Smart Urban Districts: Dynamic Energy Systems for synergic interactions between Building and City

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Abstract. The primary purpose of this paper is to illustrate the process of experimental research regarding the smart and synergic urban districts/smart and dynamic energy systems relationship, conducted by the authors as part of their activities at Technische Universität München and carried out until realization on both an urban and an architectural scale. The research and applicative experimentation regarded seven German urban situations on the conforming dimension of the "smart district" (between 15,000 and 20,000 inhabitants): the urban communities of Feldkirchen, Aschheim, and Kirchheim, the historical centres of the cities of Iphofen and Taufkirchen, the municipality of Ismaning, and the Wüstenahorn neighbourhood in Coburg. The various urban communities that were the object of research signed an agreement with the Technical University of Munich as part of the German national line of research called "Energienutzungsplan" - "Energy Use Plan" - supported by the Ministry of the Environment of Bavaria, for which the authors were awarded grants and served as rapporteurs.

Keywords: Smart Energy Systems, Smart Synergic Districts, Dynamic Simulation Tools, Positive Energy Architecture, Energy Integrated Storage

Introduction: overall considerations

The constantly growing threat of climate change, excessive consumption of energy with its harmful emissions, and a dearth of resources - and particularly of fossil energy resources: these are an explosive combination that make this one of the biggest issues in our time, and the most urgent problem to be coped with for our common future. It is a challenge that involves the life of every human being, that must indispensably be met through the contributions of a multitude of stakeholders: administrators, politicians, technicians, and consumers (Dohler et al., 2016).

The need to reduce energy consumption, to transfer production towards renewable sources, and to best distribute and share the fruits of this production in a manner that is smart and adaptive to the different requirements is a widespread and widely shared problem that may even be quantified in its basic approach: to be able to cover total energy needs using renewable energy sources, the reduction in overall consumption must be equal to two thirds of the current value, since the total potential that may be obtained from renewable energies equals approximately one third of the total (Hausladen, Liedl, Saldanha, 2015).

However, this is but one aspect of the problem. It is well known, and also quantified, that the activity of building generates a consumption of resources that is increasing exponentially due to demographic growth and the planet's development. To deal with this phenomenon, research has created instruments to assess the savings potential and to construct buildings and urban settlements with an energy requirement that is minimum or even negative - which is to say capable of reversing their course and transforming them from energy *demanders* into energy *producers* not only for themselves, but also to obtain a surplus to be distributed to those who need it. This practice is now being trialled on a worldwide scale, and there are currently many examples bearing witness to the possibility of constructing buildings that produce more energy than they consume (Campbell, 2012). But almost all the best and most virtuous architectures produced from this perspective have been "prototypes", experimentations of "models", "race cars" of a sort, on which to explore possibilities and test cutting-edge systems and technologies through which to acquire knowledge to be transferred in the current practice of designing and building.

What is new is that today, thanks to the numerous experiments and the many prototypes anticipating present and future potentials, we now have all the technologies to construct buildings with a minimum energy requirement, and with no excessive additional costs. And the most important thing is that these examples highlight a new degree of complexity for the system: a vision must be built that considers not only the building in the context of the city and in the relationships, it imposes, but *the city as a whole* and *the network of relationships between its parts* (including buildings) as the linchpin of the question to be dealt with and resolved (Herzog, Steckeweh, 2010).

From the strict standpoint of energy and thermodynamics, the city offers a vast range of systems with different temperature levels, and structures with alternating needs and load curves - elements that can and must be placed in relation to one another. Simultaneity of demand may be reconsidered by assessing the availability of thermal energy derived from systems that can be integrated with one another due to non-coinciding temperatures and load curves, and by deferring the need. These aspects make it possible to create - if one so wishes - exceptional synergistic effects within the network of buildings and between the parts of the city with different functional profiles and use intervals. Energy may be taken into consideration as a function of the "value" it takes on, in relation to the systems and to the necessary operating temperatures.

To summarize, it is not a matter, then, of a challenge linked to technology and to systems, but one linked to the creation of a strategic path in which the process we have thus far applied must be inverted: until today, we have calibrated production to the energy requirements imposed by the buildings' construction characteristics and their functional profiles. In the future, however, we should calibrate requirements to production capacity and to its availability over time to the entire scale of the city understood as a "smart environment" (Pedersen Zari, Jenkin, 2012).

In the setting in which we are called upon to intervene, architects and in particular technologists have an essential task and a strategic role, since through design they generate not just an idea, but a full-blown *vision* that is realized in the project intervention, and that must take a multitude of aspects into account, from design to urban planning, from costs to environmental issues, from beauty

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to the demands imposed by the social sciences, and from exploiting natural capital to making the most of cultural, social, and technological capital (Hausladen, Tucci, 2017).

Methodological approach: the first trials of synergic interactions between Building and City

