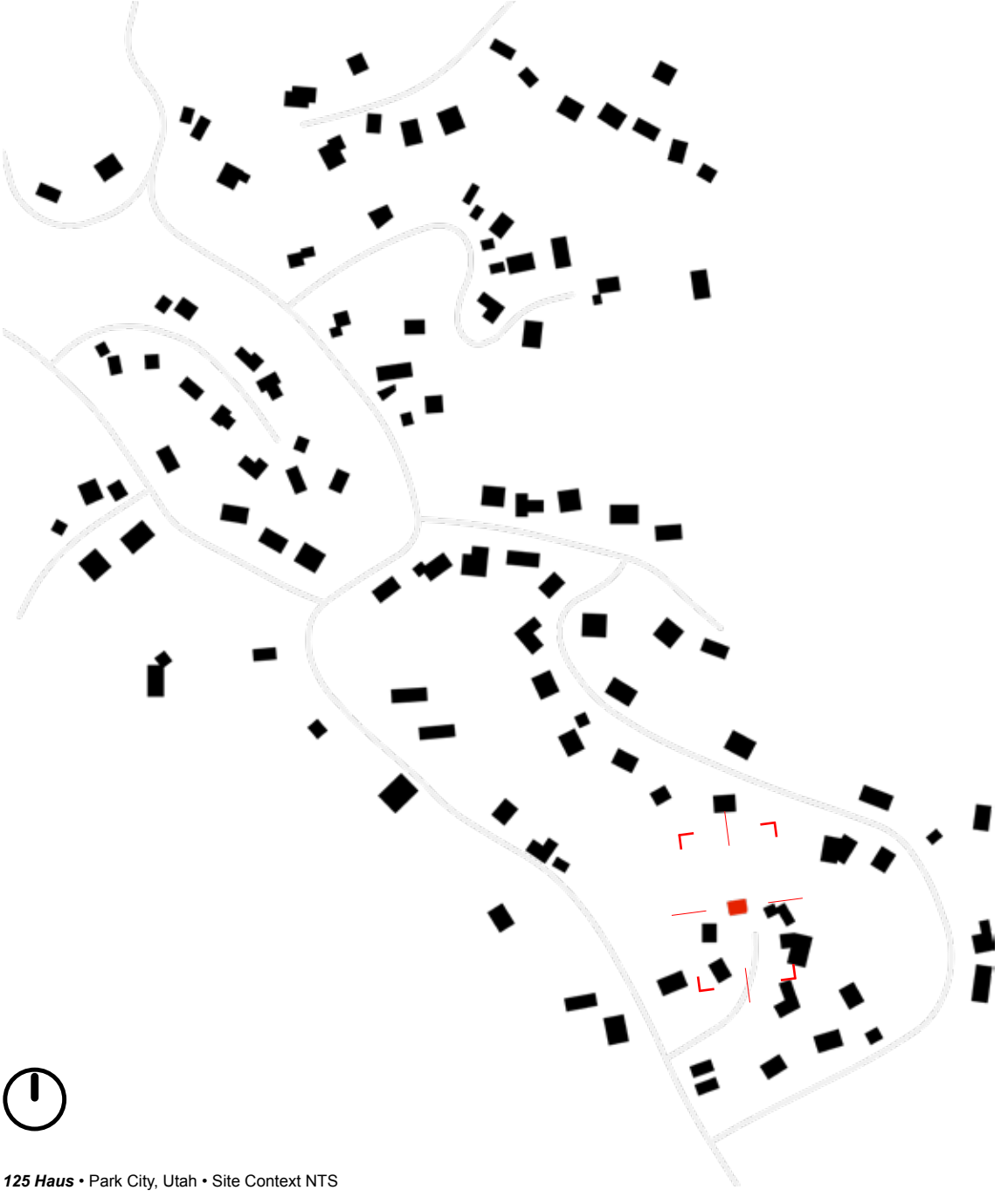
Energy-Efficiency at Market Rate Cost

125 Haus

Utah's most Energy-Efficient and Cost-Effective House

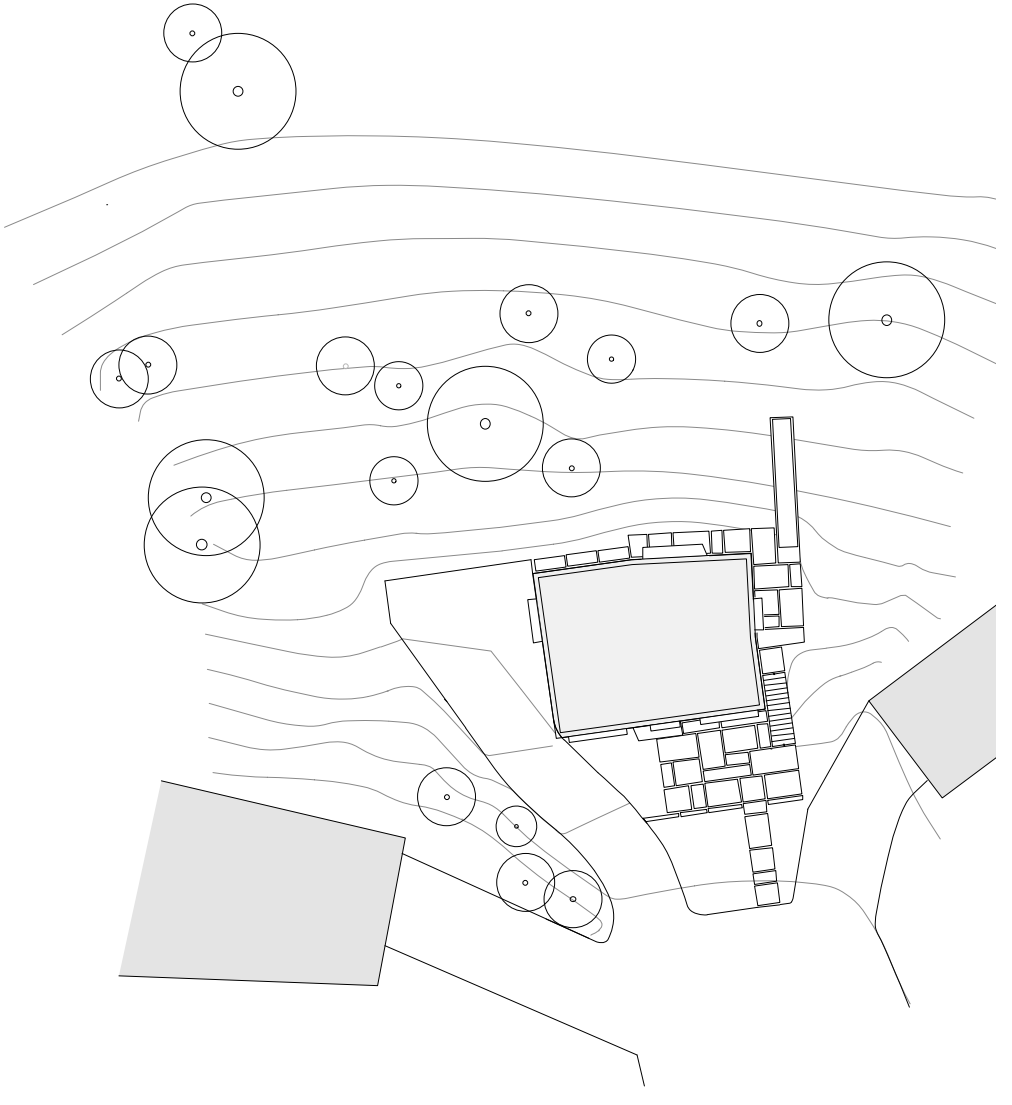


