1. IEA SHC Task Definition Meeting

Solar Energy Buildings - Integrated solar energy supply concepts for climate-neutral buildings and districts for the "City of the Future"

25. March 2020, 10:00 – 16:00 h

University of Stuttgart
Internationales Begegnungszentrum der Universität Stuttgart
(IBZ / Eulenhof, Campus Stuttgart-Vaihingen)
Robert-Leicht-Straße 161
70569 Stuttgart, Germany

Agenda

till 09:30	Arrival and coffee
10:00	Welcome and Opening by Harald Drück (IGTE) and Christian Fink (AEE INTEC) Introductory round of all participants Presentation of planned IEA Task "Solar Energy Buildings" (SEB) Short presentation (approx. 5 min) of ongoing and planned projects on Solar Energy Buildings and Districts ***Note**: If you would like to give a presentation please inform us at latest until March 10th, 2020*
12:15	Lunch break
13:00	Elements of the planned Task on SEB: Discussion, brainstorming - goals - structure - deliverables - participants
15:45	Summary and next steps
16:00	End

Contact persons for questions regarding the content:

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Contact person for organisational questions:

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Note: This Workshop is jointly organised by IGTE, University of Stuttgart, Germany and AEE INTEC, Gleisdorf, Austria

Gefördert durch:

Bundesministerium für Wirtschaft und Energie

aufgrund eines Beschlusses des Deutschen Bundestages

IEA SHC Task Proposal

Proposed Project Title	Solar Energy Buildings - Integrated solar energy supply concepts for climate-neutral buildings and districts for the "City of the Future"
Date	31.10.2019

Provide a brief description of the proposed project and the objectives.
(Include an explanation of the research problem the project would be attempting to solve).

General conditions

On global level the operation of buildings accounts for around 40 % of the primary energy consumption and approximately 25 % of the greenhouse gas emissions. In Europe buildings are responsible for 40 % of energy consumption and 36 % of CO_2 emissions[1]. Additionally large amounts of energy are embodied in the building's construction materials.

A significant reduction of the non-renewable energy consumption of buildings is an important goal of many countries and regions. As a step towards this goal the European Parliament and the Council already on 16 December 2002 agreed on the energy performance of buildings directive (EPBD; Directive 2002/91/EU).
According to the latest version of the European Building Directive, only nearly zero energy buildings that meet specific energy requirements from renewable energy sources at the site or in the immediate vicinity may be erected from 2021 onwards. A completely renewable, central energy supply for cities will in many cases not be possible due to a lack of space for renewable energy production inside the city. For this reason, decentralized solutions will also be needed in the city of the future that interact with existing grid infrastructures in the best possible way.

In order to characterize the impact of the building on the electrical and – if available thermal grid – in an appropriate way it is important to perform the calculations of the solar fractions based on short time intervals e.g. 15 minutes, and not on an energy balance over one complete year as it is e.g. the case for the definition of the German "Effizienzhaus-Plus". Using short time intervals to calculate the net energy balance is important, in order to reflect the fact that the electricity grid has no ability to store energy, so electricity fed into the system is used immediately. As a result, electricity that is fed into the grid as excess photovoltaic energy in the summer cannot be taken out of the grid again in the winter. Instead, to cover electricity requirements in the winter, fossil fuel power stations have to be used. Calculating net values based on annual values therefore produces significantly lower equivalent carbon emission values than is actually the case.

[1] https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings

Draft work program

- Definition of the framework conditions and system boundaries as well as screening for legal framework conditions and definition of reference buildings (single and multi-family houses) or districts; Definition of the involved stakeholders (energy suppliers, housing developers, urban planning, etc.); Discussion and definition of different scenarios regarding overall energy system developments; Determination of specific KPIs;
- Definition of potential technologies in a technology portfolio, such as solar thermal (conventional collector technologies, medium temperature collectors, charge boost sorption collectors, other specific new developments), PVT hybrid collectors, PV, micro heat pumps, different thermal and electrical energy storage technologies (e.g. activation of thermal masses, water storage with vacuum insulation, sorption storage, ice storage, stationary and mobile battery storage, etc.), heat and cold supply systems, water heaters and other technologies for heat, cold and power generation (biomass, green gas, cogeneration, etc.). If applicable, further development of individual technology elements.
- Exploiting the new degrees of freedom and possibilities by linking individual technologies from the technology portfolio from a perspective that looks at the entire energy system, such as sector coupling, SRI indicators (Smart Readiness Indicator), self-consumption levels and grid load rejection potentials (overall grid infrastructures), etc.; Consideration of available surface and the area-efficiency of individual technologies; Definition of integrated and grid-interacting energy supply concepts for heat, cold, domestic electricity demand and e-mobility; Development of intelligent control concepts (data-based and predictive); Consideration of aspects of increased user involvement;
- Modeling, simulation, determination of levelised cost of energy, evaluation with technical, economic and environmental KPIs and optimization procedures;
- Addressing aspects of scalability and assignability, user and stakeholder engagement, business and statement models, financing;
- Summary and preparation of the results; dissemination measures;

