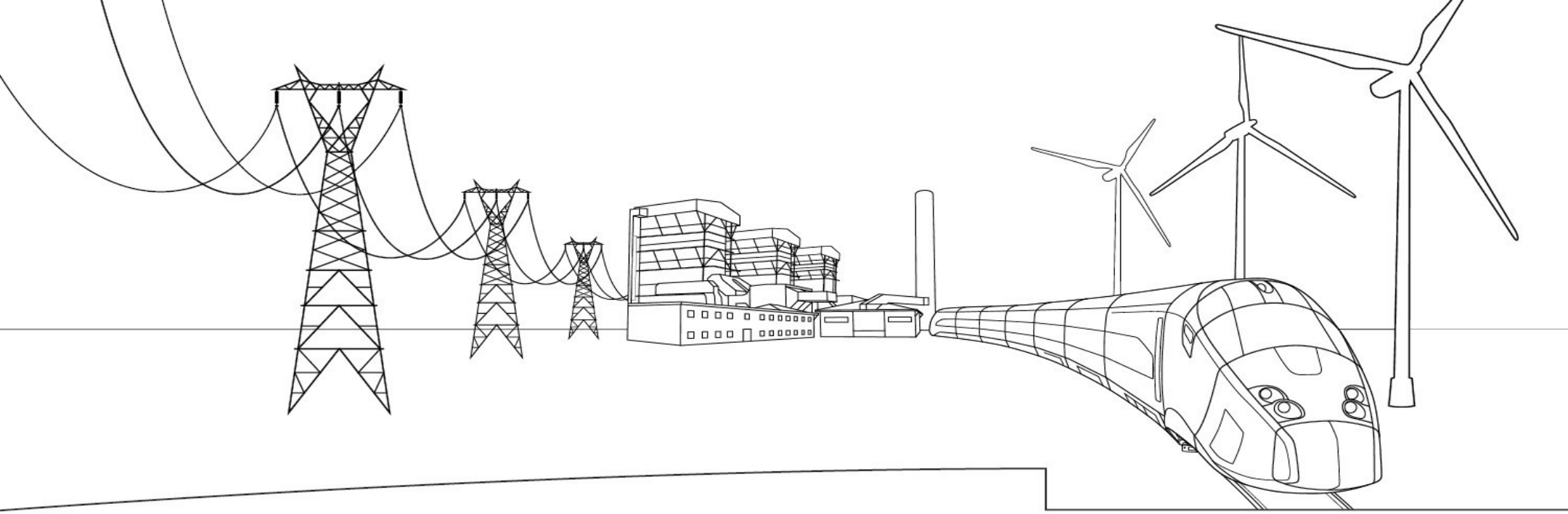

Emissions- och Energioptimering m.hj.a. avancerad Spetsteknologi

Christer Mauritzson

PANNDAGARNA 2015 - Aros Congress Center, Västerås

14-15 April 2015

ALSTOM
Shaping the future

Nyleverans, underhåll och service inom miljövård

Med rötter från 1920 med namn som Fläkt, Bacho och ABB

Globalt R&D center för miljöteknik i Växjö

Teknikområden

- Elfilter
- Slangfilter
- DeNOx
- DeSOx
- Fläktar
- Styrsystem

Utbud

- Nyleverans
- Reservdelar och studier
- Underhåll och reparationer
- Ombyggnader och uppgraderingar

Vi utför service på alla typer av miljövårdsutrustning, Alstom eller icke-Alstom

Agenda

Topic 1	Concept of Electronic Products for ESPs
Topic 2	T/R Controller EPIC-III with features and results
Topic 3	High Frequency Power Supply - the SIR concept
Topic 4	What you can achieve with the SIR concept
Topic 5	Summary on experience with EPIC & SIR

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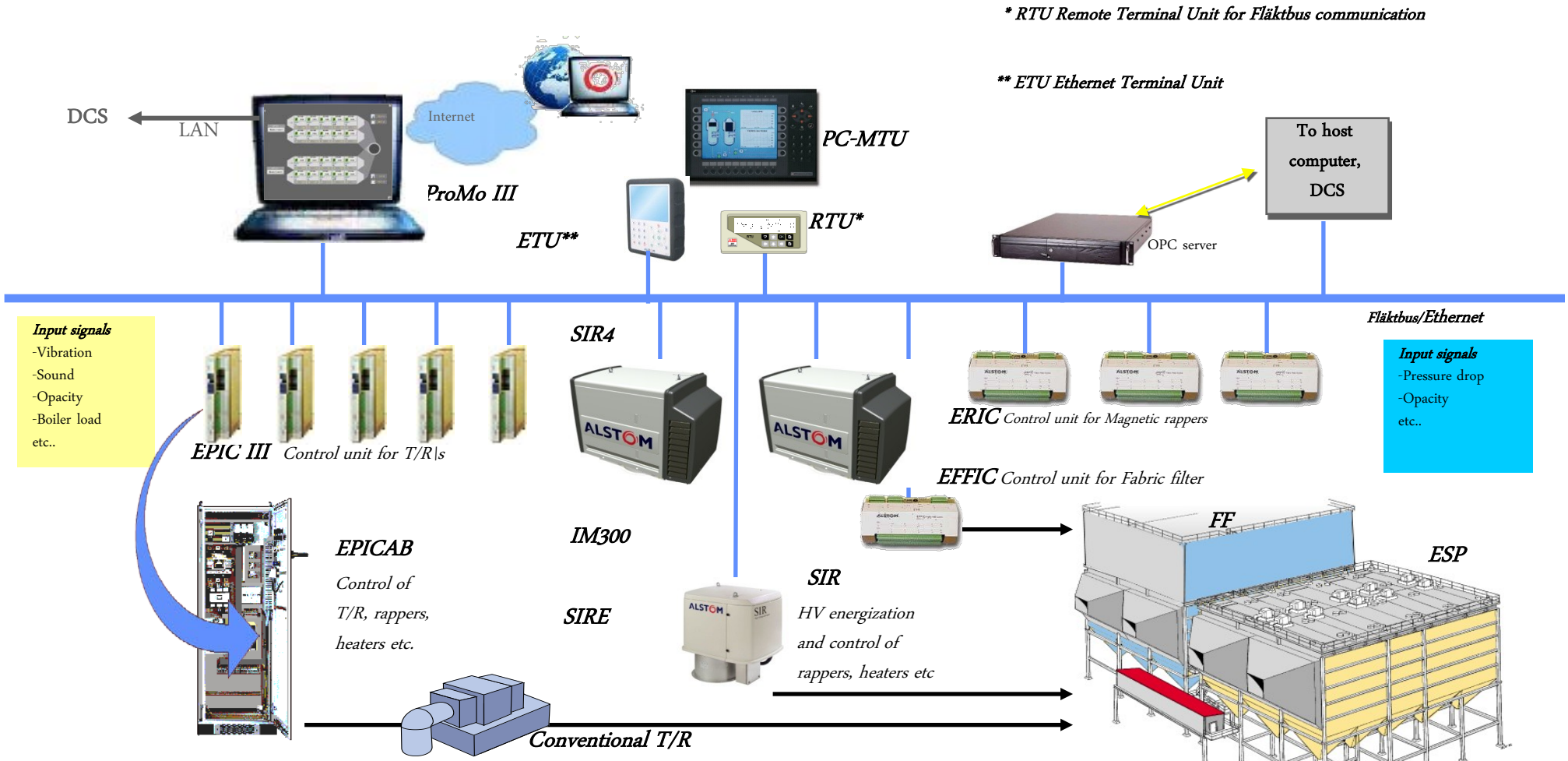
Background and drivers for ESP upgrades

- Stricter environmental requirements
- Reduce power consumption
- Ageing ESP's
- Process changes/fuel changes
- Reduce maintenance cost

Electronic Product Portfolio to use on ElectroStatic Precipitators (ESP)



A core control system upgrade

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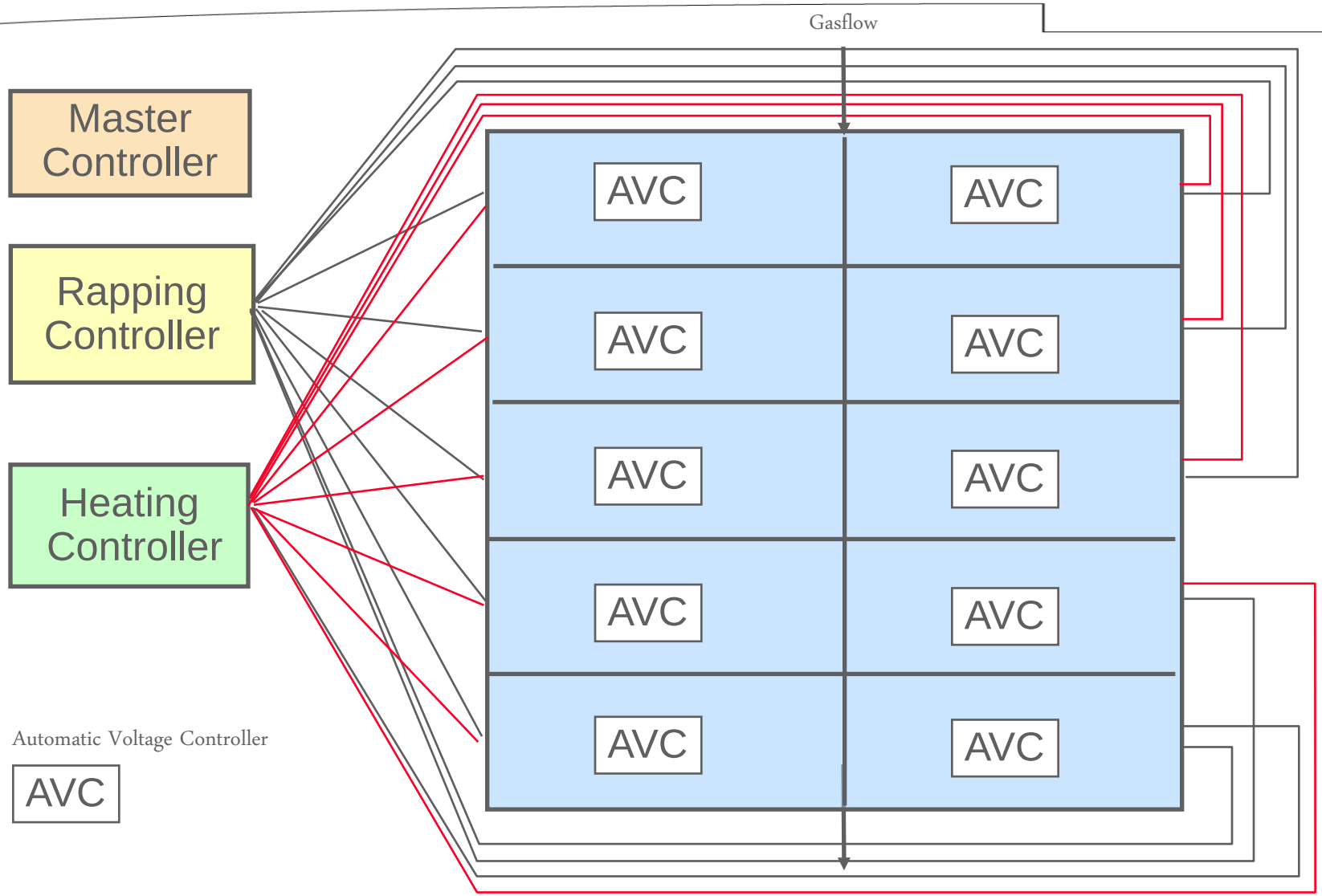
Traditional Concept to Control ESPs



