Electric Drives Potentials on Tractors and Implements

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John Deere
Global Tractor Electronic Engineering
8 July 2010

Agenda

- John Deere E-Premium
- Tractor / Implement Electrification
- Design Criteria
- Summary & Vision

E-Premium 7430 and 7530

Intro at Agritechnica in 2007

First Electrification in series production within Ag

Catalyst for Electrification within Ag

Awards:

Agritechnika Gold Medal

FIMA Gold Medal

Royal Show Award

...

6030 E-Premium: vehicle features

- Flywheel mount 20kW generator

- High power 14 V system, 300amps cont.

- Full reversible radiator fan drive (screen cleaning)

- Mobile power generation
  - utility tools
  - emergency power supply
  - 230V 1-phase / 400V 3-phase

- Auxiliary power management to reduce parasitic power losses

- Engine rpm independant cab cooling

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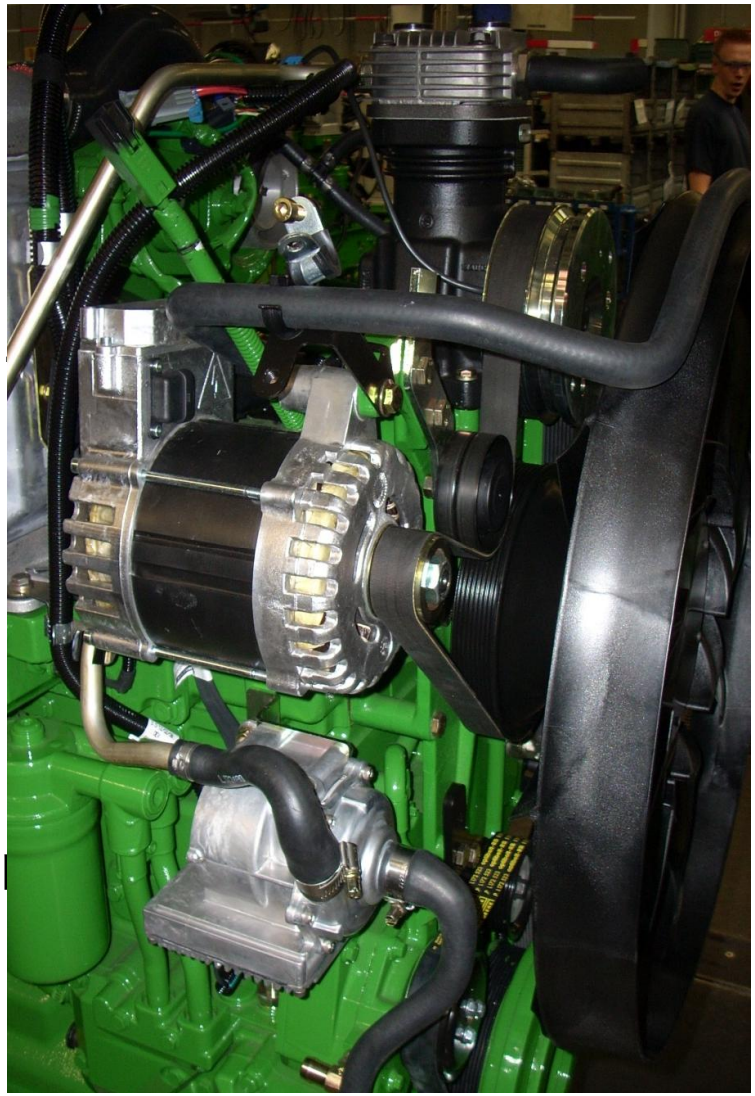