The key objectives of the project are:

Numerous research projects have shown that 100 % solar fractions of the power and heat requirements for individual buildings (mostly single-family homes) are basically feasible. However, these demonstrators were all in economic terms not nearly competitive with conventional supply solutions and were characterised much more by a high degree of self-sufficiency. A potential IEA SHC task will focus on the development of economical energy supply concepts for high solar fractions of at least 85% of the heat demand, 100% of the cooling demand and at least 60% of the electricity requirements for households and e-mobility of multi-storey residential buildings in single buildings and building blocks or distinguished parts of a city for both, new buildings and the comprehensive refurbishment of existing

buildings. A central component of the concept development is the synergetic consideration of the interaction with grid infrastructures (electricity and heat) in the sense of bidirectional flexibility.

In recent years, numerous technological advances have been made in the field of solar energy (thermal and electrical), in the field of other renewable energy technologies as well as in the field of building services. As a result, both at the technology level and at the energy-system level (e.g., through sector coupling), new approaches will be followed in a potential IEA SHC task. These will then be further developed quantified and scalability and transferability assessed.

Finally, for the broad applicability in the "city of the future" holistic renewable energy supply concepts for residential buildings should be available, which enable a high energy grid interaction and flexibility potential, high surface efficiency of the conversion of solar radiation into heat and power on site or nearby the building, a high economic competitiveness and high user acceptance.

Task category: Research, Demonstration, Promotion or Information?
Research

Who is the intended target audience for each outcome of the project?
Solar Industry, HVAC Industry, Grid Operators, Housing Associations, Property Managers, Planners, Representatives of Cities and Municipalities, etc.

How does the proposed project relate to the current Solar Heating and Cooling Strategic Plan: *http://www.iea-shc.org/about/strategicplan/index.html*

The proposed project is in line with the focus of the TCP SHC (mentioned below):

"Solar energy technologies and architectural designs that include active solar thermal heating and cooling, photovoltaic driven heating and cooling, passive solar building design and solar architecture, including the consideration of daylighting and thermal comfort. This definition includes hybrid technologies and companion heat storage and supply technologies and applications. Active and passive solar heating and cooling can be applied to provide light, hot water as well as heating and cooling in the residential and service sectors and heating, cooling and drying in industrial and agricultural processes."

Furthermore, this project addresses central parts of the SHC TCP Vision listed below and supports its achievement:

"Solar energy technologies will provide more than 50% of low temperature heating and cooling demand for buildings in 2050 and contribute a significant share to the heat supply for the agricultural and industrial sectors. Thus, solar heating and cooling will contribute significantly to lowering CO_2 emissions worldwide and reaching the Paris Agreement goal."

Among others, the project supports in particular "Objective 2" of the SHC strategic plan as mentioned below:

"Objective 2: To contribute to a significant increase in the cost effectiveness of solar heating and cooling technologies and designs through increased performance and reduced costs to increase their market competitiveness in heating and cooling applications."

How does the proposed project relate to ongoing or previous SHC Tasks?

Among others, the current project has thematic links to the following ongoing SHC Tasks:

Task 63: Solar Neighborhood Planning
Task 60: PVT Systems - Application of PVT Collectors and New Solutions in HVAC Systems
Task 58: Material and Component Development for Thermal Energy Storage
Task 56: Building Integrated Solar Envelope Systems for HVAC and Lighting

Is there any expected overlap with projects of the EU or other international organizations?

There are some direct links between the proposed project and ongoing European projects or bilateral research cooperations between countries on the topic. These connections are important because they create knowledge and insights for further processing in an international context. In the following a few project cooperations are listed:
Among others, project cooperations can be named such as the Austrian-German research cooperation "Sol4City", the H2020 project "EXCESS- Flexible user-centric energy positive houses" or H2020 project "CREATE - Compact Retrofit Advanced Thermal Energy storage".