Improved redundancy/availability after upgrade

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SIR - Comparison to Other ESP Power Supply

Mains Frequency Power Supply

(Single or 3-phase)

Output power:	120 kW
Weight:	200 kg + 1'400 kg
Oil volume:	350 - 600 l
Efficiency*:	75-89%
Form factor**:	1,4

*: output power/(output power + power losses) **: form factor = I_{rms}/I_{avg}

High Frequency Power Supply

SIR E / SIR 4

	28 – 120 kW
	240 – 500 kg
	48 – 90 l
	approx. 96%
	1,11

Higher efficiency with SIR than with conventional T/R

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EPIC III - Automatic Voltage Controller

- Electrostatic Precipitator Integrated Controller – Generation 3 (EPIC III) the cellular ESP field Controller – each bus section is individually optimized
  - Spark rate control
  - Charging Ratio control - Semipulse
  - Self-optimization algorithm for best performance (EPOQ)
  - Rapping optimization + Power Control Rapping (PCR)
  - Power optimization (OpOpt)
  - Alarm handling and ESP operation overview

EPIC III maximizes performance at the lowest possible power

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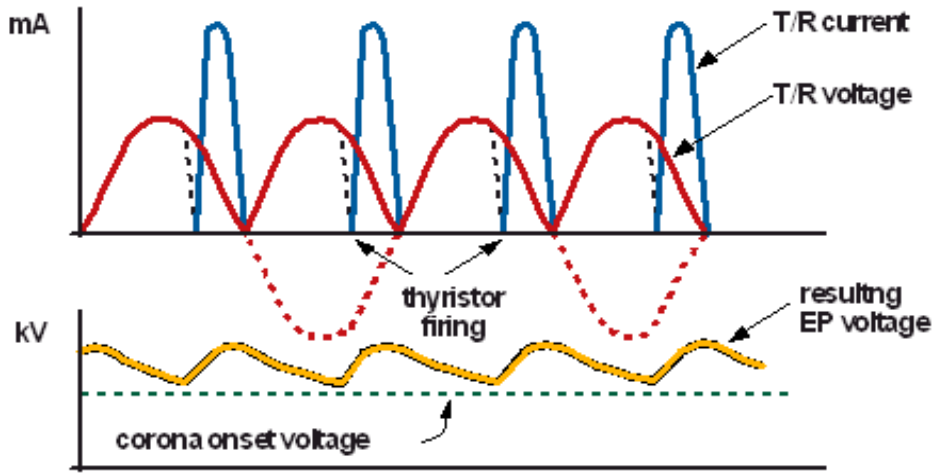
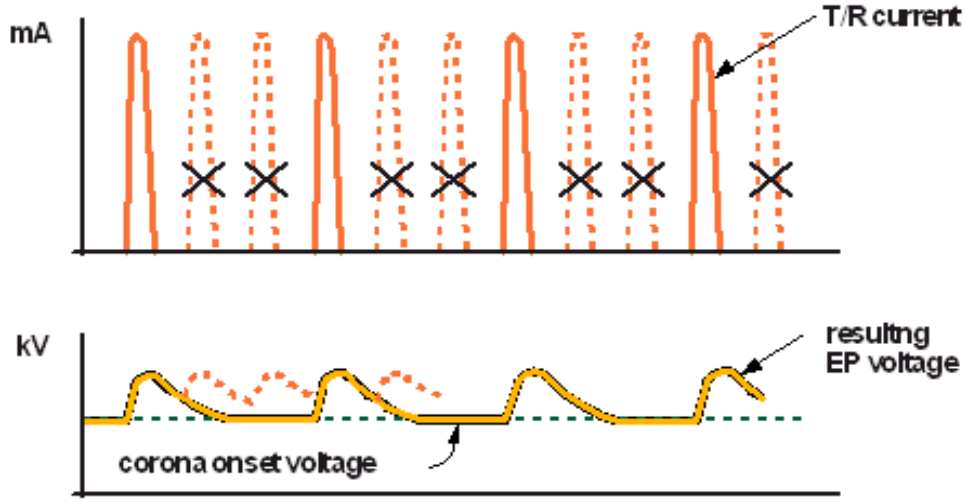
Semipulse on conv. T/Rs

Conventional full wave T/R operation

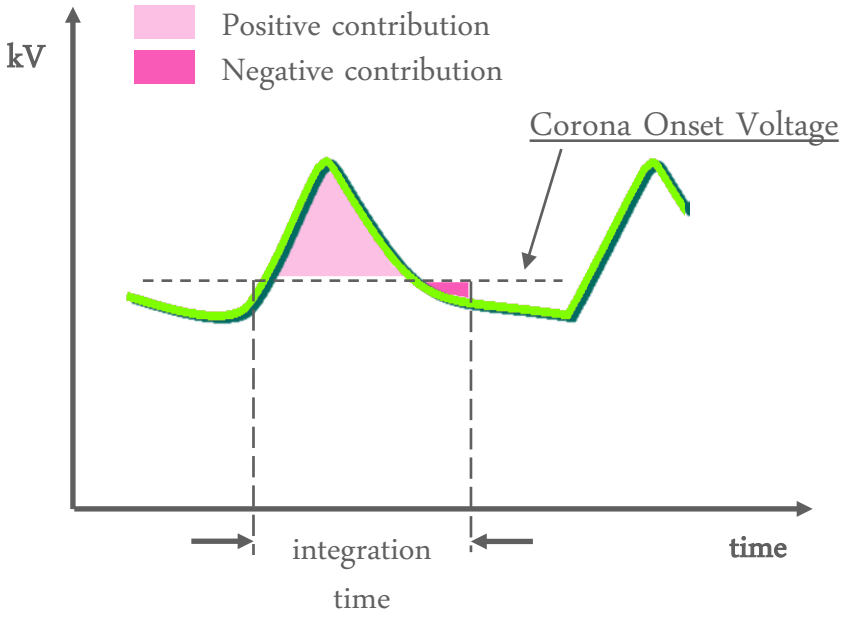


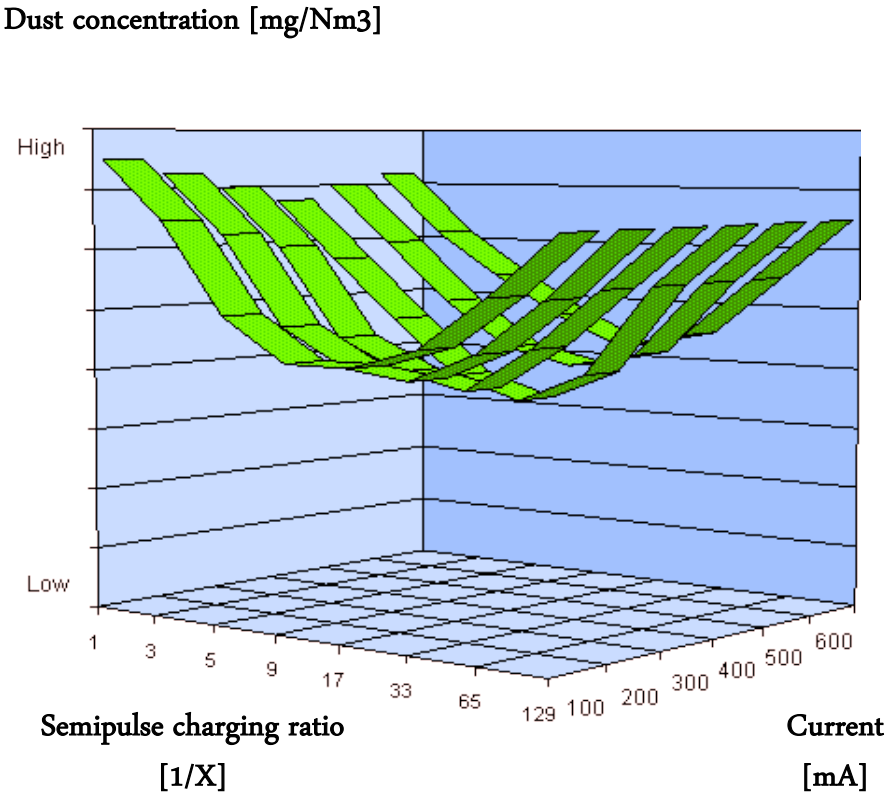
Semi-pulsed T/R operation



EPOQ - optimum operation point

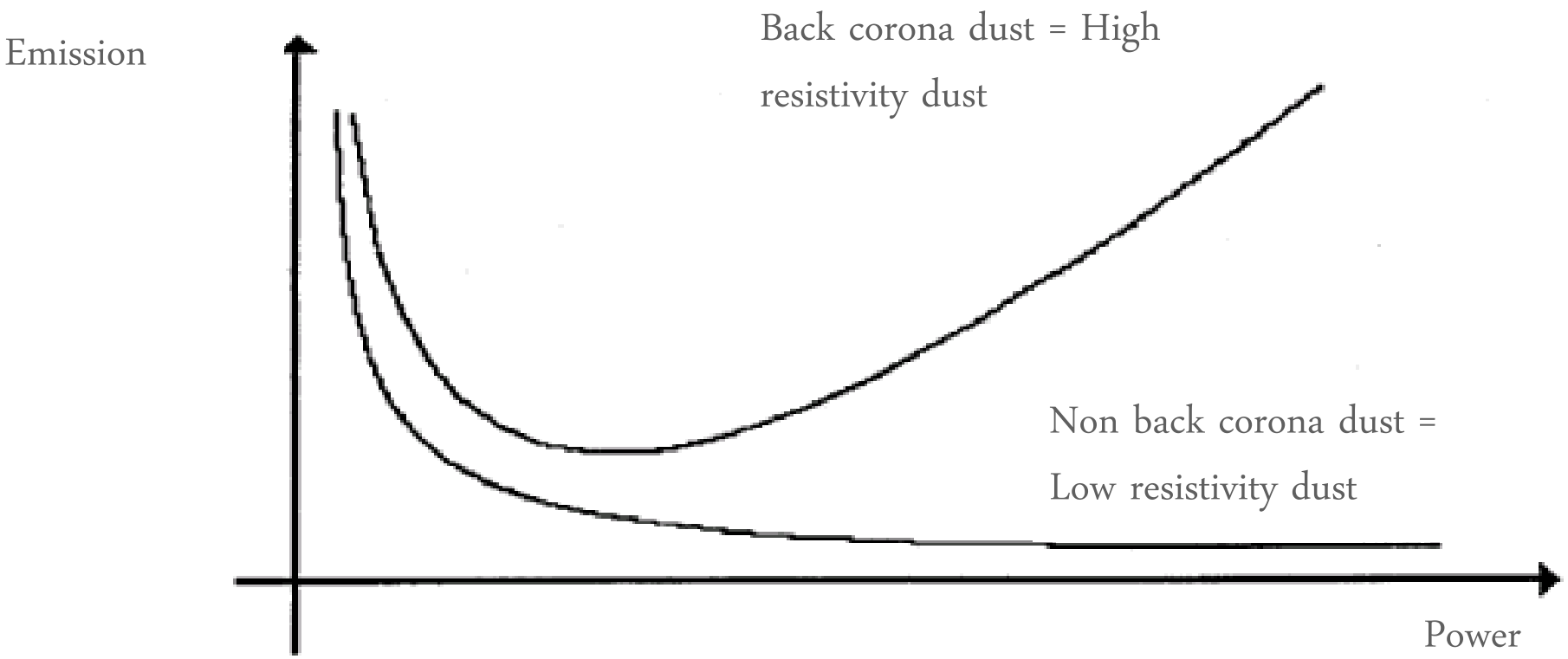
EPOQ Operation





Unique self optimization system to adapt for fuel quality variations

Dust emission vs. power consumption



Typical ESP behavior

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EPIC III Energy Reduction on a Coal fired Power Station

