On the road to net zero

How to achieve your emissions target sustainably and with more than just an alternative drive!

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Aebi Schmidt Group

Your global partner for intelligent solutions for clean and safe infrastructure and challenging grounds

aebi | schmidt | nido | arctic | meyer | swenson | mb | monroe | towmaster | elp

Snow & ice clearing

Street cleaning and marking, environmental maintenance

Airport runway clearing

Agriculture

Commercial trucks & trailers

- presence in **16** countries with our own sales & service organisations, in another **90** countries through established partnerships with dealers who in turn serve even more countries
- **3,000** employees
- **14** production facilities
- **935 Mio. €** net sales in 2023

Emissions targets: Municipal equipment is a key piece of the puzzle

The municipal sector is increasingly important in the context of rapid developments to reduce emissions

Importance of the municipal sector

- Global population to surpass 10 bn; more than **70%** will live in **cities**
- **97 % of the EU's urban population** was exposed to emission levels above WHO guidelines
- **Majority of emissions** come from combustion processes
- **Examples of city targets:**

City		Target	
Copenhagen (DK)		2025	Carbon-neutral
Nottingham (UK)		2028	Carbon-neutral
Liverpool (UK)		2030	Carbon-neutral
Munich (DE)		2035	Carbon-neutral
Düsseldorf (DE)		2035	Carbon-neutral

Regulation

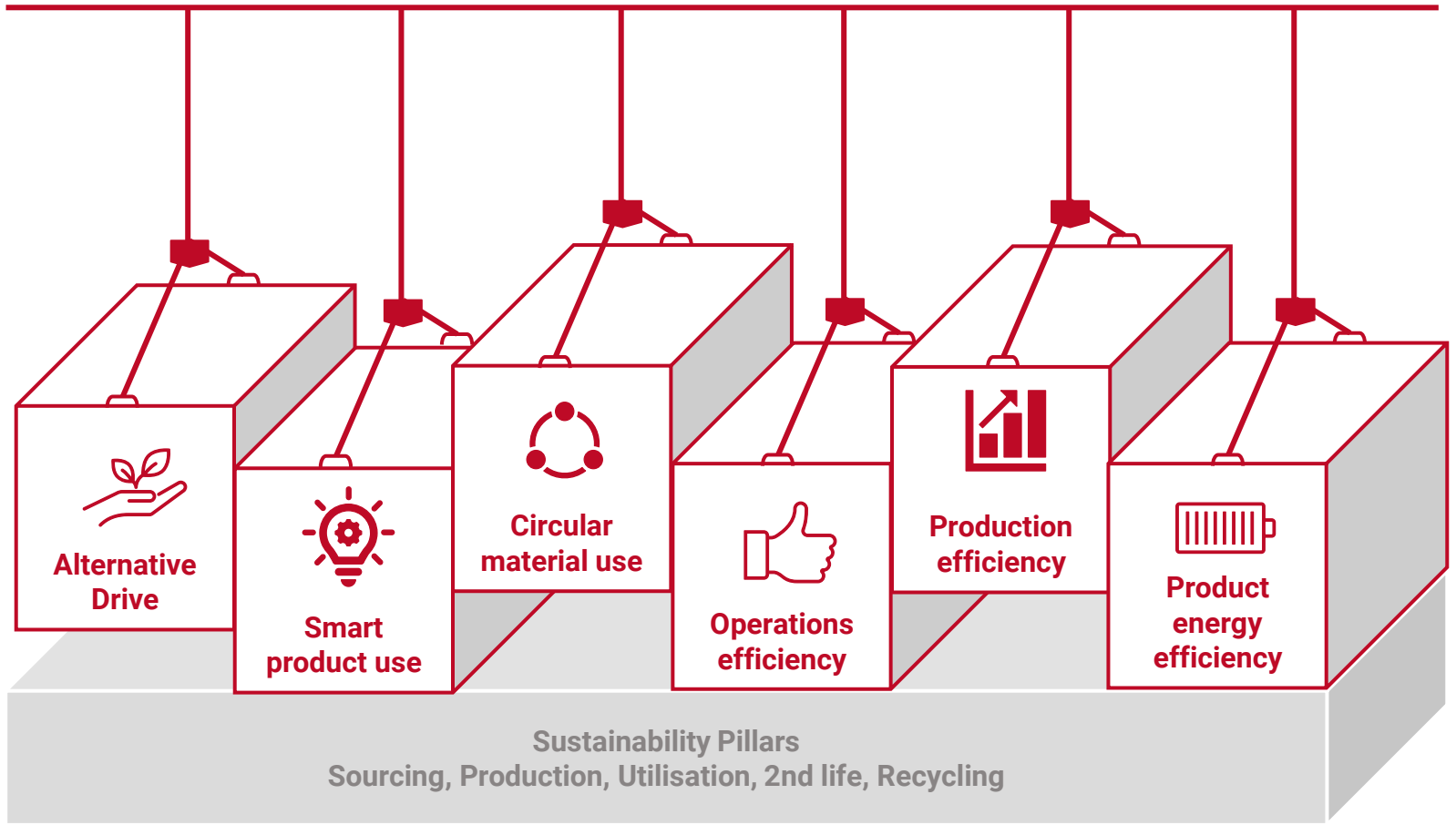
- **Ambitious EU climate protection targets 2030 to 2050**
- **European Green Deal**
  - Achieving climate neutrality by 2050
  - Transitioning to a circular economy
- **Government programs** to embrace the transition:
  - Netherlands - Circular economy strategy
  - USA - Clean energy programs
  - South Korea - Circular economy act
- **Growing public demand for public action by European Union and national and local governments**

