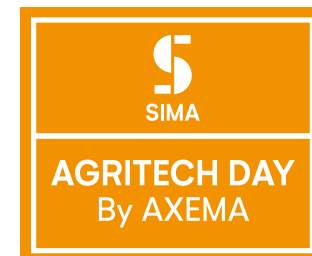




Mild Hybrid T4 e-Source with EasyTrim^e and e-Mulcher

FIORATI Stefano –
CNH Industrial – Zero Emission & Advanced Drivetrain Manager,
Modena, Italy



Who are we (Who am I) ?



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Ph.D in Mechanics of Machine

Zero Emission & Advanced Drivetrain Manager – CNH Industrial - Modena,
Italy

Summary

1. Executive Summary: vision & business needs
2. Product overview
3. Technical Description
4. Experiment & Simulation
5. Conclusion

01

Executive Summary: vision & business needs



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Mild Hybrid T4 e-Source with EasyTrime and e-Mulcher

Bring innovative solutions for our customers improving profitability and costs with cleaner solutions



➤ **Need – Vineyard and orchard customers are more and more looking to new solutions**



➤ **Solution – Mild-hybrid solution coupled with an engine downsizing allowing After Treatment System simplification**



➤ **Innovation – combine electric needs for implements with torque assist in a compact Specialty tractor**



➤ **Benefits – Flexible solution with clear customer benefits**



➤ **Market availability – Concept is developed with the new compact tractor architecture that would be introduced in the market in 2022**

