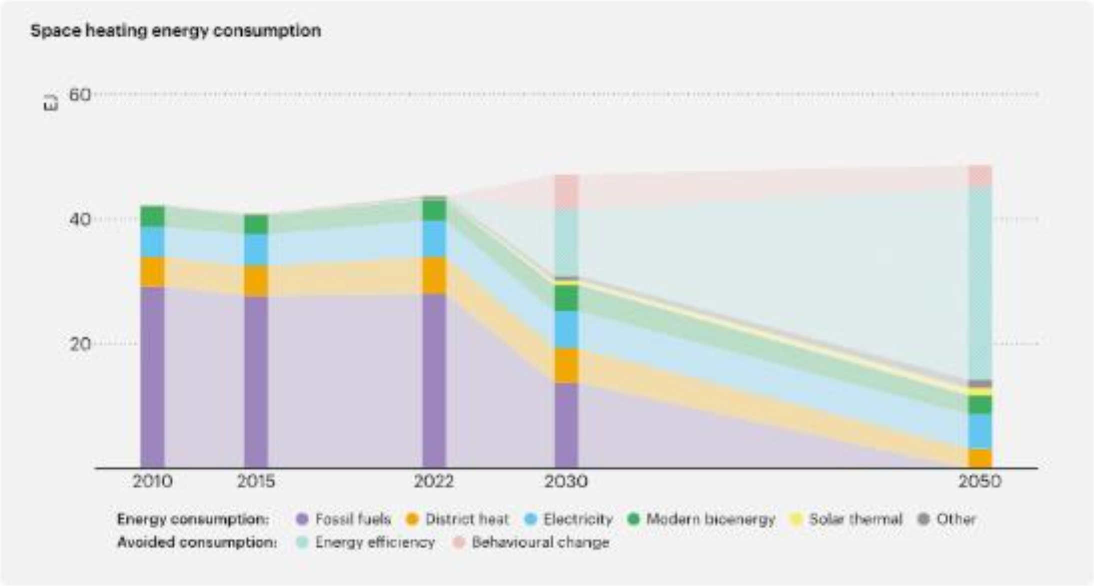
Simulieren, Optimieren, Profitieren: Gewissheit für Bauherren

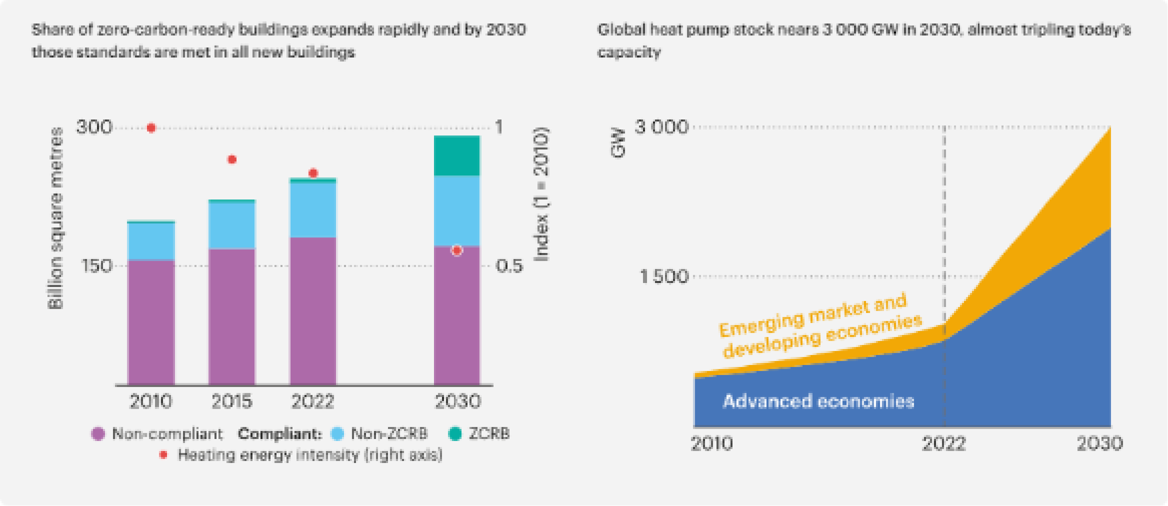
Gebäudesimulation Schweiz
Und Sie wissen was Sie bauen!