Latitude: 40º 44’ 36.74” N
Longitude: 111º 36’ 38.92” W
Elevation: 6,982” / 2.128m

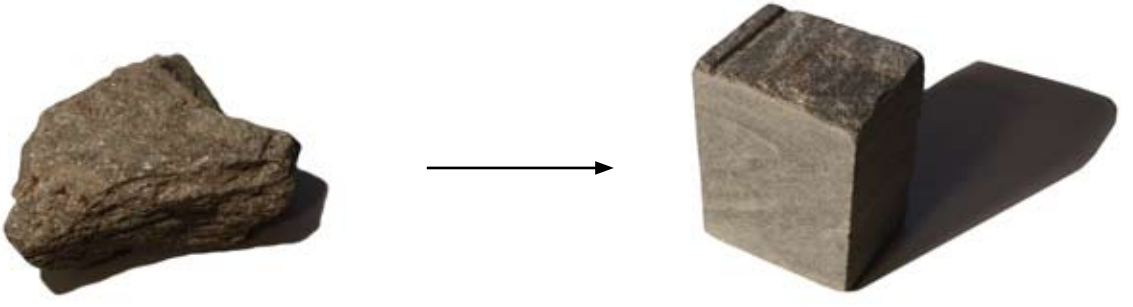
125 Haus • Park City, Utah • Site Context NTS

