MHPS

Mitsubishi Hitachi Power Systems

Project "FlexIgnite"

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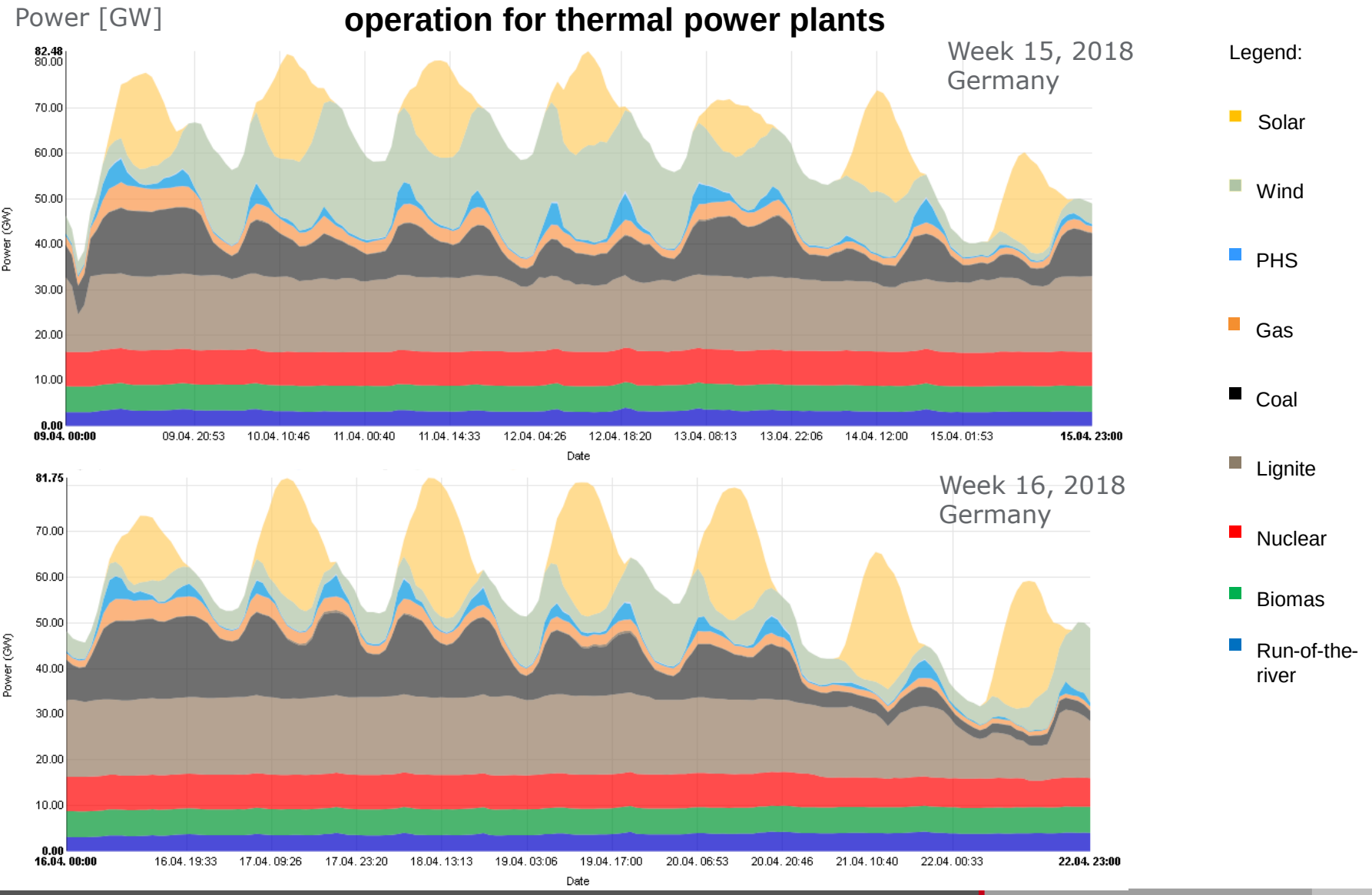
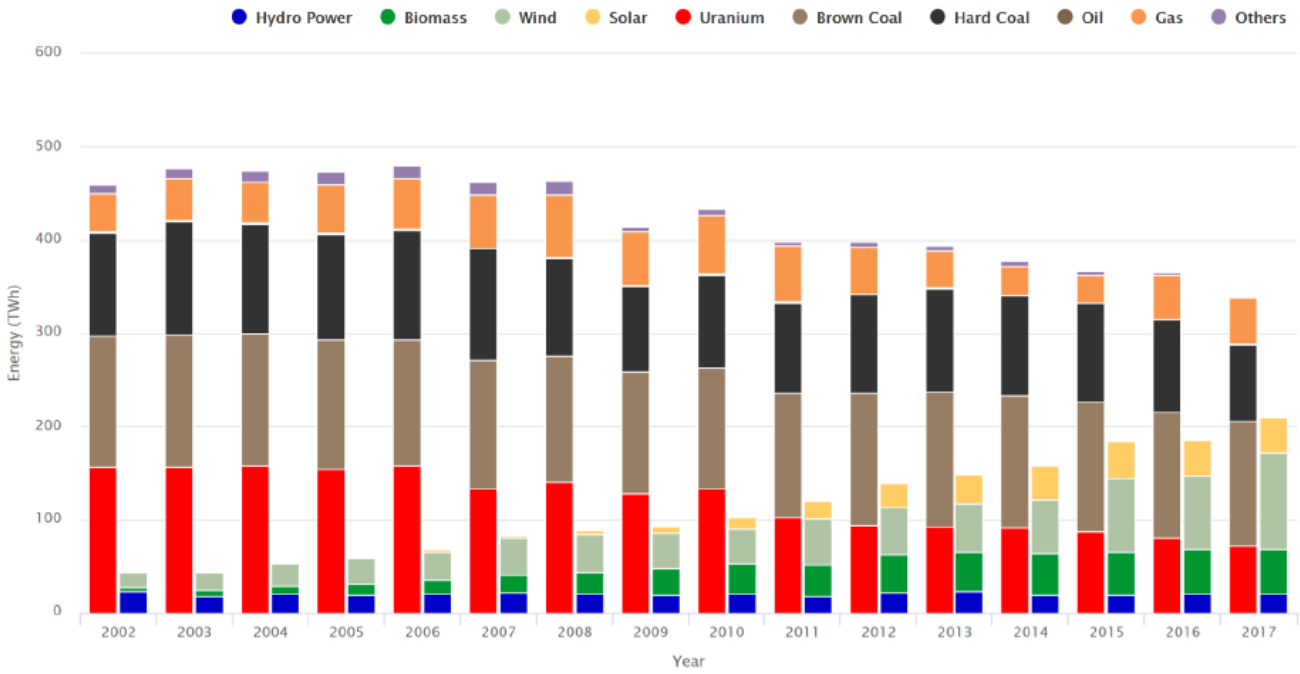
Renewables have reached 30% on average in German grid electricity

