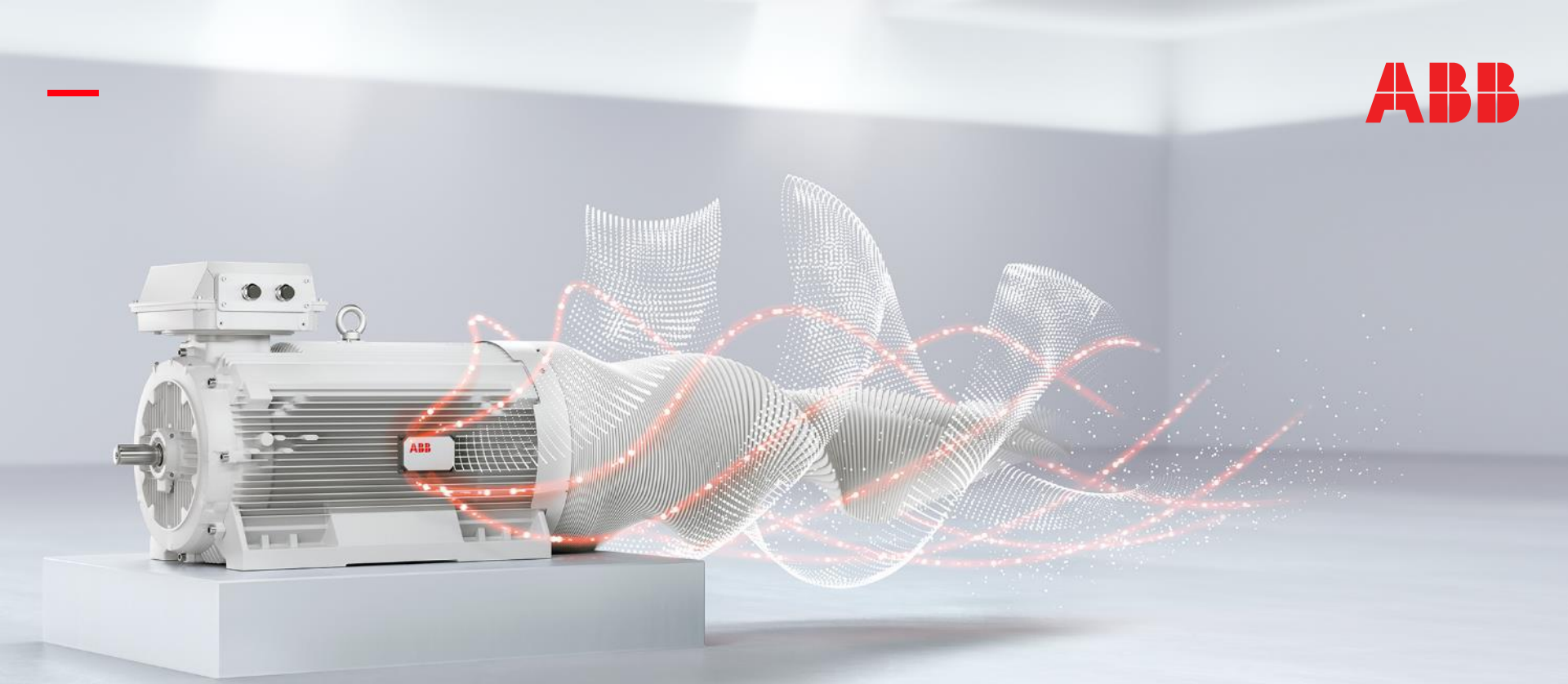
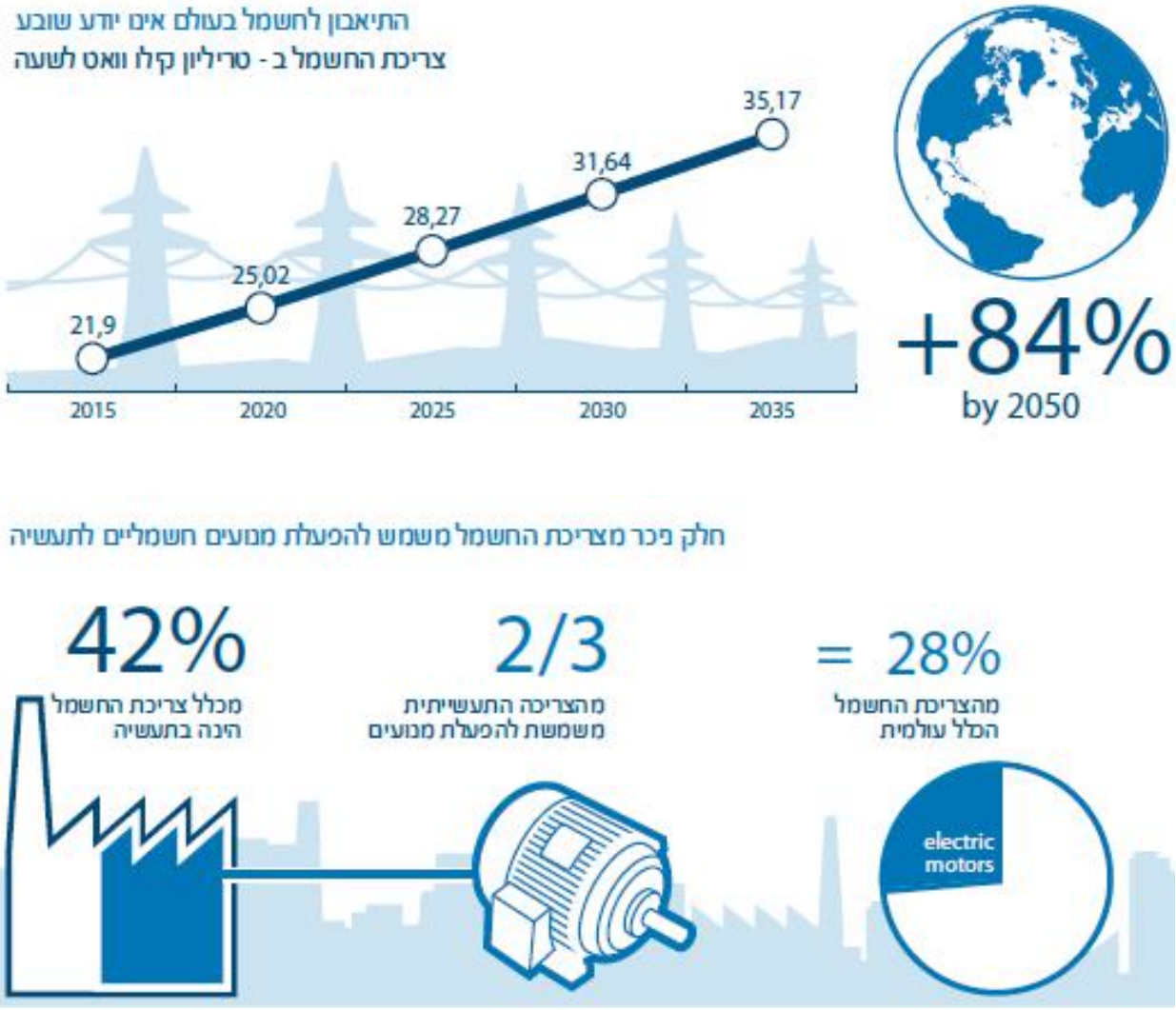


MOTORS AND GENERATORS SERVICE 2017-09 EXTERNAL PRESENTATION

ABB Ability ™ Smart Sensor

Motors that let you know when it's time for a service


התיאבון לחשמל בעולם אינו יודע שובע
צריכת החשמל ב - טריליון קילו וואט לשעה
21,9
25,02
28,27
31,64
35,17
2015
2020
2025
2030
2035
+84%
by 2050
חלק נכר מצריכת החשמל משמש להפעלת מנועים חשמליים לתעשיה
42%
מכלל צריכת החשמל הינה בתעשיה
2/3
מהצריכה התעשייתית משמשת להפעלת מנועים
= 28%
מהצריכת החשמל הכלל עולמית
electric motors

