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“Linking business and higher education institutions on
bioresource education” and “Creating regional outreach
networks”

**Task: “Regional higher education and
business survey in the bioresource sector”**

Part 1 – Higher education survey for the Hamburg region in the bioresource sector

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BET - summary

The development and adoption of renewable and sustainable energy has become a top priority in Europe, and is Horizon 2020's most prominent theme. Bioenergy is a particularly important field. It is at the cross-roads of several important European policies, from the Strategic Energy Technology Plan Roadmap on Education and Training (SET-Plan) over the European Bioeconomy Strategy up to the European Food Safety and Nutrition Policy. Bioenergy policies can only be successful, if they are interconnected with other sectors such as the material and food supply chains.

The SET-Plan Roadmap defines the needs on education in the bioenergy sector in a holistic sense. It states an additional demand in a highly skilled and innovative workforce from up to 5 Mio. till 2020 for Europe. It furthermore suggests to establish interdisciplinary higher education schemes in the direction of *Bioresource Management* and *Biorefinery Technology* and to improve linkage between professional education and training with industry needs.

The BioEnergyTrain project (BET) brings together 15 partners from six EU countries to create new post-graduate level curricula in key bioresource disciplines, and to improve outreach of higher education institutions and research centers. From the content to the whole value chain of bioresources - from field and forest systems up to integration into the sustainable energy and material provision systems of regions shall be included.

In BET-work-package (WP) 1 of the project, a Master curricula "*Biorefinery Engineering (BRE)*" and in WP 2 a Master curricula "*Bioresource value chain management (BVM)*" shall be developed and established at TU Graz (Austria) resp. TU Twente (The Netherlands). The project partners contribute with courses, which are aimed to be used over an open-online-platform. The contribution of TUHH is the course "*Residue and by-product based bioresources – characterization, properties and pathways*".

In WP 3 and 4 of the project the regional outreach of Higher Education Institutions (HEI's) and linking's between HEI's and other regional stakeholders shall be highlighted. For that purpose, in the regions North Rhine-Westphalia (Germany), Hamburg (Germany), Brasov (Romania), Brussels-Capital Region (Belgium), Overijssel (Netherlands), Lisbon (Portugal), Western Slovenia (Slovenia), Styria (Austria), Upper Austria (Austria) surveys on the situation and on the demands shall be prepared. Suggestions to improve HEI's outreach shall be made.

1. Background and goal

The BET-task considered in this study aims to provide a regional survey regarding actual available bioresource-related higher education (Part 1) and regarding concerned other stakeholders (Part 2) for the region of Hamburg. The goal was/is to evaluate regional demands or potentials in the direction of bioenergy, bioresource and biorefinery education. Based on this knowledge regional HEI-outreach may be improved. TUHH is involved in the task with a very limited time budget from approximately one month only. Therefore focuses had to be laid.

2. Hamburg Region

If speaking of Hamburg as a region, it has to be distinguished between the Federal State (the Free and Hanseatic City of Hamburg, FHH, with around 1.8 Mio. inhabitants, and 755 km²), and the Metropolitan area of Hamburg (with around 5 Mio. inhabitants, and 26.078 km², covering the Federal States FHH, Schleswig-Holstein, Lower Saxony, Mecklenburg-West-Pomerania). The FHH is turn-over-based the biggest location of industry in Germany. It is strongly shaped by small and medium sized industries. From the 16.000 industries registered in Hamburg's Chamber of Commerce, 98 % belong to this group [1]. The FHH has also a reputation as scientific city with 21 higher education institutions (HEI) [2].

Due to the large numbers of e.g. inhabitants, industries and HEI's in the Hamburg region, it is impossible to provide a complete overview on the region with the available limited time budget - not only for the Metropolitan area, but also for the FHH. For that reasons simplifications were made and focuses laid. In this study, the FHH was considered as regional frame, although for the bioresource topic, the Metropolitan region with agricultural and forest areas and connected branches are very important too.

In this part of the study a comprehensive overview on the state-of the art regarding bioresource education in HEIs shall be provided (Part 1). The businesses in the FHH can be categorized into following: domestic trade, foreign trade, consulting, service sector, financial management, real estate business, industry, information technologies, logistics, media and creative industries, sport business, tourism and recreation [1]. From these some will be selected exemplarily and contacted regarding their future demands on workforces in connection with the bioenergy sector. These results should only be considered as "snapshots" will be provided in the next reporting period (Part 2).

