Introduction into the German Energy Market and Overview of flue gas cleaning technologies and recycling of residuals

Kolkata, Raipur, Hyderabad, November 2016

Dr. Claudia Weise

Agenda

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1. Who is VGB?
2. Framework and German energy market
3. Overview of flue gas cleaning – coal, technologies and framework
4. Overview of recycling of residuals
5. Conclusions and outlook

1. VGB PowerTech – who we are

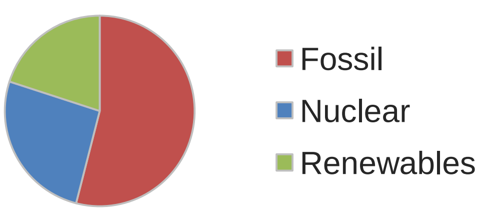
Our mission is…

…to support our members in their operational business.

…to support our members in strategic challenges.

…to be a key contact for international energy stakeholders.

- We have **484 members in 35 countries**, over 90% are European based
- We represent an installed capacity of **458 GW** based on this energy mix:



VGB is the European Competence Center of Heat and Power Generators. Founded in 1920 it is based on a voluntary association of companies active in the energy business.

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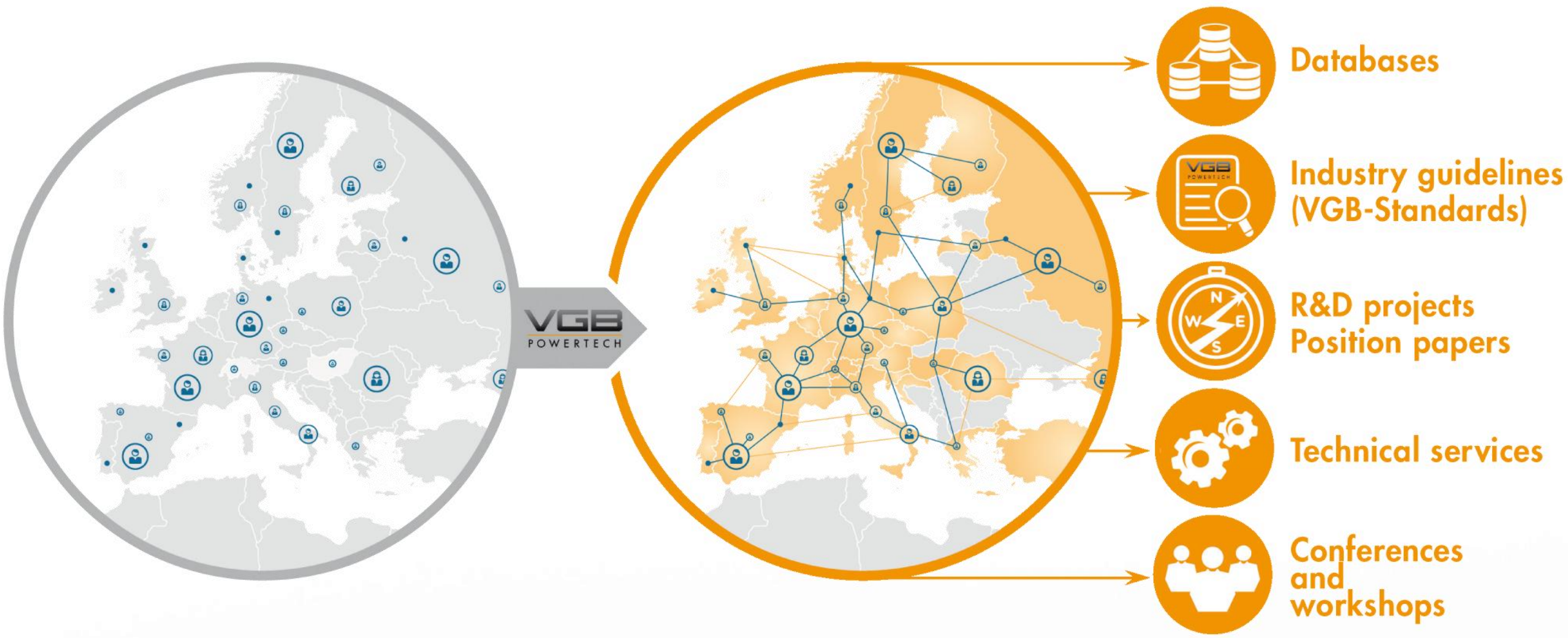
Over 1,700 experts are active in the VGB network.



VGB facilitates the exchange of experiences between the experts and document and disseminate the results for the benefit of all members.

1. Long-term co-operation with India

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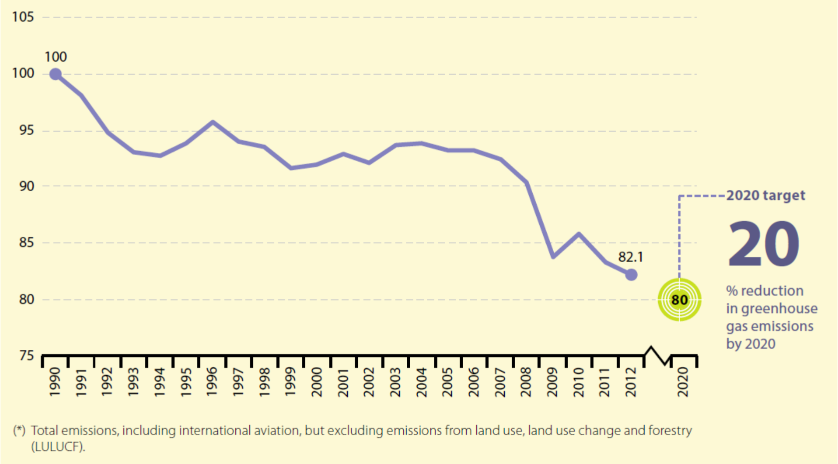
2. Energy Policy Framework

20/20/20 targets: CO_2 emission reduction, efficiency increase, share of renewables by 2020

40% CO_2-reduction target, share of renewables of 27% of energy consumption, 27% efficiency increase by **2030 framework**