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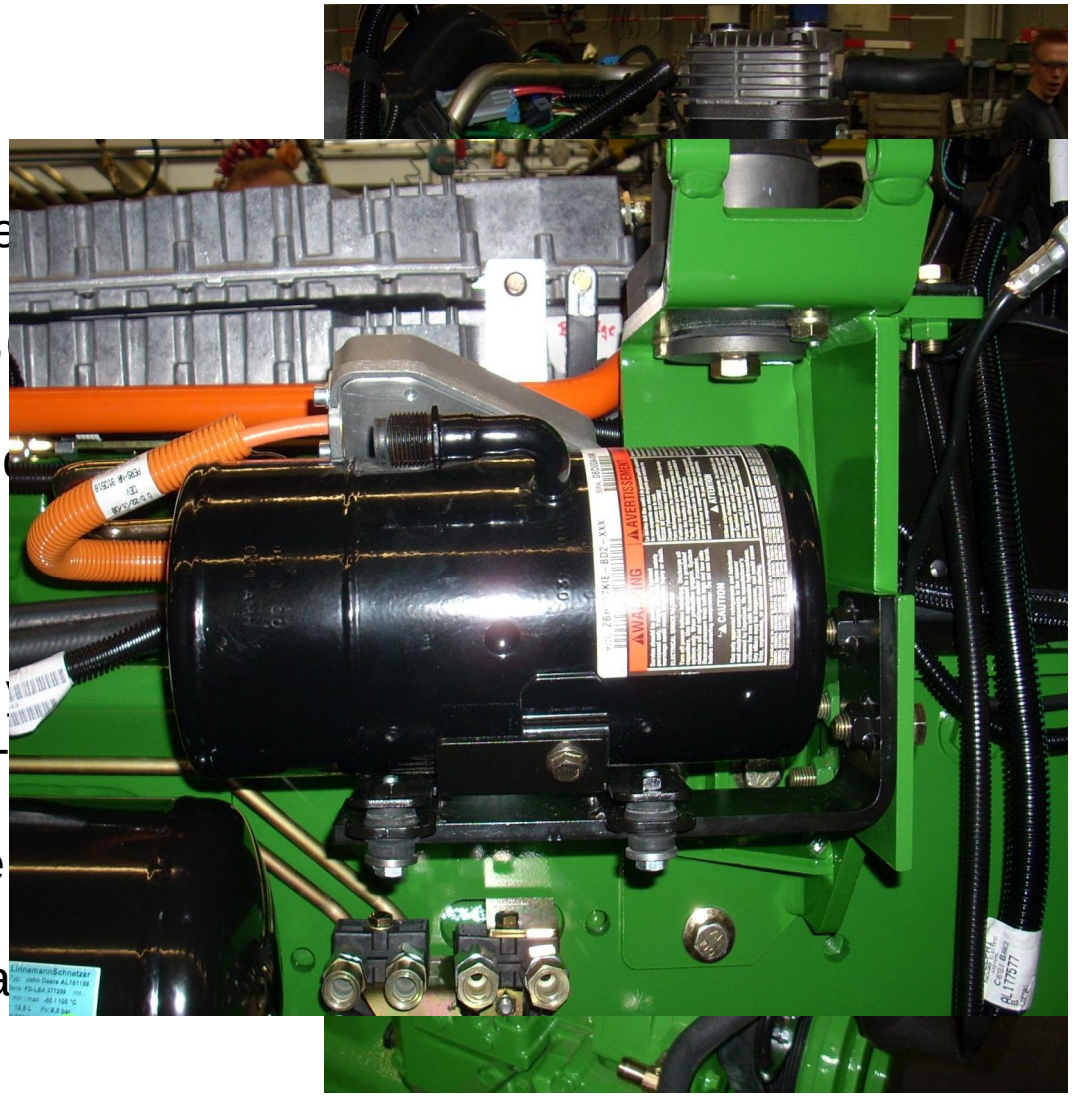