Upgrade of Control & Energization System and optmimization (EPOQ)

2x ESP: Alstom, 1 chamber, 3 cells each, 3 fields, equipped with 18 pcs conv. T/R:s

Fuel: Indonesian coals

Scope of Supply:

- Upgrade of Control & Energization System with 18 pcs EPIC-III

Original Guarantee:

- 50 mg/Nm³ for high resistivity Indonesian coals

After upgrade and optimization (2009):

- After upgrade and optimisation of the control system and rapping schedule the emissions remained steady at 10 mg/Nm³ with a power consumption decrease from 850kW to 100kW per casing

Power reduction saving/yr: 2 x (850-100)kW x 8000 h x 0.06 €/yr =**720.000 €/yr**

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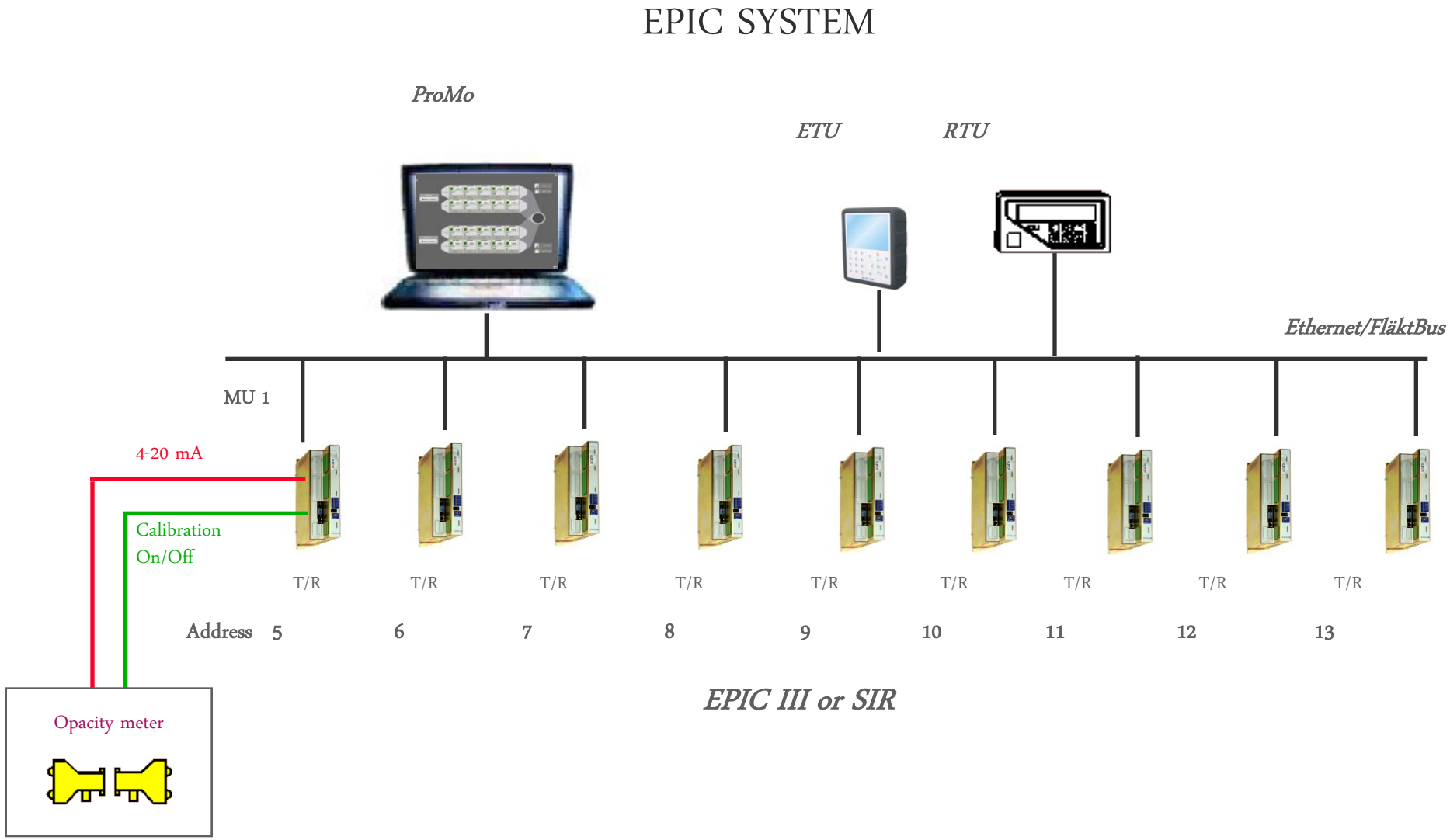
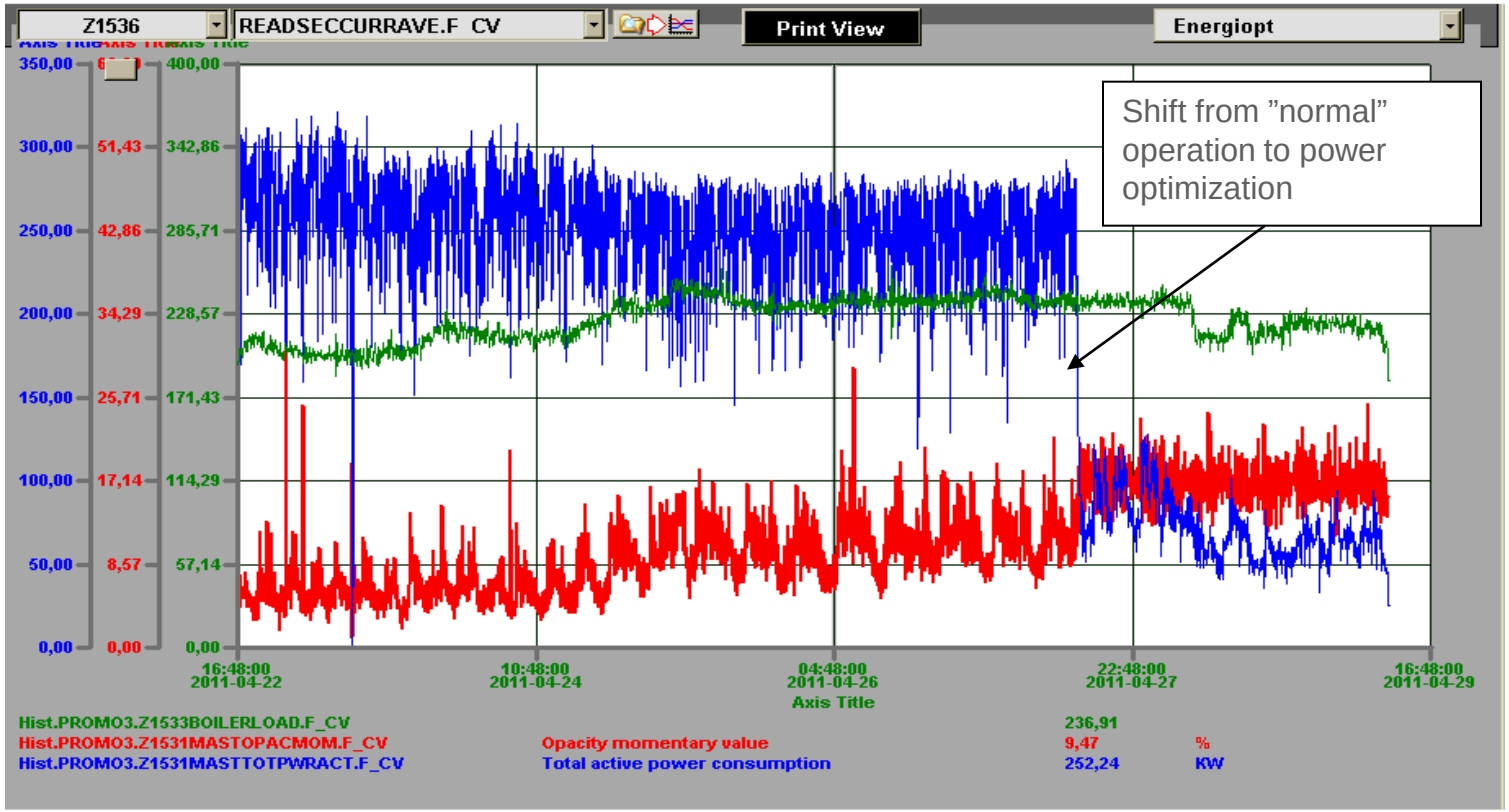
Opacity control (OpOpt) with EPIC-III and SIR



