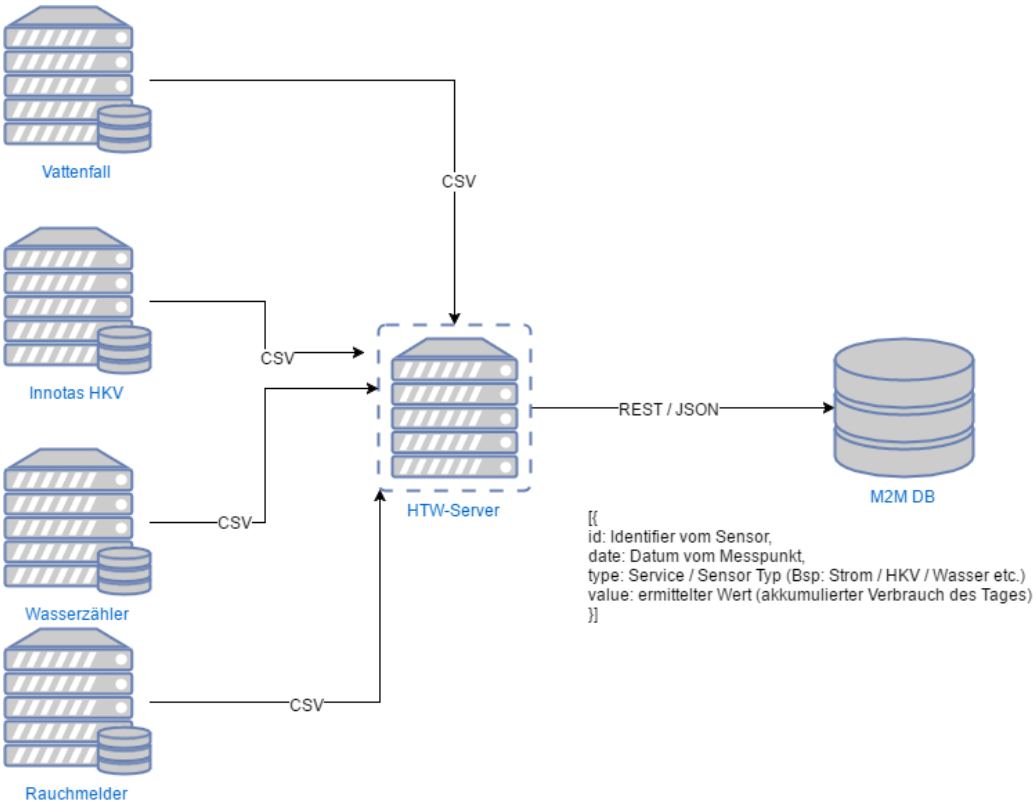


Fig. 49: Concept graphic interface architecture tenant app in the pilot project, © green with IT e.V.

b. Full project app implementation: A transaction server installed at the scientific pilot partner "HTW" served as a neutral prototype. Its service can then be set up with any property manager. However, it must be ensured that personal data is encrypted so that identification is only possible for the respective tenant. It is used as a database management system MySQL/MariaDB. For the server services and interfaces node.js is used.

5. Summarised Evaluations

5.1 Summarised feedback from the landlords

At the beginning of the project, it was clear to all project participants from science, users, industry and external parties that the project would be breaking new ground. Many providers of digitally supported solutions undermine the interests of tenants in digitisation by disregarding the WoWi as an intermediary and prioritising so-called "direct relationships with the end customer" by infrastructure suppliers. For example, the housing industry has often not been able to achieve the actual reach of 13.5 million people in Germany via the housing companies belonging to the GdW in the individual regional associations, although the association has launched a variety of useful projects in this area.

Framework agreements with two-wire or cable providers were mainly related to infrastructure, less to applications. Only services that were to be taken seriously via the intermediary "housing companies" actually functioned by mapping statutory tasks, here: Documentation and accounting - primarily warm - operating costs But the providers also agreed over decades on an “every man for himself" attitude, using proprietary protocols which are deliberately not opened to the user. In case of an opening, the added value of the integration of all collected billing data would be transferred directly to the users, as they could now work and bill with several providers at the same time. But exactly this is now possible in all value-added phases according to Dr. Weber (see Fig. 5).

