Developing the Future

# EPPSA Annual Report 2015

European Power Plant Suppliers Association

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**Credits**



EPPSA wishes to thank its President, Emmanouil Kakaras and all its members for their time and effort in making this publication possible.

# Introductory EPPSA Statement

The European Power Plant Suppliers Association (EPPSA) is the voice, at European level, of companies supplying power plants, components and services. EPPSA members, located throughout Europe, represent a leading sector of technology with more than 100,000 employees.

EPPSA actively promotes awareness of the **importance of flexible and efficient, state-of-the-art thermal power generation** and its crucial contribution to ensuring a **clean, secure, and affordable energy supply**.

EPPSA believes **increased investment in Research, Development and Demonstration** (RD&D) is a key factor in driving EU competitiveness as well as ensuring an affordable, low-emission power supply.

Virtually all thermal power plants in the EU are built by members of EPPSA or equipped with their components, and provide around 50% of Europe's electricity. EPPSA members provide the most advanced thermal power technologies in the world.

Retrofitting existing plants with state-of-the-art technologies that will enable them to use multiple types of fuel – including $CO_2$ neutral biomass – and that improve efficiency and flexibility.

Emmanouil Kakaras,
EPPSA President

# Message from the President

Emmanouil Kakaras,
EPPSA President

In 2015, the whole world closely followed the 21st United Nations Climate Change Conference in Paris. Beginning with the Rio Earth Summit in 1992, the Conference of the Parties (COP) conventions have sought to mobilise international political response to climate change and establish concrete goals to fight it. The COP21 agreement sets a new benchmark – limit the rise in global average temperature to well below 2°C. Climate change was acknowledged as an urgent threat that may lead to irreversible damage if we do not act immediately.

This agreement vindicates the EU's early efforts and associated legislation to reduce carbon emissions, and the thermal power industry is ready to tackle the associated challenges.

How do we contribute?

The thermal power generation sector has already taken a number of steps towards reducing its overall carbon footprint. For example, retrofitting existing plants with state-of-the-art technologies that enable them to use multiple types of fuels – including $CO_2$ neutral biomass. Co-combustion of primary fuels with biomass allows to cost-effectively minimise the overall $CO_2$ intensity per kWh of electricity produced. This improves the efficiency and flexibility of power generation and reduces the dependence on fossil fuel imports, tapping into indigenous resources where available, while maintaining affordable energy supply. Improvements are also being made to flue gas cleaning systems to surpass the latest requirements in EU regulations on air quality. But more can be done by investing in these technologies and this momentum must not be lost, or we risk seeing the introduction in Europe of cheaper, but much less clean and less efficient technologies from countries that are not part of the Organisation for Economic Co-operation and Development (OECD). This wouldn't just threathen the environment, but also the technological leadership of the EU - with the associated employement of a highly skilled European workforce.

Way forward

More funding for RD&D must be secured to allow the thermal power industry to develop and introduce new and improved technologies. This will help raise efficiency levels while reducing both capital and operational expenditures, ensuring affordable electricity for both consumers and industry in Europe.

The COP21 has also led to a renewed interest in Carbon Capture, Storage and Usage (CCSU) technology. CCSU has been recognised by the European Commission as a strategic technology to be further developed, as confirmed in its Energy Union Package adopted in February 2015 and is indispensable to reach EU's decarbonisation targets. In combination with efficient thermal power generation technology, it can pave the way for a clean and sustainable EU energy system. The upcoming debates on the Innovation Fund, whose predecessor NER300 supported CCS demonstration projects in the EU, must offer the opportunity to ensure adequate financial support to demonstrate this technology on large scale and unlock its potential for Europe.

Despite – or perhaps because of – all these changes, thermal power is set to have a prominent role within the energy mix. EPPSA supports the deployment of renewable energy sources, but one cannot ignore the intermittent nature of some of them. Thermal power can provide the necessary flexibility and dispatchability when demand outstrips the supply or vice versa.

The COP21 target to maintain average global temperatures to well below 2°C will result in further national efforts to reduce $CO_2$ emissions. This will impact the European energy production system, raising new challenges that will need to be tackled. EPPSA is looking forward to further working constructively with EU institutions and stakeholders to address these challenges and ensure the added value of the European Thermal Power Technology is appropriately recognised in a fair and balanced legislative framework, supporting the move to a low-carbon Europe.

Emmanouil Kakaras

# Thermal Power

has a

key enabling role

to play in a

decarbonised

energy system

Patrick Clerens,
EPPSA Secretary General

# EPPSA believes

## in a balanced energy mix

## in Europe's technological excellence

## in affordable electricity for consumer and industry



To meet the tremendous growth in demand for electricity due to the electrification of society and ensure the security of supply, all available sources are needed. There is not one, ideal energy source.

Increased investment in Research, Development & Demonstration (RD&D) in more environmentally-friendly technologies, inter-alia, Carbon Capture, Storage and Usage (CCSU) technologies, is vital.

Improved flexible, efficient and clean fossil fuel power plants need rapid implementation to preserve scarce natural resources and achieve $CO_2$ reduction targets. Funding, a comprehensive legal framework and public support are needed to make demonstration plants happen and keep Europe a global leading knowledge-based economy through centres of RD&D excellence creating skills and jobs.

Electricity in the EU must be affordable for consumers and industries to remain at the forefront of competitiveness in a global dimension.

# High lights 2015

Commission's Plan for an Energy Union Revealed

New International Energy Charter Adopted

EU Energy Days

EU Sustainable Energy Week



| January | February | March | April | May | June |
| --- | --- | --- | --- | --- | --- |

Study: Thermal Power in 2030 – Added Value for EU Energy Policy

A rapt audience at the EPPSA Technology Evening

EPPSA booth at PowerGen Europe

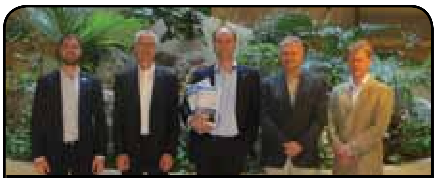

PowerGen Europe

EPPSA Technology Evening 2015

Industry letter to the European Commission on OECD Export Credit Support for coal-fired power plants

EPPSA visit to the Avedøre Power Plant in Copenhagen

Biomass at the Avedøre Plant in Copenhagen



EPPSA team at the LCP BREF discussions in Seville

Guided tour of the Avedøre Plant in Copenhagen

Dr Farley, Dr Borchardt & Dr Kakaras at the Technology Evening

Large Combustion Plants BREF Discussion in Seville

VGB Generation in Competition

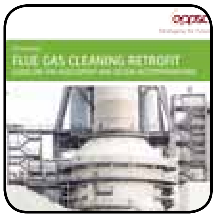

Study: Mercury Removal Guideline for Assessment and Design Recommendations


| July | August | September | October | November | December |
|---|---|---|---|---|---|
| Publication Market Design & Security of Supply | Celebrating 10 years of the Energy Community | SET Plan Conference | Public Consultation on Market Design & Security of Supply | Publication of First State of the Energy Union | Public Consultation on the Renewable Energy Directive II |


Dr Kakaras presenting at VGB


VGB Opportunities for Power Generation


EPPSA Members at VGB




Study:
Flue Gas Cleaning Retrofit Guideline for Assessment and Design Recommendations

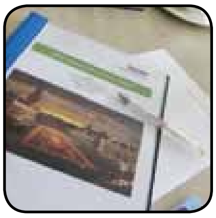

EPPSA Members at VGB



EPPSA booth at VGB

European Commission Market Design Consultation Reply

European Commission Security of Supply Consultation Reply



Workshop Modelling Energy Scenarios for South Eastern Europe

Making

clean

# Thermal Power

a Reality

Large Combustion Plants
Best Available Techniques Reference Document



## Background

In order to safeguard human health and the environment, legislations on both national and EU levels exist in order to prevent or as much as possible limit emissions of harmful substances into air, water, and soil from industry. At the EU level, the IED (Industrial Emissions Directive, 2010/75/EU) sets the frame for BREFs, BATAELs and ELVs. How to sort these different acronyms?

