wes.online – Study Tour to Sites of the Wind Energy Industry and Research in Germany

From September 24th to 28th, 2018

Study tour program & background information

UNIKASSEL VERSITÄT

Fraunhofer IEE

Fraunhofer IWES

Table of contents

Overview week program

	Sun, Sep 23rd	Mon, Sep 24th	Tue, Sep 25th	Wed, Sep 26th	Thu, Sep 27th	Fri, Sep 28th
Morning		**University of Kassel** ▪ Welcome address and presentation ▪ Site visit & Meeting ▪ Guided tour of laboratories at the University of Kassel	**Fraunhofer IEE** ▪ Welcome address and presentation **Fuldatal** ▪ Site visit of SysTec, visit of laboratories	**ENERCON** ▪ Site visit & Meeting ▪ Tour of visitor center, rotor blade production, presentation by HR department	**Fraunhofer IWES** ▪ Site visit & Meeting ▪ Presentation and tour of rotor blade testing facilities ▪ Visit of ADWEN 8 MW, DyNaLab (nacelle testing)	**WindEnergy Hamburg** ▪ WindEnergy Recruiting Day (9:00 a.m. – 4:00 p.m.)
Lunch		University canteen	Restaurant "Kleine Konoba"	ENERCON canteen	University canteen	Self-organized
Afternoon		**Söhrewald** ▪ Site visit wind farm	**Wolfhagen** ▪ Site visit ▪ Presentation on met mast and LiDAR wind measurement	**Transfer to Bremerhaven** ▪ Free time	**Klimahaus Bremerhaven** ▪ Independent tour ▪ Transfer to Hamburg	**WindEnergy Hamburg** ▪ WindEnergy Recruiting Day (9:00 a.m. – 4:00 p.m.)
Evening	Arrival in Kassel, self-organized	Dinner together (optional)	Transfer to Aurich and dinner in transit	Dinner together (optional)	Dinner together (optional)	Departure, self-organized

Detailed Program

Sunday, September 23: Arrival

Accommodation: Sandershaus, Kassel

Address: Sandershäuser Straße 79, 34123 Kassel

Phone: +49 (0) 561 49198466
Mobile: +49 (0) 163 1517444

Mail: hostel@sandershaus.de

www.sandershaus.de

Directions

From railway station Kassel-Wilhelmshöhe take tram 4 (direction: "Hessisch Lichtenau") until tram stop "Sandershäuser Straße" (approx. 25 minutes), then walk to hostel Sandershaus (approx. nine minutes, see p. 23 for map).

Monday, September 24

Morning	
9:00 -9:15	Welcoming at University of Kassel, Mönchebergstraße 7 Room 3516 *Dr. André Bisevic, University of Kassel*
9:15 -9:45	Introduction to Chladni-Experiment (Institute of Mechanics and Dynamics) *Dipl.-Ing Matthias Weiland, University of Kassel*
9:50 – 10:00	Welcoming *Prof. Dr.-Ing. Detlef Kuhl, University of Kassel*
10:00 – 11:00	Guided tour of laboratory (Department of Geotechnics) *Prof. Dr.-Ing. Oliver Reul, University of Kassel*
11:00 – 12:00	Guided tour of laboratory (Institute of Mechanics, Department of Fluid Mechanics) ▪ Wind channel ▪ Laboratory of optical flow measurement *Dipl.-Ing. Stefan Descher, University of Kassel* *Dipl.-Ing. Gerd Schneider, University of Kassel*
12:15 – 01:00	Lunch break at university canteen
Afternoon	
1:00 – 2:00	Presentation · Planning, construction, operation and maintenance of wind farm Söhrewald *Dipl.-Ing. Lars Rotzsche, Städtische Werke AG*
2:00	Transfer to wind farm Söhrewald
2:30	Arrival at wind farm
2:30 – 4:30	Guided Tour
4:30	Return to Kassel

5:00 – 7:00	Free time
7:00	Dinner with Prof. Detlef Kuhl and WES-online students and participants of certificate programs Restaurant Fratelli, Friedrichsplatz 10, 34117 Kassel; +49 561 / 76 67 91 90; http://www.fratellikassel.de/

Directions from Hostel Sandershaus to University campus

From tram station "Sandershäuser Straße" take tram 4 (direction: "Druseltal") OR tram 8 (direction: "Hessenschanze") OR bus 32 or 37 (direction "Fraunhofer Institut"), get off at stop "Altmarkt / Regierungspräsidium", then walk to university campus (see p. 22 for map).

