



O LOCATE 2019 oferecerá de **24 a 29/10** palestras sobre Tecnologias de Baixo Carbono visando à capacitação e engajamento de estudantes e pesquisadores em um tema atual e de grande relevância internacional, fomentando o desenvolvimento de pesquisas inovadoras no país e o intercâmbio de estudantes para as instituições parceiras. Serão abordados os seguintes **subtemas**: modelagem e otimização de sistemas de energia com baixo carbono; desenvolvimento e avaliação de tecnologias de captura de CO<sub>2</sub> na indústria de processos.

Esta é uma iniciativa conjunta do **PEI/UFBA** com os professores das universidades alemãs **BTU-Cottbus** e **TU-Berlin** na Alemanha, Prof. Dr. Harvey Arellano-Garcia e Prof. Dr. Jens Uwe-Repke. O evento é apoiado pela **Rebralint** (Rede Brasil-Alemanha para Internacionalização do Ensino Superior) e visa também discutir sobre as possibilidades de intercâmbio para a Alemanha.

O evento acontecerá na **Escola Politécnica da UFBA** e tem como **público alvo** pesquisadores e estudantes de pós-graduação em engenharia, bem como alunos de graduação interessados em desenvolver pesquisas futura sobre o tema.

A seguir encontram-se mais informações sobre a programação, conteúdo das palestras e perfil dos professores palestrantes. As inscrições devem ser realizadas no site do PEI: [www.pei.ufba.br](http://www.pei.ufba.br)

**Realização:**



**Apoio:**



**Parceria:**





### PROGRAMAÇÃO

Date	Lecture	Professor
<b>24/10</b>	08:30h às 10:15h	Modeling and Optimization in Low-Carbon Energy Systems Prof. Dr. Harvey Arellano-Garcia (BTU-Cottbus - Alemanha)
	10:15h às 10:45h	Break
	10:45h às 12:30h	Modeling and Optimization in Low-Carbon Energy Systems Prof. Dr. Harvey Arellano-Garcia (BTU-Cottbus - Alemanha)
<b>25/10</b>	08:30h às 10:15h	Modeling and Optimization in Low-Carbon Energy Systems Prof. Dr. Harvey Arellano-Garcia (BTU-Cottbus - Alemanha)
	10:15h às 10:45h	Break
	10:45h às 12:30h	Modeling and Optimization in Low-Carbon Energy Systems Prof. Dr. Harvey Arellano-Garcia (BTU-Cottbus - Alemanha)
<b>28/10</b>	08:30h às 10:15h	Development and Assessment of CO <sub>2</sub> Capture Technologies in Process Industry Prof. Dr. Jens-Uwe Repke (TU-Berlin – Alemanha)
	10:15h às 10:45h	Break
	10:45h às 12:30h	Development and Assessment of CO <sub>2</sub> Capture Technologies in Process Industry Prof. Dr. Jens-Uwe Repke (TU-Berlin – Alemanha)
<b>29/10</b>	08:30h às 10:15h	Development and Assessment of CO <sub>2</sub> Capture Technologies in Process Industry Prof. Dr. Jens-Uwe Repke (TU-Berlin – Alemanha)
	10:15h às 10:45h	Break
	10:45h às 12:30h	Development and Assessment of CO <sub>2</sub> Capture Technologies in Process Industry Prof. Dr. Jens-Uwe Repke (TU-Berlin – Alemanha)

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## SUMMARY

### Modelling and Optimization in Low-Carbon Energy Systems

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Distributed energy resource (DER) systems (also known as decentralized energy generation (DEG) systems) have been increasingly discussed as a viable option to better utilize small scale renewable energies and meet climate change reduction targets. DER systems are multi-input, multi-output energy networks that provide electricity and thermal energy to local consumers using small-scale technologies (1 kW to 250 MW), sometimes referred to as distributed generation (DG) units. DER systems can also include thermal and electrical energy storage devices. Optimizing the design of these networks is critical to ensuring that they are cheap to run, build and decommission at their end of life and are therefore financially attractive options. An optimal design needs to be specific to the requirements and resources of the specific area in which it is being constructed. Thus, due to the complexity of the design problem at hand, which can contain many different technologies operating at different times throughout the day and seasons, in this short course introductory designing algorithmic models and the fundamentals of optimization will be introduced, which design cost effective networks based on the above input data. These algorithmic models and optimization procedures highlight the different benefits that DER systems have over conventional generation/distribution systems and could, in future, provide a decision-making tool for designers of new micro-grids.



