Affordable Simulation Tools for Specialist Off-Road OEMs

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NAFEMS

Forestry Harvester – Ponsse Ergo

Application: tree harvesting, paired with a forwarding vehicle to remove the logs.

Operating weight **23 t**

Engine max power **210 kW**

Max. Reach horizontal **11 m**

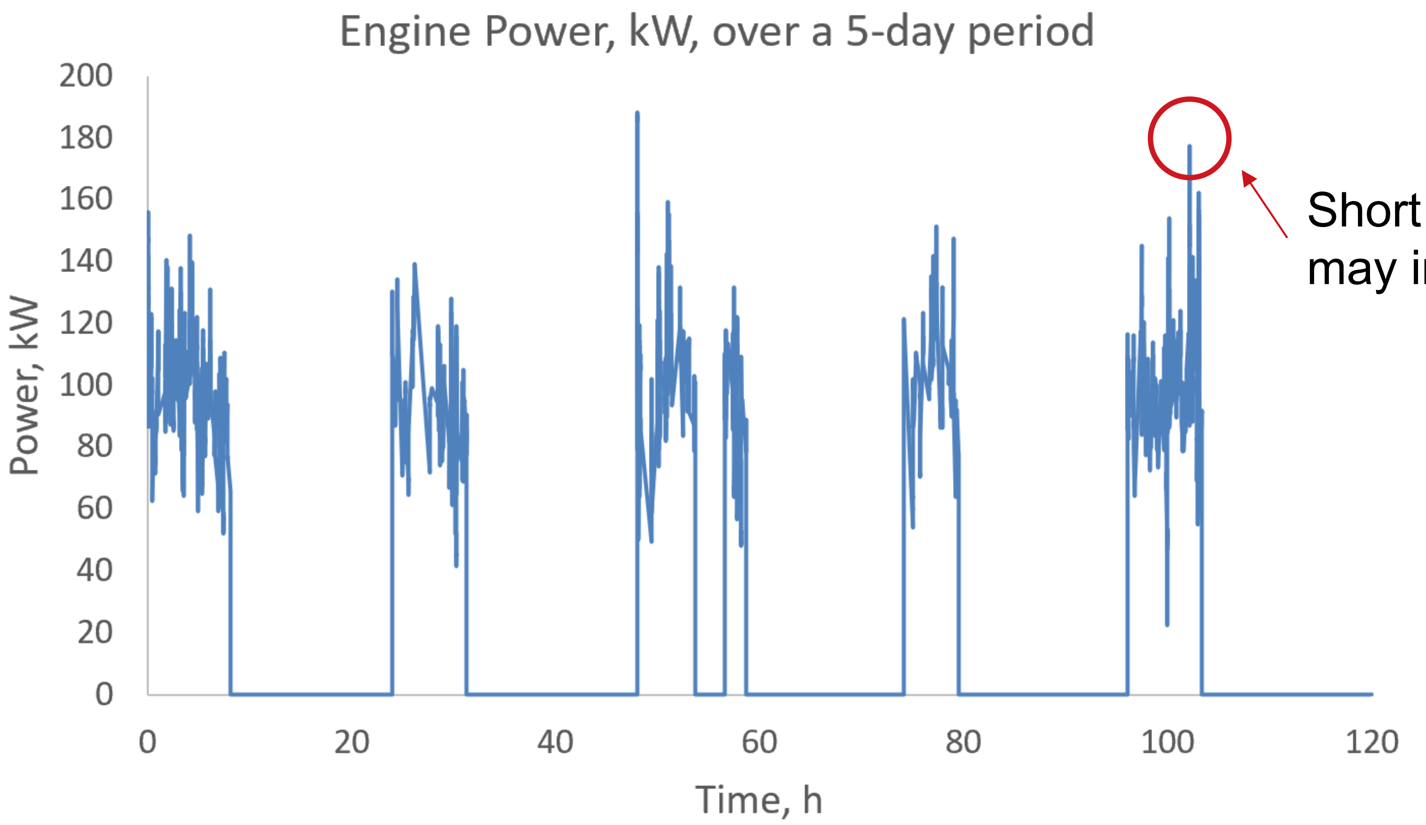
Annual Sales ~ 1200 units

https://www.youtube.com/watch?v=K_yMPnsblVA
https://www.youtube.com/watch?v=R-g_oR1_g4E