## How does the IED work?

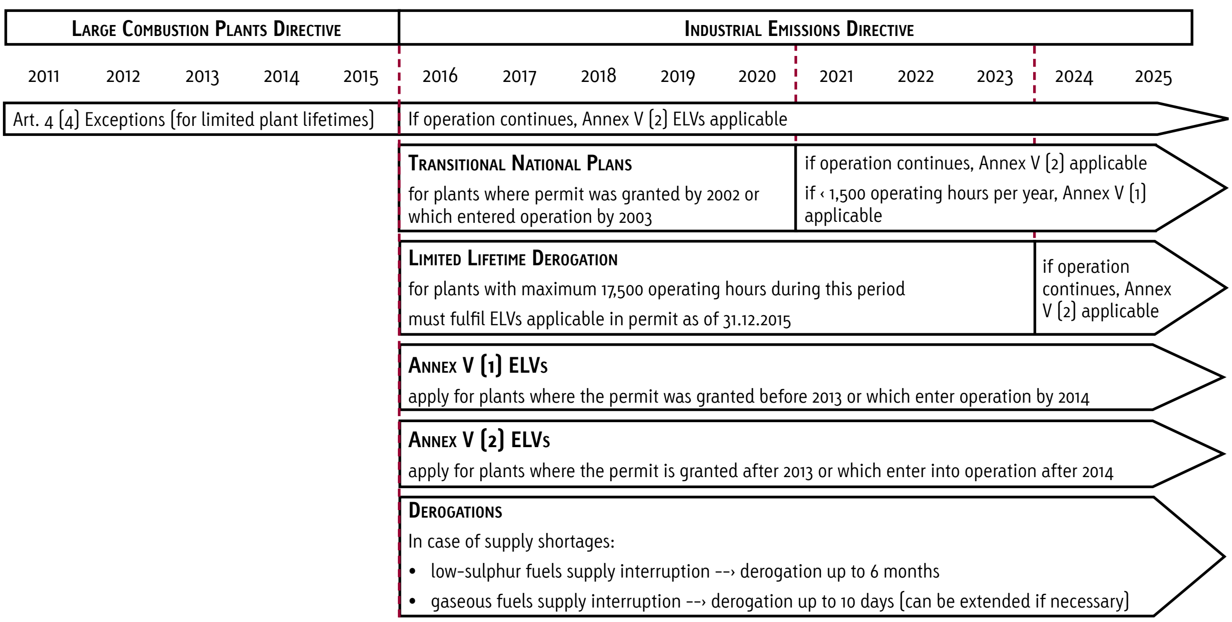
According to the IED, industrial installations like power plants need to operate with a permit, in which plant-specific Emission Limit Values (ELVs) are defined. The permitting authorities in each Member State must ensure that permits are granted only to installations that are able to fulfil Europe's strict emissions requirements, and this is guaranteed by requiring the application of Best Available Techniques (BAT), which can be found in the Best Available Techniques Reference Documents (BREFs).

## What is a BREF?

BATs are those techniques which achieve a high level environmental of protection and are both economically and technically feasible; overall, they must be reasonably accessible to the operator. Finally, BATs refer not only to specific types of technology or to specific components, but also to the way that an entire installation is designed, maintained and operated.

Emissions into air, water and soil differ according to the type of industrial activity. For each type of industrial activity, there exists a document that represents an overview of the BATs – the Best Available Techniques Reference Document, or BREF. This document contains conclusions that list the emission levels (referred to as the BAT Associated Emission Levels (BATAELs)) associated with each technique, defining a range of emissions (e.g. from 2 mg to 10 mg/Nm³) that correspond to each. When a technique meets these ranges, it is considered a BAT. Currently, 32 BREFs exist, covering all kinds of industrial activity ranging from cement manufacture to large combustion plants.

ELVs and Exemptions in the IED



Boiler with an even combustion temperature profile – optimal for handling a wide variety of fuel properties

Turbogenerator

## BREF review process

Technological progress necessitates a periodic review of the BREFs as new techniques that are able to further reduce harmful emissions are developed and refined. To ensure that the highest possible environmental protection is achieved throughout Europe given the Best [currently] Available Techniques, the IED contains provisions for a revision process.

Once a BREF has been updated and its BAT conclusions adopted, permitting authorities in Member States have a period of four years in which they must review and, if necessary, update existing installations' permits to ensure that the ELVs of all installations do not exceed the range of the BATAELs of the new BAT conclusions.

Overall, emission limits drive technological Research and Development, which result in better available technologies, which then influence future legislation. This represents a cyclical process that improves technologies for an increasingly clean environment and, consequently, a healthier planet and society.

## What is the relevant framework for thermal power plants?

The IED considers thermal power plants as "large combustion plants" (above 50 MW thermal) and sets requirements that vary depending on the age, size, fuel, and lifetime of the plant.

There are special regimes, for example for older plants that can be included in so-called "Transitional National Plans" to allow enough time to refurbish them with BATs. Otherwise, they may be exempted from the IED's requirements via the so-called "Limited Lifetime Derogation", which is granted provided that they operate for a limited number of hours. In addition, temporary derogations are possible in the case of supply shortages.

Nevertheless, once the different temporary exemptions will have expired, the large combustion plants in operation in the EU will have to meet the ELVs as set out in Annex V (2) – until the updated LCP BREF arrives at newer, stricter values.

## The new LCP BREF and its legally binding values

Since the launch of the LCP BREF review in 2011, EPPSA has been an active member of the LCP BREF Technical Working Group. EPPSA helped coordinate input on data to derive BATAELs from operational values, providing expert input on technologies and leading the Task Force on Energy Efficiency that yielded the agreed design energy efficiency values contained in the LCP BREF.

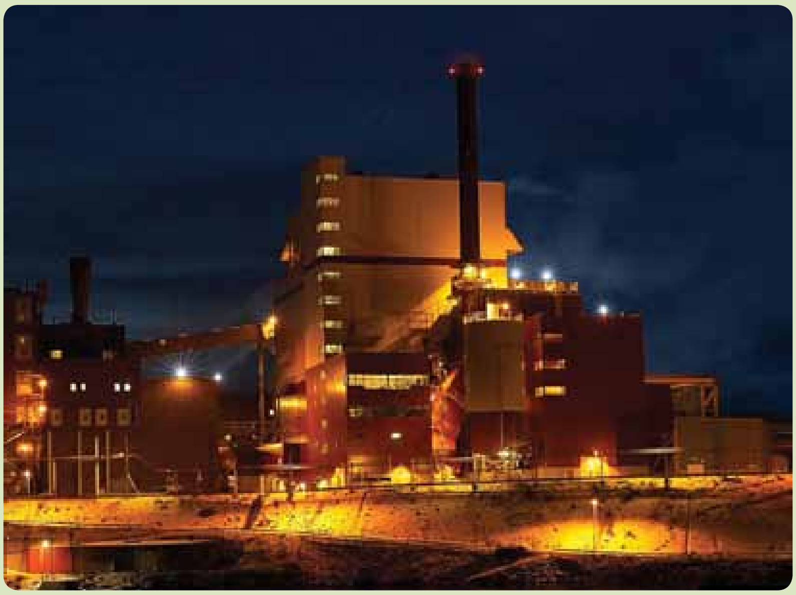
In 2015, the LCP BREF Technical Working Group finalised its work to define what should be the contents of the new BREF, including the new BATAELs and other BATAEPLs (BAT Associated Environmental Performance Levels).