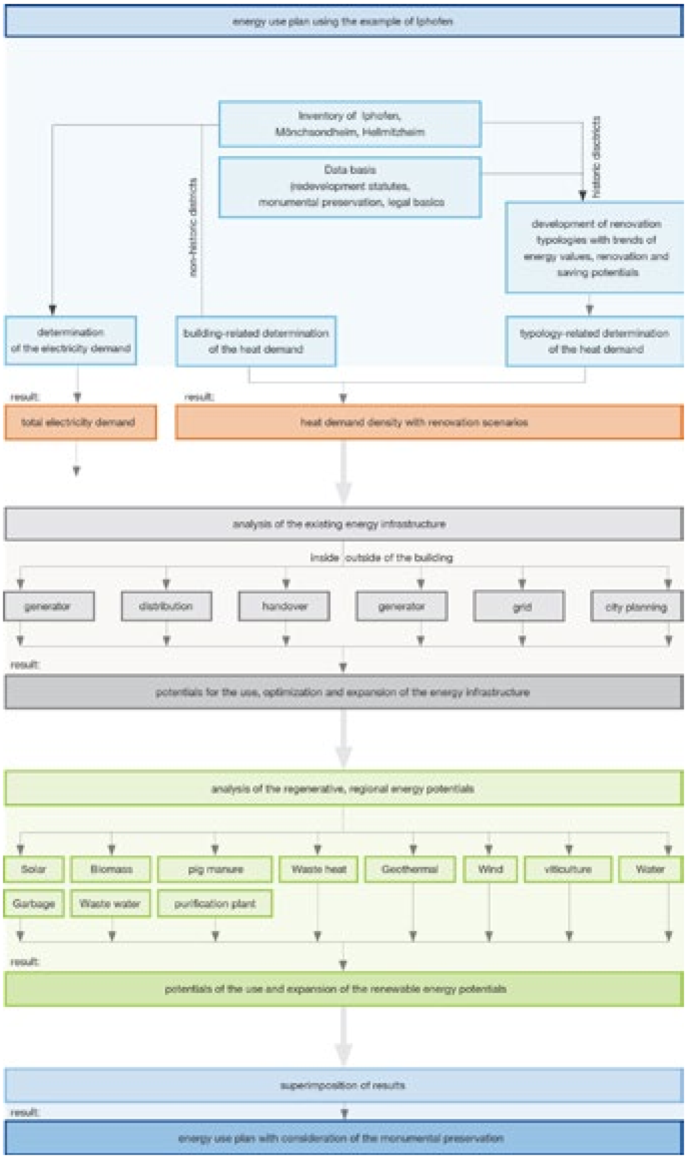
It has by now been made absolutely clear that the aspect that most influences sustainability in the design definition phase is that of assessing the impact and the effects of the intervention on the entire built environment. It is necessary to reconsider the possibility of taking action on the existing stock, with programming to regard intervention on an urban scale rather than the construction of new buildings. If the latter can easily achieve the objective of zero emissions and zero energy balance, the existing stock, on the other hand, represents the nucleus upon which to take action in order to drastically reduce energy current consumption while at the same time improving its ecological and environmental performance (Tucci, 2011).

An important recent conquest, a decisive factor for building an effective intervention vision for the existing consolidated or even historical building stock, is the acquisition of the technological/design knowledge accompanying the awareness that interventions to reduce the energy requirement may exclude invasive measures on the envelope, if interventions on the forms of energy provision and on the usable air conditioning systems are planned. Moreover, the position of the existing buildings integrated into the urban context makes them well connected to the functions of supporting the activities and the existing networks. These elements are essential in a sustainable strategy, both to limit private transport and incentivize the use of public transport, and to maximize the efficiency and performance of existing infrastructure networks - thus making it possible at the same time to effect serious efficiency operations while safeguarding the prospect that the building stock that is not ancient or under protection might in many cases still be considered as bearing testimony to an era (Battisti et al., 2015).

The following examples demonstrate that this vision, and its methodology built over the years by the research group, can be applied to urban settings, including those quite different from one another.

First, there are two cases of intervention in the early 2000s on building aggregates of such a size as to be held significant, in terms of impacts, on the scale of the urban district; these cases, on which the authors worked in experimental fashion, were the basis for the development of the subsequent *smart and green city* experiences[1].

The seat of the urban complex of the Episcopal Curia (Ordinariat) of Munich - a large historical building complex in which it was necessary to conserve architectural characteristics while reducing to a minimum the interventions to the exterior envelopes and to the interior floors and ceilings - required design choices differing greatly from requalification operations, including those of energy/environmental upgrade, as usually adopted to that time. The doors and windows were replaced and since intervening on the horizontal surfaces was not possible, the choice was made to activate the walls with a radiant heat system inserted between the plaster and the heat insulation. The energy supply is guaranteed by the return circuit of the city's district heating, which makes it possible to use temperatures lower than those needed for the previously installed system of radiators, thereby raising the degree of effectiveness of the district heating itself.



The strategy for the energetical refurbishment of the German Academy in Rome "Villa Massimo"[2] bases on the intention to create a zero-energy balance of the whole property by applying technological solutions excluding invasive interventions on the fabric. The German Academy in Rome is the first property that is selected to demonstrate technical innovation combined with the research and development on integrated design applied to an existing extra-

02 | Steps of the stock and potential analysis of historical districts

territorial property of the Federal Republic of Germany. Through the development of the design and through the implementation of interventions on the building stock, the complex should become a positive example of the use of innovative technologies and its integration in a complex of great historical value.

The overall target of the initiative is the formulation of a strategy to reduce the energy consumption, to implement renewables and to evaluate synergetic effects in a listed historic building complex without interfering with the architectural quality. The choice to examine the property of the German Academy in Rome, was originated on the one hand by the request to act on a building of particular historical value, on the other to interact with the warm climate also in relation to the use of solar energy. The property has the potential to explore the combination of load curves from different usage increasing comfort by reducing the current consumption and costs. The aspects of conservation and reconstruction of the architectural significance generally drive refurbishments of historic and heritage buildings, without enough attention to energetical aspects. Historical and monumental buildings present a series of architectural characteristics, which define identity of urban environments. For this reason, the proposed strategy bases on reducing the primary energy demand of the property through technologies that avoid invasive interventions on the built environment.

The use of renewable energy determines the need to constantly define the criteria and the way of interaction with the building. The design of increasingly sophisticated systems to produce clean energy must have as its primary objective the maximum integration with the architecture.

In this sense, the key aspect for the definition of the energy supply system is the determination of potentials deriving from renewable resources and their availability, considering the context and the existing infrastructure. Another aspect to be taken into consideration is the temporal availability of production and therefore the simultaneity of production and consumption. In the design phase, needs and the load profiles should be therefore identified and classified, comparing them to the available potential out of fluctuating renewable sources. In an optimized system the production and consumption must match and have to be put in effective relation.

