



A few quick examples of mercury control projects

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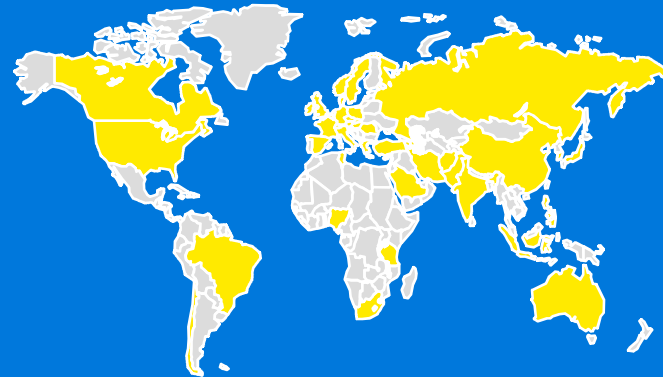
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Uniper at a glance

Our operations

- Power Generation
- Commodity Trading
- Energy Storage
- Energy Sales
- Energy Services



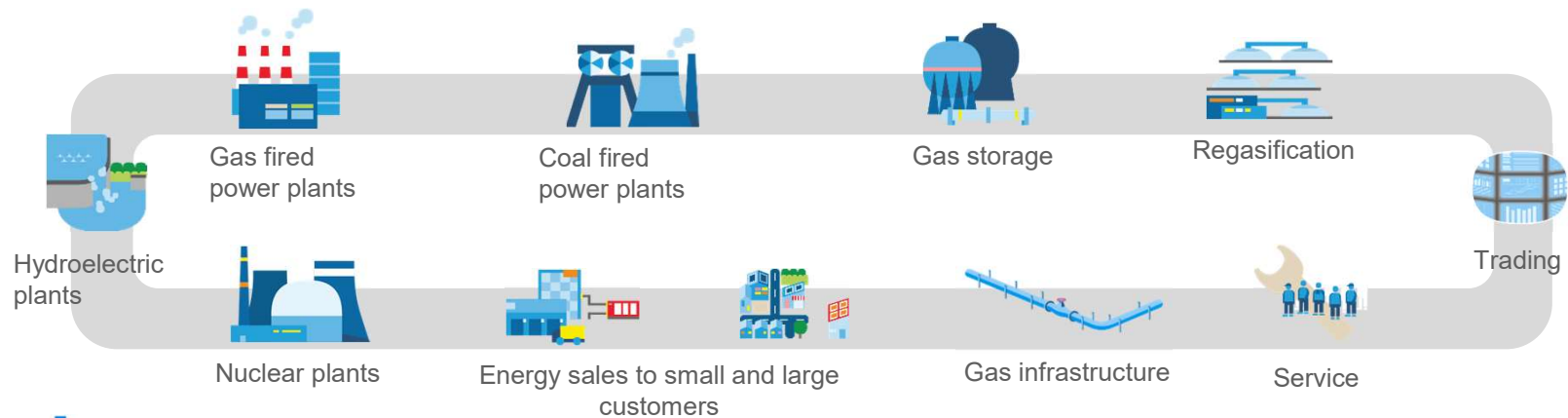
We operate in 40+ countries around the world

