Information about

KISSY flexibility evaluation

20th November 2023

ENERGY IS US

Welcome

- **Stefan Prost / vgbe**
  - Advisor of the “Performance Indicators” technical committee & their working groups

  as well as

  - Database administrator of the vgbe Power Plant Information System “**KISSY**”

Starting point

- **Abstract from the article “Flexibility – Analysis of its effects on availability by evaluation of the VGB database KISSY”, VGB PowerTech 4|2021**

“…

The operating regime of fossil convectional thermal power plants has changed due to the increased use of renewable energies such as wind power and photovoltaics. The resulting increase in power generation capacity in the power grid also leads to increased downtimes and reduced operating times under full load for the conventional power plants. As a result, these power plants are subject to increased flexible operation.

Basically, the question must be asked whether the changed operating mode has also led to increased lifetime consumption of plant components. In terms of materials technology, the relationship between cyclic loading, such as that caused by start-ups and shutdowns, and increased service life consumption for thick-walled components is well known. It was unclear whether other unexpected damage had occurred in the plants in addition to the recorded service life consumption on selected components and whether this was clearly related to the change in operating mode. To clarify these issues, all relevant boiler, turbine, and generator components were considered.

…”

Starting point

➢ Flexibility – Analysis of Coal-fired Power Plants

Experts from the vgbe “Materials and Quality Assurance” as well as “Performance Indicators” committees come together to answer the following question:

Has the more flexible operation of conventional plants already led to damage to thick-walled components in the boiler pressure system, steam system, steam turbines and generators?

This project based on operating data and unavailability incidents of the power plant information system KISSY.

KISSY is …

- German abbreviation and means “Kraftwerksinformationssystem”
- that technical benchmark tool of vgbe for thermal as well as hydro power plants
- instrument for comparing key performance indicators of own units with an international pool of power plants
- Exchange of component experience
- Error analysis application
- Online evaluation tool

- Multilingual: Dutch, English, French, German, Italian, Portuguese

Who participate in KISSY?

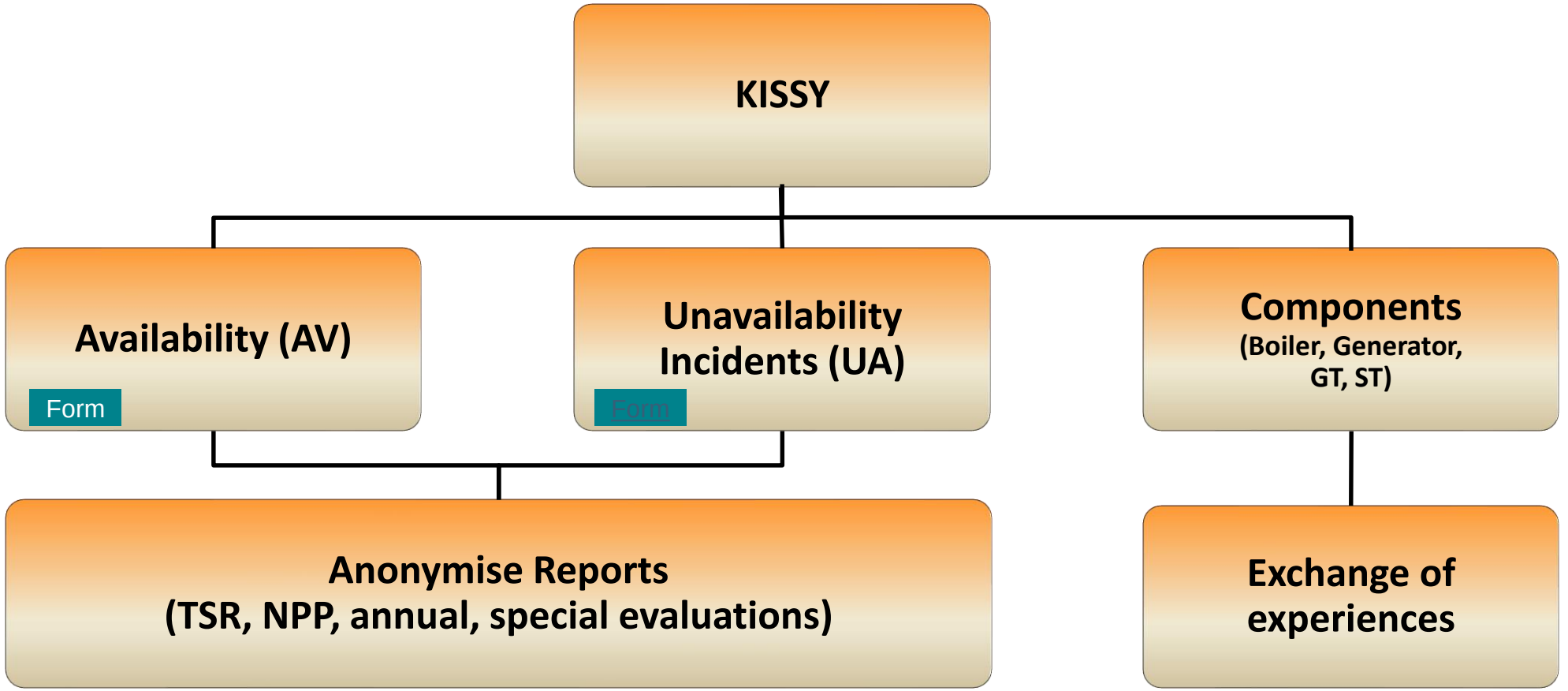
Provider	Units
Total Energies	CCGT
Engie	world wide
Enel	hydro
Uniper	hydro