Following this premise, the Villa Massimo project evaluated the possibility to achieve a substantial reduction in energy requirements by exploiting the network and the relationship with the city as a condition to prefigure new scenarios. The project's goal is to achieve an annual zero primary energy balance by experimenting innovative systems and technologies and redefining the role of the historic buildings in the context of existing structures and the local energy grid.

In the case of the complex of the German Academy in Rome the interactions and the synergetic effects between buildings are considered since there are several functions and load curves, and, consequently different technical systems. The villa, with the administrative functions has different comfort and energy requirements as the residential buildings that are used continuously. While the villa has a peak demand due to overheating in summer and significant internal loads during exhibitions and events, other buildings, which account for 75% of the total area, have a relatively low demand for cooling but have a high consumption of hot water. In this sense, the two structures are put in relation to integrate each other´s curves and demands. The project for the Villa Massimo is an example for an integral planning methodology dealing with passive and active components to deal with the historical building stock and with the transformation of built structures in the post fossil decade, without losing architectural building culture (Endres, Santucci, 2014).

Cases of study, towards the Smart Environment: seven experimentations of Smart Urban Districts

On the urban and territorial dimension, which revolves around the applicative experimentation of the Smart Cities theme, several applicative research efforts have yielded innovations in the way of organizing the design approach and of intervening in a manner fully aware of the value, in terms of culture and identity, of the settings, while at the same time highly effective in the results from the standpoint of performance.

The design of the communities of Feldkirchen, Aschheim, and Kirchheim is an initial case of what can be done on the territo-

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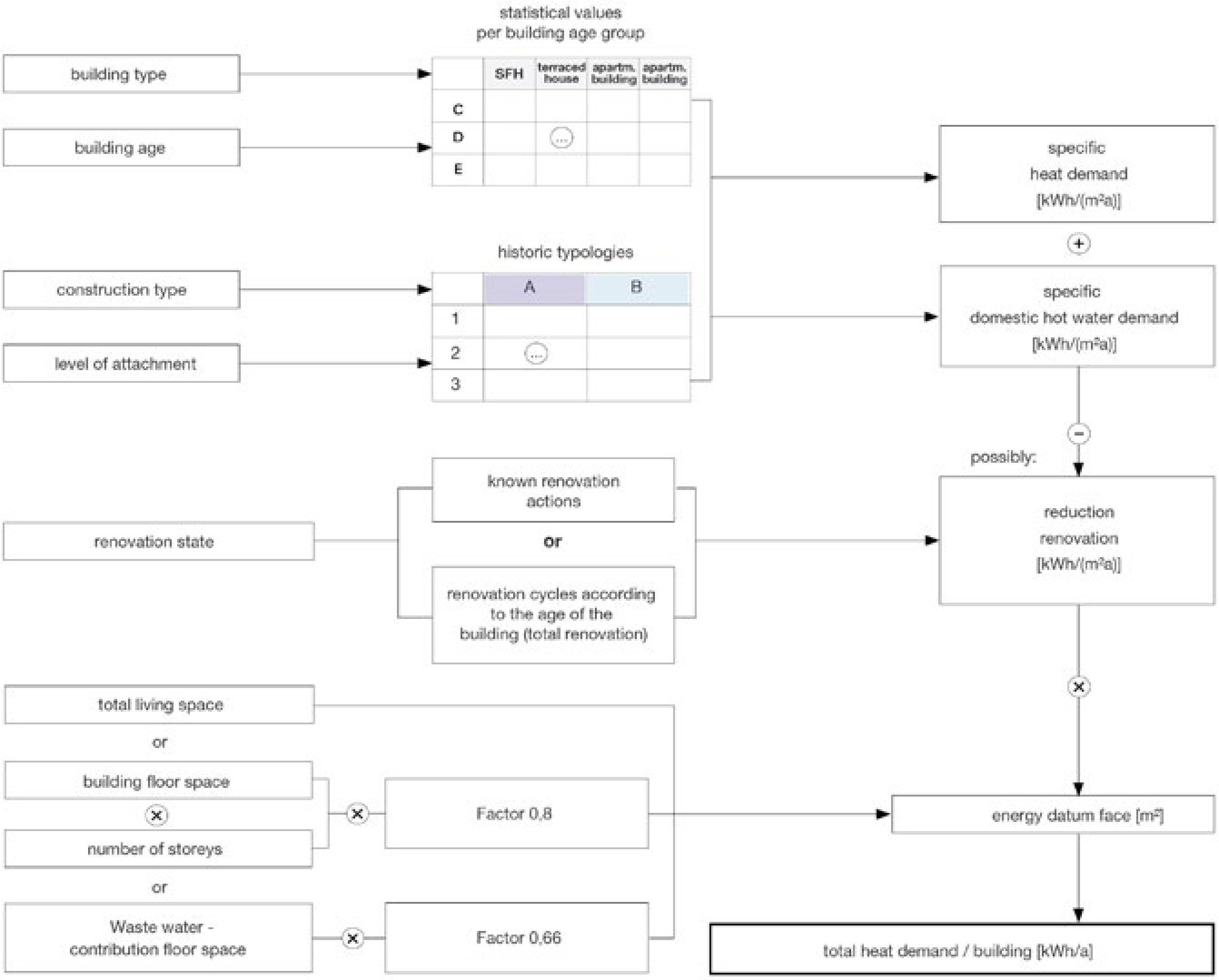

Tab. 1: specific heating demand for residential buildings [kWh/(m²a)], according [Born et al. 2011]

building age	building year	SFH SDH	terraced house	apartm. building	apartm. building (big)	high rise
		[kWh/(m²a)]				
A	before 1918 half-timbered	183		190		
B	before 1918	181	154	144	127	
C	1919-1948	165	137	168	144	
D	1949-1957	181	157	156	143	
E	1958-1968	147	106	130	132	114
F	1969-1978	156	128	134	118	114
G	1979-1983	118	128	118	114	
H	1984-1994	133	99	123	82	
I	1995-2001	110	78	93	73	
J	ab 2002	89	87	80	51	