Call for Action

- **Cities must act** to maintain clean air for livability & attractiveness
- Lower emissions **improve air quality** by reducing air pollution
- Leading cities in emission reduction **attract** investments & skilled workers

Reduce your own emissions with robust equipment and systems that deliver the reliability you need to operate in all conditions.

Beyond the drive: a holistic approach



Transformative enablers

1. Reliable technology
2. Reliable sales & service network
3. One-stop-shop
4. Critical size for future updates
5. Partnership approach

Our alternative drive product range is diverse

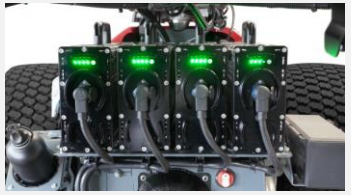
Shift started in street cleaning

Guiding principles (application dependent, excerpt)

Technology assessment	Evaluate the maturity, reliability, and performance of different alternative drive technologies for different kind of machines
Continuous improvements	Conduct rigorous testing and validation, and consider feedback to improve all our products & solutions that meet the needs of our customers
Flexible design	Modular concept with 4 or 6 independent packs for enhanced adaptability, scalability and safety
Enhanced efficiency	For example, 400 V systems in electric carrier vehicles minimise resistance for optimised performance and efficiency
Advanced battery mgmt.	Intelligent Multimaster system for monitoring and optimising battery performance and longevity
Fast charging (DC)	Integrated fast charging interface (DC) to enable swift recharges, alongside the convenience of AC charging
Maximizing range & durability	Implementing system-wide efficiency optimisations to extend operational range & enhance service life

Electric prototype chassis

Full electric winter truck



ASP on electric Volvo chassis

Our new Schmidt eCleango 550 Compact Sweeper

Design, outstanding sweeping performance, and innovation in electric drive system

Cleango 500 › Cleango 550

Heritage

Journey through the history of the Cleango 500.

- Launch of the SM4200 in in Italy in the 80s
- 1995 the SM4200 becomes the Cleango
- Production in St. Blasien (Germany) since 2005
- > 6,000 units produced

Electrification

Electrification of the first 5.2 m³ compact sweeper.

- New electric innovative battery system
- Modular high-voltage battery concept with four or six independent battery packs
- 102 kWh or 153 kWh capacity

Sweeping Performance

Fully electric, compact and robust sweeper.

- Available in 2- or 3-brush system
- Front-mounted pulled disc brush system
- Newly developed side brush kinematics and suction shaft
- Enhanced suction power