Describe any cross-cutting to ongoing Tasks/Annexes in other implementing agreements

The project at hand is part of a trend towards systemic consideration of single technologies, buildings, energy grid infrastructures and also users. For this reason, it goes without saying that there are thematic links to projects from other TCP´s such as for example:

EBC: Annex 67 "Energy Flexible Buildings", New Annex in definition phase "Positive Energy Districts"
ECES: Annex 34 "Comfort &Climate Box", Annex 35 "Sector coupling"

In each case, however, it is important to pay attention to synergies and demarcations in the planned definition phase.

State any expertise or skills the project will require.
The project in question requires persons with expertise in the technology areas of solar thermal, PV, heat pumps, energy storage as well as expertise on the systemic level in the areas of HVAC in general, energy grids and control strategies. In addition, methodological expertise such as component and system simulation and optimisation is required.

Could this proposed project accommodate PhD students? If yes, please elaborate if possible.
Yes, it is possible.

***What is your initial estimate for the duration of*:**
- One year preparation phase
- 3 years working phase

Name of Task initiator	Dr Harald Drück, IGTE, University of Stuttgart, Germany Christian Fink, AEE – Institute for Sustainable Technologies, Austria
Email address	harald.drueck@igte.uni-stuttgart.de c.fink@aee.at
Telephone	Dr Harald Drück: 0049 711 68563553 Christian Fink: 0043 3112 5886214
Will you be able to: Lead development of the proposal ("Task Organizer")?	Both IGTE and AEE INTEC are interested in the further development of this concept paper into a regular Task and are in good contact with their ExCo´s in this regard.
If approved by the Executive Committee, act as the project manager ("Operating Agent")?	Who takes over the role of the Operating Agent will be clarified as part of the Task definition phase.
Name of your national SHC Executive Committee member	Germany: Kerstin Krüger Austria: Werner Weiss
Has your Executive Committee member approved this proposal?	yes
Within SHC member countries, which institutions and companies do you propose to collaborate with on this project	At this time we have received feedback from: Germany: IGTE, University of Stuttgart, Germany Austria: AEE – Institute for Sustainable Technologies Italy: EURAC Switzerland: SPF and Andreas Eckmanns France: TECSOL Sweden: SERC Australia: Ken Guthrie UK: Richard Hall Norway: Michaela Meir

Instructions: *Please complete no later than 4 weeks before the Executive Committee Meeting at which the proposal will be presented and send to the Chairman and SHC Secretariat, secretariat@iea-shc.org for distribution to the ExCo.*

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Proposal for an IEA SHC Task on:

Solar Energy Buildings - Integrated solar energy supply concepts for climate-neutral buildings and districts for the "City of the Future“

Prepared by:

Dr Harald Drück, IGTE, University of Stuttgart, Germany
Christian Fink, AEE INTEC, Gleisdorf, Austria

Proposal for an IEA SHC Task on: „Solar Energy Buildings“

Motivation

- On global level: Operation of buildings accounts for around 40 % of primary energy consumption and approximately 25 % of greenhouse gas emissions
- Europe: Buildings are responsible for 40 % of energy consumption and 36 % of CO_2 emissions
- Additionally large amounts of energy are embodied in the building’s construction materials

→ **Goal: A significant reduction of non-renewable energy consumption of buildings**

→ **In Europe:**
Energy performance of buildings directive (EPBD; Directive 2002/91/EU, from 16th December, 2002)

→ **Latest version of the European Building Directive:**

- → nearly zero energy buildings that meet specific energy requirements from **renewable energy** sources may be erected from 2021 onwards
- → A completely renewable, central energy supply for cities not be possible
- → **Decentralised solutions** will be needed in the city of the future interacting with existing grid infrastructures in the best possible way

Proposal for an IEA SHC Task on: „Solar Energy Buildings“

Objectives

- Fact: Proven is 100 % solar fractions of the power and heat requirements for individual buildings (mostly single-family homes) are feasible
- BUT: These demonstrators were **in economic terms not competitive** with conventional supply solutions
- **→ Goal:**
  The new EA SHC Task shall focus on the development of economical energy supply concepts for high solar fractions of at least 85% of the heat demand, 100% of the cooling demand and at least 60% of the electricity requirements
- Target: Households and e-mobility of multi-storey residential buildings in single buildings and building blocks or distinguished parts of a city for both, new buildings and the comprehensive refurbishment of existing buildings
- Key aspect: The synergetic consideration of the interaction with grid infrastructures (electricity and heat) in the sense of bidirectional flexibility