It was therefore also clear that such practices can only be honed by disruptive means. Thus, the contents of the pilot project started with the smallest unit in an apartment: the individual room. From here, low-investment measures should take place in stages, like moving up a ladder, in individual "rungs". This went hand in hand with the decisions in more and more WoWi businesses to quit the unpopular heating cost consumption service providers and to take this added value into their own hands.

There was therefore a great deal of curiosity as to what options the digitisation of individual familiar processes might bring, how this could be extrapolated into the overall energy budget of an apartment, a house and an entire residential quarter, and what consequences would result from communicating the new possibilities to tenants.

The implementation of all hardware and software installations in the **B2B processes** (gateways, monitoring, smart meters, smart meter gateways, HKV technology, PLC technology) ran smoothly and professionally. The landlords had been clearly informed in advance of the foreseeable efficiency successes, for which the building simulations prepared in advance were important and also necessary.

Here are the first results of the landlord surveys:

- The promised results of the pilot project were actually achieved.
- Low-investment measures in the form of energy-efficient digital processes are persuasive because they result in easily calculable payback periods from the tenant's perspective.
- Even sceptical tenants are impressed by the goals and convinced by the results.
- Series of experiments in a new field of "digitisation" are a promising sign that further developments in this field are imminent.
- Individual room regulations are most effective where regular absences are part of everyday life (work, sports, leisure activities).
- Many untapped potentials can be identified.
- Openness in the protocols means cash money.

5.2 Summarized feedback from the tenants

At the beginning of the project, the tenants thought about the whole range of everyday communication they were used to with their landlords: letters from the administration often contain unpleasant messages such as rent increases, unexpectedly high back payments of warm operating costs, information about unpleasant accompanying measures in the district such as scaffolding downtimes with the associated increased risk of burglary, etc.

The announcement of our measures seemed at first like just one more possible piece of bad news, which meant that tenants initially approached the project with resentment and scepticism.

We were therefore surprised that the mere announcement of possible savings - from the tenants' point of view, of course, "all in all!!!"- **were received with great curiosity and positivity**. Even the fear that an intervention in living habits might meet with even greater scepticism was ultimately not decisive in the day-to-day implementation. Yes, the mere fact that a "caretaker" appeared in the apartment and pointed out jointly achievable efficiency goals created a thoroughly positive atmosphere during the installation of all hardware (**B2C processes**):

- At the start of the project, **tenants were predominantly positive**, friendly towards the potential for savings
- Older tenants were also very interested in the topic, as they have always been used to economical behaviour (e.g. switching off lights when leaving individual rooms), and the usual savings patterns are fulfilled.

- It was important to **inform the tenants personally in the apartment** and to prepare the talks in a well-founded way.
- Technical interest varies widely, with technology being of less interest than expected savings.
- The announcement of the app partly led to euphoric approval.
- Older tenants receive support from tenants with an affinity for technology, like children or grandchildren.
- Skepticism about the additional costs of own electricity consumption was surprising, but the cost neutrality on this point was easy to explain.
- Only one total refusing tenant, across all projects, rejected the system.

5.3 Summarized feedback from the custodians

The role of the custodians was **very cooperative**. Some custodians were extremely interested in the ease of installation and the possible maintenance steps of the system components. The pilot project showed that there has to be a systemic briefing and that craftsman service providers also have to be found.

- Reactions were very different depending on technical affinity, but very open to it.
- In two projects, the caretakers installed the system themselves where no tenants were found, which was facilitated by the simplicity of the system (pre-installation, "plug & play").
- In the Campus Buch all rooms could be used, but here too a subsequent installation by the responsible experts would not be a problem.

5.4 Summary of experience during the first operating phase

All system components kept their promises of simplicity, low investment, apportionability of all costs, user-friendliness and, above all, savings in the range of **20 % to 30 %** through the individual room controls alone. The prerequisite here was that there was a regular absence (work) in the apartment.