02

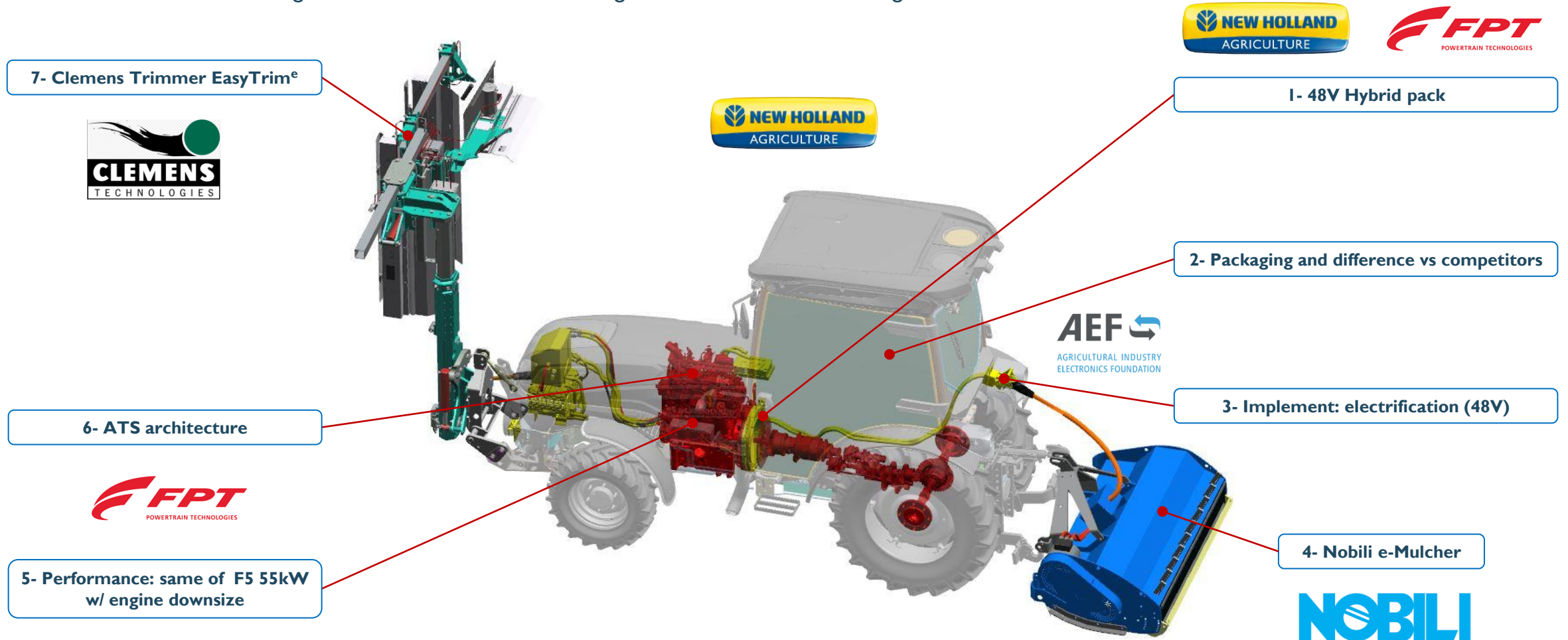
Product overview



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Mild-hybrid with electrified implement capability

T4 e-Source an integrated solution first on this segment for a sustainable agriculture



03

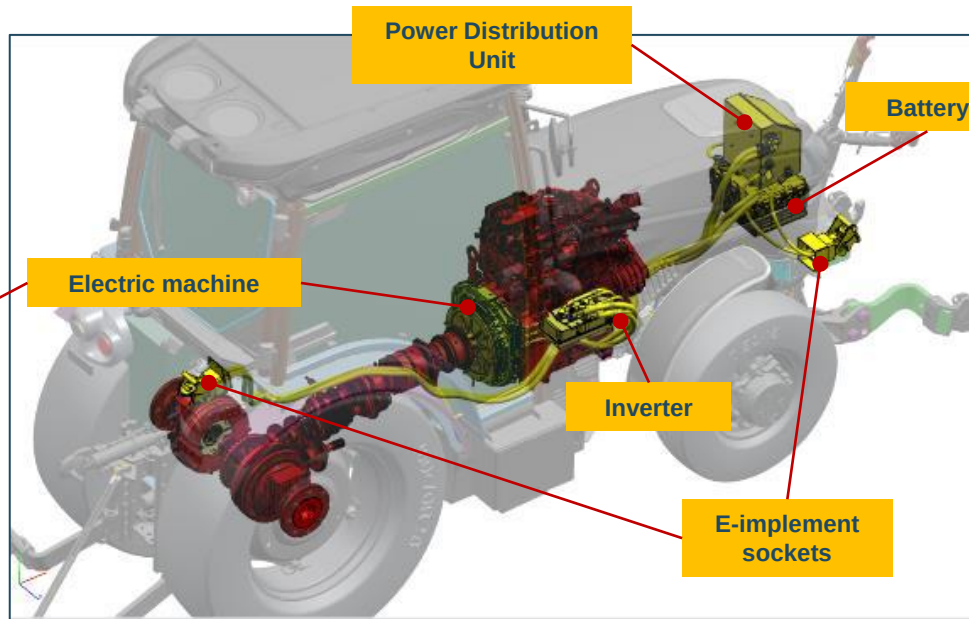
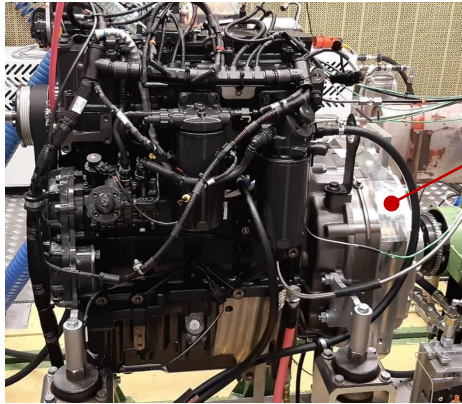
Technical Description



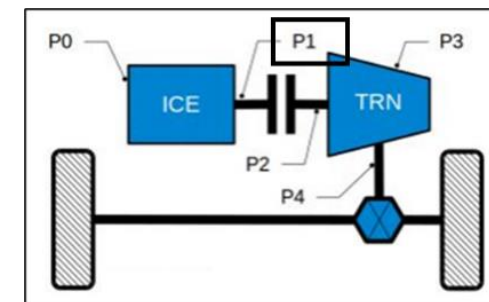
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T4 e-Source with 48V Hybrid pack