2. Workplan

The workplan refers to the whole task “Regional higher education and business survey in the bioresource sector”. It was separated in Part 1 (Higher education institutions) and Part 2 (businesses). Part 1 is finalized as draft for further discussions. Part 2 is under development.

1. General definition of stakeholder groups (Part 1)
2. Selection of important stakeholders for the bioresource sector (Part 1)
 1. Higher education institutions (HEIs)
 2. Others institutions, businesses, organizations, authorities, clusters
3. Short description of selected higher education institutions and their links to bioresource relevant topics (Part 1)
 1. Center of Wood Science Hamburg
 2. Hamburg University of Technology
 3. Selected evaluation results of the German Council of Science and Humanities for Hamburg’s MINT-institutions
4. Contacting selected other stakeholders (Part 2)
 1. Adaption of eseia questionnaires
 2. Sending information/questionnaires per e-Mail to networks
 3. Direct contacting of some industry stakeholders
5. Summarizing and concluding results (Part 1, Part 2)
6. Distribution of the Report to selected stakeholders (Part 2)

4. Stakeholder groups

Hamburg’s businesses (listed in chapter 2) are one stakeholder group. All businesses can be connected more or less to the bioresource topic – for instance as provider, user or seller of bioresources, as carrier or distributor of knowledge, as decision makers or more. A chart with a systematic prioritization regarding bioresource-relevant businesses and further important regional stakeholders is shown in Figure 1. For the HEI’s as one stakeholder group, a comprehensive overview on the FHH

region shall be given in relation to available bioresource knowledge. The focus regarding the further stakeholder groups is set on the residue and the energy sector and only selected prioritized stakeholders were included.