Growing share of renewables demands more frequent and faster cycling operation for thermal power plants



Main project objective: Increasing flexibility of coal power plants

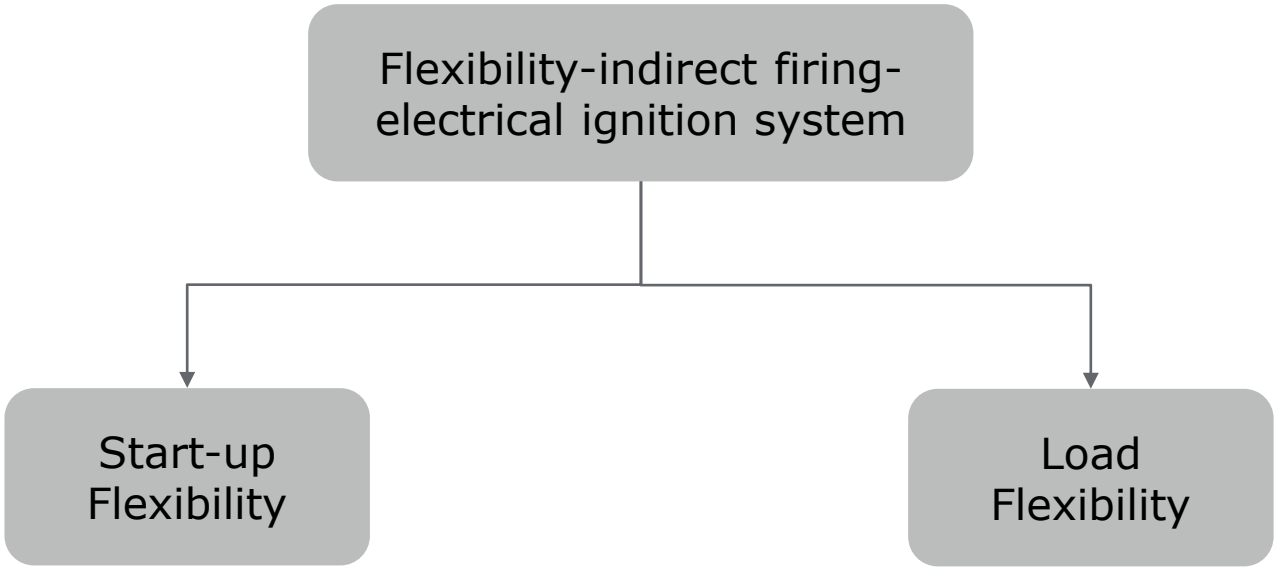
- Need on **increasing flexibility** of coal power plants to balance fluctuating renewable energy sources and cover residual load.
- Development of electrical ignition systems, in order to **reduce consumption of costly start-up fuels** (oil, natural gas)
- **Retrofitting of firing systems** by utilizing new burner types, where electrical ignition systems are installed.