What ABB Motors and Generators stands for

Our vision





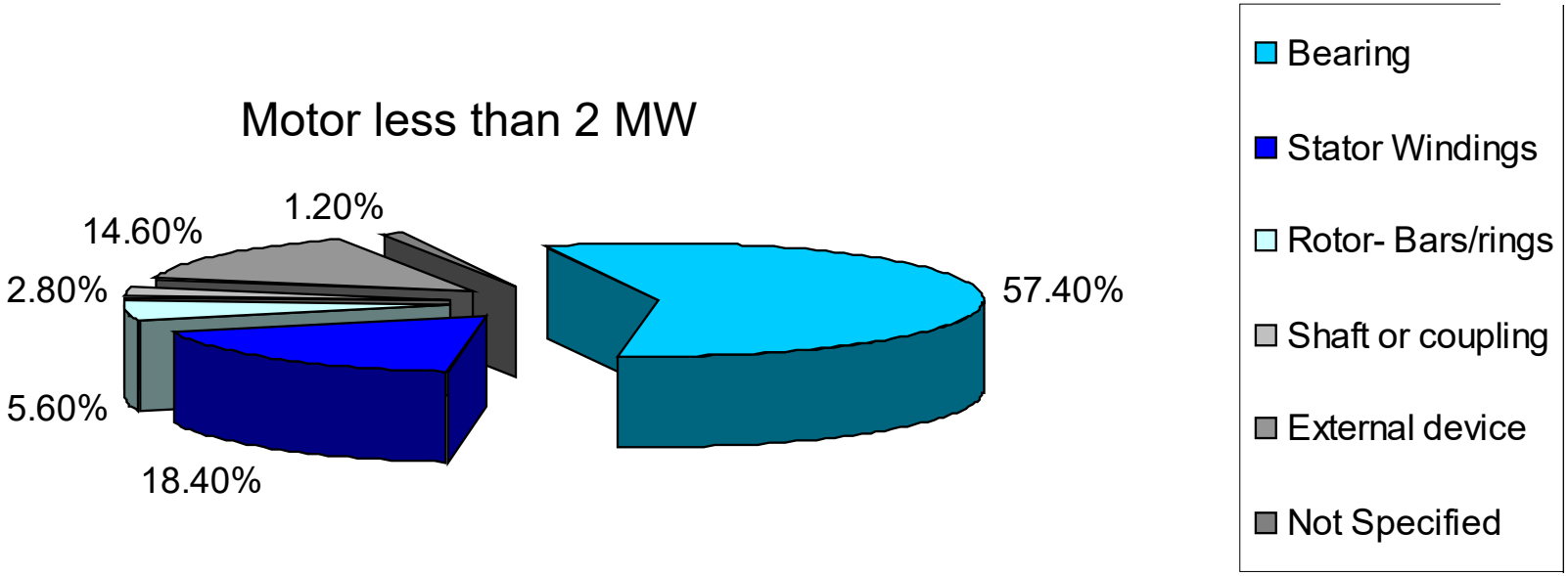



We are to be the best supplier of industrial electric motors, generators and mechanical power transmission products, as determined by our customers

With expertise, and a comprehensive portfolio of products and life-cycle services, we help value-minded industrial customers improve their energy efficiency and productivity

Failure Statistics

Motors Petrochemical Industry



For machines below 2000 kW anti-friction bearings are commonly used which are more likely to fail.

For Machines above 2000 kW sleeve bearings are often used which are less likely to fail.

Business Unit Motors and Generators in a nutshell

Serving a market of roughly 50 billion

What (Offering)

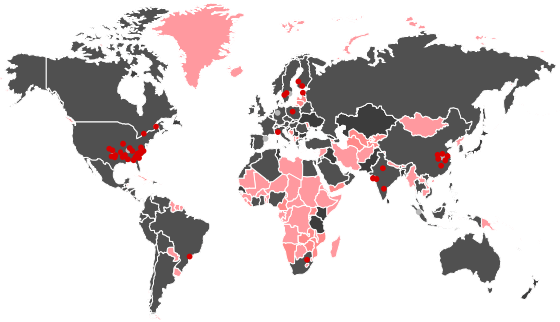
LV - Motors - MV | Gen | MPT

To whom (Customers)

OEM | Distributors | EPC / SI / EU

Where (Geographies)

AMC | EUC | AMA



> 3.5	~14,000	31	65
Billion in revenue	Employees in >80 countries	Manufacturing sites across all regions	Countries

Industrial markets primed to adopt digital technologies

Computing + connectivity + cloud + analytics set to unlock value

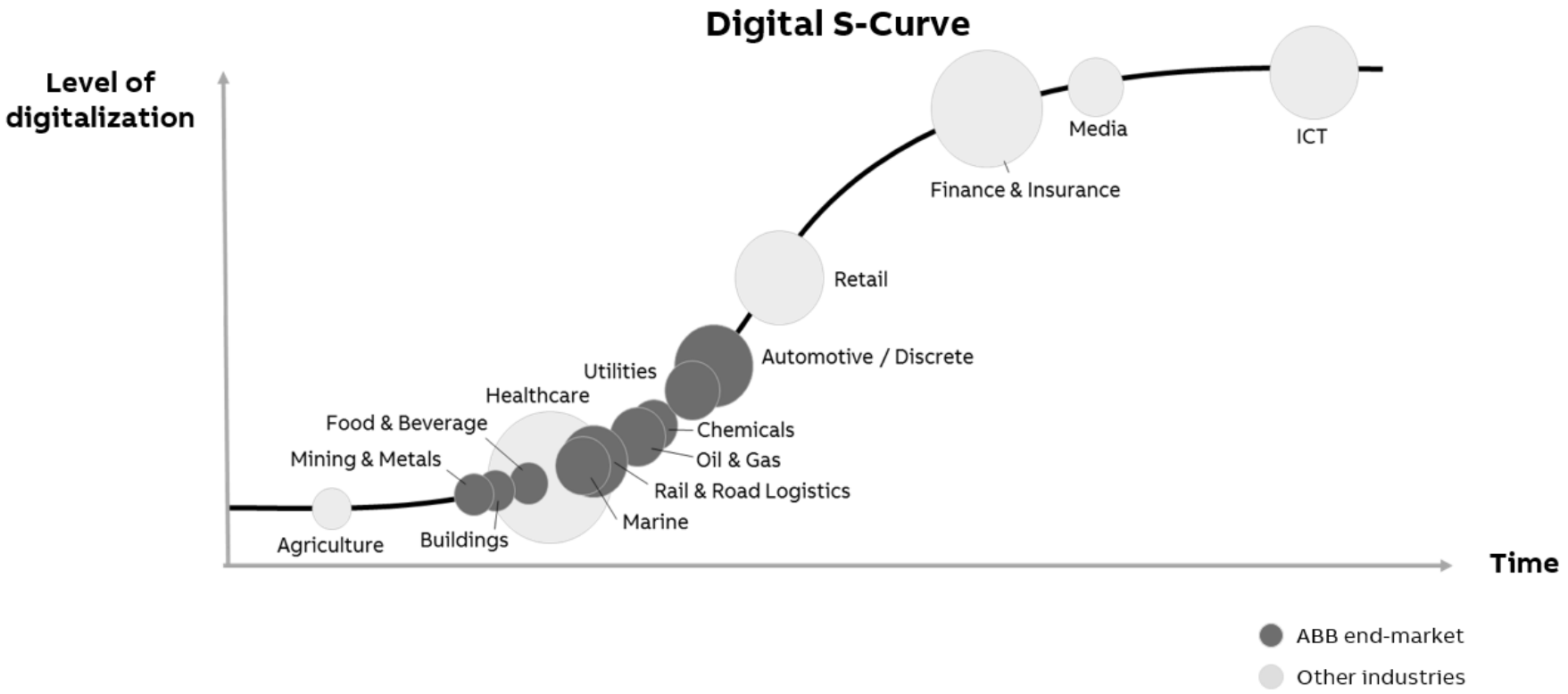
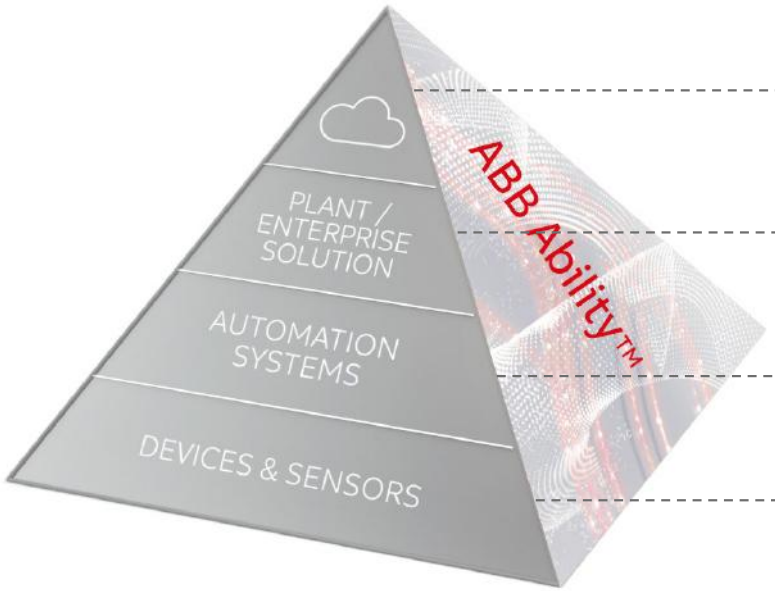