€1.5bn
EBITDA

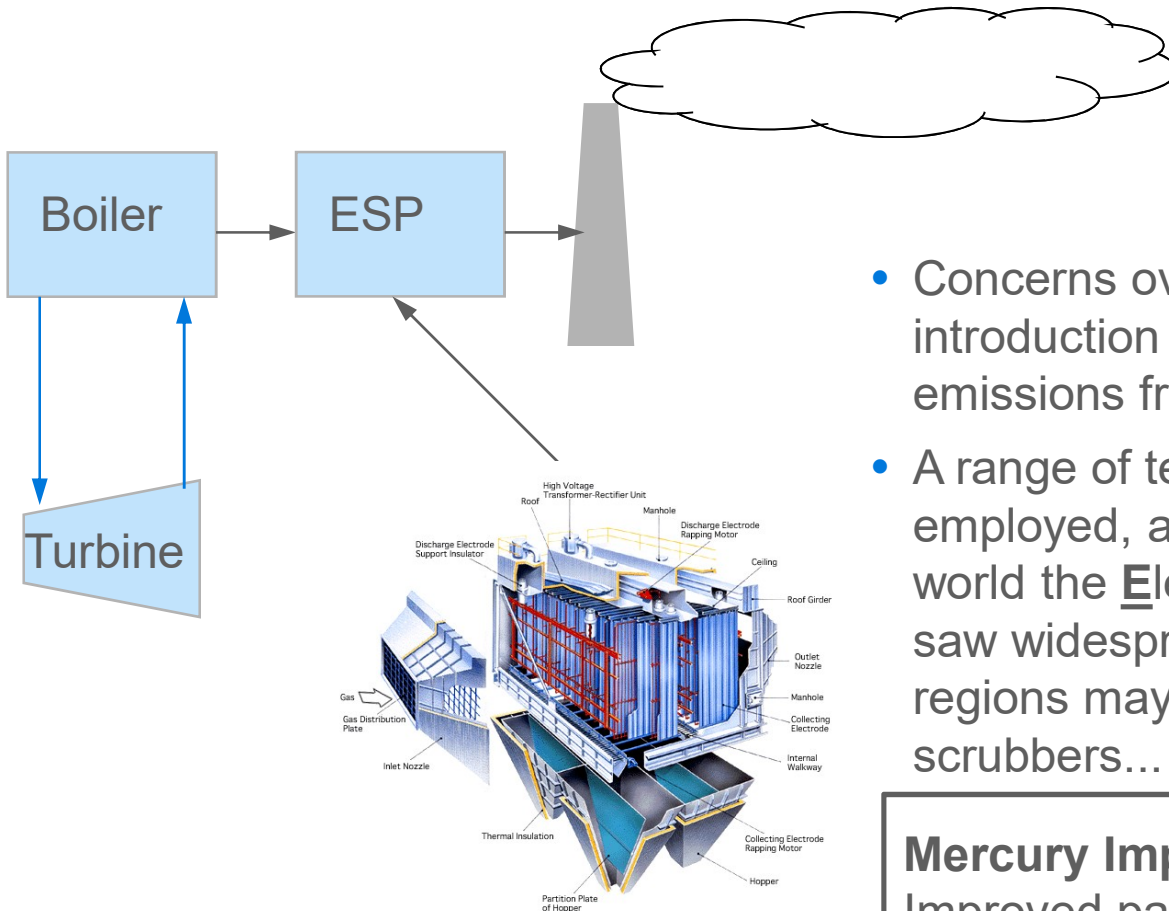
100 years
Experience

~34 GW
Generation capacity

Main activities



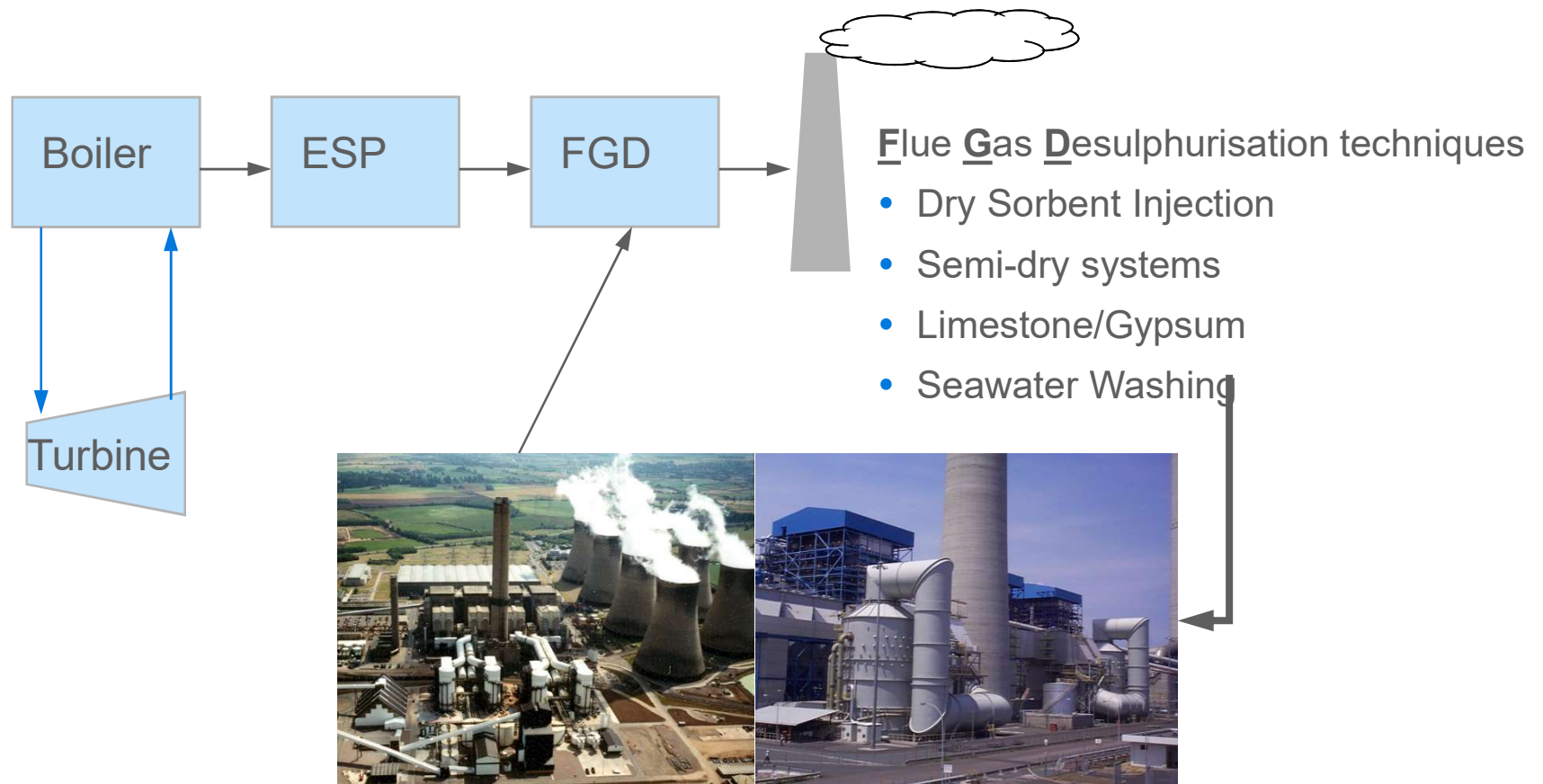
Emissions control – evolution over time



- Concerns over air quality led to the introduction of controls for particulate emissions from the chimney
- A range of technologies were employed, and within most of the world the Electrostatic Precipitator saw widespread use, though other regions may employ fabric filters, scrubbers...