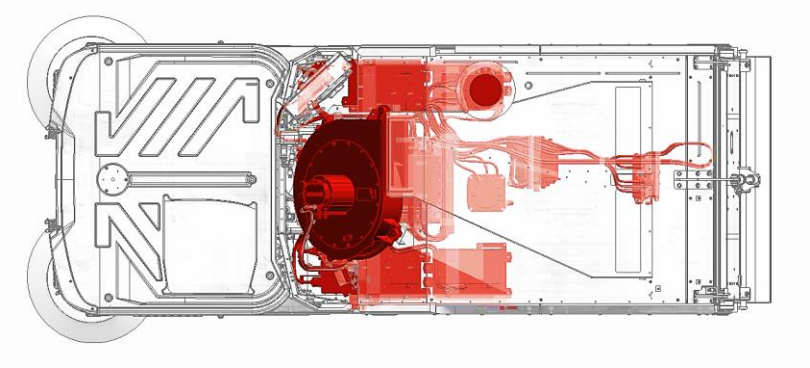
Comfort & Safety

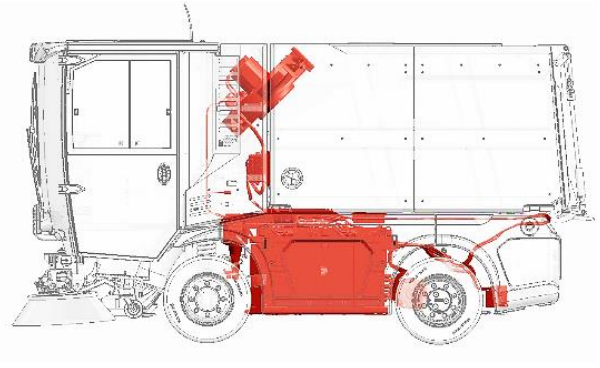
Unique cabin with enhanced safety and comfort.

- High-quality noise and vibration insulation
- Coordinated suspension package ensures a safe and comfortable ride
- ROPS tested
- Optional with air-sprung driver's seat

Our new Schmidt eCleango 550 Compact Sweeper

High-voltage architecture





Modular battery packs: The **modular high-voltage battery concept** consists of either **four** or **six independent battery packs** with up to **153 kWh**. This is the basis for **safe** and **trouble-free operation**.

Power Distribution Unit: Thanks to the **Power Distribution Unit**, the individual battery packs operate as a **complete system**. This enables an **individual** battery configuration **tailored** to the **customer's needs**.

Intelligent battery control: The **intelligent Multimaster battery control system** enables **independent organisation** and monitoring of the high-voltage architecture. This guarantees optimum usage of all resources.

Fast charging: Integrated **fast-charging interface** with a future charging capacity of up to **90 kW (DC)** ensures to achieve **short charging cycles** with **optimum battery protection, guaranteed** by an **integrated battery cooling system.**

Recuperation: During braking, the vehicle converts kinetic energy into electric energy, recharging the battery (motor as generator)

Our new Schmidt eCleango 550 Compact Sweeper

High-voltage battery pack

- **Type**: Li-Ion NMC
- **System voltage:** 400 V (Automotive standard)
- **Capacity** (one pack): 25.5 kWh
- **Temperature range**: -5 °C up to +45 °C
- **Certification**: ECE R100, UN 38.3
- **Cooling:** Liquid cooling
- **AC Charging:** Type 2 Charging socket 22 kW OnBoard Charger
- **DC Charging (Fast):** CCS2 charging socket, Charging power up to 90 kW
- One battery pack works independently, up to 8 connected (150 kWh)
- Outstanding energy density
- Clamp connection to easily replace cells – Innovation for maximum sustainability

Single cells

One battery pack

eCleango 550: German Innovation Award ’24 WINNER

Innovation leader in product performance and electric drives

Jury’s Statement:

„With the all-electric Schmidt eCleango 550 compact sweeper, noise and CO_2 emissions are a thing of the past. The powerful and durable electric drive, with its modular high-voltage battery, operates not only whisper-quiet but also sustainably, matching diesel vehicles in terms of performance and sweeping efficiency. The ergonomically designed cockpit, equipped with state-of-the-art technology, offers maximum seating and operating comfort, while the quiet drive also benefits the operator. A meticulously thought-out concept that perfectly reflects the demands of modernity, sustainability, and performance in its progressive appearance.”

Schmidt eSyntos in combination with Flux Electric Commercial Vehicle

Alternative drives

Schmidt eSyntos Spreader

- Battery with heating system, especially for low temperatures
- > 2 full hopper loads without recharging
- Safe low-voltage 48 V DC system can be maintained without special training or safety measures

Flux Electric Commercial Vehicle

- **Battery capacity**: 112 kWh
- **Real range**: around 300km
- **Engine power**: 140 kW peak / 90 kW cont. Optionally available as 4x4: 190 kW peak / 140 kW continuous
- **Charging**:
  AC up to 22 kW
  DC up to 100 kW
- **Maximum gross weight**: up to 5.5 t
- **Net payload**: up to 2.5 tons

Case study
Alternative drives

Spreader Winter service operations

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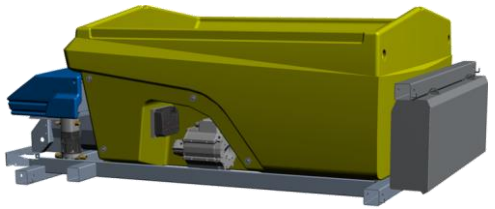
Refurbished Stratos retrofitted to an eStratos, and upgraded to FS 50

eSyntos for delivery in Netherlands (4.1 kWh or 8.1 kWh)