Country
Austria
Belgium
Czech Republic
Finland
France
Germany
Italy
Ireland
Latvia
The Netherlands
Poland
Portugal
South Africa
Spain
Switzerland

	Unit	GW (gross)	%
NPP	89	92	35
Hard Coal	249	88	33
Lignite	80	27	10
Oil/Gas	171	43	16
Hydro	162	14	6
Total	**751**	**264**	**100**

Stand: March 2023

KISSY Stucture



KISSY: Availability module

Availability of Thermal Power Plants — VGB Coal — 2021

General | Energy utilization, unit capability factor | Time utilization, Time availibility | Operational parameters

		Formula	Unit		Input
	Based on			Selection mandatory	net
4	Nominal energy	$W_N=P_N \times t_N$	GWh	☒	4,708.20
5	Energy generated	W_B	GWh	☒	2,430.53
6	Energy utilization	$n_W=W_B/W_N$	%		51.62
	Unavailable energy				
7	-- planned (specified)	$W_{nv\ p\ Soll}$	GWh	☐	535.17
8	-- planned (effective)	$W_{nv\ p\ Ist}$	GWh	☒	555.42
*	-- unplanned (total)	$W_{nv\ u}=W_{nv\ ud}+W_{nv\ un}$	GWh		797.35
9	---- unplanned (postponable)	$W_{nv\ ud}$	GWh	☒	4.70
10	---- (unplanned not postponable)	$W_{nv\ un}$	GWh	☒	792.65
11	--total	$W_{nv}=W_{nv\ p\ Ist}+W_{nv\ u}$	GWh		1,352.77
12	---- thereof unavailable energy - extended	$W_{nv\ Verl.}$	GWh	☐	0.00
13	Energy availability	$k_W=(W_N-W_{nv})/W_N$	%		71.27
14	Available unproducible energy (external influence energy)	W_{ns}	GWh	☐	0.34

Annual time series

- Generated Energy

Unavailable Energy

- planned
- unplanned

- External Influence

KISSY: Unavailability module

		Unit		Input
	Unavailability Incidents (complete and partial breakdown of power plant)			
1	Number of incident		☐	1
	Duration of incident			
2	Date of period-start (dd/MM/yyyy hh:mm)		☒	27/01/2021 08:00
3	Date of period-end (dd/MM/yyyy hh:mm)		☒	27/01/2021 15:00
	Reference for energy-data (gross or net)		Selection mandatory	net
4	Unavailability energy	MWh	☒	1000.00
4	Unavailability capacity	MW	☒	142.86
5	Affected plant system (denomination according to KKS (power plant identification system))		☒	HA Pressure system, feedwater and steam sections
	Characteristic parameters of incident			
6	Time frame		☒	A - Automatic load-rejection/fast shutdown
7	Type of incident		☒	A1 Failure without damage
8	Main impact of incident		☒	4 Plant out of operation
9	Brief description		☐	