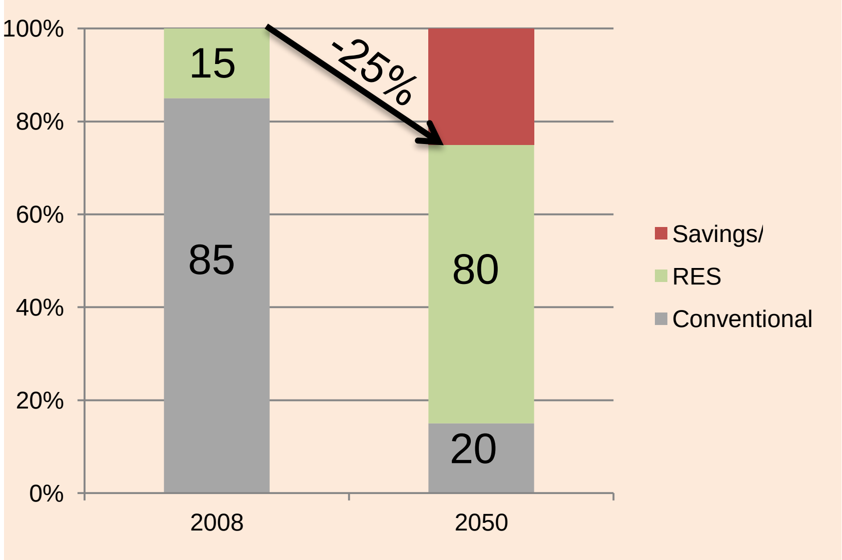


Source: Eurostat

Reduction of greenhouse gases by 40% in 2020, by 80% in 2050

Phase-out of nuclear power by 2022

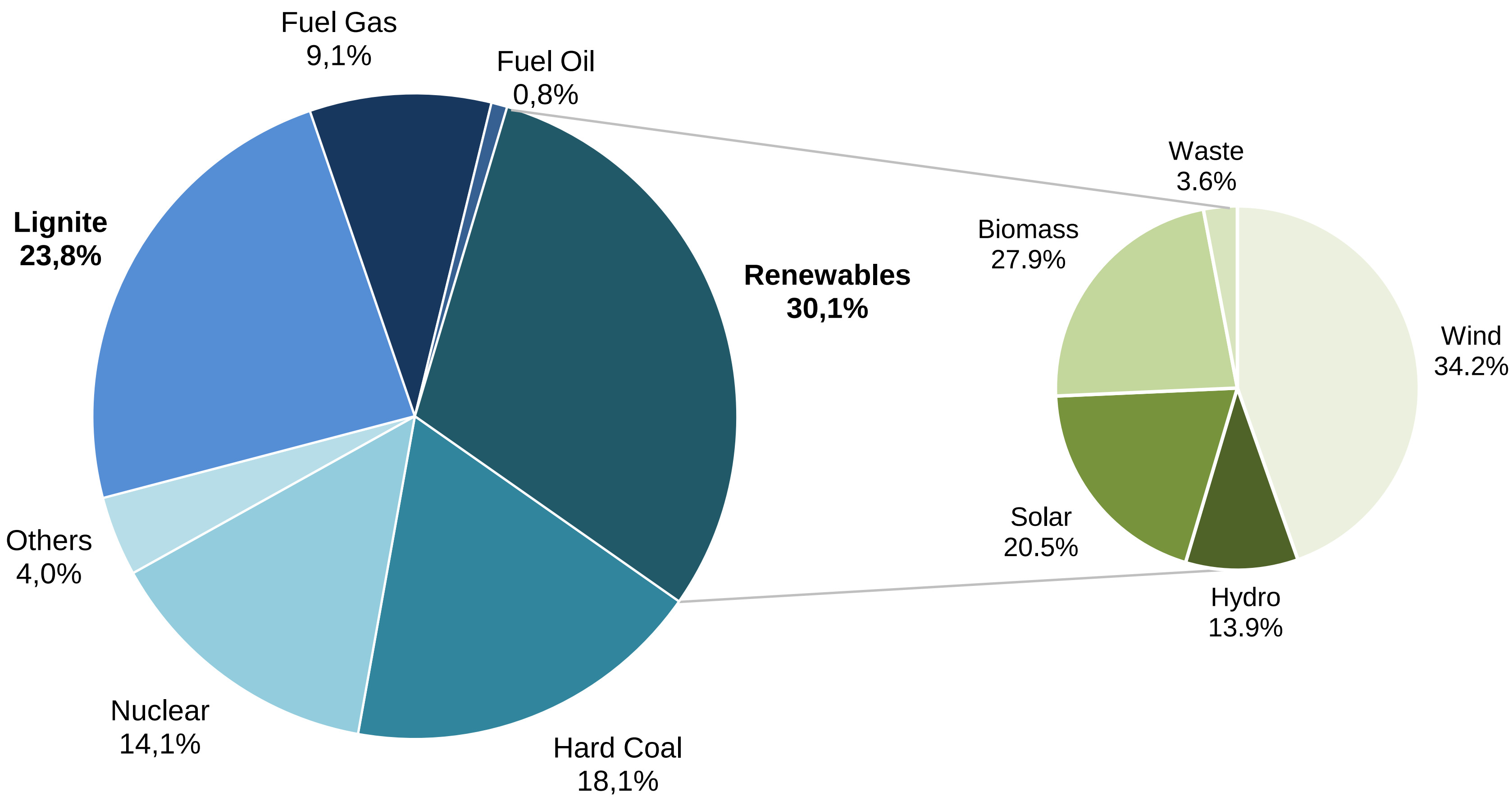
Increase of the share of renewables up to 80%, reduction of primary energy consumption by 50% and decrease of electricity consumption by 25% in 2050



Reference year for CO_2-reduction:1990

Power generation in Germany in 2015

- Installed capacity: 201 GW
- Gross power production: 652 TWh



In 2015 for the second time renewables have outscored lignite as No. 1 electricity generation source.