ABB Ability ™

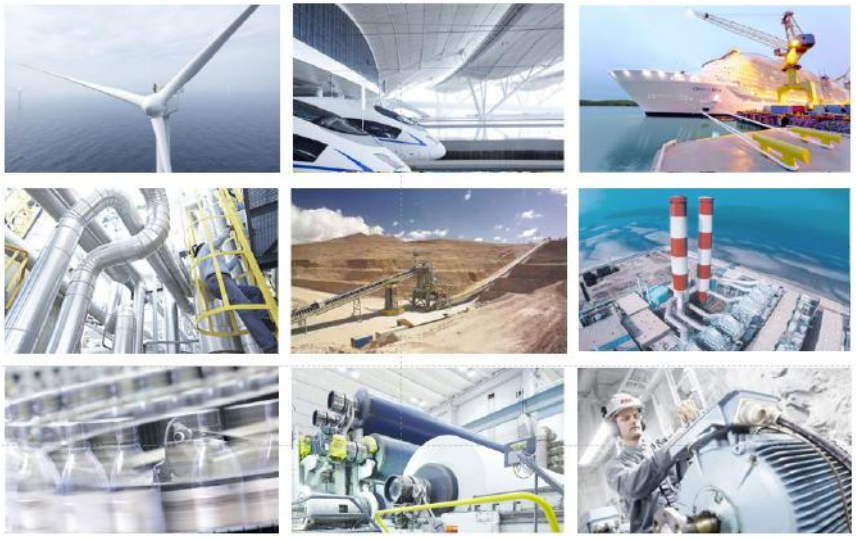
Industry -leading digital solutions built on a common set of standard technologies



- Open access, intelligent cloud
- New end -to -end digital solutions
- Systems to master process control
- Closing the loop with connected devices

ABB Ability ™ Value Creation

Differentiate, boost your IoT strategy and your service business



- **Safety** - Improve safety at work with maintenance inspections from a distance
- **Reliability** – Reduce downtime by up to 70% with a transition from reactive to proactive maintenance
- **Energy Savings** - Save up to 10% energy in a plant with data from all encompassing energy audits
- **Maintenance Savings** - Save time and effort of maintenance engineers with early warning systems
- **Net Working Capital** – Equipment can live up to 30% longer with less redundant plant and spare inventory
- **Risk Mitigation** – Minimise your liabilities, such as warranty, uptime guarantee, transportation damage, etc.

The Internet of Things is much more than condition monitoring

What Do We Actually Measure?

And what do we calculate?

The raw data we collect with the smart sensor today are:

1. **Vibration in 3 directions**
2. **Temperature in the point of contact**
3. **Magnetic field in 3 directions**
4. **Time**

The **data is preprocessed** by the microcontroller of the smart sensor tag,

- We don't send the raw data to the cloud, only selected bits.

Remember the fitness tracker.

A fitness tracker cannot directly measure how many calories you have used.

- It can measure time.
- It can measure the shock from every step you take,
- You have to enter how tall you are and how much you weigh.
- It calculate how many steps you have taken and how fast you have been.
- It calculates how many calories you have burned.

ABB Ability ™ Smart Sensor

Motors enter the digital age

- The sensor send the measurements every hour, and has a memory for a month.
- Within that month the data is collected, either manually with a smart phone or automatically via a gateway.
- The data is analyzed by the powerful algorithms of ABB, the world's leading manufacturer of electric motors.

- ABB Ability Smart Sensor is like a fitness wristband for electric motors.
- Fit it easily to the surface of a motor, without wiring or machining, and collect operational data and health information of the motor.
- Maintenance and operation can be optimized in a way that was not possible before.
- The benefits can be significant, payback time expected to be less than one year in most cases.
- With IoT-technology the sensor performs at a low cost that was unthinkable a few years ago.

ABB Ability ™ Smart Sensor

Three elements: Hardware, Apps, Web portal

Hardware kit (for field upgrade)

- Sensor
- Bracket
- Sensor mount
- Adhesive putty
- Three screws
- Quick Start Guide

Smartphone apps

- Sensor / motor registration
- Health traffic lights
- Latest operational data

Web portal

- User registration
- User group management
- Settings for alert and alarm
- Support
- Historical data
- Health parameters
- Operational parameters
- Trending

ABB Ability ™ Smart Sensor

Monitoring and maintenance of LV motors

The fourth industrial revolution

ABB Ability Smart Sensor does not do anything we could not do before - it just does it more easily and cheaply.

Most motors can get good monitoring for the first time with the ABB Ability Smart Sensor.

- Safe remote monitoring
- Proactive maintenance
- Fleet analytics
- Risk mitigation, e.g. warranty, uptime, transportation, etc.

Use your Smart Sensors on

- old motors and new
- small motors and large
- ABB motors and non-ABB

ABB Ability ™ Smart Sensor

What would a fitness wristband measure on a motor?

Motor health manifests as:

Bearings condition – e.g. lubrication issues, damaged elements

Cooling condition – e.g. dirty fan cover

Rotor condition – e.g. cracked bars or short circuit rings

Airgap condition – e.g. eccentricity, bent shaft, soft feet

Motor activity shows as:

Energy consumption

Vibration levels

Temperature

Operating hours

ABB Ability ™ System Layout

for Motors, Generators and Mechanical Power Transmission Products

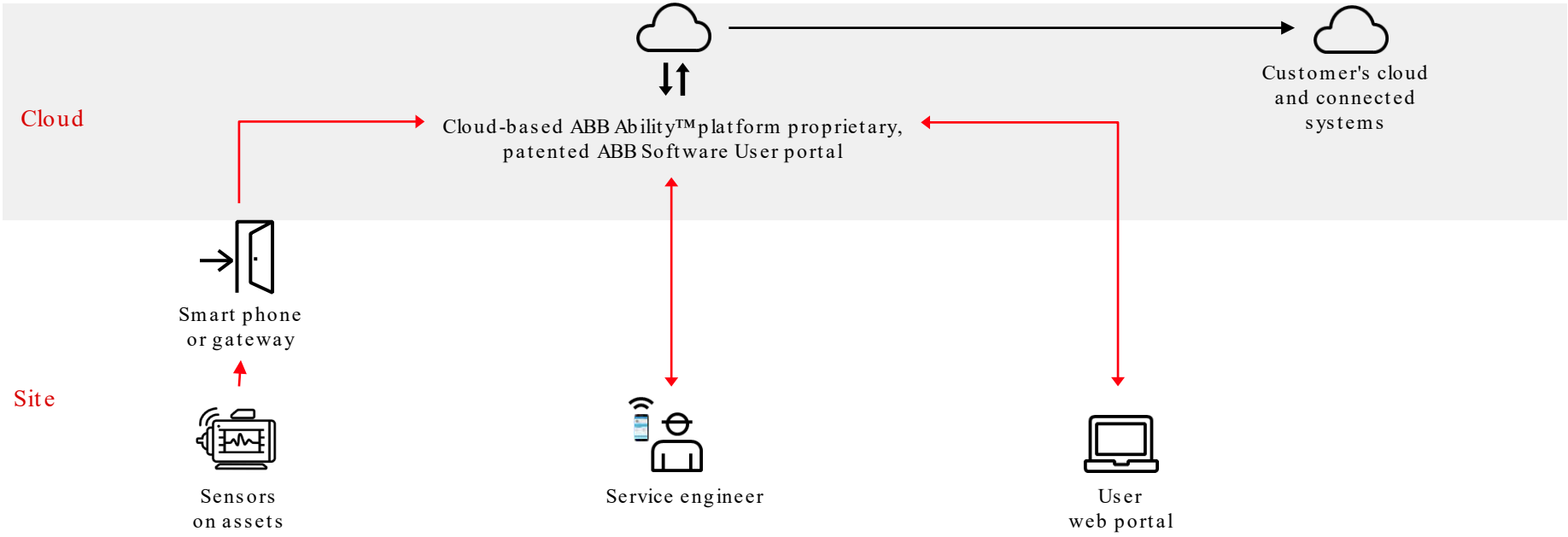


ABB Ability ™ Smart Sensor

Premium Motor Supervision – The Analyst Subscription

Imagine owning a fan and motor mounted in the ceiling…

Without sensor

Nobody ever goes near that motor.

You will be surprised when it fails, then you will:

- Pull the spare motor out of your warehouse
- Find an electrician and beg her to come
- Get the mobile lift in place

It will take at least one day to replace, even if you have a spare in stock.

If the process or the driven equipment was damaged by the unexpected motor failure, all times and cost can be multiplied by ten.

With sensor

Nobody ever goes near that motor.

You will get a warning in your Smart Sensor app before anything has happened, then you will:

- Order a new motor from your nearest ABB Value Provider
- Book the mobile lift for Tuesday
- Technician comes Tuesday with motor
- Process run down and run up in an orderly fashion

Within two hours it is replaced.