EQUA

Swissbau, 17. Januar 2024

IEA Energy report buildings 2023

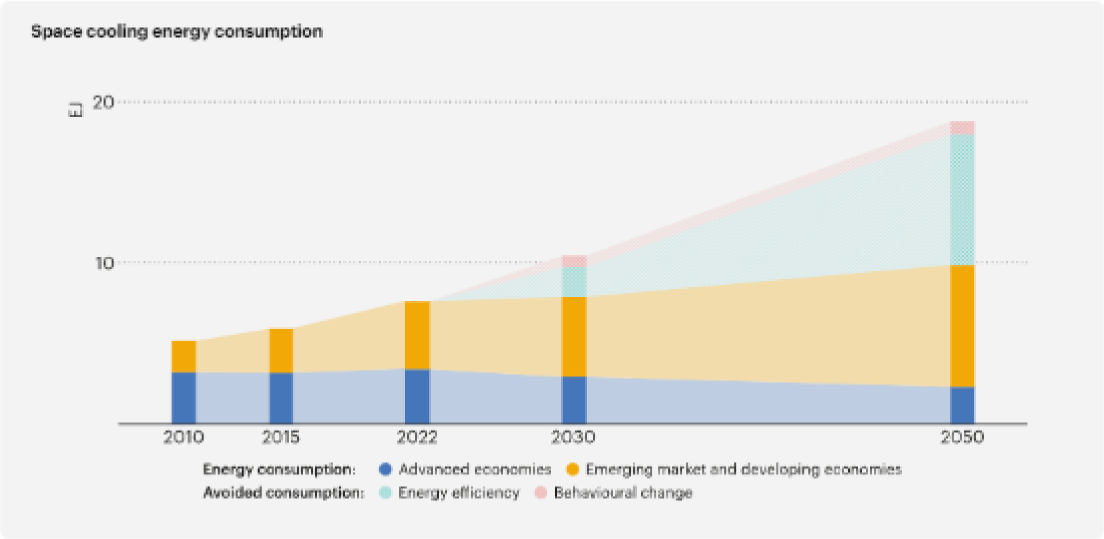


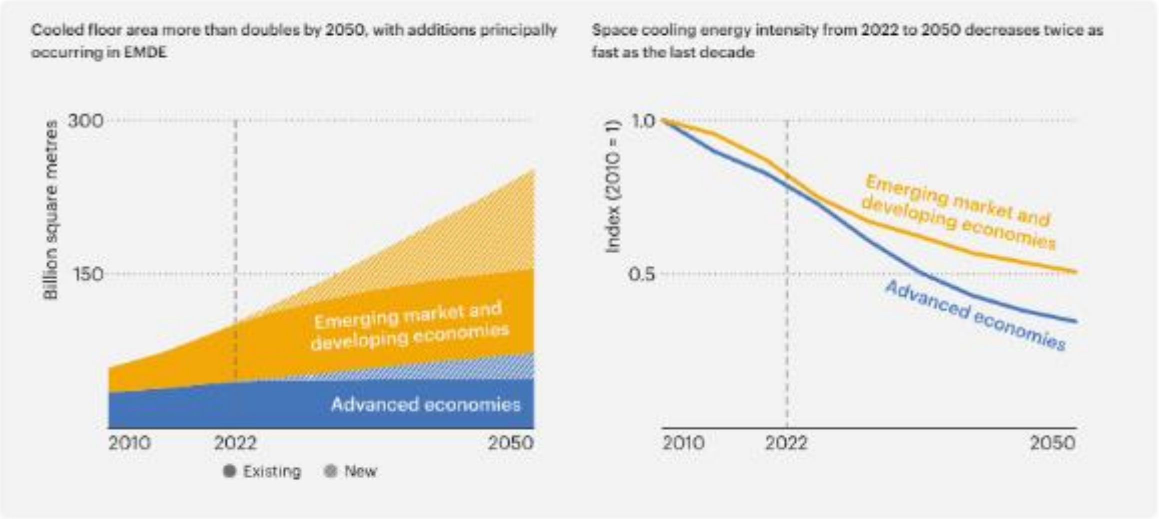


Milestones	2022	2030	2035	2050
Heat pumps installed in buildings (GW)	1 000	3 000	4 400	6 500
Share of space heating service demand met by heat pumps	12%	25%	40%	55%
Share of buildings that are zero-carbon-ready				
In new buildings and deep renovations	<1%	100%	100%	100%
In existing building stock	<5%	20%	35%	80%
Retrofit rate in advanced economies	<2%	2.5%	2.5%	2.5%
Heated floor area (billion square metres)	157	170	180	200

Quelle: https://www.iea.org/reports

IEA Energy report buildings 2023





Milestones	2022	2030	2035	2050
Cooled floor area in buildings (billion square metres)	105	140	170	250
Share of households with air conditioners	36%	45%	50%	60%
Installed capacity of space cooling equipment (GW)	850	1 400	1 750	2 700
Share of space cooling in final electricity consumption	9%	7%	6%	5%
Share of buildings that are zero-carbon-ready				
In new buildings and deep renovations	<1%	100%	100%	100%
In existing building stock	<5%	20%	35%	80%
Share of buildings that are zero-carbon-ready	3.5-4.5	5.0-6.5	6.5-8.0	7.5-9.0

Quelle: https://www.iea.org/reports

TCPs strategic vision on IEA Net Zero by 2050's buildings milestones to 2030

1. Markterschliessung und Standards:

- Aktualisierung von Bauvorschriften, Zielsetzung „Zero-Carbon-Ready Buildings (ZCRB)"
  - **CO2-Performance** Indikatoren
  - **Smart-grid** Readiness Indikatoren
  - **Verbindliche Anforderungen im Bestand**
- Verbesserung Durchsetzung und **Überwachung der Einhaltung von Bauvorschriften**
- EMS und Kommunikationsprotokolle: **Gebäudeperformance- Monitoring** an Akteure (Nutzer, Eigentümer, Netzbetreiber, etc.)
- Marktbedingungen für Erneuerbare: Verbot von nicht-erneuerbaren, **flexible Preisgestaltung**, **Optimierung** Interoperabilität zw. **Gebäuden und Netz**

Quelle: https://www.iea.org/reports/technology-and-innovation-pathways-for-zero-carbon-ready-buildings-by-2030/conclusions#abstract

TCPs strategic vision on IEA Net Zero by 2050’s buildings milestones to 2030

2. Ökonomische und finanzielle Instrumente

- Saubere Energie zur kosteneffizientesten Lösung machen (Besteuerung, CO2-Gebühr, Subventionen, etc.)
- Saubere Technologien als Teil von Renovierungsplänen vorschreiben
- Kaufanreize für saubere Technologien
- Einführung von **Handelstarifen auf Quartiersebene** (Strom und Wärme)
- Förderung **Cross-Selling** von Energie, **Echtzeit**auktionen, Angebote für Produzenten und Käufer
- Leasing von Technologien (z.B. PV)

3. Ausbildung und Training

- Schulung und Förderung von Fachpersonen
- Internationaler Wissensaustausch

Quelle: https://www.iea.org/reports/technology-and-innovation-pathways-for-zero-carbon-ready-buildings-by-2030/tcps-strategic-vision-on-iea-net-zero-by-2050-s-buildings-milestones-to-2030

