

Temperatur- und Feuchtemanagement mit porosierten mineralischen Baustoffen – Risiko oder Chance?

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ABSTRACT: Aktuelle Aufgabenstellungen, wie die Erhaltung historischer Bausubstanz oder Sanierungs- bzw. Wärmeschutzfragen bei Außenbauteilen bestehender Gebäude, sind in besonderem Maße mit Fragen des Feuchtezustandes und der Veränderung des Feuchteverhaltens infolge eines Eingriffs in die Bausubstanz verbunden (Krus, 1995). Das Prinzip der Temperatur- und Feuchtetransport- und Speichervorgänge mineralischer diffusionsoffener, kapillar leitfähiger Baustoffe – wie sie bei Bestandsgebäuden anzutreffen sind – ist bekannt. Die Wechselwirkung zwischen Raumklima und Konstruktion hinsichtlich des Temperatur- und Feuchtemanagements sind jedoch bislang kaum untersucht. Es fehlt eine systematische Untersuchung und detaillierte Erforschung der Auswirkungen auf das Raumklima - wie dies bereits 1975 gefordert wurde (Haferland et al., 1975). Im vorliegenden Beitrag wird deshalb der Einfluss porosierter mineralischer Baustoffe auf das thermisch-hygrische Verhalten von Räumen im Sommer, wie auch der Einfluss des Raumklimas auf die Konstruktion diskutiert und damit sowohl Risiko wie auch Chance porosierter mineralischer Baustoffe hinsichtlich des Temperatur- und Feuchtemanagements beleuchtet. Als Ergebnis der Untersuchung werden bisherige Aussagen, wie sie bei Treberspurg et al. (2011) oder *Nackler (2017)* getätigt werden präzisiert bzw. widerlegt. Der Beitrag stellt einen Auszug der Ergebnisse aus der laufenden, von Ao. Univ. Prof. Dipl.-Ing. Dr. techn. Klaus Kreč (AG Nachhaltiges Bauen, TU-Wien) betreuten Doktorarbeit dar, die durch das IBO – Österreichisches Institut für Baubiologie und Ökologie e.V. sowie ein Stipendium der Austrian Cooperative Research (ACR) aus Mitteln des Bundesministeriums für Verkehr, Innovation und Technologie gefördert wurde.

Baulicher und Lüftungstechnischer Radonschutz

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ABSTRACT: Radon and its radioactive daughter elements cause hundreds of deaths due to lung cancer in Austria each year. As a natural occurring noble gas, Radon can resign easily out of its place of origin, mainly bedrock. It can travel by means of diffusion and convection through the lower building envelope into the indoor air. The radioactive daughters of Radon are likely to adhere to solid particles in aerosols. In case of inhalation, they can further stick onto bronchia, where the emitted radiation increases the risk of causing lung cancer. Especially

during heating seasons, inhabited buildings tend to act as plungers. Due to the stack effect, a small vacuum compared to the underground beneath is generated, causing suction of Radon to enter the building through leakages in floor slabs, basement floors and walls. Particularly in closed rooms, there is a risk of being exposed to indoor air with high concentrations of Radon. Construction specialists play a key role in the containment of the problematic situation caused by Radon and its daughter elements, both in existing and newly constructed buildings. In a bachelor thesis, the most relevant contents of the Austrian Radon Hand Book have been compiled to assist Architects and Civil Engineers in providing sufficient protection against Radon for future and present building residents. In addition, adequate surveillance and maintenance methods have been discussed to ensure proper working of Radon protection measures. Anti-Radon measures that are already considered in an early stage of planning develop to be much easier and more effective compared to measure implemented subsequently. Additionally, even costs of remediation measures can be kept low, provided that the approach is well-conceived and carefully implemented. In a case study executed independently, the theory is transferred to practice. From the evaluation of local building conditions right up to analytic measurements, results will be interpreted, and appropriate remediation measures presented and discussed (Klose, 2018).

Einflussfaktoren auf die Qualität der Sperrmüllsammlung – Eine Analyse im Burgenland

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ABSTRACT: Due to continuously rising amounts of waste and a scarcity of resources the necessity for an efficient waste management system rises. A multitude of municipalities in Burgenland (Austria) struggle with ascending quantities of bulky waste and therefore rising costs. The focus of the present paper is on the results of the analysis of volume and composition of bulky waste in Burgenland.

The composition of bulky wastes in Burgenland was analysed via random sampling in the years 2016 and 2018. Based on the results of the examinations a comprehensive characterisation of the waste stream was done. The characterisation was classified in five main categories (bulky waste, construction waste, recyclable materials, other wastes and sorting residue) which were further divided in sub-categories.

Based on the results of the examinations the range of the reduction potential for the amounts of bulky waste (mass and volume) was identified. As the municipalities demand fees for the disposal of bulky waste in different ways this information is taken into consideration in the assessment of influencing factors for the quality and composition of bulky waste. Measures for the optimised collection of bulky waste shall be derived from the result.