2. Electricity Production in Germany

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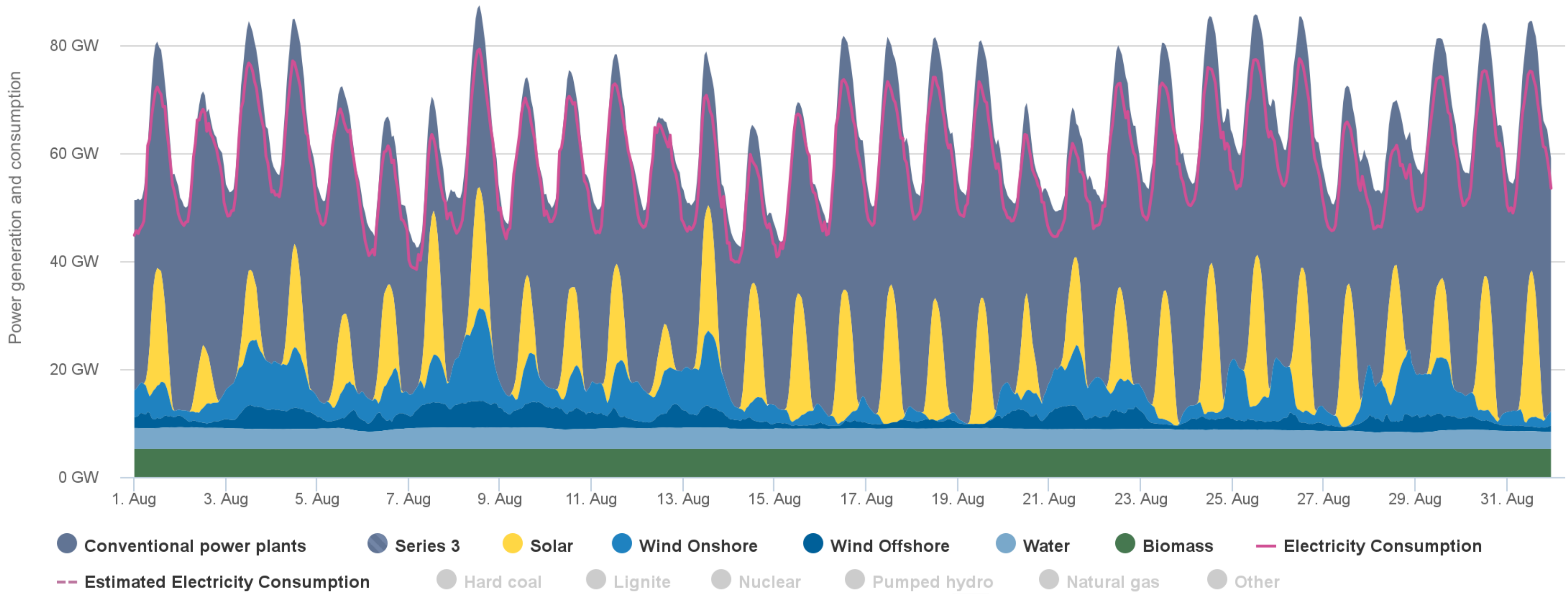
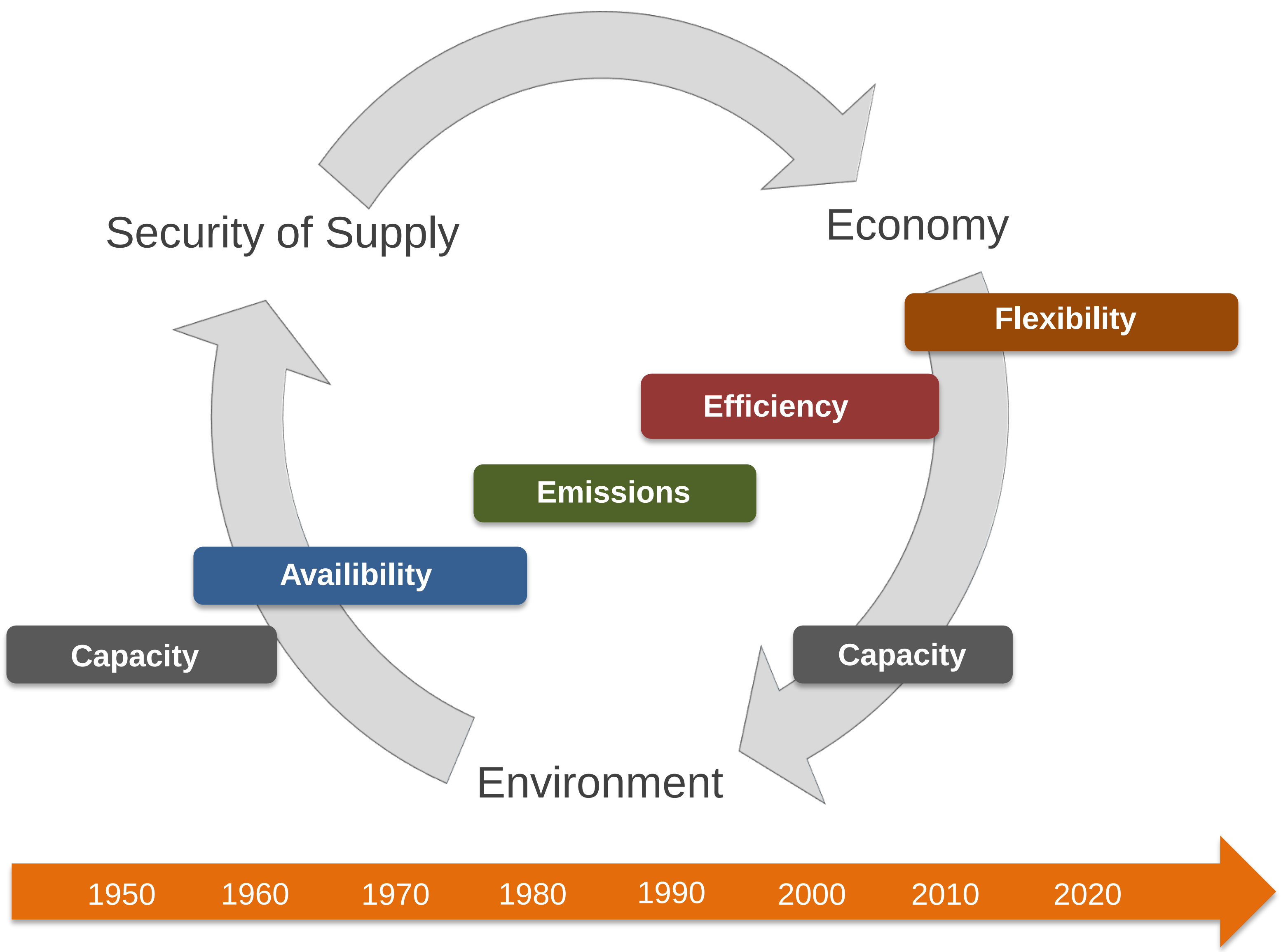


Agora Energiewende; Current to: 08.09.2016, 11:45

The profitability of conventional power plants, even on marginal costs, has deteriorated because of lower prices and reduced operating hours.

2. What have been drivers in power generation?



3. Development of Emissions in Germany

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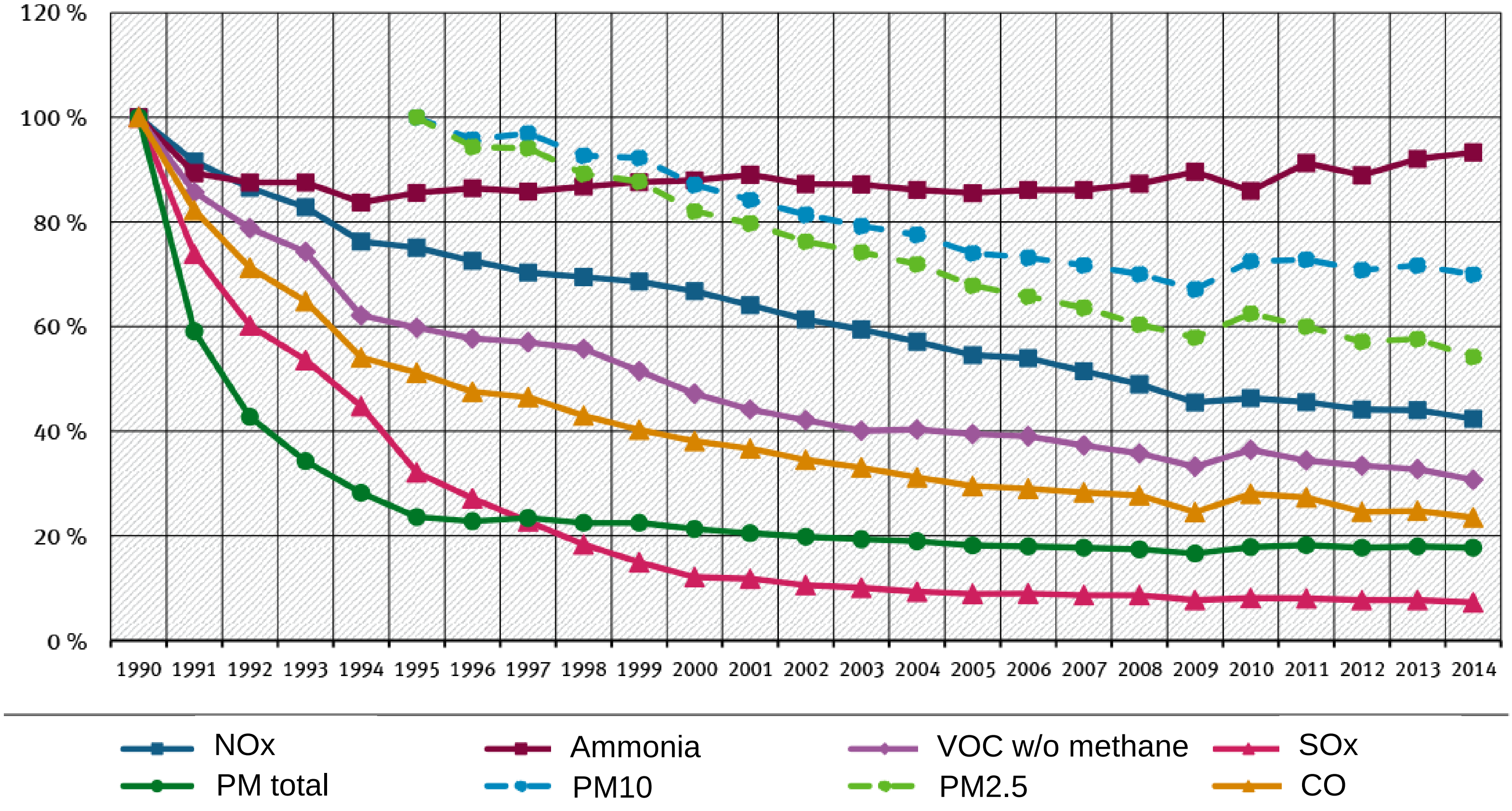
Changes in % in emissions compared to the base line 1990/1995