Tab. 2: Specific domestic hot water demand for residential buildings [kWh/(m²a)], according to [Hausladen et al., 2011]

building age	building year	SFH SDH	terraced house	apartm. building	apartm. building (big)	high rise
		[kWh/(m²a)]				
A	before 1918 half-timbered	21	18	24	27	n.a., alternatively the values for the big apartment building can be used
B	before1918	21	18	24	27	
C	1919-1948	20	20	29	33	
D	1949-1957	19	20	25	28	
E	1958-1968	18	20	20	24	
F	1969-1978	16	20	23	18	
G	1979-1983	14	16	20	18	
H	1984-1994	19	21	21	21	
I	1995-2001	19	19	21	21	
J	ab 2002	n.a., alternatively the values for building age I can be used				

03 | Determination of the heat demand
of the studied historical districts

rial scale. The three communities on Munich's eastern periphery signed an agreement for the installation of deep geothermal probes. This choice makes it possible to obtain, through a centralized generation system, a considerable quantity of high-temperature thermal energy, at approximately 90°C. Following this, a study was drawn up to test its effects on the modes of energy distribution and on the possibilities that this intervention determines. The building stock was classified by age and type of systems, and use temperature of the heating systems. This zoning enables the breakdown into divisions that use high temperatures, and others that can exploit the temperature levels of the return circuit. A cascade system is thus obtained that exploits all the available thermal energy.

The project fits into the research line carried forward by the Technical University of Munich called "*Energienutzungsplan*" - the energy use plan - supported by the Ministry of the Environment of Bavaria (Bayerisches Staatsministerium für Umwelt und Gesundheit, 2011). This instrument was created to analyze the composition of the buildings in the urban centres from the standpoint of the thermal energy requirement. The analysis regards type, age, the systems installed, the quality of the envelope, and consequently the density of consumption. Subsequently, both the energy potential that can be obtained from renewable sources and the residual resources made available by industrial processes, by waste-to-energy, as well as all the distributed energy generation systems, are quantified. The results of the analysis and quantification are associated with the available resources and placed in relation to the network that integrates the components and exploits their synergistic effects. An essential element of this strategy is the analysis of and comparison between supply and demand. The term "supply" is understood as centralized energy production, rates, temporal availability, and value from the ecological standpoint. The term "demand," on the other hand, is understood as the load profile of the various forms of thermal and electric energy required. As they intersect, the two categories create an interface we might define of the management: analysis and definition of the load profile, management of peaks, and temporary energy storage.

A similar experience was dealt with in the plan for Taufkirchen, a city of 10,000 inhabitants located to the northeast of Munich. Currently, most of the buildings are heated using Diesel or gas boilers and electricity is withdrawn from the grid. The analysis measured the systems, classifying them by age and type, and by consumption density. Moreover, the surrounding territory was analyzed from the standpoint of potential energy generation, as there are numerous biogas systems connected to cogeneration plants. The contribution of energy that can be obtained from the biomass available on the territory was quantified, and placed in relation to the buildings' requirement.

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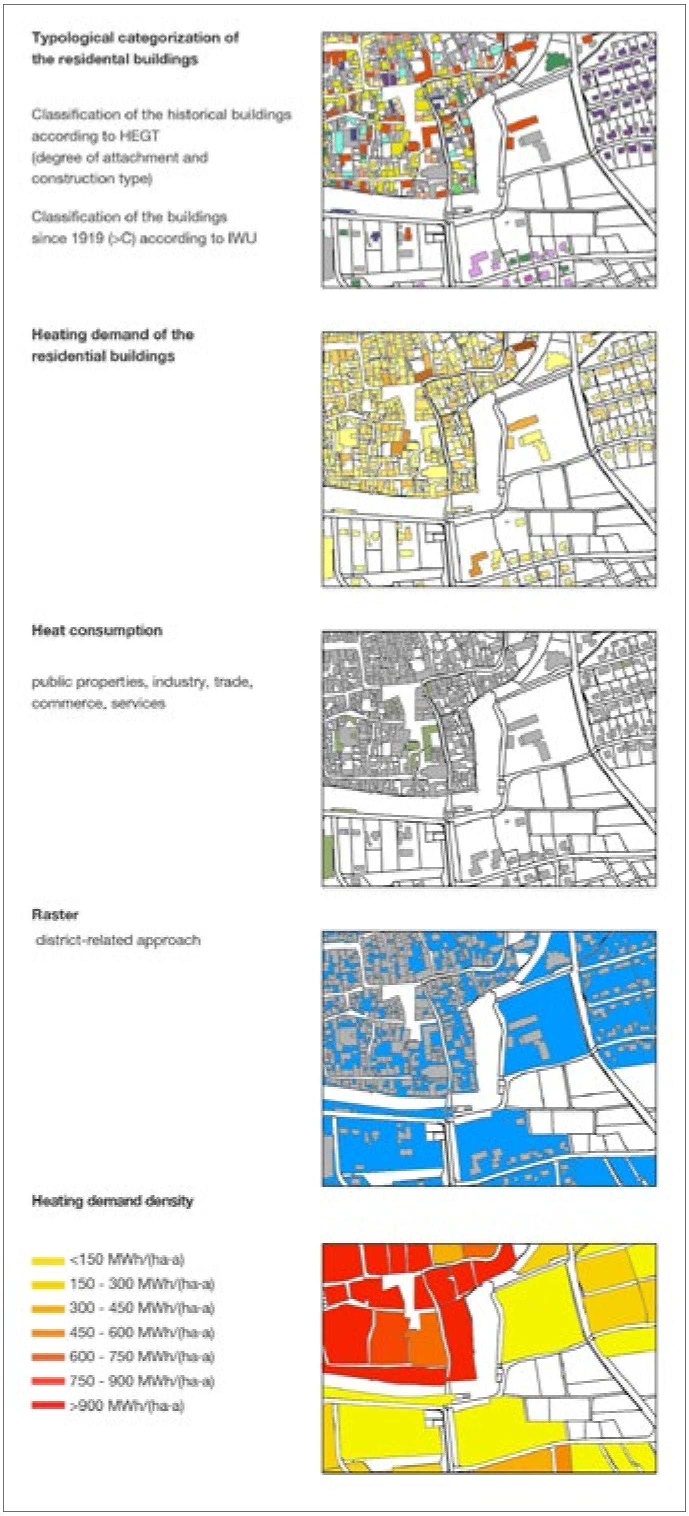

