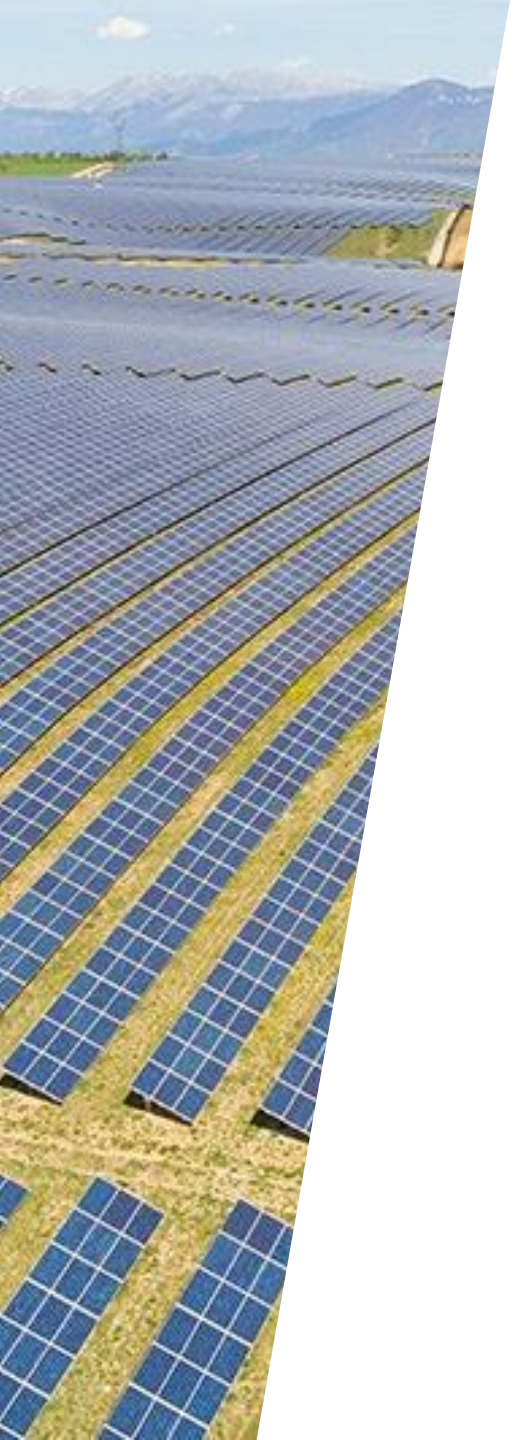
QOS ENERGY

Harnessing data intelligence in solar PV O&M:

How the Digital Twin can help operators deliver extra value



SPEAKERS

Dr Guillaume Saupin

Chief Data Science Officer

QOS Energy

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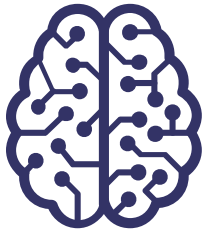
Chief Marketing Officer

QOS Energy

ABOUT QOS ENERGY

Harness the Power of Renewable Data using Cloud Computing



Make Better Decisions, Faster using Data

Increase Revenues & Lower costs to Deliver Extra-Returns

7 renewable energies

1 200+ users

8 GW + Monitored, Analysed, Maintained, Managed

5 000 renewable assets under management

250+ data exchange methods

in **23** countries

PLAN

O&M Needs

- Reach optimum production
- Take the right decision to save costs

Digital Twin

- What is « Digital Twin »
- Advantages

Case Studies

Saving cost

Conclusion

HOW TO ENSURE THE PERFORMANCE OF A PLANT ?