125 Haus, Park City, Utah

Located at an elevation of 7,000 feet, 125 Haus is a moderately sized 2,400 sq.ft. three-bedroom plus studio single-family residence in the Park City area in Utah. 125 Haus is an interdisciplinary research and design project for a highly energy-efficient residential case study priced at market rate for the Northern Utah and Intermountain West Cold Climate Zone. It will become Utah's most energy-efficient and cost-effective house in its market segment. Employing an integral planning approach that includes the general contractor, the structural and mechanical engineer, ITAC (Integrated Technology in Architecture Center) at the University of Utah, and the building department of the jurisdiction, 125 Haus was designed to the German Passive House strategy. Its construction, energy saving potential, cost efficiency, and ROI (return on investment) will be documented, evaluated, and analyzed throughout a two-year post-occupancy monitoring period that started after the building's completion in October 2011. The acquired data will be compared to virtual as well as real-time data of traditional buildings, which will allow for an evaluation of the correlation between building performance, architectural and passive solar design, systems and components, and building cost, with the goal to develop and document strategies that allow for early implementation of energy-efficient design and construction methods in future similar houses under consideration of real project costs and ROI periods for such projects. Direct cost for construction was $117.75 per sq.ft., at 2,400 sq.ft. overall gross area excluding the garage, which is of a built-in type. This adds up to $282,600, which includes permits, labor, materials, general contractor fees, overhead and profit, subcontractors, engineering fees, 3rd party evaluation and testing fees, financing fees and interest during construction, and energy-efficiency incentives from local utilities. Excluded in those cost are cost for land, impact fees, and architectural fees. By focusing on standard products and materials of high quality, coupled with common construction methods and the integration of a local production builder into the team, Jörg Rügemer expects a broad implementation of this strategy in the future housing market in Northern Utah and beyond.