Ganzheitliche Planung dezentraler Energiekonzepte durch mathematische Optimierung

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ABSTRACT: The main topic of this paper concerns the holistic conceptual design of microgrids and focuses on reducing the operating costs and CO₂ emissions of a planned residential complex in a community in Styria. Microgrids allow the coordinated generation of Distributed Energy Resources (DER), such as PV, wind, solar thermal and storage etc., as well as load management to balance heating, cooling and electricity services. Mathematical optimization serves as an unbiased and reliable alternative for the conceptual design of Microgrids, which is needed to optimize the costs and CO₂ emissions via its multiple combinations of technology choices as well as capacity ranges. The used optimization program *OptEnGrid* considers a quasi-static setup using Mixed Integer Linear Programming (MILP) models. A common and simple way to design a microgrid is to use synthetic load profiles when real loads are missing. For the planned community in Styria, however, geographical conditions, target values and control parameters have a major influence on the entire energy system. In a supporting *TRNSYS* simulation these inputs are involved and create detailed load data for a base case scenario in an optimization program. By embedding the simulation data in the optimization, it can be investigated what influence detailed and tailored load profiles have on mathematical-based investment decisions. This shows that errors can occur especially in the design of peak loads and that higher outputs must be demanded from energy resources. For the community in Styria an optimization based on synthetic heat data missed a central heating system because the peak loads in the heating season are designed too low.

Treibhausgasberechnung von Speichern im Resys-tool

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ABSTRACT: The energy simulation tool RESYS creates energy balances of cities and regions. The impact of the use of storage facilities for greenhouse gas calculations is a part of the new version.

The storage tanks are simulated hourly in their loading and unloading condition. Both thermal and electrical storage were analyzed in this greenhouse gas calculation model.

The greenhouse gases of energy from an energy-storage depend on 3 components. To which amount is the energy to be stored primarily polluted with greenhouse gases? Second, the way of the use of the storage and its construction cause emissions due to energy losses. And thirdly, the gray energy of the storage, which generates a share on emission over its lifetime on the stored energy.

Equation (1) represents the balance of greenhouse gases in the RESYS tool. The lifetime is the minimum of the calendar and cycle lifetimes.

Yearly values are compared in the RESYS tool. Here we see, that the storage usage (high utilization of the storage capacity), especially in electrical and thermochemical storage, reduces the lifetime significantly (cycle life crucial). If the storage is used only slightly compared to its storage capacity, its lifetime depends on the calendar limit.

Urbane Energiemodellierung als Grundlage für eine zukunftsorientierte Stadtplanung

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Keywords: Wärmewende, räumliche Energieplanung, Urban Building Energy Modeling (UBEM)

ABSTRACT: Our energy systems are developing rapidly, as are our cities. Climate protection must also be vigorously promoted. In order to shape the necessary energy supply of tomorrow in our cities and regions, all stakeholders must work together within the framework of "spatial energy planning" to tackle the technical and organisational challenges. The research project *EnergyCityConcepts* (www.ecc.aee-intec.at), which is presented in this paper, has dealt with this complex of topics in recent years. In the project work important contributions to the introduction and further development of spatial energy planning in the cities of Gleisdorf and Salzburg was made through the project partners AEE INTEC, Institute of Thermal Engineering at Graz University of Technology, SIR - Salzburg Institute for Spatial Planning and Housing, Research Studios iSPACE / RSA FG, Stadtwerke Gleisdorf and Salzburg AG.

Vergleich von Methoden zur Bewertung von Maßnahmen gegen sommerliche Überhitzung in Gebäuden in klimaaktiv

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ABSTRACT: The global climate change causes extreme weather conditions and poses a major challenge for architects, civil engineers and building physicists. Thermal comfort in buildings is becoming increasingly important, especially in the transition and summer months. klimaaktiv (the climate protection initiative of the Austrian Federal Ministry for Sustainability and Tourism) attaches great importance to thermal comfort, energy efficiency and ecology of residential and non-residential buildings. That is also represented in the respective klimaaktiv criteria catalogs for building certifications. Within the framework of the klimaaktiv regional partnership, the Upper Austria University of Applied Sciences compared various evaluation methods for proving the summer suitability of different types of buildings. In this context, some serious deviations in the results of the different valuation methods were identified. The fact that one valuation method ensures the thermal comfort of a building and another proves the opposite can lead to serious problems and legal issues. Furthermore, the differences between solid and lightweight building construction in terms of room temperature and the necessity of shading measures and innovative air ventilation concepts have been demonstrated. The validation of the results by means of dynamic building simulations, carried out with IDA ICE, is the subject of further research projects.

Praxisbeispiele aus energetischer Optimierung kleiner Fernwärmen

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ABSTRACT: Biomasse-Nahwärmenetze sind ein wichtiger Beitrag zur Realisierung einer nachhaltigen Energieversorgung und fördern zugleich die regionale Wertschöpfung. Der effiziente und emissionsarme Betrieb derartiger Anlagen setzt jedoch eine intelligente Vernetzung zwischen der Energiebereitstellung, der Energiespeicherung und der Energieverteilung voraus. Erst dadurch kann eine gezielte Anpassung der Lastverteilung an die optimalen Betriebsbedingungen der Wärmeversorgungseinheit unter Berücksichtigung der Nutzeranforderungen erfolgen. Derzeit werden hingegen die Fernwärmenetze bedarfsorientiert betrieben. Das bedeutet, dass die Leistung des Wärmeerzeugers immer an den momentanen Bedarf aller Wärmeabnehmer angepasst wird. Dies führt zu ungünstigen Betriebspunkten mit geringen Wirkungsgraden und hohen Emissionswerten. Aus diesem Grund werden zurzeit viele Forschungsaktivitäten im Bereich intelligenter, prädiktiver Netzregelung durchgeführt.

