# The choice of an appropriate flue gas treatment system

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# Introduction

## Design and characteristics

# System matrix for the separation of different pollutants

| Components | Electrostatic precipitator[1)] | Fabric filter[1)] | Sorption filter | Solid/moving bed filter | Scrubber | SNCR | SCR |
|---|---|---|---|---|---|---|---|
| Dust | x | x | x | | (x) | | |
| HCl | | | x | (x) | x | | |
| HF | | | x | (x) | x | | |
| $SO_2$ | | | x | x | x | | |
| $NO_X$ | | | | x | (x) | x | x |
| Hg | | x | x | x | x | | |
| Cd, Tl | {x} | {x} | x | x | {x} | | |
| Sb - Sn | {x} | {x} | x | x | {x} | | |
| As - Cr | {x} | {x} | x | x | {x} | | |
| PCDD/PCDF | {x} | {x} | x | x | x | | x |
| $NH_3$ | | | | x | x | | x |

() conditionally suitable or

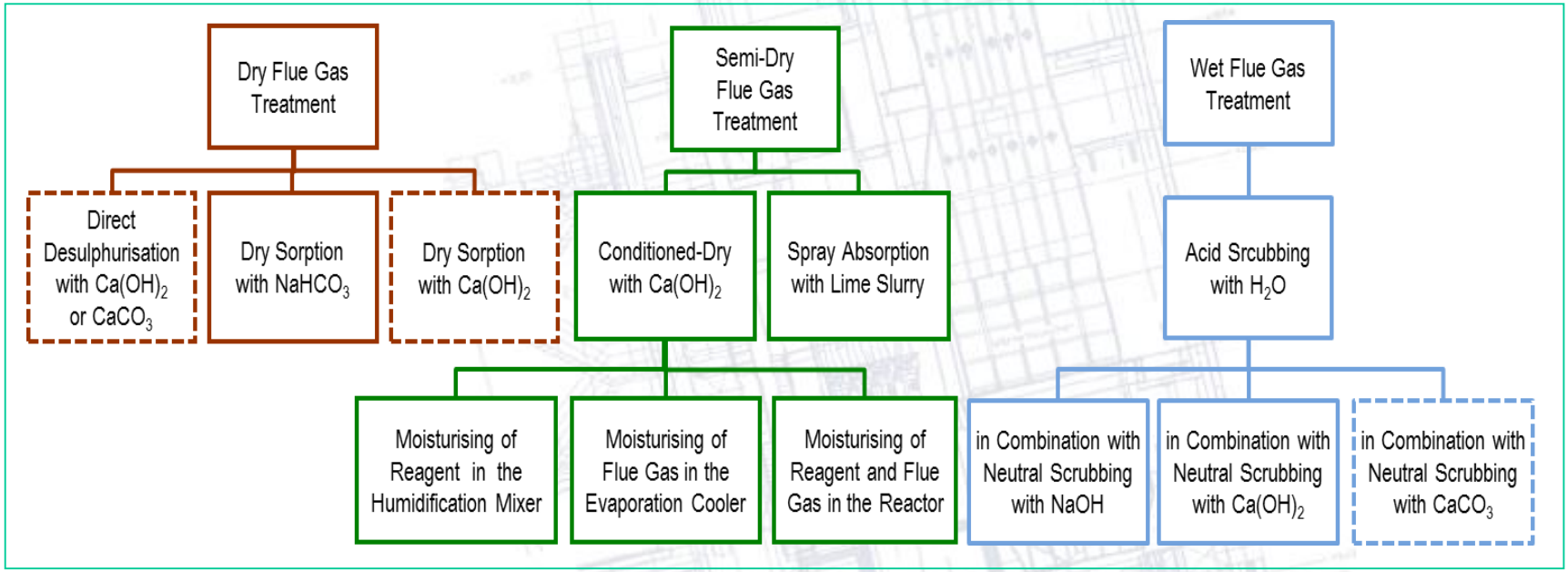
{x} dust-carrying heavy metals

[1)] clean dust collector

# Characteristics of wet and dry air pollution control systems

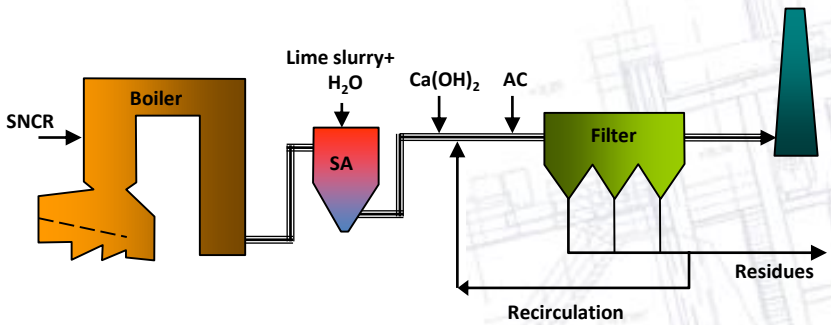
| Wet system | Dry system |
|---|---|
| **Low sorbent consumption (stoichiometry 1), resulting in low residue volumes** | Larger sorbent consumption (stoichiometry $SR_{II}$ 1.6 to> 2), resulting in higher residue volumes |
| **Expensive additives (e.g. NaOH)** | Less expensive additives (e.g. $Ca(OH)_2$) |
| **High separation capacity for HCl and $SO_2$** | Good separation capacity |
| **Selective deposition** | No selective deposition |
| **Multi-stage system** | Single-stage system |
| **Complex effluent treatment/disposal** | Simple and robust components |
| **Usually requires dust pre-separation** | Requires no dust pre-separation |
| **Greater dust/aerosol emissions** | Low maintenance demand |
| **PCDD/PCDF separation in conjunction with packed scrubbers and HOK dosage** | Very good separation for heavy metals and PCDD/PCDF using HOK |
| **Greater space requirements** | No wet stack required, hence no steam plume |