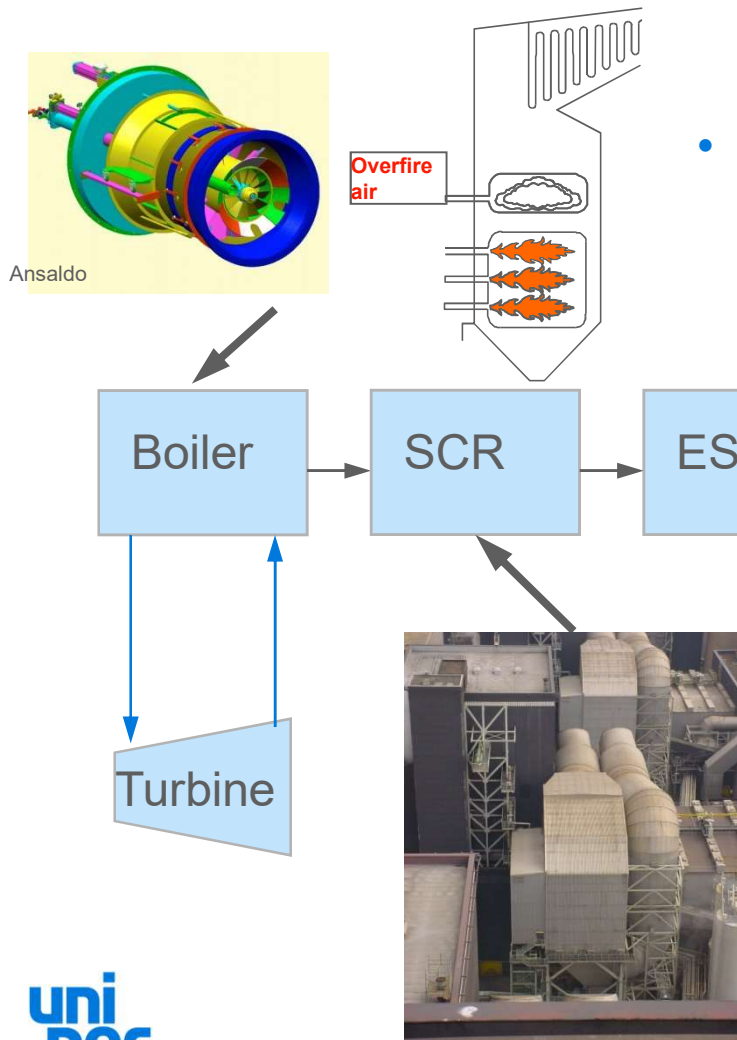
Mercury Impact:
Improved particulate collection means reduced stack mercury

Emissions control – evolution over time



Mercury Impact:
Improved collection of particulate and, especially, oxidised mercury – key part of any integrated environmental control strategy

Emissions control – evolution over time



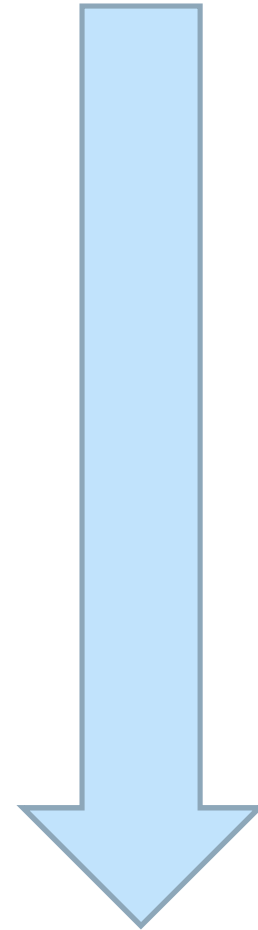
- Current EU regulations required that NO_x be reduced <200 mg/Nm³ in the EU (possibly lower depending on operating regime).
- Many plant are installing **S**elective **C**atalytic **R**eduction (SCR) to achieve these new limits, building on reductions deriving from Low NO_x Burners, or Low NO_x Firing systems.

Mercury Impact:

May increase carbon in ash, and therefore ash capture of mercury from flue gas. Catalytic DeNO_x also improves mercury oxidation for subsequent capture.