Quelle: Umweltbundesamt, Nationale Trendtabellen für die deutsche Berichterstattung atmosphärischer Emissionen seit 1990, Emissionsentwicklung 1990 bis 2014 (Stand 03/2016)

3. Development of Emissions in Germany

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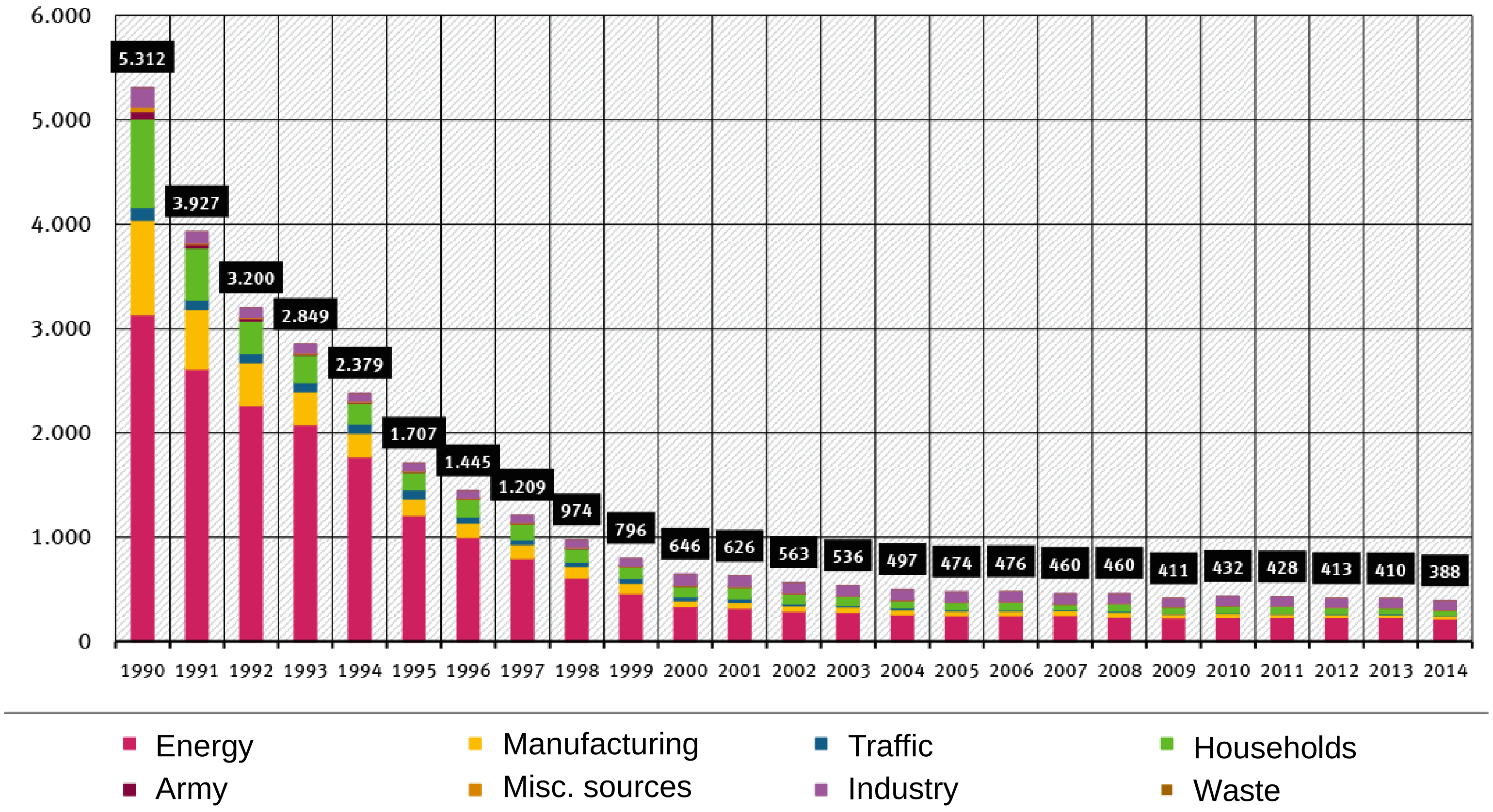
Sulfur emissions in k-tons dedicated to their originator



Quelle: Umweltbundesamt, Nationale Trendtabellen für die deutsche Berichterstattung atmosphärischer Emissionen seit 1990, Emissionsentwicklung 1990 bis 2014 (Stand 03/2016)

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3. Development of emission limits of new builds

$mg/m^3_{N,dry}$ @6% O_2	Germany: 13th BImSchV 1983 > 300 MW	Germany: 13th BImSchV 2004 > 300 MW	EU: IED 2010 > 300 MW	Germany: 13th BImSchV 2013 > 300 MW	India: regulation as of Dec 7, 2015 > 500 MW
PM	50	20	10	10	**30**
CO	250	200	-	200	
SO_x	400 + 85% DR	200 + 85% DR	200 + 97% DR	150 + 85% DR	**100**
NO_x	200	200	150	150 100*	**100**
Hg	-	0.03	-	0.03 0.01*	**0.03**
Dioxin/ Furan	-	0.1 ng/m³	-	0.1 ng/m³	

BImSchV: Bundes-Immissionsschutzgesetz-Verordnung (German immission legislation)
DR: Deposition Rate
IED: Industrial Emission Directive
EU: monthly average; Germany: daily average but * means annual average
India: units installed **after Jan 1, 2017**

3. Future challenges: BREF LCP 1/2

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Requirements for the use of solid fuels in existing Large Combustion Plants

Air pollutant mg/m³	IED Annex V > 300 MW	Preliminary-Draft 06/2015 BAT-AEL (YA) >300 MW	Preliminary-Draft 06/2015 BAT-AEL (DA) >300 MW	India: regulation as of Dec 7, 2015 >500 MW
SO_2	200	Pulverised coal: 10 – 130 FBC: 20 - 180	Pulverised coal: 25 – 165 FBC: 50 - 220	**200 / 200**
NO_x	200	FBC, lignite: 85 – 175 Other: 65 - 150	FBC, lignite: 140 – 220 Other: 80 – 220	**600 / 300**
CO	no limit value	FBC, lignite: 5 – 100 Hard coal: 5 – 100 **CO just indication, no BAT-AEL**	--	
PM	20	300 – 1000 MW: 2 – 12 > 1000 MW: < 2 – 8	300 – 1000 MW: 3 – 20 > 1000 MW: 3 – 14	**100 / 50**

YA = yearly average, DA = daily average

India: units installed **before Dec 31, 2003 / after Dec 31, 2003 and before Dec 31, 2016**

Requirements for the use of solid fuels in existing LCP

Air pollutant mg/m³	IED Annex V > 300 MW	Preliminary-Draft 06/2015 BAT-AEL (YA) >300 MW	India: regulation as of Dec 7, 2015 >500 MW
Ammonia	no limit value	< 1 – 10	
HCl	no limit value	< 1 – 5	
HF	no limit value	< 1 – 3	
Mercury	no limit value	Hard coal (YA): 1 – 4 µg/m³ Lignite (YA): 1 – 7 µg/m³	**0.03 mg/m³**