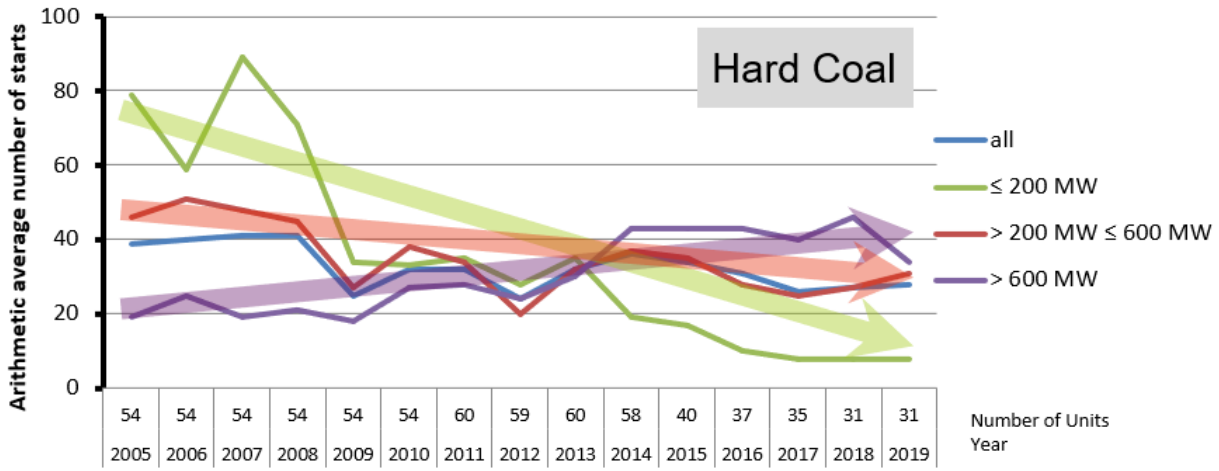
Unavailability Incident

- Duration of an incident
- unavailable Energy
- determine of component
- Reason define per EMS (Event-Characteristic-System)

Collection and filter criteria for mono/duo coal-fired units

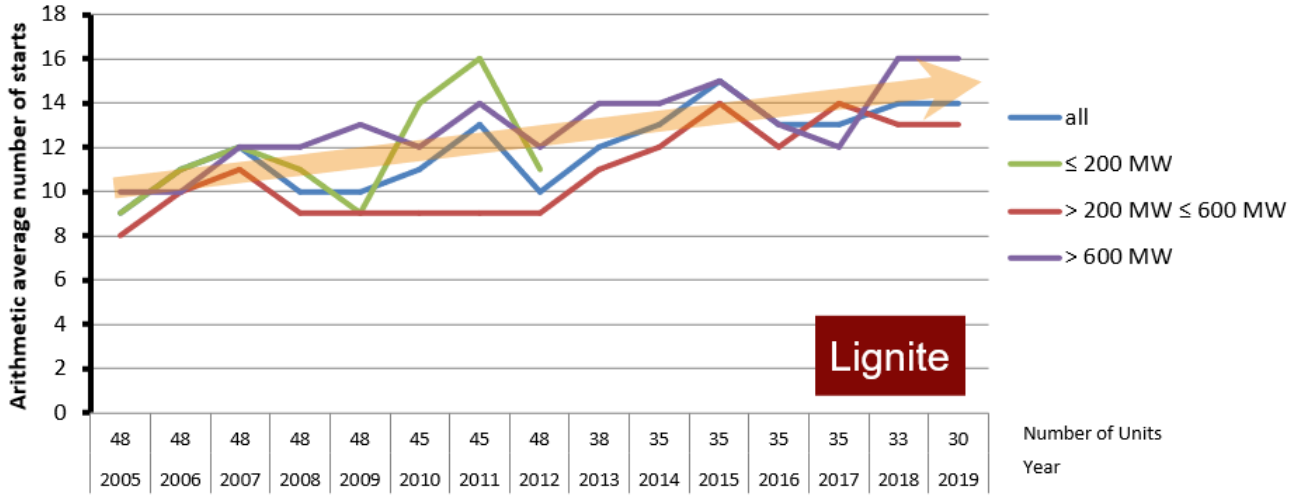
Period under review:	**2005 to 2019 (2021)**
Primary fuel:	**hard coal, lignite, oil, gas**
Nominal Capacity classes:	**All**
	<= 200 MW
	200 MW to <= 600 MW
	> 600 MW
Age classes:	**< 10 years**
	>= 10 to <= 29 years
	>= 30 to <= 39 years
	>= 40 years