In 2016, EPPSA will continue following the LCP BREF as it passes through the IED Article 13 Forum where other industries, NGOs and Member States will review and produce an opinion on the final draft BREF and its BAT Conclusions. This opinion will then be given to the IED Article 75 Committee, consisting only of Member States and the European Commission, who will adopt the BREF and turn it into a legally-binding instrument.

The BATAELs contained in the revised LCP BREF should then be published in 2017 and will form the basis for setting permit-specific ELVs. New plants will need to meet its requirements from the publication date and 4 years later for existing plants.

## State-of-the-art technology for clean coal

The new LCP BREF sets more ambitious requirements for substances already regulated and has added new pollutants (e.g. mercury) to be abated (for more information on Mercury Removal Techniques, please refer to the 'Mercury Removal - Guideline for Assessment and Design Recommendations' paper). It is understandable that implementing the LCP BREF may be a challenge for operators, but the technology is there to help make clean coal a reality.



Below are the general legally-binding values, stemming from different binding EU legislation, e.g. the BREFs, the IED or the Medium Combustion Plant Directive. Many exceptions exist and are not listed here. For more information and for a full description of this table, please visit www.eppsa.eu.

Bear in mind that local permitting authorities may always ask stricter emission levels than those described here.



| Fuel | Type of Value | Legal Instrument | MW | Type | $NO_x$ | $SO_2$ | Indicative CO (Yearly) (existing = ≥1500 hpy) | HCl | HF | Dust | Hg |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Biomass | ELV | MCP | 1-5 | | 500 | 200 | | | | 50 | |
| Biomass | ELV | MCP | 5-20 | | 300 | 200 | | | | 30 | |
| Biomass | ELV | MCP | 20-50 | | 300 | 200 | | | | 20 | |
| Biomass | ELV | IED | 50-100 | | 250 | 200 | | | | 20 | |
| Biomass | ELV | IED | 100-300 | | 200 | 200 | | | | 20 | |
| Biomass | ELV | IED | ≥300 | | 150 | 150 | | | | 20 | |
| Biomass | Benchmark | MCP | 1-5 | | 200 | | | | | 10 | |
| Biomass | Benchmark | MCP | 5-50 | | 145 | | | | | 5 | |
| Biomass | BATAEL | BREF | 50-100 | | 120-200 | 30-175 | ‹30-250 | 1-12 | ‹1 | 2-10 | ‹1-5 |
| Biomass | BATAEL | BREF | 100-300 | | 100-200 | ‹20-85 | ‹30-160 | 1-12 | ‹1 | 2-10 | ‹1-5 |
| Biomass | BATAEL | BREF | ≥300 | | 65-150 | ‹20-70 | ‹30-80 | 1-12 | ‹1 | 2-10 | ‹1-5 |
| Coal | ELV | MCP | 1-5 | | 500 | 400 | | | | 50 | |
| Coal | ELV | MCP | 5-20 | | 300 | 400 | | | | 30 | |
| Coal | ELV | MCP | 20-50 | | 300 | 400 | | | | 20 | |
| Coal | ELV | IED | 50-100 | | 300 (400 PL) | 400 | | | | 20 | |
| Coal | ELV | IED | 100-300 | | 200 | 200 | | | | 20 | |
| Coal | ELV | IED | ≥300 | | 150 (200 PL) | 150 (200 FB) | | | | 10 | |
| Coal | Benchmark | MCP | 1-5 | | 100 | | | | | 10 | |
| Coal | Benchmark | MCP | 5-50 | | 100 | | | | | 5 | |
| Coal | BATAEL | BREF | 50-100 | | 155-200 | 170-220 | ‹30-140 | 1-6 | ‹1-3 | 4-16 | Coal: ‹1-3; Lignite: ‹1-5 |
| Coal | BATAEL | BREF | 100-300 | | 80-130 | 135-200 | ‹30-140 | 1-3 | ‹1-2 | 3-15 | Coal: ‹1-3; Lignite: ‹1-5 |
| Coal | BATAEL | BREF | ≥300 | FBC | 80-125 | 25-110 | ‹30-100 | 1-3 | ‹1-2 | 3-10 | Coal: ‹1-2; Lignite: ‹1-4 |
| Coal | BATAEL | BREF | ≥300 | PC | 80-125 | 25-110 | ‹5-100 | 1-3 | ‹1-2 | 3-10 | Coal: ‹1-2; Lignite: ‹1-4 |

Upcoming technical work on the ICS BREF

# Bringing Industrial Cooling into the 21st century



## Industrial Cooling Systems BREF

Another relevant BREF for thermal power plants concerns Industrial Cooling Systems – the ICS BREF. It contains specific provisions for cooling towers used in thermal power generation. Within EPPSA, the Cooling Division is active through the ICS BREF Working Group at analysing and commenting on the current contents of the ICS BREF, written in the 90s and published in 2001.

Over the last 15 years, the landscape has changed for cooling. Horizontal thinking and resource efficiency now set the frame. This explains why the European Commission is interested in merging the ICS BREF with the Energy Efficiency BREF while encompassing the broader Circular Economy considerations as well as energy and water efficiency. This new document would be the "Resource Efficiency BREF".

## Challenges and opportunities of a "Resource Efficiency BREF"

Without the ICS BREF's specific provisions to ensure minimal environmental impacts, there will be uncertainty as to the utilities' requirements and associated guarantees that the EPPSA members will need to provide. A modernised ICS BREF should mandate the implementation of the EPPSA members' state-of-the-art technologies and their proper functioning. This will help protecting waterways and air linked with cooling towers, an important aspect to protect human health.

At the same time, the EPPSA members already are specialists in assessing the energy and water balances of their power and cooling tandems. It is hence of little value to describe such considerations in a merged Resource Efficiency BREF, which risks enlarging the technological descriptions in a way that they are either too general to derive binding values, or too specific to derive values that are applicable everywhere (e.g. making Combined Heat and Power a general requirement, which is not always feasible).

If the European Commission nevertheless moves to merge both BREFs and link them to the Circular Economy, as long as feasible environmental requirements for cooling towers remain, it could bring added value to EPPSA members by raising the profile of members' technologies.

The EPPSA members active in the ICS BREF Working Group will continue their analysis of the existing BREF and of the Commission's proposal in 2016 to determine a way forward, pending the start of the ICS BREF review during the current BREF review cycle.