Without a spare motor in stock and without an electrician on standby.

Thank you for your attention

Wrap-up

Affordable , clever and easy solutions

- Improve safety
- Reduce downtime
- Save energy
- Reduce maintenance cost
- Optimize investment
- Mitigate risk
- Grow digital business
- Grow service business

ABB Ability ™ Smart Sensor

Package Supervision

Imagine being a machinery OEM, looking to grow your business beyond product sales…

Without sensor

You manufacture machinery, package it with motors from ABB and others, and sell it.

With sensor, as before plus …

Smart Sensors are fitted on all the motors you sell. Your machinery gets fitted with sensors provided by yourself or by ABB.

App, web portal, backend, user management is provided by ABB as part of the contract.

Your sensors are connected to the same cloud, and your deep domain competence is added to the analytic algorithms in the backend.

You use your new IoT offering to grow your service business, or to build new revenue streams.

You get all data into your own system via a cloud interface.

Everything is also available as your retrofit offering.

ABB Ability ™ Smart Sensor

Authorized Value Provider Subscription

Imagine that you are a service provider with motors under contract…

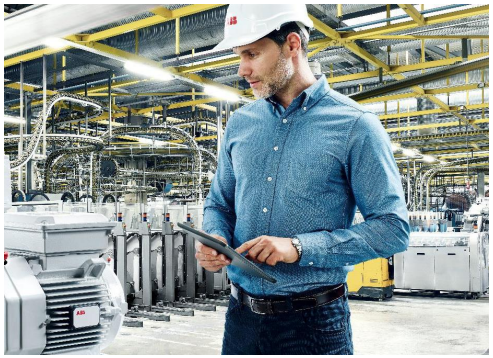
Without sensor in your portfolio

Cover 5 end-user sites with the team you have.

Take care of the reactive maintenance.

Repair when something breaks down.

Tell your customer you're working as fast as you can.



With sensor in your portfolio

Cover 10 end-user sites with the team you have.

Introduce proactive maintenance.

Make your customer happy because they have less downtime and lower cost than before.

Help your customer to save energy, and sell some drives and new motors in the process.

Help your customer avoid accidents.

Reduce your own inventory of spare motors.

Mitigate the risk when you have to give guarantees or promise something.

Buy your subscription from ABB and sell subscriptions to your clients.

Sleep until late on Sundays, because you don't have an urgent breakdown Saturday night.

ABB Ability ™ Smart Sensor

Flight Recorder

Imagine being a pump manufacturer, worried about warranty risk and transportation damage…

Without sensor

You sell a package of pump and motor.

The package is delivered to your customer.

You have previously experienced rough handling during transportation, and are always a bit worried about the rotational seals.

You have experienced customers who handled the equipment badly and then claimed a warranty defect when it broke down.

With sensor, as before plus …

The sensor is taking measurements every hour from the moment the package leaves your factory.

During transportation the sensor will monitor the treatment. After arrival you can check if the forwarder dropped the crate.

After commissioning the sensor will keep collecting data even without a cloud connection, and if there is any warranty investigation you can access the operational data several months back.

If the end user's maintenance team want to use the sensor, then they can activate a subscription with ABB. If your contract with ABB is set up accordingly you might get a share of the revenues and the data that is collected.

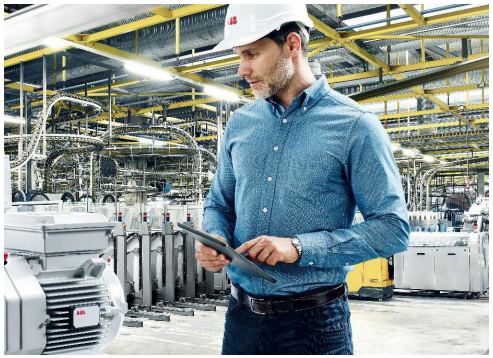
ABB Ability ™ Smart Sensor

Motor With On -demand Supervision

Imagine being a commodity manager for a global corporation,
leaving operational decisions to the production managers on site…

Without sensor

Sign a frame agreement with ABB for delivery of the best LV motors and drives in the world.



With sensor

Amend your frame agreement with ABB, to include smart sensors on all motors.

Motors arrive to the different sites with inactive smart sensors.

The plant managers decide which motors he wants to monitor, and then activates the matching sensors with his smartphone.

Subscription fee for active sensors are charged to the plant. No fee for inactive sensors.

Run trials in one plant, document entire experience . Spread the outcome of the trial as best practice.

ABB Ability ™ Smart Sensor

Hardware

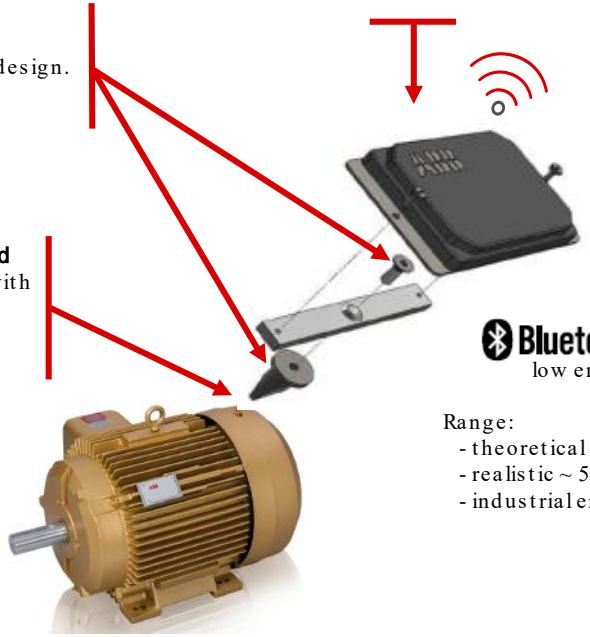
UNF 1/ 4"- 28 mechanical interface is "future proof" for possible upcoming ABB Ability™ Smart Sensor of different design.

No electrical wiring required / possible.

The sensor mount is **permanently installed** between the cooling ribs of the motor with adhesive putty (Henkel Loctite 3463). Initially 5 sizes are available.

Sensor in flight mode at delivery

MEMS **Multi -Sensor System** inside



Built -in batteries
Not exchangeable
Design life 5 years, realistically 3-5 years

Firmware with FOTA
(Firmware Over-The-Air,
i.e. updates via smartphone or gateway)

Bluetooth® low energy technology

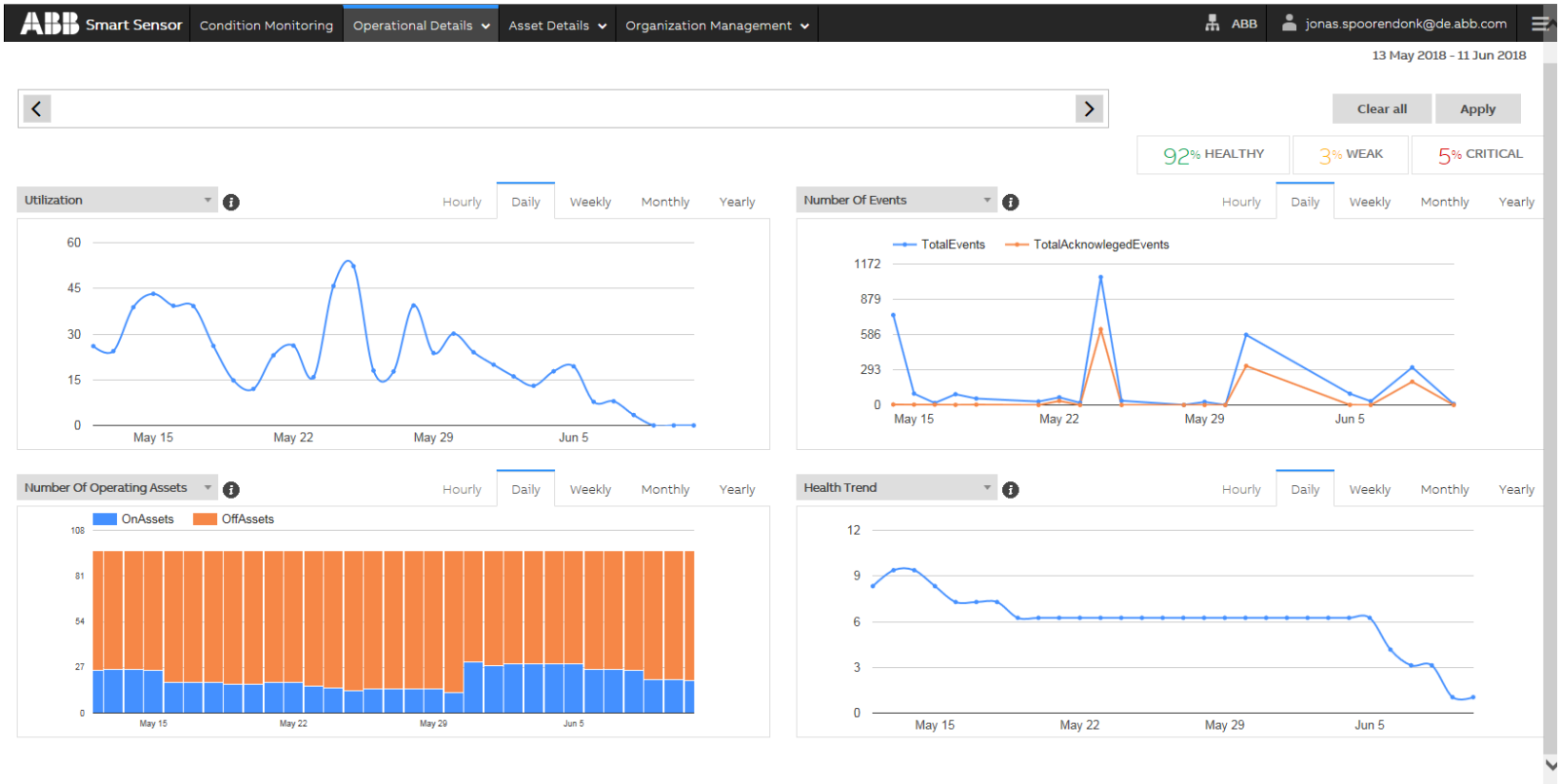
Range:
- theoretical max > 100 m
- realistic ~ 50 m
- industrial environment < 25 m