Doch es liegt auch noch sehr großes Potential in der regelungstechnischen Optimierung von bestehenden Fernwärmeanlagen, ohne Änderungen an Regelungsalgorithmen und ähnlichem durchzuführen. In diesem Beitrag soll ein Erfahrungsbericht aus regelungstechnischen und anderen Optimierungsmaßnahmen an kleinen Fernwärmenetzen gegeben werden. Dabei werden einerseits Analyse- und Bewertungskennzahlen präsentiert, typische, immer wiederkehrende Problemfälle aufgezeigt und die Ergebnisse aus den gemachten Optimierungsmaßnahmen vorgestellt.

Das Paper soll auch aufzeigen, dass neben Forschungsprojekten auch die Umsetzung von bestehendem Know-How einen wichtigen Beitrag zur Erreichung der Klimaziele liefern kann und muss.

Wind Energy Booster

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ABSTRACT: This paper describes the improvement of the operating behaviour of a wind turbine (3 MW) by varying the rotor's moment of inertia. There is an additional mass attached

in each rotor blade, which can be moved radially. The change of the rotor's moment of inertia leads to a change of the angular velocity, the torque and thereby the generator power. Thus, the wind turbine acts as energy storage system.

The system was theoretically modelled and implemented in the simulation environment MATLAB as part of a bachelor's thesis at the Institute for Mechanics and Mechatronics at the Vienna University of Technology. In general, the simulation results verify the effect of the suggested mass movement. The input of the simulation is the requested additional feeding power. The necessary motion sequence of the masses is calculated within MATLAB. Caused by its inertia, the rotating system is not able to follow the requested additional feeding power if this varies too fast. As a result of the simulation, it has been shown that the rise and the fall time of the requested additional feeding power should be at least twice the time constant of the mechanical system. The difference between the additional generator power and the shifting power needed to move the masses equals the additional feeding power. The simulation has shown that the ratio between the additional generator power and the shifting power remains approximately constant at the value of two. The simulation has been done for various generator characteristics. By using a high-rate generator characteristic (i.e. for low torque dependency of the generator speed) the trapezoidal shape of the additional feeding power can be obtained very accurate, since high-rate generator characteristics lead to small time constants.

The experimental verification of the proposed operating principle has been achieved at the Department of Mechanical Engineering at the HTL Mödling. The developed test stand includes a rotor with a diameter of 1.4 meters, which is equipped with the moving masses. The masses are actuated over a spindle drive by stepper motors. Both, the generator and the wind are simulated by two identical test devices for e-motors. The test device, which simulates the wind, is driven with constant, speed independent torque. The generator simulating test device, is controlled by a LABVIEW- application to achieve a linear speed-torque characteristic. Both test devices provide actual speed and torque signals to the LABVIEW- application. The wind power sequence and the generator power sequence are calculated based on these signals. The test results verifies that the proposed operating principle is able to increase the frequency-response reserve (inertia) of wind turbines and to support the provision of short term positive and negative regulating energy by wind turbines.

For the practical feasibility further considerations on construction and on material strength of the rotor blades including the moving masses are necessary. Detailed investigation on the energy economic aspects should be done as well.

Automatische Feuchte-Monitoring-Systeme als angewandte IoT-Technologie - Anforderungen und Erkenntnisse

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ABSTRACT: More than 50 % of building defects are caused by unintended water exposure (Balak et al., 2005). Water from rain, condensation and leakages of water installations often go unnoticed for a long period of time and may cause heavy damage in the construction and building facility. An early detection of leaks and increasing humidity in construction parts by automatic humidity-monitoring systems helps to reduce expensive renovation costs.

New technologies, changing use of buildings (continuous cooling in energy saving buildings, more timber constructions) and extreme weather conditions make higher demands on the building envelope and the technical building equipment (water, heating and cooling). New IoT solutions are offering a permanent leak and humidity detection of roofs, facades, bathrooms, basements and building installations bringing an alarm and detailed on a monitoring device (computer, tablet, mobile phone).

The Austrian Building Code OIB Richtlinie 3 RL Pkt. 6, and the Austrian Standards ÖNormen B8110 Part 2, B3691, B3692 and ÖNorm B 2320 impose requirements on the protection against humidity and water. The new "Guideline 2019 for Planning and Implementation of Tightness- and Humidity-Monitoring Systems of Flat Roofs" from the IFD International Federation for the Roofing Trade brings even more details.

Objectives of automatic Humidity-Monitoring System:

- protect the construction and hygienic situation
- protection of functionality and values (monetary, social, cultural)
- early detection of water and humidity to reduce potential damage by predictive building automation

Following Systems are to be distinguished:

- permanent humidity-monitoring or leak detection (temporary)
- systems for new buildings and / or renovation
- area or point detection
- active (automatic monitoring) or passive solutions (manual monitoring)

General requirements for an up-to-date Humidity-Monitoring:

- wide range of application (roof, facade, wet-rooms, basement...)
- simple assembly on building site
- functionality, durability and accuracy (Certification)
- operational reliability

- APP for monitoring on computer, tablet, mobile phone, data integration in local MSR Systems
- detailed data profile for experts, alarm function, data backup
- compliance with standards and codes
- data privacy according local laws (DSGVO in Austria)

Further application of Humidity-Monitoring Systems:

- quality assurance for the principal, building user and tradesmen
- application on building site and during building utilisation
- application for R&D
- new business model for building control and facility management (Smart Building Solution)

Kooperatives Wohnen Volkersdorf – Suffizienz im Areal

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ABSTRACT: Using the example of the jointly planned alternative residential and settlement form "KooWo" in Volkersdorf, sufficiency is to be implemented and the overriding goal of a holistic reduction in energy and CO₂ emissions is to be achieved. The housing project shifts the system boundary from a usable space-based to a person- and social community-based approach and generates per capita savings potential in resource consumption through collective living space.