Proposal for an IEA SHC Task on: „Solar Energy Buildings“

Draft work program (1/2)

- Definition of the framework conditions and system boundaries as well as screening for legal framework conditions and definition of reference buildings (single and multi-family houses) or settlement structures;
- Definition of the involved stakeholders (energy suppliers, housing developers, urban planning, etc.);
- Definition of different scenarios regarding overall energy system developments;
- Determination of specific KPIs
- Definition of potential technologies as elements of the system portfolio :
  - Solar thermal, including PVT collectors
  - PV
  - (Micro) heat pumps
  - Different thermal and electrical energy storage technologies (e.g. activation of thermal masses, water storage with vacuum insulation, sorption storage, ice storage, stationary and mobile battery storage, etc.)
  - Heat and cold supply systems, water heaters and other technologies for heat, cold and power generation (biomass, green gas, cogeneration, etc.)
  - ….

Proposal for an IEA SHC Task on: „Solar Energy Buildings“

Draft work programm (2/2)

- Linking individual technologies from the technology portfolio to an entire energy system, including such sector coupling
- Key aspects are e.g. SRI indicators (Smart Readiness Indicator), self-consumption levels and grid load rejection potentials (overall grid infrastructures),
- Consideration of available surfaces and the area-efficiency of individual technologies;
- Definition of integrated and grid-interacting energy supply concepts for heat, cold, domestic electricity demand and e-mobility
- Development of intelligent control concepts (data-based and predictive); Consideration of aspects of increased user involvement;
- Modeling, simulation, determination of levelised cost of energy, evaluation with technical, economic and environmental KPIs and optimization procedures;
- Addressing aspects of scalability and assignability, user and stakeholder engagement, business and statement models, financing;
- Summary and preparation of the results; dissemination measures;

Relation to the current Strategic Plan

"Solar energy technologies and architectural designs that include active solar thermal heating and cooling, photovoltaic driven heating and cooling, passive solar building design and solar architecture, including the consideration of daylighting and thermal comfort"

"Solar energy technologies will provide more than 50% of low temperature heating and cooling demand for buildings in 2050 and contribute a significant share to the heat supply for the agricultural and industrial sectors"

"Objective 2: To contribute to a significant increase in the cost effectiveness of solar heating and cooling technologies and designs through increased performance and reduced costs to increase their market competitiveness in heating and cooling applications."

Related ongoing or previous SHC Tasks

Task 63: Solar Neighborhood Planning

Task 60: PVT Systems - Application of PVT Collectors and New Solutions in HVAC Systems

Task 58: Material and Component Development for Thermal Energy Storage

Task 56: Building Integrated Solar Envelope Systems for HVAC and Lighting

Related Projects

Among others, project co-operations can be named such as the

- Austrian-German research cooperation “Sol4City”
- H2020 project “EXCESS- Flexible user-centric energy positive houses”
- H2020 project “CREATE - Compact Retrofit Advanced Thermal Energy storage”.

Duration

One year preparation phase

Three years working phase

Feedback so far

Germany: IGTE, University of Stuttgart, Germany

Austria: AEE – Institute for Sustainable Technologies

Italy: EURAC

Switzerland: SPF and Andreas Eckmanns

France: TECSOL

Sweden: SERC

Australia: Ken Guthrie

UK: Richard Hall

Norway: Michaela Meir

Proposal for an IEA SHC Task on: „Solar Energy Buildings“

We would be happy to get the approval of the ExCo for starting the Task Definition Phase for a new IEA SHC Task on „Solar Energy Buildings“

Harald Drück
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www.iea-shc.org

Universität Stuttgart

IGTE

Institut für
Gebäudeenergetik,
Thermotechnik und
Energiespeicherung

INFORMATION SHEET – Hotel / Directions

1 IEA SHC Task Definition Meeting

"Solar Energy Buildings"

25th of March 2020 in Stuttgart

- **Venue address:**

Name: Internationales Begegnungszentrum der Universität Stuttgart (IBZ / Eulenhof)
Address: Robert-Leicht-Straße 161, 70569 Stuttgart
Contact: +49 711 685-66698
Website: https://www.beschaeftigte.uni-stuttgart.de/uni-services/technik-gebaeude/ibz/

