

# Simulations over Entire Oil Fields

OPTION is a highly interdisciplinary Joint Industry Project which seeks to take oil production optimization to a new level.

The rate of production at one oil well may influence the expected output from another well in the same field either positively or negatively. It is therefore a natural ambition to simulate the production at all wells in the field in order to find the optimal way to produce the field. In other words, to find the solution that will result in the maximum output overall. This task is highly complex due to uncertainties in the geological data available. Further, it requires large computational resources as extremely large data sets are needed. The Joint Industry Project OPTION (Optimizing Oil Production by Novel Technology Integration) is set up to meet these challenges.

“We are confident that the project will result in unique software products and computational solutions which can be put to practical use through the industry partners. Key drivers of our efforts are efficient and robust mathematical algorithms combined with modern high-performance computing,” says Allan P. Engsig-Karup, Associate Professor at DTU Compute and a new member of the CERE Faculty.

Not least the project partners Lloyd’s Register Energy and Welltec are well suited for dissemination of resulting software and knowledge. Lloyd’s Register Energy is a leading consultancy company to the energy sector, while Welltec develops and provides well technology and solutions for the oil and gas industry. Both companies were founding partners in OPTION in 2014. Since then DONG Energy has also joined.

“As scientists we are excited about the addition of DONG Energy to the project,

since this ensures our access to data from real oil production. This will provide a highly valuable verification of the simulations which we create,” Allan P. Engsig-Karup notes.

**Strong synergy with industry**  
Allan P. Engsig-Karup joined the Faculty of CERE in 2015, following a DTU Compute colleague. Associate Professor John Bagterp Jørgensen became a CERE Faculty member two years earlier, and his early effort in the ADORE project contributed to lay the technology foundation for the OPTION project.

“John’s work is close to the actual implementation of new solutions in optimization of oil production, while my own efforts are focused on core scientific computing components deep inside the software solutions, allowing us to make a difference as a team,” explains Allan P. Engsig-Karup, noting that a range of other academic partners are also involved.

“The project is highly challenging, since we not only need to tackle the mathematical and computational challenges introduced by the various well locations and production rates, but also the large uncertainties related to the underground. While we may have some ideas about how the geology looks and which processes take place, we cannot know for sure. This complexity can only be addressed through a high degree of interdisciplinary cooperation. The combined knowhow from industry and academia has already proved a strong base for synergy within the project.”

As a consequence of this cooperation, both Allan P. Engsig-Karup and Manager Stefan Glimberg of Lloyd’s Register Consulting have recently completed an 11 month Executive MBA course at Harvard Business School. Entitled “Leading the Virtual Company” the course is highly relevant as the OPTION project spans across a range of groups and institutions. Faculty

from DTU Mechanics, DTU Compute, DTU Chemistry, and the University of Copenhagen are involved.

**A new breed of scientists**  
The OPTION project has four PhD students and four Postdocs employed. Also, the project contributes in educating a significant number of Master and Bachelor students. Already in the first year, more than 20 people have been involved on the academic side of the project.

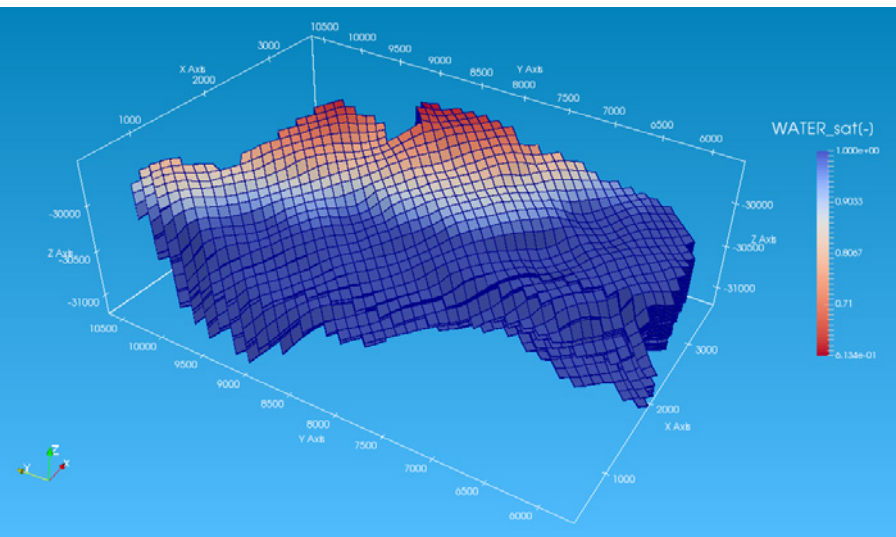
“An effort of this magnitude is close to being a guarantee for scientific progress. At the same time we contribute strongly to the training of a new breed of young scientists and engineers. Our ambition is to take the computational side of this field to a high international level, which has characterized the work of CERE’s research within thermodynamic simulations and other traditional strongholds for the center.”

Asked whether anything has surprised him in the project, he replies:

“I actually didn’t expect it would be possible to mobilize so many people so quickly. The project has created a lot of possibilities. Especially for the students and young scientists we see a lot of doors opening. Besides the networking with other disciplines and with industry, they also get a feeling for other approaches, and how teaming up can overcome challenging problems. These experiences can surely be applied when new scientific challenges are encountered.”

**The accuracy versus cost dilemma**  
A major challenge throughout the project is balancing the demand for accuracy with computational resources.

“We are always looking for smarter algorithms which will allow us to do calculations faster or with less computational costs. Still, we need to be careful not to simplify too much. To that



Data from the Danish oil field Stine, delivered by DONG, will be used to benchmark the reservoir simulation tool that applies the algorithms developed in OPTION.

end we follow a dual approach. On the one hand we will do a full, expensive simulation and on the other hand we will experiment with new algorithms. We can then compare with the full simulation and evaluate if the faster and cheaper solutions are satisfactory.”

The first application of OPTION software will probably be for optimization of production from an existing oil field. Further down the road Allan P. Engsig-Karup imagines that such software will be brought to use even before production starts:

“It is likely that we will actually be able to tell which combination of well sites will give the best overall production from the field.”

The OPTION project was initiated in 2014 and is secured funding until autumn 2018.



Allan P. Engsig-Karup, Associate Professor

## Lloyd’s Register Consulting: Commercial Potential

Through the OPTION project Lloyd’s Register Consulting has become a highly active member in the CERE Industry Consortium over a short time span. A joint Industrial PhD project within reservoir simulation led to the company’s participation in the project.

“This OPTION project is now the largest R&D project for us in Denmark,” notes Dr. Stefan Glimberg of Lloyd’s Register Consulting

“Our own contribution will mainly be within the work packages on well flow and on the link between well flow and changes in the surrounding reservoir. This is predominantly where our expertise lies, and where we see the largest commercial potential as results will begin to emerge.”