Why weren't all rental properties compared to their reference?

- Comparison is not possible because, due to tenant changes and the relatively small number of rental units per staircase (maximum 8 rental parties), any increase or decrease in consumption has a significant impact on the total consumption of the building.

Why don't all tenants have noticeable savings?

- Especially those tenants who have a very low consumption and only switch the heating on or off as required will be able to save little or no heating energy with the self-learning algorithms. This is due to the fact that if there is a demand, the heating system heats continuously and if there is no demand, the heating is turned off again. These tenants usually have a lower temperature level than other tenants who keep the heating on one level throughout.
- Changes of tenants or changes in the use of the apartment result in new demands for comfort. This can mean a reduction or increase in the use of heating energy. However, the self-learning individual room control always ensures that heat is provided as required in the newly used rooms/apartments.

In the B2B area, all options for the infrastructural replacement of old, but partly proprietary processes were implemented, tested for server suitability and put into operation under the everyday conditions of an existing smart meter gateway.

In addition, a telemetric collection point was installed on each floor based on PLC technology:

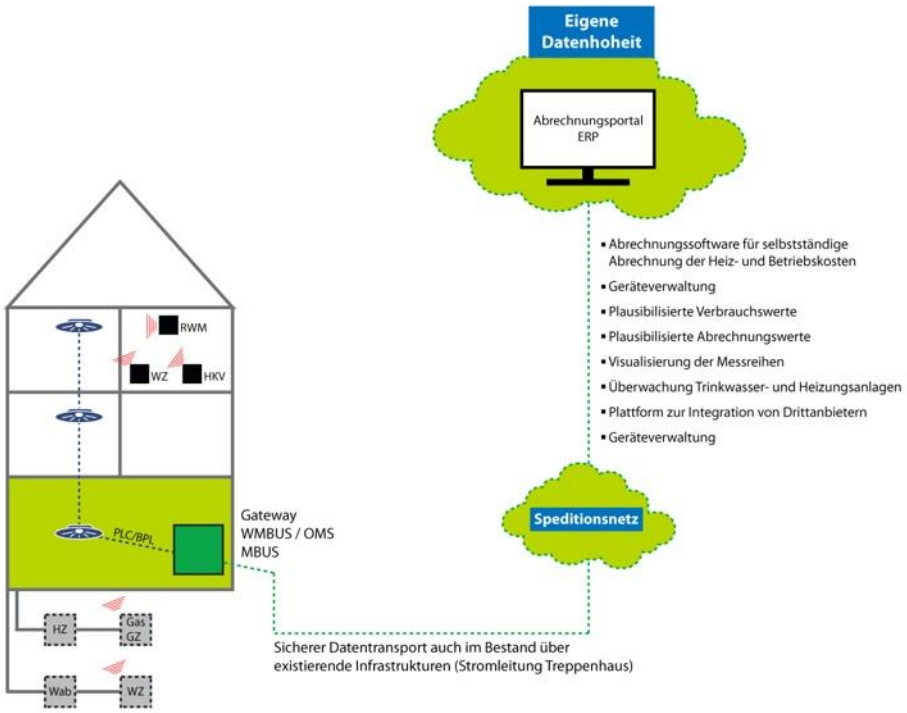


Fig. 50: Fully autonomous, data-secure accommodation solution according to common criteria, including a telemetric collection function per floor in the stairwell on a power basis, © green with IT e.V.

The previously described "ladder rungs" of the planned subsequent processes of extended gateway use and predictive load curves were prepared and set up for everyday operation. Further high savings rates are predicted here. The parallel installation of the first Smart Meters in all house connection stations (HASt) in Berlin by Vattenfall Wärme GmbH alone is a highly valid, gateway-led process that will achieve a savings rate of at least 25 % when implemented in the existing buildings; this is based on all existing kW contract data in the user companies. This will also illustrate the great importance of the landlord in this respect. Here is the eye of the needle. Here is where the input costs of the warm operating costs are decided. Those who manage their business best, while at the same time exhausting all contract options with suppliers, will be able to keep operating costs optimally under control and pass on the resulting benefits to tenants.