When there is no standard, data-driven decision making goes to prediction

Monitoring

Gather the right data and create monitoring, alarms rules

Comparison of material / plants to detect issues

Detect breakdowns and repair

Organize regular maintenance actions

Agree on Time-based availability ratio with your stakeholders

Prediction

Gather all data and integrate weaks signals

Create a complex integrative model

Anticipate & goes to predictive maintenance

Work with Energy-based availability ratio

➔ Digital twin is the tool of choice to path the way to Solar production 4.0

DIGITAL TWIN

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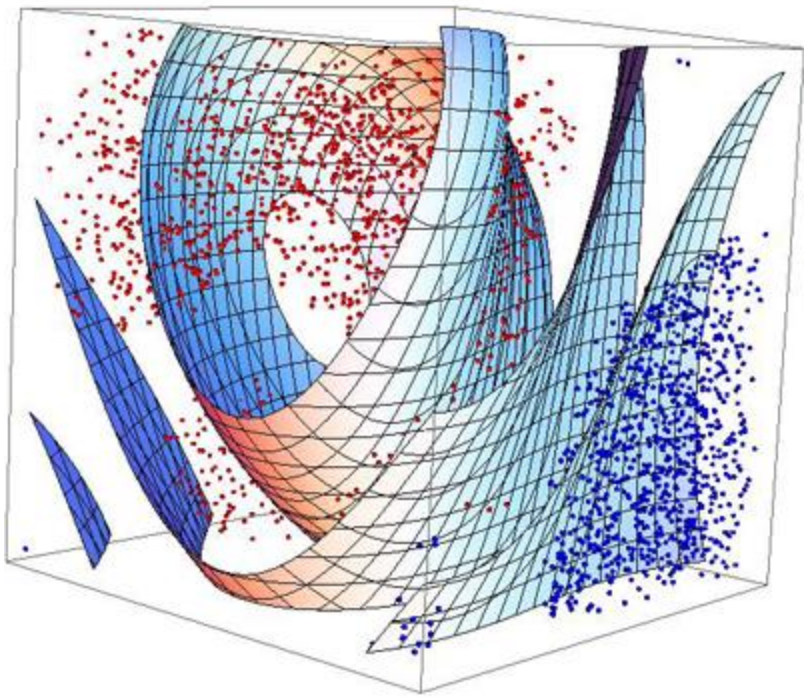
MACHINE LEARNING

Observe - Predict



1777–1855

CREATION OF A DIGITAL TWIN

1

Harvesting historical Data (large Data set) ...diverse DAS

DAS

DAS

DAS

DATA LAKE

2

Improvement of data cleaning with ML

DATA CLEANING &COMPLETION

Real Data

3

ML engine selects the best algorithms according context

ML / AI ENGINE

4

Construction of a ML/AI Advanced model behavior of the plant

DIGITAL TWIN Predictive Value

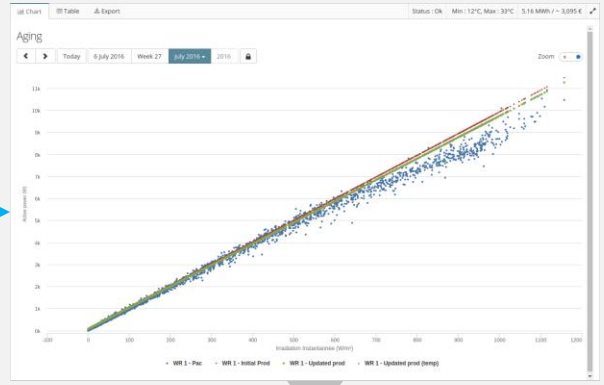
File	Size (KB)	gzip (s)	compress (s)	LZW-PF		PPA		PPA-ϕ_4	
				$\uparrow_s$ (%)	$\uparrow_c$ (%)	$\uparrow_s$ (%)	$\uparrow_c$ (%)	$\uparrow_s$ (%)	$\uparrow_c$ (%)
dna1	1	126	133	0.23	1.85	-0.94	0.69	-0.94	0.69
	10	3581	3594	3.32	1.76	2.82	1.25	2.82	1.25
	100	35782	32700	1.83	1.68	1.52	1.36	1.52	1.36
	1024	336619	318630	6.79	1.21	6.70	1.44	5.79	3.32
	3096	1001439	960249	5.59	1.54	5.75	1.70	5.91	5.00
dna2	1	105	104	1.48	1.24	1.23	0.99	1.23	0.99
	10	3310	3229	3.35	0.93	3.20	0.77	3.20	0.77
	100	30944	29852	1.41	0.91	3.71	0.19	3.71	0.19
	1024	313907	297051	6.04	0.70	5.59	0.23	6.55	1.24
	2877	866080	832173	1.64	0.75	1.33	0.43	5.89	2.05
nr.pgm (ASCII)	1	93	199	-102.15	5.53	-41.09	32.66	-41.09	32.66
	10	141	575	-281.56	6.43	-140.43	41.04	-140.43	41.04
	100	8658	10566	-16.19	4.79	-1.40	16.91	-1.40	16.91
	260	26759	29767	-7.23	3.60	6.38	15.84	6.38	15.84
ct.pgm (ASCII)	1	128	153	-15.62	3.27	-14.06	1.58	-14.06	1.58
	10	755	763	1.46	2.49	2.65	3.67	2.65	3.67
	100	18672	17524	7.77	1.72	7.61	1.59	7.61	1.59
	256	69946	67639	4.46	1.20	4.07	0.80	4.07	0.80
ct.pgm (RAW)	1	100	188	-76.00	6.38	-40.00	25.53	-40.00	25.53
	10	335	754	-111.64	5.97	-46.87	34.75	-46.87	34.75
	100	4035	5237	-22.08	5.94	13.09	33.03	13.09	33.03
	1039	112959	112383	4.10	3.61	14.56	14.12	14.56	14.12