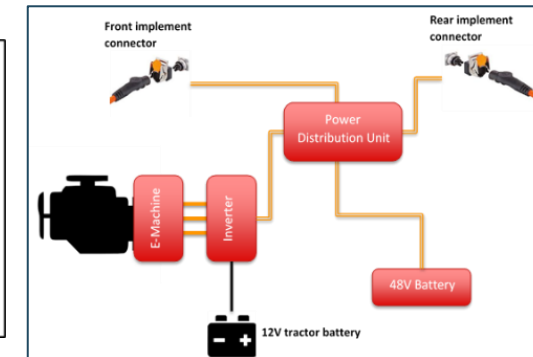
System Overview



- The **mild-hybrid architecture**, is based on a 48V electric machine integrated between internal combustion engine and tractor driveline (P1 configuration) providing 20kW continuous power and 30kW peak power.
- The electric machine can work as electric generator or as electric motor depending on the mode. **The working modes** allowed by this architecture are two:
 - Power supply to electric Implements
 - Torque assist and torque boost mode



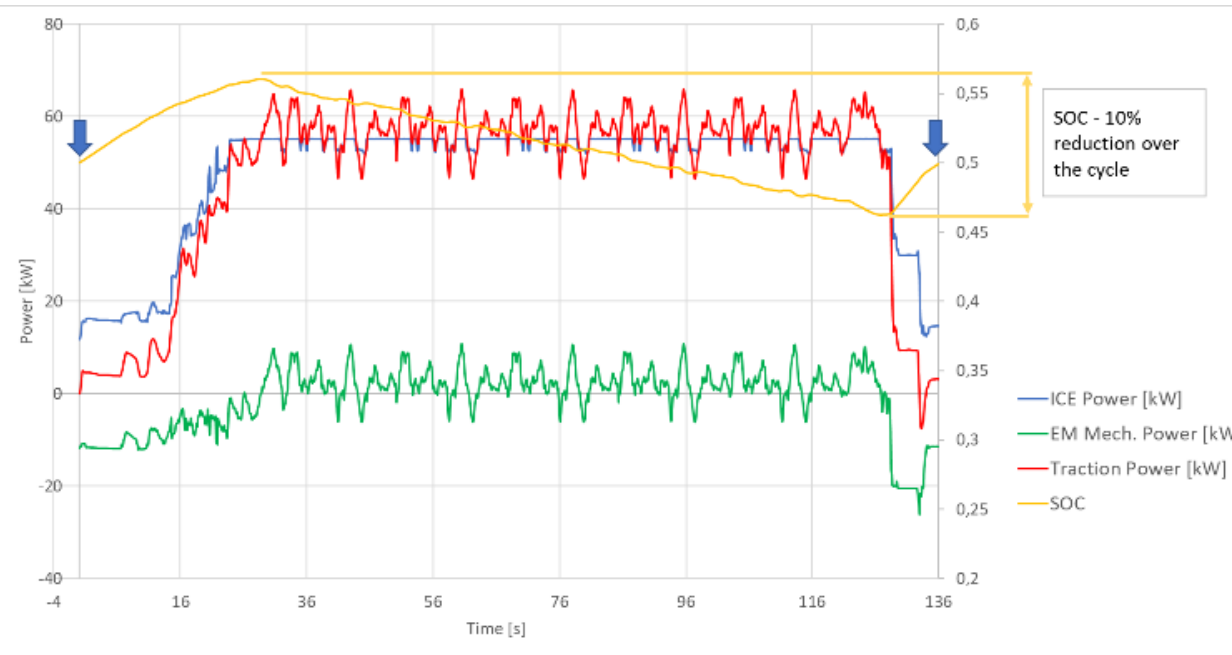
Architecture nomenclature



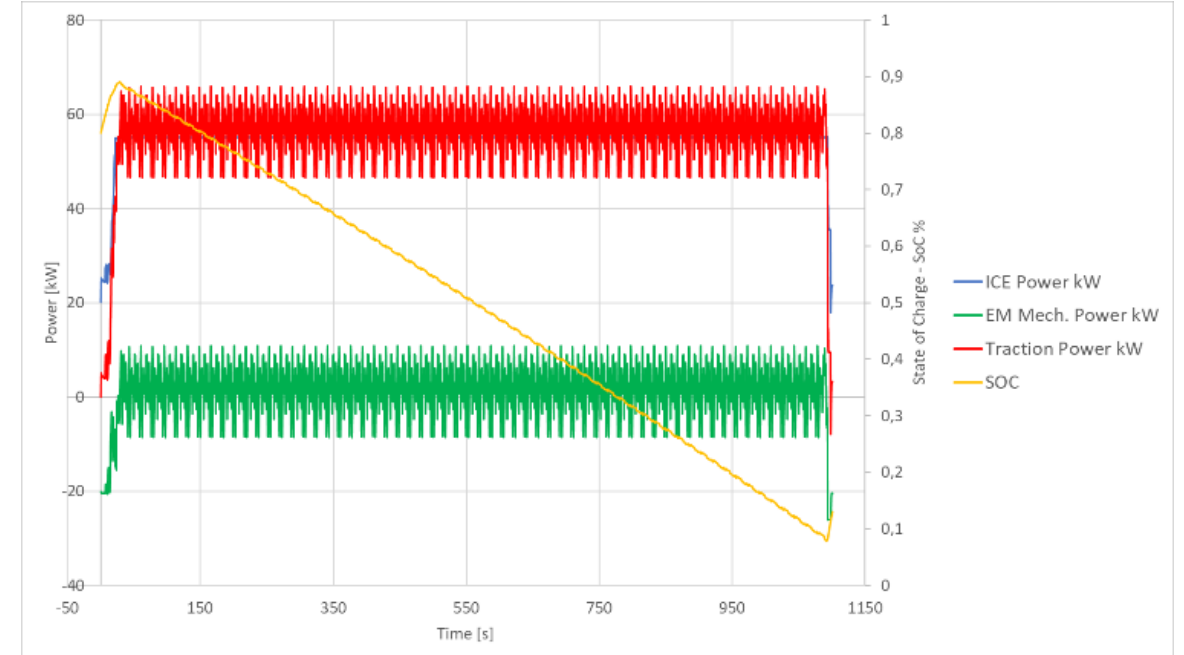
High level tractor architecture and main components