Certified:
- **IP66**
- **CE**
- **Bluetooth**
- **FCC*), UL*)**
- **Class I, Div 2 *)**
- **Intrinsically Safe ATEX *)**

*) certification still in progress

ABB Ability ™ Smart Sensor

Screenshots from the web portal



WRAP-UP

REMEMBER THE ANALOGY OF THE FITNESS TRACKER:

It is not really doing anything that was impossible before , but it is doing it easier and cheaper and that way things becomes feasible that were not feasible before .

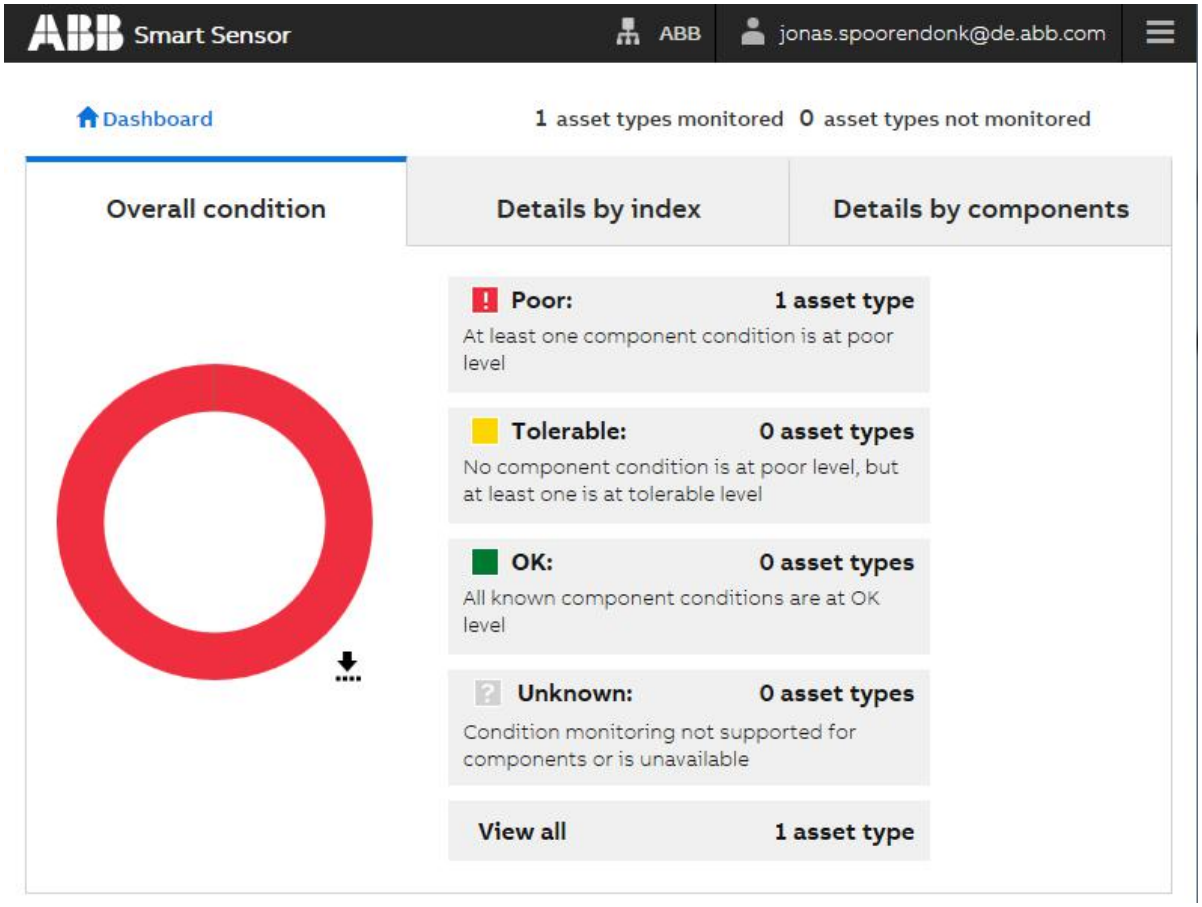
- Before you had to go to a clinic where a nurse would tape sensors to your body, now you can simply put on a wristband (without help:-).

HOWEVER:

If your fitness tracker is telling you that you have problem with your heart rate, then you should not rush to the hospital to get a hear transplant

- You should go a clinic and ask the nurse to take some measurements and give an expert opinion.

Overall Condition Index

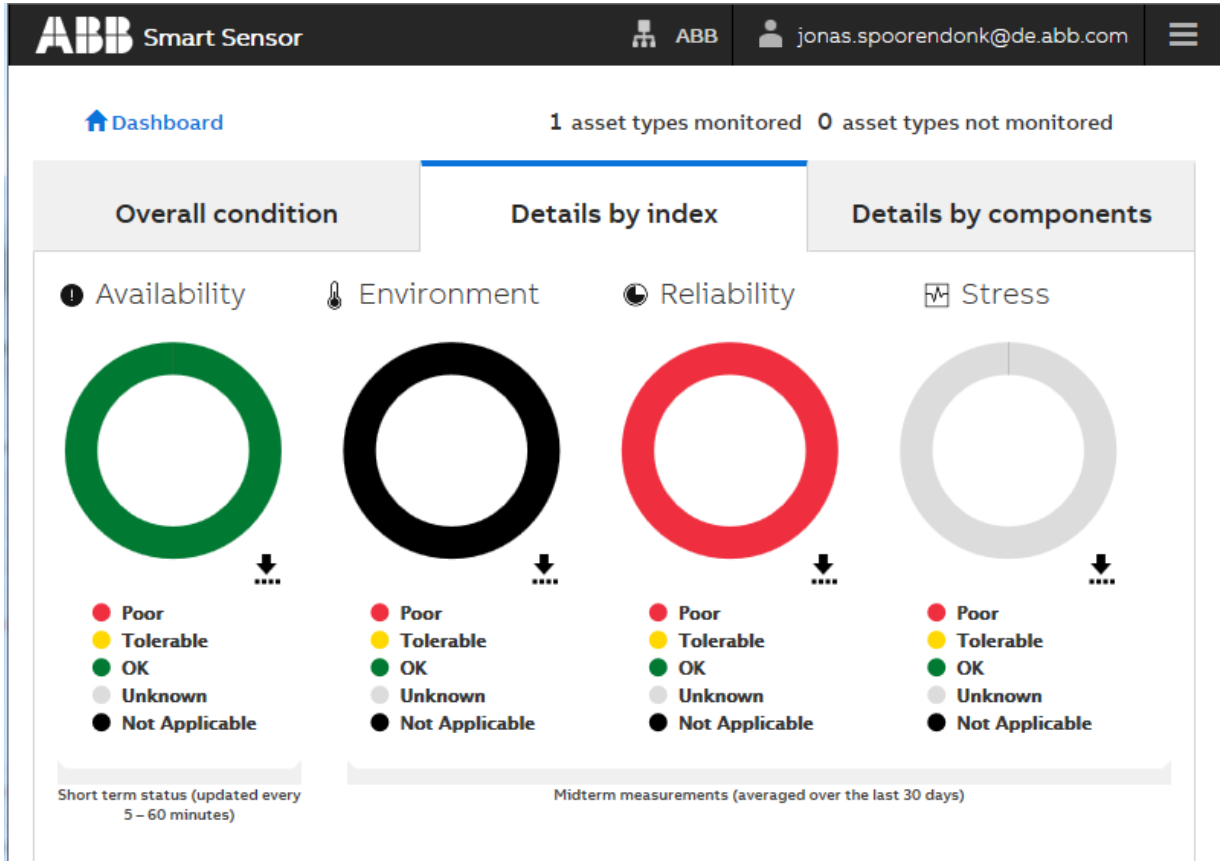


The overall condition index is the „General Manager View“ where the entire fleet of monitored assets is visualised in one view, giving a simple answer: Is everything OK or is there a problem somewhere?