Engine Specifications

Parameter	Specification	Notes
Engine Manufacturer	Mercedes-Benz / MTU	Supplied under Daimler Truck Off-Highway (MTU) branding
Engine Model	OM 936 LA	Inline 6-cylinder diesel engine
Displacement	7.7 L	6 cyl × 1.28 L per cylinder
Rated Power	210 kW @ 2200 rpm	
Maximum Torque	≈ 1200 Nm @ 1200–1600 rpm	Broad flat torque curve
Emission Standard	EU Stage V / US Tier 4 Final	DOC + DPF + SCR after-treatment
Cooling System	Liquid-cooled	Engine and hydraulic oil coolers
Machine Operating Weight	≈ 20 500 kg (minimum)	8-wheel configuration
Transmission Type	Hydrostatic-mechanical drive	2-speed automatic transmission
Reference	Ponsse Ergo Sales Folder 2023 (PDF)	https://interexport.si/wp-content/uploads/2024/09/PONSSE_Ergo_Sales_Folder_2023.pdf

Engine Dutycycle over 5 days



Short peaks of high power may indicate hybrid opportunity

Source of Dutycycle data


Home > European Journal of Forest Research > Article

High-resolution harvester data for estimating rolling resistance and forest trafficability

Research | Open access | Published: 09 July 2024

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High-resolution harvester data for estimating rolling resistance and forest trafficability. Salmivaara, Aura; Holmström, Eero; Kulju, Sampo; Ala-Ilomäki, Jari; Virjonen, Petra; Nevalainen, Paavo; Heikkonen, Jukka; Launiainen, Samuli

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Setting up and Running the Model

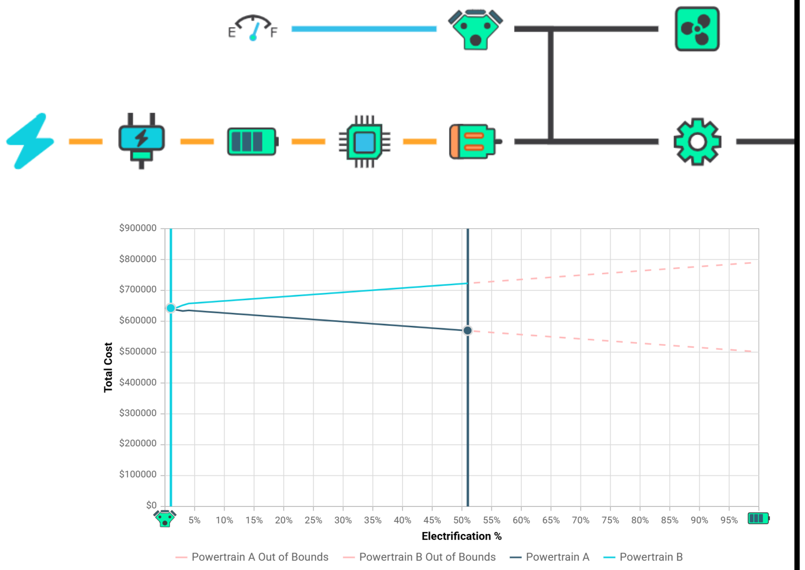
Adjustable Parameters

Dutycycle data - Power vs Time

ePOP Cloud

- Prepare Dutycycle
- Adjust Parameters
- Analyze

Results



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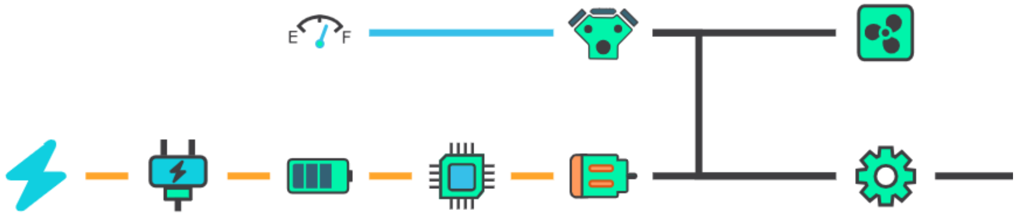
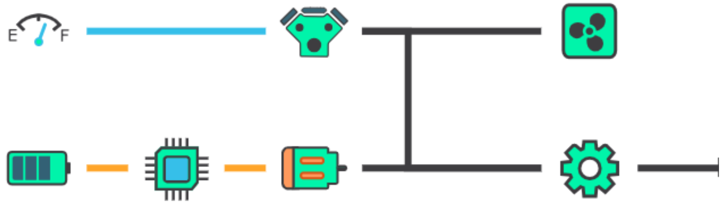
Powertrain Configurations