Battery run time analysis

Cultivator details



Power analysis

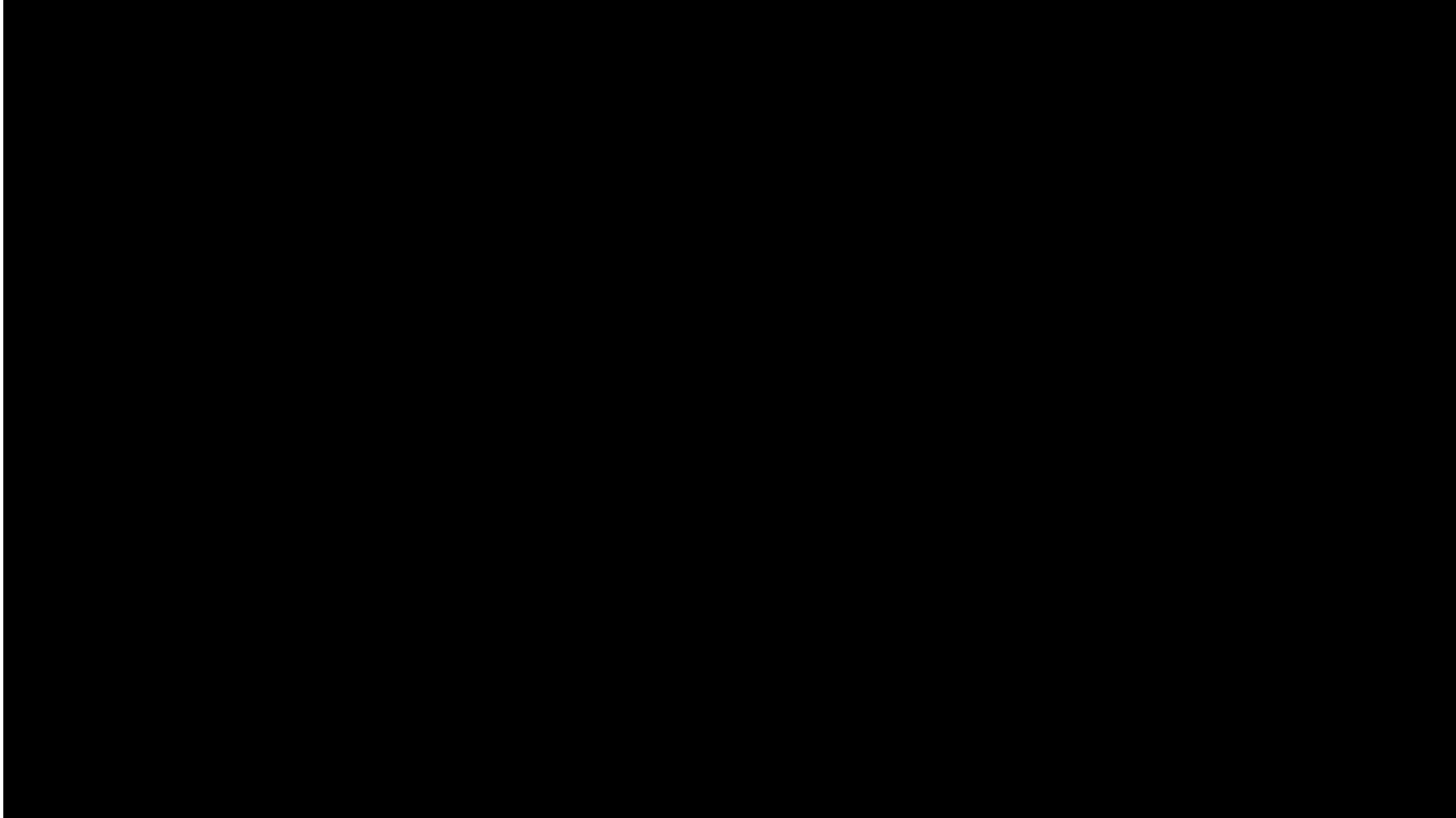


Cultivator mission max duration with current battery

- **Mechanical cultivator on flat surface and 200m length at 6.5kph**
- The battery discharging rate is about 10% over the cycle. The end of row turn maneuver, represents a phase to recover the initial State of Charge (SoC) proving that **the mission is battery energy neutral**.
- A simulation of the repetition of the active cycle has been performed till the SoC is about 10%. The simulation has shown that the tractor can run for about 1940m.