The fleet is partitioned into asset types. Today we cater for motors, pumps, or bearings, but there will be others in future.

Clicking on a segment will take you a level down.

Details By Index



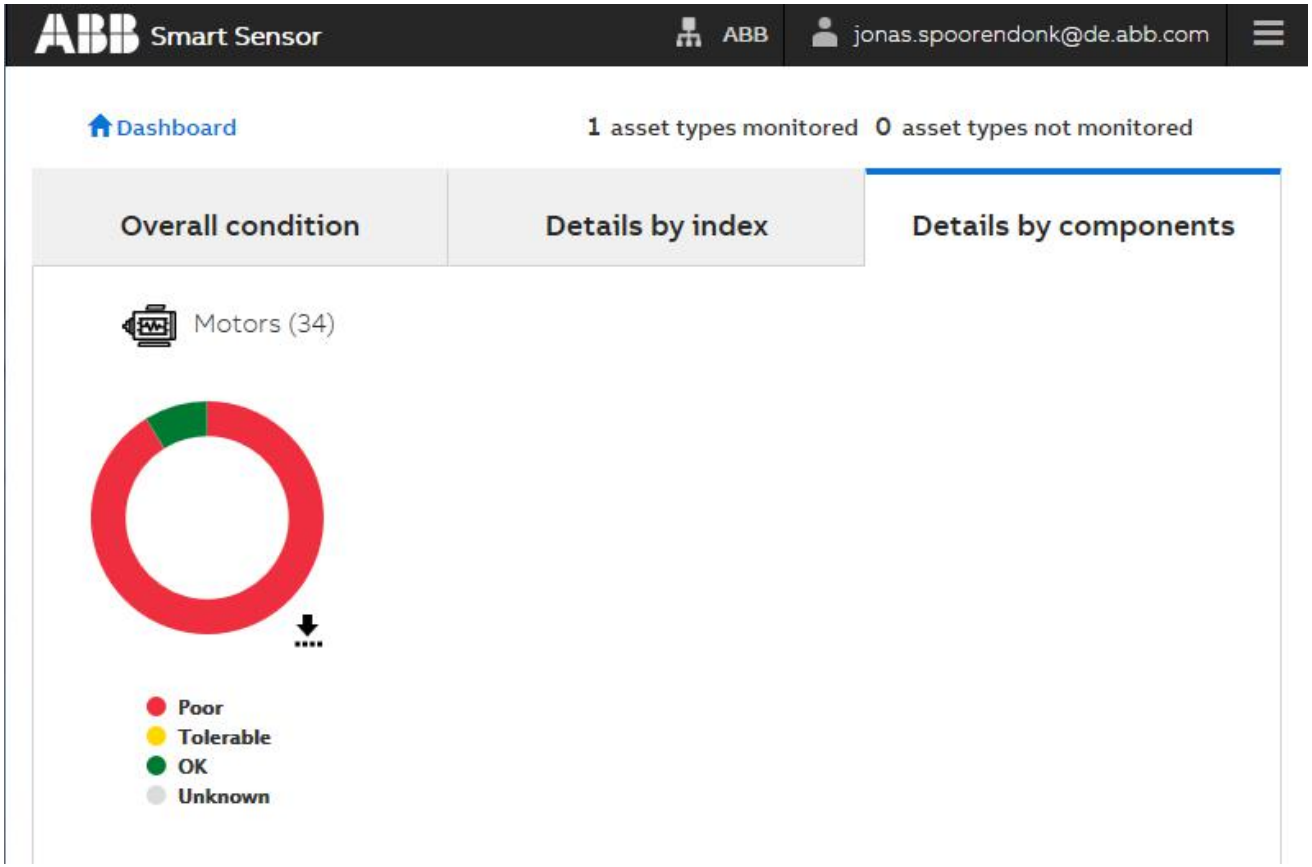
The detailed indices are how we compare different assets.

By determining what for example reliability means for each asset type we create a common scale where equipment that is very different becomes comparable.

Some indices may be irrelevant for a particular asset type.

Others may be relevant, but unfortunately we are not recording any data in that matter.

Details By Components

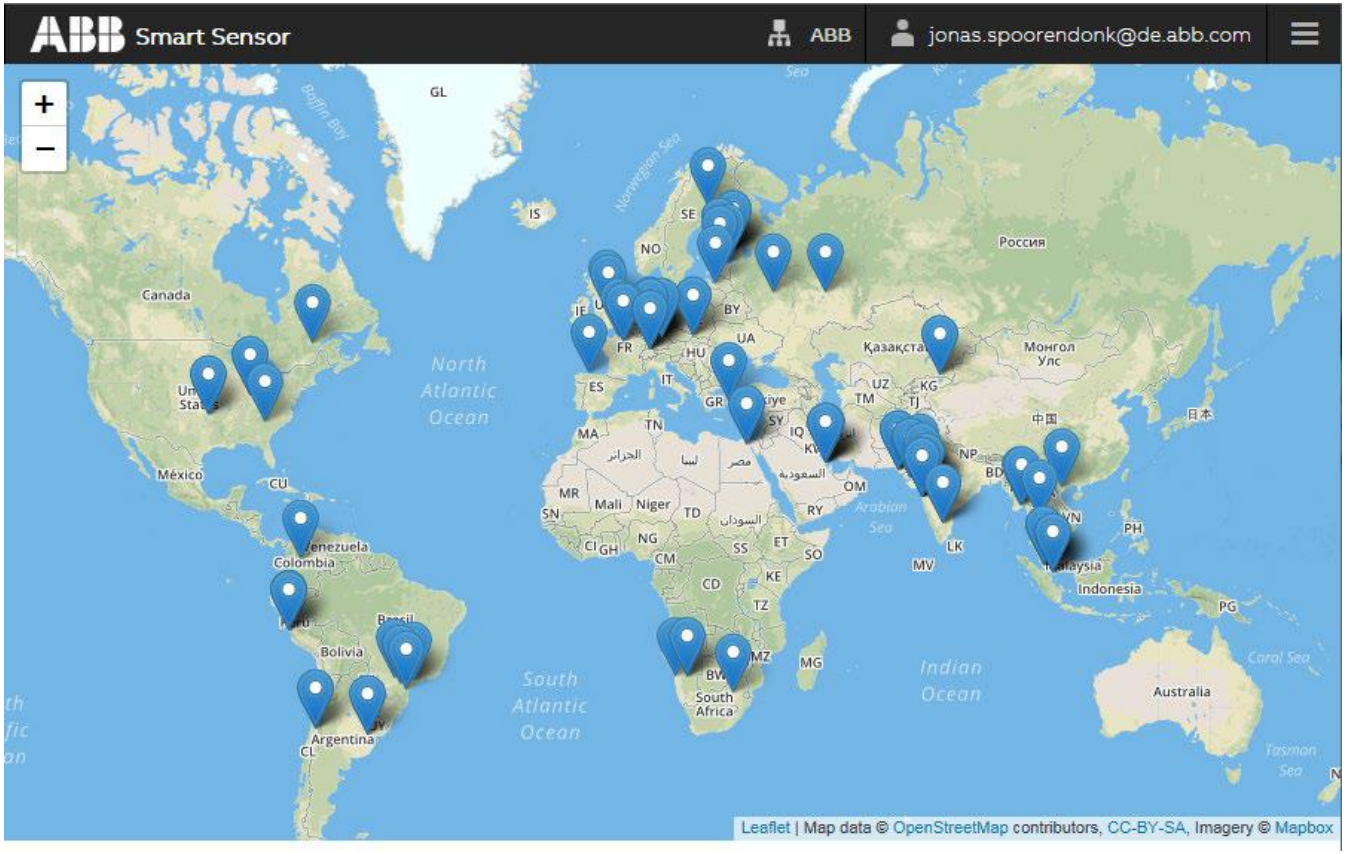


On this page we see one donut for each asset type.

In this example we are monitoring 34 motors. We are monitorin 0 other assets and therefore nothing is shown for other types.

The rules for determining the condition of an asset include looking into the history. So an asset that is green right now could still be in a poor condition, because it has been red in the past (remember the bearing condition assessment).