Original ICE-only

Powertrain A: Parallel P0 Hybrid with Charging



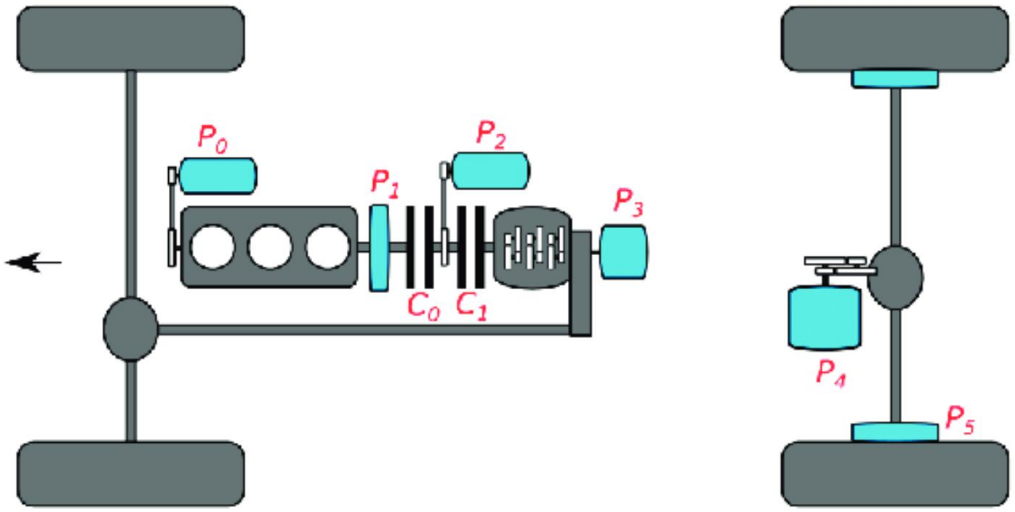
Powertrain B: Parallel P0 Hybrid without Charging



Note: P2 configuration (with engine detachment) generally offers more fuel savings thank P0, but requires complete redesign.

P0 – P5 Hybrid Configurations Explained

Notation	Traction Motor drive connection	Functional Characteristics
P0	Crankshaft, at front of engine (opposite end to transmission)	Motor cannot work with engine off.
P1	Crankshaft, at rear of engine	Motor cannot work with engine off.
P2	Between engine and transmission, after a disconnect clutch	Motor can work with engine off, saving fuel.
P3	On output shaft of transmission, before axle	Motor can work with engine off. But gearing is less advantageous than P2, and the motor must cover a large speed range.
P4	On axle	As P3.
P5	Inside wheels (hub motors)	As P3; lowest losses but highest costs.



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AU - Ruzimov, Sanjarbek
AU - Mavlonov, Jamshid
AU - Mukhitdinov, Akmal
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VL - 24
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Configuration Adjustments

Powertrain A (1 Combination) | Powertrain B (1 Combination)

Technology (18.4M combinations)

Inverter (5)
Si

Motor (4)
Induction

Rectifier (5)
Si

Generator (4)
Permanent Magnet

Battery (10)
Ergo

Charger (2)
Si

ICE (12)
Ergo_unlim

Fuel Tank (3)
Diesel

Transmission (2)
Direct Drive

Architecture (8 available)

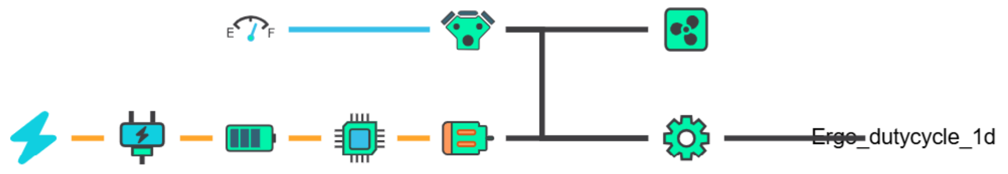
Auto | Manual | Advanced | Copy from Powertrain B

Config Name
Powertrain A

Power Source (4 available)
Parallel plug-in

Power Delivery (2 available)
1M (Ergo_dutycycle_1d)

Charge Time (hh:mm)
12:00



Key
Fuel
Electrical
Mechanical
Hydraulic

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Parameter Adjustments

ICEs 4 8

Name	Cost $/kW	Volume Density kW/L	Mass Density kW/kg	Fuel	Series B.S.F.C. kg/kWh	Series Efficiency %	Parallel B.S.F.C. kg/kWh	Parallel Efficiency %	Heat Rejected to Coolant %	Embedded CO_2 kg/kW	Minimum kW	Maximum kW
Diesel	145	0.95	0.25	Diesel	0.2593	32.3	0.3221	26	50	25		
Gasoline	115	1.25	0.4	Gasoline	0.23	34	0.3	26	50	18		
Fuel Cell	160	0.7	0.7	Hydrogen	0.0501	60	0.0601	50	50	0.05		
Diesel (NonHybrid Operation)	145	0.95	0.25	Diesel	0.38	22	0.38	22	50	25		
Fendt211	145.00	0.95	0.25	Diesel	0.25	33.50	0.25	33.50	33.00	25.00	40.00	85.00

Motors 4 0

Name	Cost $/kW	Volume Density kW/L	Mass Density kW/kg	Efficiency %
Permanent Magnet	125	10	5	96
Ferrite PM	65	3	1	93
Induction	40	4	2.5	92

