Value-in-Use Assessment of Fuels for Power Generation

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Uniper at a glance

Our operations
- Power Generation
- Commodity Trading
- Energy Storage
- Energy Sales
- Energy Engineering

€998 mln.
Adj. EBIT\(^1\)

~11,700
Employees

>40
Countries

35 GW
Generation capacity\(^1\)

100+
Years’ experience

1 As of December 31, 2020
Uniper’s energy evolution

Providing the energy our world needs today while shaping solutions that secure a thriving tomorrow

Decarbonization

Driving decarbonization actively
- Carbon neutral in Europe by 2035
- Actively reduce carbon emissions across Global Commodities and International Power

Security of supply

Evolving the power generation mix
Expand and decarbonize gas assets eg. Irsching new gas plant
- Leverage current portfolio
- Scale up hydrogen

Customer centricity

Investing in new growth
- €1.2bn Investment in CO₂ efficient revenue streams

Innovating with our partners and customers
- Hydrogen projects
- Innovative grid stability services
- Engineering solutions for decarbonization

Providing the energy our world needs today while shaping solutions that secure a thriving tomorrow
Biomass & Waste Fuels for Power Generation

Coal-to-Biomass Conversions

• Large units (up to 1100 MWe). Usually pulverised fuel combustion.
• Conversion from coal to biomass (or waste) enables assets to retain value. Worldwide, many coal-fired power plants will never reach their design lifetimes on coal.
• Key challenges are securing biomass/waste feedstock and physical modifications of power plant.
• Typical fuel options:
  • Wood pellets
  • Straw pellets, Agri-residues
  • Solid recovered fuels (waste)

Dedicated Biomass Power Plant

• Designed for specific biomass/waste fuels.
• Typically smaller units (up to 50 MWe). Usually grate or fluidised bed combustion.
• Fuel availability and/or cost challenges can incentivise widening the ‘fuel basket’ or firing alternative fuels.
• Typical fuel options:
  • Wood or waste wood chips
  • Straw, Agri-residues
  • Poultry litter, MBM
Fuel Quality Impacts

Cost impacts

- Fuel price, taxes
- Fuel delivery
- Fuel handling, blending
- CO₂ emissions
- Reagents & By-products
- Ash handling, disposal
- Unit efficiency
- Maintenance
- Availability

Delivery Costs
Self Heating
Handling

Ash Deposition (Slagging & Fouling)
Erosion & Corrosion
Heat Transfer
Combustion Stability
Bed/Grate issues
NOx control, Urea injection
Fan power

Emissions
Dust Removal
Lime Injection
AC Injection

Ash Removal/ Agglomeration
(Sand Consumption)

Ash Production/ Saleability

Value-in-Use

- Fuel buyers usually aim to minimize the fuel price delivered to the power plant (£/GJ), but the true value of the fuel is the cost of generating electricity from it (£/MWh).
- “Value-in-Use” assessment considers the entire value chain, to determine which are the optimum fuels to buy.

The best value fuels are not necessarily the cheapest

The best value fuels are not the same for different power plants

Requirements for VIU assessment

- Fuel analysis
- Power plant design and operating data
- Economic data

More detailed input information (full fuel analysis + unit specific models) leads to more accurate VIU results
Expert Models for Value-in-Use Assessment

**EPRI’s VISTA Coal Quality Impact Model**

- Background
  - EPRI* began funding an expert model in the 1980s, with development led by Black & Veatch. In 1997, CQIM was re-named VISTA, and funding for development switched to a new User Group of around 20 member companies.

**Uniper’s Fuel Evaluation Tool (FET)**

- Background
  - The FET was developed by Uniper in 2010 to address a need within the business to account for coal quality variation in transactions between coal buyers and power plants. The model is also used as an engineering tool by Uniper Technologies.

**Key Features of the models**

- Evaluation of **complete fuel analysis**: CV, proximate, ultimate, ash composition, HGI, size, trace elements.
- **Detailed power plant models**: Unit calibration and unit-specific calculations. Default data can be used.
- Capabilities of the models are in **continual development** and are regularly updated to reflect issues at power plants. This includes capability to model range of alternative fuels (biomass, natural gas, wastes etc).