Tuesday, September 25

Morning	
Travel information	The Fraunhofer IEE office is directly opposite the station Kassel-Wilhelmshöhe
8:45 – 9:30	Welcome at the Fraunhofer IEE, Kassel, Wilhelmshöher Allee 256, 4th floor ▪ Introduction to research and laboratory facilities *Prof. Dr.-Ing. Kurt Rohrig, Fraunhofer IEE*
9:45	Transfer to Fraunhofer SysTec, Fuldatal-Rothwesten
10:15 – 11:45	Visit of laboratories: ▪ Hybrid system and micro grid test field incl. wind turbine (95 kW) ▪ Research and testing laboratory for grid integration ▪ FRT / UVRT (fault / under-voltage ride through) test container *Nils Schäfer, Fraunhofer IEE*
12:15 – 1:00	Lunch break Restaurant "Kleine Konoba", Wilhelmshöher Alle 256
Afternoon	
1:15	Transfer to met mast at Wolfhagen-Nothfelden
2:15 – 4:00	Demonstrations of wind measurement ▪ Application of LiDAR wind measurement *Tobias Klaas, Fraunhofer IEE*
4:30	Transfer to Aurich (dinner in transit)
Around 10:00	Arrival at Middelpunkt Sporthotel

Wednesday, September 26

Morning	
8:45	Check out and transfer to ENERCON
9:00	Arrival at ENERCON Aurich
9:15	Welcoming at Visitor Center
9:30 – 10:00	Presentation of the HR department: Career opportunities at ENERCON *Katja Seibel, ENERCON*
10.15 – 12:45	Guided Tour ▪ Visitor center ▪ Rotor blade production site *Petra Redenius-Hinze*, ENERCON
1:00 – 2:00	Lunch break at ENERCON canteen
Afternoon	
2:00	Departure
Around 4:00	Arrival at Bremerhaven, check in at Atlantic Hotel
4:00 – 7:00	Free time
7:00	Dinner together (optional)

Thursday, September 27

Morning	
8:45	Check out and transfer to Fraunhofer IWES
9:00 – 10:30	Welcome at the Fraunhofer IWES (Am Seedeich 45) ▪ General introduction to Fraunhofer IWES *Telsche Nielsen-Lange, Fraunhofer IWES* ▪ Qualification of composite materials and components – visiting rotor blade testing facilities *Willi Wroblewski, Fraunhofer IWES*
10:30 – 12:00	Site visits ▪ Nacelle Testing and Examination of Electrical Characteristics ▪ Visit of ADWEN 8 MW wind turbine ▪ DyNaLab *Prof. Dr. Jan Wenske*
12:30 – 1:30	Lunch break
Afternoon	
1:45 – 4:30	Visit of museum *Klimahaus Bremerhaven* ▪ World of Weather ▪ Climate and Climate-Change ▪ Knowledge and Experience https://www.klimahaus-bremerhaven.de/en.html?no_cache=1
4:30	Departure
Around 7:00	Arrival in Hamburg, check-in at A&o Hamburg Reeperbahn
8:00	Dinner together (optional)

Friday, September 28

Morning	
08:15	Departure at hotel
8:45	Arrival at WindEnergy Hamburg
9:00	Send-off *The WES.online team will be present at the expo stand.*
9:00 – 4:00 p.m.	WindEnergy Recruiting Day *Free time and departure (self-organized)*

Information on contributing German institutions

► University of Kassel

Founded in 1971, the University of Kassel is the youngest university in the state of Hessen. The current enrollment is approximately 23,696 students.
Kassel has a long-standing tradition of competence in the engineering sciences. In 1832, one of the first Polytechnic Teaching Institutes in Germany was founded here; instructors included many famous scientists, including Woehler, Bunsen, Burhenne and Philippi. Later, engineering in Kassel gained a global reputation in connection with the entrepreneurial family Henschel. The transformation of the site of the former Henschel Works into a modern campus for the University of Kassel carries this tradition into the future: where cannons and locomotives were once made, careers and high-tech projects are developed today. Innovation and practical orientation are also hallmarks in the areas of civil engineering, mechanical engineering, electrical engineering and computer science. As in the related areas of architecture and agricultural science, the objective is to address questions relating to the Man-Communication-Technology triad.
Since the foundation of the University of Kassel, the environmentally responsible attitude of the University of Kassel has provided direction for academic research and cutting edge science. As a modern university, it is faced with the responsibilities and challenges of balancing the needs of humankind with the preservation of the environment. The University of Kassel's environmental profile describes the university's official position on environmental issues and offers insight into the university's excellent environmental study and research programs.

