

Mannheim, March^{3rd} 2020

Ag Emobility
Mobile machines on the grid

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FUTURE TECHNOLOGY ZONE



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Agritechnica – JD's Future Technology Zone Exhibits and Technology Fields



Autonomous Electric Tractor

- Automation & Autonomy
- Electrification



Autonomous Sprayer

- Artificial Intelligence
- Automation & Autonomy



See and Spray

- Artificial Intelligence



Large Spraying Drone

- Automation & Autonomy
- Electrification



Autonomous Drone Sprayer

- Automation & Autonomy
- Electrification



Command Cab

- Artificial Intelligence
- Automation & Autonomy



Zero Emission Compact Utility Tractor

- Electrification



eAutoPower

- Electrification



Semi-Autonomous Tractor

- Automation & Autonomy

Electrification - Key Enabling Technology

- Efficiency
- Controllability and dynamic response behaviour

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EXACTEMERGE



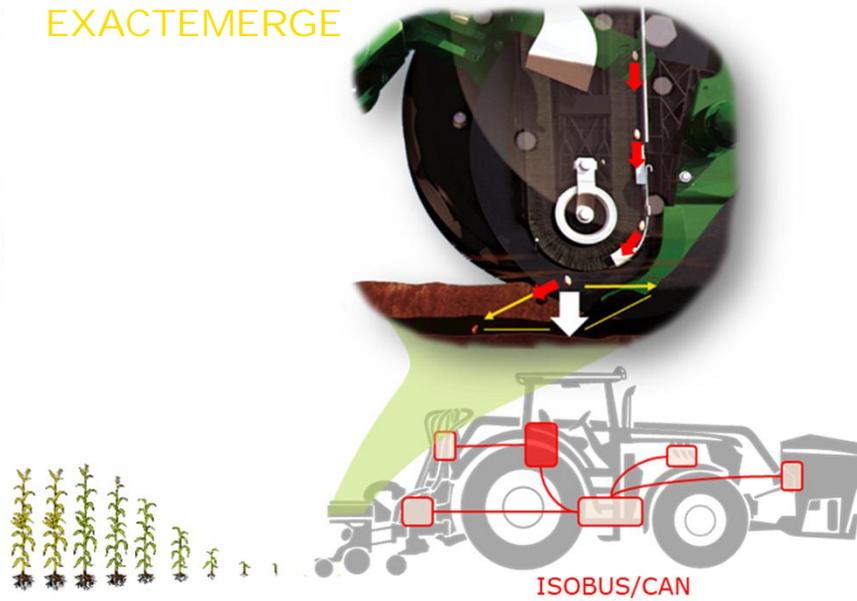
Electric system characteristics

- 48 V PTO generator or high power AEF connector
- 2 servo-motors per row unit

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JOHN DEERE

EXACTEMERGE



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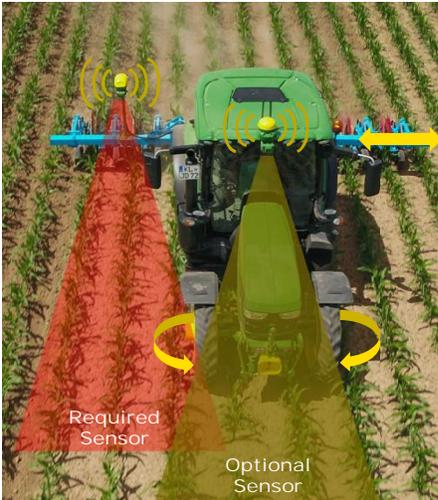
ISOBUS/CAN

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TRACTOR INTEGRATED ACTIVE IMPLEMENT GUIDANCE Steering Tractor & Cultivator precisely

- Detecting crop rows
- Calculating offset to plants
- Guiding tractor & cultivator



- Maximize weeding success
- Minimize plant losses



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ALTERNATIVES

Seeding robot (Fendt)
Bonirob (Amazone et al.)
Naio
Ecorobotix
...