T4 e-Source with 48V Hybrid pack

Working modes - video



04

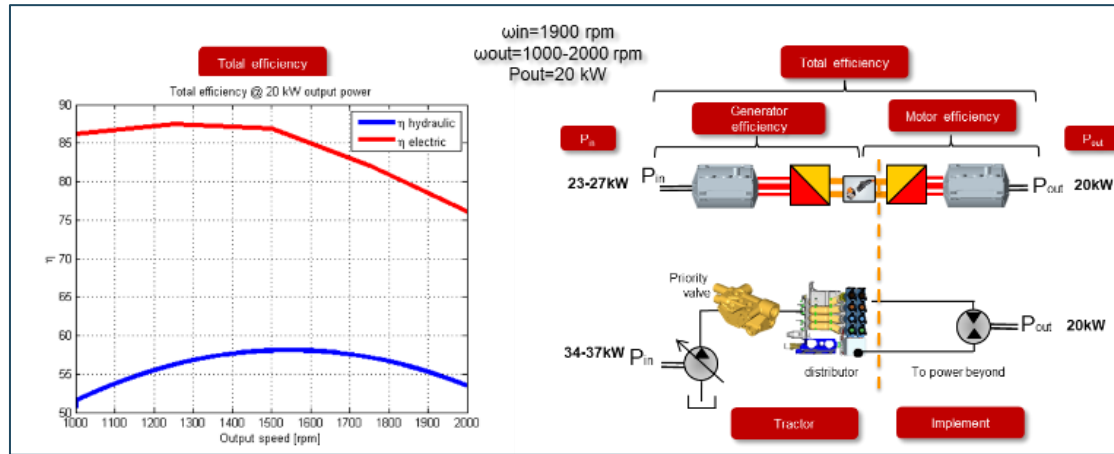
Experiment & Simulation



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Implement: electrification (48V)

Fuel saving, benefits to environment and efficient energy use



Implement electrification power saving simulation. Hydraulic architecture vs electric