Every year the University offers more than 200 courses on environmental topics, 19 environment-related bachelor's and master's programs and advanced study programs, like the Online M.Sc. Wind Energy Systems.

https://www.uni-kassel.de/uni/en/

► Institute of Mechanics and Dynamics

The Institute of Mechanics and Dynamics, directed by Prof. Dr.-Ing. habil. Detlef Kuhl, represents the department of analytical, numerical and experimental mechanics in education and research.
The field is divided into the working groups "modeling and numerical mechanics" and "experimental mechanics".
The "modeling and numerical mechanics" group currently deals with modeling advanced mechanical systems, prevalent with insufficient realistic captured mechanisms. Examples of these models are:

- the interaction of chemical processes, moisture and heat transport,
- mechanically induced deformation and damage in concrete and
- the interaction of electromagnetic fields with thermomechanics in metal parts during the manufacturing process of thermo-mechanical deformation, wit metallic contact and the subsequent cooling fluid.

The methodological and algorithmic developments and investigations are complemented by simulations of real engineering applications.

The second group, "experimental mechanics", determines the mechanical parameters of experiments, which are used to identify and parameterize mechanical models. Computer-based methods of signal analysis and system identification are developed and applied to real data structures. The methodological foci are the methods of experimental modal analyses and model

adaptation using finite element-based parameter identification. In addition, procedures for long-term observations are developed for current state analyses of supporting structures and are tested on real applications.

The interaction of the methods and results of the two fields allows challenging and innovative problems in the broad field of mechanics to be addressed.

https://www.uni-kassel.de/fb14bau/en/institute/ibsd/baumechanikbaudynamik/home.html

▶ Chladni Experiment and Chladni Figures

Vibrating structures show complex spatial structures which are called mode shapes. Today, there are lots of experimental methods to visualize such vibrations. However, they do not allow to get a direct intuitive impression of the vibration pattern.

Back to the time when sophisticated electronical means had not been available, the german researcher Ernst Florence Chladni invented a very simple but elegant way to visualize the vibrations. He had spreaded sand on vibrating plates. The sands would gather at positions of smaller motion - the so called nodal lines - which give a nice and beautiful geometrical impression on the shape of the vibration.

Since the vibrations of the plates are usually associated with the acoustic impression of the audible sound, these figures are sometimes being known as "Shape of Sound".

The experiment under demonstration is a modern method of the classical Chladni experiment.

▶ Department of Geotechnics

The department of Geotechnics is a member of the Institute of Geotechnics and Geohydraulics in the Faculty of Civil and Environmental Engineering at the University of Kassel. It participates in the academic teaching of Civil Engineering, Environmental Engineering and Industrial Engineering. The laboratory provides an experimental hall with test facilities and a test box with different static and cyclical loading devices and large containers for pilot experiments and model projects.

▶ Fraunhofer Institute for Energy Economics and Energy System Technology IEE, Kassel

The Fraunhofer IEE in Kassel researches for the national and international transformation of energy systems. It develops technical and economic solutions in order to further reduce the costs of using renewable energies, to secure the supply despite volatile generation, to ensure grid stability at the high level and to promote the success of the energy transition business model.
The institute emerged from the Energy System Technology branch of Fraunhofer IWES in 2018 but was founded as Institut für Solare Energieversorgungstechnik ISET in Kassel aleady in 1988.
Actually the institute employs approx. 400 scientists, engineers, non-technical staff, and students and has a budget of about. 22 million euros p.a.

Business units and fields

The service portfolio deals with current and future challenges faced by the energy industry. The insitute explores and develops solutions for sustainably transforming renewable based energy systems in the following business fields.

Energy economics

- Analysis and consulting for energy economics
- Energy meteorology information systems
- Virtual power plants
- Wind resource assessment with LiDAR
- Training and knowledge transfer

Energy system technology

- Grid planning and operation
- Power electronics and device technology
- Hardware in the loop systems
- Decentralized energy management
- Systems engineering
- Measuring and testing

Competences

- Energy management and system design
- Energy meteorology and renewable resources
- Energy informatics
- Energy process technology
- Power grids
- Components and plant technics

Test Centers and Laboratories

The Fraunhofer IEE disposes extensive testing and experimental facilities, laboratories, and state-of-the-art equipment.