# Classification of flue gas cleaning technologies for HCl, SOx and HF control

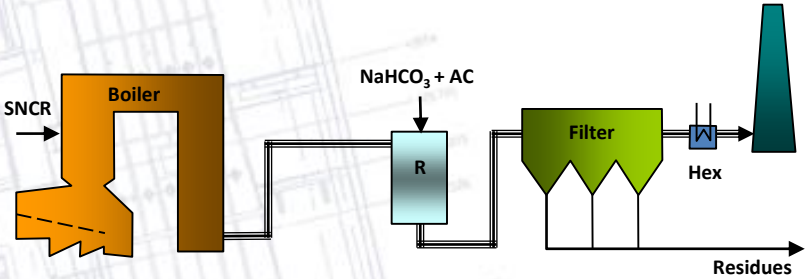



Source: VDI 3460, 1; 2014

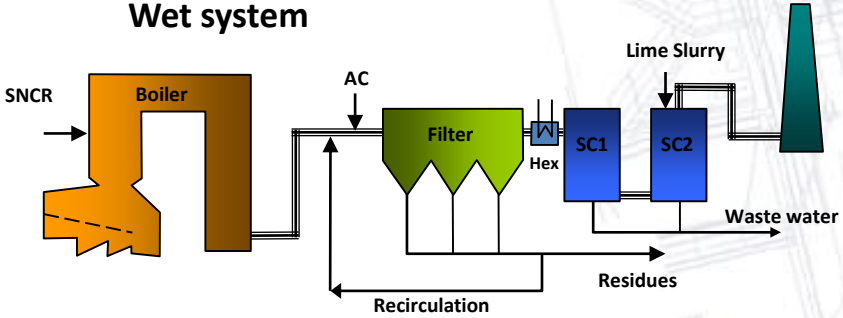
## Spray absorption system (semi-wet)



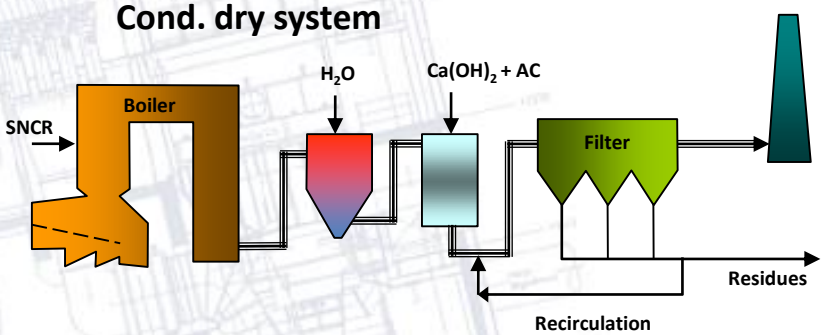

## Dry system




## Wet system

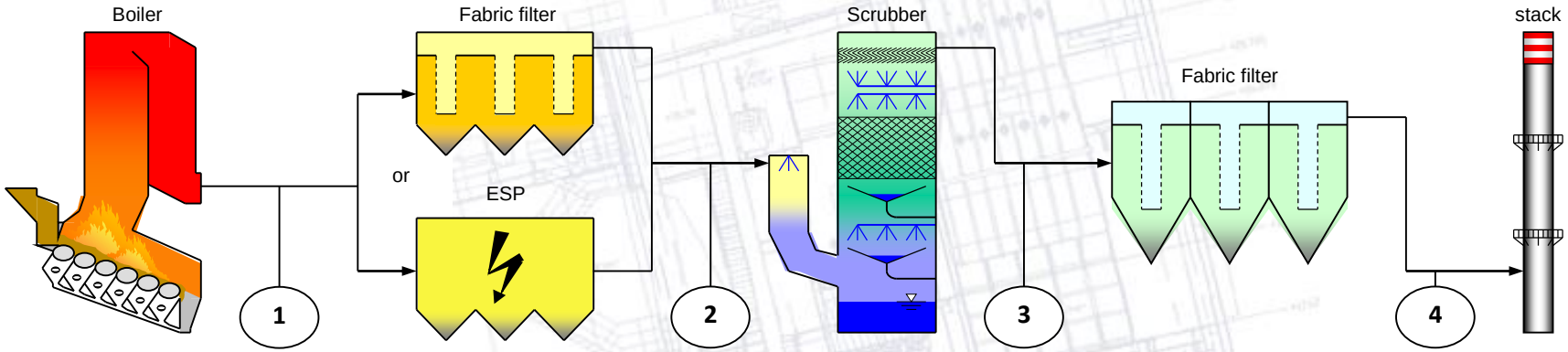



## Cond. dry system




Source: fisia-babcock

# Plant configurations for SCR




**High Dust** | **Low Dust / High $SO_x$** | **Low Dust / Low $SO_x$** | **Tail End**

# Process overview

## of the used flue gas treatment systems in Europa

Basis are data from the State-of-the-Art-Report "Waste-to-Energy", Statistics 6th Edition August 2012 from ISWA