World Map and Plants

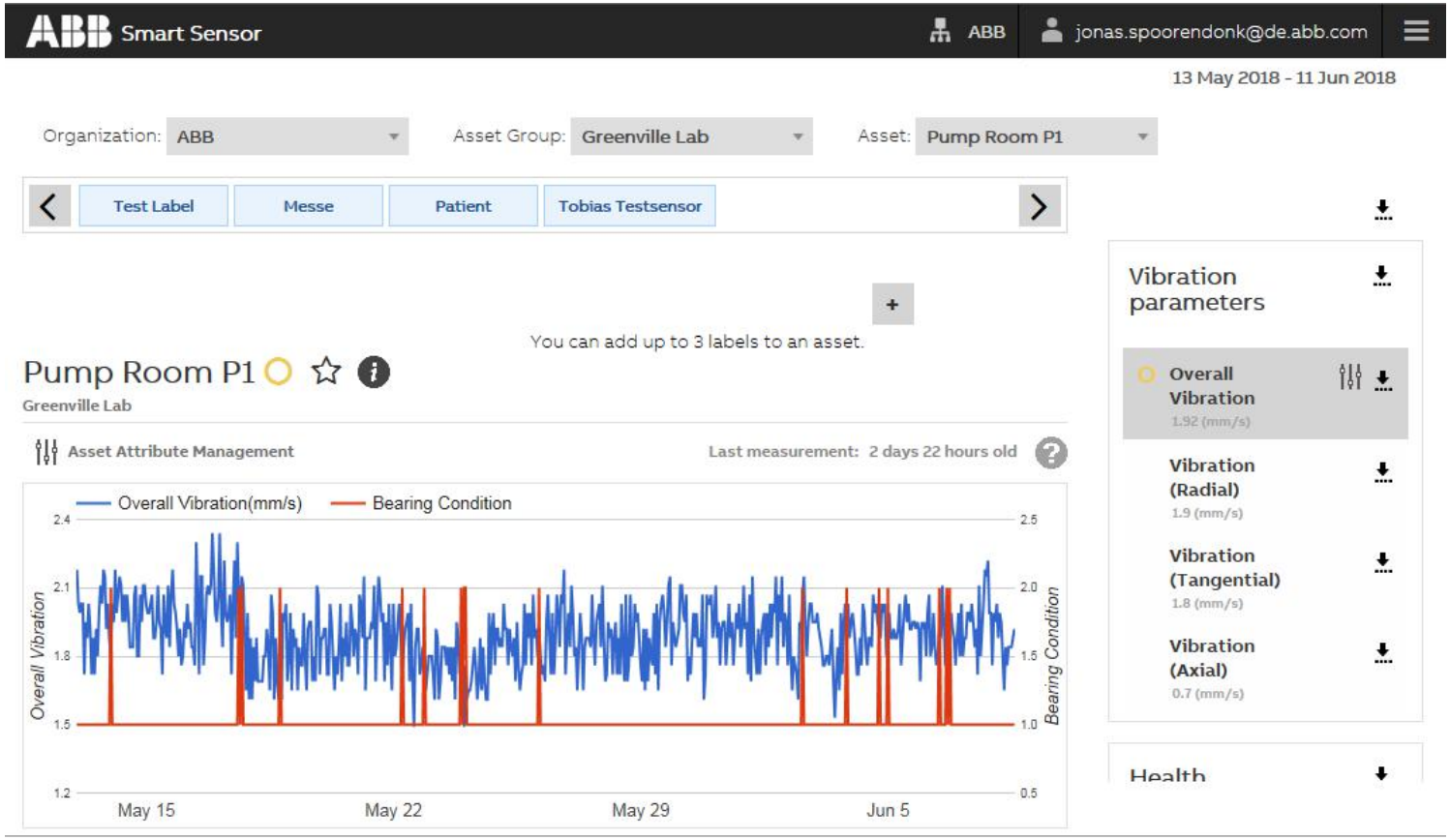


The worls map displayes the location of the plants of the smart sensors platform.

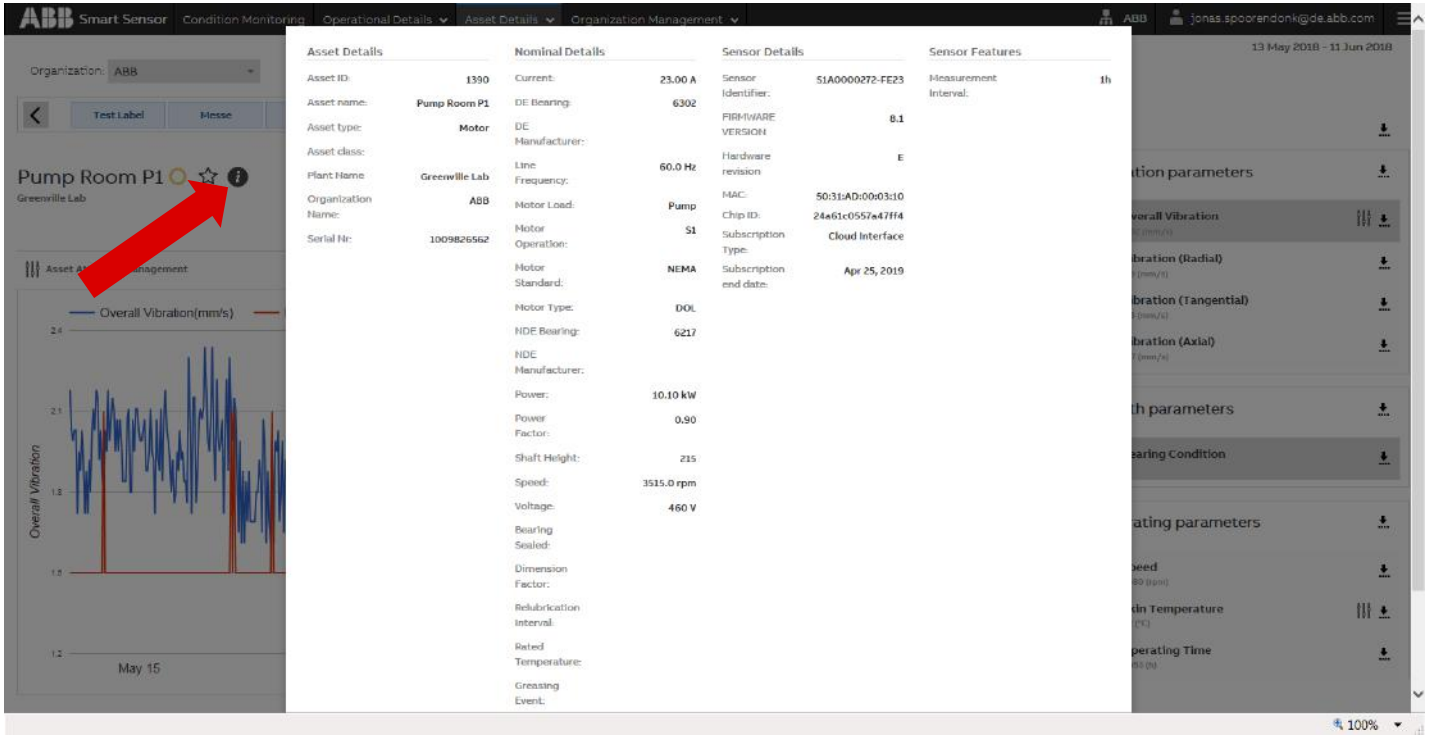
They are defined by the user, and therefore not the same as the „sites“ in ServIS.

It is possible to use the smart sensor platform without allowing the system to access locations.