Comparison of real data to ML / AI model

5

6

DataVisualisation / Event generation Alarm triggering / Predictive maintenance



7

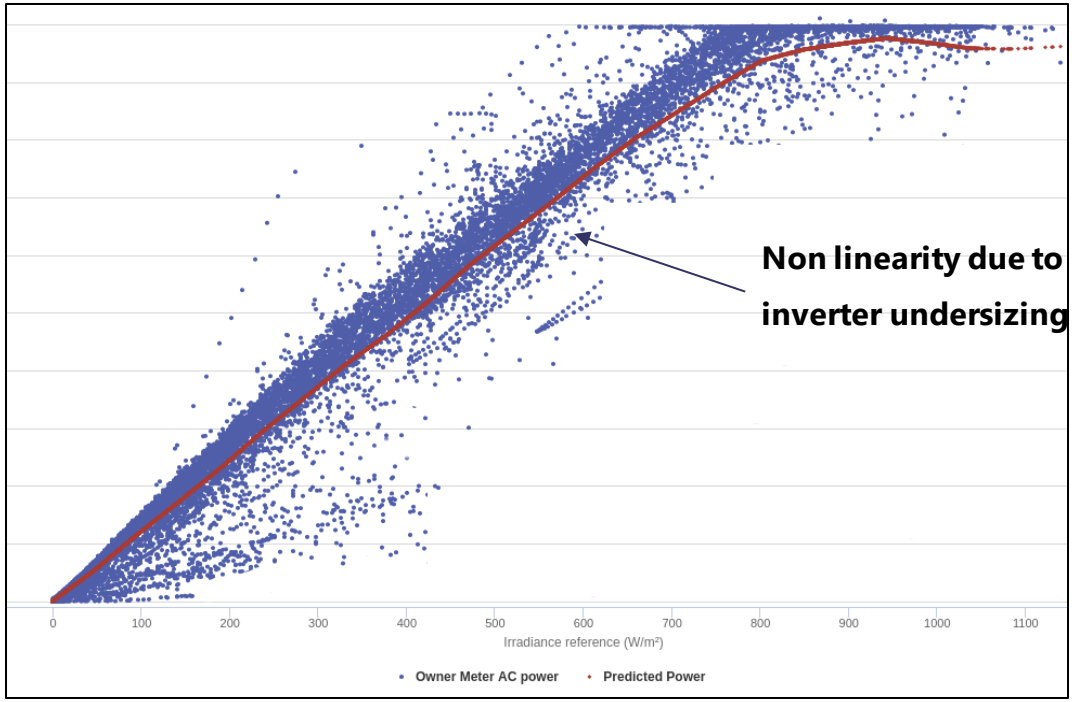
Decision / Contract management Power generation forecast /PPA optimization / Risk management

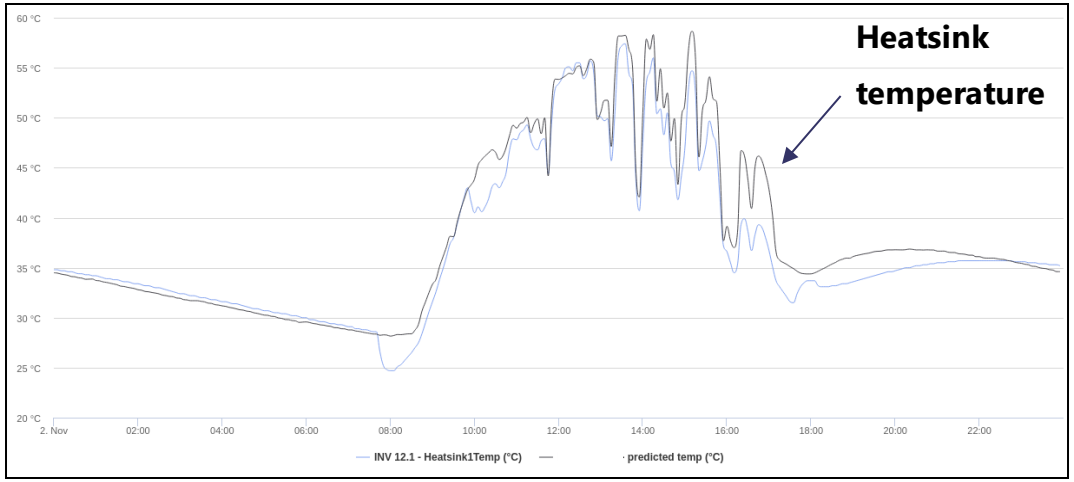
DIGITAL TWIN – MADE EASY

Powerful, Flexible, Embedded Digital Twin

Versatility

- Levels : String, Combiner Boxes, Inverters, Plant, Site, Park, Portfolio
- Any data : power, energy, irradiation, temperature, current, voltage, ...
- Any model : linear, non linear
- Various learning policies: Initial year, Last Year, Last month, ...