However, this is not a priority for all companies. In many places there is a lack of building services engineers in the WoWi companies; the experts currently working there are working at the limit; new specialists are in short supply.

All the more remarkable were the positive experience values from all 4 projects:

- Even very little feedback usually indicated a high level of acceptance.
- 1x replacement of a valve controller due to stiffness (Lübben).
- A piece of feedback that the rooms "cooled down too much" emotionally
- Positive consumption results at the residential level, also in relation to the reference dwellings.
- Energy saving potentials were also identified in the areas of the "frequent users" (pensioners, unemployed etc.) as well as the "infrequent users" (working people, students/pupils etc.), whereby the potential of the "frequent users" is on average somewhat lower.
- Users who previously left their thermostats on one level save more by using the individual room control than tenants who previously left their thermostats open or closed as required (typically position * or 5)

- For the majority of the apartments where there were no tenant changes or changes in occupancy structures in the period 2015 - 2017, significant savings can be seen.

6. Notable successes/difficulties

For the first time, **complex overall digital structures** were set up, each of which is individually separated from the others and tailored to the **individual needs of housing companies**. The goal of achieving the **greatest possible self-sufficiency** was achieved by focusing on purely residential and commercial districts. A particular success of the project is the fact that this is very complex: the project

- Has been coordinated with tenants and landlords
- Has not only planned, but executed and continued over several years of operation
- Submetering processes installed under fully autonomous conditions and expanded in stages
- The everyday operation could be adapted
- A high degree of disruption could be documented in connection with the fact that disruption is "something good" from the user's point of view

Difficulties arose from the fact that established suppliers to the housing industry consistently **refused to cooperate** because they saw that their current business models were danger. The arguments of sustainability in our approaches were recognised in the development departments of many suppliers, but were ultimately suppressed by sales decision-makers, so that there was no "going along". **The more self-sufficient the WoWi is, the less extra profit** from proprietary dominance. This pattern, already known from the earlier EHKV processes, was unfortunately also transferred to the gateways of the submetering market partners. Thus the WoWi was made to look like a "fake self-sufficiency“ with the new OMS protocol standards. But the playing field for the suppliers' desired future extra profits is now shifting towards such fake self-sufficient gateways, which are financed by tenant apportionment: all additional services such as multiple data delivery during the year, visualisation for tenant smartphones, system monitoring, etc. are already technically feasible, but should be subject to additional costs.

A further difficulty was the fact that we were using components that had not yet been certified and were not yet available in sufficient numbers in line with market requirements. This was solved by in-house development and adaptation.

7. Target Deviations

For the most part, the results of previous studies could already be confirmed with regard to the proof of valid savings ratios in Stage 1:

- High savings in the "working population", i. e. **rental parties with daytime absence at external workplaces**
- Low savings with permanently present rental parties

However, "non-measurable" savings effects rarely occurred. However, "non-measurable" savings effects rarely occurred.

Another "outlier" in the results was always observed when the letting situation changed: Changes of tenants with new user behaviour, new recommissioning of long vacant flats or the moving in of further family members led to plausible changes.

8. Review and prospects for follow-up projects

The questions listed at the beginning of the project can be answered as follows:

- How concretely can the satisfaction of innovative energy efficiency processes of digitisation be measured using valid data from tenants and landlords?
  - → The plausibility and measuring accuracy could be ensured by reading the official consumption values according to the Operating Costs Ordinance. In dialogue with the landlords, the anonymized Beko data could be communicated, assigned and evaluated. Subsequently, feedback was given to tenants whose consent had been obtained in accordance with the GDPR and whose individual Beko data could then be published.
- Can we turn scepticism into enthusiasm?
  - → Even among very elderly tenants, even among sceptical end users (some of whom are retired engineers and craftsmen) with high demand competence and their own parallel measurement system, doubts about the practicability of the first digital processes were eliminated and enthusiasm for optional follow-up processes was generated.
- Which valid efficiency factors from digitally supported residential quarter measures can be collected and how?
  - The first and equally difficult processes of our "ladder rungs" could be tested in three years of operation: End-user related processes of warm operating costs and their settlement. Subsequent processes also tended to be in the range of the predicted quotients:

	Savings rate Thermal Heat	Description of benefit	Security	Comfort
5 Collective-App	0 %	- Secure alternative to Google & Co. - Integrated app of ERP- and free processes - Convinience-, Security- and Delivery services excite tenants	BSI-compliant Common criteria	Fully digital Communication with tenants
4 SMGW	5 %	- Implementation of highly secure CLS-interfaces - Accommodation processes for landlords and tenants according to common criteria - Telemetric forwarding network	BSI-compliant Common criteria	100 % safety & security
3 Digital Benefits	5-15 %	- Reduction of heat supply contracts or heating generator dimensions - Monitoring/Smart Meter - Energy-Management-Systems (EMS) - Predictive Load Management - Bidirectional control	Non-BSI-compliant	Interdepartmental
2 Autonomous Gateways	10-12 %	- Introduction into advanced digital world nought-investment - Self-management of warm operating costs - Heat-App for all tenants - Craftsman's steering	Non-BSI-compliant	Ready for EMS
1 Artificial Intelligence	20-30 %	- Also works without complex systems - Immediate savings - Tenants are excited - BSI-compliant - Low-investment by ALFA ©	BSI-compliant ULD-Certificate	Plug and play

Fig. 51: Success quotients as ladder rungs, © green with IT e.V.

Of course, not all quotients can be added up, but each of them represents - individually - a maximum of achievable savings. For this purpose, the individual new starting position of 100 % of a “CURRENT state" to be taken as a basis applies in each case.

- Which digitally supported business models can emerge from this in the future?

From the perspective of the landlords,

→ the use of the first Smart Meters in HASt provided by the supplier is of course the primary area of savings, because there are no investments to be made, allowing a redesign of all supply contracts on the basis of all primary energy history data, which are now digitally disclosed. These lead to transparency of the actual base load values and, as the first digitally supported business model, can lead to a finely granulated consumption visualization of the daily updated electricity and heating values. The same applies to self-generated heat for gateway-supported bidirectional heating controls.

→ The installation of self-sufficient gateways for telemetric building data is a further step towards the optimal set-up of future digital business models.

→ The use of self-learning individual room controls is beneficial wherever tenants are in regular employment with daily absences.

→ The own heat generators or HASt secondary circuits can - when using a gateway - be equipped with predictive load curves relatively easily, which can lead to additional savings in the area of the purchase quantity.

→ The entry point of a residential quarter software for tenants can now be individually designed

- How do we decouple ourselves from the dominance of American servers and their goals of data collection for the purpose of selling advertising-relevant individual data to third parties?
  → This is achieved by insisting on compliance with the Common Criteria. Business models within the BSI basic protection can now be inserted into these security corridors. This forces even unwilling market suppliers to show their colours and offer business models suitable for framework agreements in such a way that landlords are primarily considered as intermediaries.
- How do we bring truly secure data infrastructures into everyday use?
  → By using truly secure telemetry forwarding network a building. This has no relevance to such B2C processes as the popular streaming of moving images. No, telemetric processes are extremely low-budget and therefore suitable to use e.g. Power-Line-Communication (PLC); especially with future potential when using the G.hn standard. The housing industry has all the necessary components at its disposal: Of course there are electric risers in all staircases. These are already sufficient, so that investments in cable or two-wire processes, for example, can be avoided.
- What degree of disruptiveness is required?
  → The housing industry has already disruptively destroyed the value creation of market partners who are unwilling to communicate, rebuilt it itself under new, more cost-effective conditions and thus put an end to the externally dominated super profits of American pension funds (at least in this niche). Digitization offers an infinite number of processes that can be improved disruptively according to this pattern.
  → In the final analysis, smart meters in HASt can replace the outdated practices of advance payments for quantitative services with standard market billing based on proven heat output.
  → Burner and secondary circuit settings in HASt or generator plants can only be touched if there are new, robust warranty and liability bases. This is now given. As a consequence, outdated, but much loved basic settings can be thrown over-

board and replaced by reduced, resilient quotients from predictively calculated load curves.