125 Haus • Park City, Utah • Site Plan 1”=40’

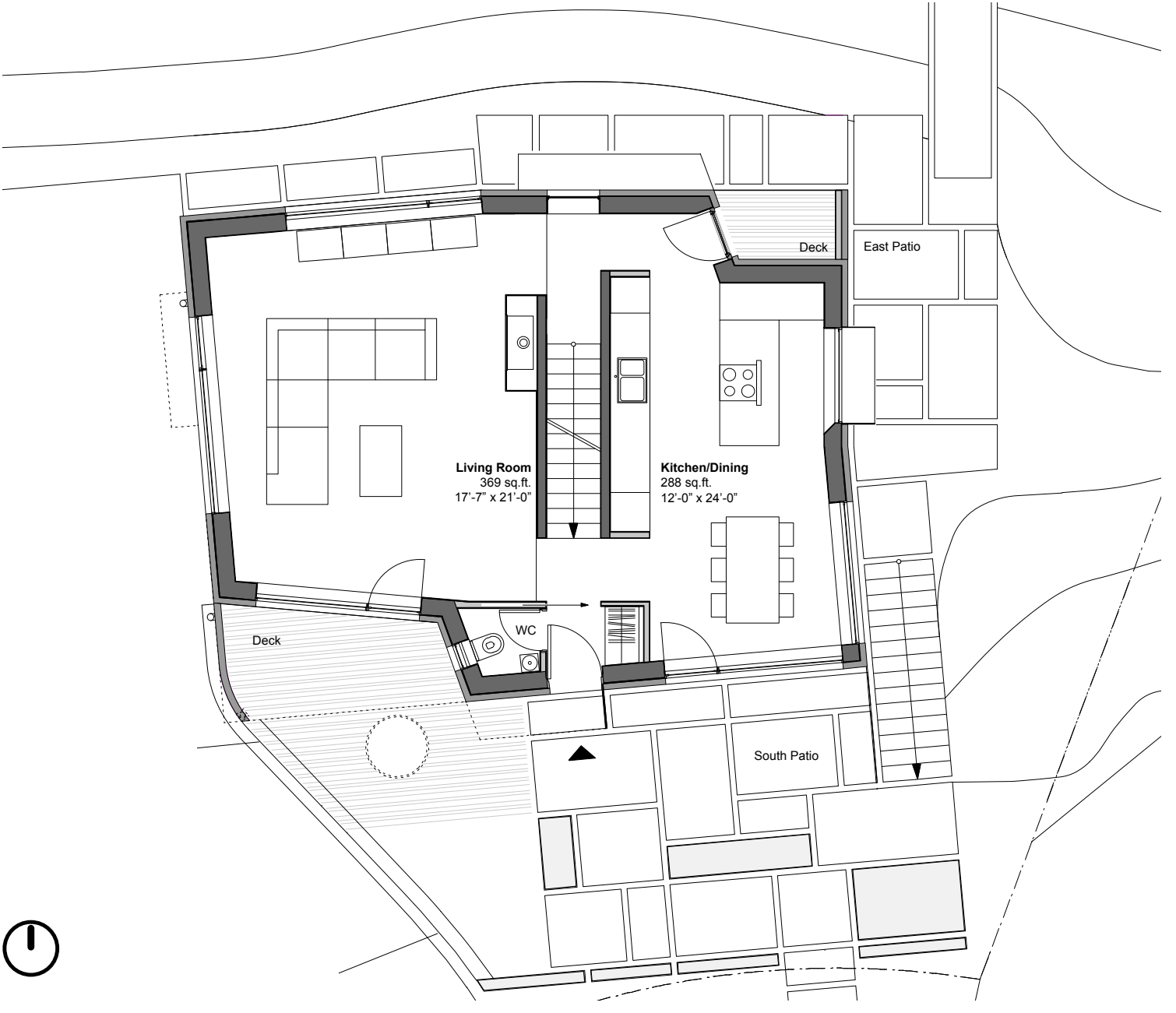


125 Haus • Park City, Utah • Concept

Jörg Rügemer is the developer and project designer of the building, and PI (Principal Investigator) of the research component of the project. He is Professor for Sustainable Architecture at the School of Architecture, University of Utah, and co-founder and Director of ITAC, the University of Utah's Integrated Technology in Architecture Center. Within his research activity, he is involved in similar projects, including the post-occupancy energy monitoring of Park City Snow Creek Project, a 13-unit energy-efficient affordable housing project that was funded by the US Department of Energy's Building America Program. Rügemer has an extensive background in sustainable contemporary design from his professional practice in Germany, his experiences as an architect at the office of Frank O. Gehry, Los Angeles, and his Master's degree education at the Southern California Institute of Architecture, also in Los Angeles.

If done correctly, Rügemer believes that architecture today has regained the power to positively change the world we live in. The building sector consumes approximately 70% of all electricity produced in the US and is responsible for producing nearly half (46.9%) of US CO2 emissions in 2009. With this enormous challenge comes enormous potential: as recently outlined in President Obama's Better Building Initiative, building energy efficiency is the most cost effective way to reduce our energy consumption and dependency on fossil fuels. With more than 100 million households throughout the US, and a projected 70 million new units to be constructed within the next three decades, the US residential building sector offers sizeable opportunities in energy-efficient construction, with possible energy savings in the range of 30 - 45% in gross energy conservation. Through its cost-effective passive energy saving and sustainable strategy, 125 Haus is expected to pioneer the US residential building sector by making such structures affordable and attractive to a broad clientele.