Optimizing ESP power consumption with EPIC or SIR

Power saving at Soda-ESP



ca 75 % power saving

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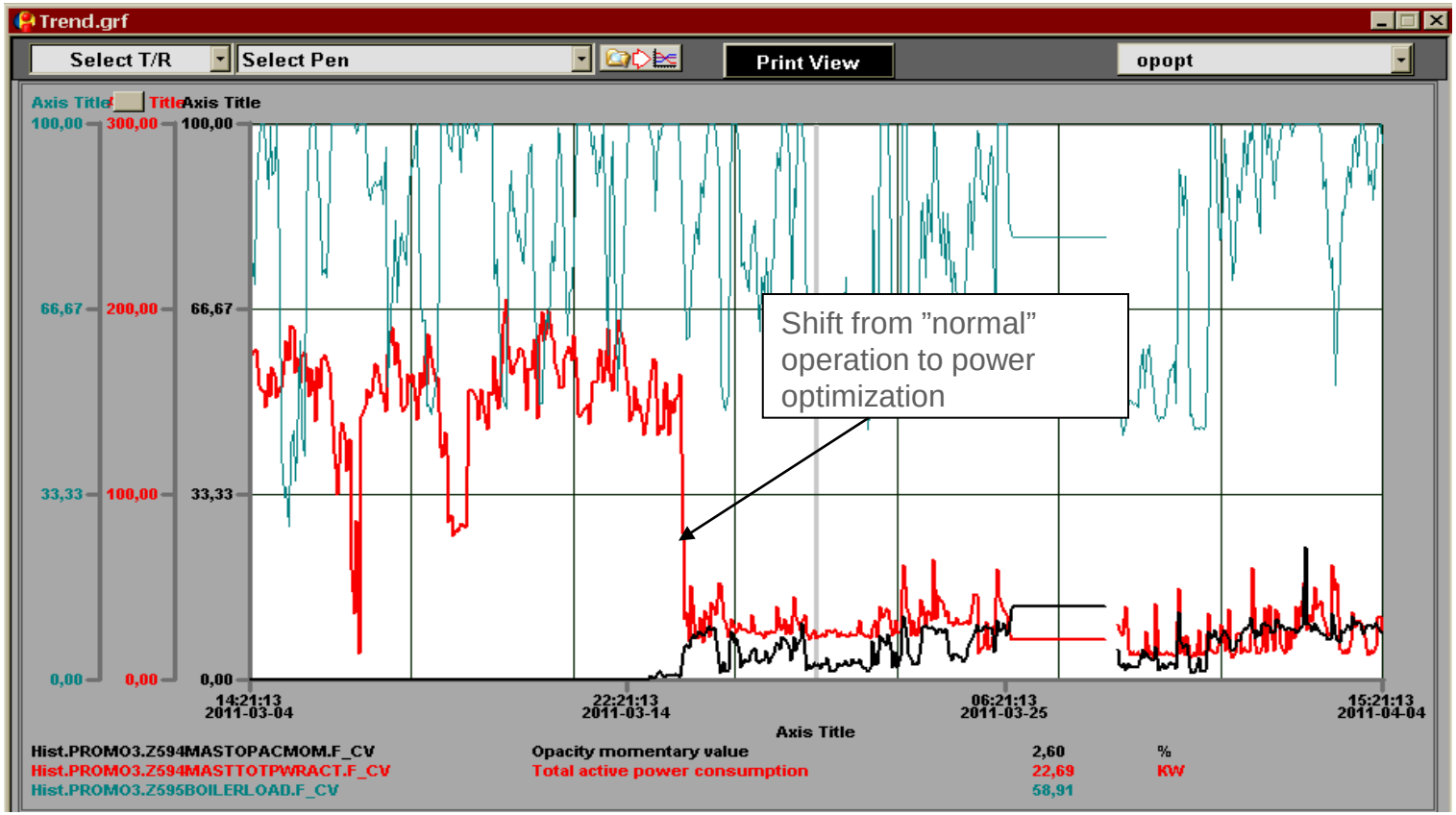
Optimizing ESP power consumption with EPIC or SIR

Power saving at Bark-ESP



ca 80 % power saving

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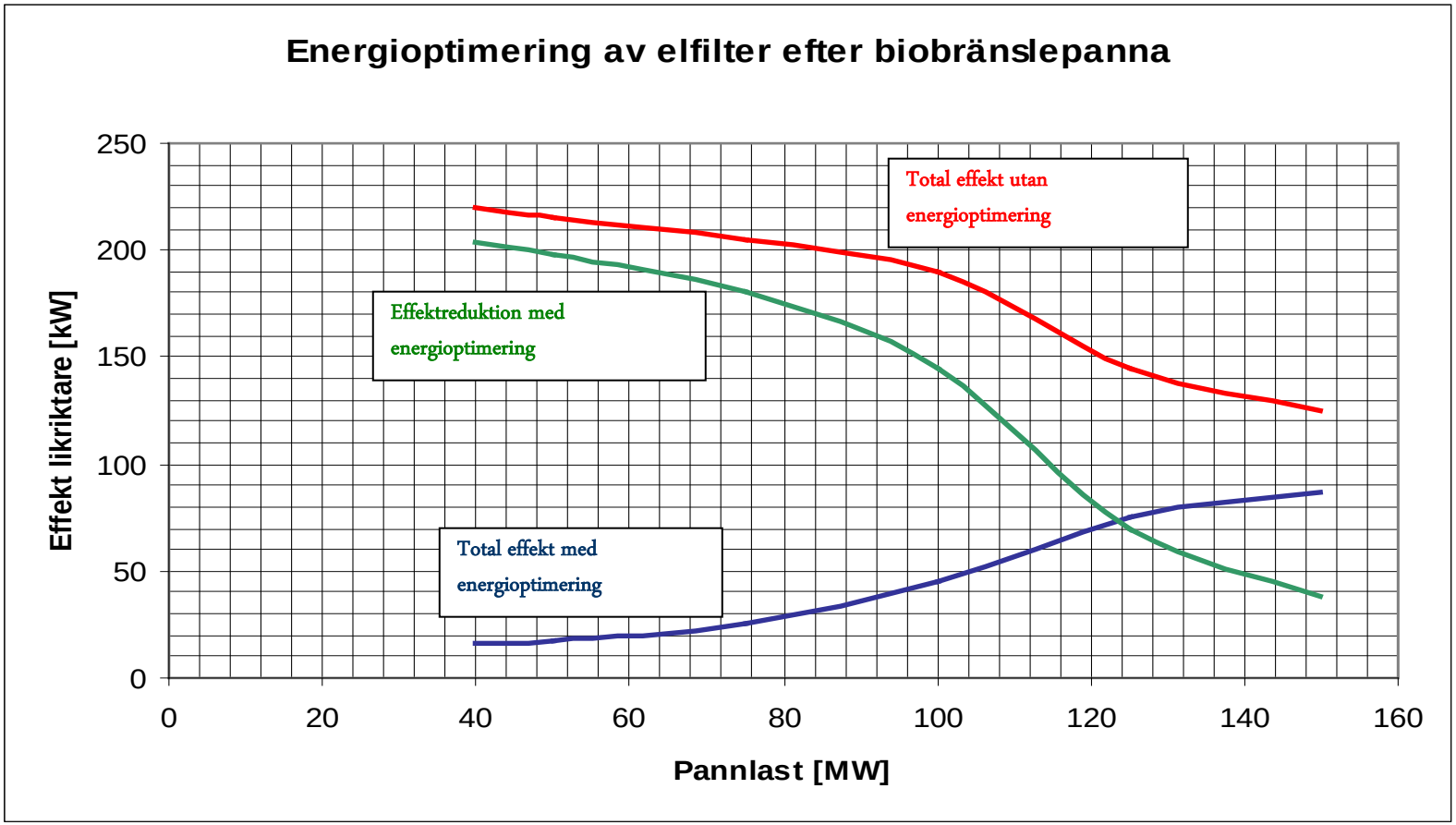
Optimizing ESP power consumption with EPIC and SIR

Possible power saving by use of opacity control



Large power savings especially at part load

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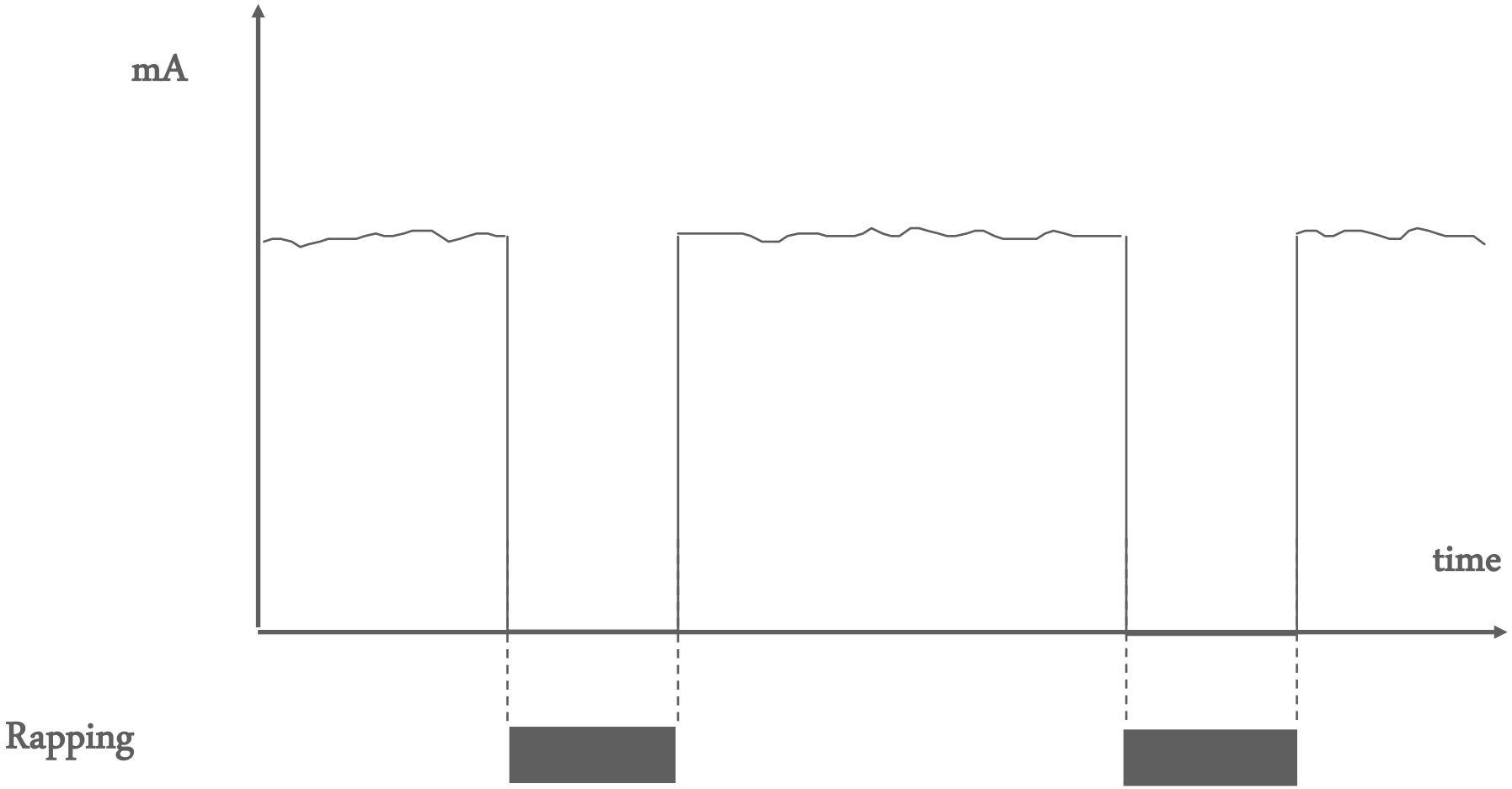
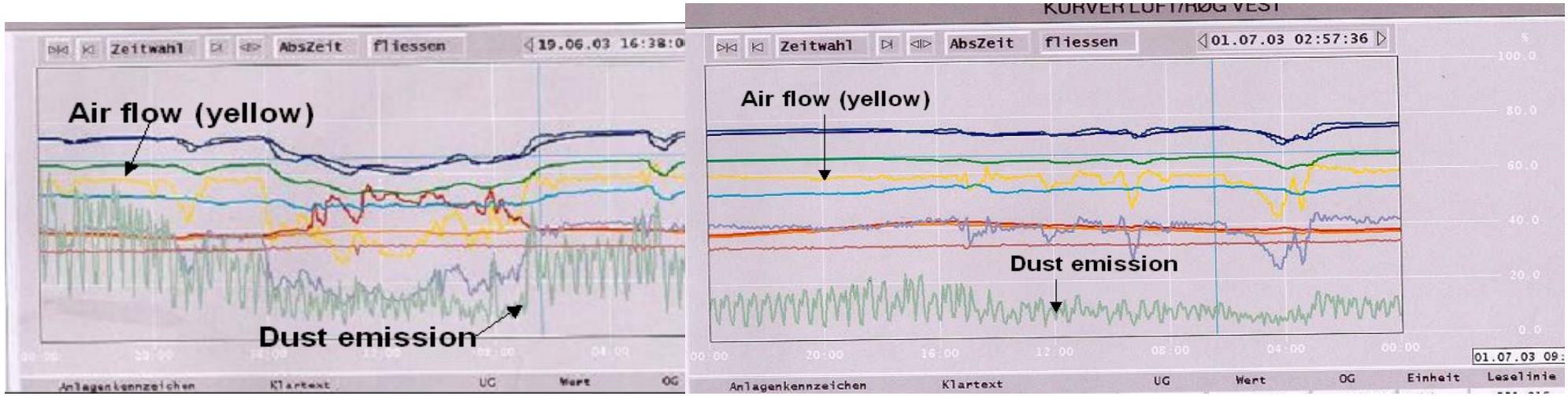
Power Control Rapping (PCR) with EPIC-III or SIR