Within the project, a suitable participation design for the planning and construction process of the KooWo neighbourhood was developed. The integration of all stakeholders (property developers, future tenants, neighbours, community representatives, planners, other stakeholders) should ensure a sustainable integration into the spatial and social environment of the settlement.

The cooperative Die WoGen constructed the buildings on behalf of the association KooWo, where the members are the future users. The buildings are financed by the users' own funds, which are at least partly provided in the form of cooperative shares, as well as by investing cooperative members. The rest is provided by external funds (bank financing).

All decisions are made by the future residents (association "KooWo") on the basis of socio-cratric principles (decisions only on the basis of a consensus of all association members).

The research project funded within the framework of "City of Tomorrow" clearly focuses on the settlement and its inhabitants.

The joint use of the infrastructure, the heat distribution network, the power generation, the workshops, the vehicle fleet, etc. generates a personal and social added value.

The aim was not the cost-intensive autonomous zero or plus energy building, but a connection between different buildings (existing and new) and uses that offer a lively living and working environment. Important is on the one hand, the lowest possible overall balance of primary energy and CO₂ emissions and on the other hand the social functionality that supports this goal from overall energy and ecological point of view.

This is also achieved through the use of ecological building materials and renewable energy supply. In addition, a photovoltaic system with an intelligent energy management system and battery storage should increase the share of renewable energy use on-site.

In cooperation with SIR - Salzburger Institut für Raumordnung und Wohnen (Institute for spatial planning and housing, City of Salzburg), target values were subsequently defined according to the "klimaaktiv" settlement evaluation tool and a klimaaktiv evaluation was created for the settlement under consideration.

The apartments were completed and occupied in the summer of 2019.

Energetisch wirtschaftliche Optimierung von Gebäuden

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ABSTRACT: As research and demonstration projects show, it is already possible to build or refurbish buildings to theoretical nearly zero energy standard or plus energy standard, which in practice also achieve extremely low energy consumption and CO₂ emissions. These projects also show that they have the same or often lower costs over the whole life cycle. However, the broad market introduction of such buildings is progressing slowly, as planning-accompanying methods and processes for cost-effective integration of efficiency measures and renewable energies have not yet been adequately described. Thus, today it is not usual that these methods are used in a normal planning process. As a result, it is criticized - in many inadequately planned buildings quite rightly - that the real energy consumption of highly efficient buildings is above the anticipated demand and that high efficiency standards are too expensive and uneconomical.

The goal is to accelerate the cost-effective integration of efficiency measures and renewable energies in the market. For this purpose, AEE - Institut für Nachhaltige Technologien and the Energy Institute Vorarlberg carried out a joint research project founded by the "Stadt der Zukunft" program of the Federal Ministry of Transport, Innovation and Technology.

Seven example buildings are examined and optimized within a parametric study. For each building, many parameters such as envelope quality, heating system or PV system are varied and all combinations are analyzed. The results on energy demand, CO₂ emissions and economic efficiency are evaluated for the large number of approximately 200.000 variants of all buildings.

A previous study of the Energy Institute Vorarlberg show that the additional cost of measures for nearly zero energy standard or plus energy standard is so low that high-efficiency buildings will incur the lowest cost in the life cycle. These previous results can be confirmed with the present study of seven example buildings. The buildings have different uses like office or residential building, as well as new construction and renovation so the results are not only valid for new residential buildings like in the previous study.

Energy efficiency measures have only a small effect on construction costs, but can save up to 75 % CO₂ emissions. In terms of the whole lifetime of the buildings, these efficiency measures are then usually cost-neutral or even economic. Energy efficiency is therefore not a significant cost driver in construction. Passive house envelope and highly efficient windows are mostly economical even without government aid. This is also due to the long lifespan of these components compared to HVAC elements. The pareto front curves of the cost optima with the live cycle costs and the CO₂ emissions are very flat what means that there is not only one optimum. Therefore, as long as the envelope is very efficient, low emissions and energy requirements can be achieved with different energy concepts. This means architectural and conceptual freedom. It shows that energy efficiency and cost-effectiveness are not opposite strategies, rather can complement one another.

Die Modernisierung von Wohnungen unter Berücksichtigung der Wirtschaftlichkeit

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ABSTRACT: Most studies for the economic evaluation of refurbishment measures for residential buildings lean on energy efficiency or energy savings. From the owner's point of view, the question arises whether and in what form improvement measures that increase the quality or the value of the property are economically profitable. This means in this case already used units, which have a potential of rent increases by improvements. In practice, such investigations are carried out in a detailed level. The owner incurs expenses as a result before he can make the decision to carry out in-depth investigations into possible renovations.

The aim of this paper is an investigation of possible refurbishment measurements on a general level. Only a few input parameters and statistical key values should calculate the economic efficiency. The lifespans of the building substance and its conditions have also be taken into account, to achieve a realistic model. The calculation of the profitability is based on a dynamic investment cost calculation. The empirical survey includes the costs for the improvement measures as well as the additional data, regarding the lifespan and the interest rates. As result the rent differences was carried out on the basis of the defined parameters and the Monte Carlo simulation with 10,000 iterations. The simulation was selected because many of the parameters are subject to uncertainties, as most of these will only be available in the future.