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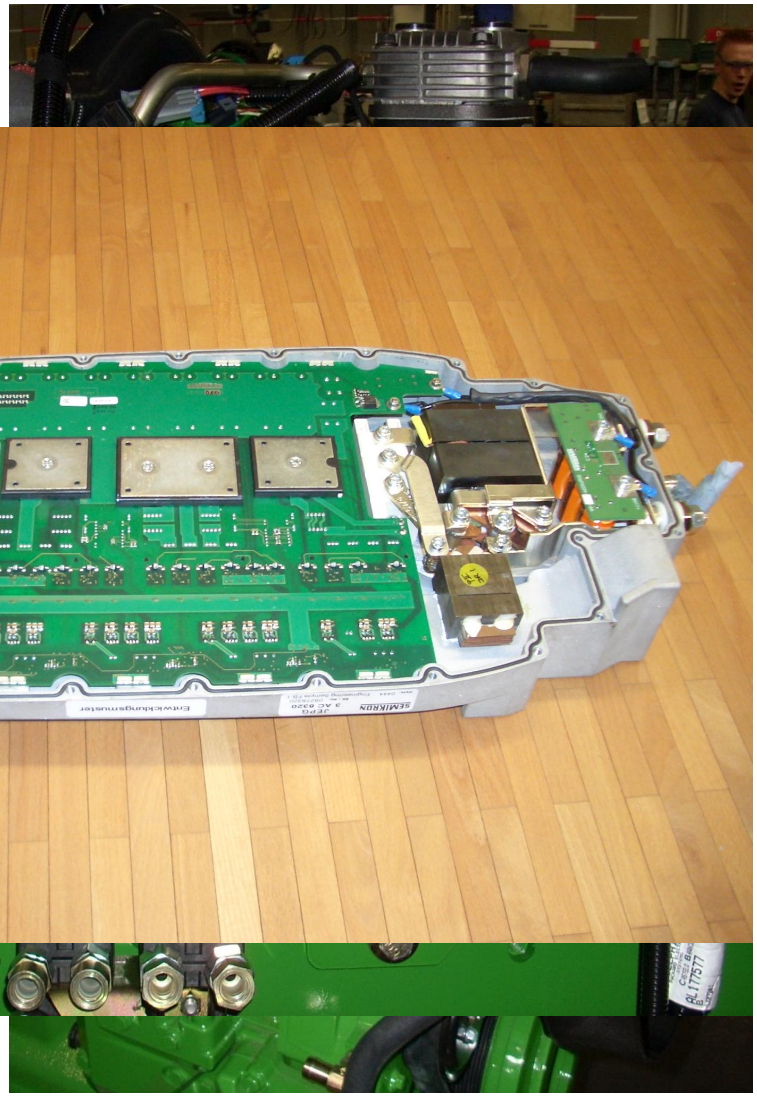
6030 E-Premium: vehicle features



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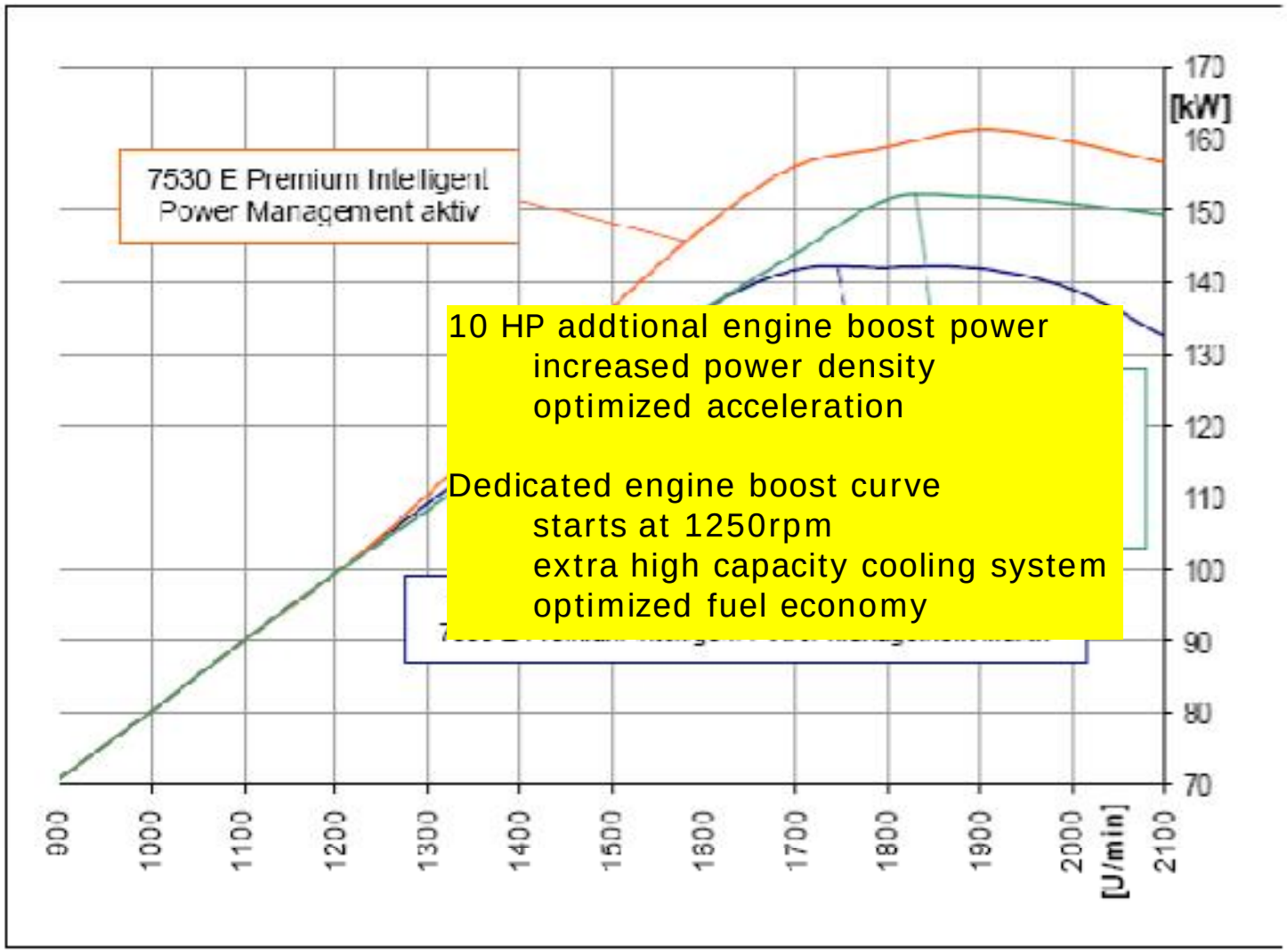