E-Motor, Inverter and Hydraulic pump

Battery

Onboard charger (OBC)

230 V plug

Large truck mounted electric system

Leveraging our partnerships and expertise

Schmidt eAS 990

- Designwerk MID CAB 4x2R 500E (all-electric truck)
- Powerful simple design: Single power supply source simplified design, while delivering sufficient capacity for comfortable sweeping and driving performance
- Sweeping unit PTO-powered
- Electrified main loads for highest efficiency

Schmidt eASP Sprayer

- Volvo FM 62 Rigid Tag Electric
- Vehicle Battery with 360 kWh
- Hooklift system connected to vehicle by ePTO
- Hooklift system provides hydraulic pressure to ASP

Sustainable heavy duty winter service operations

Connecting industries to achieve emission reduction in challenging environments

Visualization | Illustrations not binding

Challenging winter service operations with electric trucks also for highways and country roads

Utilizing full battery electric driven trucks to reduce carbon footprints in demanding winter operations

Pioneering sustainable innovation

Partnering closely with customers and industry leaders to realize challenging new projects tailored to unique operational needs

Sustainable heavy duty winter service operations

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Pioneering sustainable innovation

Partnering closely with customers and industry leaders to realize challenging new projects tailored to unique operational needs

Driver Assistance Systems to save resources

Smart product use: 85 % of the CO_2 footprint during the life-time of spreader is due to fuel and salt usage

Salt Saving

ThermoLogic

Automated temperature-based dosage

- Continuous and automated adaptation of the dosage based on road surface temperature

✓ Up to 15 % spreading material saved

✓ Optimum between safety and efficiency

Salt saving and fuel saving

Route Assistant

GPS controlled spreading and navigation

- Automatic adjustment of dosage & width based on GPS position along a set route
- Driver provides feedback from vehicle to platform

✓ Up to 15 % time saved with Smart Route Guidance

✓ Up to 30 % salt saved

Optimised salt and fuel saving

Route Manager

Online platform

- Create and optimize reference routes
- Define required activities along the route
- Send routes wireless from platform to vehicle

✓ Saving route travel times by optimised routing

✓ Salt savings due to optimised routes

Case study
Smart product use

Norwegian customer Risa AS: Salt usage reduction in winter service operations

- Risa is one of the biggest construction and road maintenance contractors in Norway
- Risa places great emphasis on continuous development of equipment, machinery and working methods
- Risa is using Schmidt spreaders with IntelliOPS, ThermoLogic and Route Assistant to achieve salt reduction

Risa has reported a decrease in salt use of more than 40% – due to the use of multiple systems!

Case study
Smart product use

Norwegian customer Risa AS: Salt usage reduction in winter service operations

Schmidt Tarron and Arctic AM SHJ with secound cutting edge (rubber) to minimize snow and water on the surface before spreading preweted salt on the road

Aebi Schmidt ThermoLogic

- Infrared sensor continuously measures road temperature changes on the surface
- Data transmitted to Control system
- Adjust spreading density automatically to current weather
- Dosage of material adjusted within milliseconds
- Suitable for dry salt, wet salt, spraying and spraying with salt
- ✓ Reduced environmental impact
- ✓ Relief for driver
- ✓ Increased road safety

Case study
Smart product use

Provence of Utrecht (Netherlands) – Winter service operations

PROVINCIE UTRECHT

- Utrecht is one of 12 provinces of the Netherlands with 1.3 Mio. inhabitants
- Equipment for winter maintenance:
  - Main roads: 13 spreaders, 28 ploughs
  - Bike lanes: 12 spreaders, 12 ploughs
  - 1’561 km per action
- Utrecht aimed to improve the quality of winter maintenance and reduce the environmental impact
- Solution by Aebi Schmidt:
  - Route Optimization
  - Route Assistant
- Achievements:
  - ✓ 29% reduction in area to treat per action
  - ✓ 22.5% reduction in kilogram salt usage per action
  - ✓ 1’900 kg CO_2 reduction per action