Herbicide robot (Ecorobotix)



Herbicide system (Blueriver T /John Deere)

But also Blueriver Technologies (John Deere)

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Electrification - Key Enabling Technology

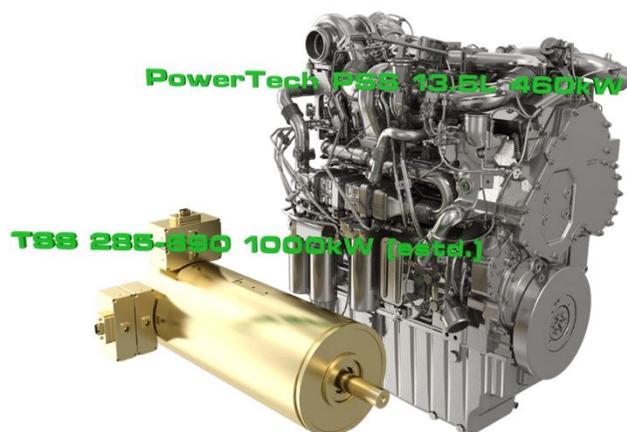
- Efficiency
- Controllability and dynamic response behaviour
- Increased power density

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TSS285-690 vs PowerTech PSS 13.5



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Electrification - Key Enabling Technology

- Efficiency
- Controllability and dynamic response behaviour
- Increased power density
- Using renewable energy

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SESAM-Farm Vision

Decentralized
Energy Supply
in Rural Areas



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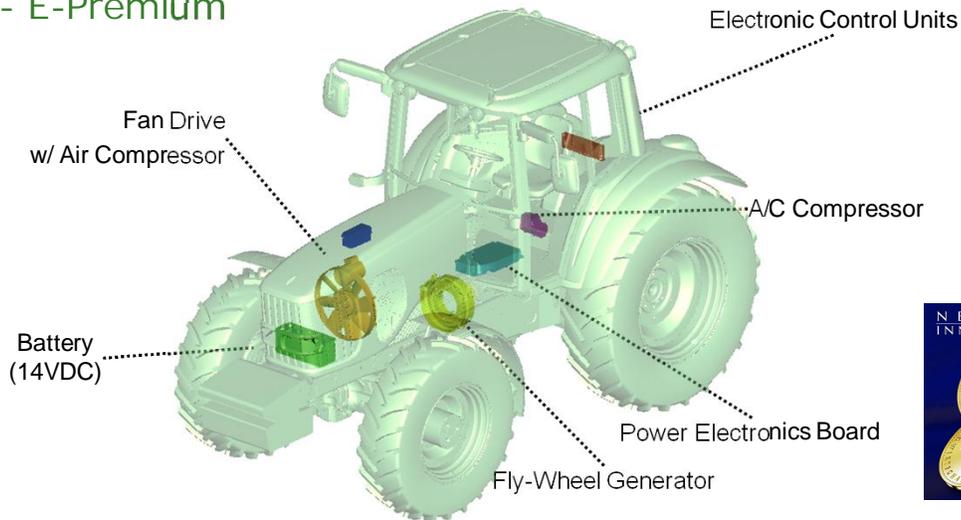
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International Green Week Berlin, Jan. 17th-26th 2020

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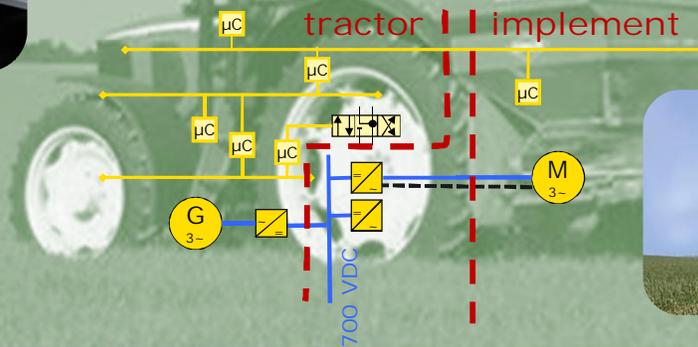
History – first milestones 2007 - E-Premium