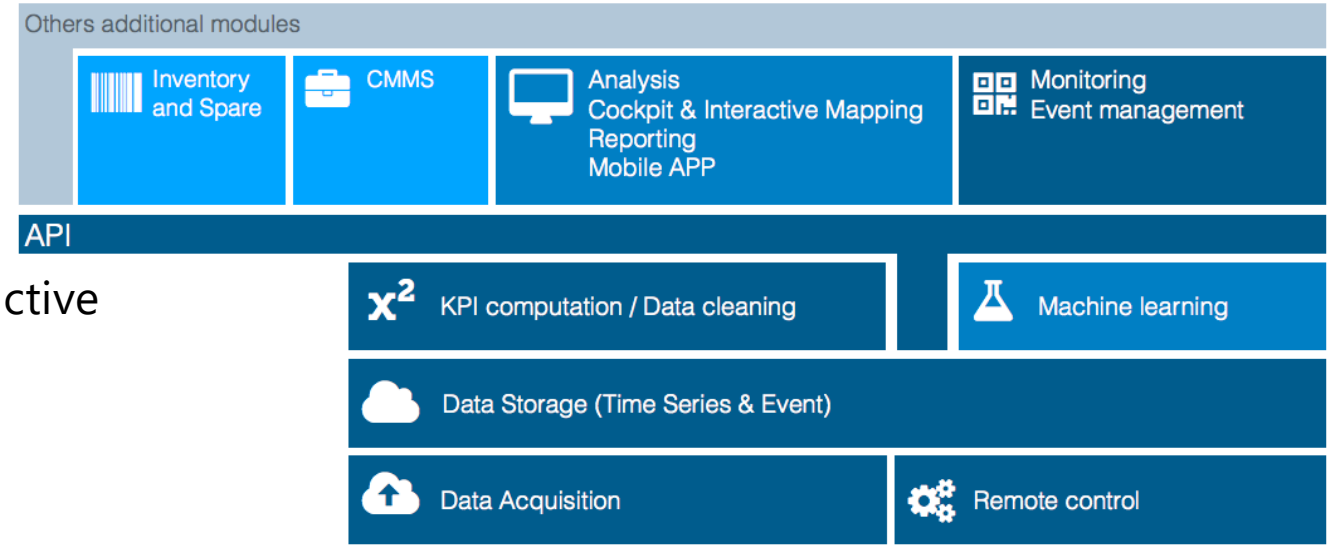


DIGITAL TWIN - APPLICATIONS

Digital Twin at the heart of Energy Management System

Digital Twin as reference

- Used in conjunction with monitoring rules –> alarms
- Get insight from data
- Estimate loss
- Energy based availability
- Abnormal behaviour -> predictive maintenance



DIGITAL TWINS ADVANTAGES

Have a reference model for any plant

- Deeper comparison study to understand plant's situation
- Reach optimum O&M activities faster
- Gain time in data-driven decision making

Works with any measured dimension / parameter

- Power, energy, irradiation, inverter temperature
- Result can be further exploited

Replace complex calculations

- Automated analysis without further software
- ML made easy

CASE STUDIES

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CASE STUDY 1 : DETECTION OF FAULTY INVERTER BASED ON INVERTER TEMPERATURE

Detect signal change in comparaison with predicted parameter

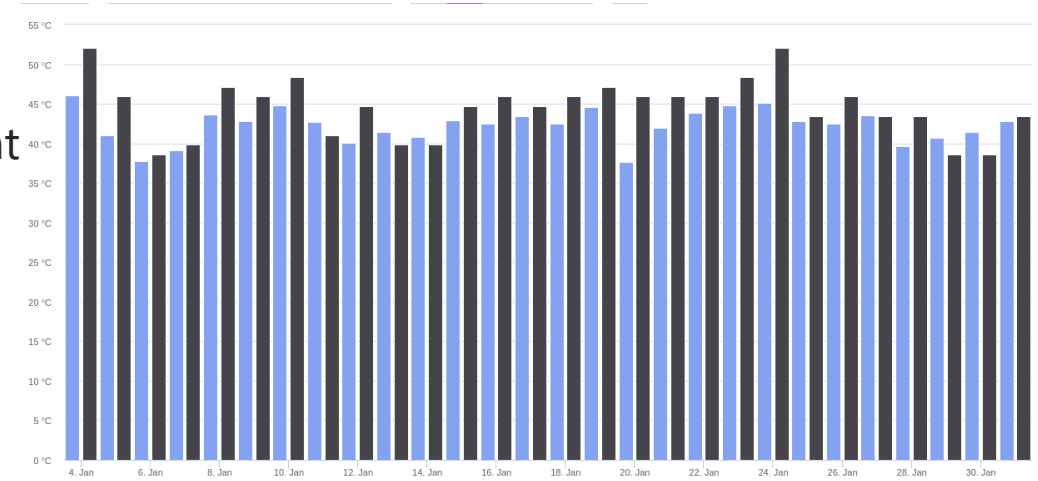
Case study

- Predict inverter temperature from ambient temperature (error below 2%)
- Comparison of predicted value to real temperature using Heatmap
- Visualization of difference in a bar graph