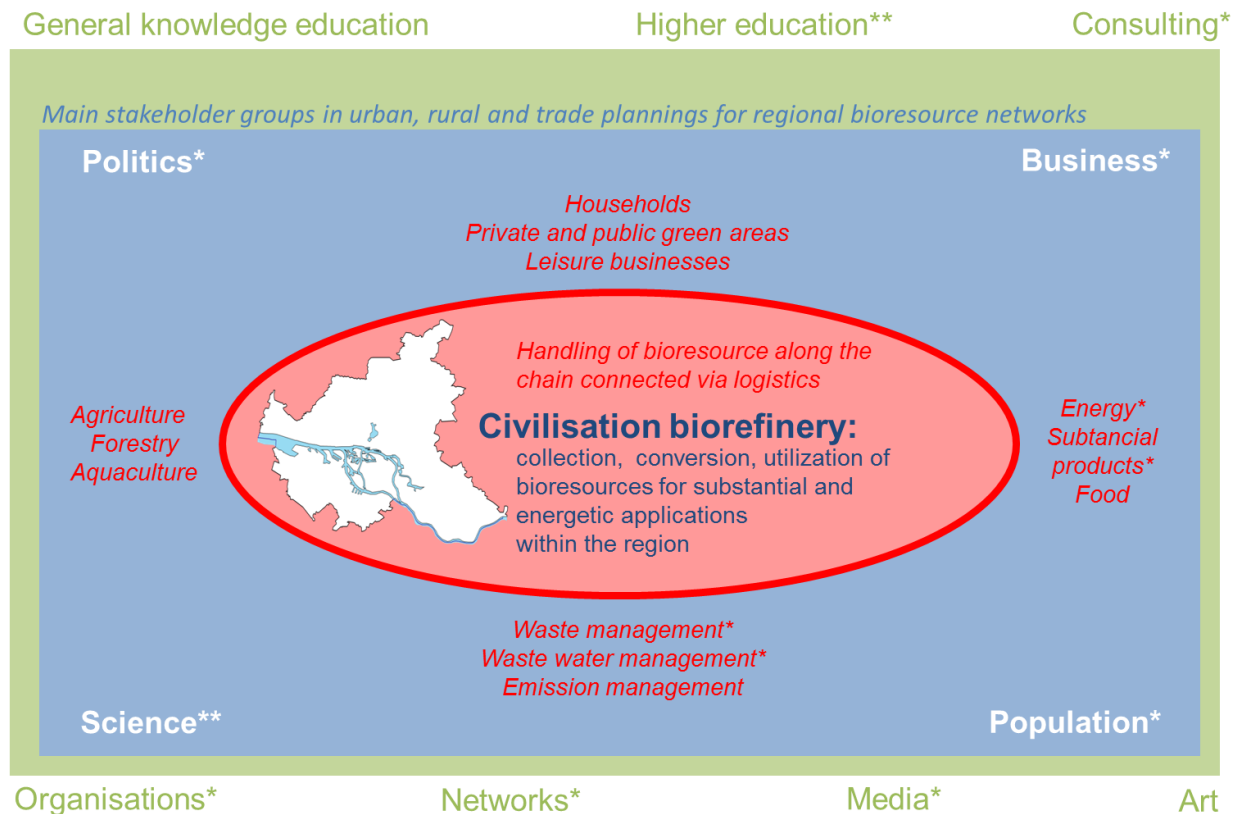


Figure 1: Overview on stakeholder groups involved in activities along the bioresource chain in technical, informative and deciding sectors.

**are contained in comprehensive way in Part 1

* some examples will be contained in Part 2

5. Higher Education Institutions with bioresource competence in the FHH region

In the following a comprehensive overview on HEIs involved in bioresource education is given for the FHH. In total, the FHH has 21 higher education institutions [2]. Especially, the *Center of Wood Science Hamburg* (ZHH) and the *Hamburg University of Technology* (TUHH) are important for bioresource-related topics. Both provide a comprehensive spectrum regarding bioresource management and biorefinery technology related issues. Furthermore, they are connected with ample bioresource-related networks in Germany and on an International scale. They will be described in more detail in chapter 5.1 and 5.2. Further HEI's which cover additional bioresource related aspects are described in chapter 5.3.

5.1. *Center of Wood Science Hamburg – Zentrum Holzwirtschaft Hamburg (ZHH)*

Several working groups of the Hamburg University (UHH) [3] are connected with branches of the Thünen-Institute (TI) [4], a governmental research institution of the Federal Ministry of Food and Agriculture (BMEL) [5]. They are in contractual cooperation and form - the Center of wood science (Zentrum Holzwirtschaft, ZHH) located in Hamburg's district Bergedorf. This Center has a history of 75 years and covers education and research in an interdisciplinary way by covering the whole product chain from production over transformation up to product consumption of wood and wood-based products. The ZHH offers a Bachelor and a Master degree in "Wood management", where traditional and innovative solutions are taught. An overview of the offered Master course subjects is attached. Extraordinary is, that engineering sciences, economics and natural sciences are closely combined. Besides lignocellulosic bioresources also bioresources from agriculture, aquaculture and from the residue sector are covered in research and education, but in less detail compared to subjects related to wood.

The actual structure of the university part of the ZHH covers following areas:

- "Wood biology" (Prof. Magel, Prof. Fromm),
- "Chemical wood technology" (Prof. Saake),
- "Mechanical wood technology" (Prof. Ressel, Prof. Krause),
- "Economics of wood management and Forestry" (Prof. Mantau),
- "World forestry" (Prof. Köhl).

The TI-branches on the ZHH cover the topics:

- “Wood research” (Dr. Schmitt),
- “International forestry and forest economics” (Prof. Dieter).

Other TI-branches with a bioresource connection are located in other German regions and include: “Rural studies”, “Farm economics”, “Market analysis”, “Agricultural technology”, “Biodiversity”, “Climate smart agriculture”, “Organic farming”. Some of them are located in the Metropolitan area of Hamburg.

All working areas of ZHH show special unique features for Germany and Europe wide.

5.2 Hamburg University of Technology – Technische Universität Hamburg (TUHH)

The Hamburg University of Technology (TUHH) [6] is one of the youngest Universities in Germany. The main campus is located in Hamburg’s district Harburg. Two of the three competence areas of TUHH are “Green Technologies” and “Life Science Technologies”. The first area covers research on renewable energies systems, storage, and grids, as well as water, residue and environmental engineering. The second focuses on research on biomaterials as well as biological and chemical process engineering. Bioresource-related topics are, therefore, covered by various institutes. The research is clustered in two Research Centers: “Climate Protecting Energy- and Environmental Engineering” [7] and “Integrated Biotechnology and Process Engineering” [8]. Following institutes belong to these Centers:

- Institute for Electric Power Systems and Automation (Prof. Ackermann),
- Institute for Energy Systems (Prof. Kather),
- Institute for Environmental Technology and Energy Economy (Prof. Kaltschmitt),
 - With Waste Resources Management Group (Prof. Kuchta),
- Institute for Multiphase Flows (Prof. Schlüter),
- Institute for Process and Plant Engineering (Prof. Fieg),
- Institute for Solids Process Engineering and Particle Technology (Prof. Heinrich),
- Institute for Thermal and Separation Processes (Prof. Smirnova),
- Institute for Thermo-Fluid Dynamics (Prof. Schmitz),
- Institute for Transport Planning and Logistics (Prof. Gertz, Prof. Flämig),

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- Institute for Wastewater Management and Water Protection (Prof. Otterpohl),
 - With Bioconversion and Emission Control Group (PD Dr. habil. Körner),
- Institute for Water Resources and Water Supply (Prof. Ernst),
- Institute for Bioprocess and Biosystems Engineering (Prof. Zeng),
- Institute for Chemical Reaction Engineering, (Prof. Horn),
- Institute for Product Development and Mechanical Engineering Design (Prof. Krause),
- Institute for Technical Biocatalysis (Prof. Liese),
- Institute for Technical Microbiology (Prof. Anthranikian).

Several Master degree programs with close connection to bioresources are offered at the TUHH in English: “Chemical and Bioprocess Engineering”, “Environmental Engineering”, “Joint Masters in Environmental Studies, Cities and Sustainability”. Additional bioresource-related Master courses are offered in German and students can choose from a variety of Bachelor degrees connected to bioresources. Also further bioresource related courses are given in a wide range of other Master studies. A topic list of bioresource-related Master courses is attached. Also concerned Master studies are listed there.

Further highlights of TUHH regarding regional outreach are TUHH’s center “*Zentrum für Lehre und Lernen*” (Center for teaching and learning, ZLL) [9], which focuses on innovations for teaching, and TUHH’s “*Start up Dock*” [10], which supports students and scientists who wants to found as business.

5.3. Further bioresource-related HEI’s Hamburg’s

Several other HEI’s, which also involve some bioresource-related topics to a smaller extend are:

- *Hamburg University of Applied Science (HAW) [11]*: The HAW founded the „Competence Centre for Renewable Energies and Energy efficiency“ (CC4E) in 2008. It is a cluster which supports HAW activities internally and externally on the energy area. More information to the cluster will be provided in Part 2. HAW also offers Master courses with bioresource connections: “Renewable Energy Systems”, “Food Science”, “Pharmaceutical Biotechnology”, and Biomedical Engineering”. Additionally, some Bachelor courses are offered.

- *Hafen City University Hamburg (HCU) [12]:* The Master in “Urban Planning” qualifies students for all levels of spatial planning which includes ecological design aspects. The “Resource Efficiency in Architecture and Planning” Programme (REAP) is an interdisciplinary study. In both, some disciplines could be connected to bioresources (e.g. landscape planning, building materials technology, building construction, environmental planning, sustainable development).
- *Helmut Schmidt University (HSU) [13]:* This is the University of the Federal Armed Forces. It offers a Master Programme in “Energy and Environmental Technology” as well as in “Renewable Energies and Smart grids”.
- *Berufsakademie Hamburg (BA) [14]:* It offers a relatively new dual course “Technique and Management of Renewable Energies and Energy Efficiency“ finalizing with a Bachelor degree and an additionally skilled worker degree.

More information about these and all other HEI’s in Hamburg are available under [15].

6. Evaluation of Higher Education in the FHH region for the bioresource sector

In the following chapter 6.1, some evaluation results of Hamburg’s MINT faculties in general are provided, in 6.2 a focus is set on an evaluation of Hamburg as a center on bioresource research and education, and finally in chapter 6.3 some suggestions are made to strengthen the further outreach of Hamburg’s Bioresource research and education.

6.1 Evaluation results of Hamburg’s MINT institutions by the German Council of Science and Humanities

“The German Council of Science and Humanities (Wissenschaftsrat, WR) provides advice to the German Federal Government and the State Governments on the structure and development of higher education and research” [17]. The FHH has asked the WR for evaluation of the MINT (Mathematics, Informatics, Natural

Sciences and Technical Sciences) sectors of Hamburg's HEI's in June 2014. WR started work for evaluation of UHH, TUHH, HAW and HCU in July 2014 and submitted the evaluation report in January 2016. The WR evaluated the institutions based on written self-reports of the universities. Additionally, two-day study visits in each institution, hearings of representatives of the institutions and other relevant stakeholders and several task group meetings were included [18].