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Automation – The electric vision (Rauch Axis EDR)



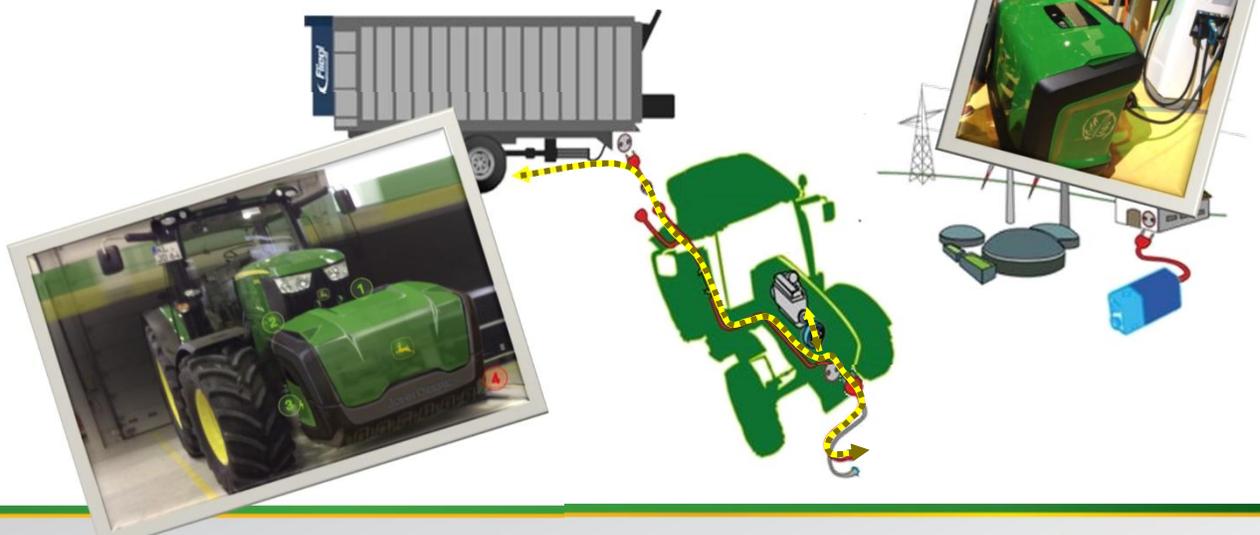
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BatteryBoost at SIMA