Construction of a cooling tower

# CCS

## Possibilities

# CCU

## Hurdles

## Applications

Any form of combustion, such as the operation of a thermal power plant, generates Carbon Dioxide ($CO_2$). There is a political will to limit these emissions.
The goal of Carbon Capture and Storage (CCS) is to prevent the $CO_2$ generated from being released into the atmosphere. Instead, the $CO_2$ is stored underground.
CCS has long been used by the Oil Industry (in a process known as Enhanced Oil Recovery). This involves injecting $CO_2$ deep underground into oil reservoirs – so that it increases the pressure, changes the viscosity and forces more oil out.
$CO_2$ can be stored in deep saline aquifers, which hold the $CO_2$ in the same way that a sponge holds water within its pores. Like the water in a sponge, liquefied $CO_2$ can be locked indefinitely within aquifer layers, which are abundant on Earth.
$CO_2$ storage has proven environmentally safe in all experiments conducted so far. 3 million tonnes of $CO_2$ every year are stored in test sites located in North America and the North Sea.

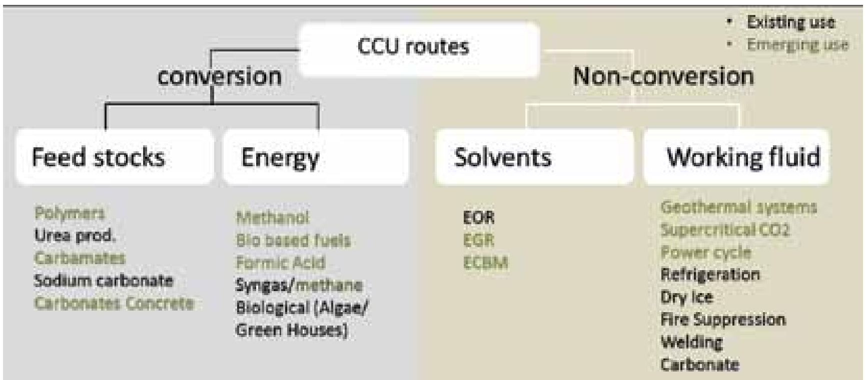
The COP21 agreement has set a new benchmark – limit the rise in global average temperature to well below 2°C. To achieve this, deep cuts in $CO_2$ emissions over the coming decades are required. Although Carbon Capture and Storage represents a potentially important abatement option for achieving this, commercial scale CCS developments are lagging behind. Therefore, the EU needs an appealing approach for CCS that provides improved solutions with respect to cost, performance, operational flexibility and re-use of $CO_2$.

$CO_2$-Enhanced Oil Recovery ($CO_2$–EOR) is a proven technology increasing oil recovery and simultaneously storing $CO_2$ permanently in the subsurface. Commercial CCU propositions such as mineralisation and $CO_2$-EOR can make a significant contribution to climate change abatement by providing long-term $CO_2$ storage and also providing an economic drive for $CO_2$ capture and network development. Other CCU propositions, although involving smaller quantities of $CO_2$, and without long-term storage potential, can also provide economic drivers for $CO_2$ carbon capture, especially in locations where access to storage sites is limited. Commercial CCU can also be part of resource efficiency and circular economy strategies that look at the valorisation and use of waste streams. The assessment of such future options for $CO_2$ re-use requires a careful comparison against alternative scenarios involving similar clean processes that do not use $CO_2$.

With the exception of mineralisation and $CO_2$-EOR, $CO_2$ will be released back into the atmosphere for a substantial number of CCU options.

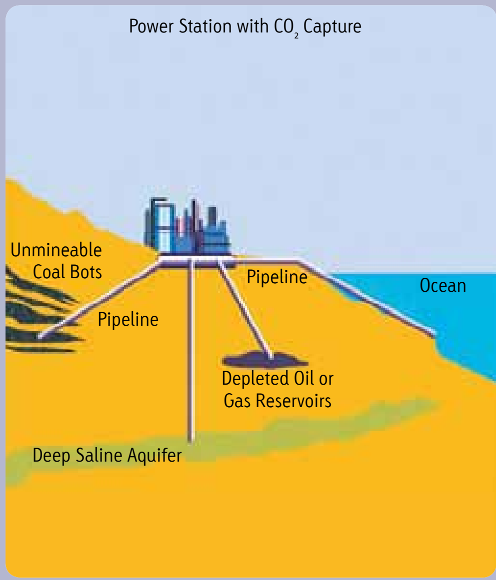
Next to the CCU options shown in the image below, there is also the option of permanent storage. This is mainly focused on using $CO_2$ as the solvent for EOR, and the emerging technologies of carbonation and mineralisation feedstock options, coming from industrial sources generating mineral residues sufficiently reactive with $CO_2$. For athmospheric $CO_2$ concentrations, these emerging options provide the long-term storage needed but their very limited scale limits their global mitigation potential.

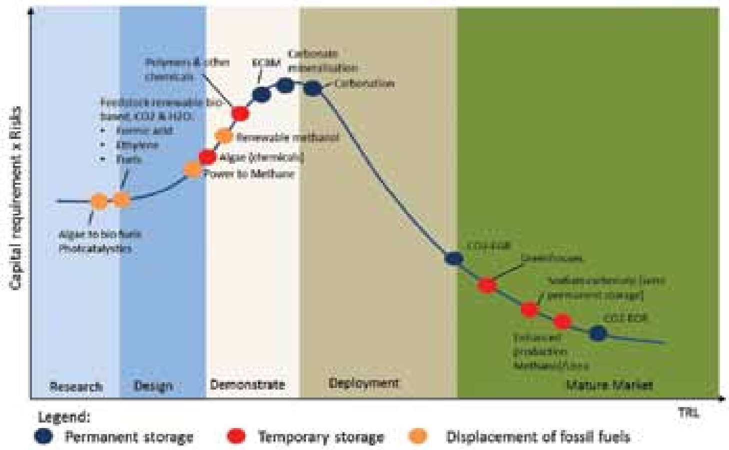
EOR is a mature technology, which can potentially fulfil a crucial role as an enabler for large uptake volumes of $CO_2$ and thus CCS. The use of $CO_2$ to boost urea or methanol production reached already commercial status whereas others are at the theoretical and research phase, or are at the pilot/demonstration phase, and need further development to reach commercial status. For example, the direct electrochemical reduction of $CO_2$ from



CCU routes (source: US DoE)