In the following some results of the report are extracted, which have relevance to the general improvement of the regional level in the HEI-sector. WR came to a very positive conclusion for the MINT-subjects and pointed out the considerable peripheries with numerous university and non-university research institutions. For instance regarding renewable energies the whole innovation chain can be covered and the transfer of results into practice can be established. No immediate overlapping between studies courses exist. Nevertheless, networking between universities and non-university institutions could be improved on a structural level. However some successful examples for co-operation between institutions exist. Successful cooperation, mainly on research level, already exists for example between ZHH and TUHH. One of the biggest chances for a further strengthening of the research sector is a mutual strategy development between universities, non-university research institutions and industry is seen for Hamburg's MINT-sectors in general [18].

6.2 Evaluation of FHH as Center of Bioresource Research and Education

Hamburg's research and education in the bioresource context is actually very well established. In Annex are the courses listed to be developed in the new Master studies "Biorefinery Engineer" from TU Graz and from the Master course "Bioresource chain value Manager" from TU Twente (pilot runs are planned for winter semester 2017/2018) and got content-wise compared with the actually offered courses from TUHH and ZHH. The assignment was based on the course list titles available from [19] and [20]. Only lecture courses for TUHH and ZHH Master students were considered. Bachelor courses and other teaching formats as seminars, practices, and exercises were not considered, but could be added to the list.

An assignment to the BET-courses is naturally not possible 1:1. For most topics, the available choices offered at the two Hamburg institutions are broader, compared to the planned new Master studies in TU Graz and TU Twente. However, only one of the two Hamburg institutions alone could not cover the broad spectra of the new

interdisciplinary courses planned at TU Graz and TU Twente, but both of the two Hamburg institutions together could cover everything and additionally offer a variety of deepening's in the bioresource and biorefinery sector. Only for a few BET-courses mentioned in Annex 1, no corresponding TUHH or ZHH courses are given, but nevertheless the knowledge is available to certain extent at TUHH and ZHH. Some examples are listed as follows:

- Some BET-topics are specific (e.g. topics 11, 12, 13, 14, 15, 17, 19, 20) which are covered in Hamburg's HEI's in various courses with a more "broad" title (mentioned in Annex 1 as "included in other lectures").
- Some BET-topics are actually not the teaching focus of the two Hamburg HEI's, but knowledge is available by projects, e.g.:
 - TransiEnt.EE – Mutual BMWi-Project of three TUHH Institutes - Thermofluid dynamics (Prof. Schmitz), Energy systems (Prof. Kather) und Electric Power Systems and Automation (Prof. Ackermann): Transient Behavior of coupled energy grids with a high share of renewable energies - simulation on the basics of the modelling language Modelica [21] (corresponding to BET-topic 16, 17).
 - DECICIVE – Horizon 2020-Project of the TUHH Institute of Wastewater Management and Water Protection, Bioconversion and Emission Control Group (PD Dr. habil. Körner) together with 13 partners from across Europe: Simulation tool for regional waste management (extending to BET-topic 16, 17).
 - Crop related topics (corresponding to BET-course 3) are covered partly in some lecture nuggets of TUHH and ZHH. If additional knowledge in more detail would be necessary regarding agricultural topics, further HEI's from the Metropolitan region of Hamburg could be included (e.g. LEUPHANA University of Lüneburg, other branches of the TI-institute).
 - Algae topics (corresponding to BET-course 10) are covered in Hamburg, too. For instance the UHH possesses one of the biggest European collections on microalgae. Additionally, algae are topic of research projects in various institutions, among these TUHH and ZHH. The topics reach e.g. from microalgae as biorefinery and bioenergy substrate up to water cleaning issues. Also macro algae are studied.