There is no uniform standardisation for the classification of quality standards and conditions for types of use or components. Different sources specify specific criteria. Based on three quality levels and four defined conditions, 24 possible maintenance scenarios can arise for an existing building or component. The results show that the difference of rent is in mean from 2.80 to 4.41 EUR / m² for the different modernization scenarios. The measurements for modernisation based on the statistical values is profitable in those locations and markets where a rent increase of at least this amount can be achieved. The calculated rent differences appear a plausible result, but must be examined on site in each individual case with the respective circumstances. As a discussion it should be noted that in this article all components and technical installations were assumed with the same quality or condition. However, these are often deviate from each other due to maintenance measures already carried out on individual components and therefore they should be assessed individually. The presented approach can take this into account, especially since the qualities, conditions and costs per component are included in the calculation.

EU Level(s) – Vergleichende Analyse des europäischen Berichtsrahmens für nachhaltige Gebäude

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ABSTRACT: This article compares the new European reporting framework for sustainable buildings 'Level(s)' with already existing national sustainability reporting systems DGNB/ÖGNI, TQB and klimaaktiv. Following a general introduction, the content and characteristics of the Level(s) reporting framework are presented. Comparison of the national assessment frameworks with Level(s) is conducted by analysing the overarching macro-goals of Level(s) and the topics/criteria of the national frameworks. A detailed mapping of the national framework's content to the indicators and life cycle tools of the Level(s) framework is presented to identify whether the national assessment frameworks are suitable to report results according to the Level(s) reporting framework. The results show that the DGNB/ÖGNI assessment system is highly suitable to report according Level(s). When compared to the requirements of the Level(s) reporting framework, TQB and klimaaktiv assessment frameworks show need for development on, e.g., inclusion of a full building life cycle assessment as well as analyses related to future climate scenarios and resilience to climate change.

Urbane Energiemodellierung als Grundlage für eine zukunftsorientierte Stadtplanung

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Keywords: Wärmewende, räumliche Energieplanung, Urban Building Energy Modeling (UBEM)

ABSTRACT: Our energy systems are developing rapidly, as are our cities. Climate protection must also be vigorously promoted. In order to shape the necessary energy supply of tomorrow in our cities and regions, all stakeholders must work together within the framework of "spatial energy planning" to tackle the technical and organisational challenges. The research project *EnergyCityConcepts* (www.ecc.aee-intec.at), which is presented in this paper, has dealt with this complex of topics in recent years. In the project work important contributions to the introduction and further development of spatial energy planning in the cities of Gleisdorf and Salzburg was made through the project partners AEE INTEC, Institute of Thermal Engineering at Graz University of Technology, SIR - Salzburg Institute for Spatial Planning and Housing, Research Studios iSPACE / RSA FG, Stadtwerke Gleisdorf and Salzburg AG.

Rethinking Systems for a Circular Economy

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ABSTRACT: The circular economy (CE) concerns rethinking how we design, produce, consume and (re-)use resources, products, services, processes and whole systems that not only work more efficiently than is possible through linear economic models, but also regenerate the natural environment upon which life depends.

Currently, the CE practice focuses on designing biological and materials cycles, but it also impacts the social fabric at large and requires whole-system transformation of the world as we know it, such as, for instance, the development of a new open banking system conceived through society's demand for transparency and achieved through circular thinking on a system level that goes beyond disciplinary, geographic, or cultural boundaries. CE practice encourages an orientation towards collaboration and service instead of competition and ownership –

leading to product and process optimizations that are based on smart knowledge and collaborative information management.

A particular challenge for the CE concept to spread across industries are the constraints of the traditional legal frame that supports the linear economy which, in turn, is based on competition. Therefore, it is difficult to apply traditional laws to the new requirements of transparency and collaboration in CE business models. While traditional contracts and other legal agreements work perfectly well in the existing economic environment, they may not deliver the desired results in a circular economy. The more sophisticated analysis of data extracted from returned parts and materials will need to lead to an even more responsible use of data. While radical thinking is required to turn outdated business models upside down and inside out, a fundamental redesign of the existing legal frame may not be required. Instead, it may suffice to define the differences between the linear and the circular models and use existing tenets to imagine future legal challenges for which traditional frames can simply be expanded.

So, how can we get there? Aligned with the CE framework, processes and tools for systemic collaborative circular innovation exist. Design challenges have changed in scale from products and services used by individuals to networks and whole systems in which actors interact across boundaries. This is to say that on a system level, it is important to become aware of the interrelationships between the parts that form the system, so that the complexity of the situation can be understood and the desired outcomes can be achieved. To understand how communication happens within these networks we might learn from nature—such as, for instance, how ecosystem services are based on intrinsically interconnected and interdependent relationships. The nature-inspired biomimicry thinking innovation process is part of the CE toolbox for circular innovation and provides a roadmap for abstracting nature's strategies into future-fit human-made products, services, processes, and systems that lead to sustainable futures.

Lebenszykluskostenbetrachtungen - die Kühlung von Technikräumen im Koralmtunnel

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ABSTRACT: To achieve the climate goals, the realization of sustainable construction in the construction industry is increasingly topical. Because of the long service life, especially in railway projects, the importance of taking life cycle aspects into consideration in the early planning stage is of major importance. Life cycle costing has gained ground in the assessment of the economic dimension of sustainability. This article presents the use of life cycle cost analysis (LCCA) for decision aid in railway construction. The two tunnel tubes of the

Koralmtunnel (KAT) project are connected by 68 cross-passages at a distance of approx. 500 m. These cross-passages serve as escape routes and additionally as facilities for technical equipment (telecommunication, power supply and remote control). Initial thermal models showed internal temperatures of up to 80° C due to the heat dissipation of the technical equipment without the use of technical cooling systems in the operating phase. This is a consequence of the limitations of the heat transfer with the surrounding rock and the adjacent tube. Hence the installation of a cooling system is required. It is found that higher internal temperatures lead to a shortened lifetime of the installed telecommunication systems. By applying the Arrhenius equation, the influence of room target temperatures on the expected lifetime of the installed telecommunications systems was determined. In order to meet the requirements for the target temperatures, suitable scenarios (different cooling scenarios) were designed. Finally, LCCA was performed using the Net Present Value (NPV) method to determine the most economical solution for cross-passages cooling systems based on selected target temperatures.