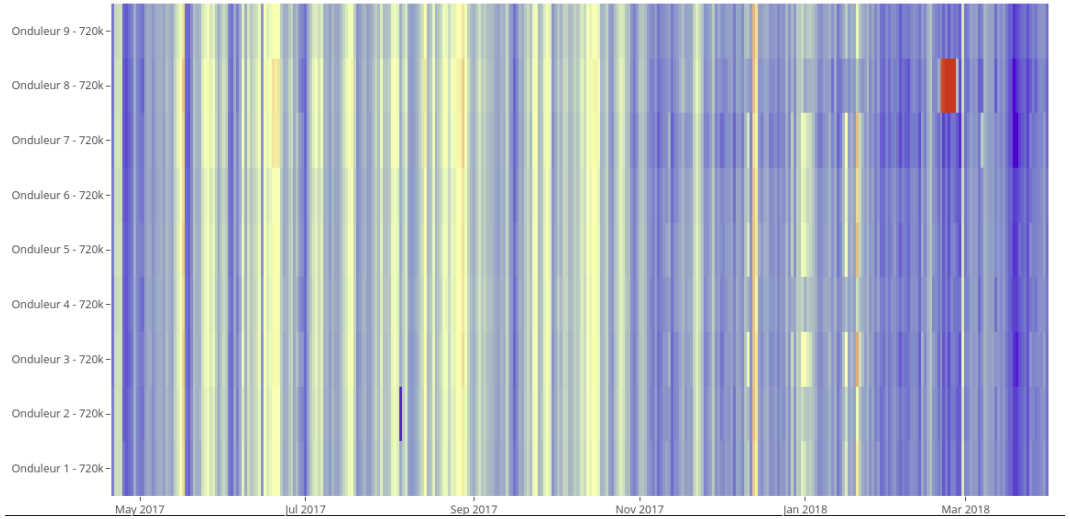
Result

- Easy detection of faulty inverter
- Accurate loss estimation

Learning phase



Detection phase



Blue : real temperature of inverter

Black : calculated by Qantum predict

CASE STUDY 2 : DETECT SNOW

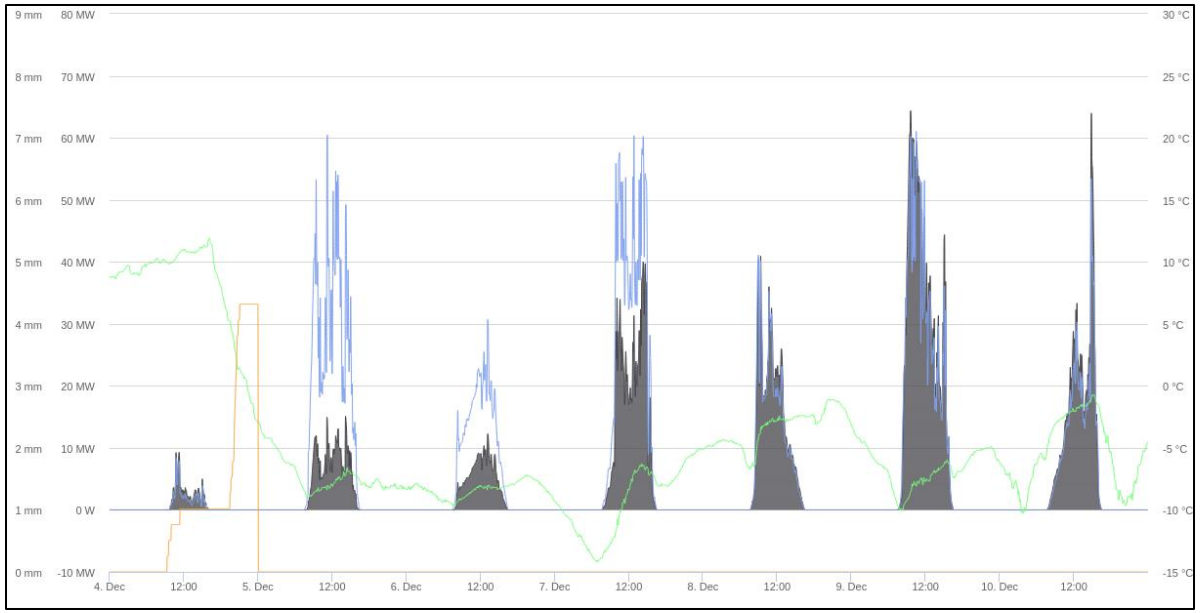
Understand operation

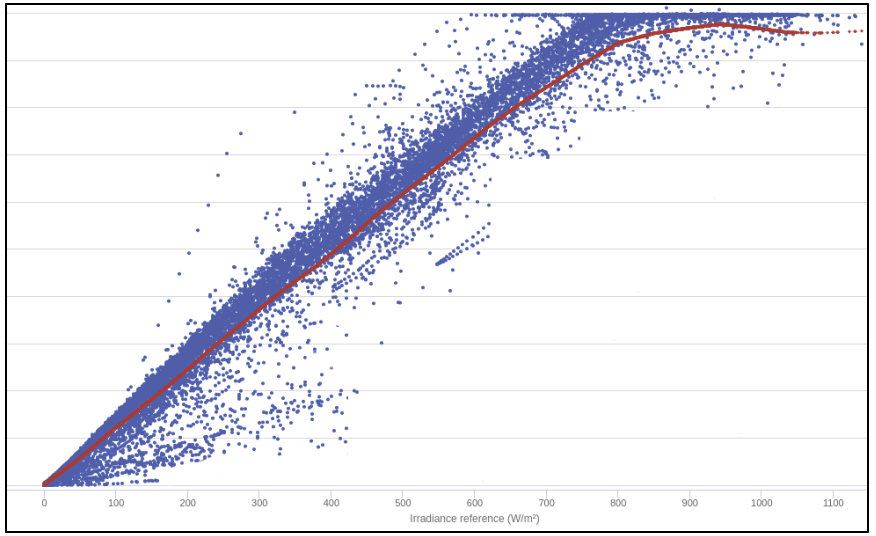
Case study

- Predict power
- Monitor irradiation, rain, temperature
- Create a monitoring rules to create snow alarms

Result

- Compute losses (61.7%)
- Understand losses (Snow on panels)