# CCSU



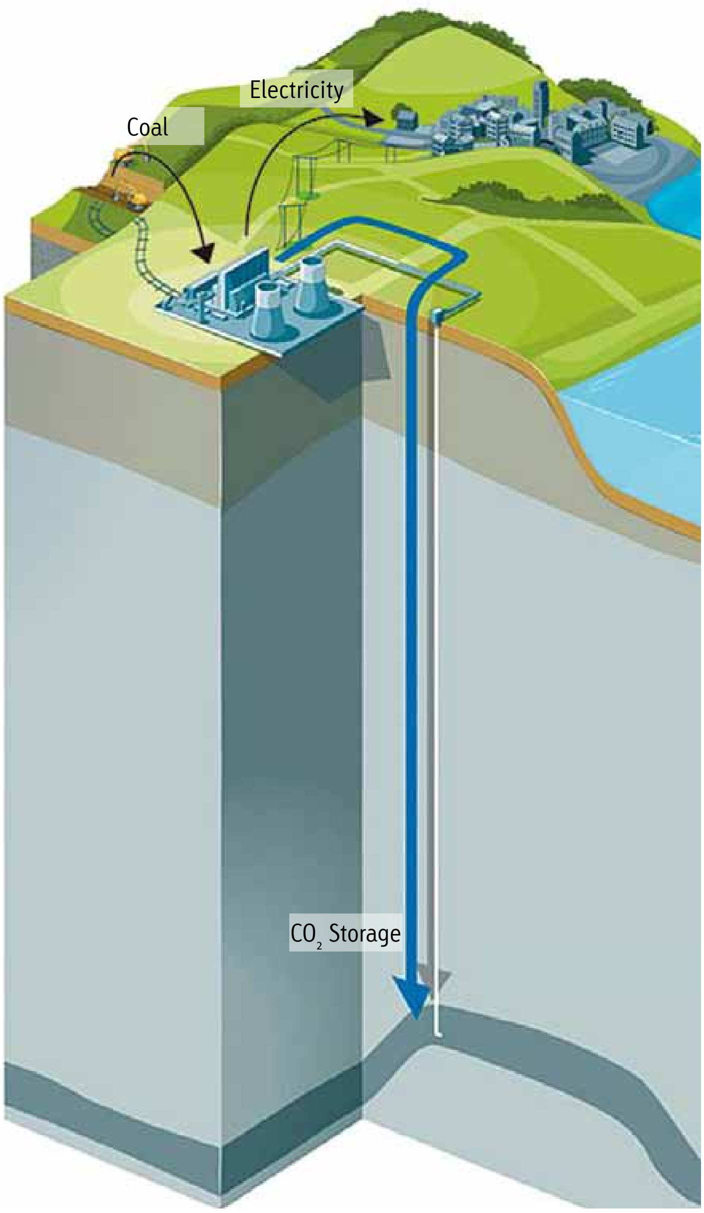

Technology maturity curve of CCU options (status: 2015) (source: ZEP)

bio-based feedstocks is currently available only at low technlogy readiness levels. Therefore, significant research efforts are still required before these technologies will have an impact.

For CCU as an enabler for CCS, system integration will be a crucial aspect to be considered, because:

- Multiple users might benefit from a common $CO_2$ infrastructure for storage and utilisation;
- Increase of $CO_2$ demand;
- System flexibility will be increased, by demand response of CCU applications, facilitating base load off-take for EOR and storage;
- Emerging CCU technologies will benefit from a reliable supply chain of $CO_2$, the emerging CCU technologies will have different flow rates and in most cases the uptake volume is lower than cost–effective capture technologies produce.

The reuse of $CO_2$ properly integrated with permanent $CO_2$ storage options enables the opportunity to develop a common $CO_2$ infrastructure, increase the demand of $CO_2$, provide system flexibility by demand response of CCU applications and provide a reliable $CO_2$ source for emerging CCU technologies with smaller $CO_2$ off- take levels.




*This short introduction to CCS & CCU was based upon the expertise of the EPPSA members and on the 2015 CCU report by the European Technology Platform for Zero Emission Fossil Fuel Power Plants.*

# Biomass

# Fuel Flexibility



**Reducing $CO_2$ intensity of fossil power plants**
**Biomass co-combustion**

The EU has set the political aim to reduce EU $CO_2$ emissions by 40% compared to 1990 and to have 27% of final energy consumption in the EU as a whole coming from renewable energy sources by 2030. The Paris Agreement is also committing parties to limit the temperature increase to well below 2°C. This will require more and more innovative ways to generate thermal power. Thermal power plants, which, amongst others, have an important grid stabilisation role, will therefore need to reduce their $CO_2$ intensity per kWh of electricity produced. This can be done by efficiency increases and carbon capture, but also by the co-combustion of biomass.

To use biomass as a fuel, it must have been harvested sustainably to avoid increasing the greenhouse gas emissions in the overall process. Sustainably-harvested biomass is $CO_2$ neutral, which means that any fossil fuel replaced by such biomass is reducing the specific $CO_2$ emission/kWh in the power plant.

Biomass combustion has its merits both on a small and a large scale and both in biomass-only plants and in co-combustion plants. But, since the ultimate goal is the reduction of $CO_2$ emissions, finding the most efficient ways to turn biomass into electricity should be the aim. When discussing co-combustion, one normally speaks of large scale (typically over 50 MW thermal) biomass co-combustion, which is the use of different fuels (which can include multi-fuel combustion capabilities) in the same power plant. Co-combustion can be done by mixing biomass with coal, and then using the blended fuel, as is often done in existing large scale power plants.

Adding the biomass to the existing solid fuel is the easiest way to co-combust: the biomass is ground and then combusted together with the primary fuel. This can occur regardless of whether the plant's firing system is a fluidised bed or a pulverised fuel combustion, keeping in mind that fluidised bed combustion boilers may handle more diverse biomass streams given their longer residence time.

If the biomass is unsuitable for this direct blending, a separate mill and, if necessary, a separate burner, can be retrofitted with little investment. It is also possible to have a two-staged process, where the biomass is first gasified, after which the thus produced syngas is combusted in a second step, with or without cleaning, in a turbine or a boiler.

Eslöv Lund, Sweden - Biomass Plant

All of these options depend on the characteristics of the biomass as well as on the specificities of the plant, mainly its age. Technically speaking, modern power plants need little to no modification to enable co-combustion. The existing mills can often be used to grind the biomass to the same particle size as the primary fuel, thus allowing a fast switching between fuels and a continuous use of the existing boiler as well as the other components, while taking advantage of the highly-efficient steam-water cycle.

Protecting the environment does not only involve reducing greenhouse gas emissions however; preserving air quality is also crucial. Small scale biomass combustion is very often criticised for emitting high quantities of Particulate Matter (PM) as well as other pollutants (i.e. $SO_x$, $NO_x$). This is in

# Multifuel



contrast with the sophisticated flue gas cleaning systems of large combustion plants, which do capture them.

EPPSA therefore welcomes the emission limit values defined in the newly-adopted Medium Combustion Plants Directive (EU 2015/2193). This directive sets the first EU-wide minimum requirements for plants having boilers with a rated thermal input of 1-50 MW. These air protection requirements and their compliance deadlines vary according to plant size and fuel, but are a step in the right direction.

Large scale thermal power plants have a higher efficiency than small scale thermal plants thanks to a high-pressure and high-temperature steam-water cycle. This means that using the highly-efficient steam parameters of existing coal plants to generate electricity from renewable biomass will bring higher efficiencies. This higher efficiency, together with economies of scale, mean that less biomass needs to be burnt to obtain the same amount of renewable electricity if it is (co-)combusted in large plants compared to small ones. This reduces the stress on scarce biomass resources. For instance, in a large, electricity-only power plant, electrical efficiencies of over 45% can be achieved, while this figure can leap to above 90% if combined heat and power is used.

Large scale biomass combustion and biomass co-combustion often are the most efficient ways to use biomass for electricity production. They have the additional benefit that large scale power plants are existing infrastructures, lowering the cost of producing electricity from biomass. Additionally, such plants can often handle challenging and/or underused biomass streams such as certain sewage sludges.

EPPSA members have successfully built and retrofitted biomass co-combustion (or multi-fuel) plants in the past. The Avedøre 2 power plant in Denmark is a multi-fuel system, able to combust natural gas, oil, straw and wood pellets with efficiencies that can reach up to 94%. The purely electrical efficiency is 49%. By co-combusting biomass in large scale power plants, state-of-the-art technologies with higher energy efficiencies and sophisticated air protection units can ensure the best environmental performance for this renewable fuel.

Avedøre, Denmark - Co-combustion

But this is not always recognised from a political point of view. For instance, in some EU Member States, financial support and preferred grid feed-in are granted to biomass combustion in smaller and/or biomass-only plants, but larger biomass co-combustion is not supported, let alone incentivised. It is not really understandable why there is such a discrepancy for the energy use of biomass. Sustainably harvested biomass is a carbon-neutral fuel, no matter where it is combusted.