04 | Pictograms: Creation of a heating energy demand density map

05 |

*abbreviation:

ESP: energy saving potential

WDVS: exterior insulation and finish systems

WLG: heat conduction group

HEGT degree of attachment	construction type A Q_h [kWh/(m²$_{living\ area}$*a)]	Konstruktionsklasse B Q_h [kWh/(m²$_{living\ area}$*a)]
1 low	176	230
2 medium	149	188
3 high	110	127

05 | Renovation-matrix: construction type A, construction type B. Building Typology (Values for two- to four- story buildings)

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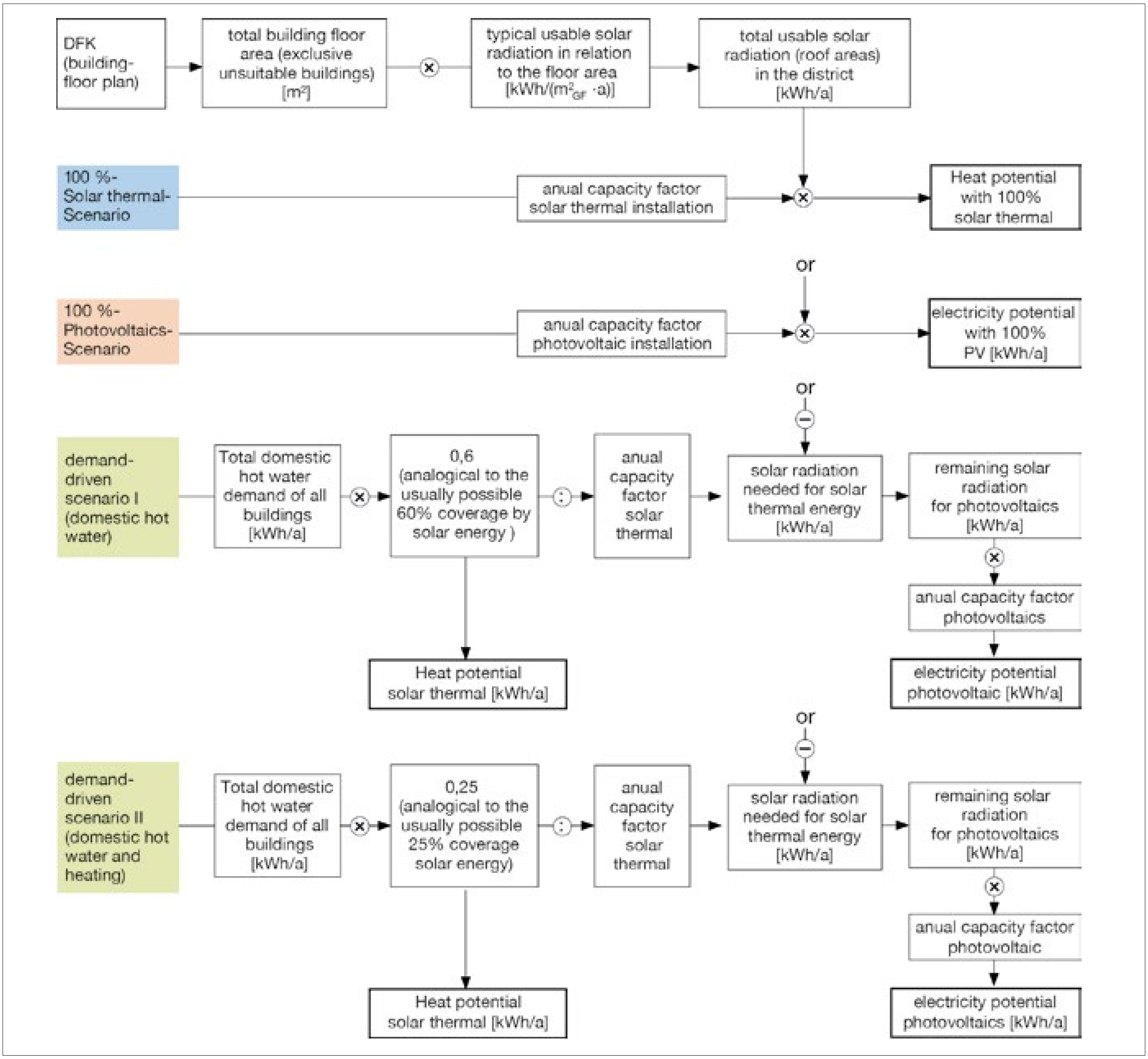

06 | Solar potential determination

This approach made it possible to develop a project to connect the generation plants distributed in the territory, and to integrate the systems: cogeneration covers both a part of the thermal energy for heating and a significant portion of electric energy. This configuration allow new plants to be created to integrate existing production (Bayerisches Staatsministerium für Umwelt und Gesundheit, 2011).

The project to upgrade the Wüstenahorn neighbourhood in Coburg dealt with the issue of the energy upgrade of a popular building settlement from the 1950s. The neighbourhood has a very high energy consumption due to insufficient heat insulation and obsolete plant. To reduce the energy requirement, a combination of different forms of generation was provided for: geothermal probes associated with new radiant heating systems, and cogeneration systems. This choice makes it possible to produce electrical energy while at the same time obtaining two different temperature levels: high, needed to produce sanitary hot water and usable on pre-existing heating systems, and low, for radiant heating systems.