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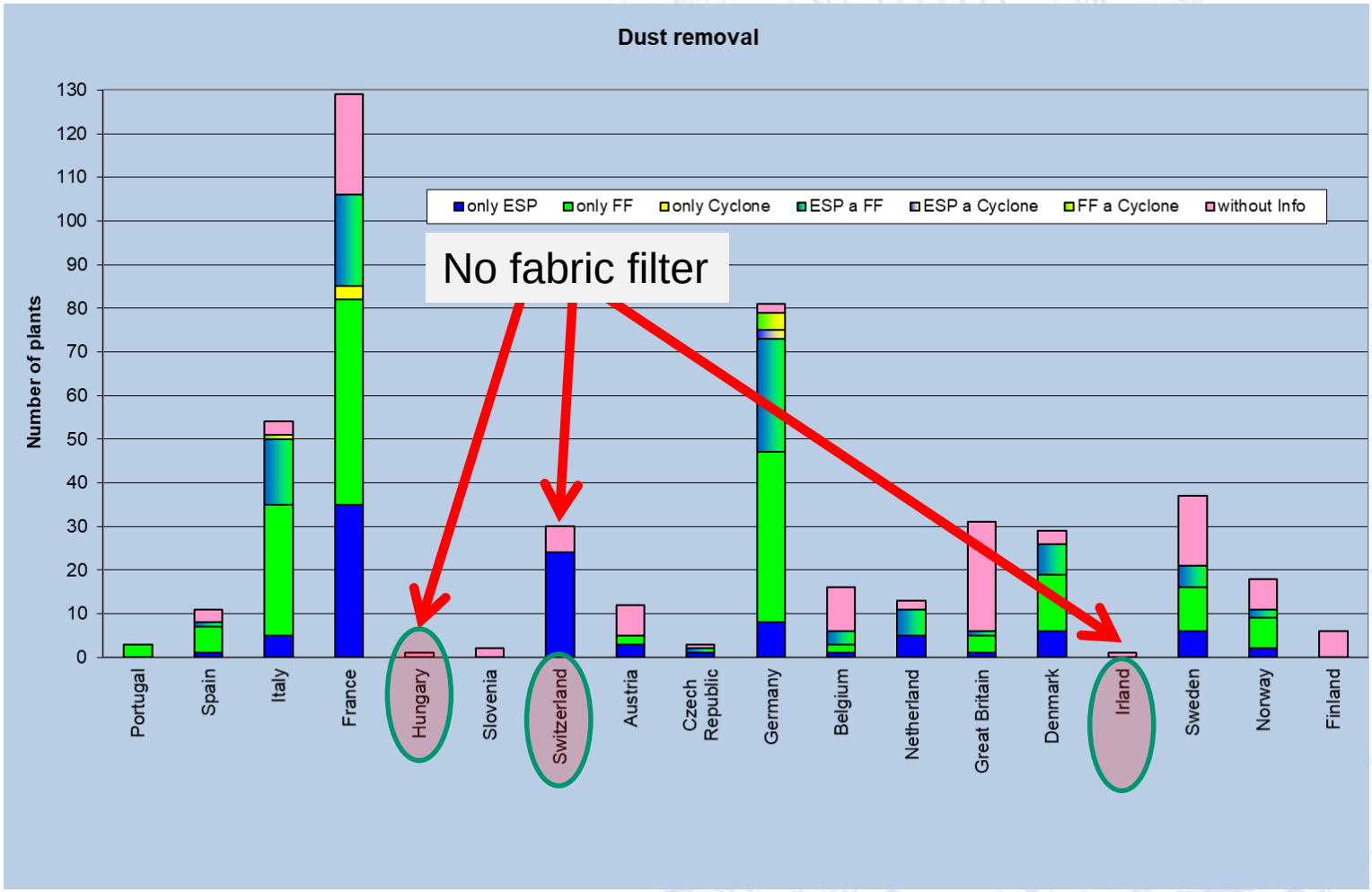
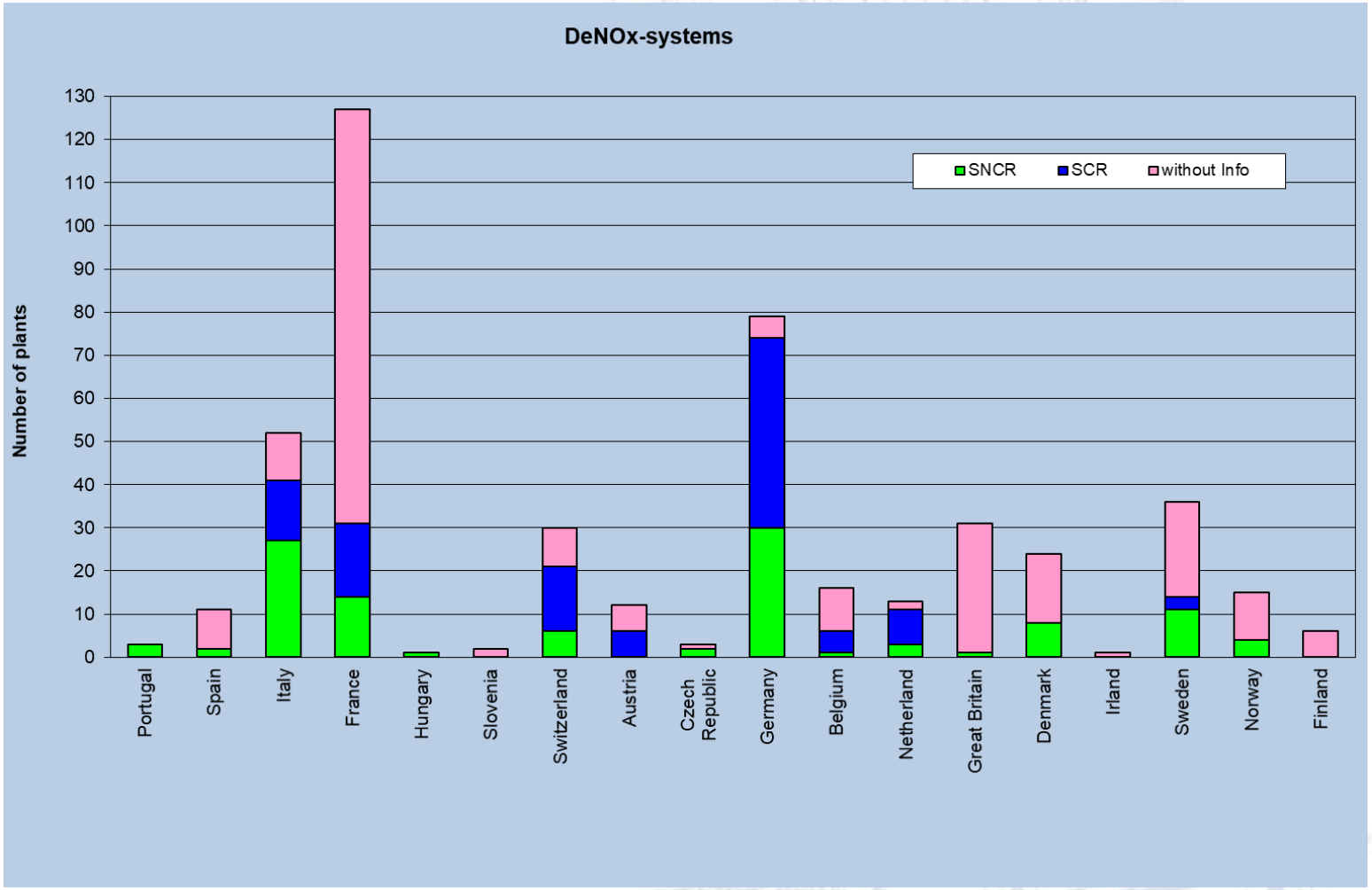
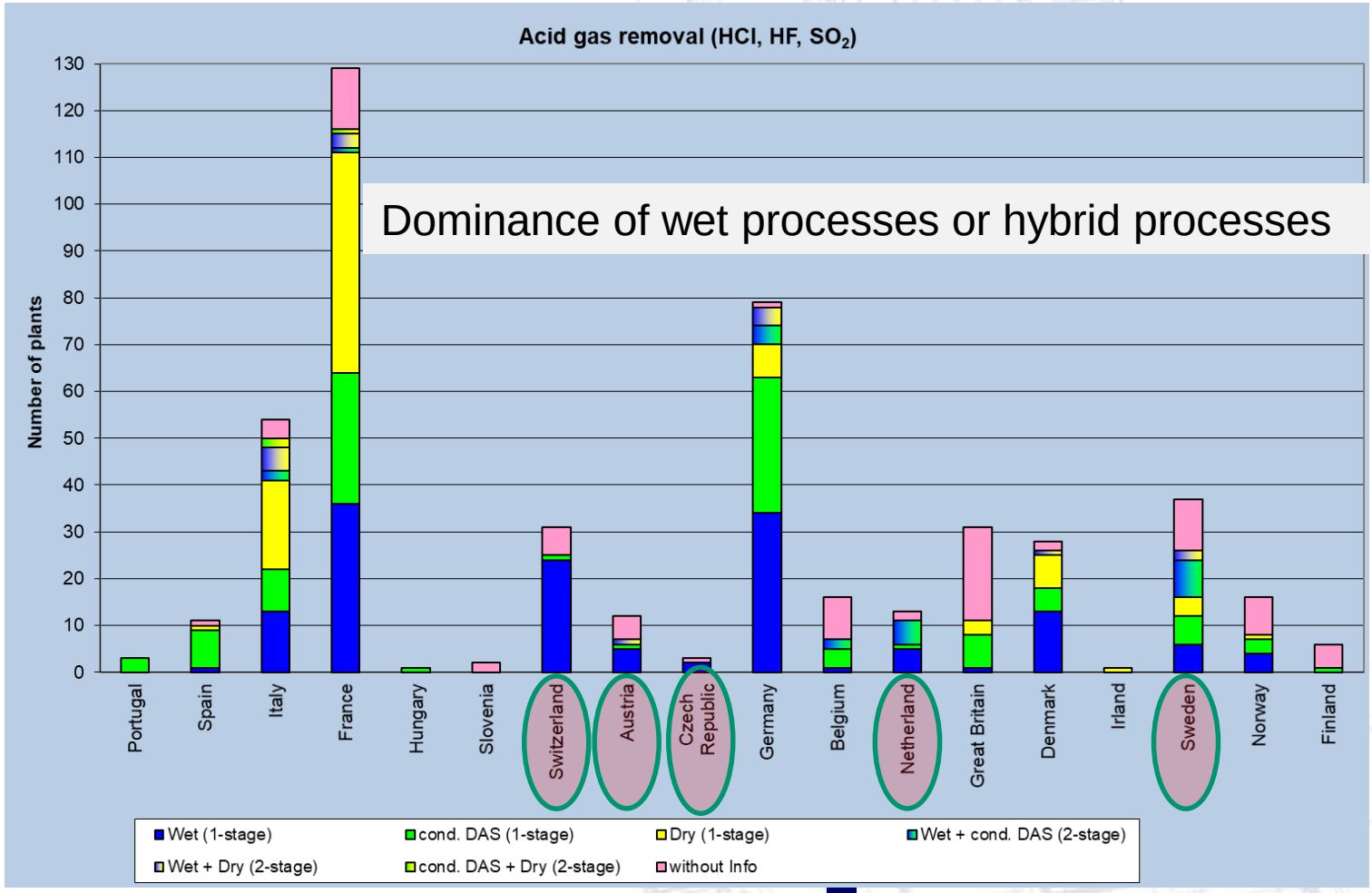
# Comparison of dedusting procedures behind waste incineration plants in European countries