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Electrification of Auxiliaries: What‘s next?

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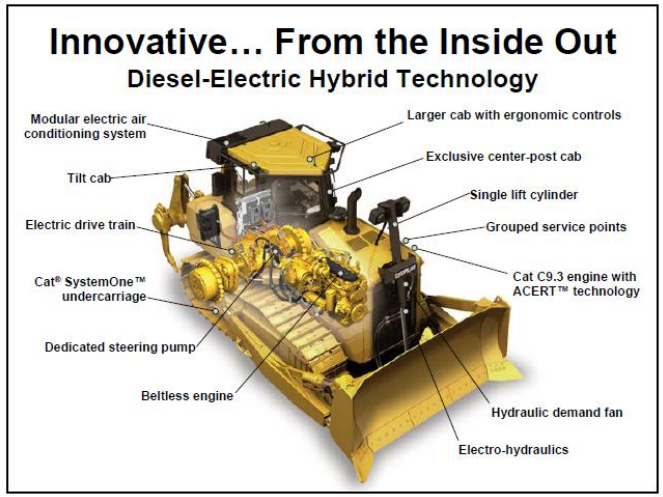
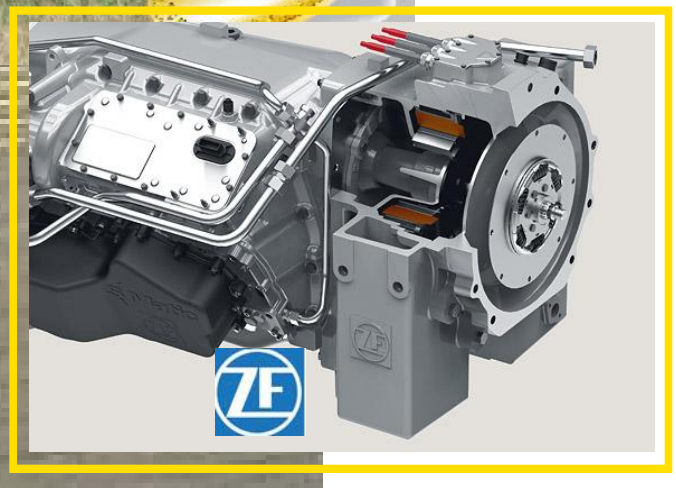
A Trend?