Together with the know-how of our scientists and engineers, these facilities mean that the institute is able to offer its customers and partners future oriented research and development services and infrastructure. Our main facilities and activities are:

- SysTec: Test center for smart grids and electro mobility
- DeMoTec: Design center for modular supply technology
- 200 meter wind measuring mast, laser wind measuring technics and wind measuring network
- Laboratory for control systems for large wind turbines
- Photovoltaic systems test field
- Experimental center for bioenergy system technology
- Accredited laboratory for inverters and EMC
- Battery storage laboratory

Collaboration

Fraunhofer IEE collaborates with the universities of Kassel, Hannover and Darmstadt.

Within the Fraunhofer-Gesellschaft, use is made of the expertise and experience of partner institutes, in particular of Fraunhofer Energy Alliance.

At national and international levels, the institute successfully collaborates with many public and industrial research groups. The large number of direct contracts with industry highlights the application-oriented work of Fraunhofer. In addition, it supervises many projects from industry work groups and many development projects are undertaken with industrial companies.

With its technical expertise, the institute contributes to the definition of political and commercial parameters.

https://www.iee.fraunhofer.de/en.html

▶ IEE – SysTec (IEE)

Test Center for Smart Grids and Electromobility

In its test centre for smart grids and electromobility, Fraunhofer IEE is developing and testing new equipment and operation strategies for smart low and medium voltage grids. In addition, investigations regarding grid integration and grid connection of electric vehicles and their power generated from renewable energy sources as well as photovoltaic systems, wind energy plants, storage and hybrid systems are carried out under realistic conditions here.

A large open-air ground of approx. 80,000 m² offers sufficient space and very good conditions for solar and wind energy. Furthermore, the open-air ground provides configurable distribution grid sectors (low and medium voltage), as well as a route offering the possibility to test inductive charging systems for electric vehicles.

In the eastern area of the premises there is a hall presently with two laboratory divisions: one of the labs includes a testing area for low and medium voltage converters, electrical machines or grid equipment. There it is possible to develop and test the electrical properties and in particular the ancillary services of remote generators in the power range up to 6 MVA. A mobile test container able to be used to measure the fault-ride-through of generation plants has been integrated into the laboratory. The second lab is equipped with facilities to test grid integration of electric vehicles and power storage. In addition to hardware simulators for batteries, bidirectional charging controllers, charging columns and grid simulators, there is a roller chassis dynamometer for electric vehicles to replicate operational profiles as well as a test facility to analyze inductive energy transfer.

https://www.iee.fraunhofer.de/en/laboratories/iee-systec.html

▶ 200-Metre High Measurement Mast (IEE)

Research and Testing Platform

The 200-metre high research measurement mast on the Rödeser Berg near Kassel is the only facility of its kind in Germany. Researchers from Fraunhofer IEE use the mast to investigate the wind profile and the wind characteristics up to very great heights. In addition, the "vertical laboratory" allows to fit sensors and measurement systems directly to the mast at heights of up to 200 metres above ground level and test them. Moreover, comparative measurements and validation tests for remote measuring systems can be carried out under complex wind flow conditions. So far, a whole variety of different testing and measurement projects have been carried out using the 200m mast, including using LiDAR and SoDAR wind measurement devices, LiDAR wind scanners, and ice and bat sensors.

The 200m mast is situated on a hilltop in a typical wooded, upland location, and it has the following specification:

- Wind measurement mast with a measurement height of 200 m
- A wide range of equipment: over 20 wind sensors distributed at 13 different measuring heights, and 40 meteorological sensors in total, including several ultrasound anemometers and a ceilometer
- High-precision measurement system: IEC-compliant, MEASNET-calibrated wind measurement sensors

https://www.iee.fraunhofer.de/en/laboratories/wind_measuring_network.html

ENERCON

Innovative products – Future-oriented company

ENERCON has been one of the technology leaders in the wind power sector for more than 30 years. As the first manufacturer of wind turbines, the company used a gearless drive concept that is a characteristic of all ENERCON wind turbines. ENERCON is also at the forefront in other areas, such as rotor blade design, control and grid connection technology, and, with its wide range of technological new developments, proves its innovative strength time and again.

Continual research and development are guarantees of the ongoing success of the company. The same applies to production and service. All key components are manufactured at exclusive suppliers for ENERCON. This ensures the high quality and extreme reliability of ENERCON wind turbines.

The product portfolio comprises wind turbines with outputs from 800 to 4,200 kilowatts. ENERCON has already installed more than 28,300 turbines worldwide with a total rated power of more than 48 gigawatts (3/2018).