Efficiency and polluting emissions improvement

- PTO driven implements:
 - fuel consumption reduction up to 29%
 - CO₂ reduction up to 1000kg per year.
- Hydraulically driven implements:
 - fuel consumption saving up to 30% is achieved

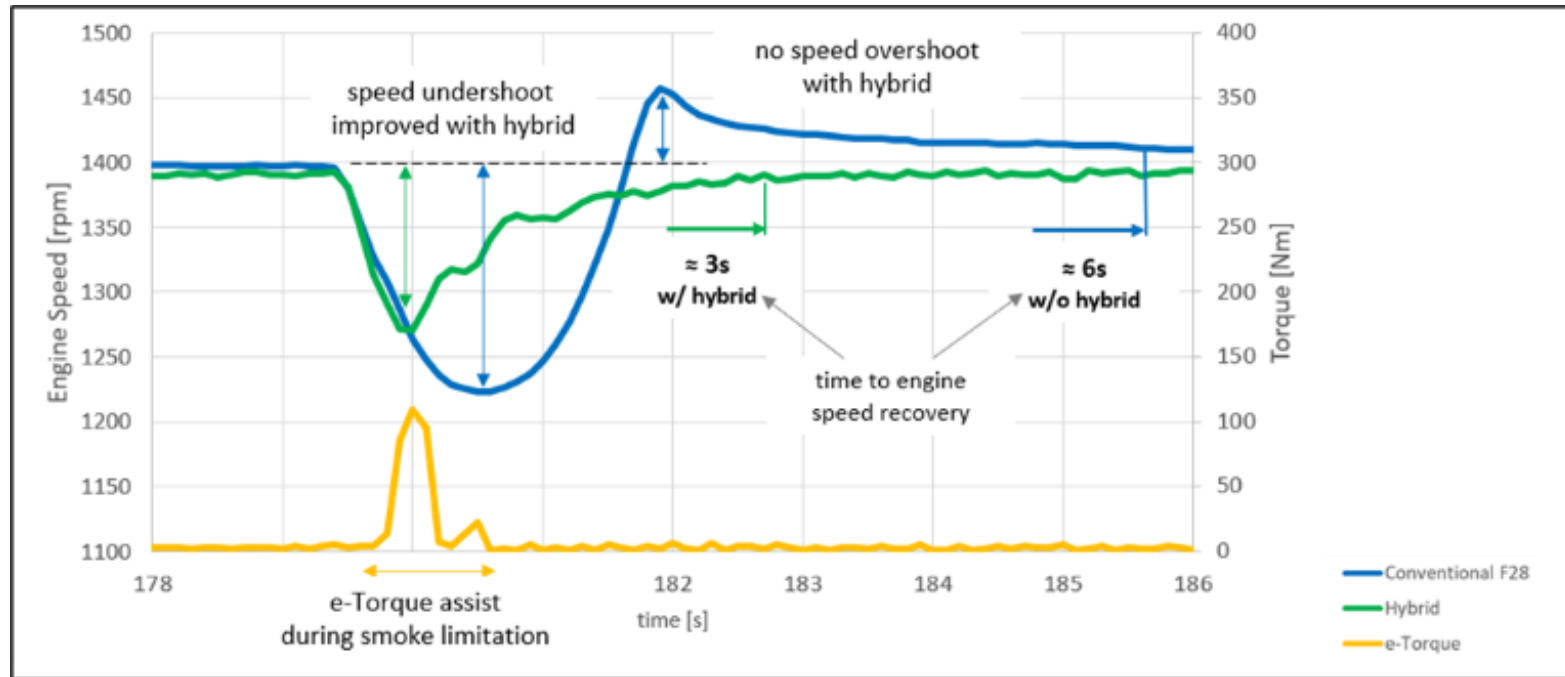
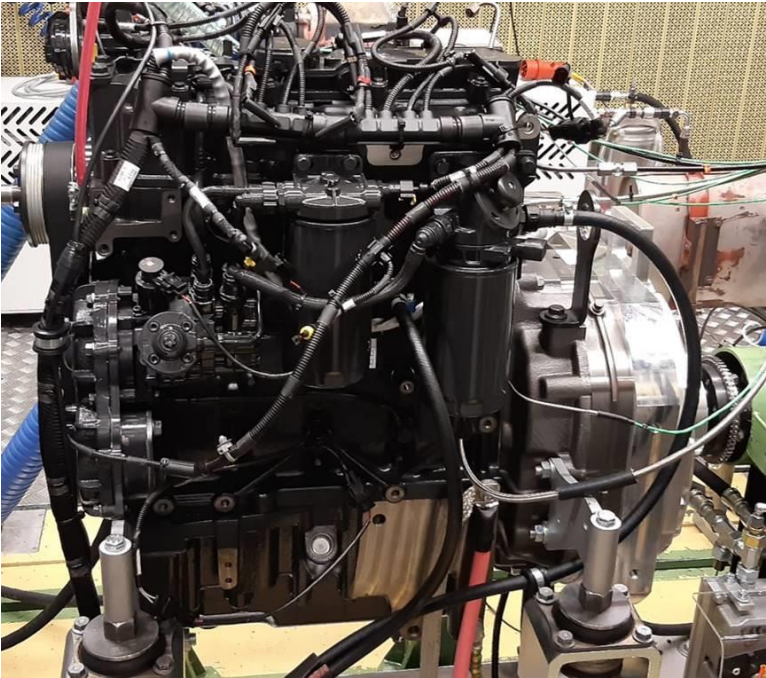