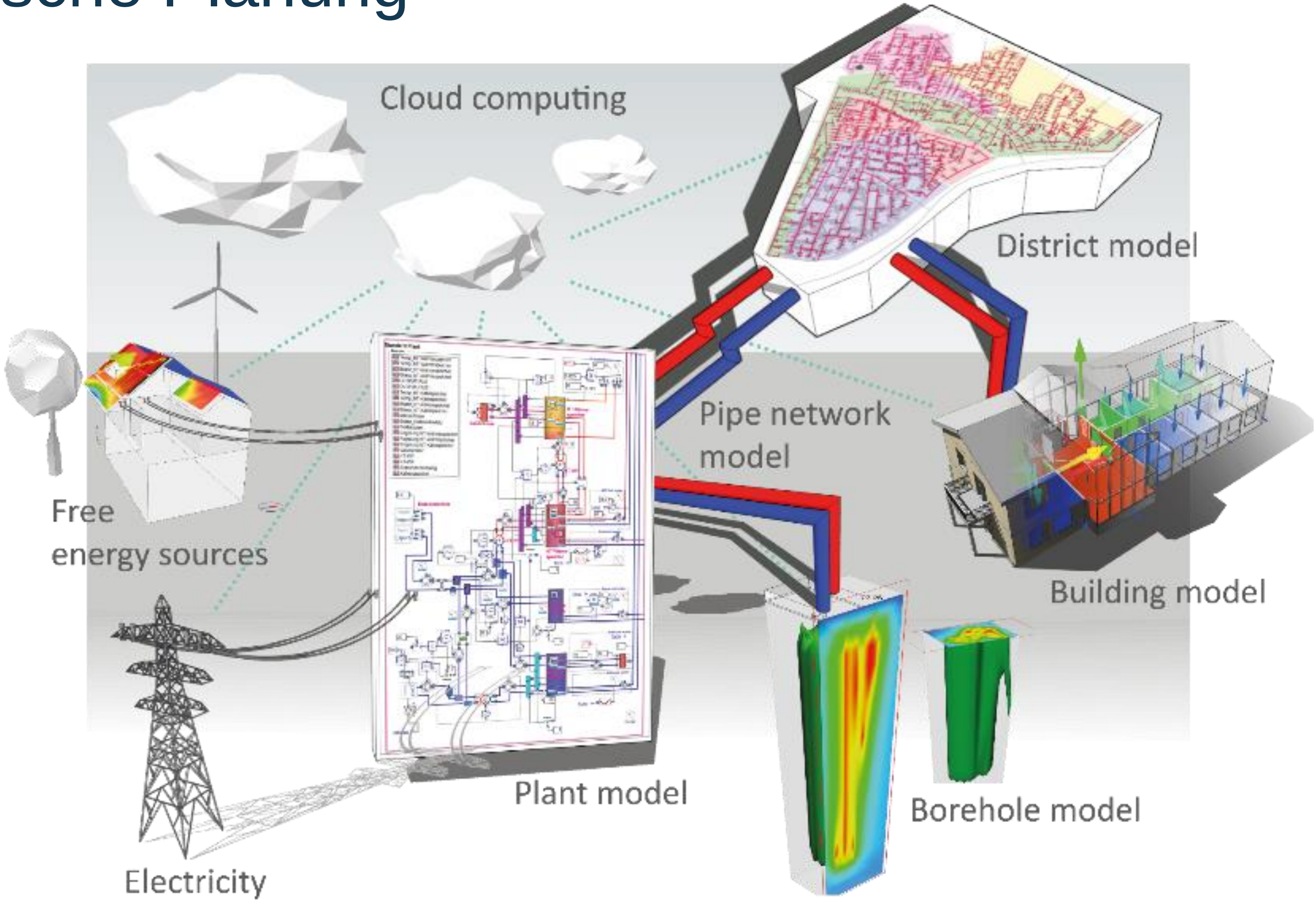
TCPs strategic vision on IEA Net Zero by 2050’s buildings milestones to 2030

4. Entwicklung von Planungswerkzeugen

- Integrierter und ganzheitlicher Ansatz in der Planung:
  - Integration von sauberen Technologien (**Solarthermie, PV, passive Strategien, Wärmepumpen, Wärmenetze und Mobilität, etc**.) in reguläre Planungspraktiken.
  - Tools, die Energieeffizienz, emissionsarme Technologien und **flexiblen Betrieb auf Gebäude- und Quartiersebene** kombinieren.
  - Initiierung von (georeferenzierten) Datensammlungskampagnen zu **Datenerhebung und-Verarbeitung in der Planung**
  - Integration der Gebäude in die Energieinfrastrukturplanung:
    - **Dezentrale Wärme- und Stromnetze, Nutzung Abwärme und erneuerbare Energien**
    - Ausbalancierung von **Speichersystemen**
    - Gewährleistung **langfristige Planungssicherheit**

Quelle: https://www.iea.org/reports/technology-and-innovation-pathways-for-zero-carbon-ready-buildings-by-2030/tcps-strategic-vision-on-iea-net-zero-by-2050-s-buildings-milestones-to-2030

Dynamische Planung



Dynamische Planung

- Änderung EBPD-Entwurf, 14.März 2023

„Ferner sollten die Mitgliedstaaten Architekten und Planer in die Lage versetzen und dazu anhalten, bei Planung, Entwurf, Bau und Renovierung von Industrie- und Wohngebieten die optimale Kombination von Energieeffizienzverbesserungen, Nutzung von Energie aus erneuerbaren Quellen und Einsatz von Fernwärme und -kälte angemessen in Betracht zu ziehen***, unter anderem durch den Einsatz von 3D-basierten Modellierungs- und Simulationstechnologien***.“

„*„Verzeichnis der Energierichtwerte für Gebäude“ … im Laufe der Zeit und im Vergleich mit ähnlichen Gebäuden oder im Vergleich mit den Modellsimulationen eines Referenzgebäudes, das gemäß einer bestimmten Norm (wie den Mindestvorgaben der Gesamtenergieeffizienz) gebaut wurde, veröffentlicht werden;*“

„***Die Mitgliedstaaten setzen sich für die Verwendung von digitalen Technologien für die Analyse, Simulation und Verwaltung von Gebäuden ein, auch im Hinblick auf umfassende Renovierungen.***“

Quelle: https://www.europarl.europa.eu/RegData/seance_pleniere/textes_adoptes/definitif/2023/03-14/0068/P9_TA(2023)0068_DE.pdf

Dynamische Planung

- SIA 380/2 (Bilanzierung nach SN EN ISO 52 000-1:2017)

> „Damit vereinigt die Norm alle Faktoren, die einen Bezug zu dynamischen Berechnungen haben. Sie fordert eine Berechnung im Zeitschritt von einer Stunde oder weniger, verlangt aber – in Abweichung von den Europäischen Normen – kein spezifisches Rechenverfahren"

> „Das heisst, dass in der Planungswelt zunehmend etablierte und für den Planungsprozess verwendete Gebäudesimulationsprogramme ausdrücklich zugelassen sind. Das ist nicht neu, es werden dafür jedoch aktualisierte Bedingungen gestellt. Deren wichtigste ist das Bestehen einer Validierung."