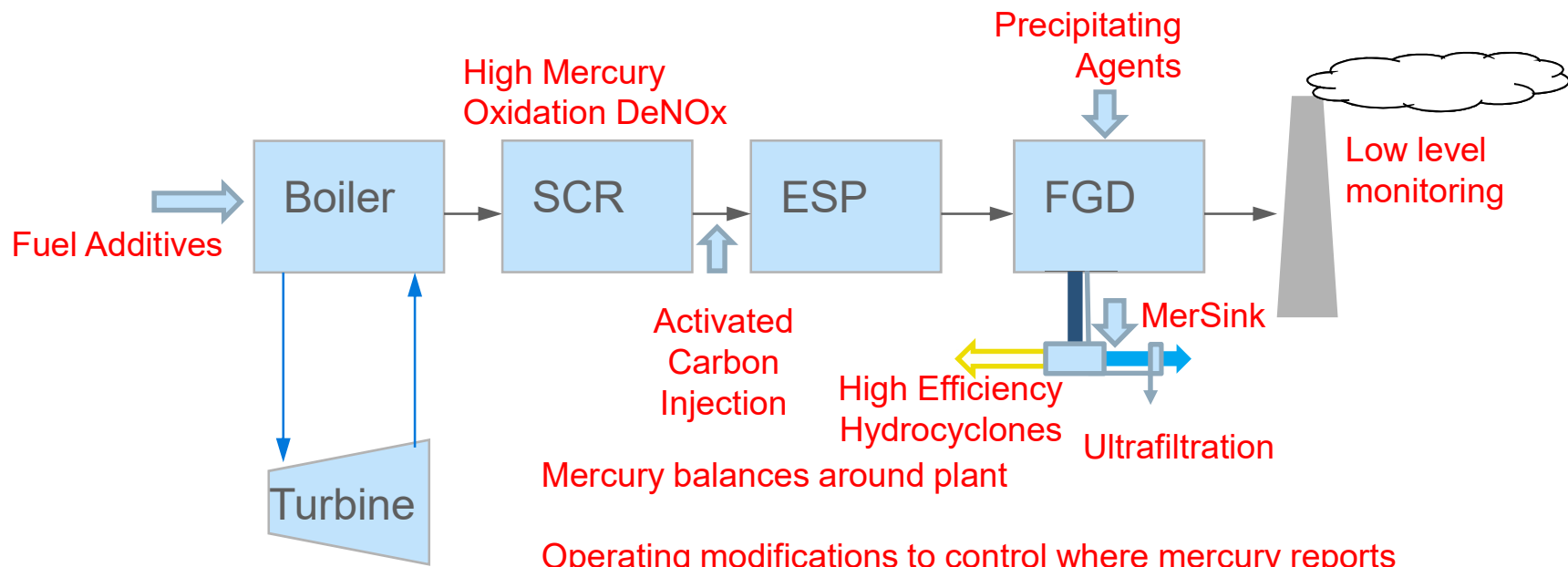
Targets of Uniper mercury research

- Develop understanding of factors affecting the distribution of Trace Elements in the Power Station
- Develop and/or verify suitable measurement technologies
- Reduce emissions - by choosing the most suitable technology and/or by optimising existing plant equipment
- Ensure saleability of by-products
- Prepare for and support full-scale implementation, and permit revision process – This is key, we can't do work simply because we want to, we focus on what is needed!



Shift in Program Focus with Learning, and Development of Fleet Position

Mercury R&D focus



Mercury balances around plant

Operating modifications to control where mercury reports

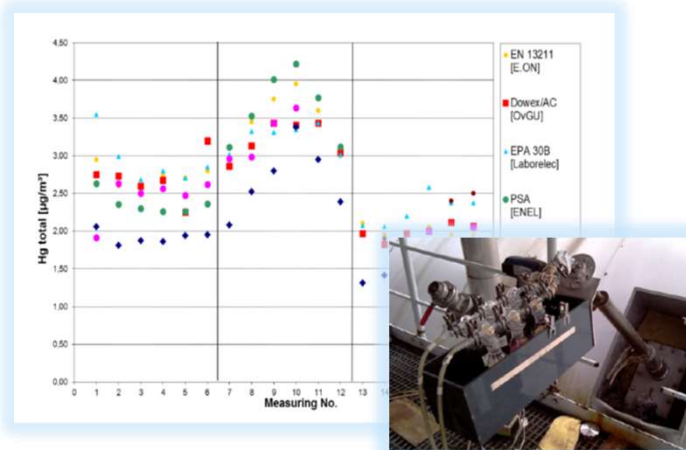
Testing of combinations of approaches

Lower cost additives

Measuring Low Mercury Concentrations

Work Undertaken

- It was identified that power plant mercury limits far lower than those for existing plant, by around a factor of 30, were being discussed. Existing standard reference methods were deemed unfit to demonstrate compliance.
- Tests were undertaken at two different plant, of known low mercury stack concentration. Four different sampling approaches were compared against one another and the requirements of the standard.
- Alternative methods deemed to be capable of meeting the requirements of CEN to become a Standard Reference Method (SRM).