Net power generation in Germany: 2002-2007, Source: Fraunhofer ISE

FlexIgnite project

Increasing the flexibility of solid fuel boilers by electrical ignition burner:



- **Reduced start-up cost of auxiliary fuel (oil or gas)**
- Reduced start-up time
- Reduced maintenance cost of auxiliary fuel equipment

- Reduced minimum load by the support of electrical ignition system
- Improved efficiency at part loads by increased flame stability
- Increased ramp rate by flame stabilization

FlexIgnite Consortium

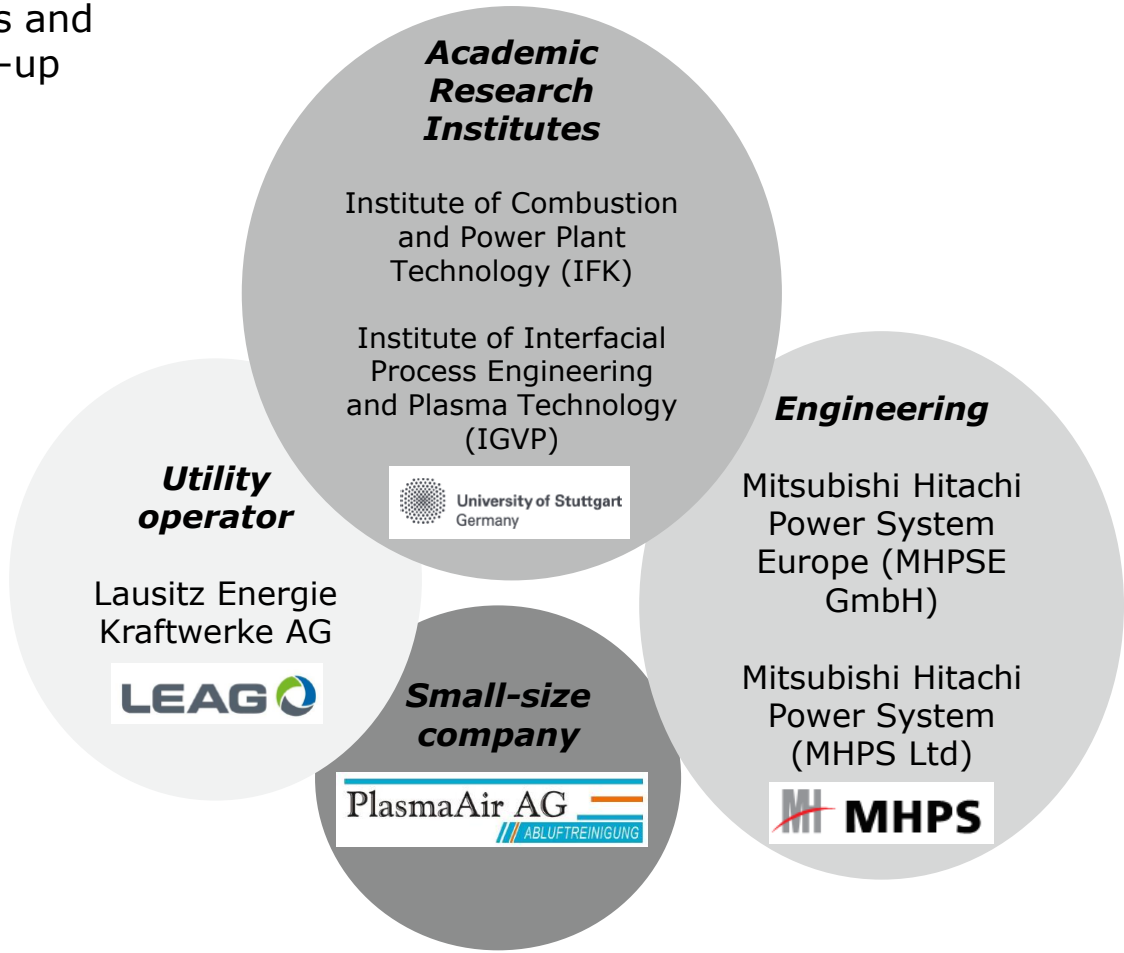
FlexIgnite: Increasing flexibility by electrical ignition burner of utility boilers