Quelle: https://www.espazium.ch/de/aktuelles/neue-normen-sia-380-und-sia-3802, Prof. Gerhard Zweifel, Präsident der SIA-Kommission für Gebäudetechnik- und Energienormen (KGE), Sachbearbeiter SIA 380 und 380/2, Projektleiter SIA 4010

Projektbeispiel: Gebäudetechnik

Schulhaus Ettelbrück

Challenge

- The client's directive was to assess the near-zero energy school building in terms of its complex control system and the interaction of all systems to ensure optimal functionality.
- The extensive building control system incorporates a hybrid ventilation concept, addressing both CO2 ventilation and the necessary thermal ventilation in summer.
- The central staircase serves a dual purpose as an exhaust duct for both natural and mechanical ventilation. Classrooms and offices are supplied with air from interconnected corridors through fans, maintaining pleasant temperatures and air quality. The system relies on reheat coils in the supply air, striking a balance between energy efficiency and occupant comfort.

Solution

- The ventilation concept hinges on a sophisticated building control system, seamlessly integrating various control strategies, building dynamics, and occupant needs. Key features include:
- Window Ventilation: Adjusts based on ambient conditions and occupancy (CO2-Level).
- Overflow Fans: Regulates for effective cooling, heating and CO2-ventilaton
- Mechanical Airflow: Controlling airflow rates for corridors on each floor based on various factors, e.g. ambient temperature, ventilation need in adjacent zones

Results

- **Control Strategy Enhancement: Rigorously verified and optimized control strategies for ventilation, heating coils, and the entire plant, resulting in heightened system efficiency and performance.**
- **Natural Ventilation Precision: Successfully calibrated and adjusted window opening sizes, enhancing the effectiveness of natural ventilation while maximizing energy efficiency.**
- **Building Services Optimization: Optimized critical building services, including an air-to-water heat pump and reheat coils, ensuring optimal functionality and resource utilization.**

Engagement summary

Project type: New construction

Type of study: Educational, whole-building study, extensive study of controls and HVAC systems

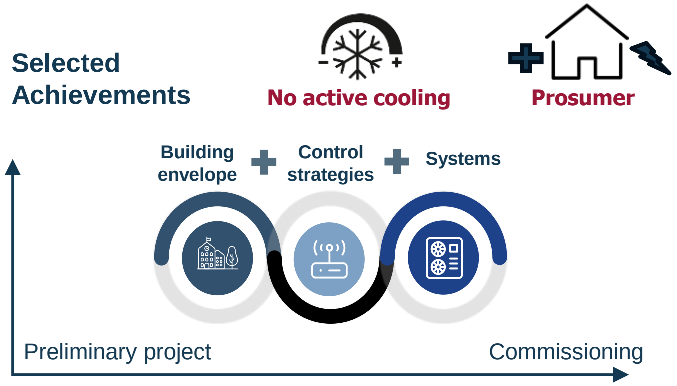
Scope: 1 standard floor

Number of thermal zones: approx. 80

Client: Betic

Image of Ventilation air flows in the simulation model

Selected Achievements



MINERGIE-P-ECO®

Projektbeispiel: Wärmenetze

Buttenheim District

Challenge

- The design and control of a low temperature, borehole coupled, district heating and cooling (DHC) network with heat pumps in each building was to be studied
- Each sub system had previously been sized by traditional methods. EQUA was to verify the design and study the full interconnected system for present as well as future climate scenarios
- The benefit of summertime thermal regeneration of the borehole field by fan powered air to brine heat exchangers was to be studied

Solution

- The district has eight identical multifamily and 79 identical single-family buildings. Detailed IDA ICE models of both types were first developed, and these were subsequently used to calibrate simplified building models
- The final system model represented the DHC pipe network model, the central pumping and heat exchange plant, and 87 simplified building models, each with a separate heat pump system for serving underfloor heating and domestic hot water (DHW).
- The 108-borehole model was simultaneously co-simulated on a separate core

Results

- **The model was primarily used to size the piping and pumping system, to develop initial control and monitoring principles, and to study the impact of borehole field summertime regeneration**
- **The PV potential of the buildings were also studied as well as the system performance under likely impact of future global warming**
- **The model itself can also be used by the client to study alternative configurations of the system and its control**

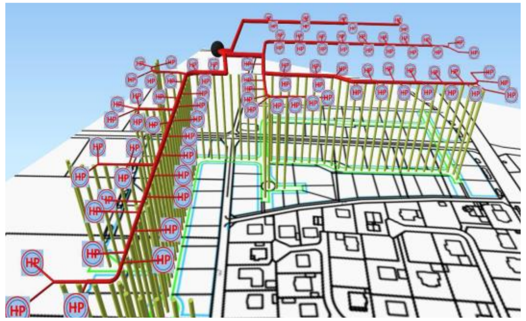
Engagement summary

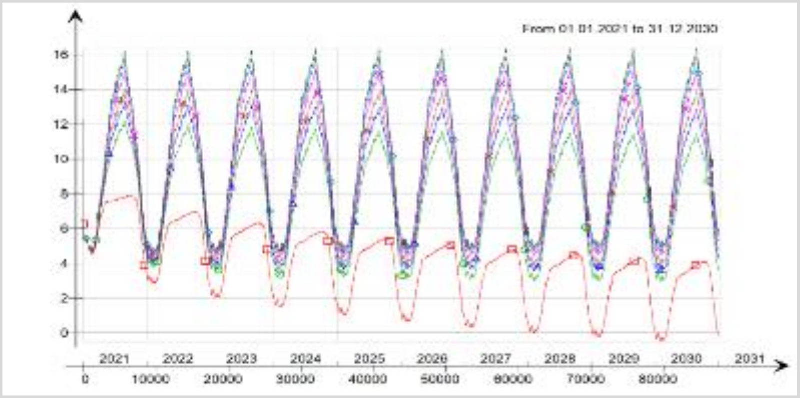
Project type: District-level construction project