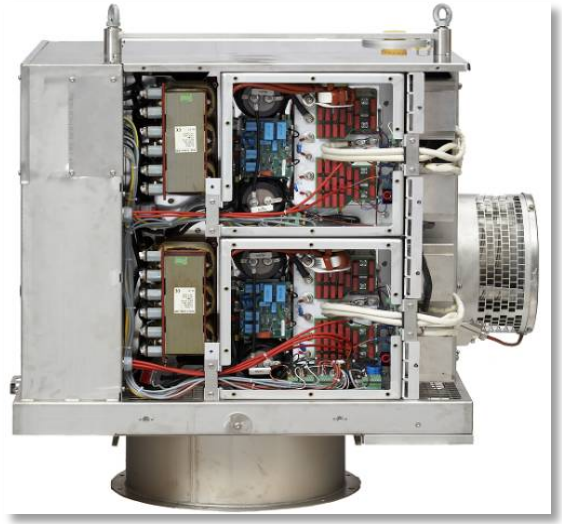
ESP control system – Rapper tuning



Increasing the current in the first fields due to a faster spark response combined with c:a 8 times increased rapping intervals

=> Reduced emissions and wear of equipment

High-Frequency Power Supply - (SIR)



- **Switched**

  High frequency electronic power processing technique.

- **Integrated**

  Transformer, power electronics and controller are integrated in the same housing.

- **Rectifier**

  AC input, DC output.

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High Frequency Power Supply – SIR fleet

- High Frequency Power Supplies – a cost efficient option to improve the efficiency of ESPs
- High Frequency Power Supplies were introduced in 1993 and have now reached >20 years of operating experience.

Model	Output	1st installation	Units in operation (2014)
SIR	80 kV / 250 mA	1993	248
SIR A	70 kV / 400 mA	1997	434
SIR E	70 kV / 800 mA	1998	1474
SIR E	60 kV / 1000 mA	2001	500
SIR 4	70 kV / 1700 mA	2006	505
SIR 4	100 kV / 1200 mA	2008	162
SIR 4	85 kV/1200 mA	2013	118

Total: 3441

Nominal input voltage (SIR 4):

380/400V, 50Hz

480V, 60Hz

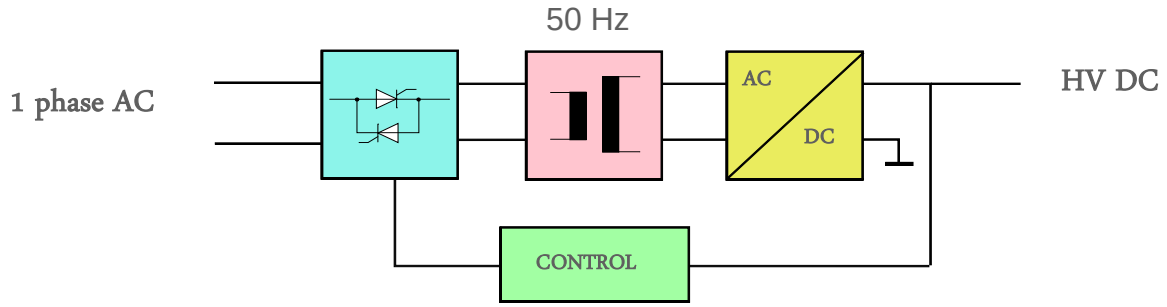
500V, 50Hz

575V, 60Hz

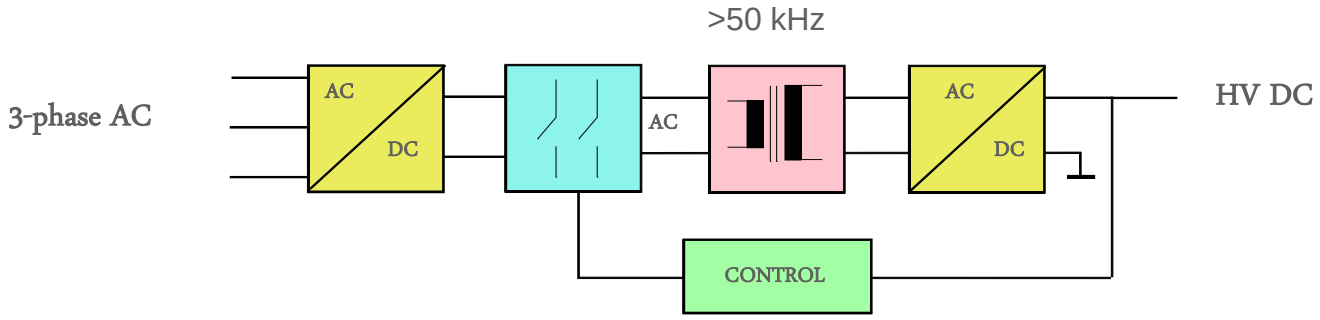
In Sweden over 355 installations

SIR - Power processing

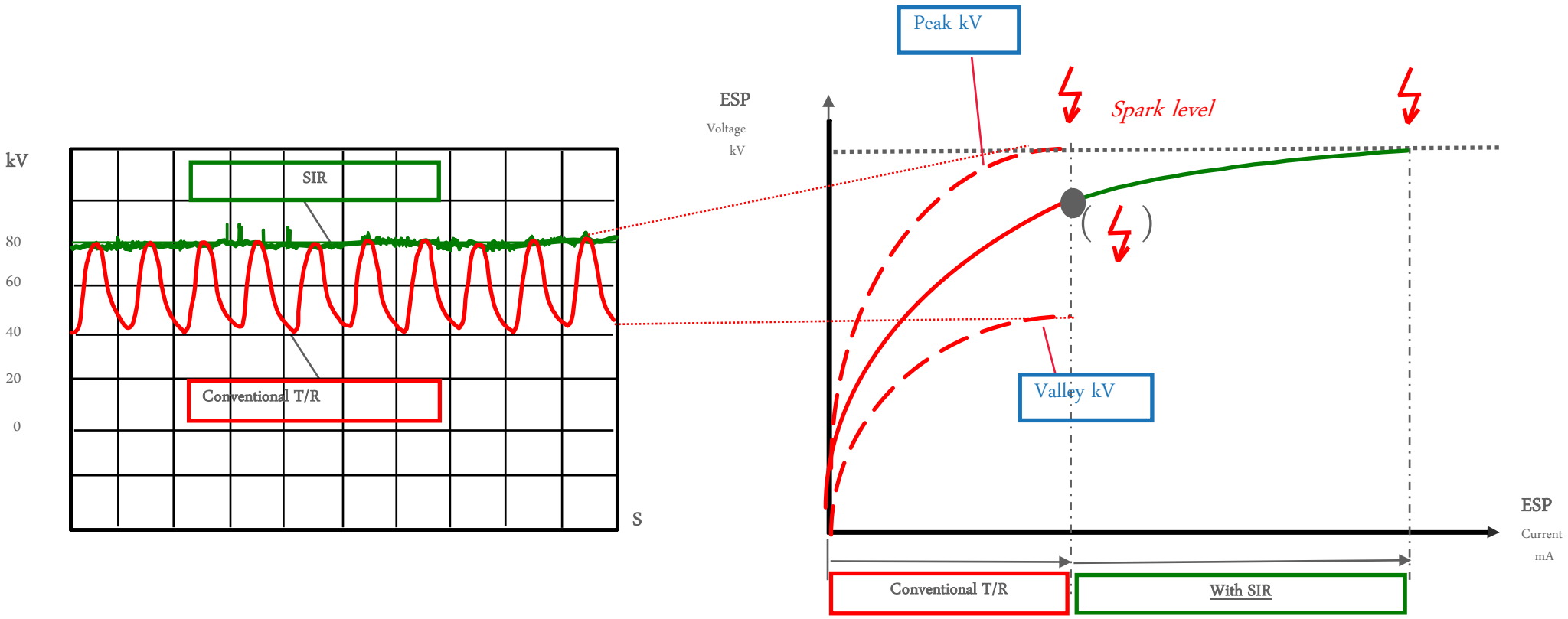
Main frequency power processing



High frequency power processing



SIR improves power input to ESP



The HFPS technology gives a higher average voltage compared to a conventional T/R

