6th TFTEI Annual Meeting (Virtual meeting)
UN-ECE CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION
22nd & 23rd October 2020

ULTRA LOW-NOx BURNERS IN STATIONARY INSTALLATIONS

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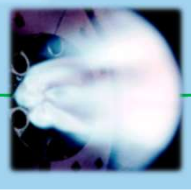
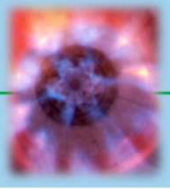
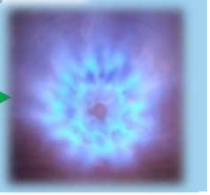
LIVING IN A CHANGING WORLD…

"In a constantly changing world, human being must move forward to be master of its own destiny ! Movement is life !"

	back to ancient times…	1999	2012	2020
telecommunication				
transport				
combustion burner for industry		 Standard NOx 	 Low-NOx 	 Ultra Low-NOx 

NOx REDUCTION - METHODS

1. CONVERSION

Fuel switch from coal/HFO to gas

2. CLEAN COMBUSTION

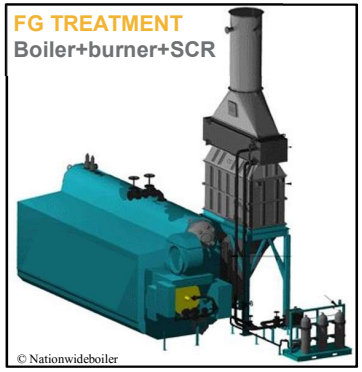
(Ultra) Low NOx burners and Primary techniques
(fuel staging, air staging, premix, reburning, FGR…)

PROS
- good NOx reduction efficiency
- limited Capex
- limited Opex costs

CONS
- NA

3. FLUE GAS TREATMENT

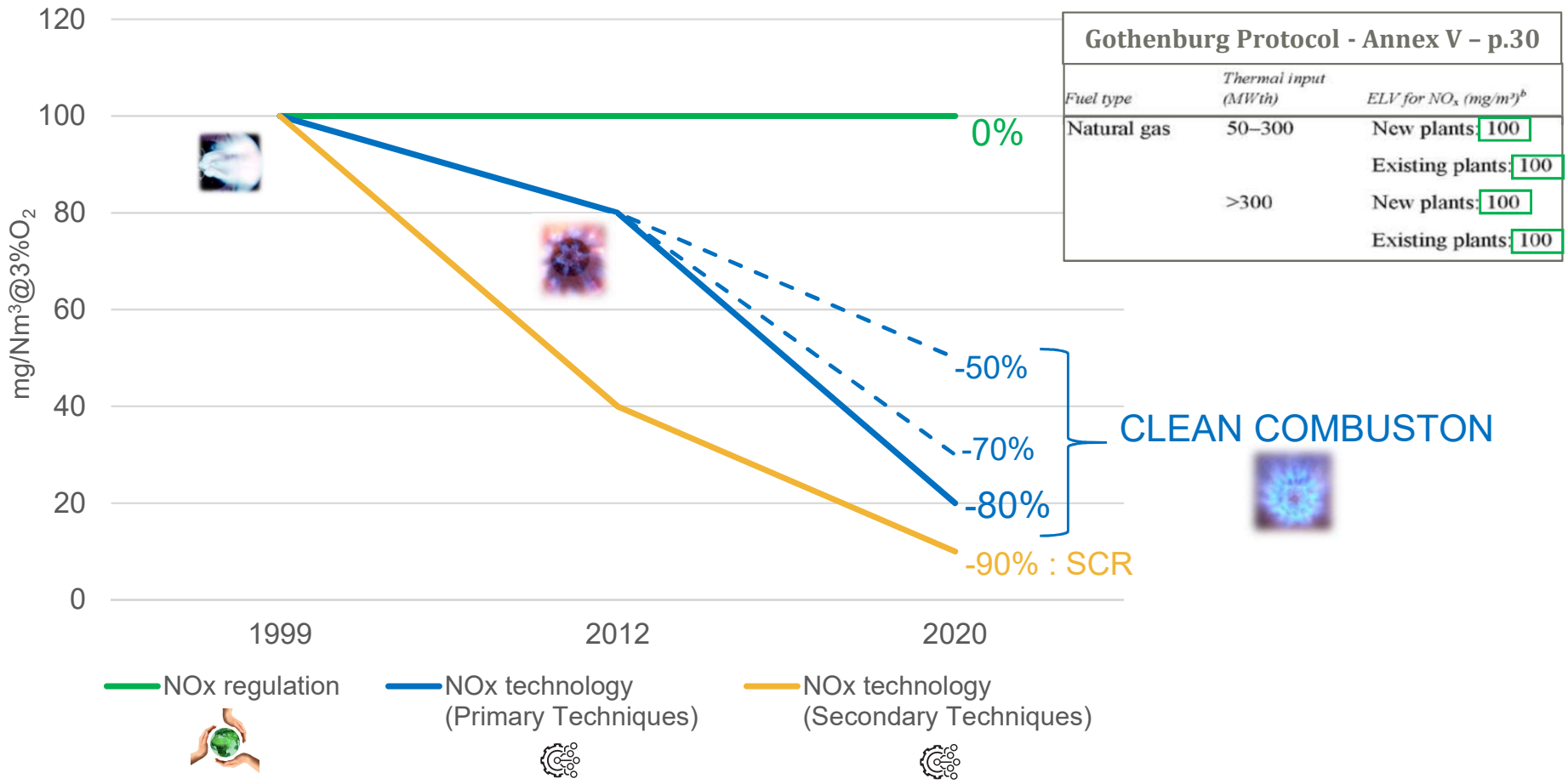
Secondary techniques
(SCR, SNCR…)