CASE STUDY 3 : IDENTIFICATION OF FAULTY STRING

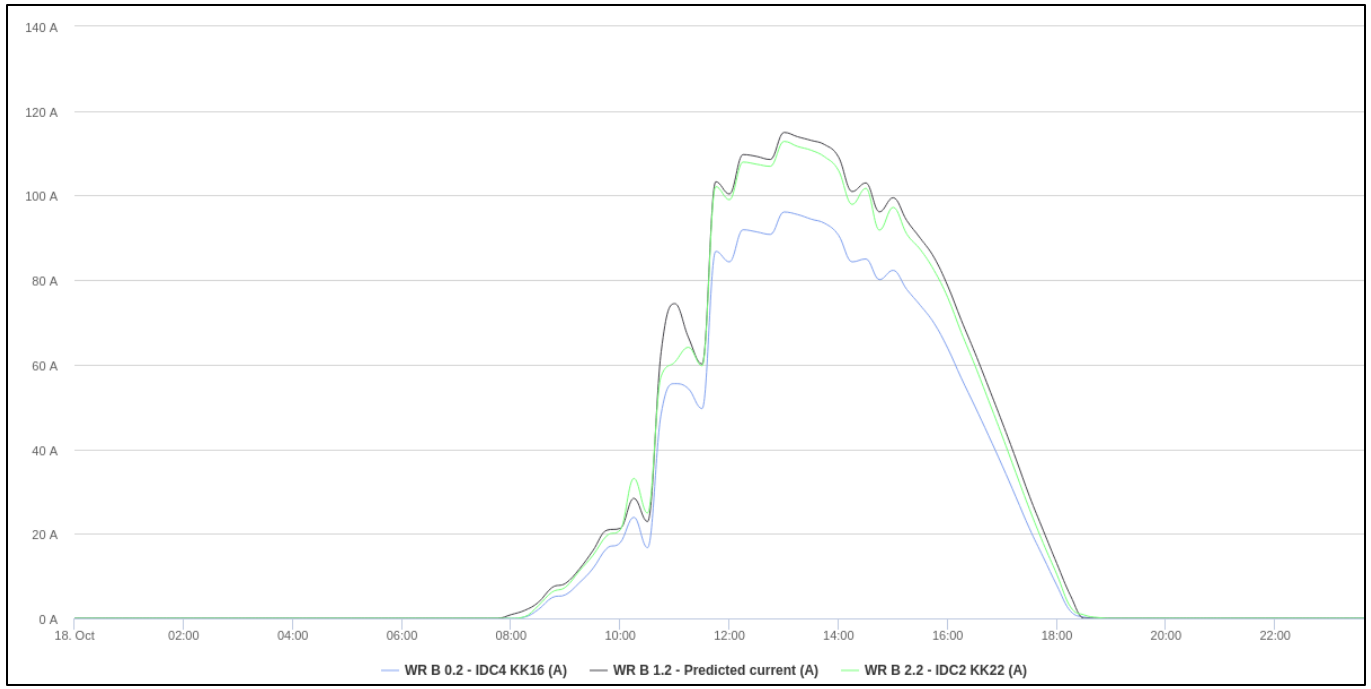
Quickly identify equipment to fix

Case study

- Learn current for each string
- Add rule to detect faulty string

Result