These first examples can be extended at will with new business areas of residential quarter management, the inclusion of B2C processes and external suppliers of landlords and tenants.

In subsequent projects, the value of digital innovations and disruptive foundations can be further explored and implemented. The project findings gained here provide an excellent database for applications for further projects in the context of federal real-life laboratories, calls for proposals by federal and state ministries, and international follow-up projects of the H 2020 series.

9. BBU Future Award 2019, winning film

We applied for the BBU Future Award 2019 with the preliminary results of the project, for which we received the prize. The BBU reported on this as follows:

„The companies honoured at the 24th BBU Days 2019 in Bad Saarow represented a wide range of innovative and tenant-oriented digitisation projects in thehousing industry. The jury chairperson Ines Jesse, Brandenburg's State Secretary in the Ministry of Infrastructure and Regional Planning, and BBU board member Maren Kern congratulated the award-winning companies.

The main objective of this collaboration with a total of four different pilot project partners is to increase energy efficiency through low-investment measures based on the ALFA® process initiated by the BBU. With this three-year project, cold and warm operating costs, heating energy consumption and CO_2 emissions could be reduced.“

Fig. 52: Presentation of BBU Future Awards 2019, source: BBU/Winfried Mausolf

BBU board member Maren Kern said: "The BBU Future Awards focusses on digital best-practice examples from the housing industry this year. Whether digital support for the living of older tenants, energy efficiency, participation through digital tools or trend-setting apps: the award-winning projects were often developed in an interdisciplinary manner and combine an innovative corporate culture with a strong tenant orientation in an outstanding way.“

The jury chairman, State Secretary for Construction Ines Jesse, said: "I congratulate the prize winners on their success at this year's BBU Future Awards. With their projects, they

demonstrate the many ways in which the housing industry can use digital technology to improve its services for tenants. For example, companies can better respond to the wishes and needs of their tenants. Another important area is energy efficiency, which can be significantly increased by digitally linking different energy suppliers."

The BBU sponsored our winning film so that the project results could be documented: https://youtu.be/zyTJ1lRzosQ

Berlin, May 2020

Jörg Lorenz

Network Manager green with IT e.V.

10. Appendix

The appendix documents the most important extracts from the application and reference buildings of the residential housing projects 1-3. This was done by presenting the official warm rent costs according to the annual settlement of the operating years 2015 to 2017. In this appendix we have documented the submetering values, some of which are even more differentiated, which then became the basis of the evaluation. Excerpts from these values are listed in this appendix. On request, scientifically interested readers of the study will be given the opportunity to view further details, most of which are available in iterated Excel tables. In case of interest, please send an email to projekte@green-with-it.de

10.1 Pilot project 1 - all apartments

The figure below shows the development of consumption from 2015 (without EZR) to 2017 (with EZR). For a meaningful before-and-after comparison, the year 2016 has been removed from the analysis, as the EZR was retrofitted there in Q3. Serious changes in consumption usually resulted from tenant changes or new housing use constellations.

WE NR	HMD-STR	2015	2017	Entwicklung [HKV-Einheiten]	Entwicklung [%]
023.01	2	3302,36	3524,68	1169,80	6,73
023.02	2	9672,96	9966,01	-35,78	3,03
023.03	2	2320,27	5606,39	2418,87	141,63
023.04	2	1928,66	552,28	-1814,09	-71,36
023.05	2	7976,46	8275,03	613,59	3,74
023.06	2	3486,38	2290,04	268,32	-34,31
023.07	2	5934,43	10133,35	2100,29	70,76
023.08	2	3834,14	5372,47	439,10	40,12
023.09	3	2190,31	1368,99	-411,59	-37,50
023.10	3	2284,69	2879,51	754,23	26,03
023.11	3	3108,70	7134,24	2567,07	129,49
023.12	3	3445,86	3024,50	-144,55	-12,23
023.13	3	121,67	19,70	-117,87	-83,81
023.14	3	1513,76	1934,67	134,68	27,81
023.15	3	1115,11	1143,52	299,82	2,55
023.16	3	1809,89	1452,32	275,55	-19,76
023.17	3	586,95	3462,77	3932,17	489,97
023.18	4	1613,47	1595,05	-14,28	-1,14
023.19	4	2142,30	3321,99	339,41	55,07
023.20	4	4422,99	4014,99	1470,99	-9,22
023.21	4	1071,09	1563,39	239,36	45,96
023.22	4	305,75	1381,36	495,81	351,79
023.23	4	2101,40	3089,06	478,31	47,00
023.24	4	4218,48	5092,59	536,35	20,72
023.25	4	7297,47	8069,98	838,37	10,59
023.26	5	2052,00	2488,52	526,88	21,27
023.27	5	2125,02	4415,40	1095,82	107,78
023.28	5	2896,13	2908,72	1720,40	0,43
023.29	5	5003,28	4740,19	-213,30	-5,26