The use profiles of residential buildings are integrated into those dedicated to the commercial and tertiary sectors, creating a constant, regular energy demand. In this way, peaks in demand are eliminated, which generally do not coincide with peaks in production from renewable sources. This classification of needs makes it possible to find more effective forms of energy supply in which the availability of energy coincides over time with production. The energy requirement is covered by the photovoltaic plants located on building rooftops and on the large station roof,

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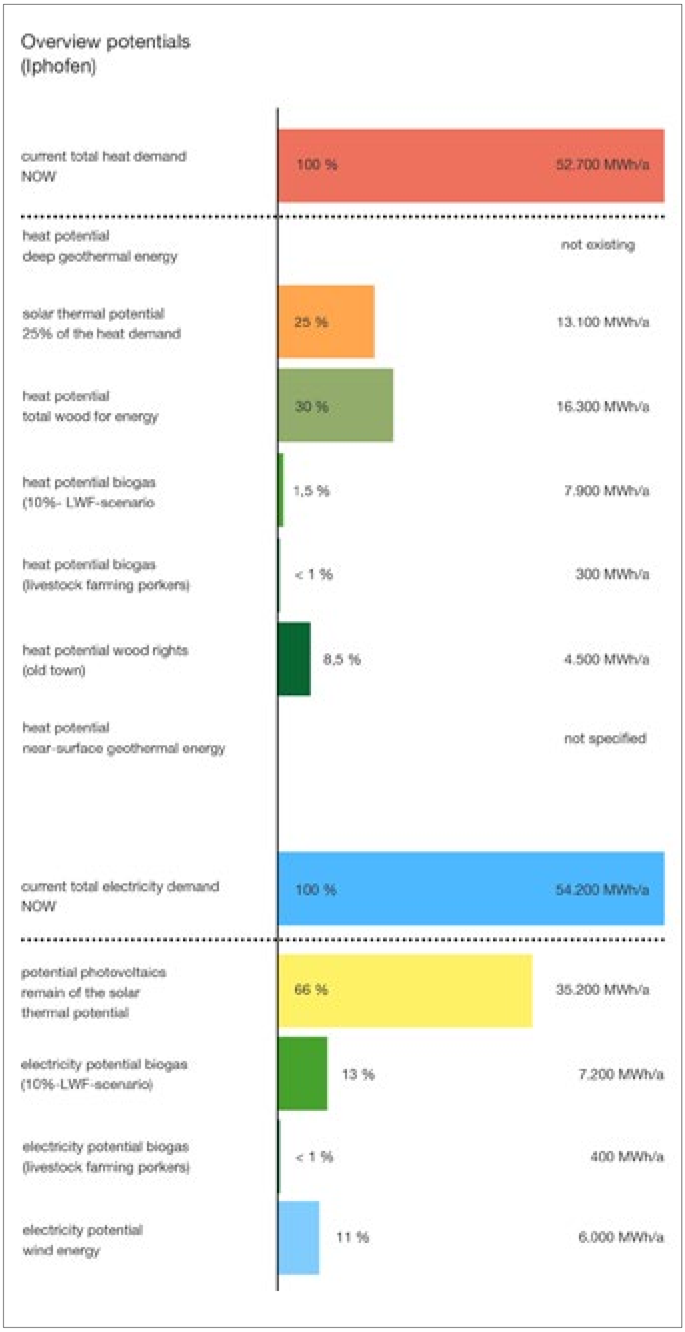

07 | Overview of the energy potentials (Iphofen)

which cover the electricity requirement, assisted by cogeneration plants dedicated to producing thermal energy for heat and sanitary hot water, as well as to covering any peaks in electricity demand. The thermal energy requirement for cooling, on the other hand, is guaranteed by heat exchangers deployed in specific, known points for extremely low temperatures, even in the summer period (BSUG, 2011).

Ismaning is a municipality of 15,000 inhabitants located to the north of Munich, between the centre and the airport, for which a feasibility study was done. The study describes a highly efficient scenario for procuring and distributing energy that does not interfere with existing structures. As in prior experiences, areas with different construction types, requirements, and consumption densities were identified. In parallel, the energy potentials from renewable sources were quantified, opting in particular for photovoltaic and geothermal, and the existing infrastructure networks were surveyed. The possible interventions on existing buildings, aimed at reducing the thermal energy requirement for heating, were listed, and the industrial settlements generating residual heat were identified. The latter on the one hand yield heat that may be recovered and used to climatize other buildings, and on the other have a thermal energy requirement for cooling. This gave rise to the idea of creating a network to distribute the cold generated via the absorption systems (BSUG, 2011). The scenario planned by the study will be realized in the near future through financing by the municipality.

The same methodological approach was applied in the design for the historic centre of Iphofen (Fig. 1).

Iphofen is a city in Franconia known above all for wine production and for its beautiful and virtually intact historic centre. The buildings, the so-called *Fachwerkhäuser*, were built with characteristic wood frames, and have a very high thermal energy requirement for heating. The energy upgrade project identified the strategies to prevent invasive interventions on the ancient envelopes, also by identifying, in parallel, the alternative measures for reducing the energy requirement. Since the region has a great production of lumber, cogeneration plants were planned for the generation of thermal energy, deployed on the territory to cover - with the delivery circuit for high-temperature needs, and with the return circuit - the systems in the most recently constructed buildings. The study does not rule out the possibility of intervening on the envelopes, but guides the reduction of the city's overall need for primary energy towards forms of generation and above all of "dynamic" and "adaptive" interaction between systems at different temperatures in order to guarantee safeguarding the historic buildings (Fig. 2) (Hausladen, 2012).