www.landwirt.com


AXIS


Innovative… From the Inside Out
Diesel-Electric Hybrid Technology
Modular electric air conditioning system
Larger cab with ergonomic controls
Exclusive center-post cab
Tilt cab
Single lift cylinder
Electric drive train
Grouped service points
Cat® SystemOne™ undercarriage
Cat C9.3 engine with ACERT™ technology
Dedicated steering pump
Beltless engine
Hydraulic demand fan
Electro-hydraulics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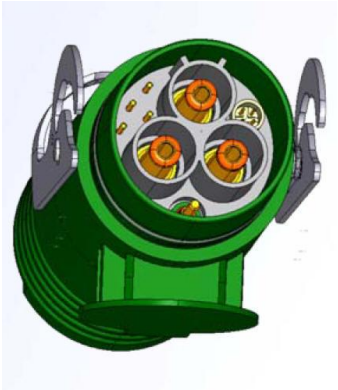
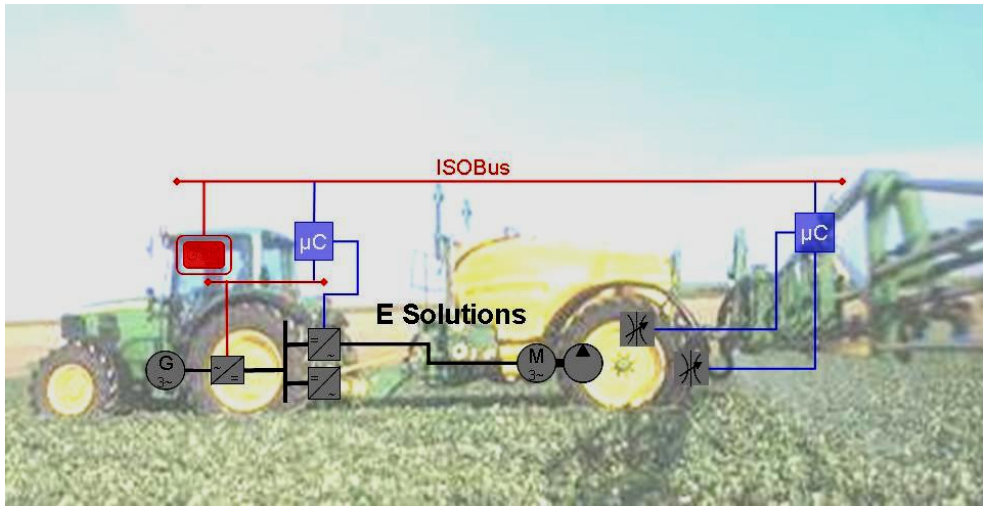
Vision: Next level of Electrification

Electric power for Implements





Targets:

- Enhanced plug-n-play
- Increased power density
- Controlled power distribution
- Reduced input costs
- Optimized implements, better output quality

Electrification: Control and Distribution of Power

A New Idea?

EQUIP YOUR

Farmall 450

WITH

IH Electrall

PORTABLE POWER
Gives you "highline" power wherever your tractor will go

STANDBY POWER
Provides stand-by power in case of highline outage

MOBILE POWER
Drive balers and other machines with electric power

IH Electrall is a high-capacity electric generator that you can mount on your Farmall 450. It furnishes 115-volt and 208-volt single-phase service and 208-volt three-phase service. Output rating is 12.5 kva. This capacity lets you use your time-saving electric tools, and motors up to 10 hp, wherever your tractor will go; powers your house and barn equipment during highline failures; and drives a McCormick 55 baler, or other machines equipped with Electrall motor.

(Above) When the power line fails, just plug in Electrall to prevent financial loss and inconvenience. It supplies power to keep the farmstead fully electrified.

(Below) Electrall powered baler is started and stopped by an on-off switch. Electrall motor is completely enclosed and waterproof, readily transferred to other jobs.

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Farmall 400, 1954

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... should we really continue this way?

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15

... or is there a vision?

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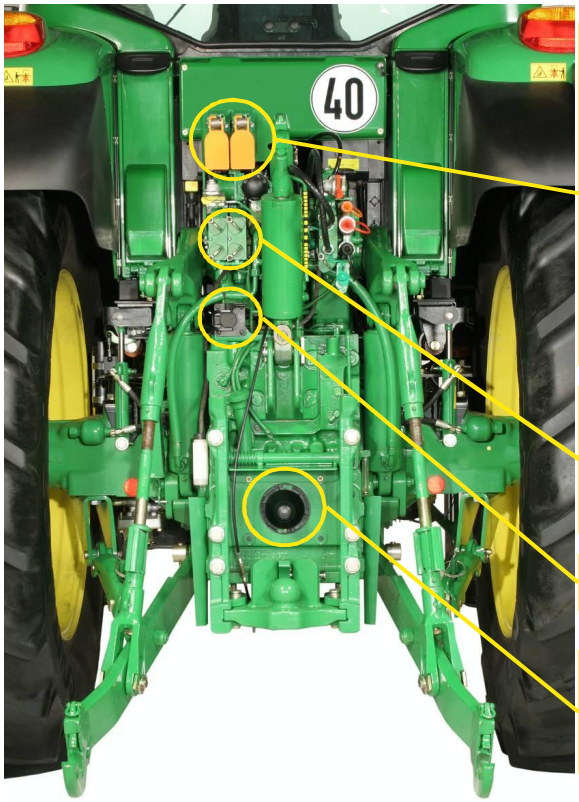
16

Electric Power Interfaces: A complement



Electric Power
(e.g. 2x 150kW),
integr. communication
and 14V supply for
controller on implement

Hydraulic Power
(e.g. 40k

ISOBUS

Mech. Po
(e.g. 150

Modes:

- Implement sends demands
  - Tractor sets voltage / frequency
- Tractor provides constant U/f
  - Implement integrated power electronics
- ...