Studies on optimal brine and salt ratio in winter service operations

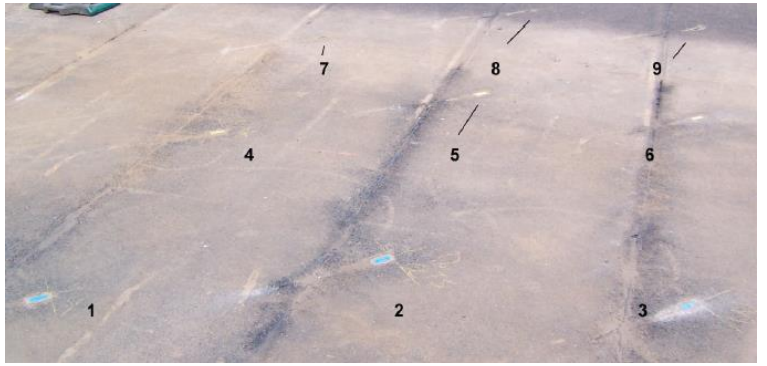
Optimize salt brine ratio

- Studies on distribution of salt on the road, after spreading and after time
- Investigation studies, e.g.
  - 'Distribution of de-icing salt on the road'
    2008 Study. Original title: 'Verteilung von Tausalzen auf der Fahrbahn'
  - 'Thawing Capacity, Freezing Time and High Shares of Brine as Main Factors in the Success of Preventive Winter Maintenance'
    Austrian Study, presented at Piarc Winter Congress 2018
- Pre-wetting concept
  - Dry salt usually mixed with brine (approx. 20% dissolved salt)
  - Currently commonly used is FS 30 ("Feuchtsalz 30"), but very country specific
  - Also FS 50, FS 70 and FS 100 possible (increase brine in mixture)

? How does an optimized brine salt ratio benefit the environment and cost?

Measuring the amount of salt using wet wash vacuum

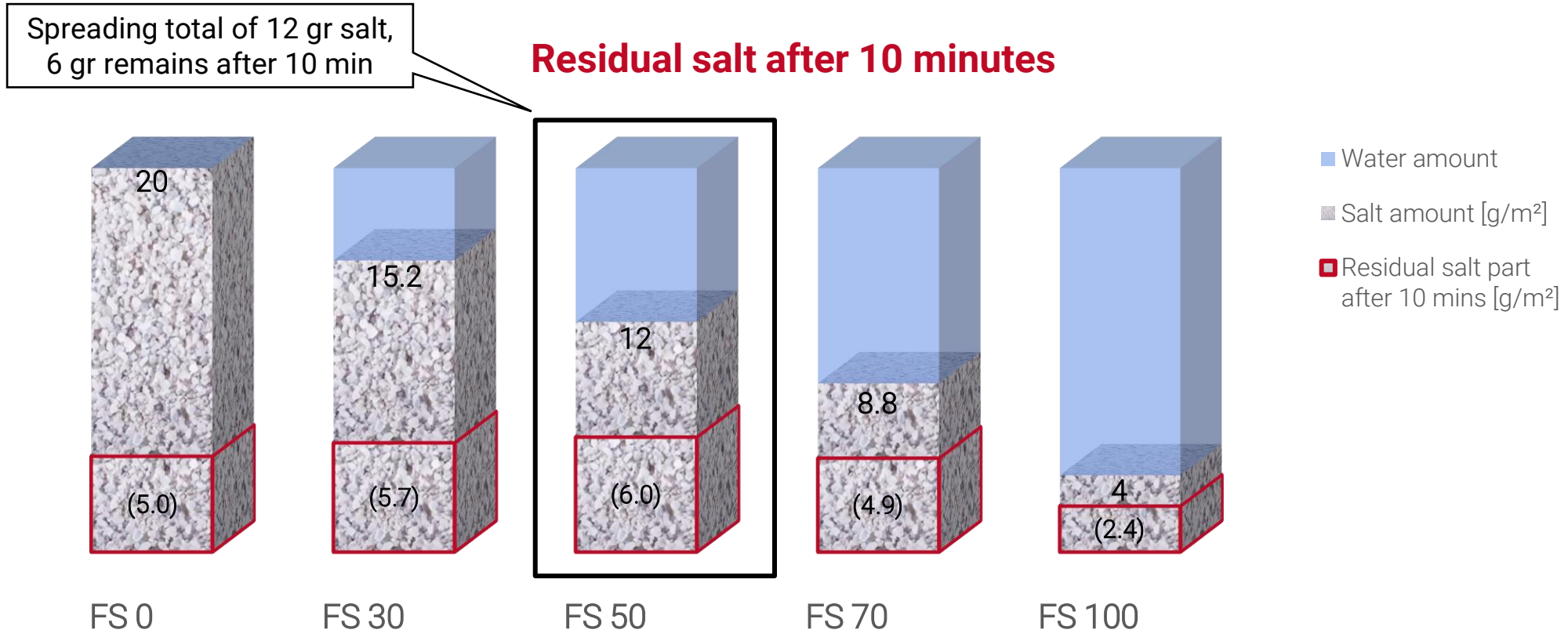
Measuring the amount of salt using sensors (test field, 12 sensors)



Residual salt on road surface

The higher the brine percentage, the more of the spread salt (percentage-wise) still present after time.

