SUPER-COMPACT ENGINES

A WORLDWIDE MATCH

Certainly pump injectors and rotary pump definitively belong to the past. In fact, even the super-compact ones need an efficient common rail to comply with Stage V regulations.

That's why we excluded those mechanical units, such as the Kioti 4A220Lws, 2.2 liters (BxS 87x92.4 mm), which with its in-line pump, 33.6 kilowatts and 140 Nm is particularly suitable for stationary and semi-stationary applications. The DOC - DPF combination has also established itself here and helps combustion in applications that often avoid the most stressful profiles. Unburnt hydrocarbons and particulate are thus processed downstream of the combustion process.

The heterogeneity of the selected engines remains intact, and although falling below the fateful threshold of 56 kilowatts they mainly differ in terms of specific performance. It couldn't have been any different, since Hatz and Yanmar on one side and Kohler and Mitsubishi on the other - the two extremes in the eleven competitors - are divided by a 20% displacement gap.

Even this power range - like the one published in the last issue - (engines displacing between 2.8 and 3 liters) is a candidate to equip those hybrid machines which some consider a residual choice, some others see as the protagonists of the third decade of the century. 'Small is beautiful', especially in times of downsizing, and not only because of compatibility with hybrid systems. And this is how **Hatz** remains on top of the podium thanks to specific curves: the German 2-liter wins the primacy of power per liter while specific torque rewards **Doosan**, which switched from Delphi to Bosch in the transition from Stage IV to Stage V. Even torque at maximum power sees the central of the Korean G2 trio on top, along with Deutz and **Kohler**. Speaking of the Rising Sun, the string quartet appears here in full. Kubota, like **Yanmar**, in Stage V, while **Isuzu** and **Mitsubishi** as far as we know boast their Tier 4 Final and slightly leave behind the other competitors. **Perkins** Syncro is the new name for this scenario (see the monographic article on this number) .

Deutz brings in its 2.2-liter that shares the same cylinder displacement of the TCD2.9, Diesel of the year 2010, equips the Carraro Agritalia Hybrid introduced at EIMA 2018 and is also available in a LPG version. **Kubota** is also familiar with the so-called alternative fuels, the dual fuel, featuring a balanced four-cylinder engine both for specific curves and mass-weight-power ratio.

The only three cylinders in the comparison are the aforementioned Deutz, **VM** and FPT. Despite the fact that the parent company has oriented the

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We find 11 competitors in the 2 – 2.5 liter range. Hatz still shows the best specific curves

	DEUTZ	DOOSAN	FPT INDUSTRIAL	HATZ	ISUZU	KOHLER	KUBOTA	MITSUBISHI	PERKINS	VM	YANMAR
I. D.											
B x S mm - S/B	92x110 - 1,20	90x94 - 1,04	94x107 - 1,14	84x88 - 1,05	85x96 - 1,13	88x102 - 1,16	87x102 - 1,18	86x95 - 1,10	84x100 - 1,19	94x107 - 1,14	86x90 - 1,05
N. cil. - dm³	4 - 2,92	4 - 2,39	3 - 2,22	4 - 1,95	4 - 2,17	4 - 2,48	4 - 2,43	4 - 2,20	4 - 2,21	3 - 2,22	4 - 2,09
Maximum power kW - rpm	**55,4** - 2.200	55 - 2.600	52 - 2.600	**55,4** - 2.800	43 - 2.200	55 - 2.600	55 - 2.700	44 - 2.500	55 - 2.800	52 - 2.600	44 - 3.000
Mep at max power bar	10,5	10,8	11	12,4	11	10,4	10,2	**9,8**	10,8	11	11
Piston speed m/s	8,1	8,1	9,3	8,2	**7**	8,8	9,2	7,9	9,3	9,3	9
Maximum torque Nm - rpm	300 - 1.600	320,5 - 1.600	249,9 - 1.800	240 - 1.600	215 - 1.600	299,9 - 1.500	249,9 - 1.600	220 - 1.600	270 - 1.800	249,9 - 1.800	215 - 1.600
Mep at max torque bar	13,2	17,2	14,4	15,8	**12,7**	15,5	13,2	12,8	15,6	14,4	25,1
% power at max torque (kW)	44,4	48,1	37,9	33,5	40,4	44,4	35,3	39,9	39	37,9	**74,4**
Torque at max power Nm	**235**	206	196	186	186	206	196	167	186	196	176
% power at max torque (kW)	90,8 (50)	97,70 (54)	90,60 (47)	72,60 (40)	83,80 (36)	85,70 (47)	76,20 (42)	83,80 (37)	92,60 (51)	90,60 (47)	127,00 (**62**)
DETAILS											
Specific power kW/dm³	18,8	23	23,4	**28,2**	19,5	22,2	22,6	19,9	24,8	23,4	21,1
Specific torque Nm/dm³	102,5	133,9	112,1	123	98,6	120,8	102,6	99,6	121,7	112,1	103,1
Areal spec. power kW/dm²	20,83	21,65	**25**	24,95	18,94	22,63	23,11	18,97	24,77	**25**	19
RULES AND BALANCE											
Dry weight kg	237	204	210	173	199	267	245	310	242	225	210
L x W x H mm	648x560x685	673x556x690	519x524x723	680x540x595	725x530x737	704x521x715	866x540x753	656x559x647	757x535x807	614x557x723	890x543x766
Volume m³	0,25	0,26	**0,20**	0,22	0,28	0,26	0,35	0,24	0,33	0,25	0,37
Weight/power kg/kW	4,3	3,7	4	**3,1**	4,6	4,9	4,5	7	4,4	4,3	4,8
Weight/displacement kg/dm³	**81**	85,3	94,3	88,7	91,3	107,6	100,6	140,5	109,2	101	100,4
Power density kW/m³	221,6	211,5	**260**	251,8	153,6	211,5	157,1	183,3	166,7	208	132,4
Total density t/m³	0,95	0,78	1,05	0,79	0,71	**1,03**	0,70	1,29	0,73	0,90	0,57
Displacement/volume dm³/m³	**11,70**	9,20	11,14	8,87	7,78	9,55	6,96	9,20	6,72	8,91	5,65