If courses at TUHH and ZHH are compared, following major differences can be seen:

- The TUHH has a large number of courses, which contain bioresource-related aspects. They are offered in various Master studies (see chapter 5.2 and annex 1.), which are commonly not focused on bioresources or biorefinery topics alone. They contain these topics as a specific aspect in more or less detail.
- The ZHH offers an interdisciplinary study, where the courses cover the whole bioresource chain for lignocellulosic bioresources; other bioresources are connected in a minor part too. The study contains engineering, economic and natural science parts and is very close to the needs defined in the SET plan roadmap.

Compared to the planning's of the Master studies Biorefinery Engineer and Bioresource Value Chain Manager developed within the BET-project for TU Graz and TU Twente, the ZHH- studies can be considered as analogous regarding the interdisciplinary structure and the focus on the whole chain. TUHH in contrast offers additionally bioresource-related aspects with a broad variety.

In conclusion, the region of Hamburg can be considered as pioneer regarding bioresource and biorefinery related topics, since education of such aspects is already established since a long time in the education plans of the TUHH and ZHH. However, there are some needs to keep this situation as well as to extend and structure bioresource-related education to provide the increasingly needed workspace for the future in the bioresource sector as mentioned in the SET-plan roadmap.

6.3 Suggestions for improving Hamburg's HEI outreach on the bioresource sector

In the following suggestions are made by the author for improving the regional HEI outreach, bearing in mind general suggestions of the WR:

- Improvement of institutional structures among HEIs: TUHH and ZHH supplement each other perfectly in regard to bioresource topics. However, ZHH is actually connected to the Department of Biology of UHH, which focuses on other working topics than bioresources and wants to close this center. It is therefore not the best match for the ZHH. In order to improve bioresource research and education a new structural platform, connecting TUHH and ZHH more closely should be established. This launch would have to be prepared and pushed for by Hamburg's local politicians (Senatorin Fegebank). It could improve bioresource research and education significantly.
- Formation of a bioresource research cluster: The existing expertise at the TUHH and ZHH could be bundled. Based on this, a new level of interdisciplinary research combined with new mutual research projects could be gained. Besides sharing of knowledge, sharing of laboratory and technical infrastructure could be advantageous, especially in times with reduced research budgets provided to the universities by the FHH. For instance, the WR noticed missing chemical competence at TUHH, which could be supplemented by ZHH.
- Offering new Master courses: With the actual available TUHH and ZHH study topics, new Master courses could be created easily. A modular set-up, combing expertise from TUHH and ZHH could lead for instance to Master courses such as "Bioresource Management" and "Biorefinery Engineering".
- Extension of advanced vocational trainings offers: The available teaching competency of TUHH and ZHH could be used to prepare new offers for the continuously increasing area of advanced training, for instance for deepening educations, student summer schools or on-the-job-trainings. The offers could be designed for regional, national and international levels.
- Further improvement by co-operations with other HEI's: TUHH and ZHH as core unit could be extended to include further knowledge on bioresources. This includes deepened networking with other HEI's Hamburg's, with further HEIs from



the Metropolitan area and also in international scale. For international scale Hamburg's competences could be "exported" for instance via distance education platforms.

Certainly more ideas for improving regional outreach could be collected by discussions among the various stakeholders.

Further information

- [1] https://www.hk24.de/produktmarken/branchen/industriepplatz_hamburg/branchenueberblick/3162454
- [2] <http://metropolregion.hamburg.de/hochschulen/272070/hochschulen-hamburg/>
- [3] <https://www.biologie.uni-hamburg.de/zentrum-holzwirtschaft.html>:
- [4] <https://www.ti.bund.de/>,
- [5] http://www.bmel.de/DE/Startseite/startseite_node.html
- [6] <http://www.tuhh.de/>
- [7] <https://www.tuhh.de/alt/fsp-energieumwelt/home.html>;
- [8] <https://www.tuhh.de/fsp-bioprosesstechnik/start.html>;
- [9] <http://cgi.tu-harburg.de/~zllwww/>
- [10] <http://www.tuhh.de/startupdock/home.html>
- [11] <http://www.haw-hamburg.de/>
- [12] <https://www.hcu-hamburg.de/>
- [13] <https://www.hsu-hh.de/hsu/index.php>
- [14] <http://www.ba-hamburg.de>
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- [19] <https://studiengang.tuhh.de/app/controller.php?site=smartyLehrveranstaltungList>
- [20] <https://www.biologie.uni-hamburg.de/zentrum-holzwirtschaft/02-studium.html>
- [21] <http://www.modelica.org>

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