- Remarkable: residual salt levels differ for the individual brine percentages
- Higher brine percentage = more residual salt (relative)



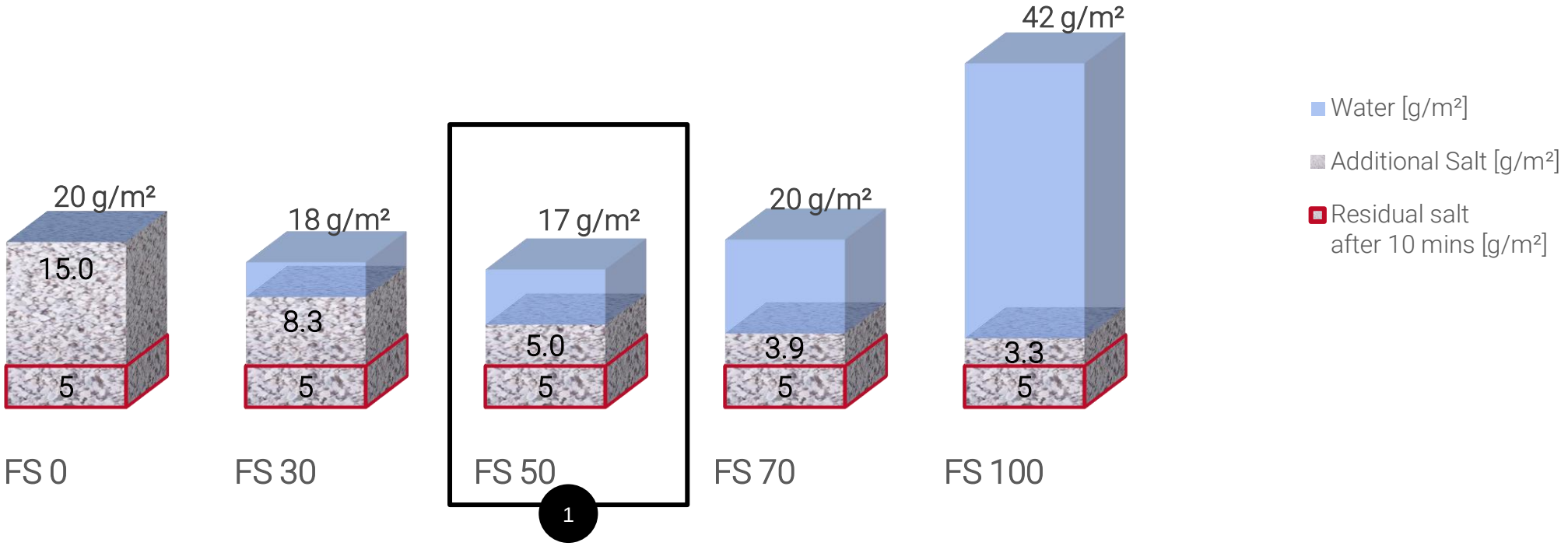
Example for 20 g/m² material dosage setting. Brine contains ca. 20% dissolved salt, adding up to the dry salt amount.

Required dosage for specific residual salt levels

The higher the brine percentage, the more of the spread salt (percentage-wise) still present after time.

- Let's calculate the required dosage per FS setting for a specific residual salt level
- Example: 5 g/m2 residual salt on the road desired

Required dosage for specific residual salt level



Conclusion: FS 50 requires the lowest amount of material, thus most effective

Example: Stratos 3 m³

With optimized hopper/tank ratios the action distance with the FS 50 is similar to the FS 30 version

Optimized hopper/tank ratio for FS 30

Parameters

Weight salt	1'200 kg/m³
Weight brine	1'150 kg/m³
Salt solution	22 %

Data machine:

Salt	3	m³
Brine	1'270	liter
Spreading width	6	m
Dosage	15	g/m² spreading
Dosage	30	g/m² spraying

Pay load:

Weight salt	3'600	kg
Weight Brine	1'461	kg

Results

Methode	Dry salt	FS	FS	FS	Spraying
Dosage	15	15	15	15	30
FS	FS 0	FS 30	FS 50	FS 70	FS 100
Salt in gr	15.0	11.5	9.2	6.8	6.6
Salt m²	240'000	342'857	480'000	800'000	0
Brine m²	0	324'556	194'733	139'095	48'683
Salt km	40	57	80	133	
Brine km		54	32	23	8
Max. dist	40.0	**54.1**	**32.5**	23.2	8.1