- Fast identification of the string to fix
- Isolation default



CASE STUDY 4 : MODULE CLEANING EFFICIENCY

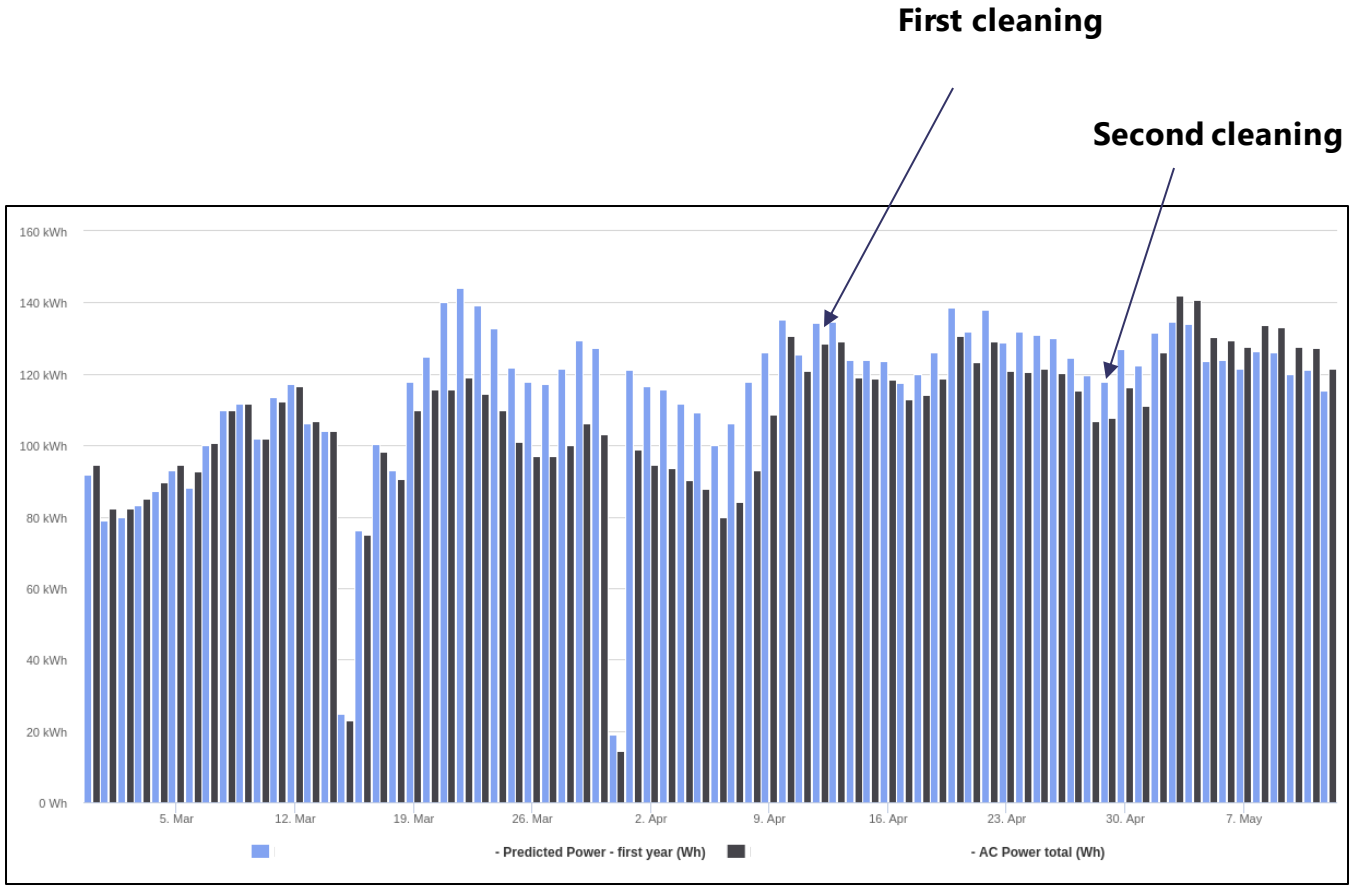
Digital twin is able to detect actual action on sites