The efficiency of biomass use should be the determining factor. Neither the size of the plant nor the question of whether it is a biomass-only or a biomass co-combustion plant should play a role in ranking such plants for policy-setting.

This is why EPPSA asks policy-makers to treat all sustainably harvested biomass as carbon-neutral and to support all biomass combustion the same way!

# CSP

## Concentrated Solar Power

### Making Concentrated Solar Power part of the future energy mix

The EU has set the political objective to have 27% of its total final energy consumption coming from renewable energy sources by 2030. This increasing share of partially intermittent renewable energy sources in a fully integrated European electricity market will surely be one of the biggest challenges of the Energy Union. Concentrated Solar Power (CSP), however, could very well bring tomorrow the operational stability that is currently lacking in the renewable energy sources that are the most common in the EU, i.e. Wind and Photovoltaic (PV).



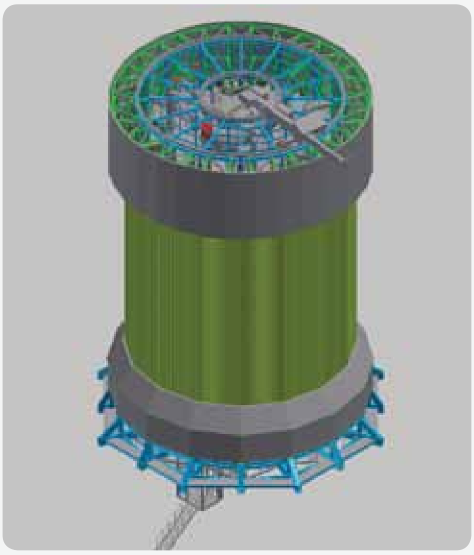
CSP is produced by concentrating sun rays towards a solar receiver to generate superheated steam (based or not on heated fluid e.g. boiling water, thermal oil, molten salt). From this point, the mechanism is identical to the one of a classic thermal power plant, with the steam feeding a steam turbine to produce electricity.

New developments in thermal storage capacity have increased the dispatchability of solar-based thermal power generation by dissociating steam production from solar energy absorption (e.g. through energy storage). This dispatchability is a key advantage over cheaper photovoltaic plants, as electricity cannot efficiently be stored at an industrial scale based on the state of existing technologies and photovoltaic-based production necessarily follows sunshine fluctuation.

Despite these prospects, CSP has yet to achieve significant market penetration. One of the obstacles is the regional limitation of CSP; i.e. it cannot be implemented everywhere. Similar to traditional photovoltaic solar panels, to fully implement this technology, one

Khi Solar One Power Plant

Atacama Power Plant in Construction



Molten Salt Receiver

requires favourable weather conditions, i.e. a high ratio of sun throughout the year. Typically, such “favourable” circumstances can usually only be found in desert climes, of which Europe has only a limited capacity. An exception in this is Spain, which is one of the leading European countries in this field with several CSP plants, e.g. the Solnova Solar Power Station (150 MW), the Andasol solar power station (150 MW), and Extresol Solar Power Station (100 MW). Examples of larger demonstration plants can be found outside Europe, e.g. The Ivanpah Solar Power Facility is the largest solar power plant in the world (377 MW), located in the Mojave Desert of California, or the SEGS installation (354 MW). Other solar thermal plants include the molten salt plant (110 MW) built in the remote Atacama desert in north Chile, which has one of the highest level of solar power radiation in the world.

## More Research and Innovation support

More needs to be done to preserve the Solar Thermal Electricity European industry global leadership. Enabling framework conditions in the European Union and the EU Member States to foster the mass deployment of this technology are currently missing at the moment. Specifically, market development programmes with associated learning and economies of scale as well as intensified R&D efforts to bring Technology Readiness Levels of innovative concepts closer to the market need to be supported by the European Commission and EU Member States in conjunction with the continued efforts by the private sector. This should lead to a substantial cost decrease for CPS in those regions where it can be applied, with a view to optimise the share of solar thermal power and CSP in the future European energy mix, complemented by state of the art classical thermal power generation, and guaranteeing a continuous energy supply in the future and contribute to a successful, clean and sustainable European Energy Union.

Direct Steam Generation Solar Receiver

Communication

# Activities



## Technology Evening 2015 & EPPSA Study "Thermal Power in 2030 – Added Value for EU Energy Policy"

On the 19th of January 2015, EPPSA organised its 9th Technology Evening, with the theme "Thermal Power: a Bridge to the Future", attracting more than 100 attendants.

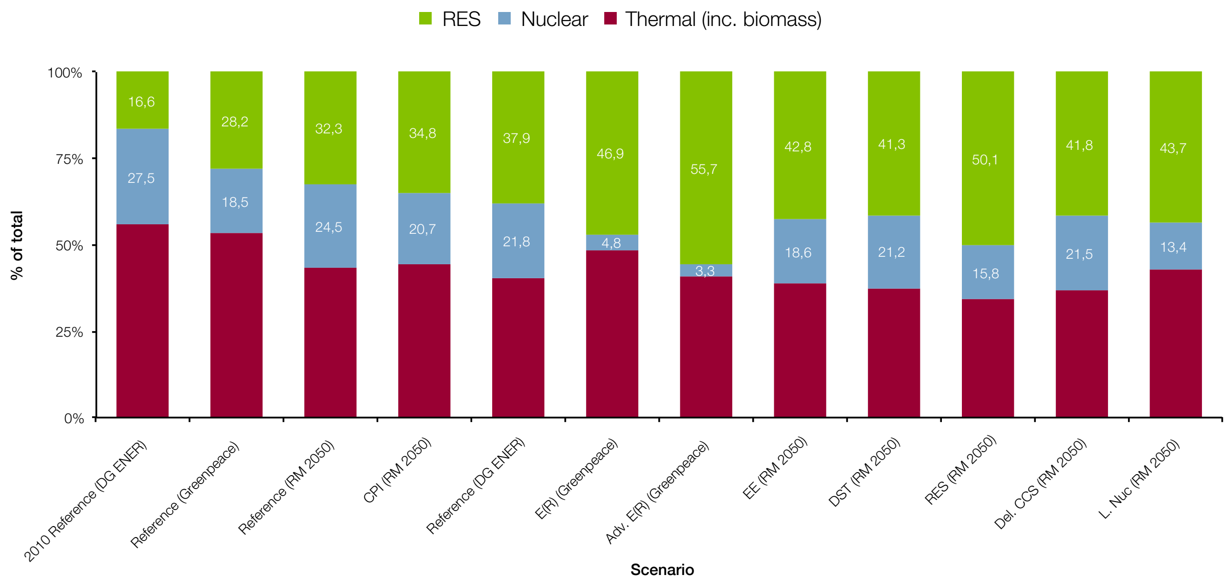
The evening saw a keynote of Dr Klaus Dieter Borchardt - Director of Directorate B - Internal Energy Market of DG Energy - and the official launch of the EPPSA study on "Thermal Power in 2030 - Added Value for EU Energy Policy", which was presented by Dr Kakaras, EPPSA President, and Dr Farley, its co-author.