Optimized hopper/tank ratio for FS 50

Parameters

Weight salt	1'200 kg/m³
Weight brine	1'150 kg/m³
Salt solution	22 %

Data machine:

Salt	2.1	m³
Brine	2'140	liter
Spreading width	6	m
Dosage	15	g/m² spreading
Dosage	30	g/m² spraying

Increased tank size

Pay load:

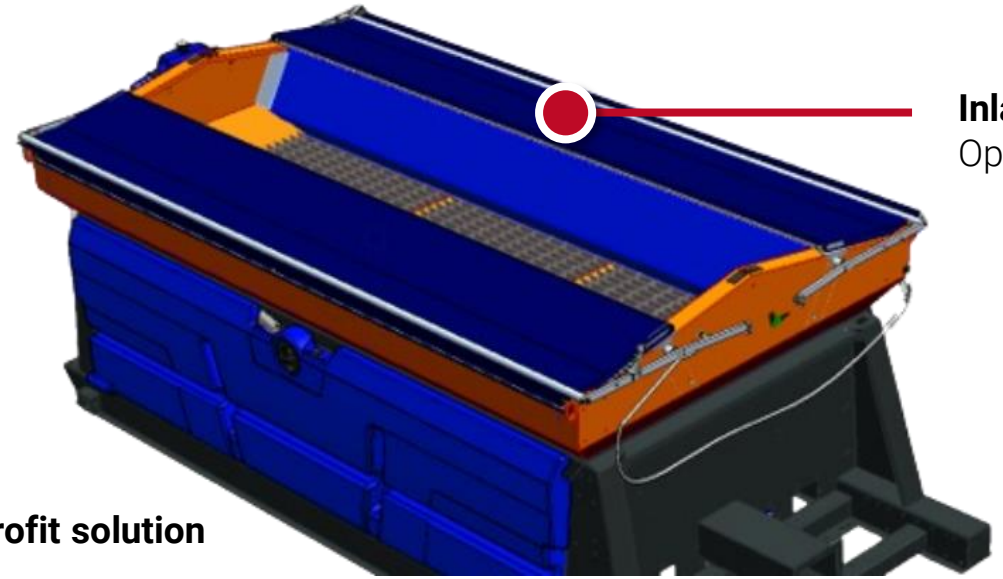
Weight salt	2'460	kg
Weight Brine	2'461	kg

Results

Methode	Dry salt	FS	FS	FS	Spraying
Dosage	15	15	15	15	30
FS	FS 0	FS 30	FS 50	FS 70	FS 100
Salt in gr	15.0	11.5	9.2	6.8	6.6
Salt m²	164'000	234'286	328'000	546'667	0
Brine m²	0	546'889	328'133	234'381	82'033
Salt km	27	39	55	91	
Brine km		91	55	39	14
Max. dist	27.3	**39.0**	**54.7**	39.1	13.7

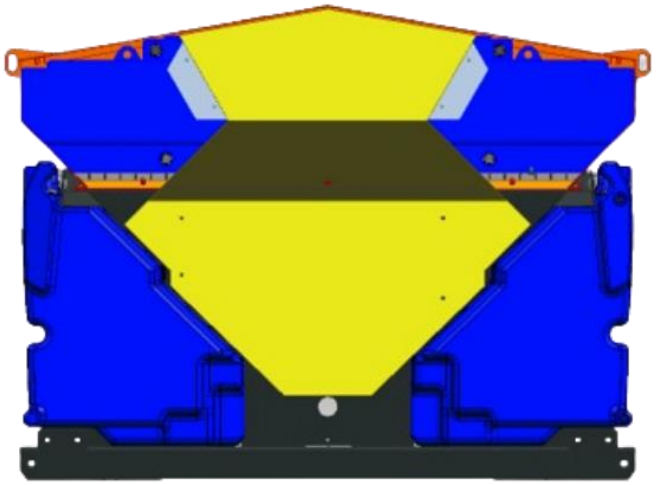
Stratos with FS 50 Hopper

- Studies have shown that use of FS 50 (50% dry salt and 50% brine) have a positive effect on residual salt, and positive results regarding cost savings and environmental protection
- For increased brine share, larger brine tanks are reasonable
- Current hopper / tank ratios are based on pre-wetted salt on the use of FS 30
- Aebi Schmidt will offer the FS 50 optimized hopper / tank ratio as an option on the Stratos Middle and Big Range
- We aim for a retrofit solution



Retrofit solution

Inlaying tanks
Optimized for FS 50



Results of optimization on FS 50 tank hopper ratio (option)