PROS
- high NOx reduction efficiency

CONS
- High Capex
- Opex costs
- Large footprint

NOx REDUCTION - REGULATION vs TECHNOLOGY EVOLUTION (ex : Combustion plants, Natural Gas)



Gothenburg Protocol - Annex V – p.30

Fuel type	*Thermal input (MWth)*	*ELV for NO_x (mg/m^3)[b]*
Natural gas	50–300	New plants: 100
		Existing plants: 100
	>300	New plants: 100
		Existing plants: 100

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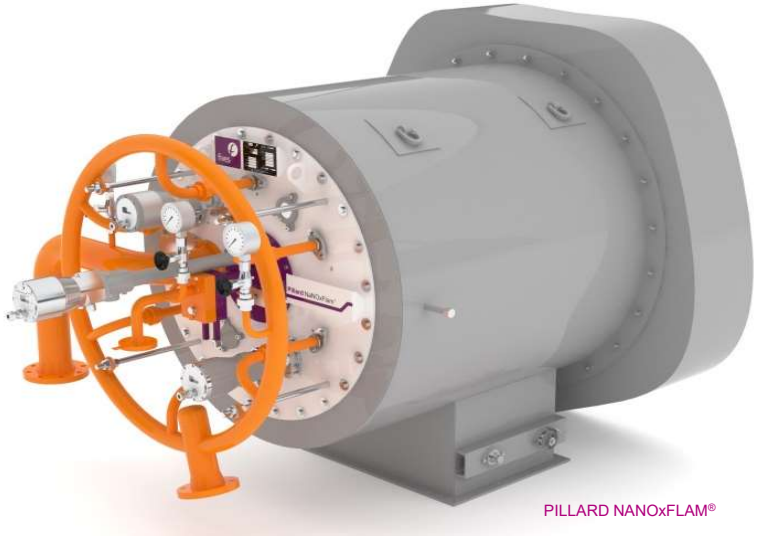
NOx REDUCTION – ULTRA LOW NOx BURNER