AJR Atelier Jörg Rügemer

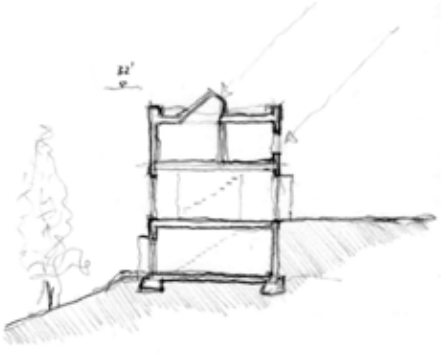


125 Haus • Park City, Utah • Main Floor 1/8"=1'-0"

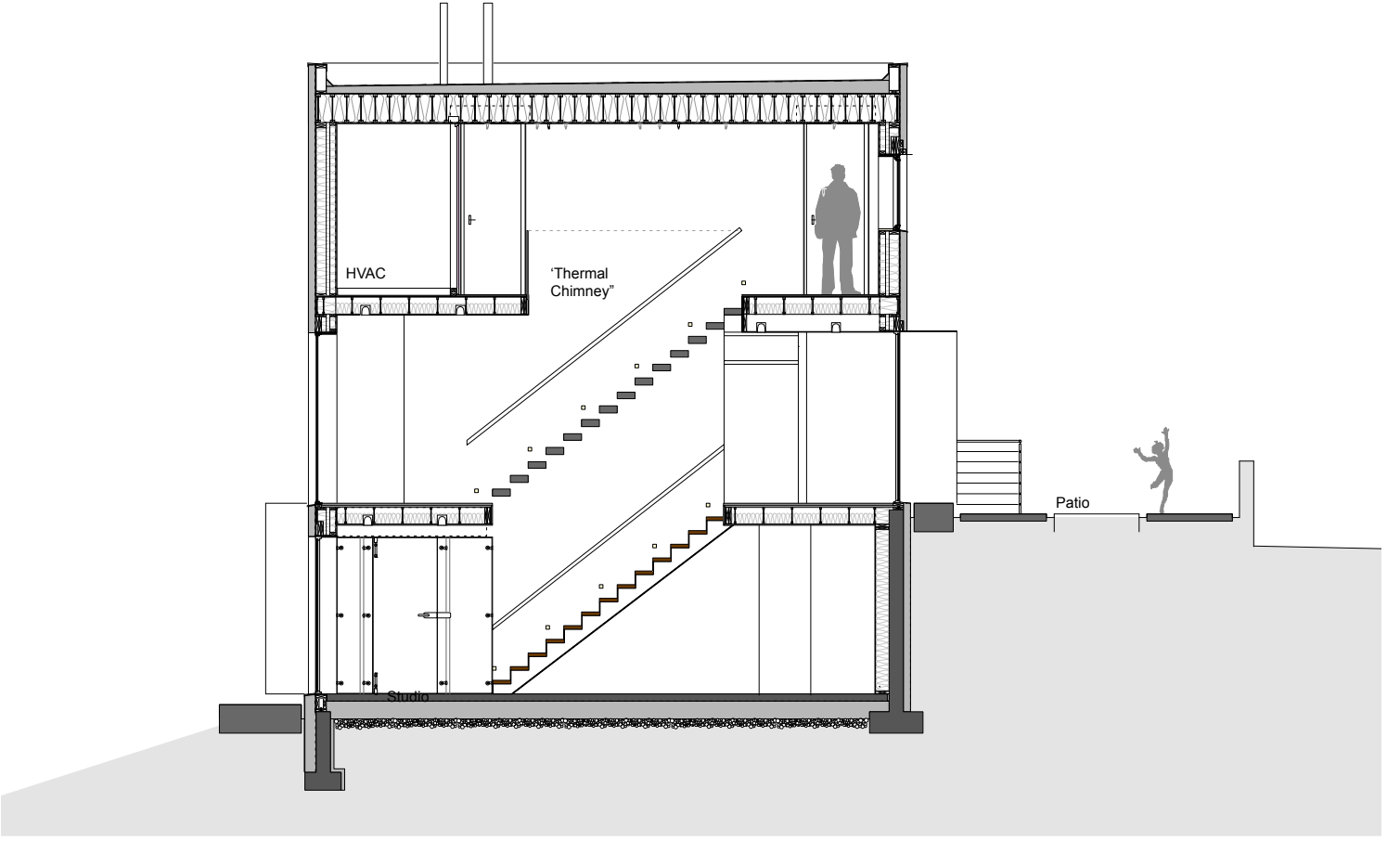
Family Kitchen

Family and Living Room

Family and Living Room



Sectional sketch with light dome that was not realized due to winter snow conditions

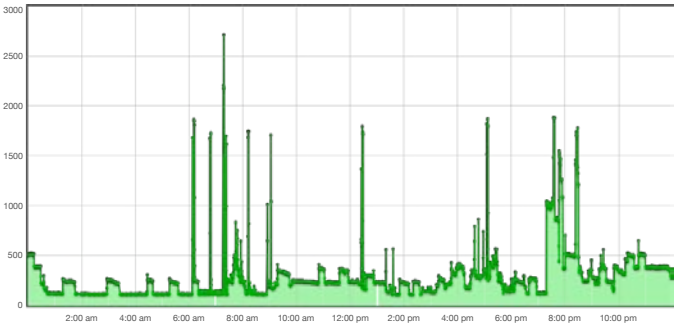


125 Haus • Park City, Utah • South-North Section 1/8"=1'-0"

Direct Vent Gas Fireplace as Main Floor Heating Source

1/4” Scale Study Model

Passive Design and Energy Efficiency



Electric Consumption Rate in Watts, Mon., June 4, 2012: 6.2 kWh

wattvision

To optimize 125 Haus' design and predict its energy performance, PHPP Passive House Planning Package was applied during the design phase; an additional 3rd party DOE EnergyPlus energy simulation was conducted at the end of the design phase. The results were used to adapt the building to its specific site conditions, to test different design configurations, wall systems, and components, and to optimize performance with regard to efficiency and costs. One of the results is a new wall system that is based on double framing coupled with an exterior insulation system; it can be applied in ratings from R-40 to R-70 for other buildings at various locations and climate zones. Furthermore it can be applied to existing buildings.