- Development of an electrical igniters and system design for (cold) boiler start-up
- Start time: 01.07.2016
- Duration: 24+12 months
- Funding rate: non-academics 50 %
  academics 100 %
- Funding: German Federal Ministry of Economic Affairs and Energy (BMWi)

Gefördert durch:

Bundesministerium für Wirtschaft und Energie

aufgrund eines Beschlusses des Deutschen Bundestages



FlexIgnite Structure

WP1: **Development, optimization and scale-up of electrical ignition system-plasma torch**

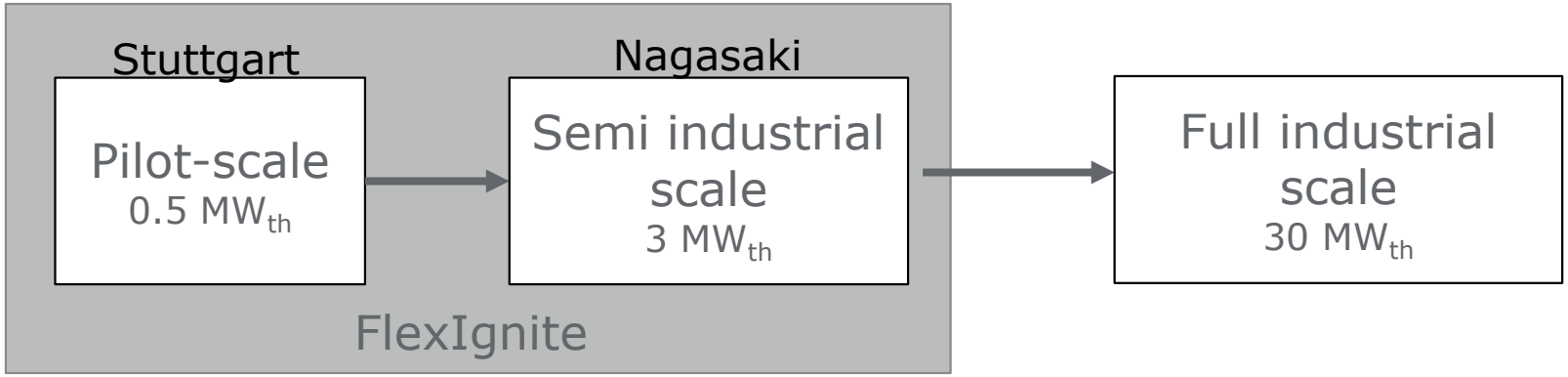
- Plasma and burner design
- System optimization

WP2: **Investigation of electrical ignition system at 0.5 and 3 MW test rig**

- Ignition limit and flame stability
- Impact of operational parameters
- Impact of fuel characteritics

WP3: **Integration and techno-economic analysis of electrical ignition systems**

- Determination of operational safety
- Comparison of the plasma-integrated burner Techno-economic analysis



FlexIgnite Technical Objective

- Development of a **0.5 MWth pilot-scale** burner integrated with the plasma ignition system
- Development of a **3 MWth prototype** burner integrated with the plasma ignition system for a dedicated hard coal quality
- Detailed experimental investigations on plasma ignition system for ignition of **difficult solid fuels** in pilot-scale and large-scale (0.5 MW and 3MW burner)
- Investigations on **ignition boundaries** for solid fuels using plasma ignition system under cold condition
- Techno-economic evaluation of plasma-assisted start-up