Grid plug-in hybrid tractor with a battery change system

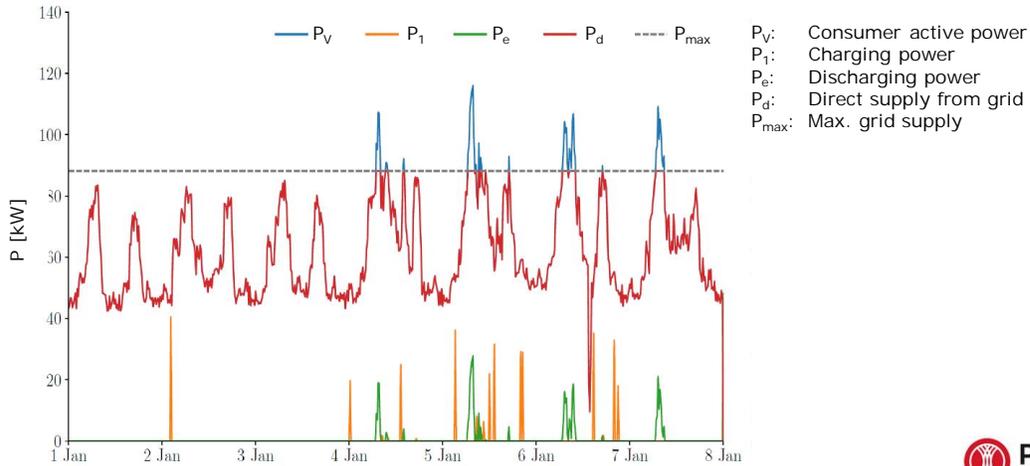


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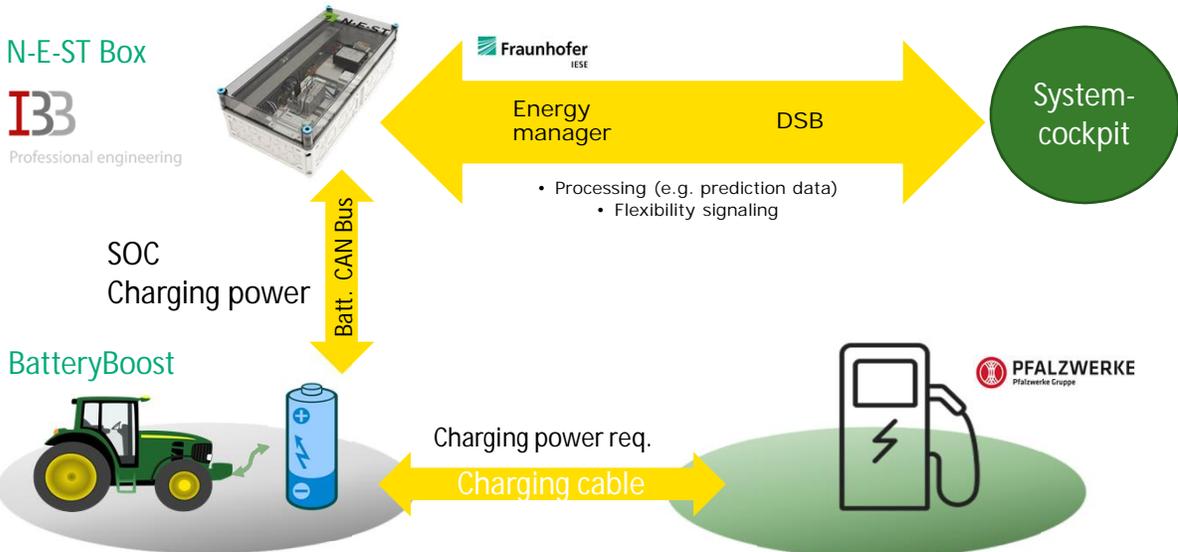
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„Peak shaving“ with Battery and model based predictive control



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Infrastructure



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Overview

Engine off


Electrical engine boost


Grid integration


BatteryBoost hybrid tractor features

- Filling processes
- Comfort applications
- Intelligent power supply

- Boost at all speeds
- Range extension
- Smoothing transient engine operation
- Recuperative braking

- Cost effective integration through CCS 2
- Energy / capacity trading
- Emergency power generator
- Battery exchange concept
- Smart power/energy management

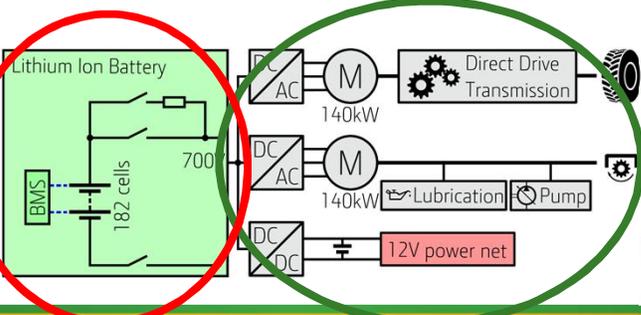


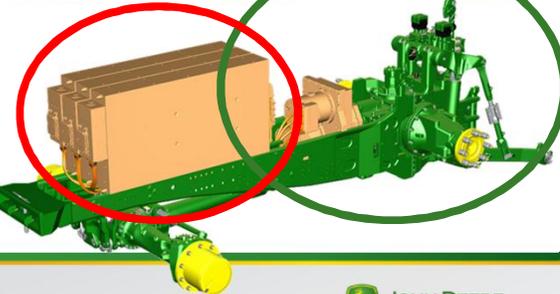


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Fully battery electric tractor SESAM tractor concept 2017