To heat 125 Haus on sunny winter days, it primarily relies on passive solar heat gain harvested through large south-facing windows; during periods with little to no sun and very cold nights the building is heated with an HRV (Heat Recovery Ventilator), which is supported by an on-demand hot water heater that feeds warm water into a radiant loop in the lower story concrete floor. A direct-vent gas fireplace on the main floor was installed as a back-up system, but also for visual comfort. Active night air-cooling through operable windows and an open staircase, which functions as a thermal chimney, provides cooling during the moderate to hot summers.

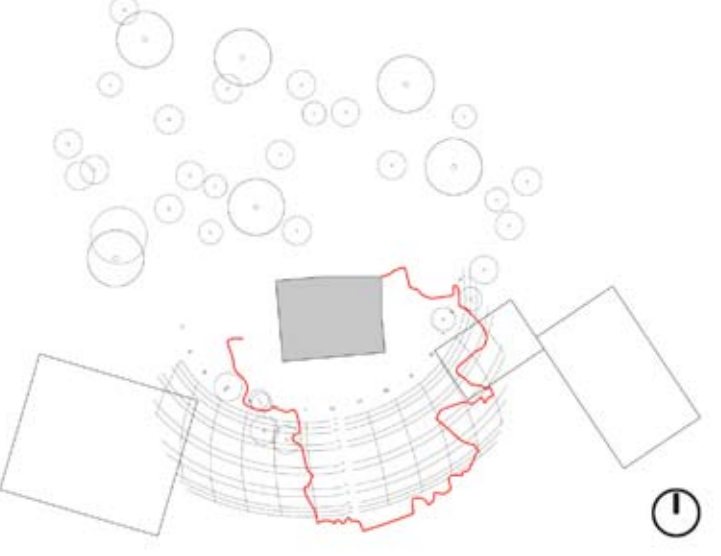
According to the energy simulation results, the building is approximately 80 - 90% energy-efficient over the built-to-code IECC 2006 standard benchmark building, which is the code benchmark applicable in Utah. To verify those results, an independent HERS rating was conducted with the second and final Blower Door test after completion of the building. As expected by the researchers, all results were different, ranging from 5.6 MMBTU to 21.4 MMBTU per year for heating and cooling only, which fortifies the necessity for post occupancy monitoring to learn about the real performance of the building. Based on 11 months of post-occupancy monitoring as of September 01, 2012, the acquired data allow for a first 12-month energy consumption projection. Thereafter, the building used an average of 2.18 MMBtu/month or 26.10 MMBtu /year on natural gas for heating only. A monthly 54.92 kWh or annual 659 kWh was used to run the HRV, electric pumps and the on demand hot water heater for heating purposed only. Cost wise, this adds up to monthly heating cost of $22.90 or annual cost of $275. Cooling is included herein because natural nighttime cooling is used to cool the building during the summer time.

Based on the same projection method, overall energy consumption for the household of four is as follows: occupants used an overall of 3.14 MMBtu/month or 37.70 MMBtu/year on natural gas, which includes domestic hot water and natural gas for the dryer, and a monthly 308.25 kWh or annual 3,699 kWh for overall electricity. The equivalent overall energy cost for natural gas and electricity are $53.72 per month or $644.58 per year.

Water consumption is at 3,083 gallons/month, which equals roughly 25 gallons/person/day.

As of September 2012, these numbers can be compared to general annual residential energy consumption data along the Wasatch Front only. Although data for Summit County and Park City exist, these numbers are not representative due to the high amount of second and third homes that are occupied for a few weeks per year only. According to Salt Lake City and Salt Lake County data[1], annual electricity consumption per household is 15,803 kWh, and 174.44 MMBtu, at an average elevation of 4,200'. Compared to 125 Haus data taken at 7,000', 125 Haus uses about 23% of the average electricity and 22.5% of the average natural gas; it is therefore about 77% more efficient than the average building stock in the valley. Further research over the next 13 months will allow for more precise comparables.

[1] Data sources: International Energy Agency, 2011; U.S. Energy Information Administration, 2011; Southwest Energy Efficiency Project, 2011; Energy Strategies, LLC 2009; U.S. Census Bureau 2010



125 Haus • Park City, Utah • Solar Pathfinder Site Analysis as Decision Making Tool, Site Overlay

Visible Light Image

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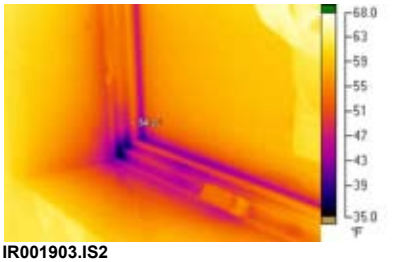