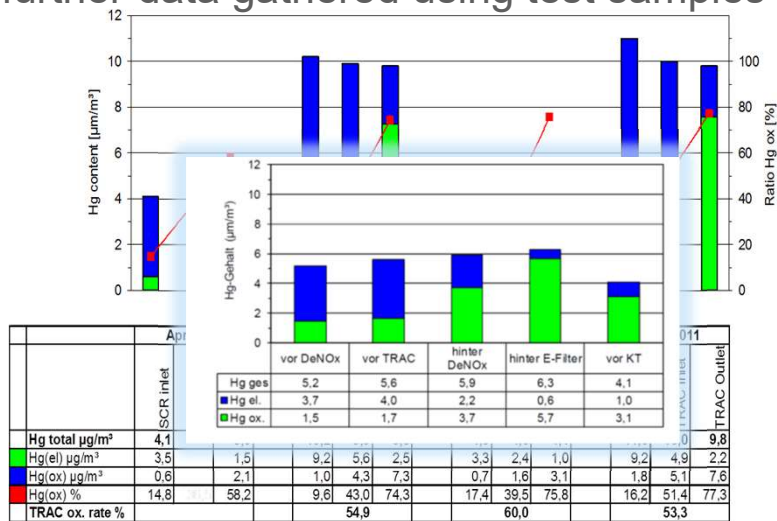
Key Result and Value Derived

- Recent regulatory activity has confirmed that far lower limits are to be implemented and that this work was necessary.
- Retest due to spurious results could carry major costs each time, or lead to false results for newly commissioned costly equipment – therefore testing and methods are important to get right.

Mercury Oxidation Catalyst

Work Undertaken

- SCR catalyst is known for its ability to increase mercury oxidation (important for subsequent removal in FGD), but specific products have been developed claiming to be more effective in increasing the portion of flue gas mercury present in the oxidised form.
- Following negotiations as part of plant development projects we undertook to complete testing of an enhanced mercury oxidation catalyst type.
- Mercury oxidation and DeNOx performance have been tested over a number of years, with data gathered across the SCR reactor to demonstrate the ability of the catalyst, and further data gathered using test samples of the catalyst in a bench scale reactor.



Key Result and Value Derived

- Overall testing has shown the potential of this type of catalyst to increase flue gas mercury oxidation, but some questions on performance raised.
- This is a building block of an integrated environmental controls strategy for plant equipped with SCR DeNOx.