3. Coal composition used in German power plants

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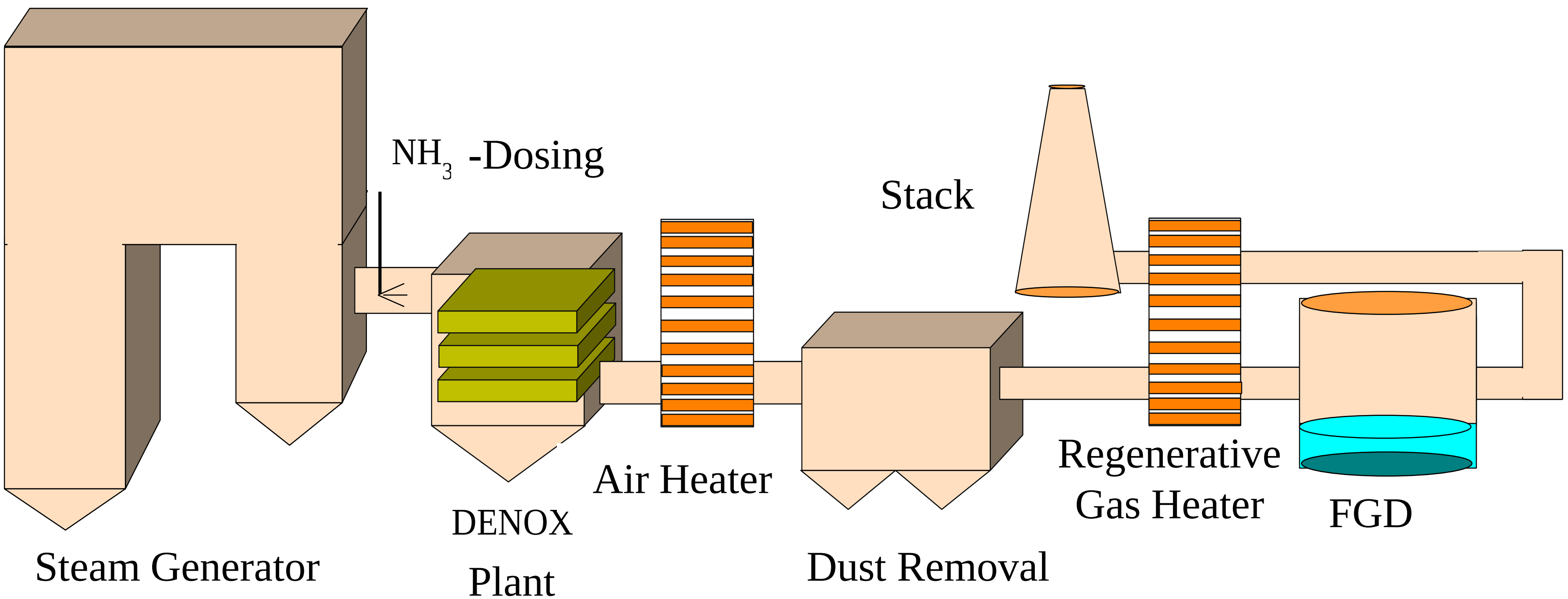
Type of coal	Calorific value [kJ/kg]	Ash content [%]	Water content [%]	Sulphur content [%]
Lignite – GER Rhineland	7,800 – 10,500	2.5 – 8.0	50 – 60	0.15 – 0.50
Lignite – GER Lusatia	7,800 – 9,500	2.5 – 16.0	48 – 58	0.30 – 1.50
Lignite – GER Central Germany	9,000 – 11,300	5.0 – 20.0	40 – 50	1.00 – 3.00
Hard coal	~25,000	7.0 –15.0	9.0 – 12.0	< 1.0

Differences to Indian coal:

- lower ash content
- calorific value in the same range
- less water content

Best Available Technology



Power Plant with SCR „high dust", dust removal and FGD

3. Examples of VGB-work / Flue gas cleaning

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R&D projects
Position papers

- Flow Correlated Positioning of Spray Nozzles in Flue Gas Scrubbers
- Description of the Interaction of Liquid Layer and Flue Gas Flow on the Walls and Inserts of Flue Gas Desulphurisation Plant Scrubbers
- Optimisation of Wet Hg Capture from Flue Gases of Coal-fired Power Plants in the Case of Co-combustion of Mercury-rich Secondary Fuels
- Optimisation of a Condensing Wet Electrostatic Precipitator for Particulate Matter and Aerosol Separation

Industry guidelines
(VGB-Standards)

- VGB-Guideline R 302: Guideline for the testing of DENOX-catalysators
- VGB-Standard S 015: Type, Operation and Maintenance of Flue Gas Desulphurisation Plants (FGD)
- VGB-Standard S 014: Type, Operation and Maintenance of Flue Gas DENOX Plants (only in German)

3. Mercury-debate in Germany

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VGB-Initiative „Hg$^{cap(ture)}$“

Further reduction of mercury emissions from coal-fired power plants

The VGB Initiative Hg^{cap} pools know-how and ensures transparency by:

→ Objectifying the debate

→ Public relation and transfer of information

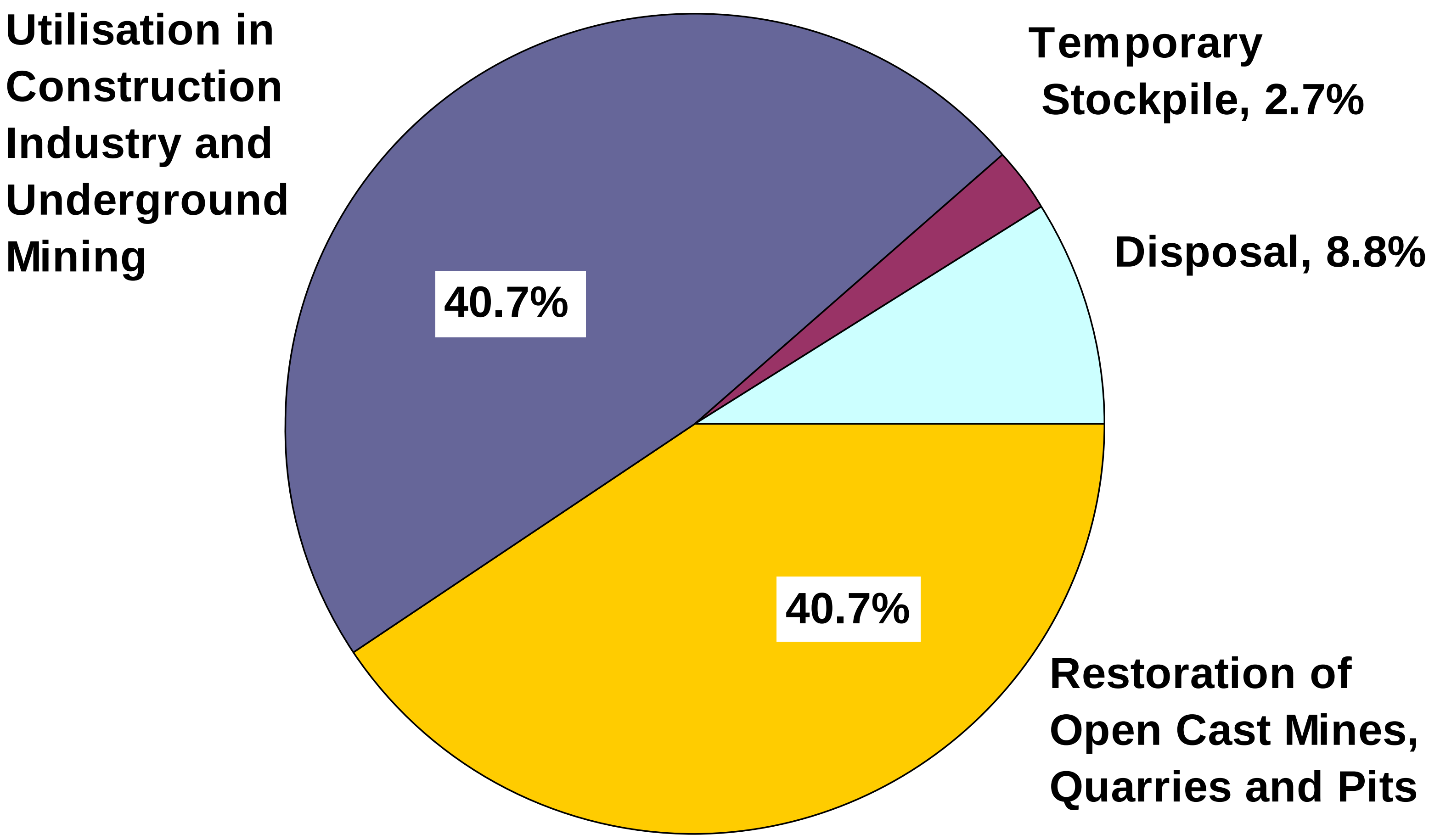
→ Development of further reduction technologies for mercury emissions