End-of-Life Management of Si-Wafer Based Photovoltaic Panels and its Effect on Sustainability Assessment

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ABSTRACT: In den letzten Jahren gab es weltweit einen großen Anstieg hinsichtlich der installierten Kapazität an Photovoltaik (PV). Während die Gesamtkapazität im Jahr 2000 1.5 GW betrug, waren 2018 bereits über 500 GW installiert. Prognosen gehen davon aus, dass diese Entwicklung auch in Zukunft anhalten wird (4.500 GW bis 2050). Damit verbunden ist auch ein Anstieg der zu behandelnden Mengen an End-of-Life (EOL) Modulen. Diese Thematik wurde bisher kaum wahrgenommen, da die aktuell anfallenden Abfallmengen noch gering sind. Um auf den zukünftigen Mengenanstieg gut vorbereitet zu sein, ist es allerdings sinnvoll sich schon jetzt mit den verschiedenen Aspekten des EOL Managements auseinanderzusetzen. Mittels Literaturrecherche und Stakeholder-Befragung wurden die aktuellen rechtlichen und technischen Rahmenbedingungen bzgl. PV untersucht. Hierbei zeigt sich, dass die EU mit der Integration von PV Modulen in die WEEE-Richtlinie eine gute Grundlage für das EOL Management geschaffen hat. Basis dafür ist das in der Richtlinie enthaltene Prinzip der erweiterten Herstellerverantwortung. Vergleichende Betrachtungen in verschiedenen Mitgliedsstaaten (Österreich, Deutschland, Italien) zeigen allerdings, dass es in der praktischen Umsetzung teilweise große Unterschiede gibt. Außerhalb der EU gibt es aktuell noch keine Regelungen für diesen Bereich. Aus technischer Sicht, haben sich bisher noch nahezu keine spezialisierten Anlagen für das PV Recycling etabliert. Heutzutage erfolgt die Behandlung von EOL Modulen daher primär in anderen abfallwirtschaftlichen Anlagen. Als besonders geeignet, bedingt durch die Tatsache, dass der mengenmäßig größte Anteil der Module Glas ist, hat sich dabei der Prozess des Flachglasrecyclings herausgestellt. Hier wird aus dem PV Abfall durch Zerkleinerung und anschließender mechanischer Trennprozesse (Siebung,

Wirbelstromscheidung, etc.) eine möglichst reine Glasfraktion gewonnen. Zusammen mit den Produkten der manuellen Vorbehandlung (Alurahmen, Anschlussdose und Kabel) ist es möglich die rechtlichen Vorgaben bzgl. Verwertung zu erfüllen. Weiterführende Recherchen zeigen, dass es in den letzten Jahren eine Vielzahl an Forschungsaktivitäten bezüglich alternativer Behandlungsmethoden gegeben hat. Der erste und zentrale Schritt dabei ist die Auftrennung des Verbunds durch Entfernung des Einkapselungsmaterials. Dies kann über mechanische, thermische oder chemische Prozesse erfolgen. Erste Ergebnisse sind vielversprechend, allerdings bedarf es in Zukunft noch weitere Untersuchungen um eine Umsetzung auf kommerziellem Level zu ermöglichen. In diesem Zusammenhang wird es auch wichtig sein belastbare Daten über die unterschiedlichen Behandlungsoptionen zu gewinnen. Dabei handelt es sich um Input- und Outputspezifikationen der einzelnen Verfahren sowie (im Hinblick auf den Nachhaltigkeitsgedanken) um mit den Prozessen verbundenen Umweltauswirkungen. Diese Informationen ermöglichen zum einen den Vergleich verschiedener Recyclingoptionen untereinander sowie zum anderen die Integration der EOL Phase in die Nachhaltigkeitsbewertung von PV im Allgemeinen. In vielen bisher durchgeführten Untersuchungen wurde diese nicht berücksichtigt, da keine belastbaren Daten vorhanden waren. Allerdings ist erst bei Mitberücksichtigung eine ganzheitliche Bewertung möglich, welche bspw. auch einen fairen Vergleich mit anderen Energietechnologien erlaubt.

Sekundärressourcen aus Photovoltaik, Windturbinen und E-Autos

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ABSTRACT: The recycling of photovoltaic (PV) panels, wind power plants, and electric vehicles will gain importance in future considering the fact that such products contain valuable resources. The implementation of these product groups has been dynamic and they are likely to enter markets even more drastically if national pledges to achieve the climate change targets in the Paris Agreement are taken seriously. However, not much attention has been set on the recyclability potential of these product groups. With regard to the circular economy in Europe, the recovery of secondary raw materials (SRM) is desirable but in practice often hindered due to economic reasons.