- **Hotel:**

Name: Hotel Motel One Stuttgart Feuerbach
Address: Heilbronner Str. 325, 70469 Stuttgart
Contact: +49 711 32779230
stuttgart@motel-one.com
Website: https://www.motel-one.com/de/hotels/stuttgart/hotel-stuttgart/

Please note:
From this hotel, it takes about 40 minutes by public transport to the venue. Due to an important trade fair, the hotel situation in Stuttgart is very tense at this time. We have reserved 15 rooms in this hotel in advance. These can be used as single or double rooms. The overnight stay including breakfast costs 120, 50 €.

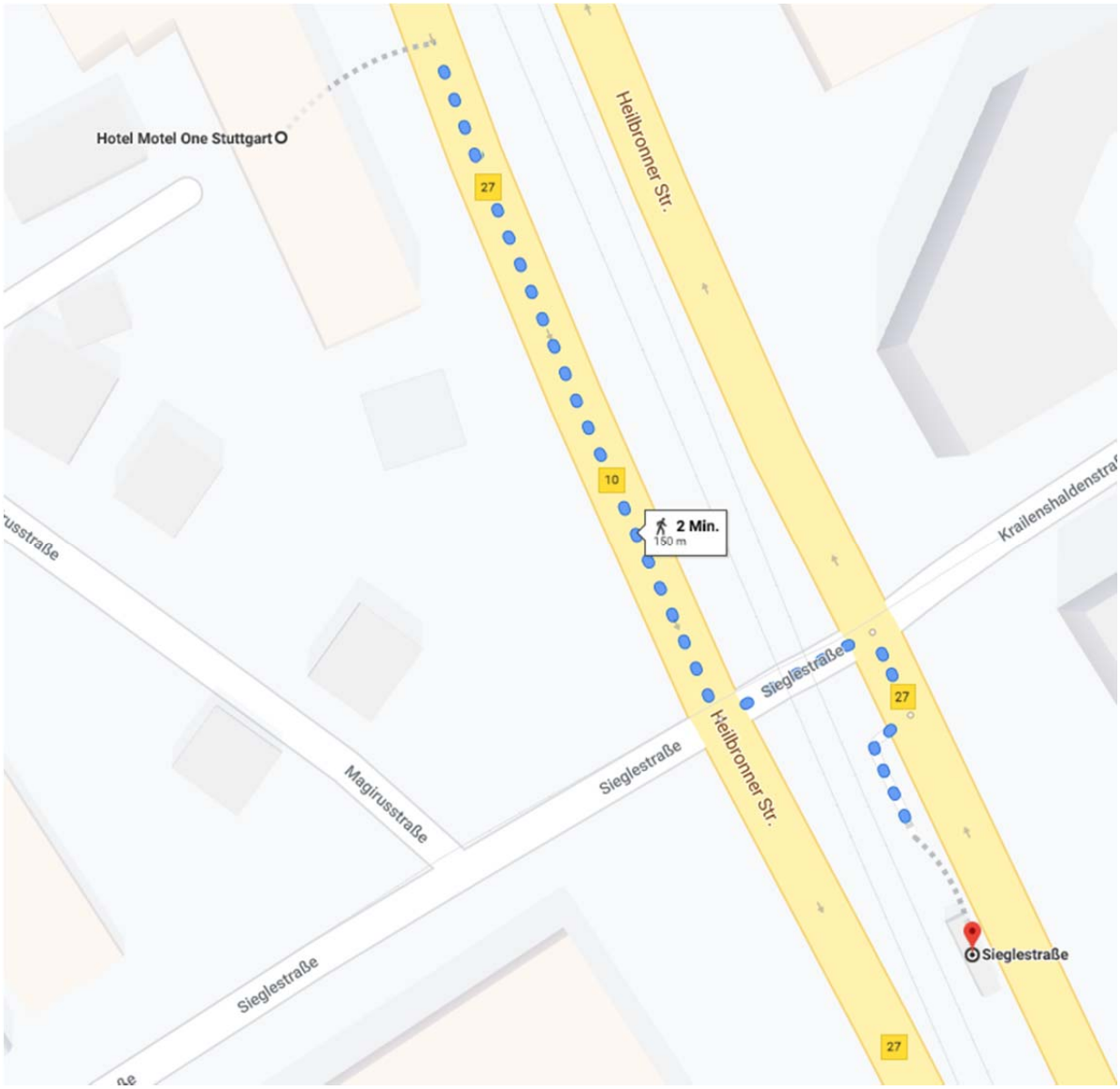
Your reservation goes through us. If you are interested, please contact Claudia Haaf until **29th of February 2020**, directly via e-mail: claudia.haaf@igte.uni-stuttgart.de