Duo & Mono fossil-fired Power Plants
Fuel: Coal; Start-ups via Nominal Capacity classes

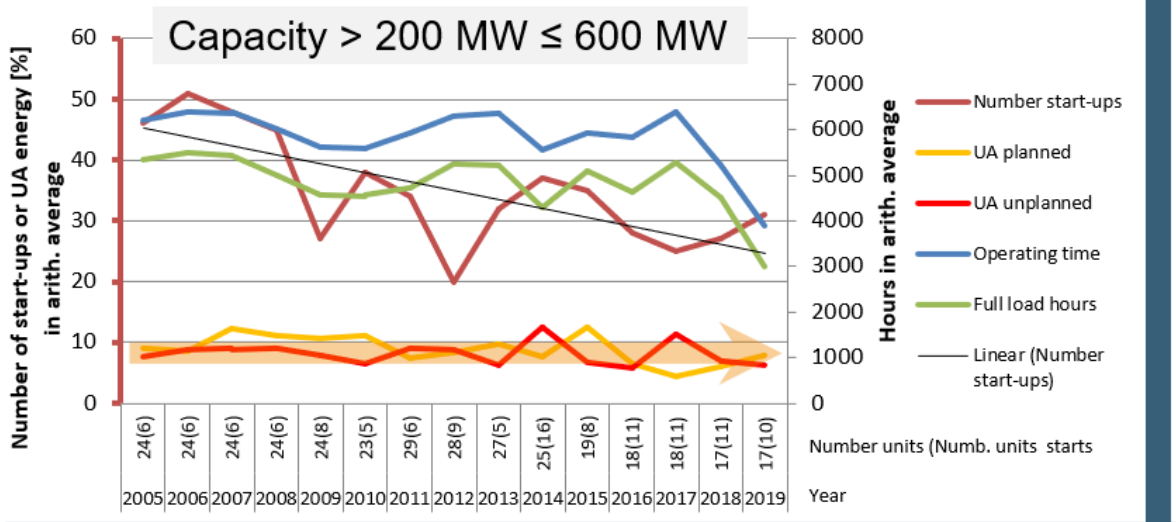


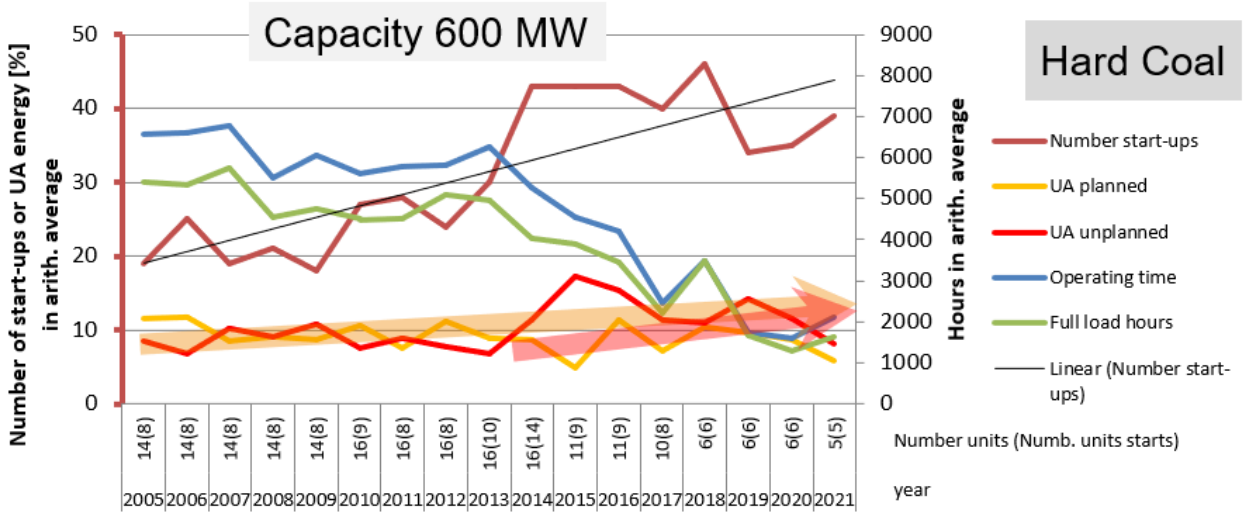
Trend dependent on capacity class

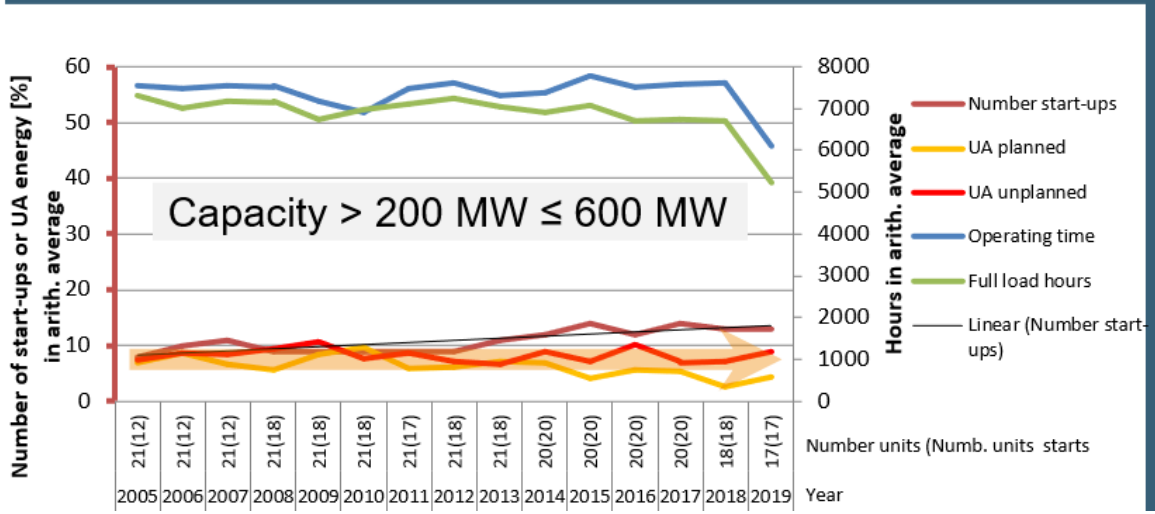
Uniform trend: moderately increasing

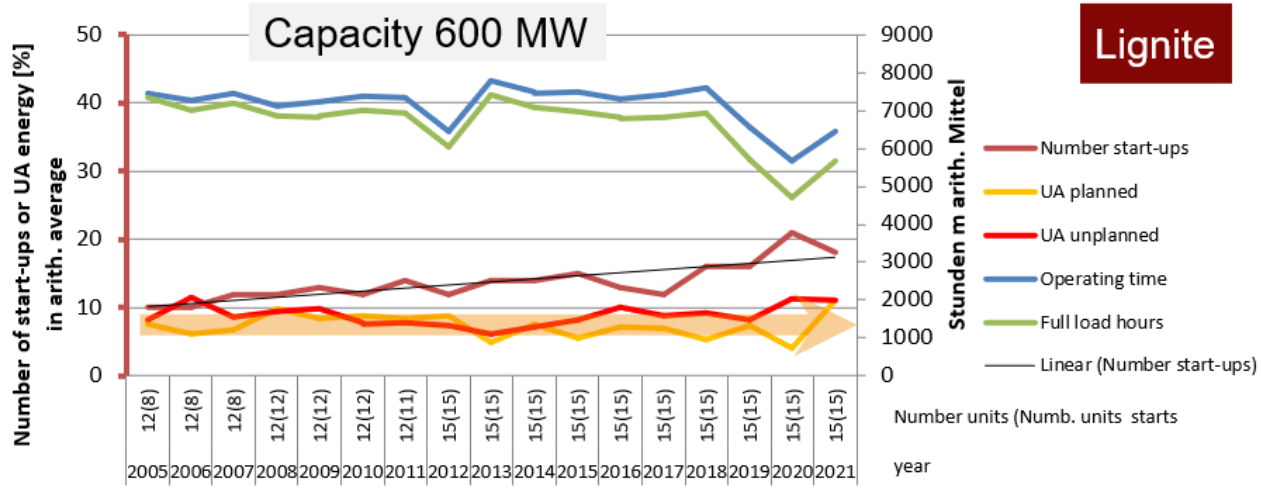