From a resource point of view, PV plants seem to be interesting due to the following aspects: high amounts of laminated glass and valuable resources, particularly critical raw materials contained in PV panels (e.g. semiconductors and precious metals) but also in battery systems to increase power self-supply (e.g. lithium-ion battery), inverters (e.g. printed circuit board) as well as cable and wiring (e.g. copper). A critical resource which is used in wind power plants is neodymium, which is economically attractive but also the copper-wiring in the generator is

of interest for recycling processes. The biggest share in wind turbines has though the steel tower with up to 50 mass-%. Moreover, the most relevant component in electric vehicles is the heavy battery system which is interesting for recycling not only because of the resource point of view (e.g. cobalt, copper, nickel) but mainly due to safety reasons (risk of releasing hazardous substances or thermal runaways in case of improper disposal). The electric motor plays also a significant role, as it contains the critical resource neodymium.

This presentation gives an overview on the composition of photovoltaic panels, wind power plants, and electric vehicles and their relevance for recycling in view of a circular economy and sustainable thinking. Existing recycling technologies are shown and their potential to increase resource efficiency discussed. The presented project aims to develop a database for recyclables that is in turn the basis for macroeconomic modelling which will be conducted by the Austrian Institute of Economic Research (WIFO).

Scanning, data capturing & visualization for Integrated Resource Management

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ABSTRACT: Resource scarcity, sustainability challenges within the construction sector, as well as stricter legislations on the efficient use of resources and on environmentally sound waste management practices instigate companies and organizations in the fields of Architecture/Engineering/Construction (AEC), Facility Management (FM) and Deconstruction to manage resources effectively over the entire lifespan of a building, including its end phase - the demolition stage. In industrialized countries, the amount of built-in resources already exceeds the quantity of useful resources occurring in natural deposits. Buildings and infrastructure, therefore, represent valuable material stocks for recovery-oriented dismantling. At the same time, however, in order to guarantee clean material cycles, contained pollutants need to accordingly be discharged and directed into dedicated sinks. For the protection of human health and the environment it is crucial to free accruing demolition waste from any contaminated building components before it undergoes further reuse or recycling procedures. In Austria, the state of the art approach to the identification and the controlled separation of potentially contaminated construction waste from valuable building materials, for demolition projects with more than 750 tonnes of demolition waste, is the so called pre-demolition waste audit; a procedure involving an investigation of pollutants and impurities in buildings prior to their demolition. One of the many objectives of this conduct is the quantification of waste qualities to be expected in the course of demolition work. Here, building material-related mass estimations of anticipated waste qualities are usually derived from the evaluation of not only on-site but also considerable off-site investigation results. The reliability of the assessment,

therefore, significantly depends on the availability of appreciable documentation records. For many existing buildings, however, sufficiently accurate information about their true geometrical structure or their actual material constitution is missing. Situations of this kind lead to mass estimates fraught with high uncertainties, leading to potential cost increases for waste management. In order to optimize the steering of material flows, the Austrian engineering consultancy RM Umweltkonsulten ZT GmbH, as an affiliated partner of the joint research project "SCI_BIM – Scanning and data capturing for Integrated Resources and Energy Assessment using Building Information Modeling" funded by the Austrian Research Promotion Agency (FFG) [Stadt der Zukunft programme, grant number 867314], has developed a potent tool, intended to be provided as a service in the near future. Defined as a mechanism for the quantitative and qualitative documentation of waste qualities and, in particular, localized pollutants in structures, it is able to combine the use of innovative low-tech geometry acquisition systems with a tailor-made transformation process that converts 3D scans into models designed with Building Information Modeling (BIM) technologies. In parallel, the company's proprietary Web-based geoinformation system (WebGIS) has been refined correspondingly, now supporting centralized model embeddings, digital depositions of chemical quality assessments, as well as automated generations of volume and mass estimates.

Thermochemische Behandlung einer organikreichen Feinfraktion

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ABSTRACT: Owners of bio-mechanical treatment processes might face legal emission limitations which also affect the costs of operation of such facilities. Therefore the project *Waste2Material* – funded by EFRE – takes a deeper look at a pyrolytic process for the treatment of such a waste material stream with high content of organic compounds.

On the site of Umweltdienst Burgenland a bio-mechanical treatment process produces a stream of a waste material with a particle size of <25 mm. Currently this material passes an intensive rotting before it ends in a landfill. In pretests the material has been analysed on the potential to be treated in a pyrolytic process as an alternative to the bio-mechanical treatment. The first trial on a large scale pyrolytic process showed that the management of the process could be performed with only minor difficulties and satisfying results in general. The paper gives insights how the first series of test was performed and conclusion been drawn for the next tests.

Carbon Monoxide Emission Models for Small-Scale Biomass Combustion

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ABSTRACT: Rising legal emission limits require means to prevent the release of harmful substances into the atmosphere during the combustion of biomass. Economic considerations suggest to meet these restrictions by improving the ability to predict and therefore prevent emissions before they are formed. This information can be used by a process controller or for fault detection of sensors. In order to make such predictions, qualitative models of the complex thermo-chemical reactions of the combustion process have to be found. This is a difficult task and often has to be done for each furnace individually. The application of flue gas emission models based on mass balances or kinetic approaches is however often restricted, because constant knowledge of the fuel composition and the fuel flow entering the system is necessary, which is usually not standard. Partial differential equations may offer the wanted process descriptions, but are typically too complex for an implementation. A potential solution is to use data driven or black-box models, which are based on measured input and output data. Any available measurement or signal can directly be used as an input to describe a specific output and therefore to identify a model for the prediction of different species in the flue gas.

In this work, a black-box model is introduced and compared with a neuronal network for the prediction of CO emissions based on measured data from a small-scale biomass combustion furnace (100 kW).