Type of implement	Ground speed [kph]	Engine speed [rpm]	Fuel consumption [lph]	Fuel saving percentage
PTO 540e rpm	4	1503	5,5	from 10 to 29
PTO 540 rpm	4	1904	6,9	
Electric	4	1309	4,9	

Type of implement	Knife speed [rpm]	Engine speed [rpm]	Fuel consumption [lph]	Fuel saving percentage
Electric	2500	1010	3,6	25
Hydraulic	2500	1400	4,8	
Electric	2750	1011	3,9	30
Hydraulic	2750	1621	5,6	

Engine test bench activities

Performance of F28 55kW w/engine downsize



Hybrid system impact over standard internal combustion engine. Test bench cycle

Improved reactiveness: up to 50%-time reduction

05

Conclusion



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Conclusion

- Mild-hybrid architecture with electrified implement capability keeping the **overall tractor dimensions** within the range for **vineyard and orchard applications**.
- **Flexibility**: it allows customer to use both electric and traditional Hydraulic/PTO implements.
- **Clean**: Improved fuel consumption with respect to conventional implements up to 30% with a consequent reduction of CO₂ thanks to engine decoupling from e-implements.
- **Simplified** After Treatment System: SCR removal for F28 55kW engine rating.
- **Engine drivability**: up to 50% less time to recover target engine speed vs conventional tractor.
- Potential for **oil free application** and additional hydraulic power unit removal.
- **Maintenance** operation and running cost reduction.
- **Productivity improvement**: electrification as enabling factor for implement automation and coordination of multi-implement tasks (trimmer, mulcher and other electrified tools).

QUESTIONS & ANSWERS