ENERCON wind turbines have a grid feeding system that is certified to the latest grid connection requirements. They can therefore be integrated without difficulty into all supply and distribution grid structures.

True to the company's claim of «energy for the world», ENERCON is driving forward supply with renewable energies worldwide and is involved in areas of future technology such as energy storage, e-mobility and smart grid solutions. In doing so ENERCON is expanding its worldwide activities in line with demand. Internationally, ENERCON has a presence in the major markets with a decentralized service and sales network.

https://www.enercon.de/en/home/

Fraunhofer Institute for Wind Energy Systems IWES, Bremerhaven

Fraunhofer IWES ensures investments in technological developments in the field of wind energy through its validation services. By operating large test rigs, it accelerates the market introduction of innovative products, enhances certification processes and increases planning security by using state-of-the-art measurement techniques. Fraunhofer IWES employs around 180 scientists and administrative staff and 70 students at five sites: Bremerhaven, Hanover, Bremen, Hamburg and Oldenburg. In 2017, the operational budget has been 18.9 million Euros.

Today, IWES operates test rigs for rotor blades, nacelles, support structures, rolling bearings and main shafts - which has been possible thanks to continous public funding right from the start in the founding year 2009. The testing spectrum was developed in cooperation with industry leaders, who were involved from the design phase right up to commissioning. This approach made sure that the test rigs and measurement equipment comply with actual industry needs. These assets combined with the methodological competence of its employees make Fraunhofer IWES a preferred research and development partner for companies all around the globe. By participating actively in international commitees and associations, the institute contributes to technology development and quality assurance within the wind industry.

Together with the German Aerospace Center (DLR) and the university association ForWind, IWES is part of the Research Alliance Wind Energy. In total, this alliance comprises more than 600 scientists all investigating topical issues in the field of wind energy. In order to guarantee transfer of academic expertise, strong ties with further universities have been built.

https://www.iwes.fraunhofer.de/en.html

▶ Rotor blade test center (IWES)

Rotor blades are central components of wind energy turbine systems and subject to a wide variety of demands. The blades' aerodynamic efficiency must be high and resultant loads and manufacturing costs as low as possible. The combination of extreme operational demands with low structural costs can only be successful at the highest level of technology engineering. In order to continually advance the technology, the Fraunhofer IWES offers its customers a wide range of sophisticated testing technologies and a unique infrastructure.

In order to keep up with increasing cost pressure the rapidly, soaring quality requierements and an accelerated innovation cycles, new technological methods from fields like aerodynamics, load and structural calculations as well as material-, component- and structural testing are applied.

Fraunhofer IWES is certified according to DIN EN ISO 9001:2008 regarding "product development up to the prototype stage, technology development and optimization, technology assessments and studies" as well as "trials in demonstration centers".

https://www.iwes.fraunhofer.de/en/quick-guide-from-entry-site/quick-guide-acredited-rotor-blade-testing.html

▶ DyNaLab Nacelle Testing Laboratory (IWES)

The expectations placed on the performance of wind turbines have increased significantly during recent years. The increasing competitive pressure which prevails on the global market and the noticeable professionalization of the industry have increased these expectations: With new turbine designs, the expectation nowadays is that the first turbines of a new type already run with high reliability when they are first delivered. Investors demand proof of comprehensive operational experience before they will commit financing for projects. New developments – even modifications of existing products – therefore represent a significant economic risk as far as the manufacturers are concerned. The experimental validation of prototypes on large test benches reduces this risk, accelerates the certification, and improves the plannability.

The higher proportion of electricity from regenerative sources in the distribution and transmission grid structures at various voltage levels increases the demands being placed on the grid integration of wind turbines as power generating units (PGU) even further. These requirements are laid down in standards and guidelines which have to be taken into account in future developments. Turbine certificates are mandatory for new and modified turbine designs. They ensure that the PGU operation is compliant with the grid code and thus guarantee the grid connection in the long term and the continuation of the feed-in tariff.

Fraunhofer IWES assists turbine manufacturers by offering efficient test methods for the accelerated validation of the electrical properties of PGUs on test benches to meet the increasing requirements.

https://www.iwes.fraunhofer.de/content/dam/windenergie/de/documents/aktuelleDatenblaetter/DB%20DyNaLab_2017_en%20print.pdf

▶ Klimahaus Bremerhaven

The museum Klimahaus Bremerhaven 8° Ost is a mixture between a science center and theme park. It shows a unique world of weather, climate and climate-change knowledge and experience, also making it a climate museum.Travel the world along the eighth longitude and experience the earth's climate zones close up – exciting and spectacular.