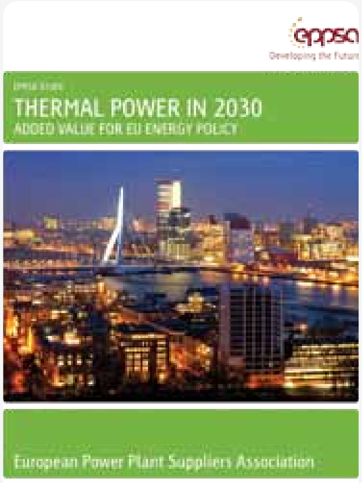
The study analyses 24 scenarios, as set forth by 7 studies, with attention to their projections for 2030 for the Generation Mix, the Capacity Mix and the Thermal Capacity. These projections were prefaced by an in-depth analysis of the EU Energy Policies and juxtaposed with the findings of the EPPSA New Build Database to get a better idea of where we are coming from, where we could go and where we should go.

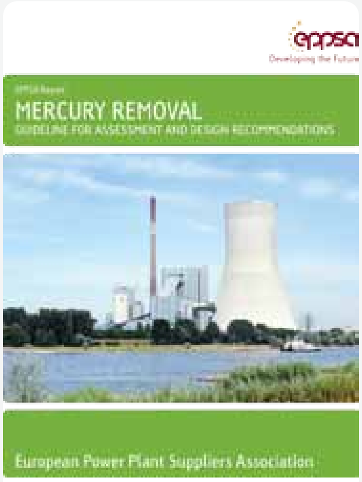
Main conclusions of the study:

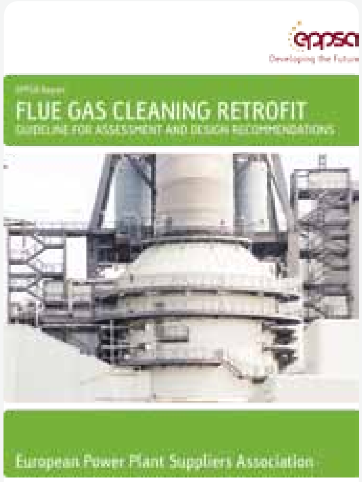
- EU Energy Policies have set the market on course for a low-carbon electricity system but the importance of Thermal Power and fossil fuel diversity has not been fully recognised.
- Though all studies foresee an important role for Thermal Power plants, this role is changing as a result of the increasing deployment of intermittent RES and Thermal Power plants are moving from mostly "baseload" operation to more flexible operation.
- Thermal Power plants (coal, lignite, gas and biomass), new and retrofits, are capable of balancing the variabilities of demand and intermittent generation whilst meeting environmental limits over their full load range. But there are important consequences for the economics of the whole power system and for current and future investments.
- EU and Member State policy makers must address the disconnection between, on the one hand, the importance of Thermal Power through to 2030 and beyond and, on the other, the lack of economic viability under current policies.

Generation Mix in 2030










An additional highlight of the event was the renewed cooperation of the thermal power representation on EU level, which will lead to an enhanced collaboration for thermal power generation. This collaboration is meant to highlight the crucial role of Thermal Power Generation in ensuring the affordability and security of supply in Europe.

### PowerGen Europe & EPPSA Study "Mercury Removal - Guideline for Assessment and Design Recommendations"

Once again, EPPSA was present at the PowerGen Europe / Renewable Energy World Europe (PGE/REWE), which took place in June in Amsterdam, the Netherlands. The EPPSA team manned the booth – answering questions about Thermal Power and EPPSA – and Dr Harald Reissner, chairman of the Flue Gas Cleaning Working Group, presented the latest EPPSA Study on 'Mercury Removal – Guideline for Assessment and Design Recommendations'.

Published in June 2015, this EPPSA technical report aims at identifying the state of play on mercury emissions from coal-fired power plants. The Minamata Convention is a strong push to abate mercury emissions from power generation worldwide. In the EU, the new LCP BREF contains BATAELs for mercury emissions to air, figures that will be translated into Emission Limit Values in individual plants' permits.

| | |
|---|---|
| Oxidation | High Halogenic Content Fuel + SCR $DeNO_x$ Catalyst |
| | Low Halogenic Content Fuel + Oxidation Catalyst |
| | Low Halogenic Content Fuel + Bromine Addition to Fuel |
| Separation | Absorption into Wet Scrubber + Additives to Minimise Re-Emission |
| | Adsorption on PAC in Fabric Filter/CDS/SDA Systems |
| Treatment | Gypsum-, Wastewater- + Sludge Treatment |

Main unit operation for mercury control

EPPSA therefore wanted to provide insightful information on the chemistry and technologies behind mercury removal, explaining at the same time what combination of techniques and technologies exist and can be adapted for every local situation.

Abating mercury is important to preserve human health and the environment. Modern technology can help achieving this goal while complying with the tight new legislation. It is important that coal-fired power plant operators plan and successfully retrofit their plants to achieve this new requirement to enable clean coal to play its role as a reliable and dispatchable source of indigenous energy.


Wet Limestone FGD plant Lünen (Source Trianel)

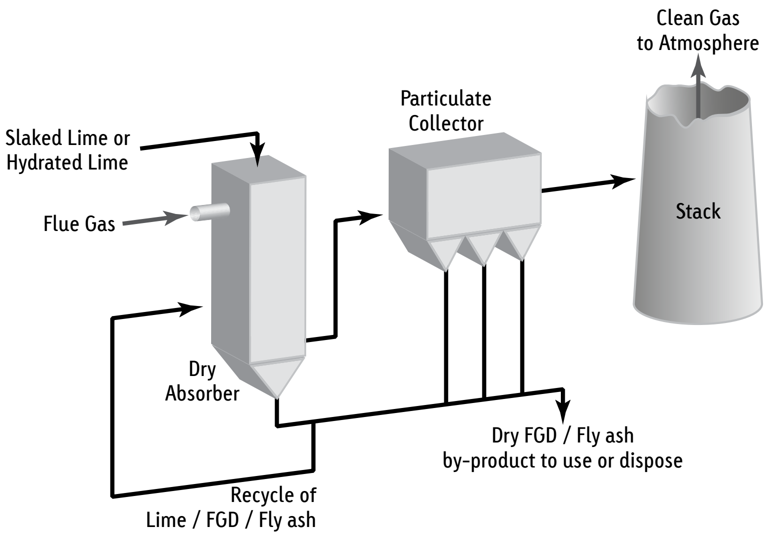

EPPSA Booth at PowerGen

A lime stone quarry, providing lime stone for Flue Gas Cleaning

## Modelling Energy Scenarios for South Eastern Europe and EPPSA Study "Flue Gas Cleaning Retrofit - Guideline for Assessment and Design Recommendations" study

The Energy Scenarios for South Eastern Europe Workshop' was organised by the European Commission Joint Research Centre (JRC) and the Energy Community Secretariat (ECS) in December in Vienna, Austria. The workshop aimed at exploring possible energy scenarios up to 2030-2050 for South Eastern Europe, and EPPSA was invited to present its vision.