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The inherent dimension problem of tractor batteries

Rated power	kW	50	180	290	380
Operational time/day	h	4	10	12	12
Req. battery cap. ¹⁾	kWh	100	900	1740	2280

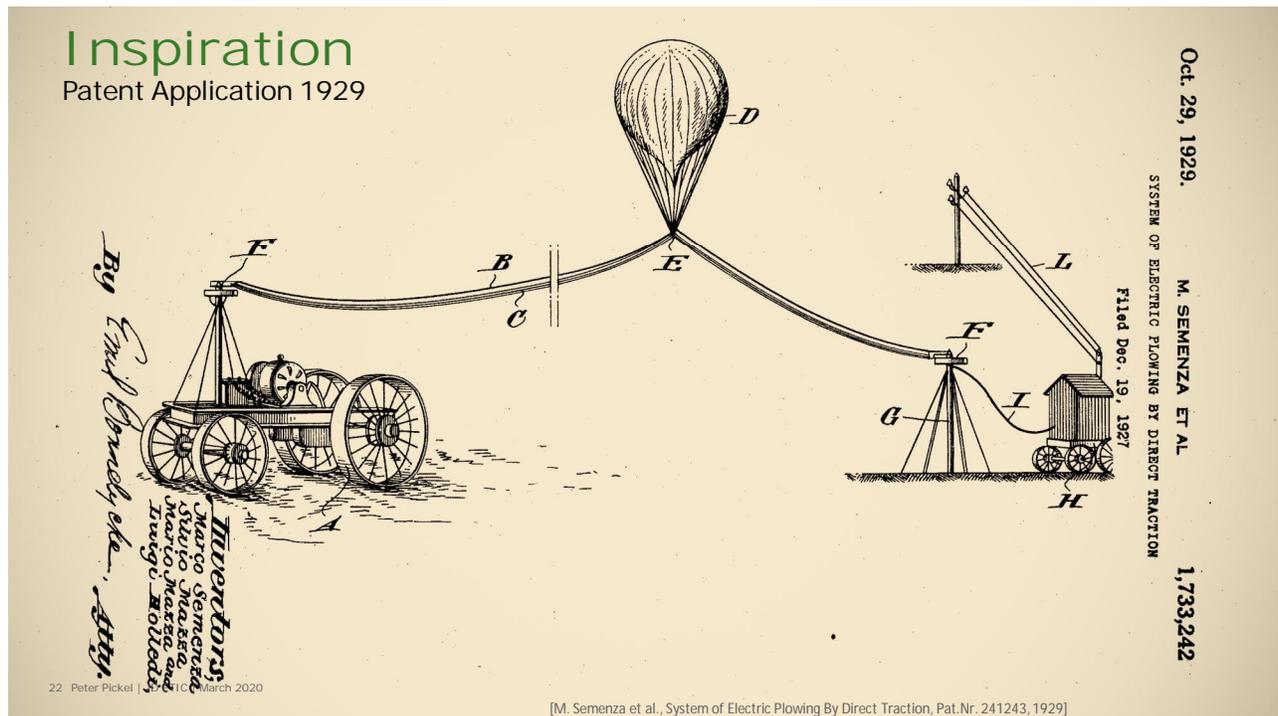
¹⁾ at 50% utilization

Battery dimension



Assumptions:
 ca. 6,6 kg/kWh (for comparison: SESAM bei ~10 kg/kWh)
 ca. 2,2 l/kWh