You will cross five continents and nine locations. You will sweat, freeze, marvel and laugh, and above all, meet people from around the world who will talk about their everyday lives and describe how the climate affects them.

https://www.klimahaus-bremerhaven.de/en.html?no_cache=1

▶ WindEnergy Hamburg

The Expo

As the global leader in its sector, WindEnergy Hamburg is the international meeting point and is held in even-numbered years, while HUSUM Wind is the meeting point for the German-speaking wind energy market and is held in oddnumbered years.

WindEnergy Hamburg is tailored toward addressing the major issues facing the international wind energy sector. The trade fair covers the whole value chain of wind energy, and provides a special focus for expertise in its section on storage technologies. It also has an extensive supporting programme.

https://www.windenergyhamburg.com/en/the-expo/profile/

Recruiting Day on Friday 28th of September

On Friday many of the exhibitors will present themselves as employers in the Recruiting Area. Skilled specialists will have an opportunity, alongside the normal expo and meeting activities, to meet up with human resource managers and find out about further education opportunities.

https://www.windenergyhamburg.com/en/the-expo/expo-programme/job-route/?no_cache=1

Program responsibility

Prof. Dr.-Ing. Habil. Detlef Kuhl

University of Kassel
Head of Institute of Mechanics and Dynamics
Mönchbergstraße 7, 34125 Kassel
☎ +49 (0) 561 / 804 1815
✉ kuhl@uni-kassel.de
💻 https://www.uni-kassel.de/fb14bau/institute/ibsd/baumechanikbaudynamik/team/kuhl-detlef.html

Coordination

Dr. André Bisevic

University of Kassel / Fraunhofer IEE
Goethestraße 27, 34119 Kassel
☎ +49 (0) 561 / 7294 451
✉ andre.bisevic@iee.fraunhofer.de

Logistical and social support

Laura Große

Fraunhofer IEE
Goethestraße 27, 341129 Kassel
☎Phone +49 (0)174 / 700 7393
✉ laura.grosse@iee.fraunhofer.de

Information on lecturers

KASSEL / SÖHREWALD / WOLFHAGEN	
Prof. Dr.-Ing. Detlef Kuhl, University of Kassel	✉ kuhl@uni-kassel.de ☎ +49 561 / 804-2654
Prof. Dr.-Ing. Oliver Reul, University of Kassel	✉ o.reul@uni-kassel.de ☎ +49 561 / 804-2631
Prof. Dr.-Ing. Kurt Rohrig, Fraunhofer IEE	✉ kurt.rohrig@iee.fraunhofer.de ☎ +49 561 / 7294-330
Dr. André Bisevic, Fraunhofer IEE / University of Kassel	✉ andre.bisevic@iee.fraunhofer.de ☎ +49 561 / 7294-451
Dipl.-Ing. Stefan Descher, University of Kassel	✉ descher@uni-kassel.de ☎ +49 561 / 804-3980
Dipl.-Ing. Lars Rotzsche, Städtische Werke AG	✉ lars.rotzsche@sw-kassel.de ☎ +49 561 / 782- 2927
Dipl.-Ing. Nils Schäfer, Fraunhofer IEE	✉ nils.schaefer@iee.fraunhofer.de ☎ +49 561 / 7294-146
Dipl.-Ing. Gerd Schneider, University of Kassel	✉ schneiderg@uni-kassel.de ☎ +49 561 / 804-3979
Dipl.-Ing Matthias Weiland, University of Kassel	✉ mweiland@uni-kassel.de ☎ +49 561 / 804-3321
M. Sc. Tobias Klaas, Fraunhofer IEE	✉ tobias.klaas@iee.fraunhofer.de ☎ +49 561 / 7294-447
AURICH	
Katja Seibel, ENERCON	✉ katja.seibel@enercon.de ☎ +49 4941 / 927 225
Petra Redenius-Hinze, ENERCON	✉ petra.redenius-hinze@enercon.de ☎ +49 4941 / 9187 2900
BREMERHAVEN	
Telsche Nielsen-Lange	✉ telsche.nielsen@iwes.fraunhofer.de ☎ +49 471 14290 217
Willi Wroblewski	✉ willi.wroblewski@iwes.fraunhofer.de ☎ +49 471 14290 336
Prof. Dr. Jan Wenske	✉ jan.wenske@iwes.fraunhofer.de ☎ +49 471 14290 502