# Comparison of denitrification processes behind waste incineration plants in European countries

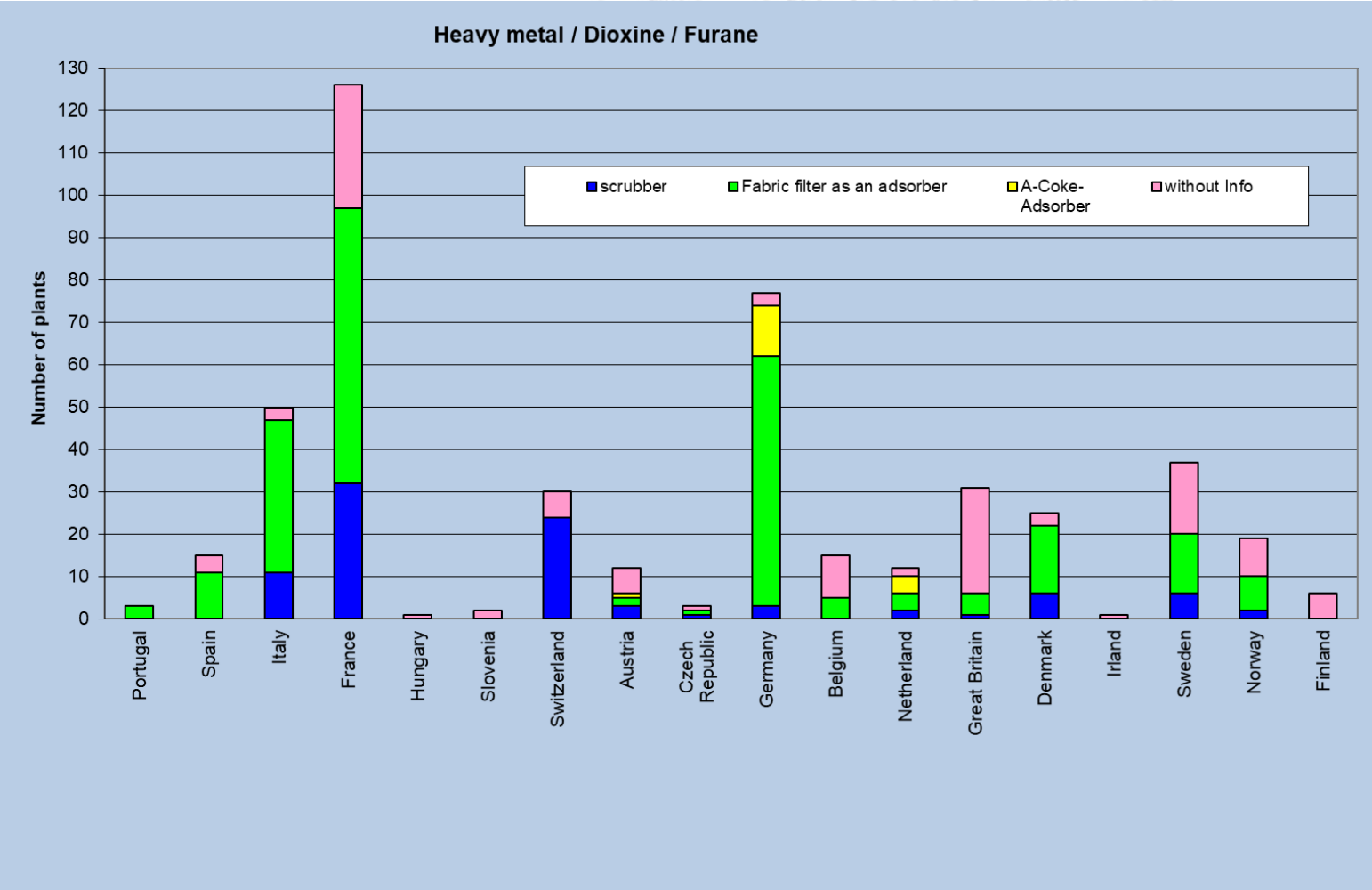


# Comparison of the processes for the separation of the acidic constituents of harmful gases *HCl, HF,* $SO_2$ behind waste incineration plants in European countries




Dominance of wet processes or hybrid processes

# Comparison of the processes for the separation of heavy metals, dioxins / furans behind waste incineration plants in European countries



# Selection criteria and procedures of emission control systems

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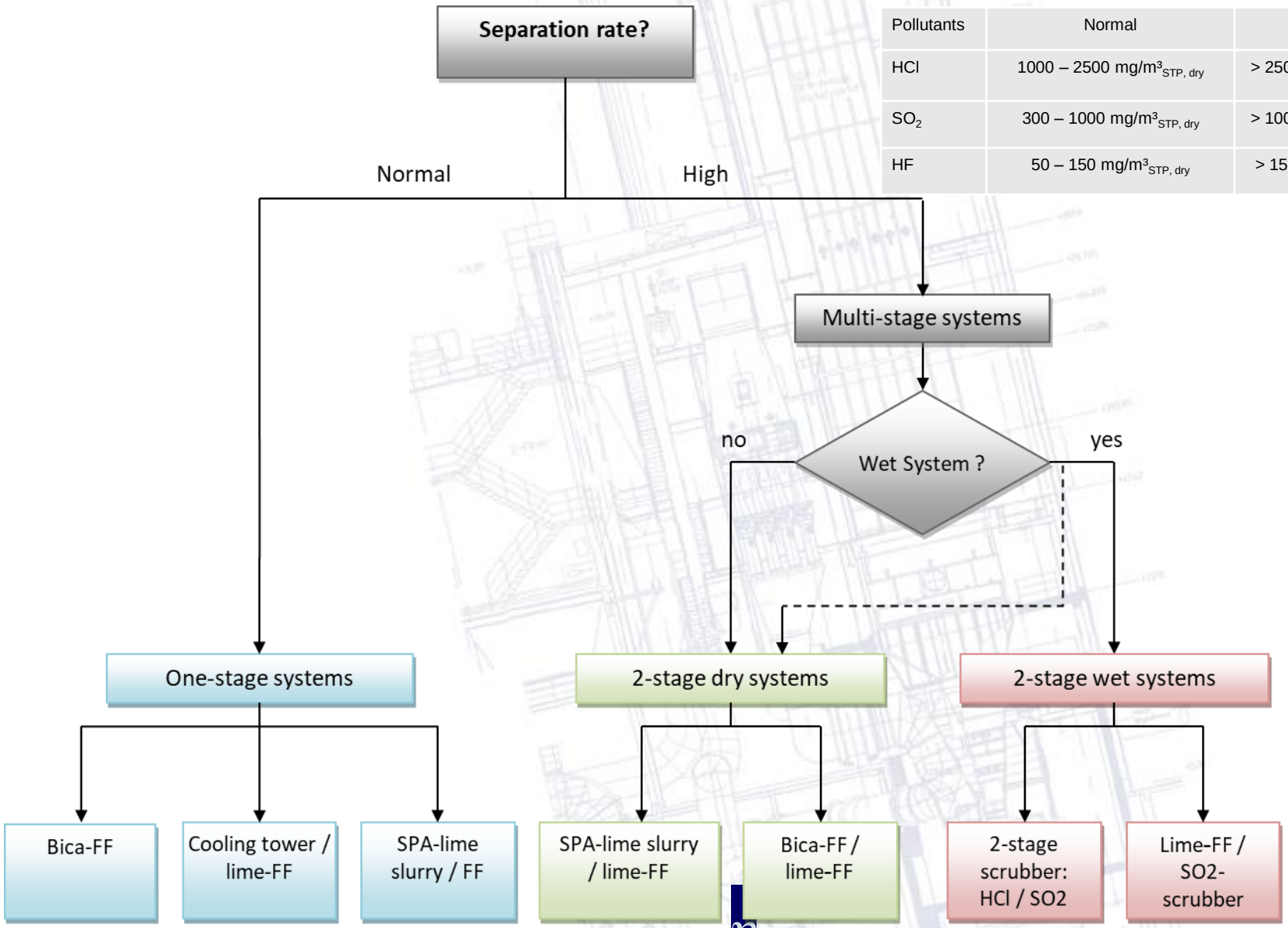
# underlying exhaust parameters for the decision matrices

| Component | Unit | NORMAL | HIGH |
|---|---|---|---|
| TOC | $mg/m^3_{STP,dry}$ | 10 | **5** |
| CO | $mg/m^3_{STP,dry}$ | 50 | **25** |
| HCl | $mg/m^3_{STP,dry}$ | 10 | **5** |
| HF | $mg/m^3_{STP,dry}$ | 1 | **0,5** |
| $SO_2$ | $mg/m^3_{STP,dry}$ | 50 | **20** |
| Dust | $mg/m^3_{STP,dry}$ | 5 | **3** |
| $NO_X$ | $mg/m^3_{STP,dry}$ | 200 | **100** |
| Hg | $mg/m^3_{STP,dry}$ | 0,03 | **0,01** |
| Cd, Tl | $mg/m^3_{STP,dry}$ | 0,05 | **0,025** |
| Sb - Sn | $mg/m^3_{STP,dry}$ | 0,5 | **0,25** |
| As - Cr | $mg/m^3_{STP,dry}$ | 0,05 | **0,025** |
| Dioxine/Furane | **$ng/m^3_{STP,dry}$** | **0,1** | **0,01** |

| Pollutants | Normal | High |
|---|---|---|
| HCl | 1000 – 2500 mg/m$^3_{STP, dry}$ | > 2500 mg/m$^3_{STP, dry}$ |
| $SO_2$ | 300 – 1000 mg/m$^3_{STP, dry}$ | > 1000 mg/m$^3_{STP, dry}$ |
| HF | 50 – 150 mg/m$^3_{STP, dry}$ | > 150 mg/m$^3_{STP, dry}$ |