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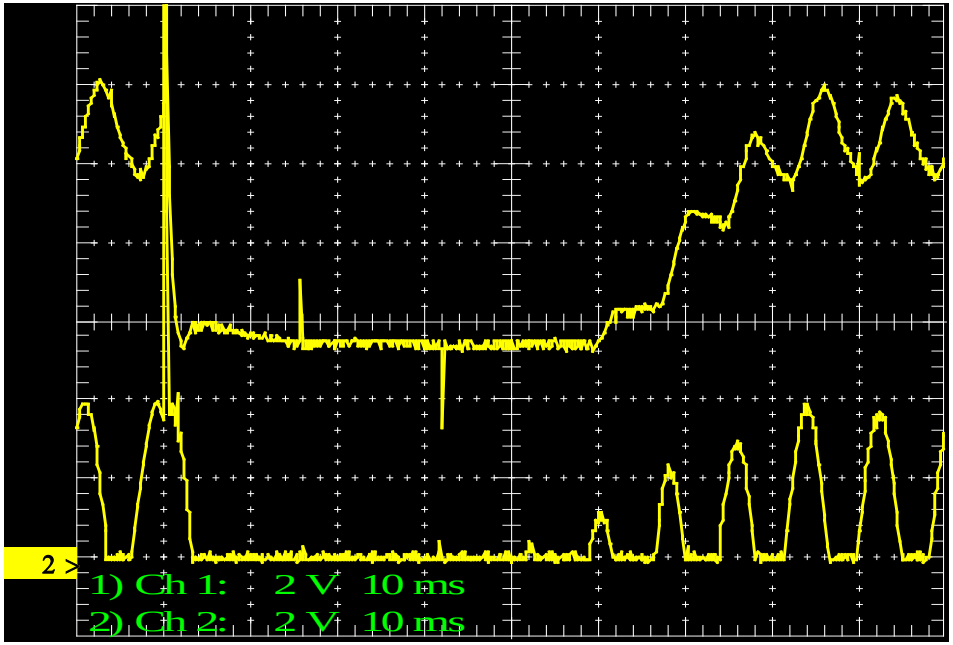
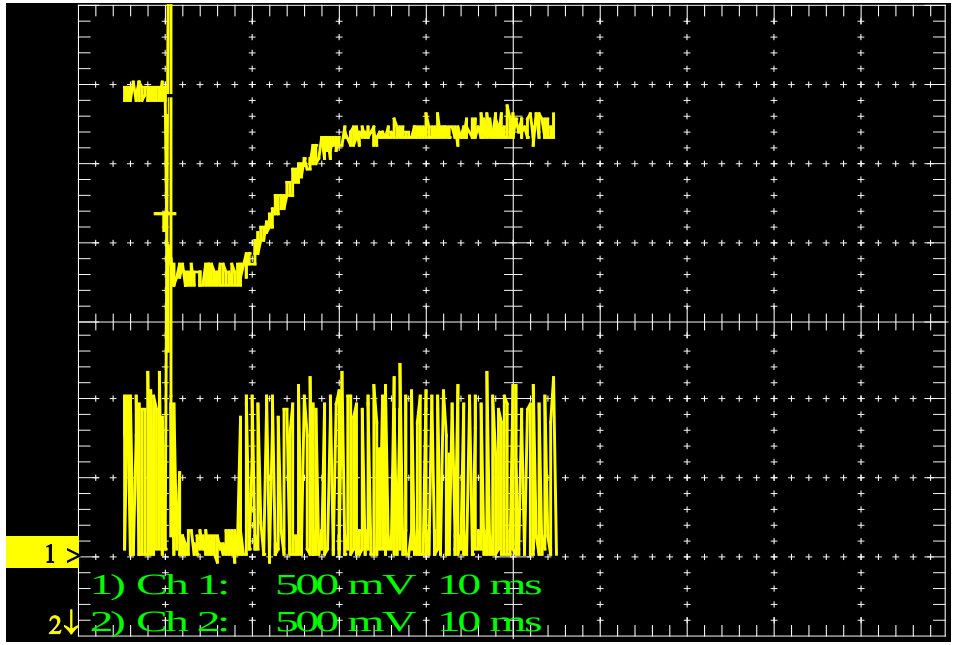
Spark handling, conv.T/R vs. SIR



Conv. T/R



SIR

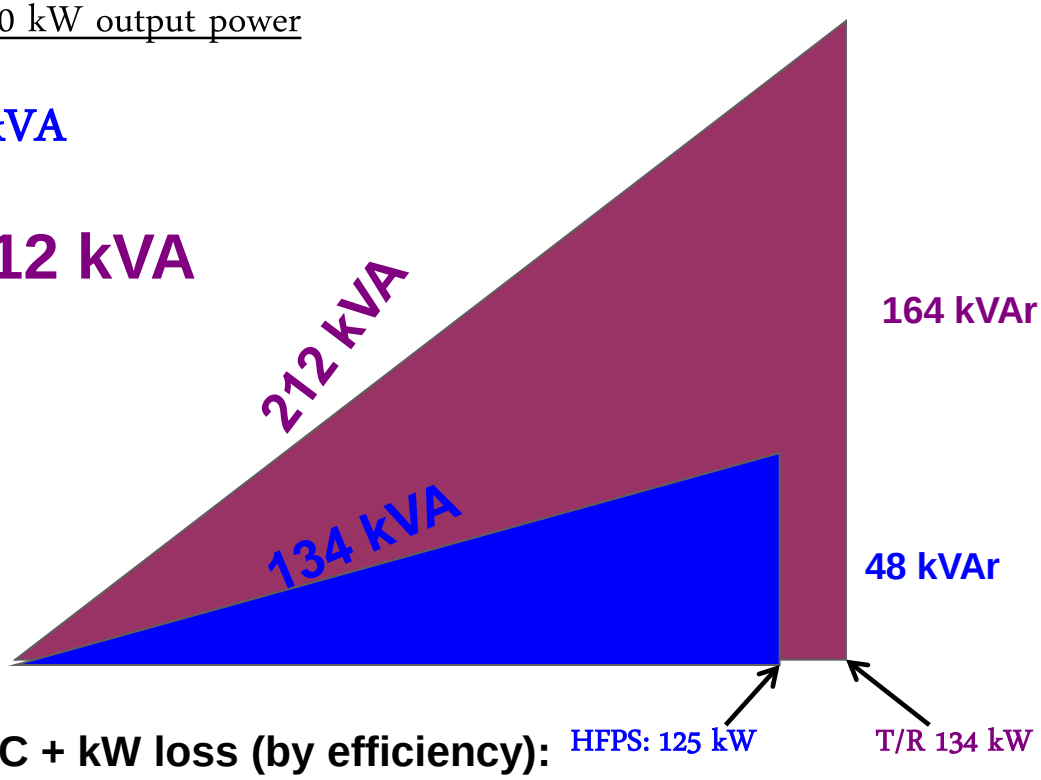
Power Factor, Efficiency – SIR vs. Conv. T/R

The HFPS unit typically uses approximately 63% of the kVA required by a conventional unit and can still provide the same kW to the ESP.

Example: 120 kW output power

SIR: 134 kVA

T/R: 212 kVA



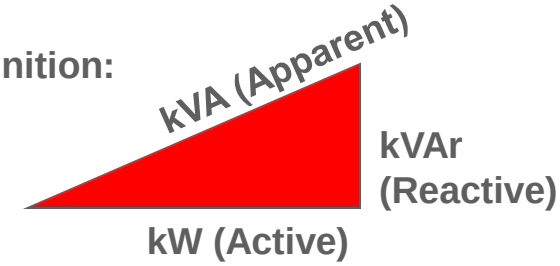
kW out HVDC + kW loss (by efficiency):

Power factor=kW/kVA

SIR Unit
Power Factor = 0.93
Efficiency: 95%

Equiv. T/R Set
Power Factor = 0.63
Efficiency: 89%

Definition:



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Ruien # 3 – 120 MWe, Electrabel - Belgium

ESP: R.C., 2 chamber with 4 fields + MIGIs

Fuel: Import Coal + SO3 - injection

Before upgrade

- Discharge electrode: weighted wire
- T/R: 4 pcs conv. 70 kV/1250mA
- Dust em: 150 – 200 mg/Nm³ at 100 kW

After upgrade

- Discharge electrode: ribbon
- 8 pcs SIRE 70kV/800mA
- Dust em: 20 – 25 mg/Nm³ at 220 kW

Alt. Investment for 20 mg/Nm³: Ext. with 1 field for 2.0 MEUR + 5w downtime à 1.0 MEUR or Inst. of 8 SIRs for < 0.6 MEUR + 3 days downtime à 0.1 MEUR !!!

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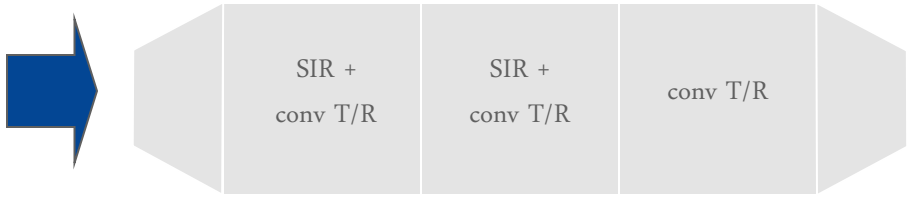
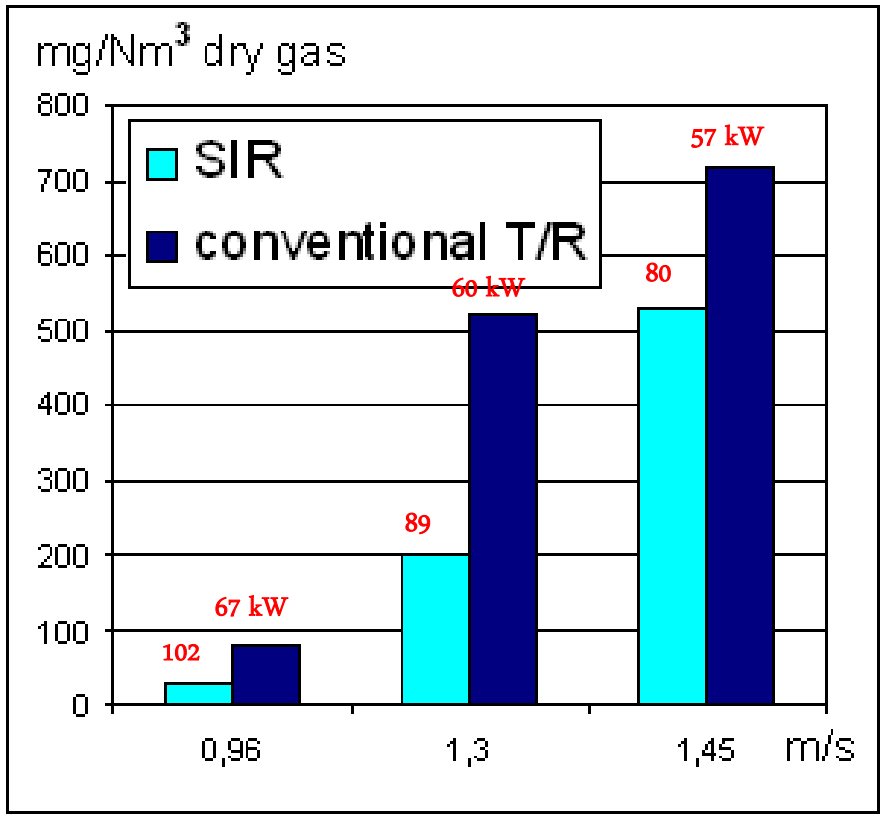
SIR - Switched Integrated Rectifier

Result of SIR-tests at a soda recovery precipitator

SIR was installed in parallel with the existing conventional T/Rs on the two front fields of a three field soda recovery precipitator.