→ Joint activities for the research and testing of new and existing removal technologies

→ Ensuring knowledge and experience exchange with science and politics

→ Professional support of the legal implementation for setting future limits on the basis of BREF-LCP with reasonable period for the implementation of appropriate and effective procedures

4. Recycling of residuals – an overview



Utilisation and Disposal in Europe (EU 15) in 2013

The majority of the residuals (boiler slag, bottom and flue gas ash, gypsum) is utilised in construction and building value chains.

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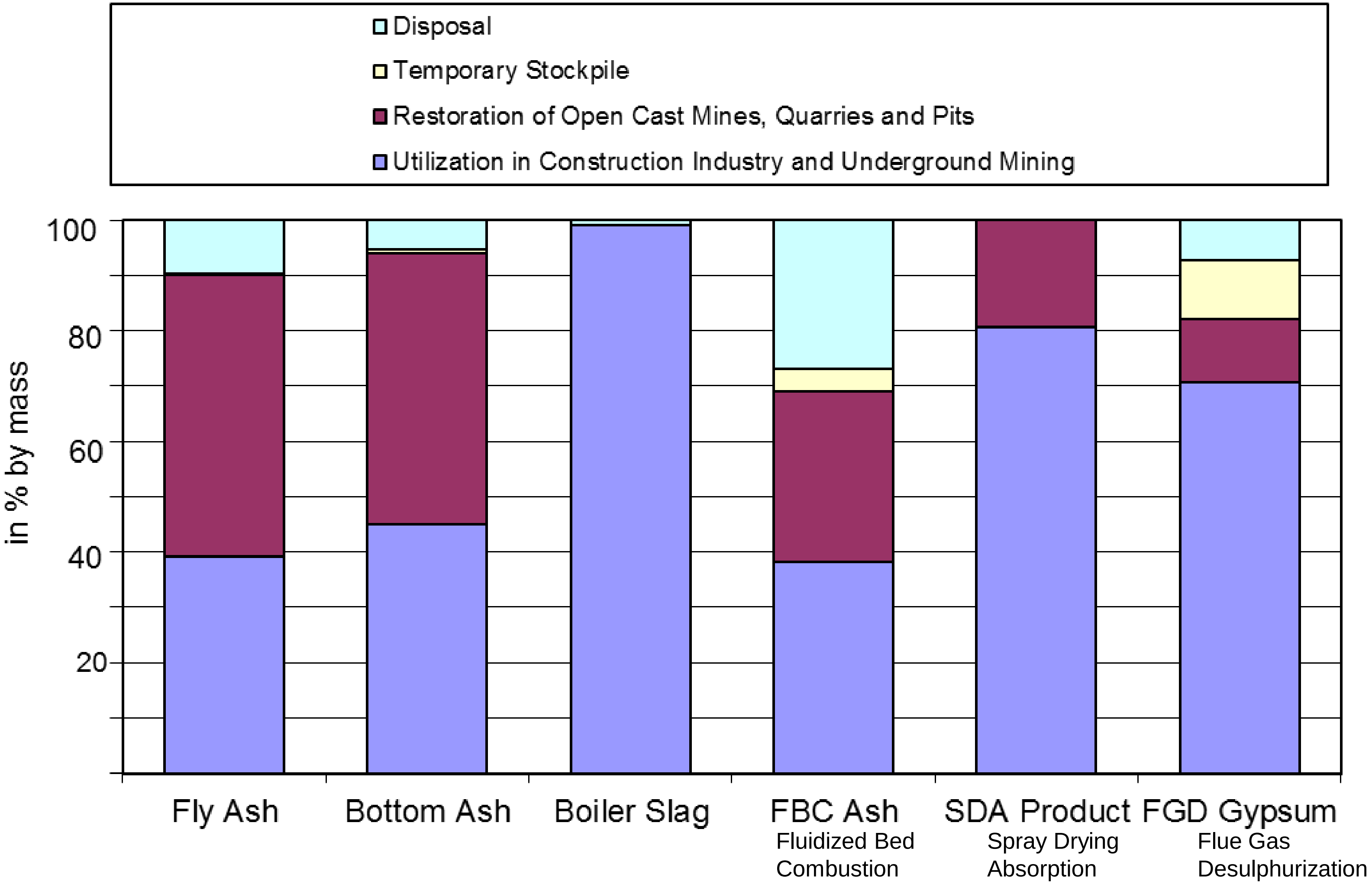

Utilisation, temporary stockpile and dispoal of residuals of coal fired power plants in Europe (EU 15) in 2013