- **Stuttgart Transportation:**

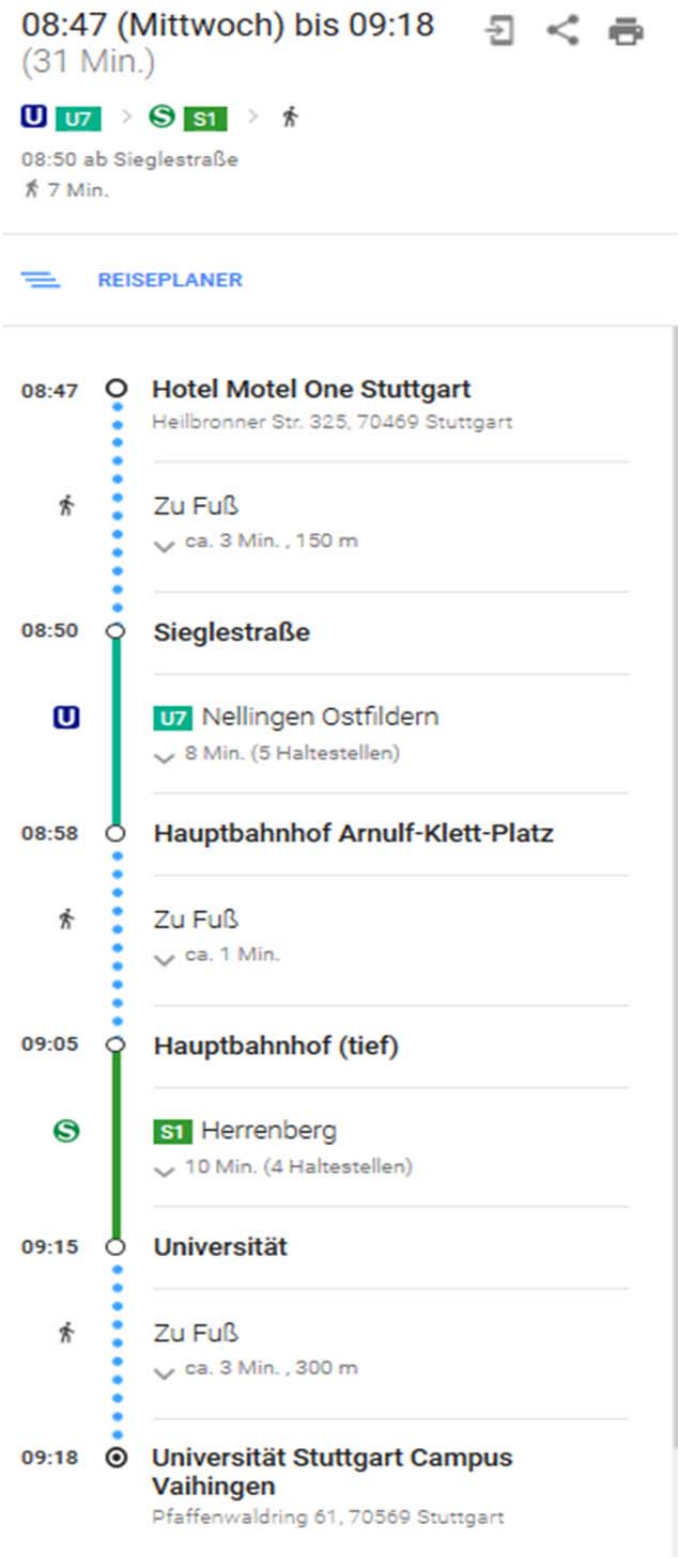
  https://en.vvs.de/home/

  - **From Motel One to Venue „IBZ“by public transportation:**

  ➔ First take a walk from the Motel One to the tram stop: “Sieglestraße”:



➔ Then take tram and subway until stop „Universität / University“:



➔ Finally go by feet to IBZ (venue) – approx 10 min: