EPA – Conference 2012, Atlanta

Pressure and Temperature Measurement

Mitigating Potential SF_6 Leaks

Through Early Leak Detection

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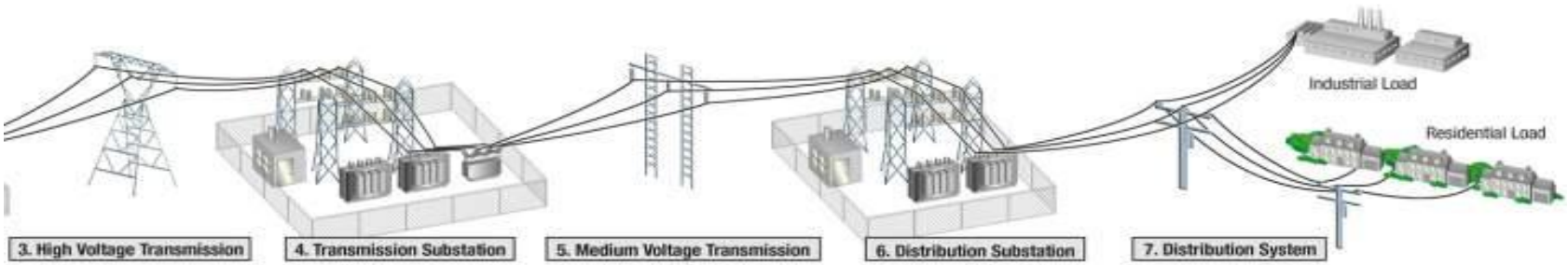
Pressure and Temperature Measurement

We take care of your assets

Transmission & Distribution

High Voltage — Flow of electricity — Medium Voltage



- Gas Density

- Valves

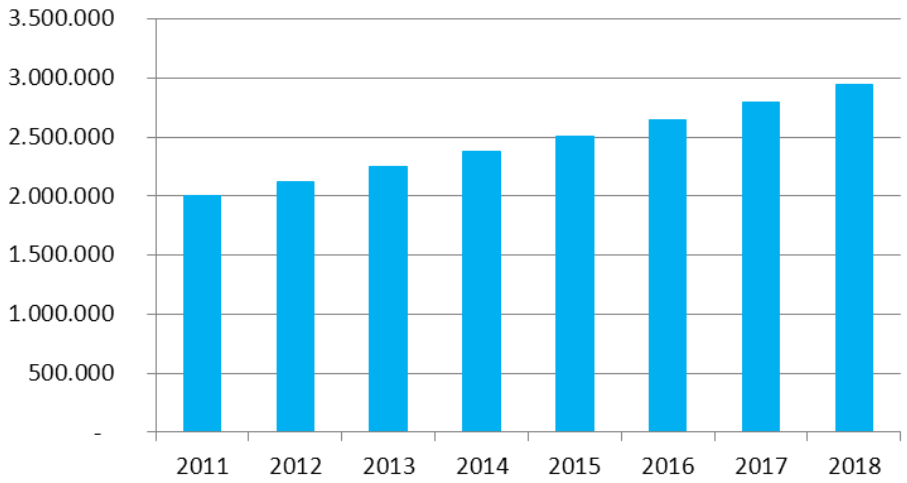
- Gas Analytics

- Gas Handling

Gas zones in Service

WIKA has equipped more than 1,000,000 gas tanks worldwide with:

750.000	Gas Density Monitors
200.000	Gas Density Indicators
50.000	Gas Density Switches
25.000	Gas Density Transmitters



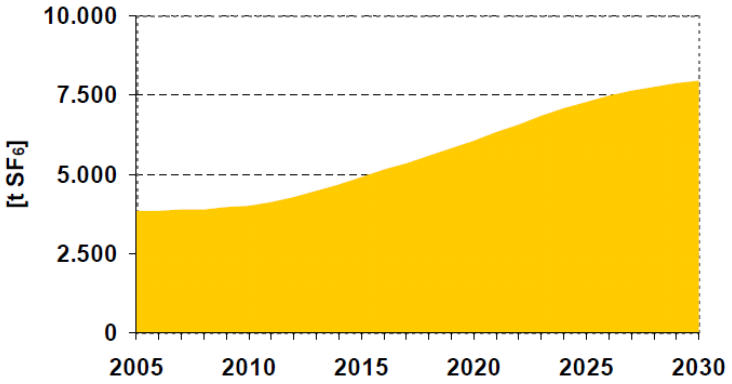
- **Baseline banked SF_6 in electrical Equipment**
  - *At least 2,0 Mio. Gas zones are in service*
  - *Average fill pressure = 6 bar (abs)*
  - *Average Density = 40 g / l or 40 kg / m³*
  - *Average Volume Gas Zone = 700 l*
- **Conclusion**
  - *Mass per Zone = 40 kg/m³ x 0,7 m³*
  - *Mass per Zone = 28 kg/Gas zone*
  - *Bank SF_6 = Zones x Mass*
  - *Bank SF_6 = 2,0 Mio. Zones x 28 kg/ Gas zone*
  - *Bank SF_6 = 56.000.000 metric kg*
  - ***Bank SF_6 = 56.000 metric tones***

***Bank SF_6 = 56.000 metric tones equal to* 1.276.800.000 metric tones CO_2 eq.**

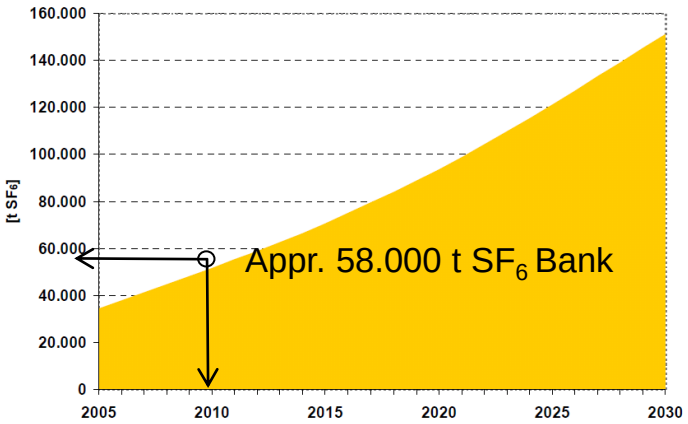
Source: Sold Instrumentation WIKA & Market Information

Global annual consumption of SF_6

Annual consumption & projection for the electric industry



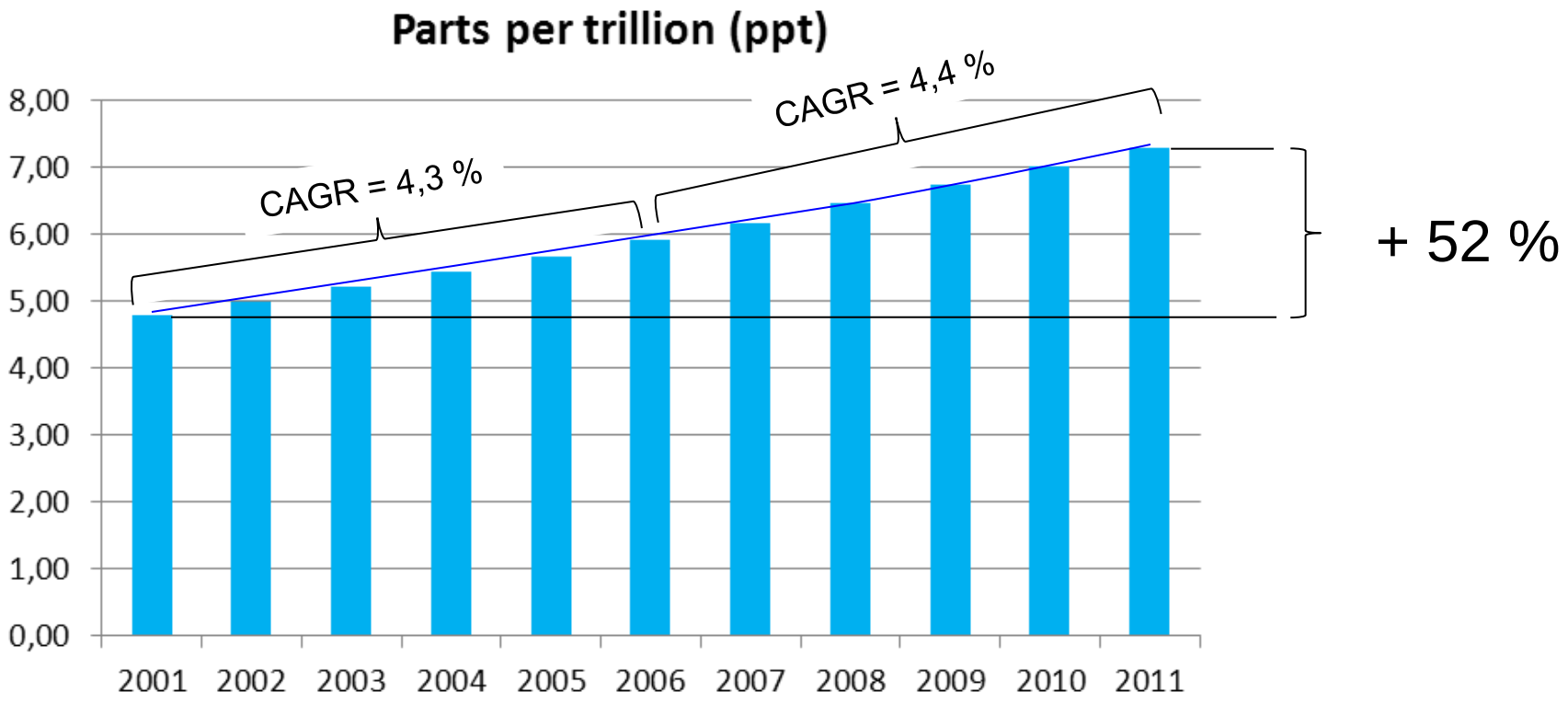
Projection: Aggregated SF6 bank development



- **Estimated SF_6 mass in the equipment**
  - *Bank SF_6 = 58.000 metric tones*
  - *Bank SF_6* = 1.322.400.000 metric tones CO_2 eq.
- **Some simple figures**
  - *10 % of Bank SF_6 = 132.240.000 metric tones* CO_2 eq.
  - ***2,5 % of Bank SF_6 = 33.060.000 metric tones CO_2 eq.***
  - *1 % of Bank SF_6 = 13.224.000 metric tones* CO_2 eq.
  - ***0,5 % of Bank SF_6 = 6.612.000 metric tones CO_2 eq.***
- **Conclusion**
  - *Proactive leak detection reduces the contribution to CO_2 Emissions even more*
  - *More precise methods for leak detection allow emission reductions*

Source: Update on global SF_6 emission trends from electrical equipment – Edition 1.1, 01.07.2010, Ecofys GmbH Germany

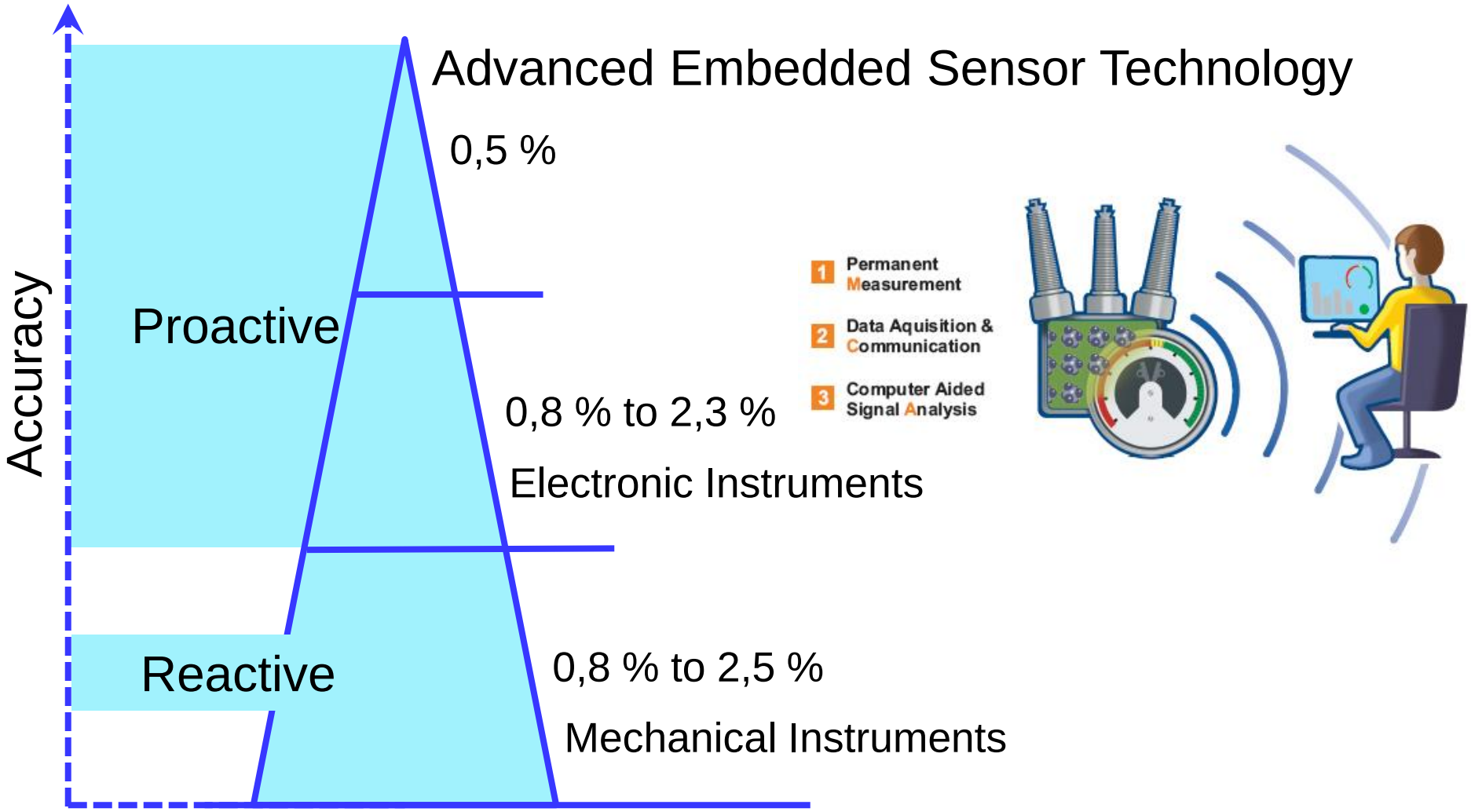
Global SF_6 Concentration



CAGR % ….Compound average growth rate

Source: Sulfur hexaflouride data from the NOAA/ESRL halocarbons in situ program.
Sulfur hexaflouride (SF6) hemispheric and global monthly means from the NOAA/ESRL
Recent data (less than 1.5 years) are considered preliminary.
Average Values are calculated based on the global monthly means.

SF_6 Emission Pyramid



Benefits of SF_6 online monitoring as part of a proactive strategy

Predictive Maintenance

- Keep equipment in safe condition
- Proactive maintenance strategies vs. reactive strategies from online monitoring ensure that switchgear is in safe condition
- Detect issues during warranty period and get them fixed
- Prepare Pareto profiles of top leakers to optimize maintenance strategies and avoid any potential issues of non switching

1

Simplified emission reporting

- Accurately capture SF_6 gas usage across entire gas tank fleet online and in near real time providing fully auditable system
- Avoidance of human error or poor calibration of weighing equipment as part of the reporting process
- Improve ecological and environmental standing
- Know precisely how much gas is needed to fill any given tank (no over fill or under fill)

2

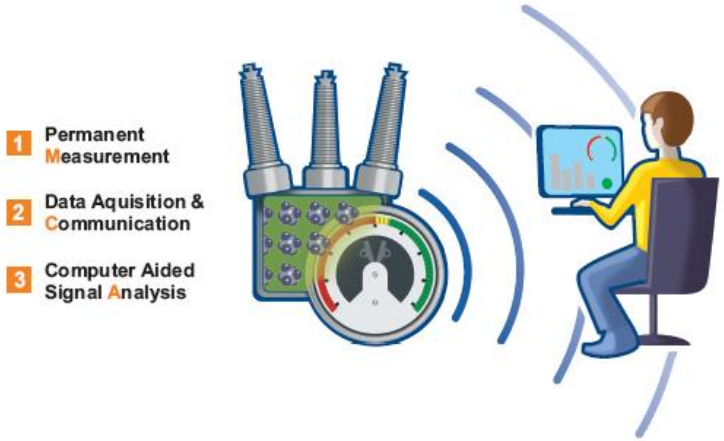
Multiple parameter sensors are essential for a proactive CBM strategy

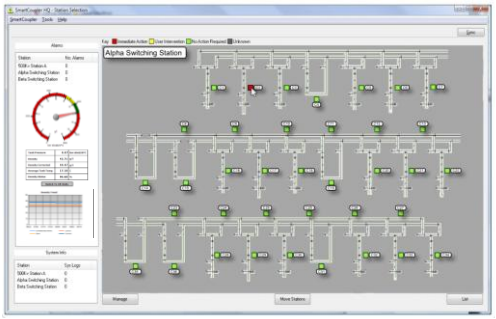
- Transmitters with integrated pressure, temperature & moisture sensors minimize overall costs for the monitoring
- Digital Communication safes costs for wiring significantly

Why advanced sensor technology ?

- **Humidity (One Embedded Sensor)**
  - ⇨ *Root Cause (Humidity / Oxygen / Energy)*
  - ⇨ *Dielectric Strength influenced dramatically*
  - ⇨ *Acidic Atmosphere (SO_2, HF, SOF_4 …)*
- **Pressure (One Embedded Sensor)**
  - ⇨ *High Precision Sensor 0,06 % FSD*
  - ⇨ *High Sampling Rate allow identification tanks effected by PD events*
  - ⇨ *Basis of the density calculations*
- **Temperature (Three Embedded Sensors)**
  - ⇨ *2 Temperature sensors exposed to the gas*
  - ⇨ *1 Temperature sensor close to ambient*
  - ⇨ *Thermal Image (Thermodynamics)*
- **Density (calculated; Density = F (p,t))**
  - ⇨ *Operational Safety*
  - ⇨ *Early / Proactive Leak Detection*

Proactive Emission Monitoring



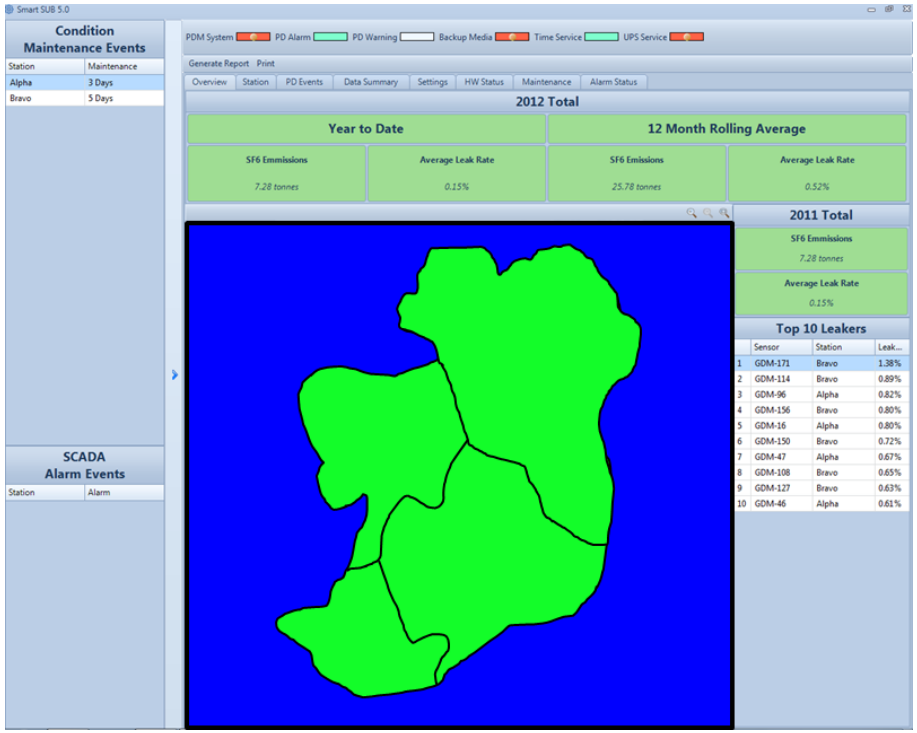


- *Combined* **G**as **D**ensity-**H**umidity **T**ransmitter, digital, MODBUS, (Option: DNP 3.0) - RS485
- High Accuracy of the density signal 0,5 % of full scale over a wide temperature range
- Excellent Long-term Stability
- Early Leak Detection (Operational Safety)
- Leak Trending (Maintenance & Emission Reporting)
- Early Moisture Detection (Operational Safety)

Advanced Technology is the foundation for sound reporting

Nationwide Emission Reporting

Pressure and Temperature Measurement



- **Precise Information**
  - *Density*
  - *Humidity*
- **Early Leak Detection**
  - *Reduces Emissions*
  - *Allow planned outages*
- **Software**
  - *Modular Concept*
  - *Software Platforms*
- **Reporting**
  - *Substation Level*
  - *Utility Level*
  - *Nationwide Level*

Advanced embedded Sensor technology SOP (start of production) in spring 2013

Samples are currently tested in pilot substations worldwide

Identify & Fix

- **Precise Information**
  - ⇨ *Density*
  - ⇨ *Humidity*
- **Early Leak Detection**
  - ⇨ *Reduces Emissions*
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Measure

- **Precise Information**
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  - *Reduces Emissions*
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- **Software**
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Control the corrective action

- **Precise Information**
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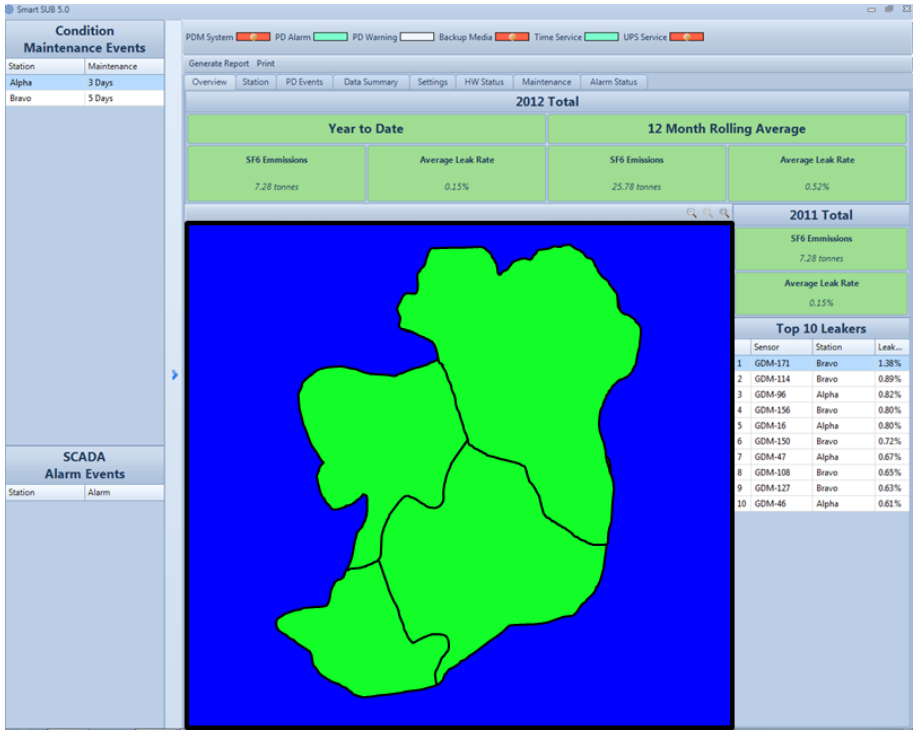
Zero Emission Initative



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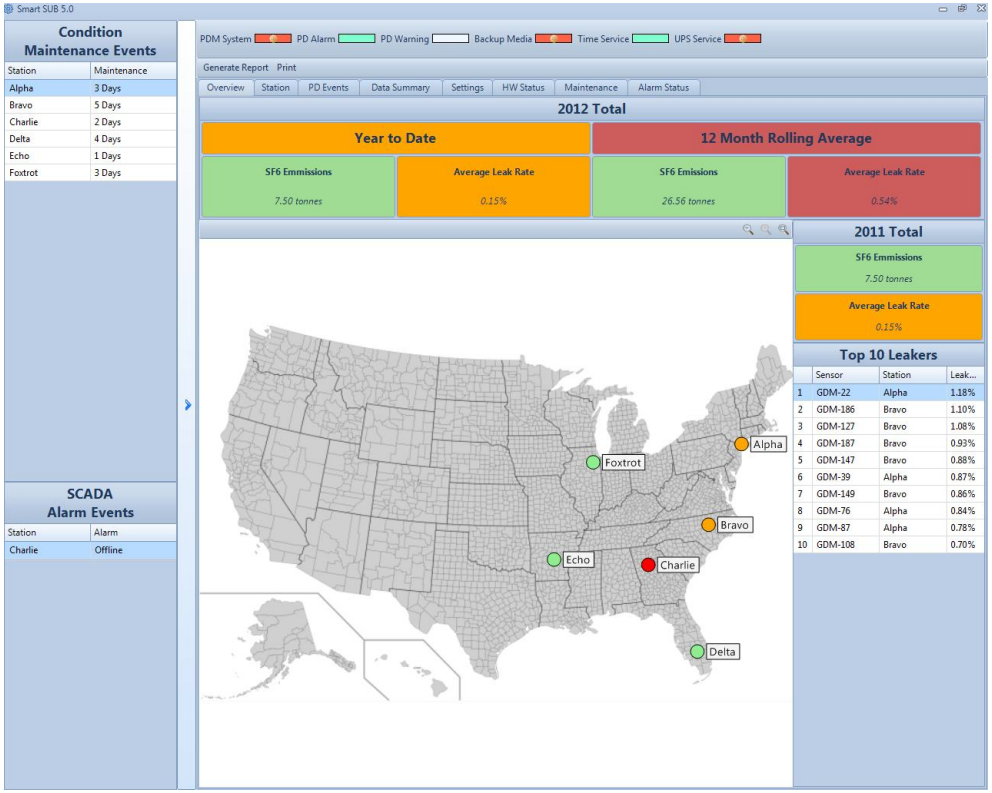
Zero Emission Initiative - USA



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Advanced embedded Sensortechnology SOP (start of production) in spring 2013

Samples are currently tested in some pilot substations around the globe

Conclusion

- **Precise Information**
  - ⇨ *Density (early leak / emission reporting – Fix it now and not later)*
  - ⇨ *Humidity (additional Information = asset protection)*
- **Significantly improve the accuracy of the reporting**
  - ⇨ *In all levels of the reporting scheme*

Example:

(Based on Bank SF_6 = 1.276.000.000 metric tons CO_2 eq. ; see page 4)

Accuracy of the reporting is based on the instrumentation (gauges, leak detectors, transducers, scales, cameras)

A threshold of 10 % of the nominal density means: 132.240.000 metric tones CO_2 eq is emitted before you act.

2,5 % Accuracy allows reporting in a level of ***±33.060.000*** *metric tones* CO_2 eq.

0,5 % Accuracy allows reporting in a level of ***± 6.612.000*** *metric tones* CO_2 eq.

Thats all - Thank you

Questions ?

1 Permanent Measurement

2 Data Aquisition & Communication

3 Computer Aided Signal Analysis