Batteries 6 4

Name	Cost $/kWh	Volume Density Wh/L	Mass Density Wh/kg	Minimum S.O.C. %	Maximum S.O.C. %	C Rating Peak	C Rating Continuous
LFP	120	275	130	20	100	5	3
NMC	140	575	225	20	100	10	2
NCA	150	650	250	20	100	12	2.5
Lead-Acid	100	95	40	60	100	20	0.4
Ultra-Capacitors	3000	0.01	15	10	100	500	10
LFP 30kWh Limit	120	275	130	20	100	5	3
LFP_724	120.00	275.00	130.00	20.00	90.00	5.00	3.00

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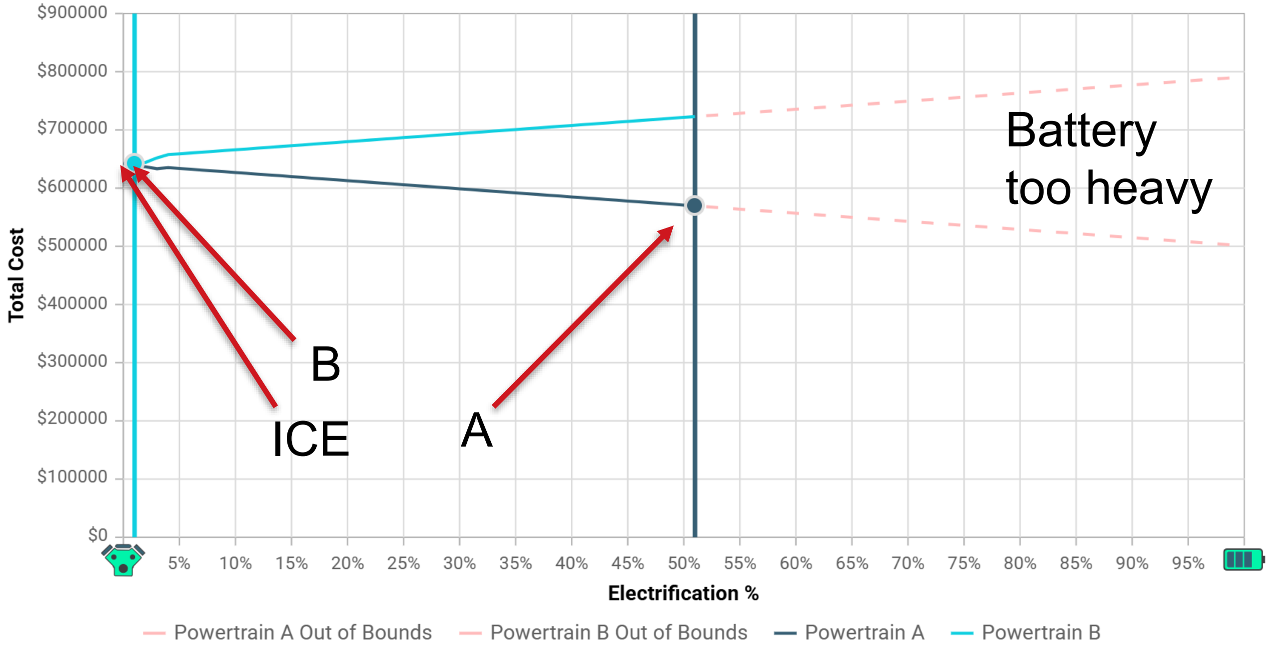
Results: Hybrid versus Original ICE

	ICE only	A: Hybrid - charging	B: Hybrid – no charging
ICE Power kW	202.2	107.4	107.4
E-motor Power, kW		188.3	88.3
Battery size, kWh		591.9	20
Powertrain Cost $	31930	115219	31051
Diesel Fuel Cost $	611104	299448	611119
Electricity Cost $	0	168318	0
TCO (10 year) $	643034	582985	642170

ePOP Results:

- Fully electric is not feasible – battery weight
- ICE power set to 202 kW (actual vehicle 210 kW)
- Both hybrids downsize ICE to 107kW
- Hybrid A (with charging) reduces TCO by 11%
- Hybrid B (without charging) offers no benefit

Conclusion: Recharging is probably impractical for this application, so neither solution is attractive.



Summary and Conclusion

- Forestry Harvester: Off-highway, low volume, diesel-powered.
- Short peaks of max power suggest a hybrid opportunity.
- ePOP Cloud allows quick, non-expert analysis
- Results of study:
  - TCO savings are possible with a P0 hybrid, but only if charging is available
  - Charging is probably impractical in this application, so it’s not worth pursuing
  - P0 is not the best configuration – P2 is better - BUT needs complete redesign
- This analysis is deliberately quick and simple to understand. It can be applied to low-volume applications as a first check to identify opportunities for hybridization.