Participants

Participants **No.**	**Name**	**First Name**
1.	Abraha	Alfa Hailemariam
2.	Abuzayed	Anas
3.	Brünjes	Jannis Oskar
4.	Emam	Eslam
5.	Fromm	Daniel
6.	Hernández Fillols	Francisco
7.	Hesping	Tobias
8.	Kankelfitz	Fred
9.	Mbomba	Zacharie
10.	Plaisir	Marie
11.	Poritskiy	Nazar
12.	Rahmanian	Anahita
13.	Sargin	Okan
14.	Shimonishi	Marco
15	Wusten	Eric

Accommodation

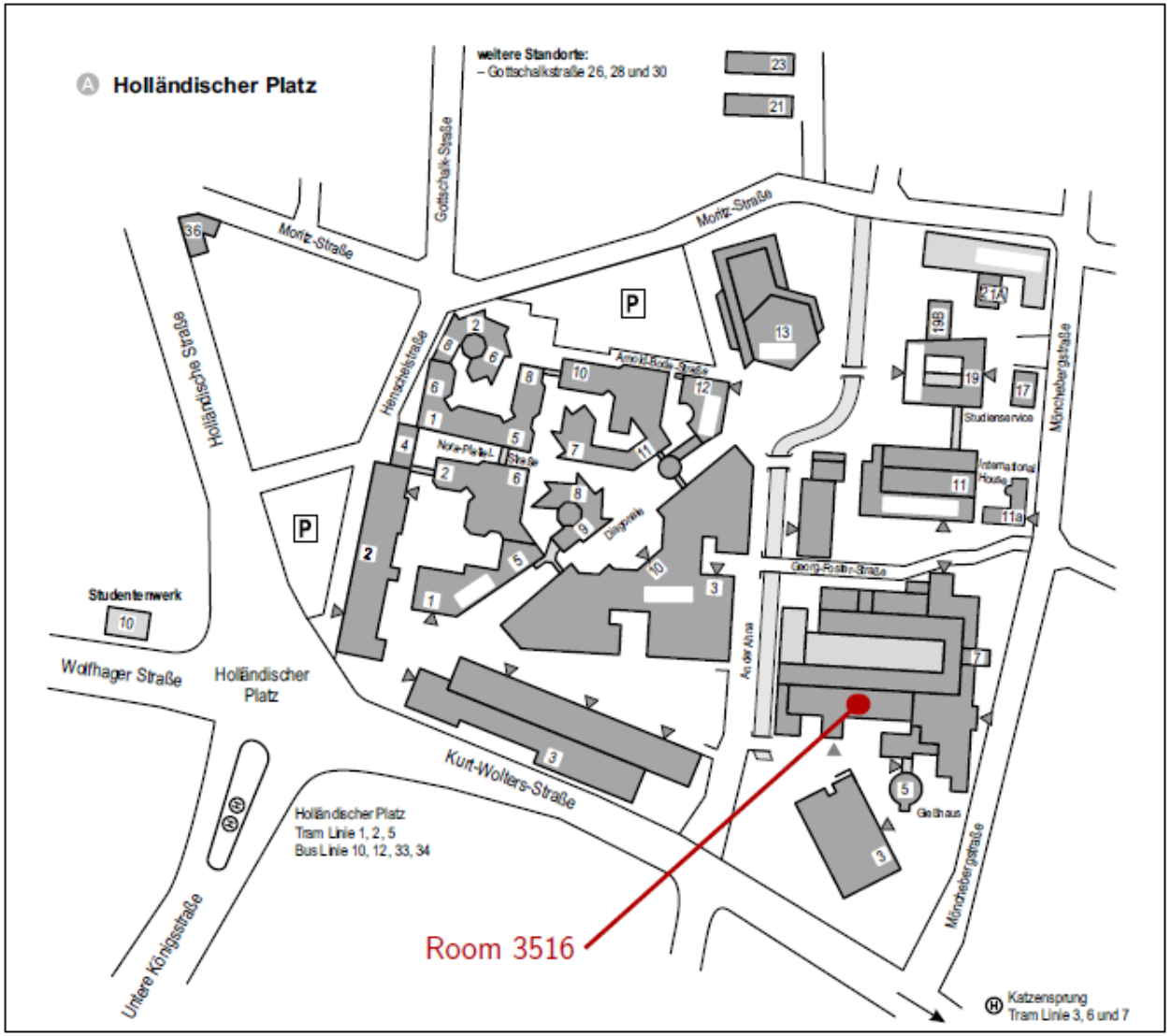
Kassel:
Sandershaus
Address: Sandershäuser Straße 79, 34123 Kassel
Phone: +49 (0) 561 49198466