Smart Product Use

Results

- **Salt reduction**: Reduction of salt use (> 20 % compared to FS 30)
- **Cost reduction:**
  - 5 m3 spreader, cost for road salt approx. 120 EUR / t, weight of 6 t
  - **Savings per action: Approx 150 EUR**
- **Operations:**
  - No change in planning (same distance with FS 50 possible)
  - Longer intervals between operations possible
- **Performance:** Higher amount of residual salt on road surface
- **Product:**
  - Retrofit of existing machines
  - Flexibility: Customers can choose Combi functionality (FS 0 – FS 100) also for carrier vehicles such as the Unimog, allowing them to operate one machine during the complete season
- **Environment:** Overall reduced environmental impact

Circular strategies
Increase resource efficiency

Circular strategies (10 R)

Design Responsible use and production	R0	Refuse
	R1	Rethink
	R2	Reduce
Consumption phase Optimal use Preserve and extend life of products	R3	Re-use
	R4	Repair
	R5	Refurbish
	R6	Remanufacture
	R7	Repurpose
End-of-life or return phase Capture and retain value	R8	Recycle
	R9	Recover

Examples (excerpt)

Refuse / Reduce (R0 / R2)

- Optimize equipment size and machine size (consultative approach)
- Reduce routes by optimal routing (Route Manager, IntelliOPS)
- Use sustainable fuels (e.g. HVO) or alternative drives (eSpreaders)
- Reduce salt material with automation applications (up to 30 %)

Repair / Remanufacture (R4 / R6)

- Focus on repair and maintenance to extend life of spreaders
- Refurbished or remanufactured spreaders to save about 85 % of $C0_2$ emission compared to new production
- Remote diagnostics to detect failures early and solve them fast

Sustainable businesses aim to minimise waste & maximise resource efficiency

Circular strategies
Spreader Lifetime Extension

What are lifetime extended spreaders?

- Process as rigorous and qualified as original manufacturing, spanning from maintenance and repair to refurbishment or remanufacturing of equipment
- The machine is brought to the latest state of the art (e.g. control systems)

Current stats

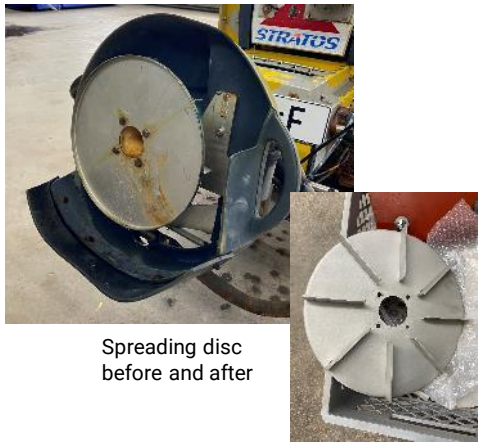
- **> 177** refurbished spreaders & ploughs until 2023
- In total, **> 20 customers** have refurbished spreaders in use (provinces, municipalities & contractors)

Impact on emissions

- Approx. **70 % savings in CO_2 emissions** compared to production with new material

Further actions

- The growing demand for lifetime extended spreaders is shaping the evolution of our product line-up.



Spreading disc
before and after

Stratos 2, Built Year 2005,
Refurbished Spreader

Nido Refurbished Spreader

Case study
Smart product use

Provence of Utrecht (Netherlands) – Winter service operations

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15 refurbished spreaders

34 refurbished plows

Savings per spreading operation based on optimization:

- > - 44 km (-3%)
- > - 1,708,272 m2 (-29%)
- > - 560 tons of salt per winter

Spreading methodology variable wet salt ratio

FS 50 savings: 506 tons of salt per winter

Over total contract period (15 years) savings of 1,900 tons of CO_2 (-25 %)
potential up to 52 %

Conclusions

Embracing sustainable municipal equipment

Profound transformation is unfolding

- Urbanisation is advancing on a global scale
- Cities are at the forefront to set examples and new standards for sustainability
- Regulatory adjustments, both on the EU and national levels, are imminent

Benefits of environmentally friendly and sustainable equipment

- Reduced emissions and pollution
- Reduced noise
- Cost savings
- Enhanced public health
- Attractive urban environment

How to efficiently transform your operations in both summer and winter applications

- Use the complete variety of sustainability pillars
- Take a broad and integrated approach to climate protection, energy, and resource efficiency

Transformation as an opportunity

- View the current transformation not as a challenge, but as an opportunity for growth and progress
- Lead by example and demonstrate commitment to environmental stewardship

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Thank you for your time and interest!