Duo & Mono fossil-fired Power Plants









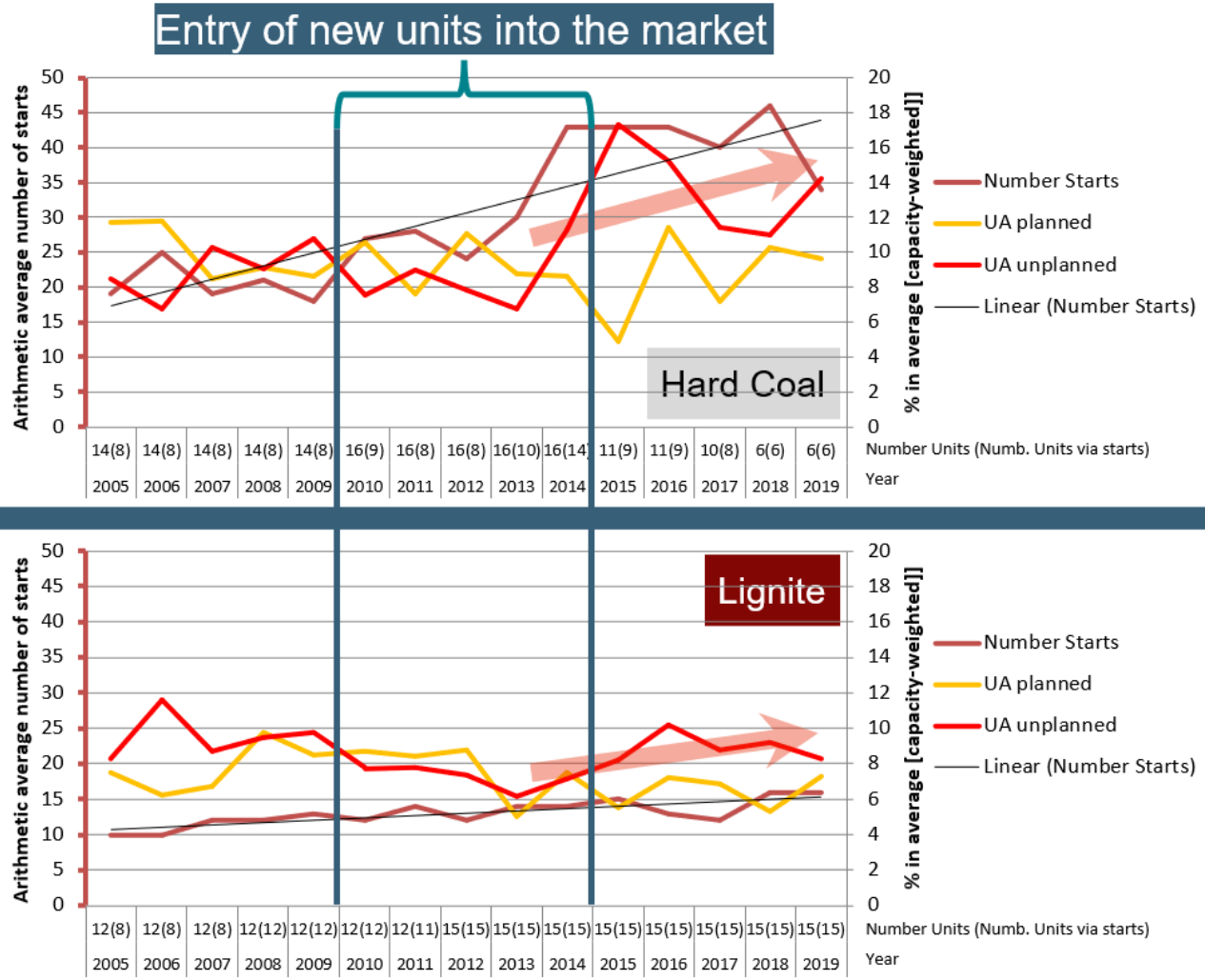
Duo & Mono fossil-fired Power Plants

Increase of unplanned unavailable energy could also be the result of a change in maintenance strategy

Capacity 600 MW

Maintenance strategy?

Market entries?