Visible Light Image

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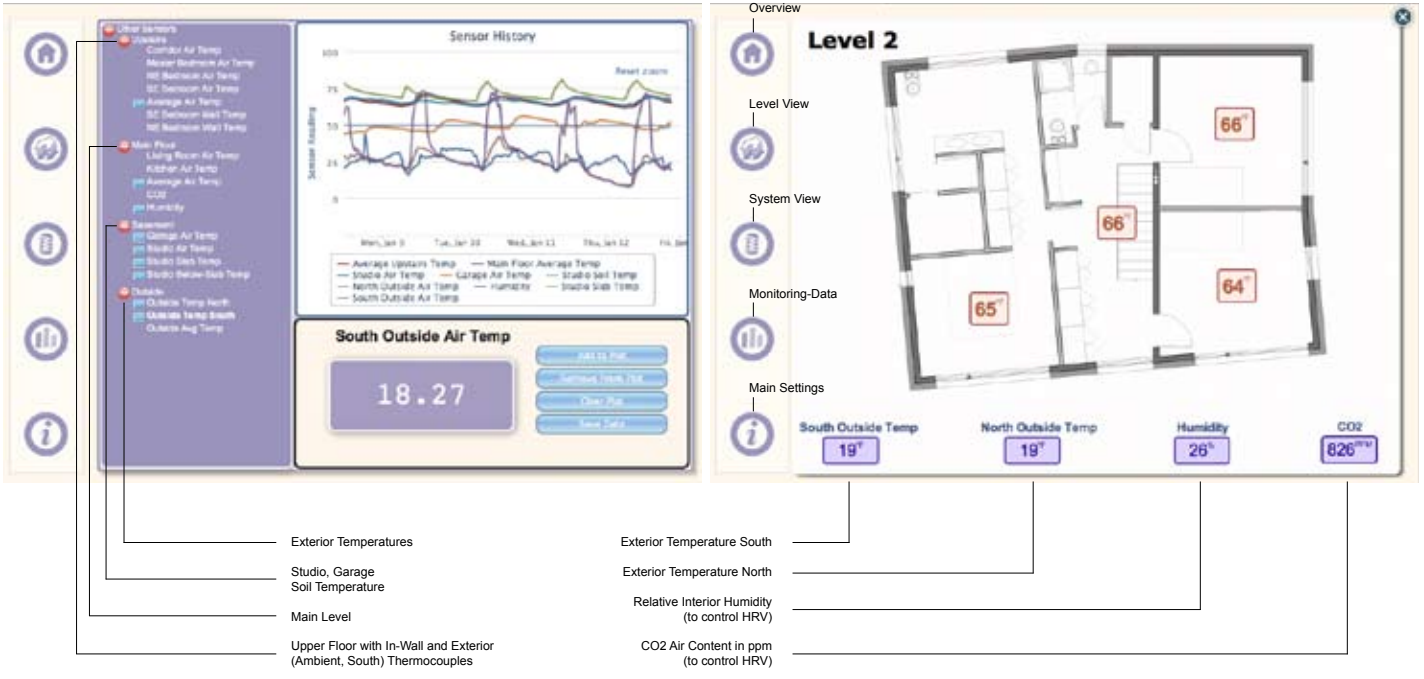
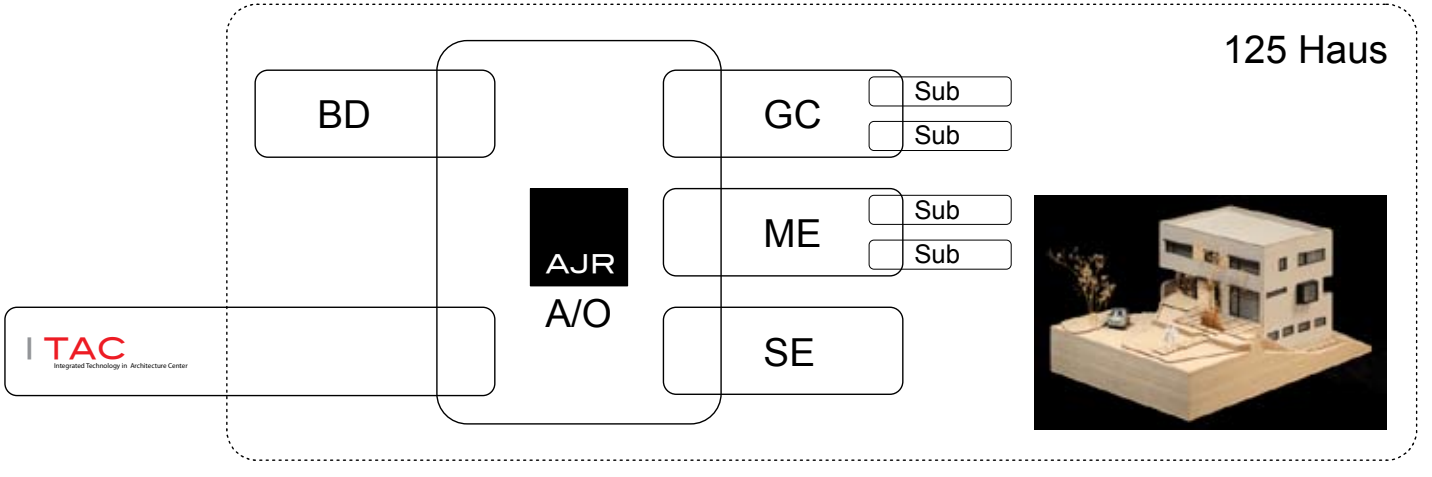
Post-Occupancy Thermal Imaging Cold Bridge Analysis