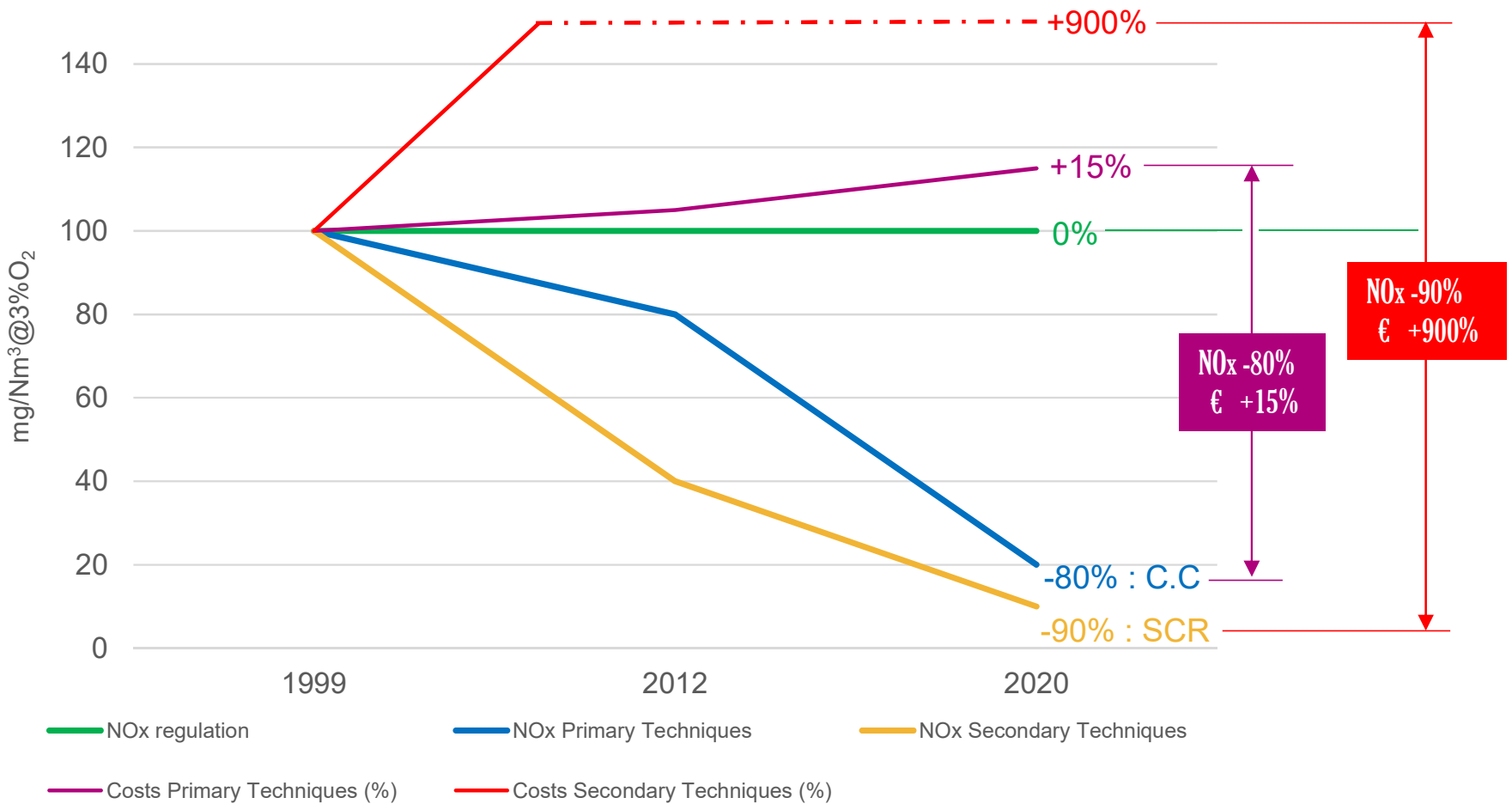
✓ Extract of BAT applicable to Large Combustion Plants (BREF 2017)
3.2.2.3.5 New generation of low NOx burners (p.203)


PILLARD NANOxFLAM®

"For boiler applications, there are currently few implemented lean premix burners in industrial natural-gas-fired boilers. This technique has been successfully implemented in an industrial boiler in France in 2014…...NOx levels below 50 mg/Nm3 are generally achieved with this technique.
Tests carried out at a demonstration-scale application have shown that NOx emission levels around 20–30 mg/Nm3 (at 3 % O2) are achievable when a lean premix burner is used in conjunction with external flue gas recirculation..."

« Reference literature
[Development of an ultra-low NOx burner based on the technology of the premixed flame, Final report, Convention ADEME / Fives Pillard #1281C0035, November 2014] »

NOx REDUCTION - TECHNOLOGY EVOLUTION vs COSTS



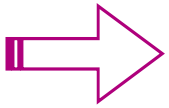
EXAMPLE OF CALCULATION - *Industrial boiler 50 MW – natural gas firing*

Industrial Park

NOx = 100 mg/Nm3

Operation = 8000h / year

Pollution = 40 t NOx / year



NOx = 20 mg/Nm3

Operation = 8000h per year

Pollution = 8 t NOx / year

32 t NOx removed !