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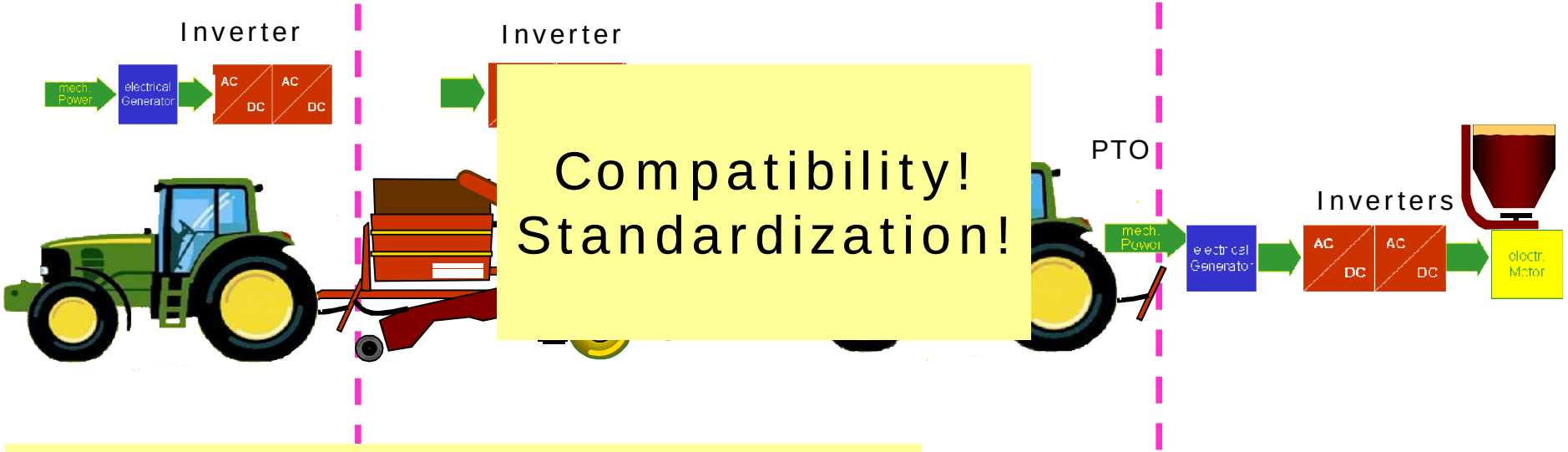
17

Tractor / Implement Electrification Architectures

„traditional“ tractors:
Implement integrated generator
Control and Distribution on Implement



Compatibility!
Standardization!

most common case:
Tractor integrated power generation
Control and Distribution on Implement

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18

Implement Example – Sprayer

Source: K. Hahn: High Voltage Tractor-Implement Interface, SAE Commercial Vehicle Engineering Congress , 2008

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Pneumatic Planter

Hydr. Fan Drive

12V metering drive

Hydraulic Pump

Source: N. Rauch: Mit elektrischen Antrieben Traktor-Geräte Kombinationen optimieren, VDI Profi Tagung, Feb. 2010