Given the delicate nature, the difficulty, but also the central importance of the issue represented by this experience, the decision has been made to take it as an example of the seven experimenta-

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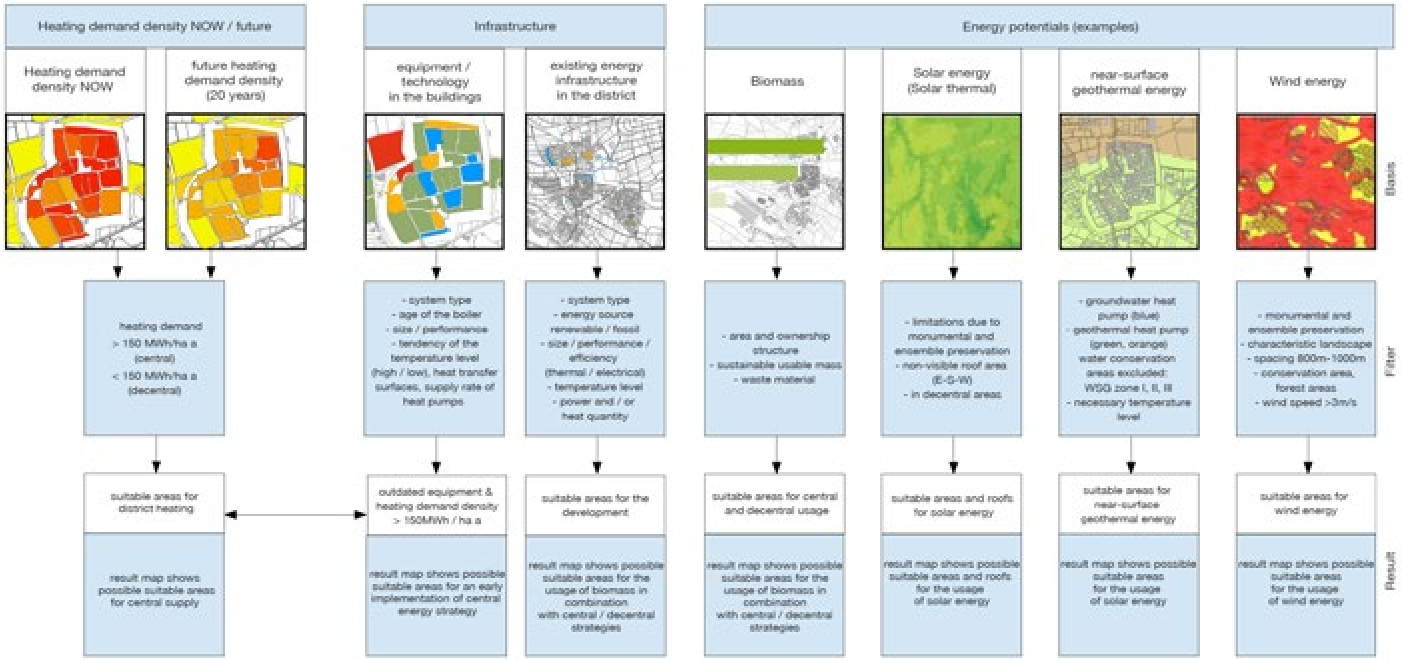

08 | Filtering through the heat energy demand density map, infrastructure and energy potentials

tion cases on the urban districts presented in this paper, assigning the 8 images, tables, and graphics[3] the task of illustrating the process in a more in-depth manner, and the results.

A careful study was carried out, aimed at classifying the entire stock (Fig. 3) in accordance with the energy demand values (useful energy) for specific heating demand values (Fig. 3, Tab. 1) and the domestic hot water demand values (Fig. 3, Tab. 2), which yielded a heat requirement density map (Fig. 4).

Fig. 5's technical data sheets provide important information on aspects of historical compatibility, the building's physical and energy importance, and legal requirements. Although the study was developed for the city of Iphofen, it is generally transferable to other cases for the efficiency of historic centres, as the fundamental legal and physical relationships are listed. In the data sheets, letter A indicates the construction class, whose U values of the exterior walls are within an interval of +/- 1.4 W/m²K. In this case, the walls of the "reference building " were calculated with a U value of 1.4 W/m²K. Letter B stands for construction Class, whose U values of the exterior walls are included within an interval of +/- 2.4 W/m²K. The approximate characteristic value for the adequate implementation of the central energy procurement solutions is 150 MWh/ha per year.

First of all, this means that the energy requirements connected with space in neighbourhoods are closely correlated with the potential for using renewable energies at a central or local level. The example of Iphofen shows that structural density has a decisive influence on energy absorption density. Secondly, it was found that the thermal quality of the building's fabric is crucial. The greater the energy absorption density is, the greater is the potential for centralized use of renewable energies. From this, it may be concluded that the districts with high structural density have a high potential for centralized assistance, upon which different intervention scenarios for a Smart Urban District (Fig. 6) may be constructed.

The choice of the most suitable design intervention in the specific context of Iphofen is thus reached, and may be summarized in Fig. 7, showing the current total heat and the total electricity demand (current state), in addition to overviewing energy potential in the municipality of Iphofen. For solar potential, consideration was made of a 25% maximum share of coverage of solar thermal energy. The remaining coverage areas are then assessed for use by photovoltaics. The biogas potential is based on a 10% use of total agricultural land, in line with the share currently used in Germany for energy production.

For the intervention, it was identified which areas are most suited for central or decentralized assistance (Fig. 8). Here, in addition to the current heat demand, the future heat need is also taken into account. Future demand takes account of the reduction in energy absorption density through the buildings' requalification. The approximate threshold of 150 MWh/ha per year mentioned above may be used to identify areas suitable for the concepts of centralized supply, keeping in mind that, at the central institutional level, local heating networks are promoted, with regenerative function starting from an energy absorption density of 0.5 MWh/trm per year.

The results point to a reduction in energy consumption from fossil fuels of 65% for thermal energy and 91% for electrical energy.

Conclusions in progress

The experimentations that were presented, all of which completed, demonstrate that it is possible, today, to regenerate the urban settlements and the network of their buildings and open spaces, making them capable of sustaining themselves, drastically reducing the requirement of primary energy, and bringing emissions to zero, while improving their environmental comfort.