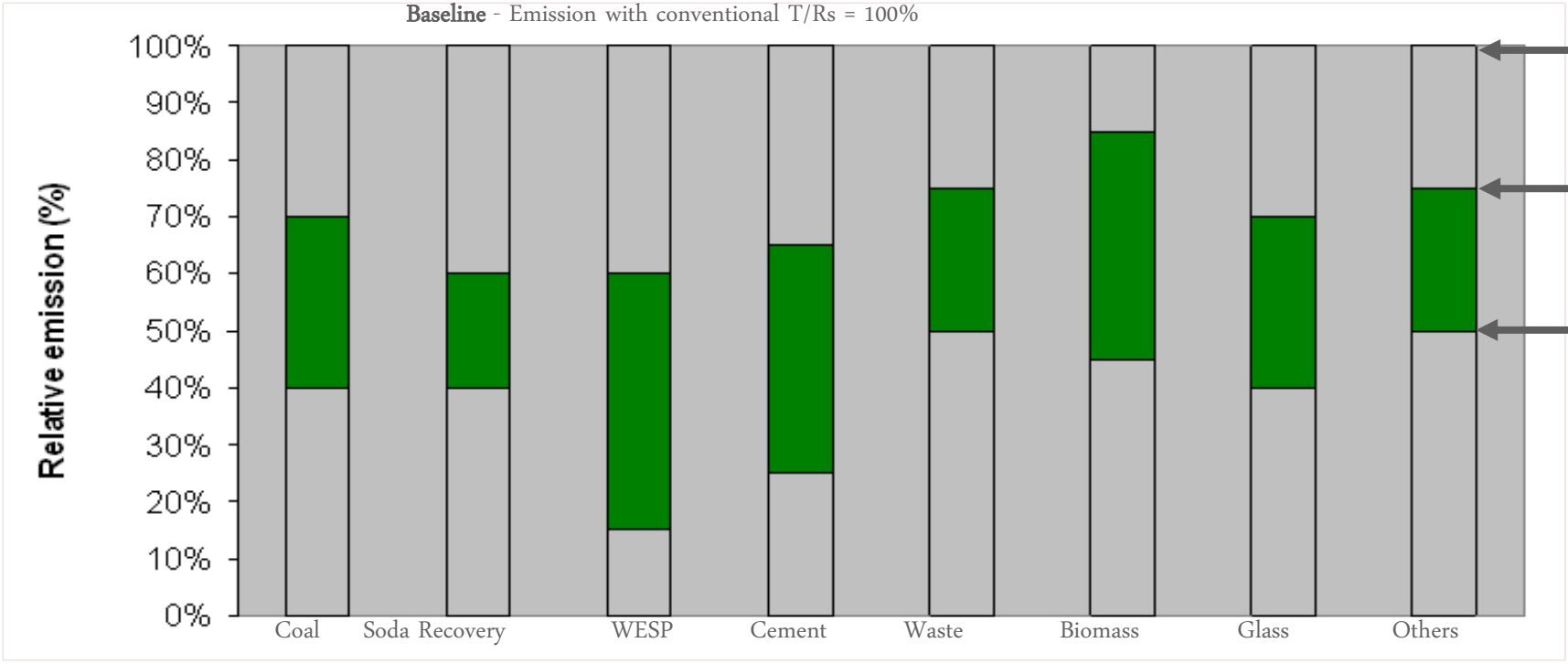
The dust emission was measured at three different gas velocities using alternatively 2 SIR+1 conv. T/R and 3 conv. T/Rs.





SIR – Summary of emission reductions

No. of SIRs by application & corresponding SIR emissions achieved



No. SIRs	956	287	150	115	98	200	91	297	Total: 2.194 SIR
No. Plants	128	110	62	42	41	115	27	105	at 630 Plants (35.500 MWe)

In average 50 % emission reduction achieved after SIR installation

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Summary on experiences with EPIC & SIR

EPIC III

- Power saving up to 90 % combined with emission reductions up to 50% or more for difficult Coal
- Always optimised tuning even at Fuel changes (EPOQ)
- Much improved cleaning with Power Control Rapping (PCR)
- Payback often less than one (1) year
- T/R efficiency approx. 85%

SIR

- Dust emission reductions with 15 – 70% on existing ESPs
- Substantial reduction in System Cost
- Outstanding emission reduction for the money
- Increased availability with maximum 2 hour down-time (if spare-parts and competence at site)!
- SIR efficiency approx. 95%
- Over 350 references in Sweden

Cost efficient solution for substantial emission reductions

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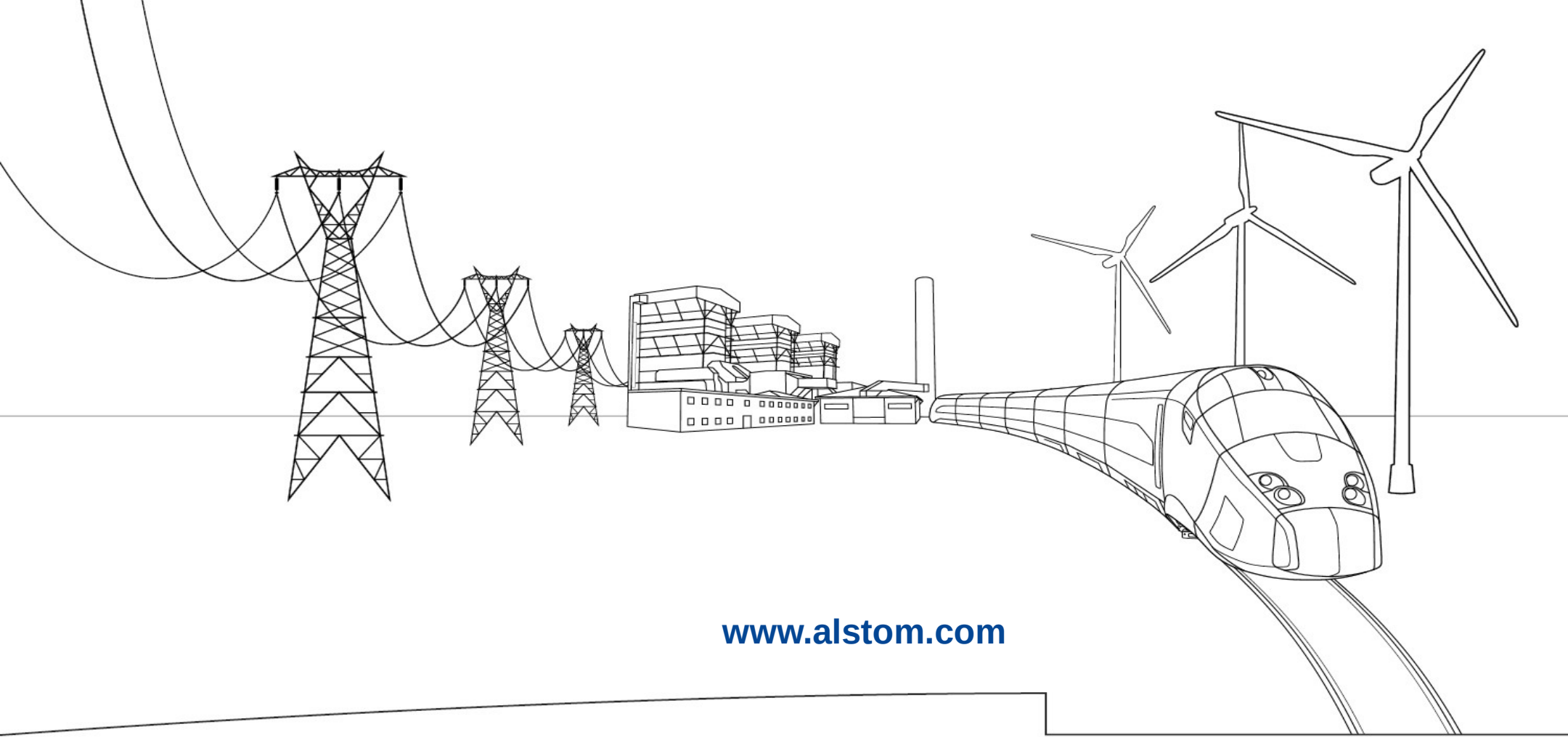

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Do you have any questions?

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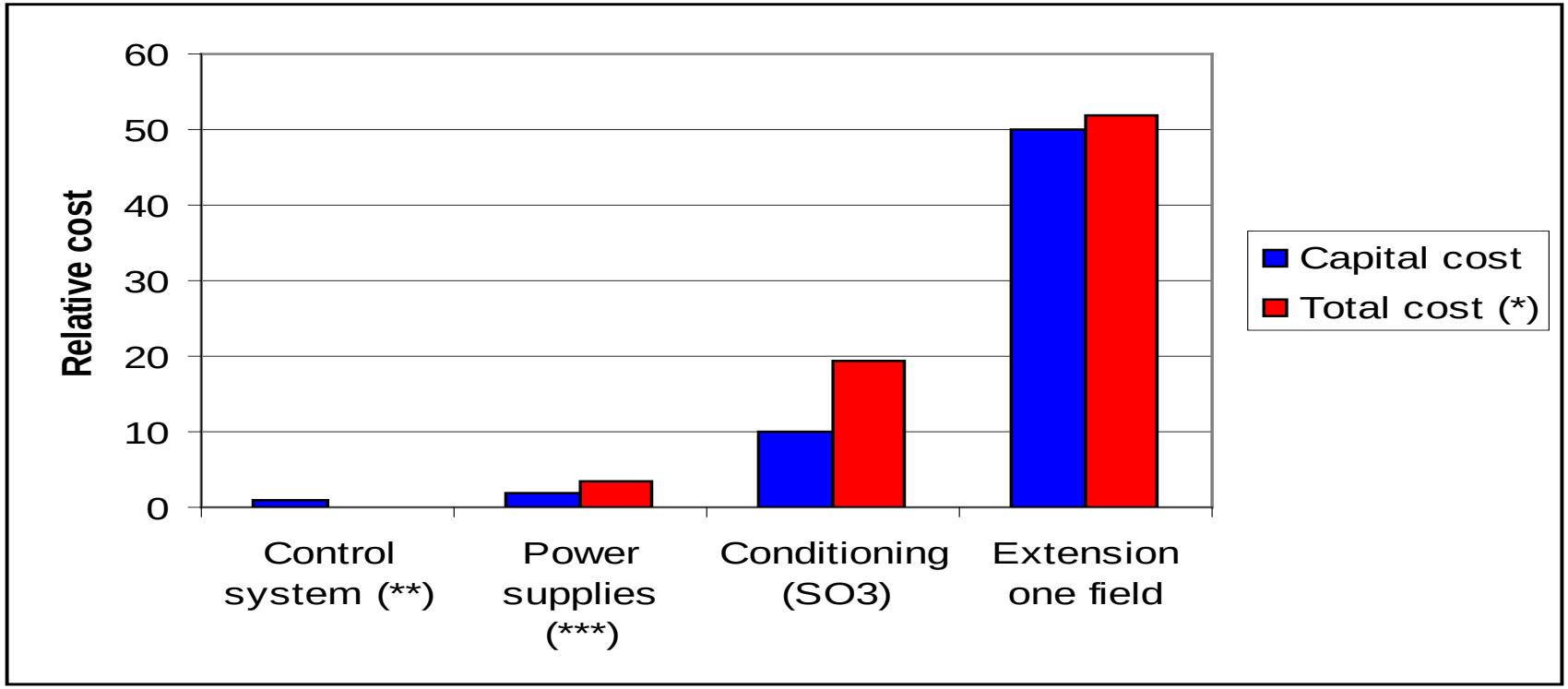
Shaping the future