# Characteristics for the use of lime and sodium bicarbonate

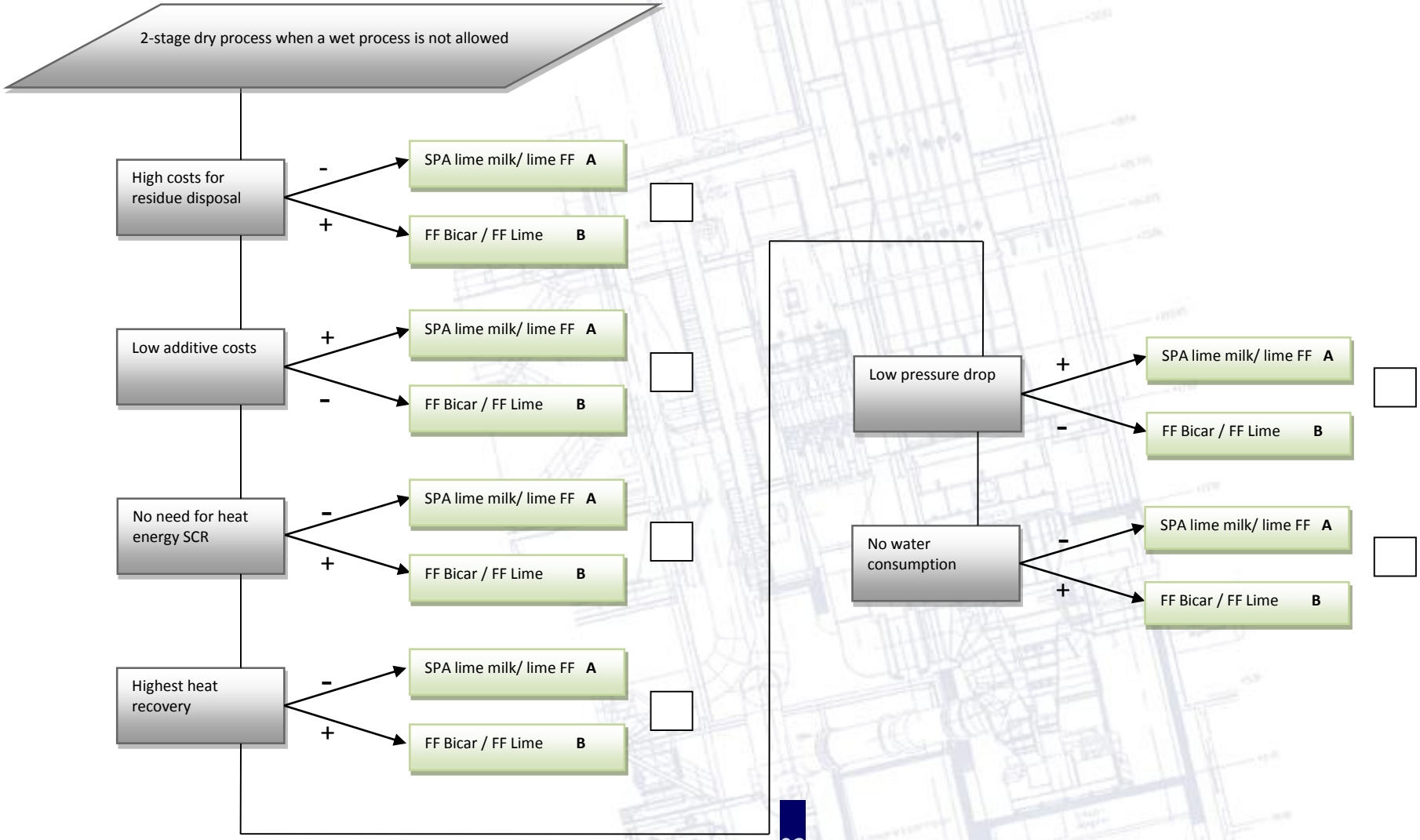
( + good; 0 neutral; - unfavorable)

| Characteristics of the plant / infrastructure | $Ca(OH)_2$ | $NaHCO_3$ |
|---|---|---|
| low additiv costs | + | - |
| high waste disposal costs | - | + |
| downstream SCR-DeNOx-system | +[1)]/- | + |
| maximum use of heat energy | +[1)]/0 | + |
| Use of dry fuel/waste | +/- | + |
| For smallest HF- und $SO_2$-Emissions | + | - |
| Hg-removal | + | - |
| System with buffer effect (Emissionen) | + | - |

[1)] using the PTU method (PTU = partial dew point underrange, process patented by ete.a)

# Decision matrix for selecting a process

(+ good, - unfavorable; Sprayabsorption (SPA), Fabric Filter (FF))



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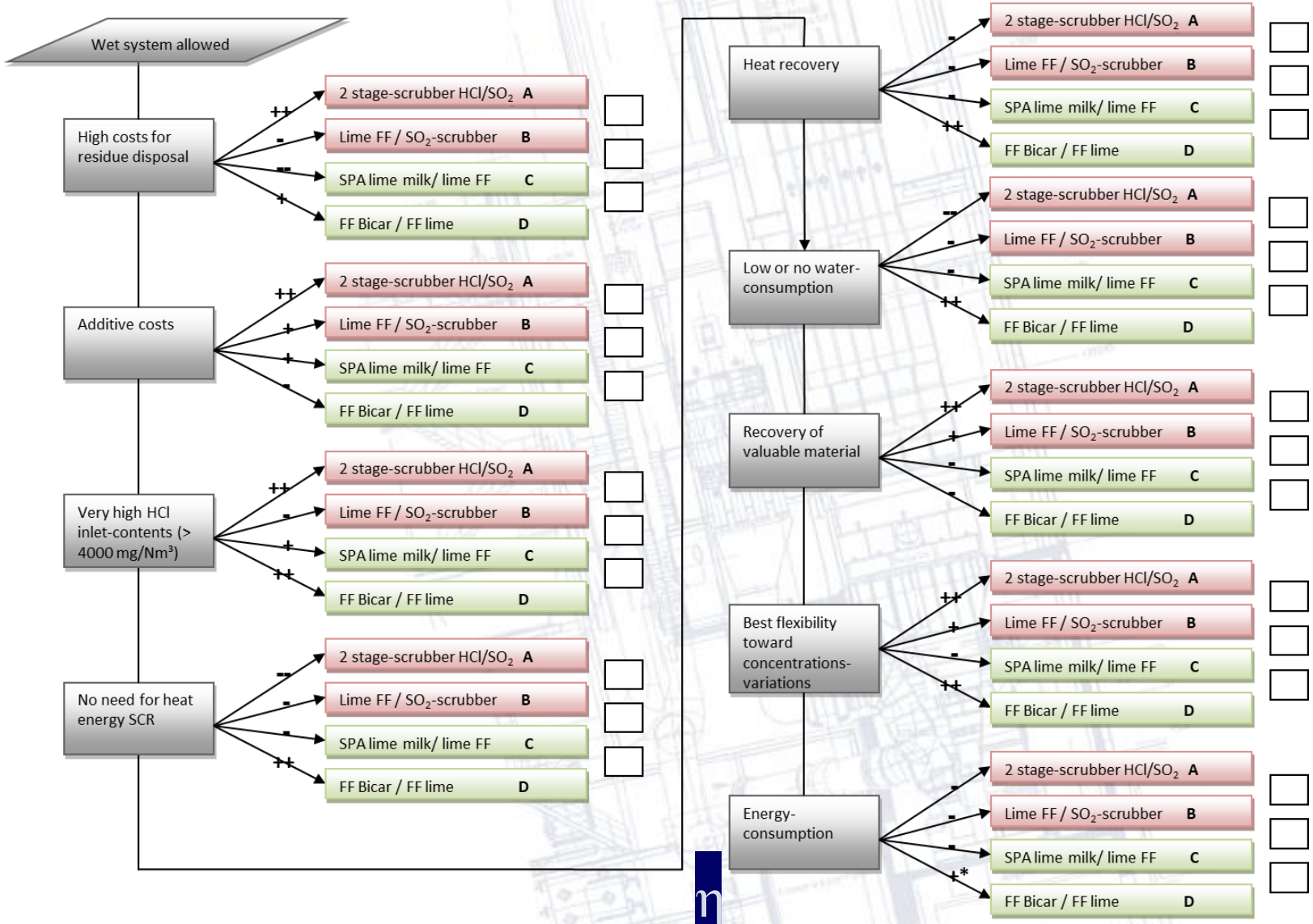