Source: Fendt / AGCO - modified





Overcoming Limits of Onboard Batteries

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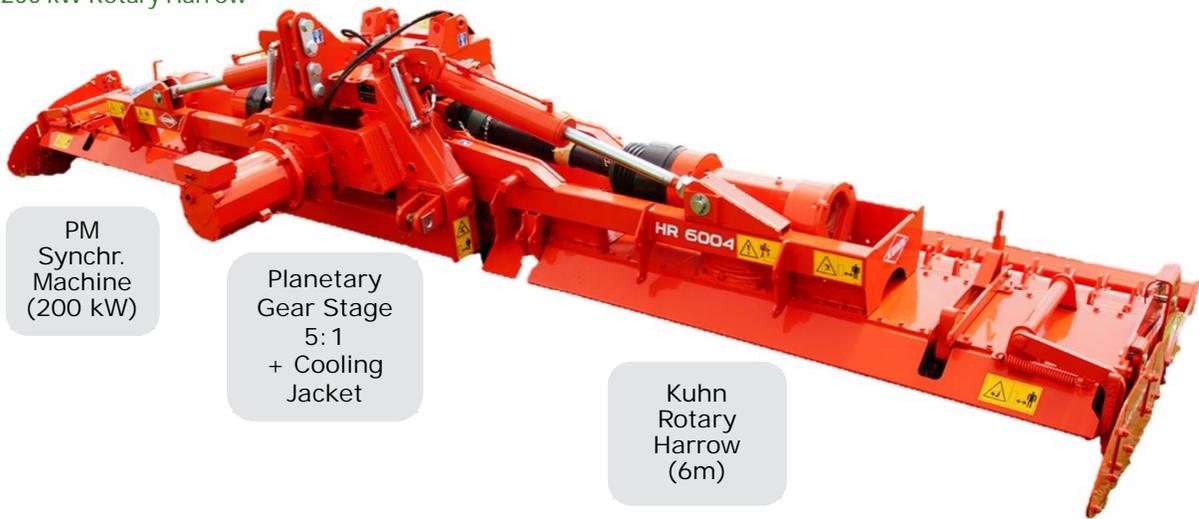
Corner Stones

Machine Performance	200%
Power Density	200%
Machine Cost	50%
Operating Cost	50%
Applicability of Renewable Power	up to 100%
Supports different stationary power sources	Power grid Battery Generator

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Electric Implement

200 kW Rotary Harrow



PM
Synchr.
Machine
(200 kW)

Planetary
Gear Stage
5:1
+ Cooling
Jacket

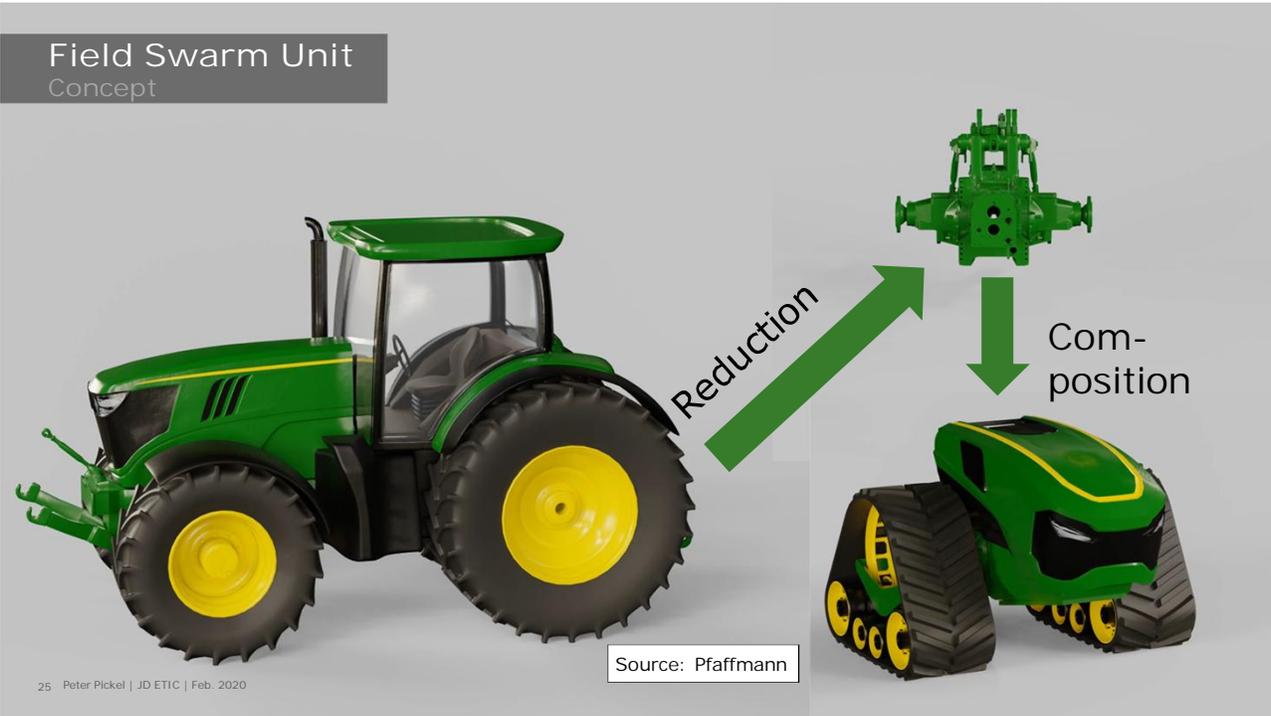
Kuhn
Rotary
Harrow
(6m)