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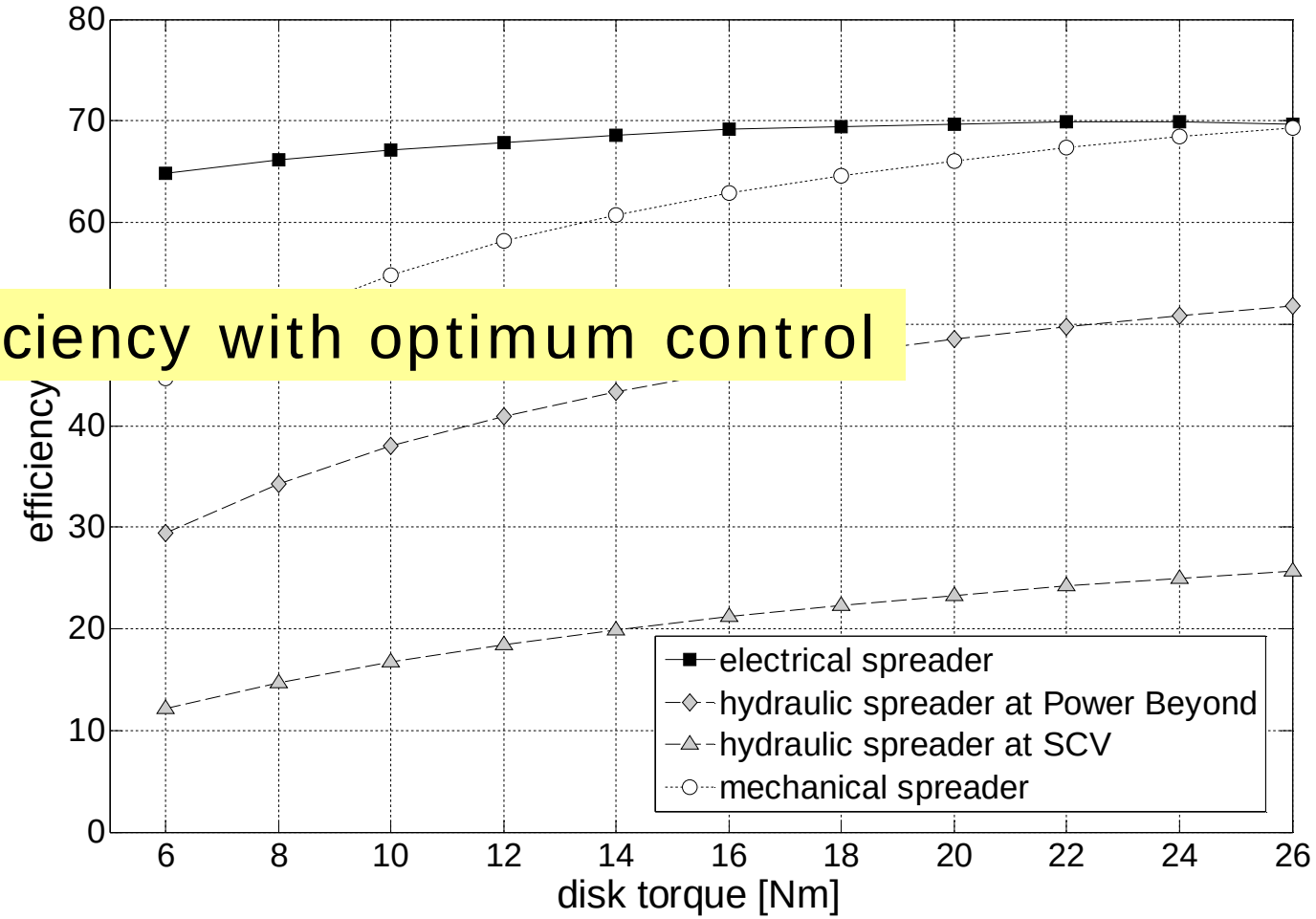
Rauch EDR fertilizer spreader

Source: N. Rauch: Mit elektrischen Antrieben Traktor-Geräte Kombinationen optimieren, VDI Profi Tagung, Feb. 2010

Rauch EDR fertilizer spreader

„clearly arranged“ coupling

Best efficiency with optimum control



Source: N. Rauch: Mit elektrischen Antrieben Traktor-Geräte Kombinationen optimieren, VDI Profi Tagung, Feb. 2010