Ultrafiltration Pilot

Work Undertaken

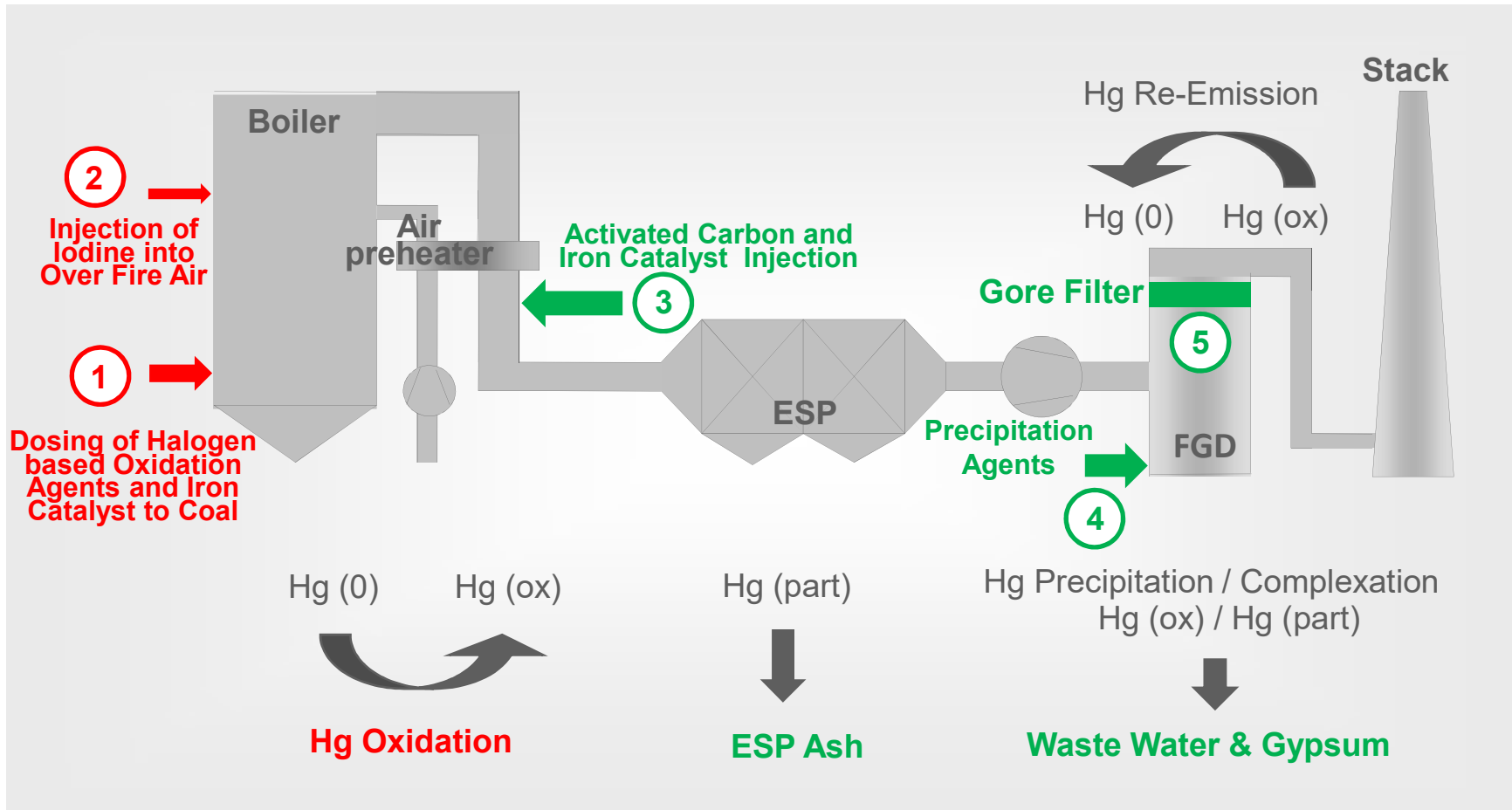
- Due to tightening constraints we recognized mercury reductions in wastewater were required.
- It is important also to consider that much of the work elsewhere is to “move” the mercury from the gas phase, into the wet phase of the FGD, and from there out of the gypsum into the water.
- This project tested a technique to ensure, when in the water phase the mercury can be controlled to low levels.
- Ultrafiltration technologies enable the separation of suspended solids down to a sub-micron particle size.
- This technology was tested at Heyden and then at Staudinger, and show that the very fine, mercury rich particles in the waste water can be removed with this technique - however, operation has not been trouble free.



Key Result and Value Derived

- Full scale UF plant are now installed at Heyden and Staudinger PS and form a part of the toolbox of techniques available to the plants.
- Whilst deployed, this would not be a favoured technique due to operational challenges.

Low rank coal – overview of tests 2015-2020



Plant in this category generally don't get the oxidation benefit of SCR DeNOx, and are also deeply staged. They also have limited fuel switching capability due to being mine mouth. Therefore, challenging.

Uniper – an active role in standards development

As an owner and operator of plant Uniper recognizes the importance of supporting the development of measurement and monitoring standards.

Uniper supports the development of CEN mercury standards as a member of CEN Working Group 8:

- PD CEN/TS 17286:2019 Stationary source emissions. Mercury monitoring using sorbent traps
- EN 14884:2005 Air quality. Stationary source emissions. Determination of total mercury: automated measuring systems (under revision)
- BS EN 13211:2001 Air quality. Stationary source emissions. Manual method of determination of the concentration of total mercury (under revision)

To Close

- The Electricity Supply Industry and other industrial users of coal have done much work to achieve environmental regulations and deliver a secure supply of energy to end customers.
- Finely tuned flue gas cleaning equipment, coupled with effective monitoring and measurement, is critical in ensuring a high level of overall environmental control from the process, and this is especially important when considering an integrated environmental control strategy for mercury and other emissions.



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