Type of study: 5th generation district heating, district level building simulation, borehole heat extraction & storage

Scope: 87 building-district with a low temperature district heating and cooling ("DHC") network connected to a 108-hole ground heat exchanger

Client: Naturstrom AG





Mean borehole heat exchanger field temperature depending on the design power of the regenerator

Selected Achievements

- The model can be used by the client to study alternative configurations of the systems and its control
- Study of system performance under likely impact of future global warming
- Determination of the PV potential of buildings

Projektbeispiel: Gebäudeperformance

EQUA. Gebäudesimulation Schweiz

Mall of Scandinavia

Challenge

- The Mall of Scandinavia is one of the largest shopping centers in Scandinavia with around 200,000 m2 of retail outlets and an additional 100,000 m2 of indoor parking garages.
- EQUA was commissioned to build the energy model for national energy code compliance as well as for the energy credit for the BREEAM label.
- The shops are supplied by a temperature controlled VAV-system. Air is then exhausted from the mall concourse.

Solution

- The IDA ICE model was automatically generated based on an IFC-model.
- Zone templates containing heating and cooling set-points, heat loads, schedules, air-flow rates and flow control type were automatically selected based on IFC space types.
- The model was decoupled into multiple substructures, each running on a separate core to increase simulation speed.
- The exhaust air from the mall concourse was pressure-controlled with openings between the shops and the concourse.

Results

- **The model was used to test different approaches to recover heat from the return air and to size the cooling equipment.**
- **The model had over 1000 zones and took a few hours to run. The control of the temperature and pressure controlled VAV-system was designed and verified using the model.**
- **Both optimisation and sizing was achieved, as well verifying the energy use for the Swedish building code and the BREEAM energy credit.**

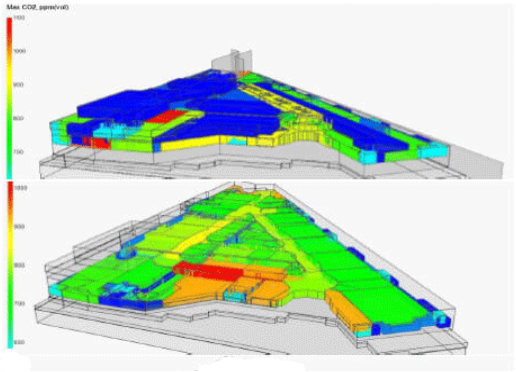
Engagement summary

Project type: Whole-building studies, code compliance, labels and standards

Type of study: Energy performance, Certification

Scope: 200 000 m2 shopping mall with over 1000 zones was simulated, using IFC and parallelization.

Client: PEAB



Zone templates containing heating and cooling set-points, heat loads, schedules, air-flow rates and flow type control

Selected Achievements

BREEAM – A CODE FOR A SUSTAINABLE BUILT ENVIRONMENT – DGBC

Projektbeispiel: Gebäudeperformance

Frankfurt Airport

Challenge

- The client's objective was to develop a strategy for the reduction of the energy consumption of Terminal 2. The annual cost for heating, cooling and ventilation of the Terminal was EUR ~6m
- The client was under the assumption that most of the energy is consumed in the large passenger hall
- However, EQUA proposed an extended study to encompass the entire terminal building, including 4 levels of underground operational areas such as baggage handling, to ensure that potentially critical areas were not missed, and that the full energy balance of the building was captured

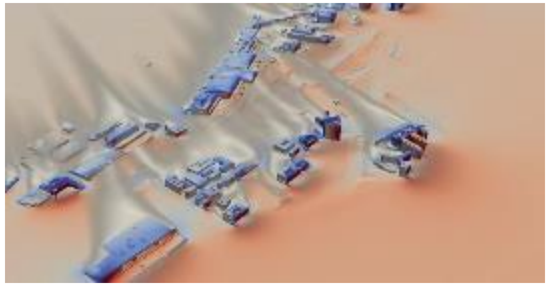
Solution

- An IDA ICE model with 174 thermal zones was created which contained, dozens of air handling units, measured passenger distribution figures, thermal bridges from thermal imaging of the building envelope, etc.
- IDA ICE CFD studies were used to determine pressure distribution around the building
- The IDA ICE model was calibrated against measured monthly energy consumption data

Results

- **The findings supported the decision to model the entire Terminal 2 building. The energy savings potential in the operational areas was of the same magnitude as that of the passenger hall**
- **All in all, a savings potential of 50% was established**
- **This was mainly achieved through the adjustment of supply temperatures and improved volume flow controls in the air supply of the building**

Engagement summary



Project type: Refurbishment project

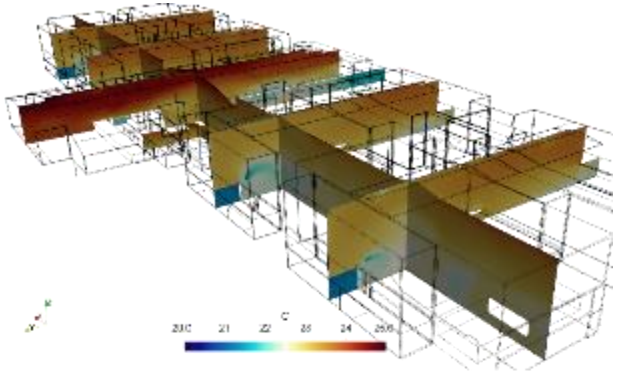
Type of study: Transport sector, public building, energy retrofit, mechanical ventilation