Design Criteria

Voltage level

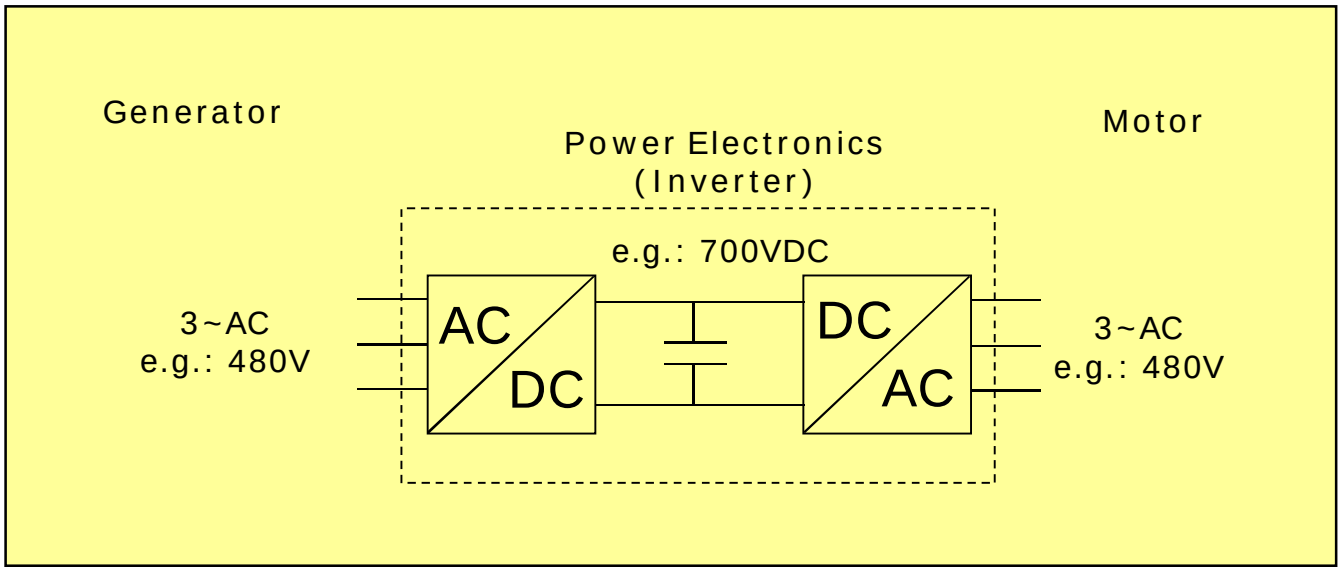
- power level to be considered
- technology from industrial automation
- components from automotive applications

Safety

- to be ensured during design, manufacturing, operation & service
- safety by system design
- system design has to avoid need for educated personal in service

23

Design Criteria: Voltage Level



- Costs for power electronics driven by current level
- same relations apply from 50…1000VAC (75…1500VDC)
- 400/480VAC common in industry/on farms
- e.g. 100kW @ 480VAC: 50A; 6mm^2…10mm^2

- Automotive e.g.: 300VDC (Prius 2002) to 700VDC (Lexus 2009)

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Design Criteria: Automotive target costs

Automotive Industry:

Electric Propulsion System with a 15-year life capable of delivering at least 55 kW for 18 seconds and 30 kW continuous at a system cost of $12/kw peak by 2015.*

Susan Rogers, Manager Vehicle Technologies
Program: Energy Efficiency and Renewable Energy
U.S. Department of Energy
Feb 28, 2008

Traction drive system: motor, power electronics, wiring harness, 30 (50) kW

Design Criteria: Automotive target costs

Automotive Industry:

	Power Electronics			Motor			Traction Drive System				
	($/kW)	*(kW/kg)*	*(kW/l)*	*($/kW)*	*(kW/kg)*	*(kW/l)*	*($/kW)*	*(kW/kg)*	*(kW/l)*	*Efficiency*	*Coolant*
Targets											
2010	7.9	10.8	8.7	11.1	1.2	3.7	19	1.06	2.6	>90%	90°C
2015	5	12	12	7	1.3	5	12	1.2	3.5	>93%	105°C
2020	3.3	14.1	13.4	4.7	1.6	5.7	8	1.4	4	>94%	105°C
Traction Drive System Efficiency Target is for 10% -100% speed @ 20% of Rated Torque											

Susan Rogers, Manager Vehicle Technologies
Program: Energy Efficiency and Renewable Energy
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Traction drive system: motor, power electronics, wiring harness, 30 (50) kW

Summary & Vision

Electric drives have entered the arena of Ag machinery

- Tractor
  - Engine Auxiliaries
  - Traction Drives
- Implement
  - Control and Distribution
  - New Implement Topologies (compare to industrial automation)
  - Optimized attachment, plug&play
  - Enhancement to ISOBUS and Automation

Summary & Vision

- Tractor/implement system electrification

  - Technology transfer from automation industry

  - Agricultural System Engineering will apply technology to optimize processes and reduce input costs

  - Obvious system level benefits of electric drives will allow new types of machinery

  - For Ag a standardized interface is one key element for success

  - Mitigation scenarios have to be provided for existing equipment

  - The ideas for system-level opportunities in combination with automation, navigation and energy storage systems

28


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7530
E Premium

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