Asset Details

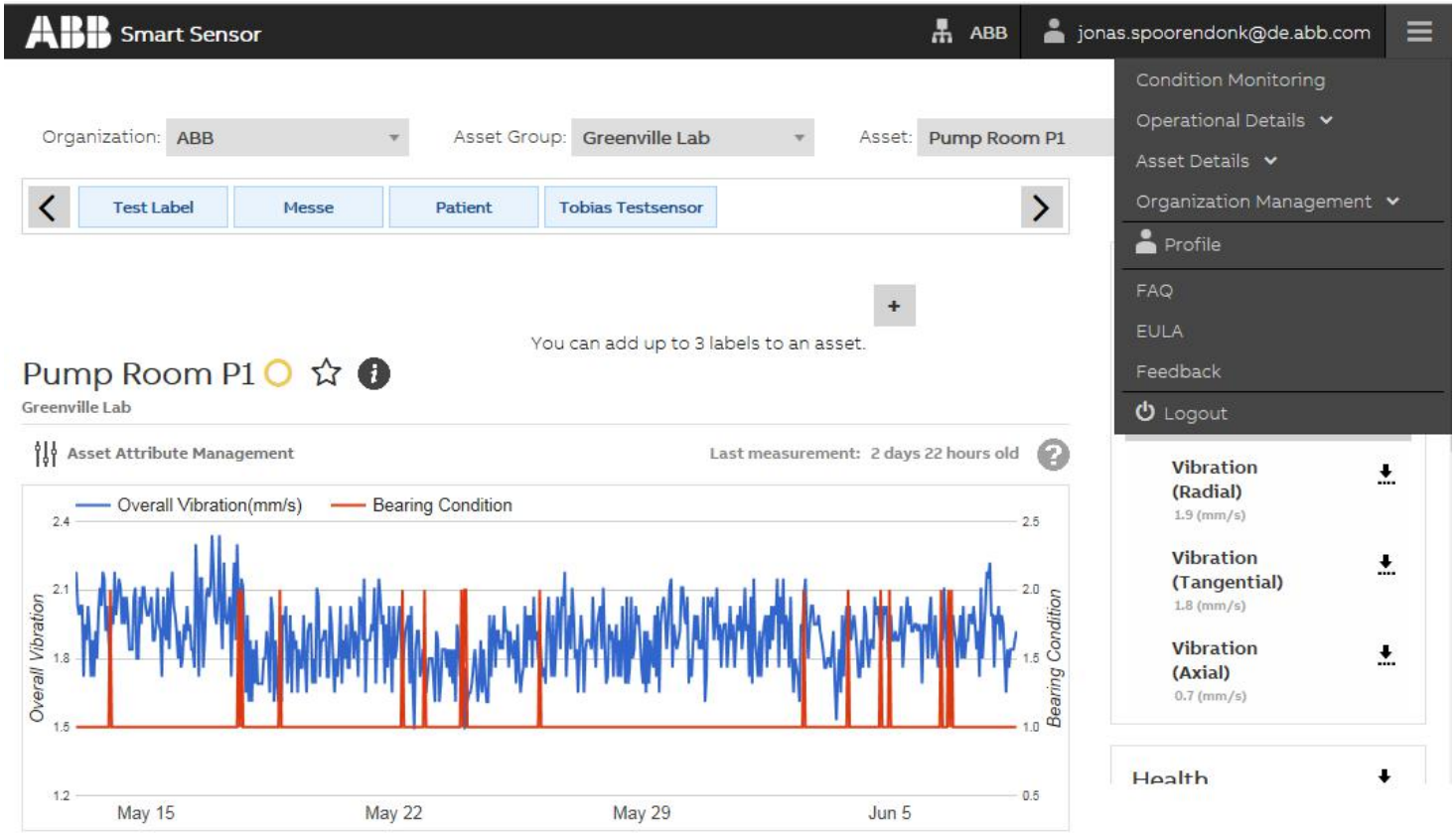


Additional Information



By clicking on the ⓘ you will get pop-ups with additional relevant information, for example about the asset.

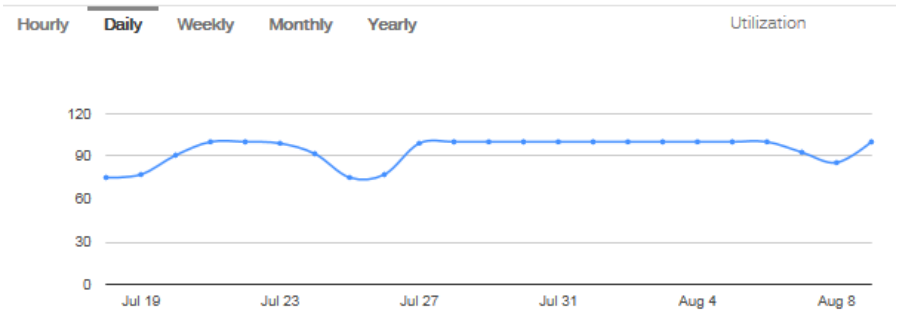
The „Hamburger Menu “



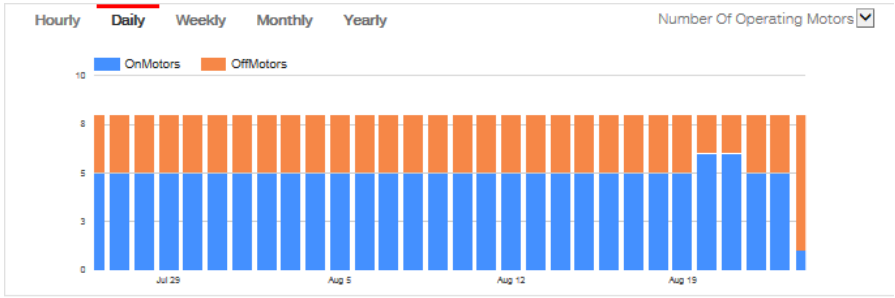
A „hamburger menu“ is the menu opens when you click on the symbol that looks vaguely like a hamburger.

Among other this is where you find the links to the End User License Agreement (EULA) and the Frequently Asked Questions (FAQ)

Utilization and No. Of Operating Assets



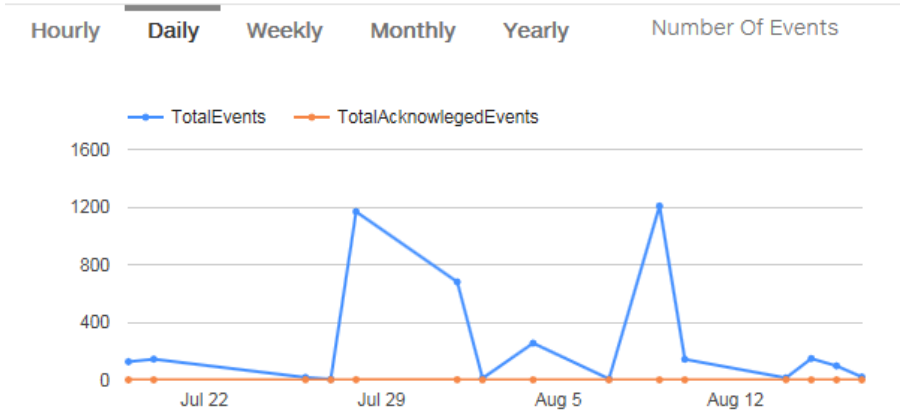
- The graph measures if your motors are running all the time.
- In the normal configuration the smart sensor takes one measurement every hour, and if you have 10 motors with sensors, then you get a total of 240 measurements points per day.
- 70% for a particular day means that 168 out of 240 measurements (168/ 240 = 70%) were taken while the motor was working, while 72 measurements were taken on a resting motor.



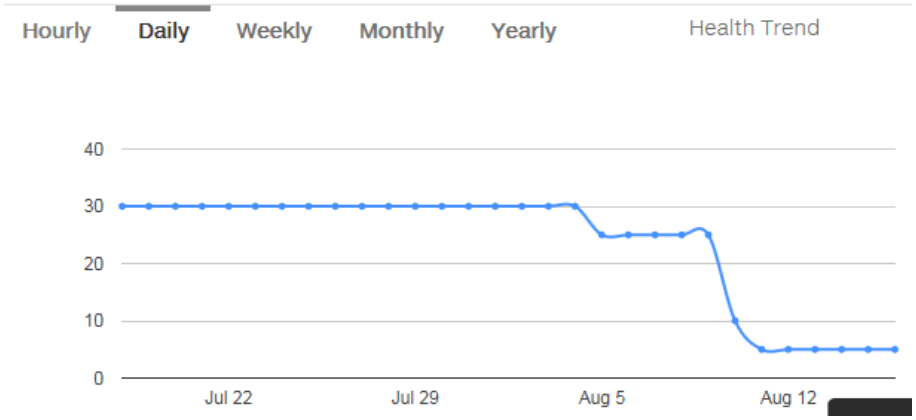
- This graph measures how many redundant motors you have.
- In this case each stack represents one day.
- If you have 8 motors, then the total stack will go up to 8.
- If the stack is blue up to 5 and orange the rest of the way up to 8, it means that 5 motors have been running at least once that day, and the other 3 have stood still that day, not running at all.

NOTE: The curve is based on the reported data, and sensors are not reporting at the same time. For that reason the curve may show retroactive changes, because it is recalculated based on all available data.

Number Of Events and Overall Health Index



- This graph shows how many notifications you have received for your fleet of motors
- Every notification you receive in the app adds one to the count of total events (the blue line).
- Evey time you are confirming an event by registering a corresponding action in the app, it counts as one acknowledged event (the orange line)



- This graph shows the overall health index of you fleet of motors
- Ideally it should always rise and rise
- In the last days the curve always dips, because the data from many sensors have not yet been collected.
- Yes, this is redundant info since we have the condition index donuts now.

NOTE: The curve is based on the reported data, and sensors are not reporting at the same time. For that reason the curve may show retroactive changes, because it is recalculated based on all available data.