Case Study

- Cleaning is planned every month
- Most of the time useless

Result

- Optimize cleaning planning
- Reduce Cost
- Optimize production



SAVING COSTS

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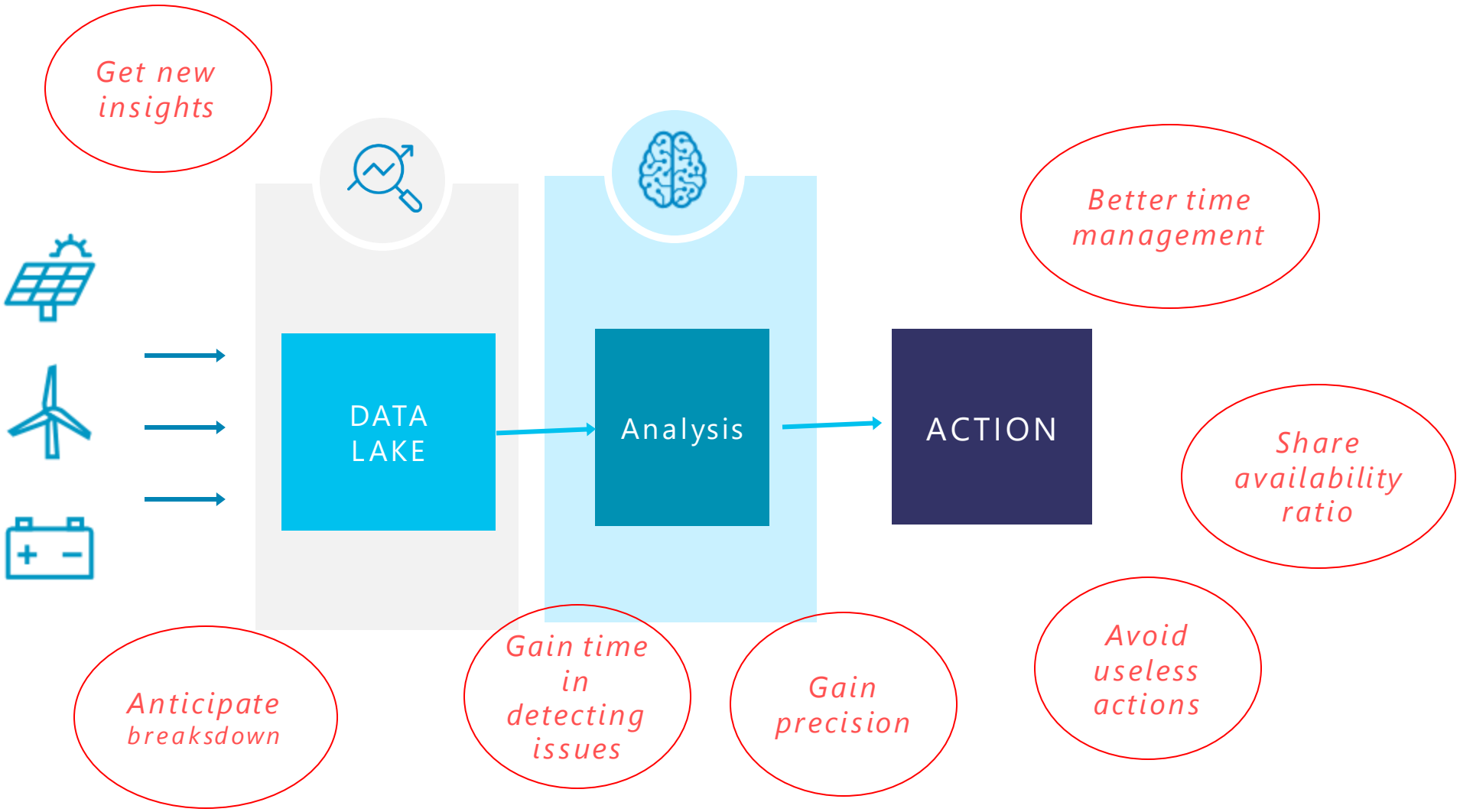
SAVING COST WITH DIGITAL TWIN



CONCLUSIONS

DIGITAL TWIN: MACHINE LEARNING IN REAL LIFE

A Flexible tool to enter predictive maintenance

- Any parameters can be injected into ML model
- Easy visualization of difference real/predicted
- Triggers monitoring rules, alerts and dashboard visuals

Better Management of Plants

- Increase up-time with weak-signals analysis
- Avoid cost of emergency maintenance actions
- Get reliable forecast

QANTUM *PREDICT* : MACHINE LEARNING MADE EASY

Qantum *Predict*

- Still in the validation phase
- Available for a selected number of R&D studies
- Will be available for all, towards 2019

The Future

- Case studies remain to be worked together
- We are eager to grow with our customer in their data analysis projects