Duo & Mono fossil-fired Power Plants

Results regrading unavailability incidents based on KKS function code

		Unavailability of Hard Coal Units		
		Number KKS	Number HILP	HILP/Year
HA	Pressure system, feedwater and steam sections	8,036	34	3
LB	Steam system	1,241	9	1
MA	Steam turbine	2,944	43	4
MK	Generator	618	23	2
	Total:	**12,839**	**109**	

HILP: **H**igh **I**mpact **L**ow **P**robability

The evaluation is based on EMS 1: (A1) Fault without damage & (A2) Damage

Duo & Mono fossil-fired Power Plants
Statistical data analysis (unplanned Unavailability)

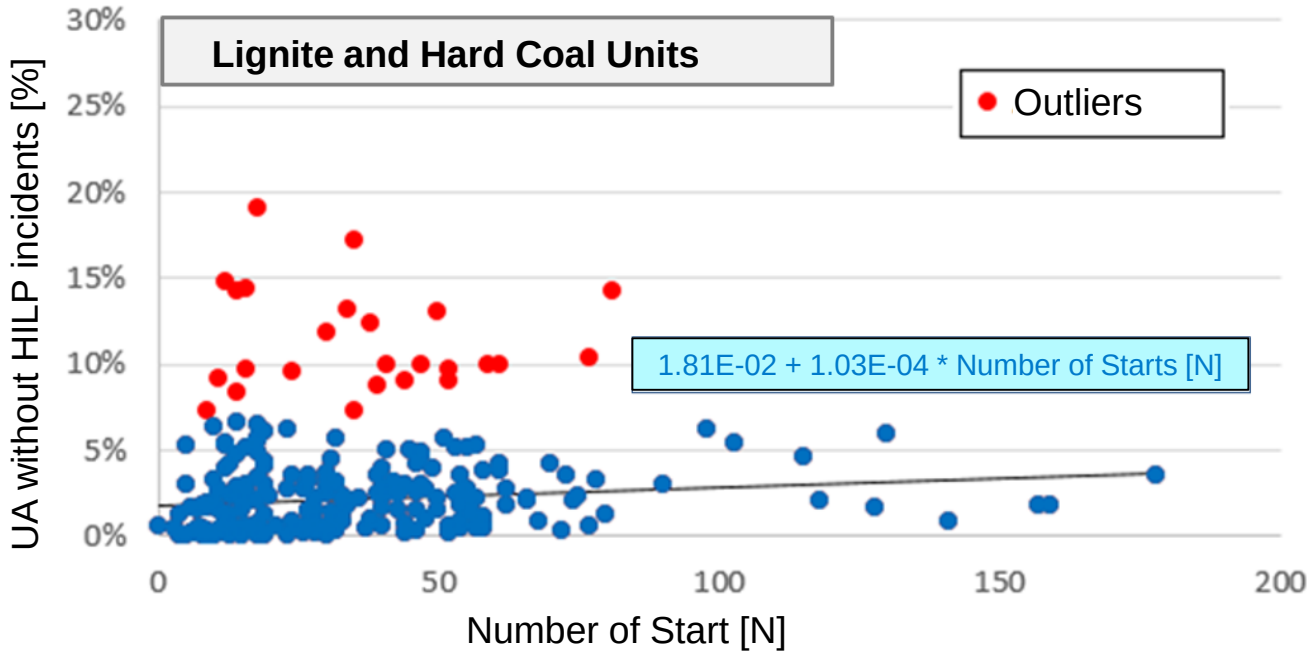
Preliminary remarks:

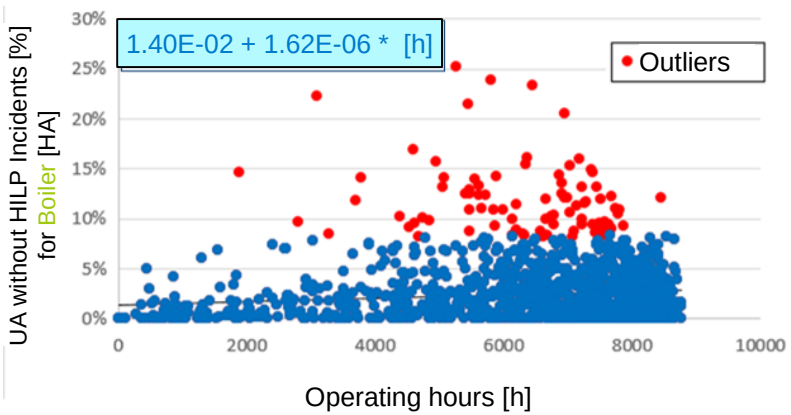
- When analysing heterogeneous data sets with complex correlations and many influencing factors, simple averaging is generally not sufficient.

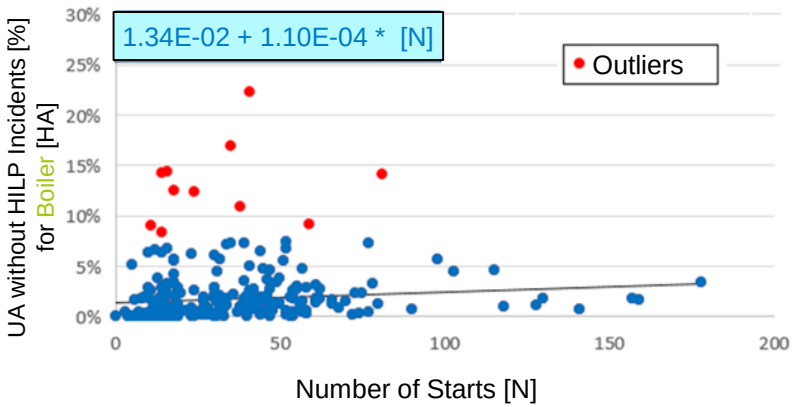
- It is therefore necessary to analyse them using advanced statistical methods that include so-called robust estimation methods. In this way, outliers in data sets can be identified and excluded and separated for further analysis.

- The following statistical analyses were carried out using open source analysis software (here: PSPP) in combination with MS Excel.

Duo & Mono fossil-fired Power Plants
Statistical data analysis (unplanned Unavailability)







UA = Unavailability

Summary

Task definition

- Analysis of > 14,600 unavailability incidents in 129 coal-fired power plants (2005-2019) from the vgbe KISSY database with regard to market-related influences on coal power plant components
- Influencing variables: Power plant type, fuel, nominal capacity, age, region, number of starts

Finding

- **Hard Coal:** significant market influence with decreasing operating and full-load hours and increasing number of starts
- **Lignite:** continuously increasing number of starts with recognisable displacement from the market in 2019

Summary

Findings from the statistical analysis:

- Unavailability UA (unplanned, without HILP incidents) increases moderately with increasing number of starts, for coal-fired power plants more than for CCGT and combined cycle plants
- Significant ageing effect in the form of increasing unavailability in coal-fired plants for boiler, steam turbine and generator, no ageing effects on the steam turbine but on the boiler in CCGT and combined cycle plants

Conclusion and outlook

- Clear influence on power plant availability due to market influences
- Need for further investigation into changed maintenance strategy, standstill corrosion and other additional stress due to off-peak operation and more frequent start-ups and shutdowns

Thank you for your attention!

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be inspired
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