## Challenges for flue gas treatment systems in the future

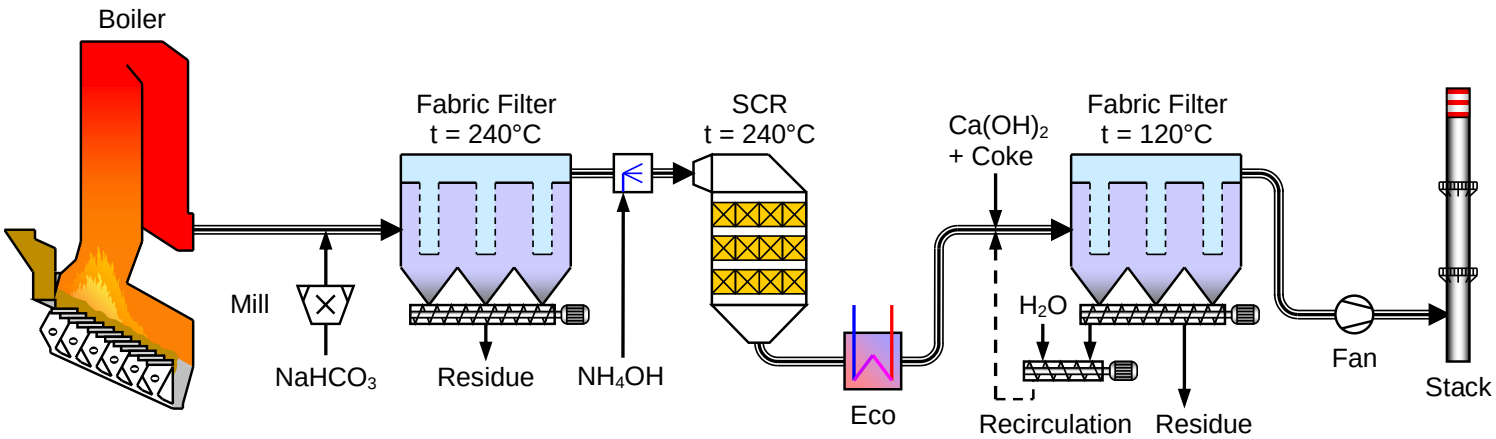
Increasing energy efficiency will continue to be another challenge for flue gas treatment processes!

A very comprehensive and detailed study on the net emissions balance as a function of energy expenditure shows that the energy expenditure for a multi-stage flue gas treatment system with minimum emissions is not necessarily higher than that of single-stage systems!

➡ Modern-day and future know-how regarding the design of efficient plants will not necessarily imply the development of new processes, but rather place a focus on the intelligent combination and configuration of proven process stages

# Challenges for flue gas treatment systems in the future

One example of this is the Delfzijl waste incineration facility in the Netherlands.