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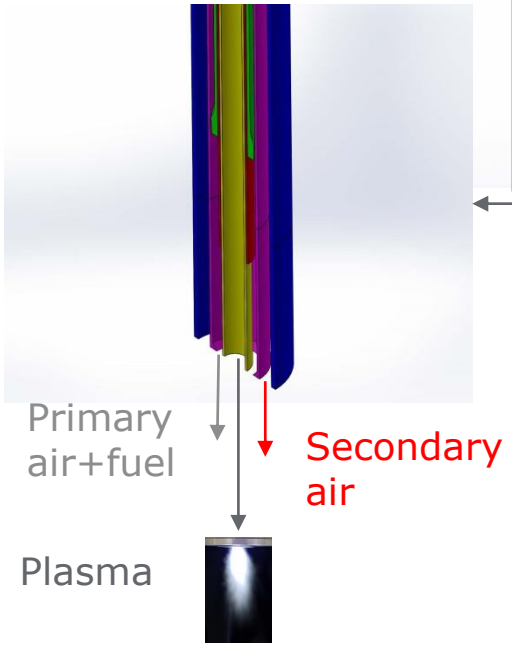
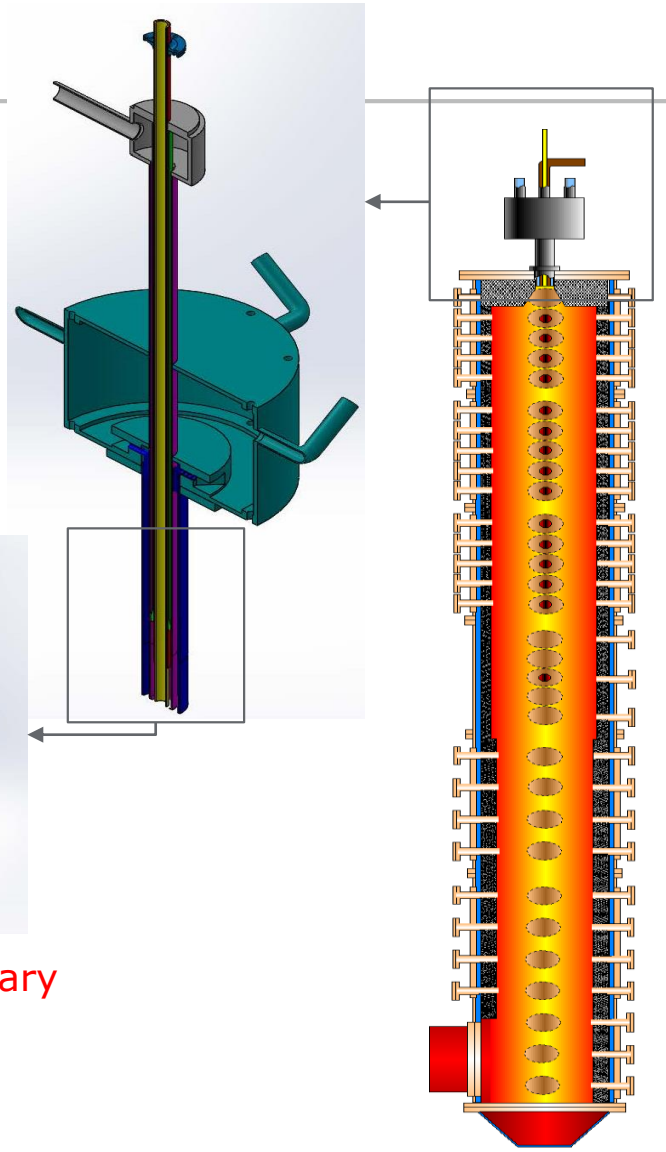
Results

- Design and integration of plasma ignition system in a low NOx swirl burner
- Determination of boundary conditions for successful ignition and stable combustion for each fuel quality
- Validation of pilot scale testing in a 500 kW (max.) burner on plasma assisted combustion using different fuels
- Identifying the **parameters and boundary conditions** for a successful ignition and flame stabilization using 10 fuel qualities of hard coal, lignite and biomass in the 0.5 MW facility of University of Stuttgart, **several hundred ignition tests**