Energy Monitoring - Interactive Web Control Interface



A/O	Architect/Owners
GC	General Contractor
ME	Mechanical Engineer
SE	Structural Engineer
BD	Building Department

Project Data

125 Haus - Utah's most Energy-Efficient and Cost-Effective House

High Performance Single Family Residence at Market Rate Cost

Architekt, Developer
Atelier Jörg Rügemer
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General Contractor
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Salt Lake City, UT 84103
801 • 456 • 2430
www.garbetthomes.com

Photograph
Scott Zimmerman
PO Box 289
Heber City, UT 84032
435 • 654 • 2757
scotzman@sprynet.com
www.scotzimmermanphotography.com

Location: Park City, Utah

Gross area without garage: **2,400**

Net area conditioned space: **1,800**

3 bedrooms, 2.5 bathrooms, 1 studio

Number of inhabitants: 4

Lot size: 0.37 acres

Direct construction costs per square foot: **$117.75**
Including: permits, labor, materials, subcontractors, general contractor, overhead, profit, finance/interest during construction.
Excluding: cost of land, impact fees, architectural fees

Direct construction cost overall: **$282.600**

Land Development cost: **$135.800**
Cost of land, financing fees, impact fees

Date of completion: October 2011

AJR Atelier Jörg Rügemer

Build your own 125 Haus!

Cut along these lines

AJR Design Strategy

The focus of my work concentrates on the understanding of architecture as applied research. As a result of selective investigation, potentials arise within each design process, strengthened by the intensification of existing possibilities. A radical analysis points out possible directions, which can be discussed controversially. Those directions will be described by scenarios and examined for their effects.

The quintessence of each multi-level design process is defined by a holistic and conceptual approach with a focus on an energy-efficient, sustainable architecture, which is combined with experimental proceedings within the architectural activity. The intensive engagement with the genius loci – the specific location - obtains central meaning in every individual design tasks. All aspects of sustainability, the examination of the building program and the interior organization is incorporated into the early work process. In the dialogue between location, space, and the respective task, specific and distinctive solutions are developed, containing their own spatial identity. This identity can serve both as a static and/or variable program; furthermore it might serve as a setting for temporary overlays.

Within this procedure, the use and understanding of the traditional, tangible working model acts as a base of my design process philosophy. Using the model as a tool, each project is developed intensively and comprehensibly. The method is supported by the employment of advanced digital media and technologies. Depending on the necessary equipment, the workflow from the first sketch to the finished presentation as well as the design and production process is optimized to the newest state of the art.

Besides the traditional approach in architectural design, I have investigated new fields of architecture in past and recent years. I have developed projects that incorporate all aspects of energy-efficiency and sustainability, pushing the building's performance far beyond code requirements both in Germany and the United States. The recent goal is to be 85% more energy efficient then code requirement simply by passive means of design and construction, pushing the limit toward net zero. This activity is also reflected in my recent research that deals with post-occupancy monitoring and analysis of energy-efficient buildings along the Wasatch Front in Utah.

To test, extend, and finally establish methods and strategies that I have intensively discussed in the field of research and education in my own atelier, I connect and cooperate with different partners in interdisciplinary, professional networks. These networks can be seen as a platform that reflect a specific mindset for strategies of interdisciplinary networking in architecture and design, which is applied to different fields of professional activity. The global concept of the interdisciplinary network, which is supported by the local atelier, emerged from the necessity to integrate other professional disciplines; it also emerged from the demand to shift the profession of architecture toward communication and open work forms.