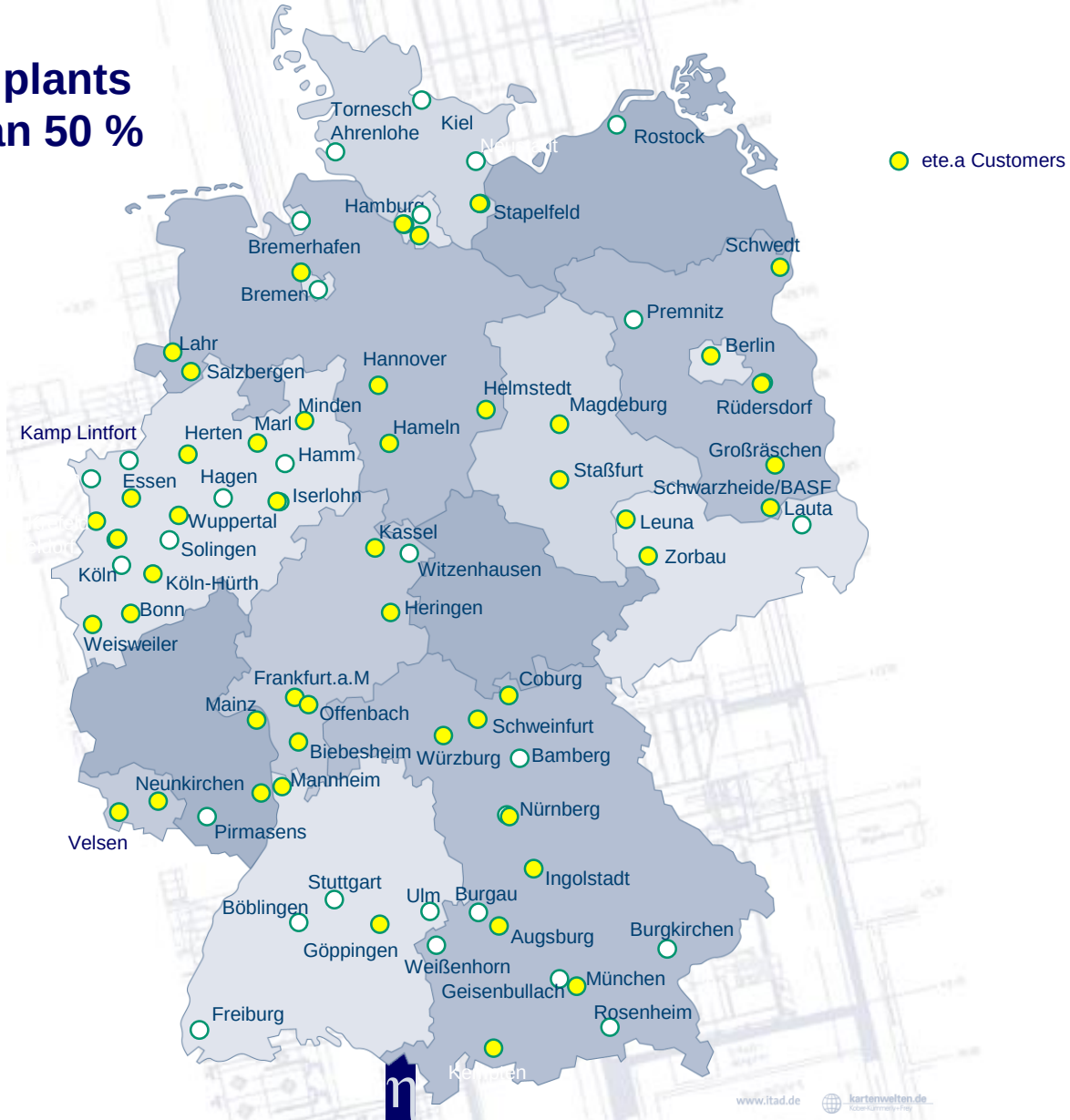



## Challenges for flue gas treatment systems in the future

# My appeal is …

**.. as regards the future selection of sites for new plants, this implies that plants should be built at sites where a suitable infrastructure including energy sinks exist!**

# market share on wte plants in Germany more than 50 %

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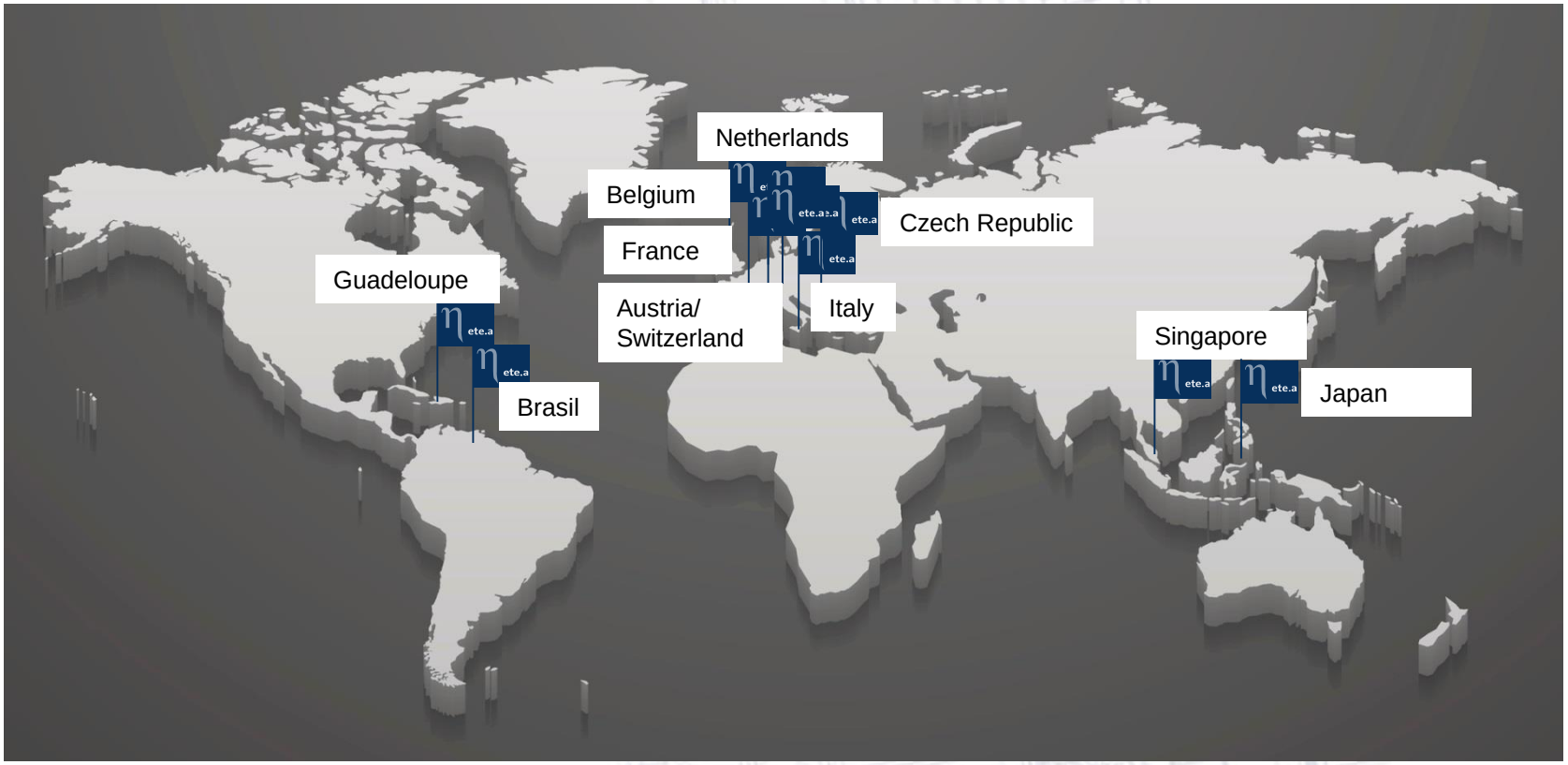
# References in the World



# Summary

**Which method or concept is ultimately the right one depends on many plant- and location-specific factors and is not subject to a flat rate.**

**Pablo Picasso's quote "If there was only one truth, one could not paint a hundred images on the same subject" reflects causality very well.**

# HerzLICHe Grüße
# aus dem Herzen der Natur!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