Automotive Fleet

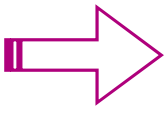
NOx = 168 mg/km

(Euro 6d-TEMP)

Operation = 20 000km / year / car

Pollution = 40 t NOx / year

Nb cars equivalence = 11 905 cars



NOx = 168 mg/km

(Euro 6d-TEMP)

Operation = 20 000km / year / car

Pollution = 8 t NOx / year

Nb cars equivalence = 2381 cars

9524 cars removed !

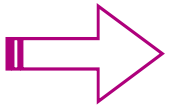
EXAMPLE OF CALCULATION - *Industrial boiler 50 MW – natural gas firing*

Industrial Park

NOx = 100 mg/Nm3

Operation = 8000h / year

Pollution = 40 t NOx / year



NOx = 20 mg/Nm3

Operation = 8000h per year

Pollution = 8 t NOx / year

32 t NOx removed !

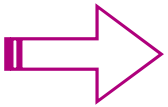
Investment

NOx = 100 mg/Nm3

Burner = 70 k€ / Skid = 70 k€ / BMS* = 60 k€

Total Capex = 200 k€

BMS : Burner Management System*



NOx = 20 mg/Nm3

+15%

Burner = 75 k€ / Skid = 70 k€ / BMS* = 60 k€

FGR = 25 k€

Total Capex = 230 k€

Opex ~ 5% Capex (%02 controlled – no efficiency loss)

EXAMPLE OF CALCULATION - *Industrial boiler 50 MW – natural gas firing*

$$Ca\left(\frac{€}{year}\right) = I(€) \times \frac{(1+p)^n}{(1+p)^n - 1} \times p$$

$$Ct\left(\frac{€}{year}\right) = Ca\left(\frac{€}{year}\right) + Co\left(\frac{€}{year}\right)$$

I (€) = investment required
p (%) = amortization rate (4%)
n (years) = equipment lifetime (15 years)
Ca (€/year) = annualized investment
Co (€/year) = annualized operational costs (5% x I)
Ct (€/year) = annualized total costs

Ratio cost/efficiency (R_{eff})

$$R_{eff}\left(\frac{€}{\text{t NOx removed}}\right) = \frac{Ct}{M_{NOx}}$$

Ct (€/year) = annualized total costs
M_{NOx} (t/year) = tons of NOx removed per year

Source : CITEPA

	I (€)	Ct (€/year)	M_{NOx} (t/year)	**Reff (€/t NOx removed)**
Clean Combustion	30 000	4 198	32	131

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NOx REDUCTION – COMMITMENT

✓ Some industrial companies start to have an environmental virtuous approach for their projects

Examples of implementation of ULN technology in France, Poland, South Korea, Canada…

SOLVAY asking more from chemistry®

EDF Fenice

SAMSUNG ELECTRONICS

SUNCOR ENERGY

✓ TFTEI Clearing House of Control Technologies – Exchange Platform

http://tftei.citepa.org/en/exchange-platform/latest-developments/3-pillard-nanoxflam-burner

✓ Burners manufacturers invest equity capital to push forward the technology

Combustion Centre dedicated to high level R&D activities, Smart technologies, Additive manufacturing…

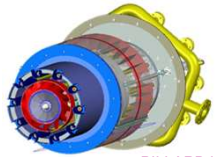
FIVES REMOTE SERVICES

AddUp GLOBAL ADDITIVE SOLUTIONS

NOx REDUCTION – COMMITMENT

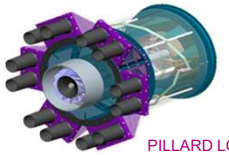
✓ Ultra low-NOx burners available for most of industrial applications and different fuel mixing

- Auxiliary boilers firing natural gas, biogas, hydrogen, heavy gases (ethane, propane…)



PILLARD LONOxFLAM® G2

- Oil&gas furnaces firing fuel gas, diesel oil, heavy oil, special liquid fuels



PILLARD LONOxFLAM® AS

- Cement furnaces firing natural gas, liquid fuels, alternative solid fuels (RDF, SRF…)

PILLARD NOVAFLAM® evolution

- Post-combustion HRSG furnaces firing natural gas, fuel gas, diesel oil

PILLARD INDUCTFLAM®

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CONCLUSIONS

- Ultra low-NOx burners are ready, reliable and available to decrease significantly NOx levels
- Access to ultra low-NOx technology is not cost-prohibitive
- Many industrial references are operational across the world
- NOx regulation for combustion plants is “out of phase” with respect to 2020 technology level

“ - we can no longer say that we didn't know -”

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THANK YOU FOR YOUR ATTENTION !

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