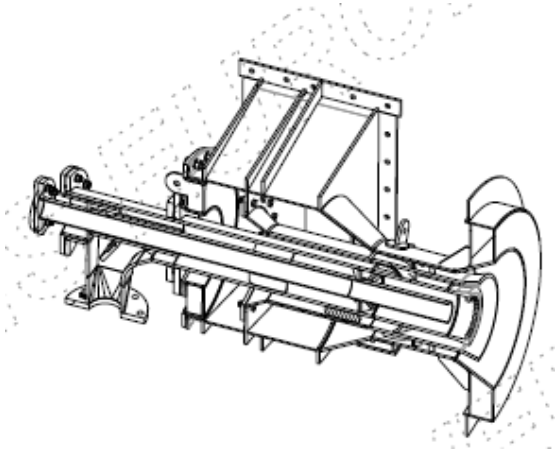
500 kW combustion rig of IFK

Results

- **Predicting the ignition and flame formation** with CFD simulations, performed by MHPSE, and validation of the simulation results with experimental observations

- **Determination of design parameters for 3 MW burner**, obtained from the test results at the pilot-scale

The FlexIgnite is still ongoing. **3 MW large-scale test under preparation** and expected to deliver additional valuable results to the project



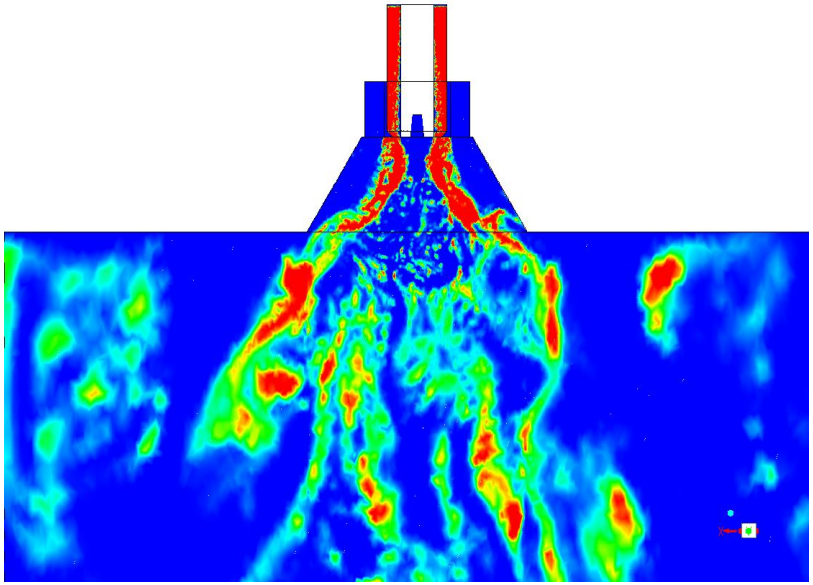
Lessons Learned

- At project start there was a substantial need for a parameter assessments, contributing to a successful ignition in plasma ignition systems and develop new analytical methods for future design/prediction

- Development of a plasma-coal combustion model and its integration in CFD simulations of pilot- to large-scale plasma ignition systems

- Comprehensive combustion measurements to support analytical studies and the validation of the CFD simulations

Large Eddy Simulation



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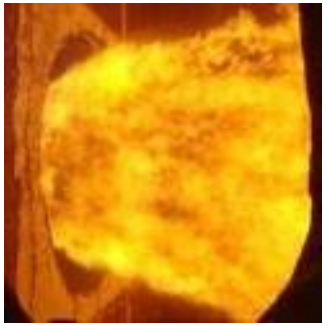
Need for future R&I

- **Demonstration** test of plasma ignition systems with the selected hard coal at full-scale (>15 MWth)
- Development of a **design guideline** for full-scale applications
- Development of a **safety guideline, standards** for full scale applications
  (Existing standards can prevent the use of plasma igniters in some countries)
- Burner **design optimization,** considering the fuel quality
- Overall (retrofit) **concepts** need to be checked for competitiveness



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Deployment prospects

- The results of pilot scale test with plasma ignition systems shows the potential of the technology to be used for lower quality and cheaper fuels (coals, carbon containing waste streams) as well as biomass

- **Full-scale demonstration tests (single burners/burner levels) and competitive overall solutions needed before deployment in the market**

- The conventional start-up systems for (existing) power plants in future can be replaced by cost- and energy- efficient plasma ignition systems

Thank You

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Power for a Brighter Future