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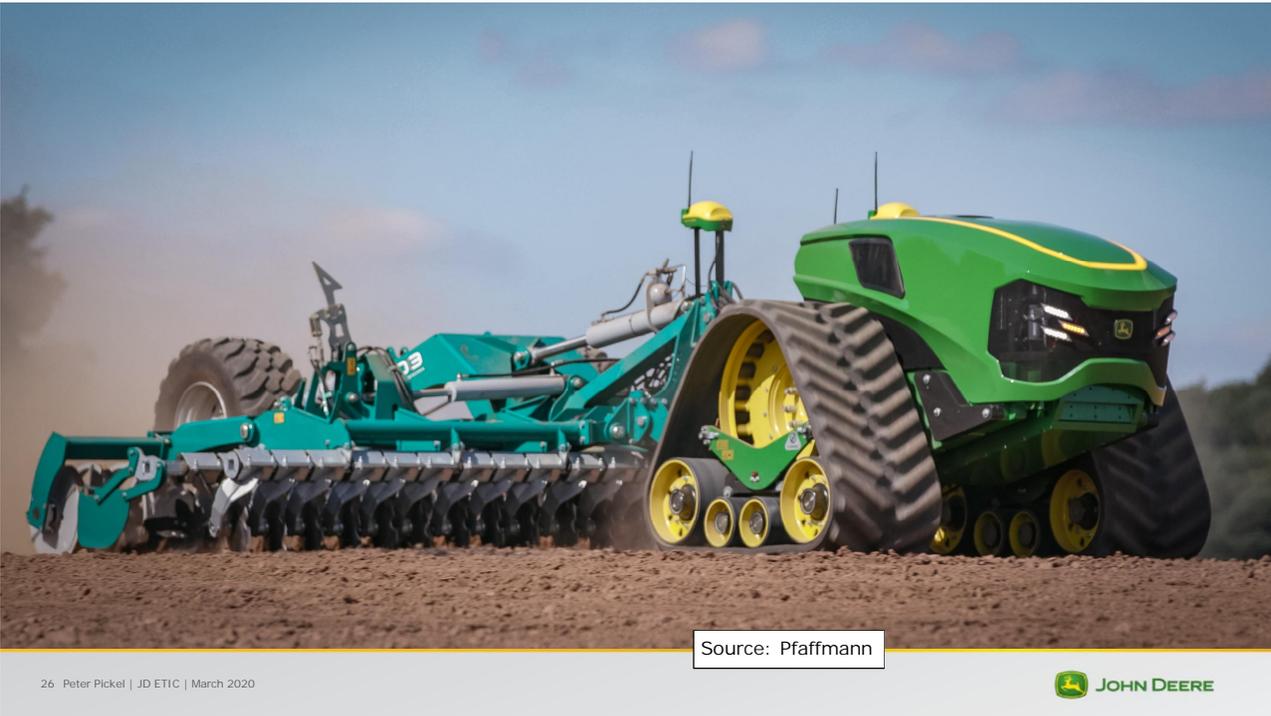