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### Development and Assessment of CO<sub>2</sub> Capture Technologies in Process Industry

Examples: Oxidative Coupling of Methane Process, Coke Oven Gas Treatment

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The removal of CO<sub>2</sub> from gaseous streams is a common separation task in industry, with natural gas sweetening and post-combustion carbon capture being two very investigated applications. Carbon dioxide separation also appears frequently in the chemical and coal/coke processing industries. A number of different technologies can be used for the task, such as physical or chemical absorption, adsorption, gas permeation, and cryogenic separation. The selection of the technology and optimization of process parameters is not a trivial task as it must take several factors into account, such as the gas composition, i.e. CO<sub>2</sub> concentration, presence of oxygen, water and contaminants; gas conditions, i.e. whether the gas is available at high or low pressure; gas amount, i.e. some technologies are better suited for large-scale applications and vice-versa; availability and cost of utilities, i.e. steam, electricity, process water, amine solution, etc; and even location, i.e. on-shore or off-shore. This contribution discusses the development and assessment of CO<sub>2</sub> separation technologies in process industry on the example of the Oxidative Coupling of Methane (OCM) process, which have been performed in mini-plant scale and through process simulations and optimizations and the coke oven gas treatment technology.

The OCM process is the catalytic oxidation of methane, e.g. from natural gas, into ethylene, which is a major feedstock for the chemical and polymer industries. This process is not yet realized in industrial scale, but significant research in catalyst development, reaction engineering, and downstream process optimization is being carried out. The reaction must be performed at low pressures (1-10 bar) and high temperatures (700-900°C), which also leads to the unselective oxidation of the hydrocarbon educt and products into CO<sub>2</sub>. Besides that, additional CO<sub>2</sub> can also enter the process with the feed stream. For instance, the associated natural gas in the Brazilian pre-salt oil reserves can contain 10-45mol% of CO<sub>2</sub>. Biogas can also be used as a sustainable alternative methane source for OCM, but it can contain up to 50mol% of CO<sub>2</sub>. In all scenarios, a CO<sub>2</sub> separation step is required to treat the OCM reactor outlet gas prior to the final ethylene purification step via cryogenic distillation.

In order to discuss suitable CO<sub>2</sub> removal technologies e.g. for OCM, a fully automated mini-plant has been implemented in the *Technische Universität Berlin* containing absorption, gas-permeation, and adsorption units. The absorption-desorption unit has been used to investigate different amine solutions at a wide range of operating conditions; the gas-permeation unit contains two flat sheet envelope-type membrane modules, which can use different membrane materials and cascade configurations; the adsorption unit contains two beds that are used to investigate the CO<sub>2</sub> and hydrocarbon separation via pressure-swing-adsorption.

For the second mentioned example, a larger and modular carbon capture pilot-plant has been built aiming at the treatment of gases from the coke industry. The pilot-plant has been transported from TU Berlin into the industrial coke plant and successfully applied to investigate the feasibility of newly developed amine solutions to treat real industrial gases at relevant conditions. The experimental activities are complemented by the development of simulation models, optimization studies, and techno-economic assessments for the implementation of these processes in industrial scale.

In the presentation, the methods employed to develop these CO<sub>2</sub> separation technologies are introduced, discussed and analyzed, including an overview of the mini-plant facilities and the experiments, as well as the models developed, and the simulations and optimizations performed. The resulting solutions are described and assessed under techno-economic and environmental point of view.

References: <sup>1</sup>Gás do Pré-Sal: Oportunidades, Desafios e Perspectivas, E. de Almeida, M. Colomer, W. Vitto, L. Nunes, F. Botelho, F. Costa, L. Waeger, Ciclo de Debates sobre Petróleo e Economia, 2017

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## PALESTRANTES

### Prof. Dr. -Ing Harvey Arellano-Garcia –B-TU Cottbus



Prof. Dr.-Ing. Harvey Arellano-Garcia é Professor da *Brandenburgische Technische Universität* em Cottbus na Alemanha e Professor Honorário da UFBA. Atua na área de Engenharia de Processos e Sistemas com aplicações em intensificação e integração de processos incluindo simulação estacionária e dinâmica de processos, análise e otimização de processos complexos e sistemas de energia. Atenção particular tem sido dada à visão holística dos fenômenos envolvidos em micro e macro escalas do processo, desde o projeto do processo até a verificação experimental usando miniplantas.

### Univ.-Prof. Dr.-Ing. habil. Jens-Uwe Repke



O Prof. Dr.-Ing. Habil. Jens-Uwe Repke é chefe do Departamento “Process Dynamics and Operations” do Instituto de Engenharia de Processos Químicos da *Technische Universität Berlin* (TU-Berlin). Sua atuação em pesquisa se concentra em transferência de massa e dinâmica de fluidos em escoamento homogêneo e heterogêneo, separação de fases em condições críticas, modelagem, simulação e análise experimental de processos de separação híbridos e reativos, desenvolvimento de processos/// como, por exemplo, processos de separação de CO<sub>2</sub>, processos de membrana.

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