023.30	5	512,65	954,10	268,91	86,11
023.31	5	1794,40	6716,80	1350,74	274,32
023.32	5	7427,15	5810,68	-1176,99	-21,76
023.33	5	4865,41	4778,78	1430,82	-1,78

Table 8: Project 1 Project and reference dwellings

10.2 Pilot project 2 - all apartments

The figure below shows the development of consumption from 2015 (without EZR) to 2017 (with EZR). For a meaningful before-and-after comparison, the year 2016 has been removed from the analysis, as the EZR was retrofitted there in Q3. Serious changes in consumption usually resulted from tenant changes or new housing use constellations.

The saving for all long-term tenants (who have been living in their apartment since 2015 or longer) is about 12 %.

Spalte1	Sausenberger Straße	2015	2017	Entwicklung [HKV-Einheiten]	Entwicklung [%]
Tenant 1	26	3911	3741	-170	-4,35
Tenant 2	28	7826	6282	-1544	-19,73
Tenant 3	28	5454	4036	-1418	-26,00
Tenant 4	28	4565	2480	-2085	-45,67
Tenant 5	28	3521	1469	-2052	-58,28
Tenant 6	28	1238	4165	2927	236,43
Tenant 7	30	6423	6641	218	3,39
Tenant 8	30	1060	1957	897	84,62
Tenant 9	30	5476	6191	715	13,06
Tenant 10	30	4145	61	-4084	-98,53
Tenant 11	30	5764	2284	-3480	-60,37
Tenant 12	32	2998	3712	714	23,82
Tenant 13	32	3149	4333	1184	37,60
Tenant 14	32	6753	6428	-325	-4,81
Tenant 15	34	2948	12023	9075	307,84
Tenant 16	34	3475	3430	-45	-1,29
Tenant 17	34	8896	9437	541	6,08
Tenant 18	34	6844	5103	-1741	-25,44

Table 9: Project and reference housing

10.3 Pilot project 3 - all apartments

The figure below shows the development of consumption from 2015 (without EZR) to 2017 (with EZR). For a meaningful before-and-after comparison, the year 2016 has been removed from the analysis, as the EZR was retrofitted there in Q3. Serious changes in consumption usually resulted from tenant changes or new housing use constellations.

VER.Nr	Freieslebenstraße	2015	2017	Entwicklung [HKV-Einheiten]	Entwicklung [%]
137	7	7.728,40	9.491,01	1.762,61	22,81
138	7	5.081,27	8.296,85	3.215,58	63,28
139	7	2.222,48	3.103,89	881,41	39,66
3295	7	204,00	747,58	543,58	266,46
4148	7	5.165,37	4.161,78	-1.003,59	-19,43
6525	7	2.836,15	2.691,77	-144,38	-5,09
6677	7	3.898,33	2.885,73	-1.012,60	-25,98
140	8	4.729,23	6.641,30	1.912,07	40,43
1499	8	954,69	1.453,25	498,56	52,22
2535	8	5.068,88	4.415,91	-652,97	-12,88
9615	8	5.251,77	7.680,19	2.428,42	46,24

Table 10: Project and reference dwellings

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