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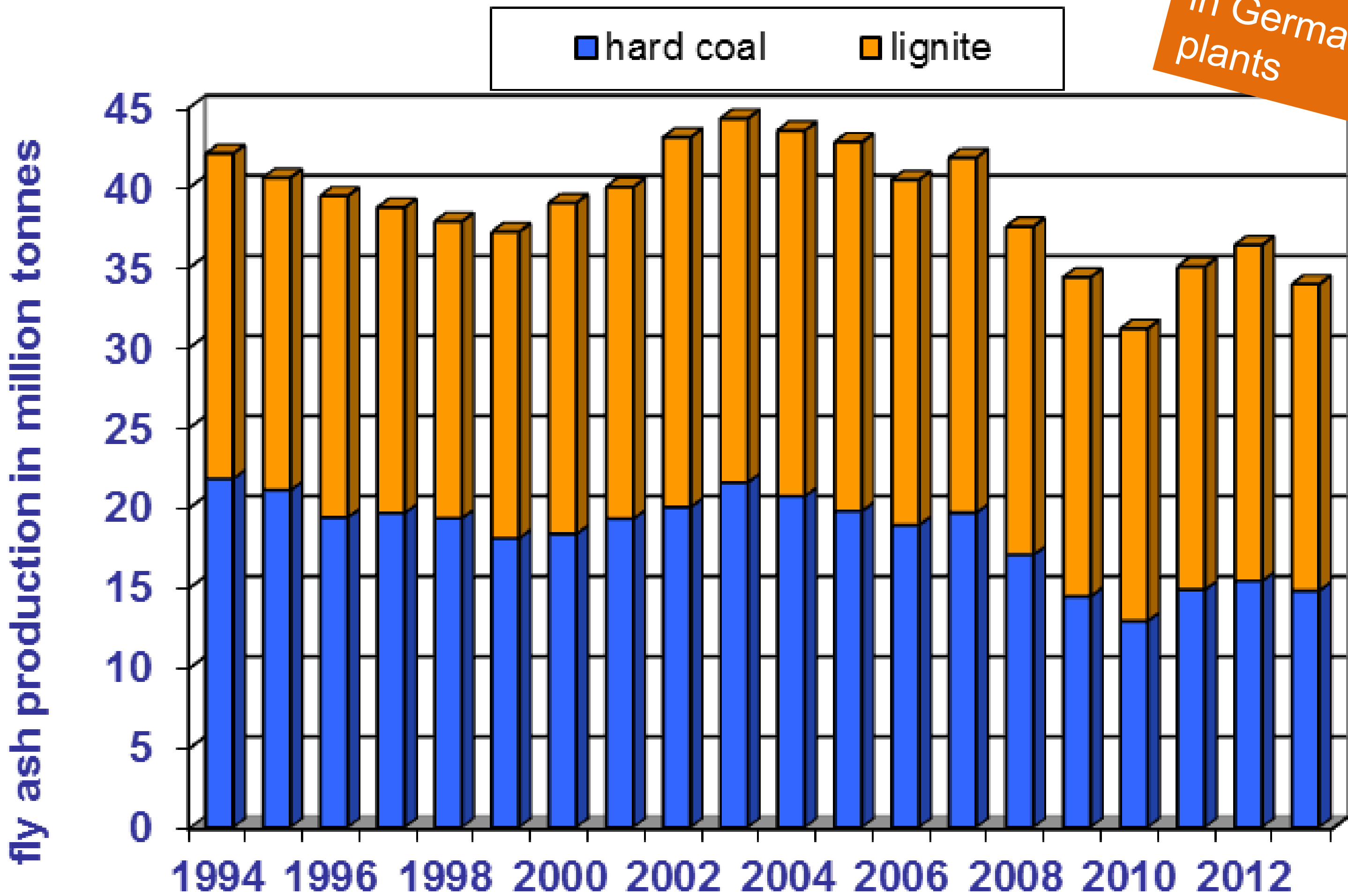
22.8 Mio tons in 2014 in German coal fired plants



Development of fly ash production from hard coal and lignite in Europe (EU 15) from 1993 to 2010

4. Recycling of residuals – fly ash utilisation

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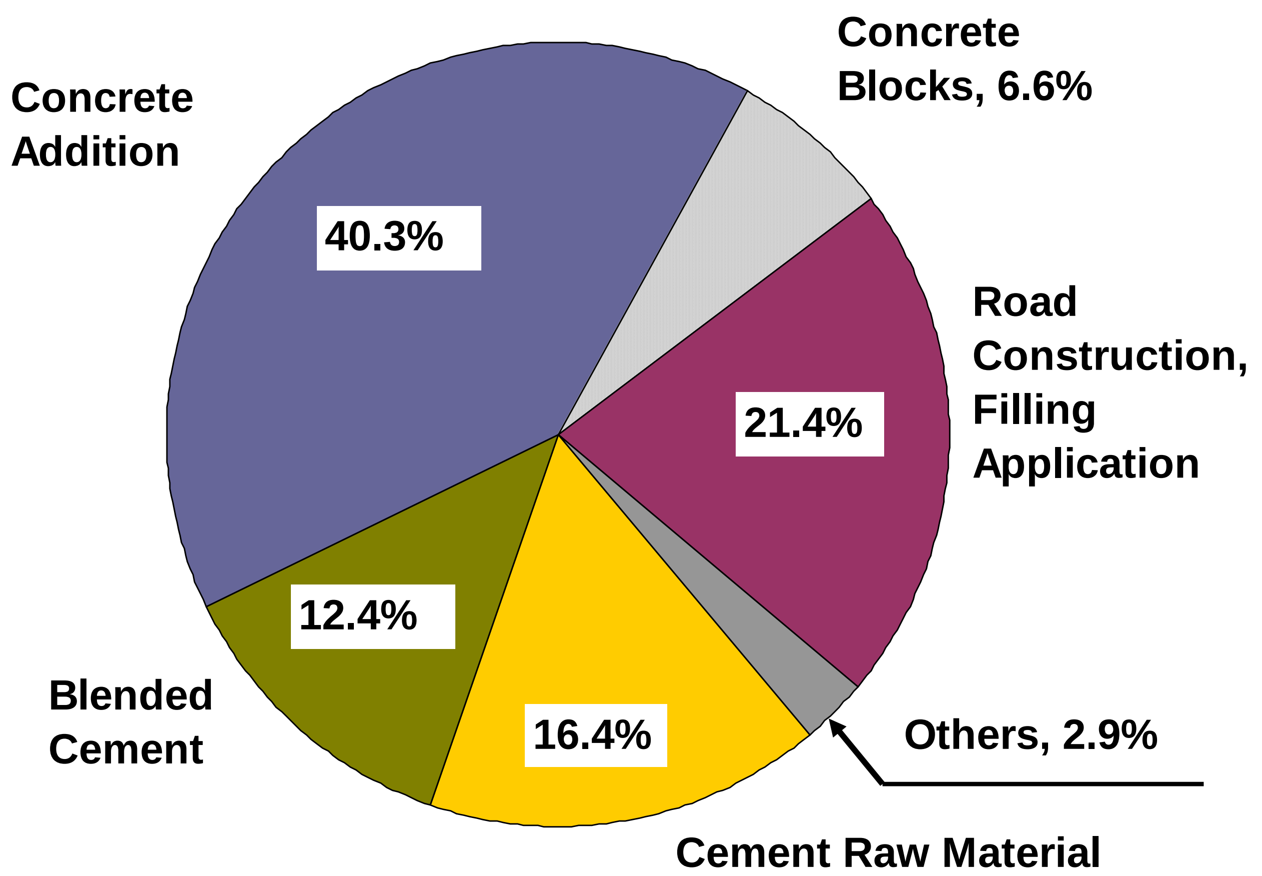
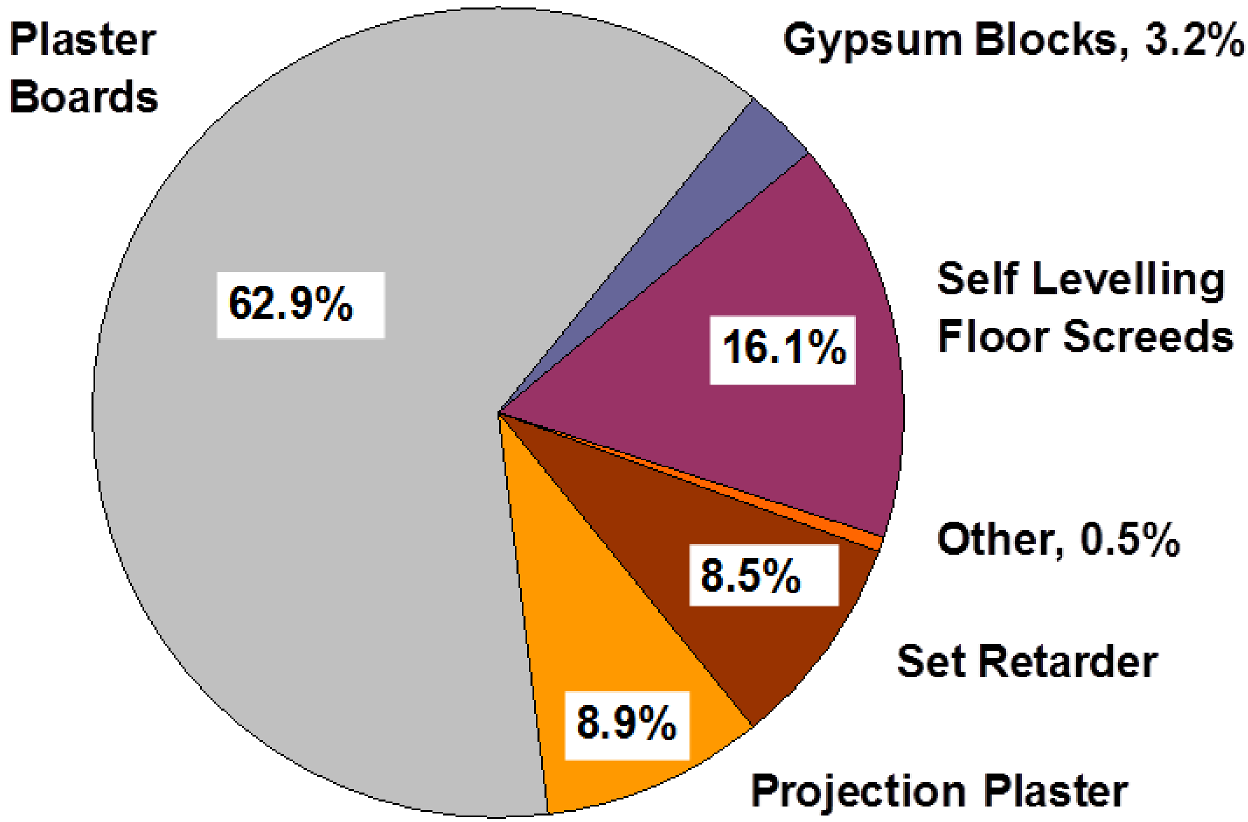