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* EPRI = Electric Power Research Institute, headquartered in Palo Alto, CA, USA.
** Only Uniper and Black & Veatch have the licence to use VISTA on behalf of third parties. Royalty payments to EPRI apply.
VIU Calculations - Fundamentals

• Many plant performance impacts can be assessed with high accuracy using fundamental engineering/chemical calculations (“combustion calculations”):
  • Fuel, air and flue gas flow rates
  • Boiler efficiency (including flue gas losses, latent heat losses, unburned carbon)
  • Equipment system throughput vs capacity
  • Emission rates
  • Reagent use and by-product production rates

Example 1:
• Fuel switching from low-calorific value lignite to biofuels significantly affects fuel, air and flue gas flow rates. Major impacts on fuel handling, combustion and boiler heat transfer.
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Example 2:
• Understanding impacts of fuel quality variability is important: systems must be designed to operate on the worst-case of the expected fuel quality range.
VIU Calculations – Unit Specific Correlations

• Further plant performance impacts can be easily correlated to certain fuel parameters, but ‘calibration’ is required to ensure ‘baseline’ and ‘sensitivity factors’ are correct.
  • Unburned Carbon losses – correlated to fuel volatiles, carbon & boiler $O_2$.
  • NOx emissions – correlated to fuel nitrogen, volatiles & boiler $O_2$.
  • Mercury emissions – correlated to fuel mercury (chlorine, carbon-in-ash…)
  • Auxiliary Power demands – mills, fans, pumps etc
VIU Advanced Calculations – Slagging & Fouling

- Some performance impacts are assessed using special calculations.
- Uniper has developed some advanced slagging & fouling calculations to assess risks.

- Four different modes of slagging & fouling are assessed: iron-induced slagging, calcium-induced slagging, high-temperature fouling, and low-temperature fouling.
- Different risk calculations are applied for coal and for biofuels.

- Calculations are based on the chemical composition of fuel ash. These analyses are far more reliable than traditional Ash Fusion Temperature (AFT) measurements.
VIU Advanced Calculations – Corrosion

• Prediction of corrosion risks also requires advanced calculations and site-specific factors.
• Fuel quality impacts are related to:
  • Chlorine, and chlorine / sulphur ratio
  • Alkali metals (Na, K)
  • Heavy metals (Zn, Pb)
• But also dependent on many Plant parameters:
  • Steam & Flue Gas Temperatures
  • Reducing conditions
  • Waterwall thickness
Ultimately, Value-in-Use assessment shows the economics of power generation.

Example: Decarbonisation options

Variable power generation costs for coal/lignite plants are now dominated by CO$_2$ costs.

Biofuels (e.g. wood pellets) are often expensive – direct switching may require subsidy (or higher CO$_2$ prices).

A CCS-enabled power plant would have lower variable generation costs – it would run preferentially.
Total Power Generation Costs

- Ultimately, Value-in-Use assessment shows the economics of power generation

Example: Decarbonisation options

Adding Fixed Opex and Capex costs delivers the Levelised Cost of Electricity (LCOE)

Changes in prices assumptions for fuel, CO₂, Capex and Opex can be easily modelled, enabling correct fuel sourcing and/or technology upgrade decisions to be made.
Summary

- Uniper has extensive experience in all aspects of fuel supply and power plant operation.
- Value-in-Use assessment is a powerful tool to deliver added value to generation assets:
  - Identify best value fuels from supplier offers.
  - Predict or characterize fuel-related plant performance problems.
  - Optimize fuel blending strategy.
  - Optimize fuel washing / preparation.
  - Determine fuel quality price adjustments (sulphur, ash, moisture etc).
  - Evaluate fuel flexibility requirements for new build plant.
  - Evaluate low-cost / off-spec fuels.
  - Evaluate technology upgrade options.
Engineering for the Energy Evolution

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