We have seen how effective, from the standpoint of the methodological approach, the arrangement can be of starting from the innovative, mixed modes of producing entirely zero-emission energy, through the use of new systems for the dynamic storage of surplus energy: this was why a *Simulation Tool* was implemented, making it possible to assess, in the design phase, the effects on the modes of distribution of the energy produced in various, integrated ways, entirely from renewable sources, and on the possibilities these interventions determine. We point out that the *Tool* has central importance, providing accurate analysis of the composition of the buildings in urban centres, from the standpoint of the thermal energy requirement - an analysis that regards type, age, systems installed, quality of the envelope, and consequently the density of consumption.

We have also seen how key a passage in methodological innovation is the subsequent quantification of the energy potential obtainable from renewable sources, as well as that of the residual resources made available by the processes of distributed energy generation. In practice, the experimentation showed that only in this way can the results of the analysis and of the quantification be effectively associated with the available resources and placed in relation to the network that integrates the components and exploits their synergistic effects. And it is to be borne in mind that current research frontiers in this setting are oriented to the theme of constant "dynamic" adaptation of the needs both to the potential of production and to the (growing and innovative) possibilities for storing the generated energy.

The prospects are outlined and proved by the excellent results of the first real experimentations: only through a highly accurate management of energy, integrated into the architectural and urban systems - which "dynamically" and "adaptively" considers and associates the load profile of production and absorption, the types of requirements, the temperature levels and the interaction between the various forms of production - will it be possible to achieve real *smart cities* with *net zero energy*, or even *positive energy* and *zero emissions*. And in this perspective, it is important to keep in mind that in the design conception phase, it was essential in these experiences of experimental research - and it will always remain so in the future - to devote very careful consideration to the form, the technological characteristics, and the relationships of the urban and building structures, as well as the existing energy infrastructures and networks, by seeking the optimal combination to place them in relation to one another, by broadening the system's limits, and by redrawing the boundaries of the energy balance in relation to the broader vision and conception of the architectural and urban systems typical of technological design in an international perspective.

NOTES

[1] Another trial case in addition to those illustrated in the text, must be pointed out, marking an occasion for experimentation encouraged by the research group on the issues deal with in this passage of the paper. This is the large *Munich Re* building complex, built in the 1980s and the object of an upgrade competition in the early 2000s, which in effect constitutes an additional example of this approach. The design competition was won by proposing not to intervene on the façades, considering them to be an undeniable testimony of a period, while showing preference to replacing the air conditioning systems and the energy supply procedures. The existing air systems were replaced with radiant heating systems and low-enthalpy cooling. The proposed solution was assessed from the standpoint of primary energy savings, comparing the solution involving the heat insulation of the façade - assuming that this could be done without modifying the existing envelope - with the one excluding it. After 80 years of use, the variant without heat insulation reaches an equivalent primary energy requirement since, in this case, the consumption linked to manufacturing that insulation need not be considered. The proposed solution, which entails no modification to the façade system, turns out to be, in terms of energy, just as sound, but avoids any intervention on the envelope.

[2] The project procedure started in 2010 with an initiative funded by the "German Federal Environmental Foundation" (Deutsche Bundesstiftung Umwelt). This first phase had its core on the definition of optimization the performance of the existing technical supply systems integrating renewables in the complex. To the first feasibility study a second phase of investigation succeeded, supported by joint funding from the Ministry of Economics and Technology (Bundesministerium für Wirtschaft und Technologie (BMWi)), the Ministry of Transportation and Development (Bundesministerium für Verkehr, Bau und Stadtentwicklung (BMVBS)) as well as through a grant from the Government of the Federal Republic of Germany through the "Beauftragten der Bundesregierung für Kultur und Medien (BKM)".

[3] Figures 1, 2, 4, 5, 7 and 8 come from: Hausladen et al., 2012. Figures 3 and 6 come from: Hausladen et al., 2011.

ACKNOWLEDGMENTS OF VALUE

Edo Ronchi

National Council of the Green Economy

If we are to achieve the 80-90% reductions in greenhouse gas emissions needed to limit the average temperature increase to below 2°C as established by the Paris Climate Agreement, it is crucial to be able to meet the energy, electricity, and thermal needs of existing buildings using renewable sources alone. This is to be done by coping with the problems of the production and discontinuity of some of these sources and with issues of inconstant availability, while setting targets for the greater efficiency and considerable energy savings needed to achieve adequate performance with 100% renewable energy.

The experimentations presented by this study, addressing the possible relationship between "smart and synergic urban districts" and "smart and dynamic energy systems," show that if the right questions are asked, answers are found - and that these answers are already today technologically practicable and economically feasible. There appears to be great potential to spread these experimentations: existing buildings and the characteristics of urban districts in the considered conditions are numerous and ubiquitous; urban areas show a frequent presence of differentiated energy demands; the possibilities of integrated recourse to differentiated forms of renewable sources (geothermal, biomass cogeneration, solar and wind) are widely accessible, as are the various energy storage technologies; the combined, "dynamic" use of measures and technologies to reduce energy consumption and for the efficient employment of renewable resources, although highly innovative and advanced in the described experimentations, appears broadly feasible in urban landscapes where there is a desire to promote it.

In brief, the research and experimentation presented in the paper by Tucci, Santucci, Endres and Hausladen are convincing, showing that Smart Buildings and Smart Urban Districts are feasible today, if we have the desire (while in the awareness that they require great awareness and clear vision) and if we have the multidisciplinary skills needed to carry out all the phases in the knowledge-design-realization process, from systematic energy and environmental diagnoses of buildings and urban districts, to the complex process of the creative, innovative, and dynamic conception of the uses of potential and different renewable sources for procuring power, and the design and realization of necessary and adequate interventions in the dimension that is both architectural and urban.

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