Scope: Entire terminal 2 building (Incl. 4 levels of underground operational area)

Number of thermal zones: 174

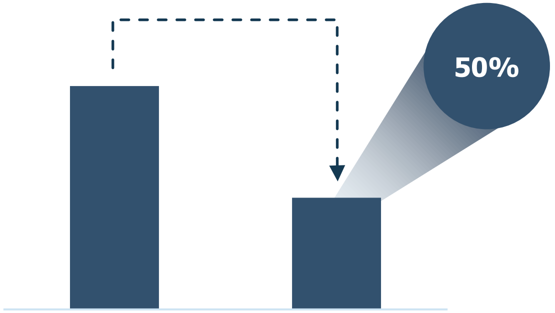
Client: Fraport AG

Image of the CFD studies



Selected Achievements

Energy savings potential



Projektbeispiel: Komfort

Office Tower

Challenge

- The client aimed to secure certainty in the planning process concerning thermal comfort in a fully glazed office tower.
- A typical floor comprises a central area with bathrooms and circulation spaces. Individual and group offices, along with meeting rooms, are positioned along the exterior facade.
- The core area of the building is not conditioned. The office spaces are equipped with component cooling and low-temperature radiators. The mechanical ventilation system features a rotary heat exchanger, mixing box, heating and cooling coils, as well as supply air humidification.

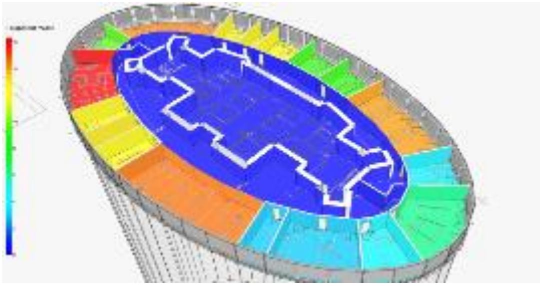
Solution

- A model of a typical floor with 25 thermal zones including the room-level heat and cold distribution systems, as well as the central ventilation units. was created in IDA ICE.
- In the simulation model, a control system for water-based room cooling and ventilation was developed and evaluated. Peak shifting was implemented to pre-cool building masses during the night, thereby increasing the thermal storage capacity of the components during the day. This allowed meeting the comfort requirements.

Results

- **The results of the study have demonstrated that comfort is ensured throughout the entire year. This was made possible solely through the control strategy developed in IDA ICE.**
- **A savings potential of 35% has been identified for the low-temperature heating elements, with respect to the installed capacity.**

Engagement summary



Project type: New construction

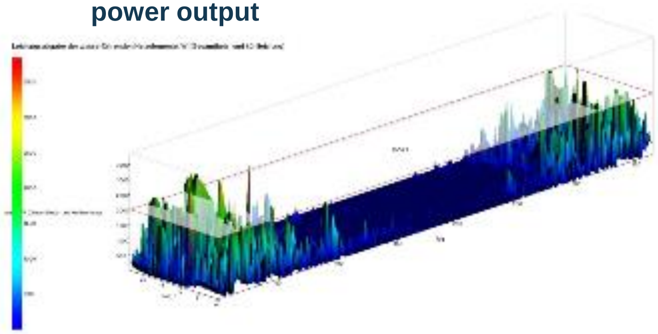
Type of study: Administration/Office, private building, study of thermal comfort, various heating and cooling delivery systems, solar shading, ventilation