Aurich:
Middelpunkt Sporthotel
Address: Westerlooger Straße 1, 26607 Aurich
Phone: +49 (0) 4947 509790

Bremerhaven:
Atlantic Hotel am Floetenkiel
Address: Nordstraße 80, 27580 Bremerhaven
Phone: +49 (0) 471 806260

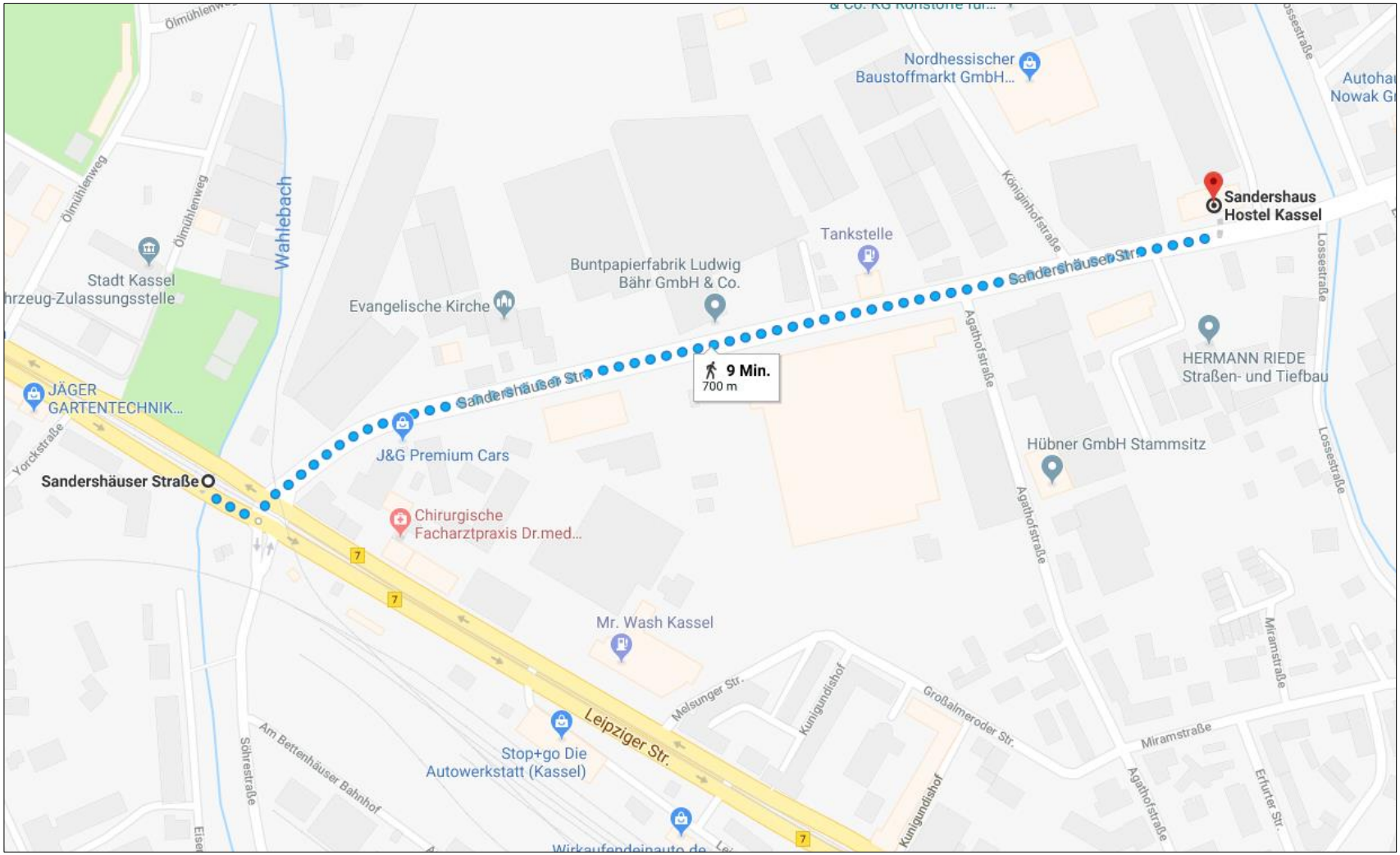
Hamburg:
A&o Hamburg Reeperbahn
Address: Reeperbahn 154
20359 Hamburg
Phone: +49 (0) 30 80347 5110

Maps



1) University Campus

2) Tram station to Hostel "Sandershaus"



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