Utilisation of fly ash in the construction industry and in underground mining in Europe (EU 15) in 2013

4. Recycling of residuals – gypsum utilization



(total utilisation 8.2 million tonnes)

Utilisation of FGD Gypsum in the construction industry in Europe (EU 15) in 2013 in million tonnes

4. Examples of VGB-work / Utilisation of residuals

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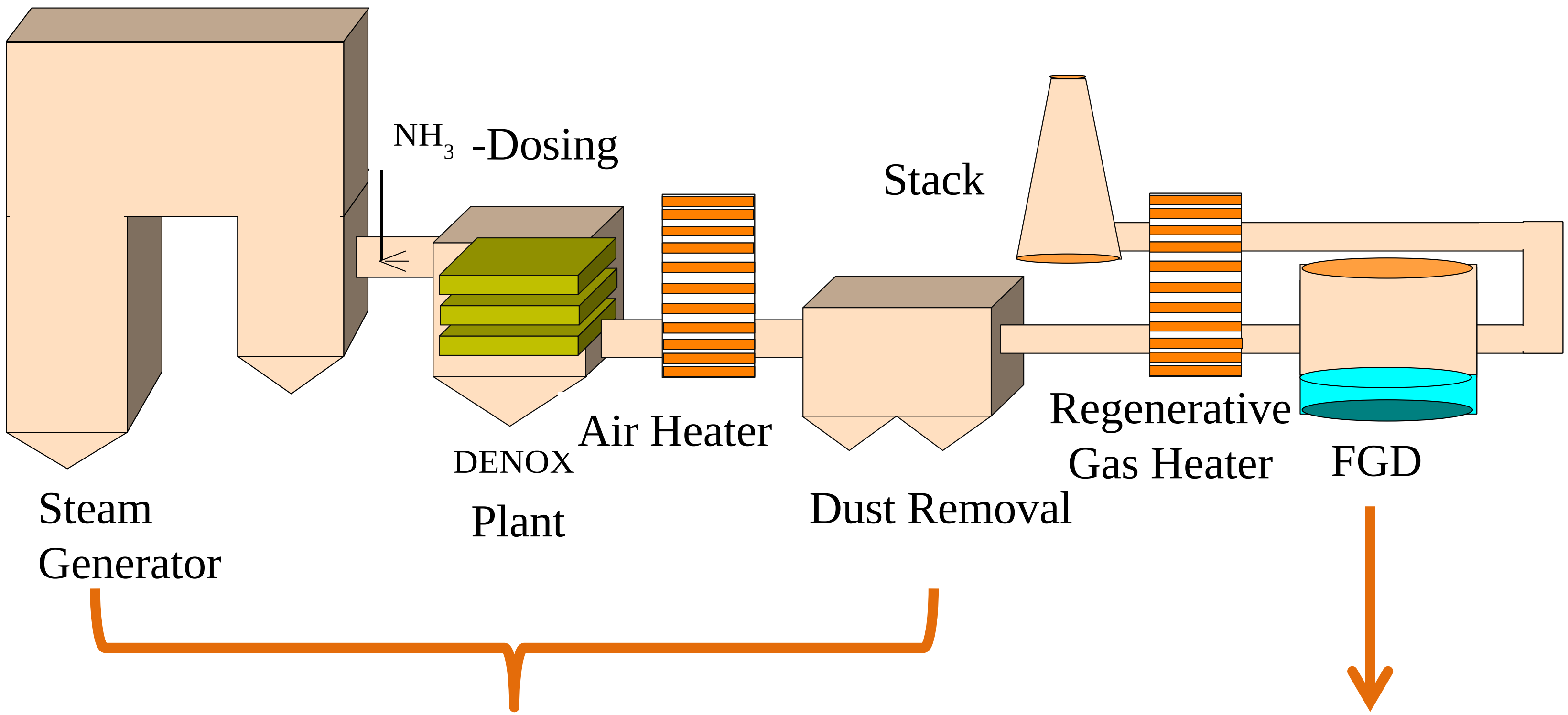
R&D projects
Position papers

- Avoidance of Alkali Reactions by Fly Ash –
  Examinations of concretes during long-term storage
- Avoidance of Alkali Silica Reaction (ASR) by Fly Ash due to External Alkali Supply - long term behaviour
- Further Investigations of the Sulphate Resistance of Fly Ash Concrete
- VGB runs the secretariat of the European Coal Combustion Products Association e.V

Industry guidelines
(VGB-Standards)

- VGB-guideline M701e: Analysis of FGD-gypsum
- VGB-guideline R201e: Guideline for the Construction and Operation of Ash Handling Plants – 1992)
- VGB-work is considered in relevant norms and standards such as:
  - EN 197-1 Composition, specifications and conformity criteria for common cements
  - EN 450-1 Fly ash for concrete: Definition, specifications and conformity criteria
  - EN 13282 Hydraulic road binders : Rapid hardening hydraulic road binders - Composition, specifications and conformity criteria

5. Program of the workshop



- Dr. Dirk Porbatzki, Uniper
- Matthias Schneider, Steag

- Dr. Annette Ziemann-Nöthe, Doosan
- Dr. Frank Delle, Steinmüller Babcock

5. Conclusions and outlook

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- Flue gas cleaning technology has been in operation for decades in Germany: wet FGD and ESP are the most common technologies in Europe
- The majority of residuals (ash and gysum) is utilised in the construction and building industry
- Solid framework regarding legislation, norms and industry guidelines are essential
- EEC is an ideal platform to share experiences and lessons learnt; e.g. guideline for implementation of FGD in existing plants, reference concepts for new builts; train-the-trainer programs would also provide valuable assistance

Indo-German Energy Forum

EEC Excellence in Power

VGB is eager to support these activities together with the EEC as an important platform generating solutions for the Indian power sector.

धन्यवाद

Thank you
for your interest!

Contact:
Dr. Claudia Weise
Project Manager
Deilbachtal 173
45257 Essen / Germany
Phone: +49 201 8128 335
Mobile: +49 151 2524 8343
claudia.weise@vgb.org

www.vgb.org