Scope: 1 standard floor

Number of thermal zones: 25

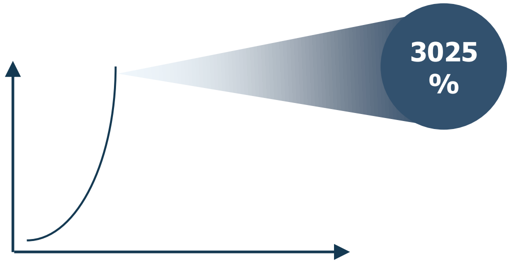
Client: Anonymous

Image of the annual and daily distribution of heating power output



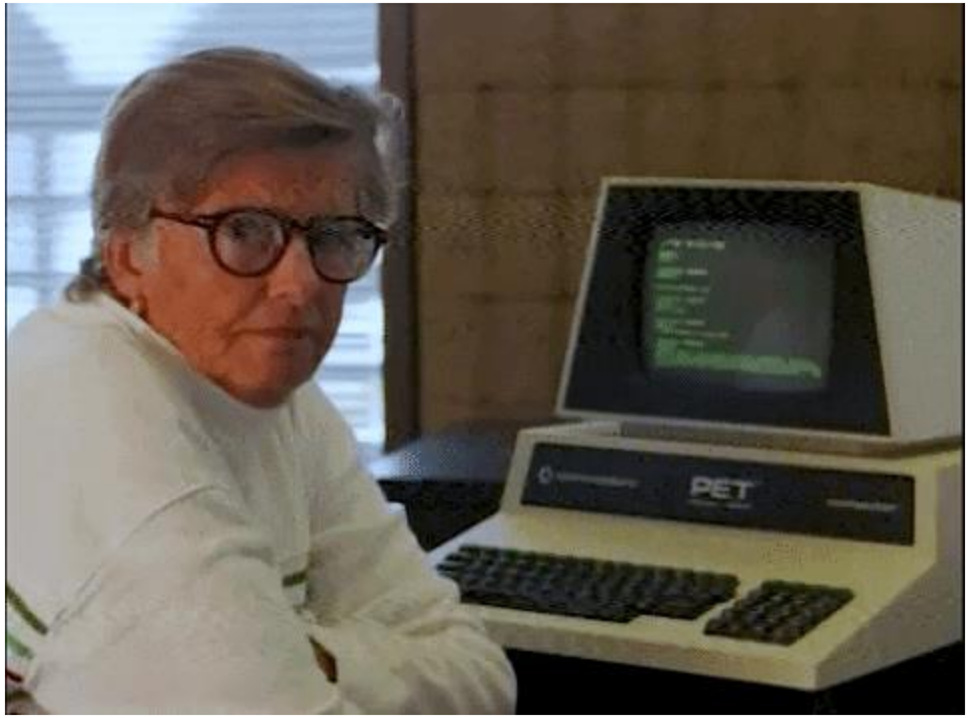
Selected Achievements

Immediate ROI of simulation study

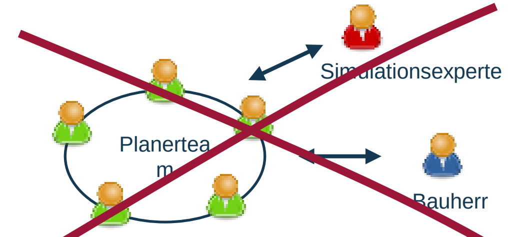


Wer garantiert die Energieeffizienz?

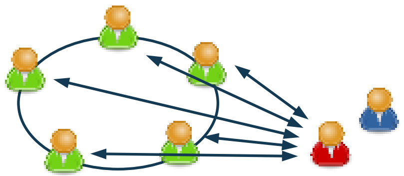
- Das Simulationsmodell gehört in die Hände des Bauherren!



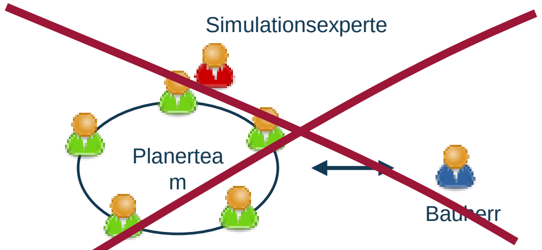
Die Rolle des Simulationskoordinators



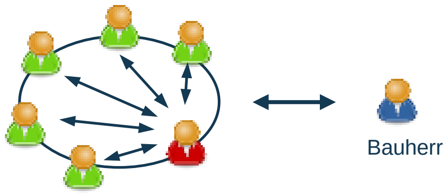
Unterauftrag Team



Bauherrenberater



Unterauftrag Fachplaner



Teammitglied

Angebot von Gebäudesimulation Schweiz

- Informationsmaterial
- Service des Vereins
  - Persönliche Beratung
  - Hilfe bei der Ausschreibung
  - Vermittlung von Experten (Expertenliste)
- Service der Experten
  - Simulationsdienstleistungen
  - Simulationskoordination

Gebäudesimulation Schweiz
Und Sie wissen was Sie bauen!

https://www.gebaeudesimulation.ch/

Wie profitiert der Bauherr?

Die Kosten für eine Gebäudesimulation hängen stark vom Auftragsumfang und von den projektspezifischen Anforderungen ab. Allgemeingültige Aussagen sind daher schwierig. Wir wagen es trotzdem. Die Angaben sind Schätzungen für ein grösseres Mehrfamilienhaus oder ein Bürogebäude.

10 000 bis **20 000 Fr.** kostet eine Standardsimulation von Strom-, Heiz- und Kühlbedarf, sommerlichem Wärmeschutz und den von Behörden oder Minergie geforderten Nachweisen.

20 Stunden dauert das Zusammentragen der Eingabedaten und das Erstellen eines einfachen Modells,

35 Stunden die Behandlung von Rückfragen und die Auswertung und

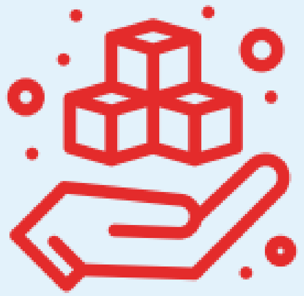
20 Stunden die Kommunikation mit Planerteam, Bauherrschaft und Behörden.

5000 Fr. lassen sich mit einer Standardsimulation bei den Nachweisen sparen, weil sie nicht separat berechnet werden müssen.

Insgesamt liegt das Einsparpotenzial in der Planung je nach Projekt bei **50 000** bis **100 000 Fr.**

So können zum Beispiel die Sicherheitsreserven bei der Dimensionierung von gebäudetechnischen Komponenten durch Simulationen um ungefähr **40** bis **50 %** reduziert werden.

30 % tiefere Betriebskosten sind durch Simulationen möglich.