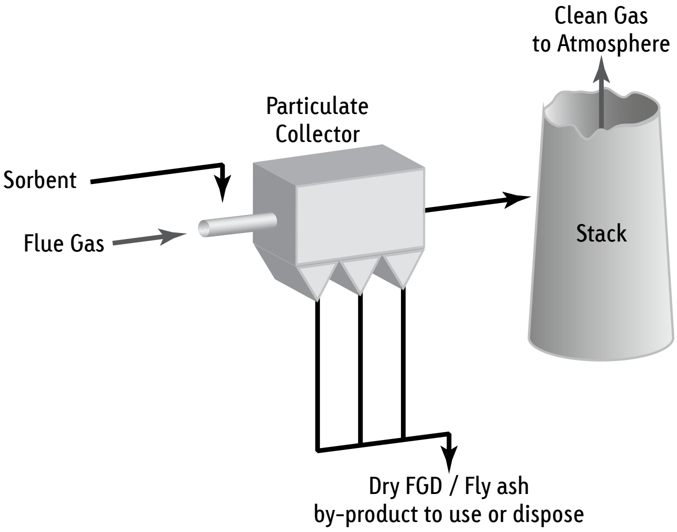
Mr Clerens gave a presentation which analysed the current situation in South Eastern Europe – which is still heavily reliant on thermal power but risks having an outdated fleet – and explained the need for state-of-the-art thermal power plants able to provide flexible backup to an increasingly large renewable energy fleet.




Flow diagram of semi-dry technique (CDS)

Specific points of emphasis were placed upon Mercury Removal Techniques and Flue Gas Cleaning Retrofits. On the latter, Mr Clerens was supported by the "Flue Gas Cleaning Retrofit - Guideline for Assessment and Design Recommendations" study, as prepared by the Flue Gas Cleaning Working Group in December 2015.

Flow diagram of dry technique (DSI)




Broader than the previous publications, this paper is primarily aimed at coal-fired power plant operators, particularly those in Europe beyond the EU, who may not have had experience with retrofitting their installation(s) with more efficient flue gas cleaning technologies.

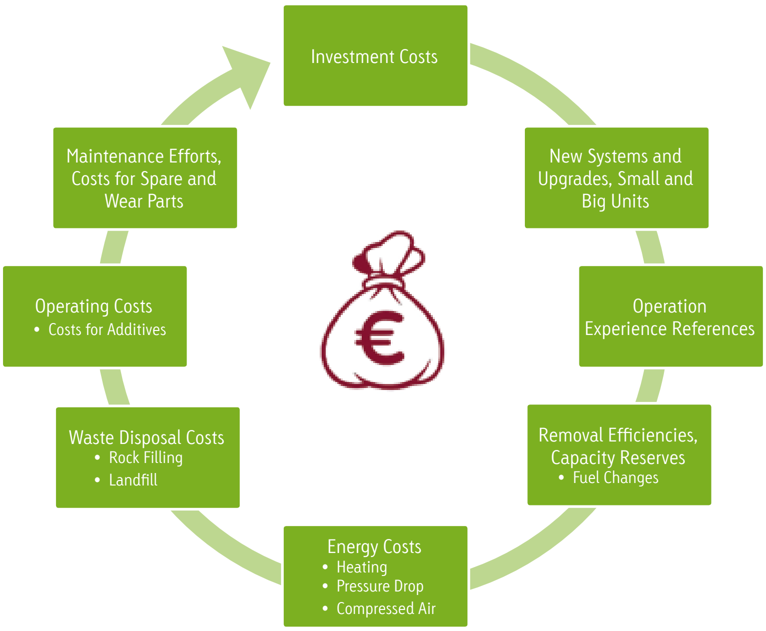
EU Legislation is going in the direction of spreading the use of BATs and mandating their implementation, which is positive news for the environment. Cleaning up coal-fired power plants by bringing them among the top environmental performers in terms of air emissions also carries great public image benefits.

Nevertheless, retrofitting flue gas cleaning systems to meet requirements on $SO_x$, $NO_x$, Dust, and from now on also mercury, carries technical challenges and associated costs.

Flue Gas Cleaning at the Moorburg Plant

EPPSA therefore wanted to provide background information on chemistry and technology enabling the abatement of the various types of regulated pollutants. The paper then provides an insight into the trade-offs of different technologies (e.g. abating $NO_x$ through Selective Catalytic Reduction or Selective Non-Catalytic Reduction) and the "DOs and DON'Ts" when retrofitting an existing installation.

The resulting report provides an all-in-one document that is useful to technical experts tasked with devising and tendering the retrofit. It also can inform higher-level / management within the utility as well as civil servants on the necessity to retrofit. Equally, it can help underlining the limits and realities of bringing an installation into compliance with what is now one of the most advanced set of emissions requirements for power plants in the world.




Key parameters to consider during technique selection

## Other Events where EPPSA presented

2015.04.16 EEF Working Group Assistants Briefing,
Brussels, Belgium

2015.04.22 VGB - Generation in Competition,
Berlin, Germany

2015.05.06 All-Energy 2015,
Glasgow, UK

2015.06.25 Member of the European Parliament Assistant Briefing,
Brussels, Belgium

2015.07.08 11th European Commission-Euracoal Coal Dialogue,
Brussels, Belgium

2015.08.26 NRW - Disponible Strombereitstelling der Zukunft,
Düsseldorf, Germany

2015.09.09 VGB - Opportunities for Power Generation,
Vienna, Austria

All EPPSA publications, presentations and information are available on the website, www.eppsa.eu.

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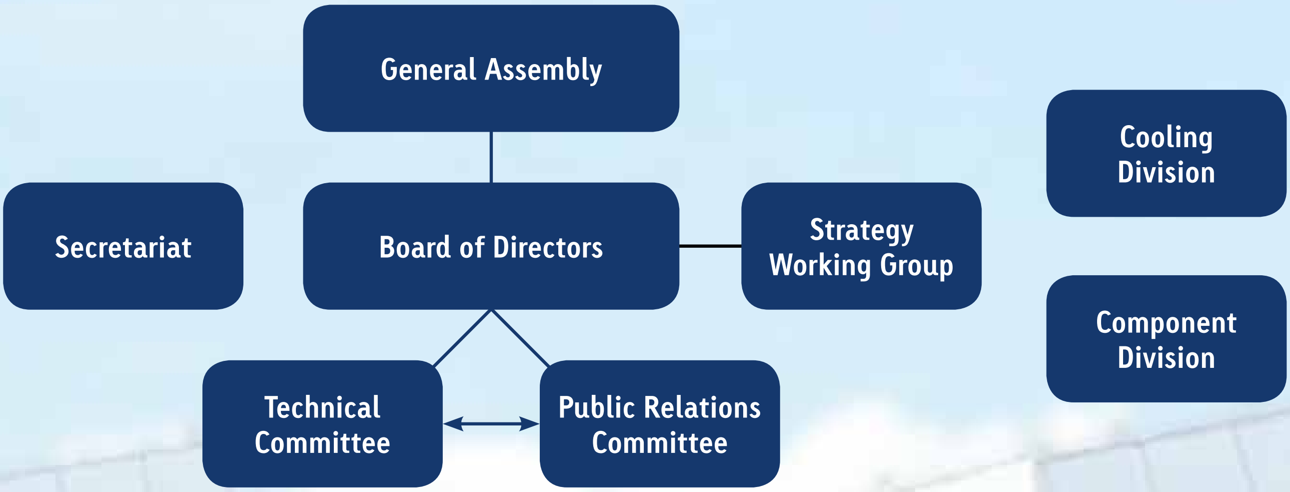


**The Secretariat**

EPPSA's Secretariat is the bridge between the member companies and the EU institutions. It consists of a Secretary-General backed up by a policy and communication team. Together, they monitor EU legislation concerning energy and funding opportunities. The secretariat promotes the awareness of the positive implications of technologies in conventional power generation.

After 4 years of dedication as the EPPSA Policy Officer, Mr Nicolas Kraus left the Association in September 2015. He was replaced by Mr François Paquet.

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