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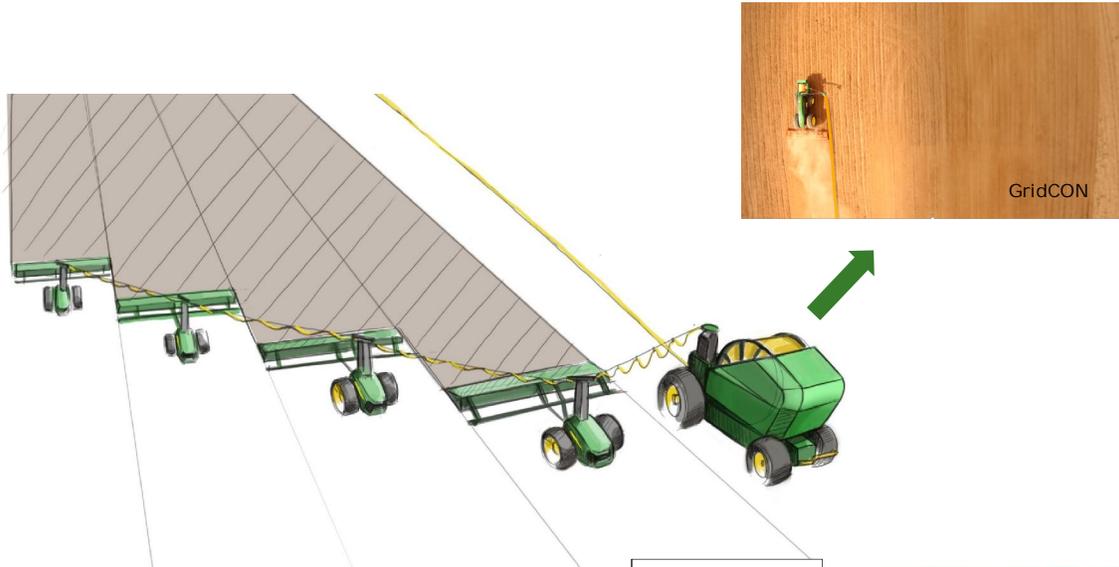


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John Deere Field Swarm Vision



Source: Pfaffmann

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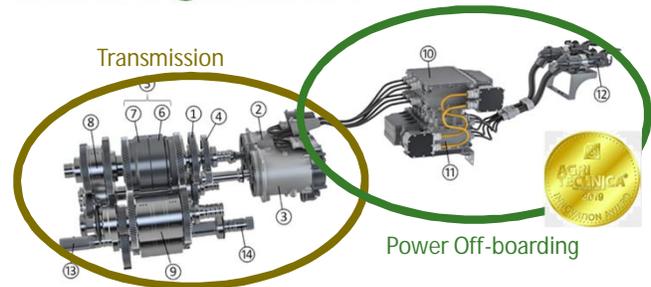
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7 Key Theses for Electrification in Agriculture

1. Electric power trains are the future

- effectivity
- controllability
- access to renewable energy
- power density



2. Tractor-implement-electrification important driver (*hen and egg problem*)
3. Hybrid systems depending on need for boost power (not range extenders)
4. Still missing business case and poor energy density for battery electric ag machines
5. Grid services and increase of self-supply with grid-plug-in systems as new (secondary) business cases in agriculture
6. CCS2 standard needs to provide bidirectional power flow
7. Cable powered machines are still visionary