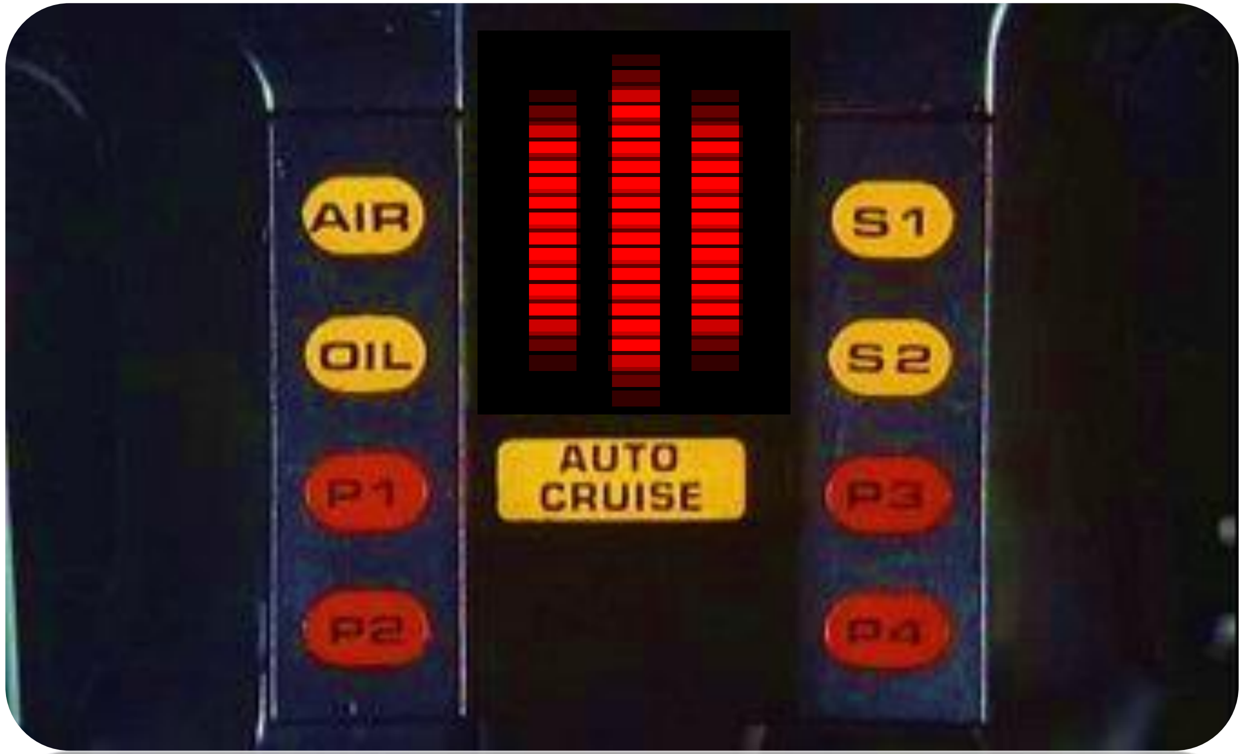


Mehrwerte von Simulationen

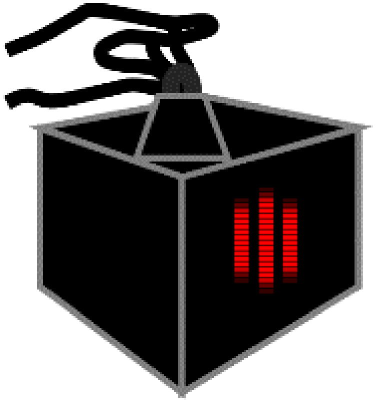
- ✓ Optimierung von Kosten, Komfort und Energie
- ✓ Entwickeln von Varianten und Optionen
- ✓ Erbringen von Nachweisen
- ✓ Korrektes Dimensionieren der Gebäudetechnik
- ✓ Bessere Abstimmung zwischen Gewerken

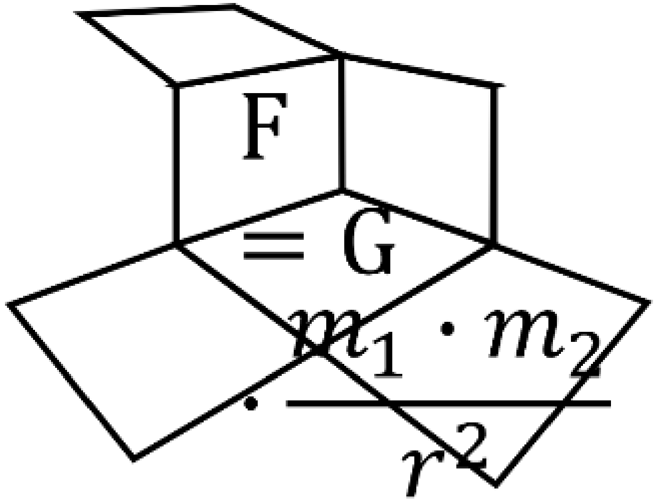
Quelle: Faktor-Verlag, Heft 57 „Simulation“

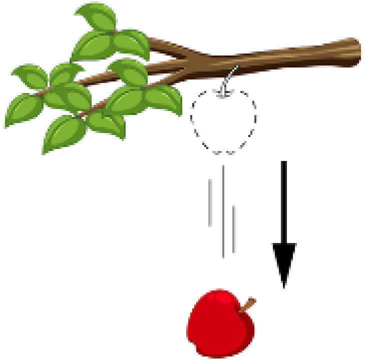
Und was ist mit KI?

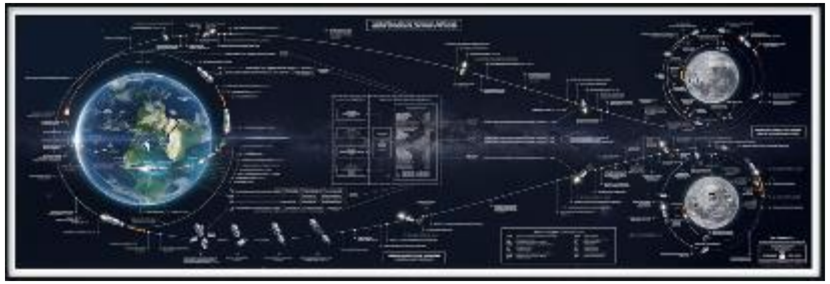


Black Box AI und White Box DT



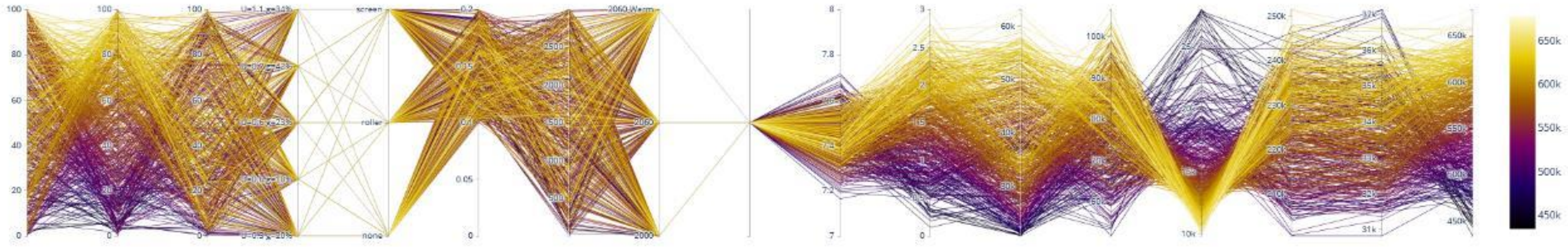






Optimierung und Parametric Runs

DEMO



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