Effizienzsteigerung von Wärmenetzen durch sorptionsbasierte Wärmeübergabestationen

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ABSTRACT: This study focuses on existing district heating systems with common operating temperatures of the networks (above 120,0 °C), which may need to be expanded or which are newly installed. With the investigation, the influence of a low return temperature is

demonstrated by means of heat losses on one hand, and the electrical energy consumption of the network pump on the other hand. In order to reduce these two key performance indicators and thus increase the efficiency of district heating supply systems, a new heat transfer technology based on a water-lithium bromide absorption cycle is presented. The main idea behind this transfer technology is to guide the primary network flow through an external heat exchanger after it passed through the desorber and thus raises the fluid in the consumer circuit to a higher temperature level. After that, the district heating fluid flows through the evaporator of the absorption cycle to vaporize the refrigerant and reduce the return temperature of the grid, respectively. In order to investigate this new technology and compare it to conventional heat transfer stations, a semi-empirical process model is developed using the commercial simulation software IPSEpro[®]. Subsequently, a MATLAB[®] coupling is used to apply the recorded measurement data (primary hot water temperature and heat load) in equidistant time steps as boundary conditions to the numerical model. In addition to the quasi-stationary calculations, stationary parameter variations with regard to the primary hot water temperature and the temperature levels in the consumer circuit are carried out and analysed. The Results show that the heat losses and the energy consumption for pumping of the district heating grid can be reduced by lowering the primary return temperature. In addition, this results in a reduction of the primary mass flow, which in turn leads to an increase in network capacity.

Die Anwendung der thermodynamischen Transformation im Fernwärmesektor

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ABSTRACT: The starting point is district-heating with conventional supply temperatures that already exist or that need to be expanded or newly constructed. The aim is to use an innovative sub-station concept to cover a bundle of energy-services (not only heating but also cooling, reduction of primary side return temperature and even power production).

The proposed concept ("exergy transformer"), patented to a large extent, uses unit operations from the absorption technology and is supposed to reach the targets by shifting operational conditions within the unit operations and by novel flow sheets.

Numerous thermodynamically simulations prove, that the proposed concept is flexible and energy-efficient. In case of the co-generation of heat and chillness an overall degree of utilization above 100 % or a reduction of return temperature below 40 °C seems reachable.

Additionally, exergetic evaluations confirm the thermodynamic improvement against conventional solutions. Thus, the proposed concept can enhance the contribution of district heating to reduce emissions, losses, to substitute fossil fuel use and to increase annual utilization.

The exergy transformer could be a useful link when different sectors of processes are intended to be coupled in order to conserve energy.

The instant feasibility study started with the proposed promising concept and proves the concept by means of thermodynamic simulations and plausible considerations. Further experimental developments and industrial research work should increase the technology readiness level of the concept.

Selbstlernendes Empfehlungssystem zur Steigerung der Behaglichkeit.

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ABSTRACT: Within the project „Empower Citizens“ technical as well as social and health aspects are combined in order to increase the subjective comfort inside a flat with respect to room temperature, CO₂ concentration, humidity, and so forth. Therefore, a low-cost system advisory system is developed which reads the aforementioned data from sensors situated in the different rooms of a flat. Using these measurements advices are given in order to increase the resident's comfort. The advices are based on the computation of the so-called predicted mean value (PMV) which aims at capturing the comfort with respect to different parameters, e.g., age, body weight, and height.

To achieve this goal, first, a co-simulation using Matlab and IDA-ICE was conducted utilizing a detailed model of the investigated flat. The model is split into two different zones, living room and bedroom, where a zone is defined through the presence of dedicated sensors inside the zone. The sensor data are transmitted to a central station, which reads also outside temperature and humidity, and form the basis for the PMV computation. If the PMV exceeds pre-defined limits, an advice is given, either to open a window or the shadow a window. Additionally, an advice is output if the CO₂ concentration is too high. Furthermore, the advisory system is capable of learning how well the given advices are followed by the resident. Thus, the total number and the times at which advices are output can be flexibly adjusted by the system itself to optimally suit the resident's fondness for following the advices.

To evaluate the developed advisory system a parameter study was conducted evaluating different reference cases with respect to the parameters affecting the PMV calculation, e.g.,

age and bodyweight. Additionally, different motivations to follow the given advices were modeled within these reference cases. The simulation results prove that following the advices given by the advisory system leads to increased comfort for the residents while keeping the increase in energy demand for heating occurring from more ventilation to a minimum. Additionally, the study shows that ventilation only in the morning results in high CO₂-concentrations heavily influencing the resident's comfort.

Furthermore, this study presents a first easy-to-install hardware prototype comprised of a RaspberryPi 3B+ and an ARDUINO MKR1000 where the developed algorithm for the advisory system can be deployed. This prototype includes also the required sensors to monitor room temperature and CO₂ concentration. In order to output the computed advices, it is equipped with an LCD display acting as human machine interface.

Making smart devices really smart - A design guideline for networked household products with reduced standby energy consumption.

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ABSTRACT: The proliferation of "smart technologies" becomes visible with more network connected devices in modern households. Such devices require a network connection, which demands the network modules to be active at all times, leading to additional energy consumption even during periods of inactivity - so called "network standby". This research investigated the network standby power consumption of connected products in Austrian households, by selectively conducting power measurements and comparing the results with the regulatory requirements of the EU Ecodesign Directive for Network standby. Modems, game consoles, network printers, home gateways, smart lights, smart plugs, and home (audio) assistants, were investigated. The results show that there is potential to optimize the EU regulatory framework, as well as for product improvements. Therefore, a guideline for the design of networked devices with reduced standby energy consumption was developed.