ESP Upgrade methods - Cost

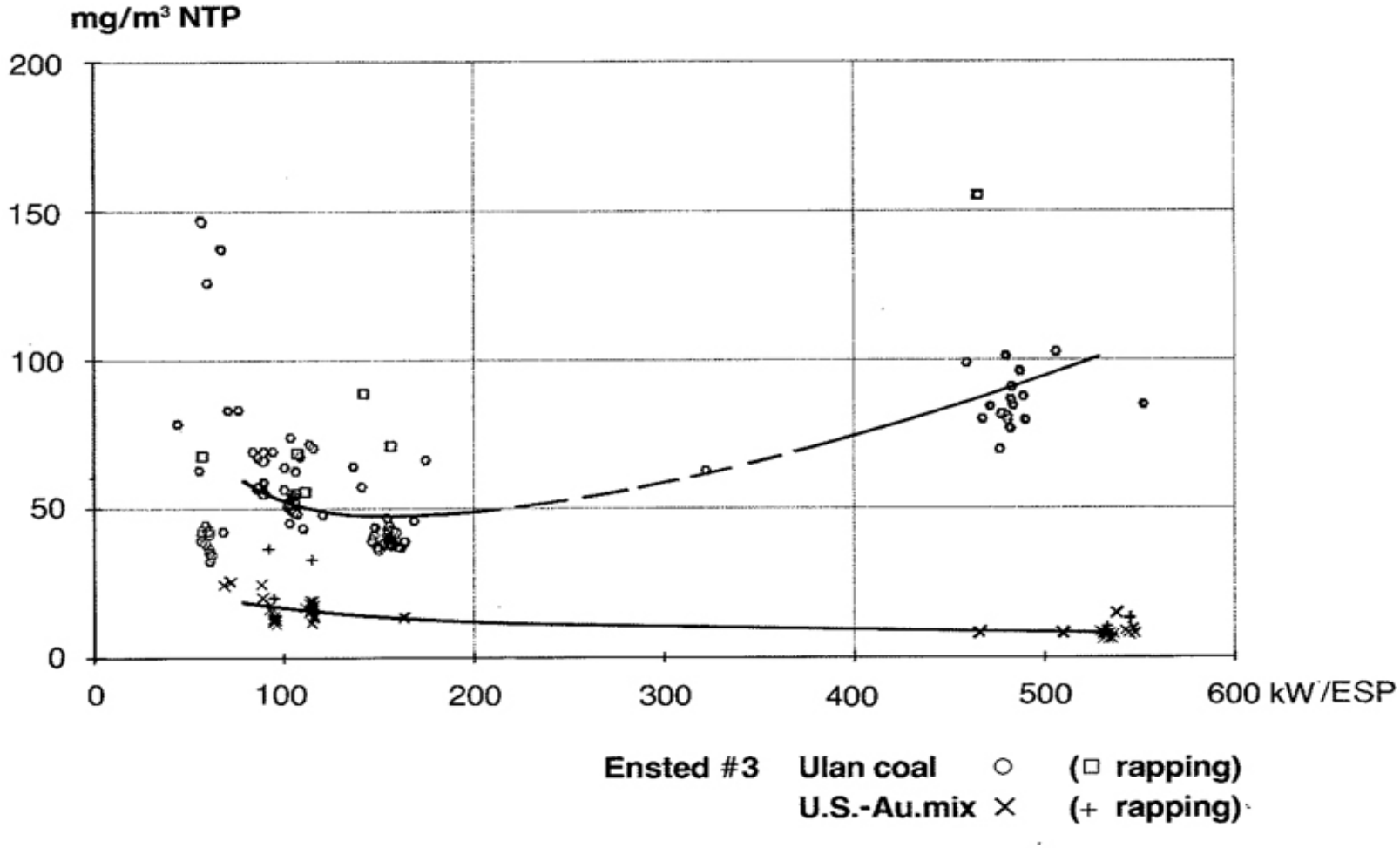


(*) Total cost includes evaluated cost for power consumption and consumables

(**) The capital cost for the control system is paid off due to reduced power consumption

(***) Power supplies = High-frequency power converters in the first ESP field

Ensted #3 – First SPC campaign in 1983 with EPIC-I



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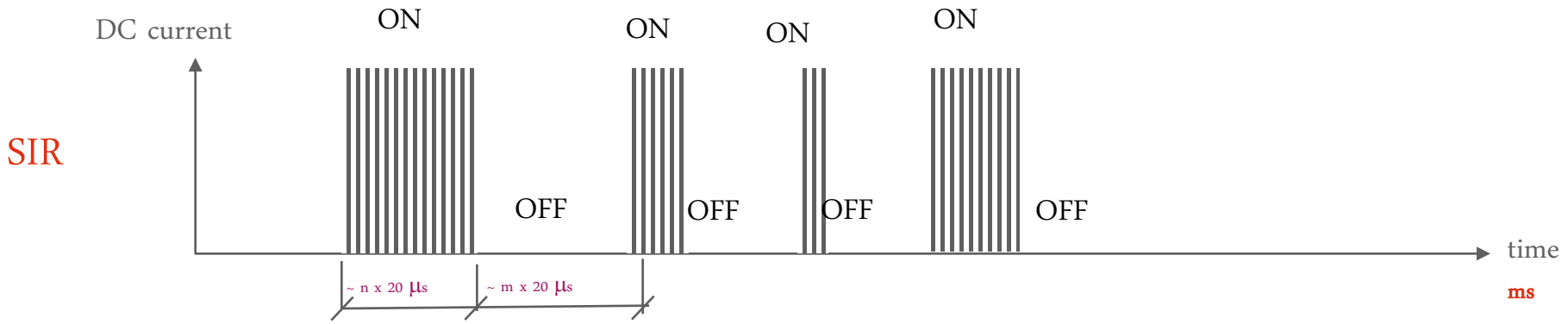
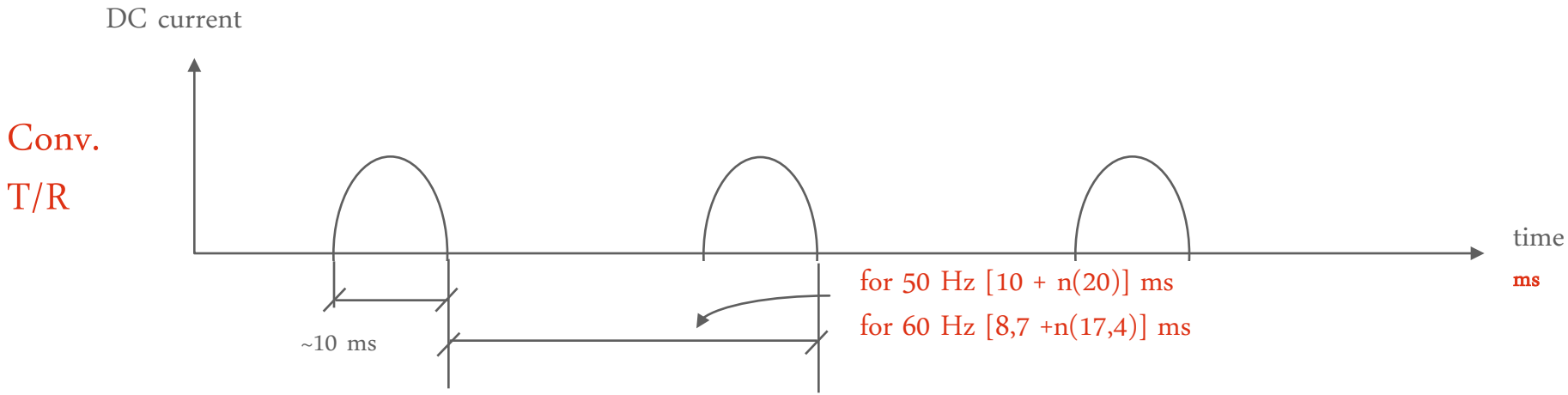
SIR has Independent pulse control

*Pulsing with **SIR** is **totally independent** of mains frequency !!*





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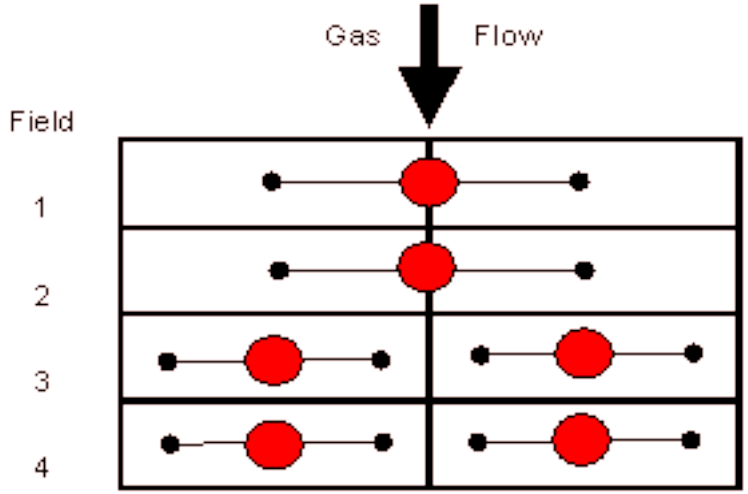
Utility USA – 10 x 125 MW, upgrade with SIR Eastern Bituminous to Low Sulfur Fuel Blend



Original Sectionalization per Unit

	Total Moisture (%)	Fixed Carbon (%)	Ash (%)	Sulfur (%)	T/R or SIR-power (kW)	Opacity (%)
Baseline Specification w 6 T/Rs:	19.5	29.0	9.1	1.7	99	16.0
Medium Sulfur, 8 SIRs not optimized:	18.4	41.7	7.1	1.0	296	13.0
Extreme L. Sulfur, 8 SIRs, EPOQ+PCR:	21.6	38.7	6.3	0.5	124	13.5

Conclusion: C:a 100 Million USD in saving due to reduced SO_2 emission ➔ No need to install Wet FGD

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