Deutz, Liebherr, Manitou

This trio was one of the first to convert operating machines with a hybrid or electric package. The preview of Deutz's collaboration with the two OEMs was unveiled at the Electrip in Cologne. From Deutz 3.6 to 2.2 liters. The ICE is integrated by a 20 kW synchronous electric generator that brings the total power to 75 kW of the diesel version. Also thanks to Torqeedo, whose contribution can be seen in several details: 48V, with the electric motor supporting the endothermic or in full electric mode, LiFePo or LiNMc batteries, sensors, IP67 casing, synchronous electric motor.

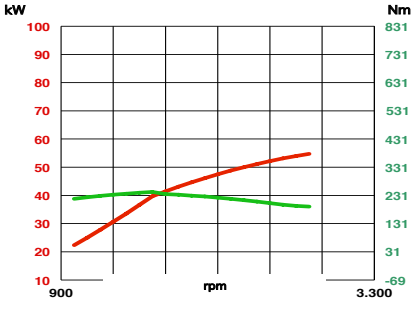
Italian plant towards automotive propulsion, the 3-liter is confirmed to be reliable, climbing to the top in all the indexes. Stage V was introduced at EIMA 2018. 1,600 bar common rail, single canning for DOC and DPF, easy maintenance thanks to the starter on the injection side and lateral PTO. Mirroring the R753 we find the **FPT** R22, which also follows the curves of its Italian twin, currently oriented towards the captive applications of the CNH group.

A final thought on the recirculation of exhaust gases: among the super-compact the EGR is still alive. ■

	DEUTZ	DOOSAN	FPT INDUSTRIAL	HATZ	ISUZU	KOHLER	KUBOTA	MITSUBISHI	PERKINS	VM	YANMAR
INDEX											
Torque	8	12,4	10,1	14	7,9	13,1	12,9	10,9	12,2	10,1	**10,8**
Performance	4,2	4,9	4,7	4,8	4	4,7	4,4	4,1	4,9	4,7	6,2
Stress	**7,1**	8,4	7,9	8	6,6	8,1	7,5	6,9	8,3	7,9	11
Lightness	9	9,2	10,8	9,8	10	12,2	11,6	15,8	12,3	11,8	10,4
Density	23,3	28,4	**32,4**	31,1	19,5	25,9	16,6	23,1	20,5	25,9	28,1
DIESEL INDEX	6,2	7,2	6,6	7,6	6,2	6,7	6,6	6	6,9	6,6	6,7

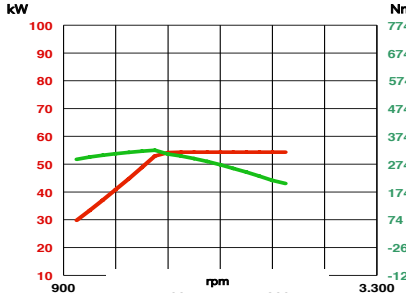
1 HATZ

HATZ



2 DOOSAN

DOOSAN



3 YANMAR

YANMAR