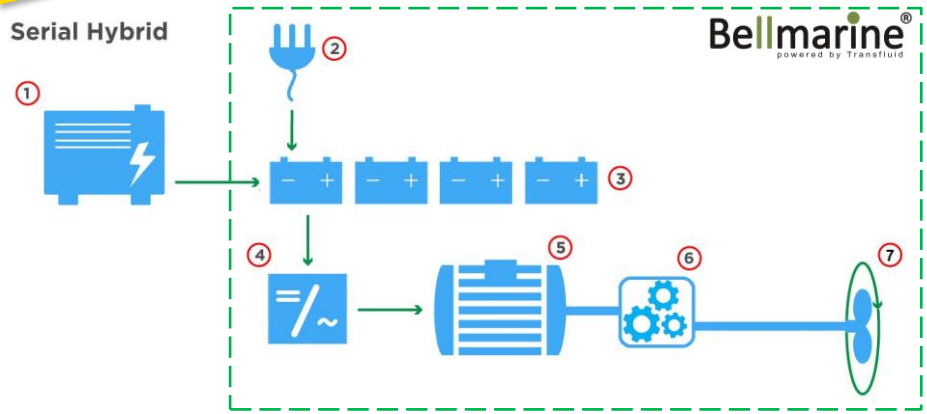
SERIAL OR PARALLEL HYBRID

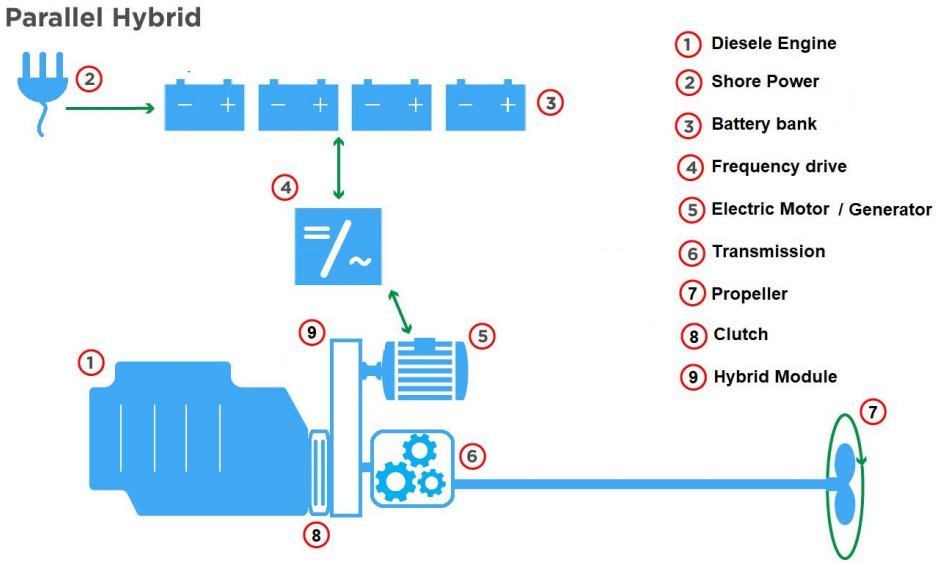


Serial Hybrid

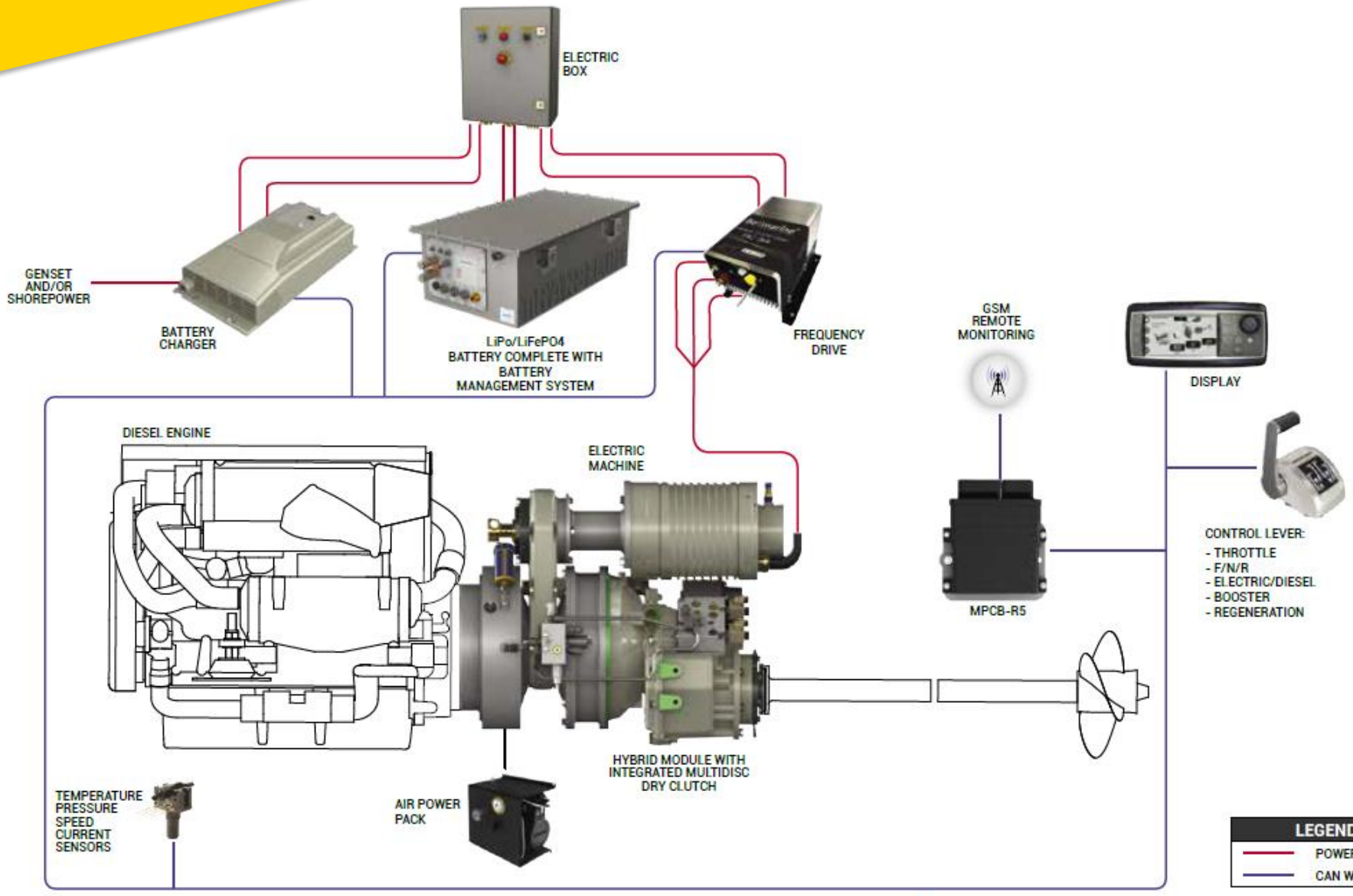
- Bigger e.motor
- More complicated electrical system
- Only e.motor providing mechanical power
- No redundancy
- Lower efficiency due to several energy transformations

Parallel Hybrid

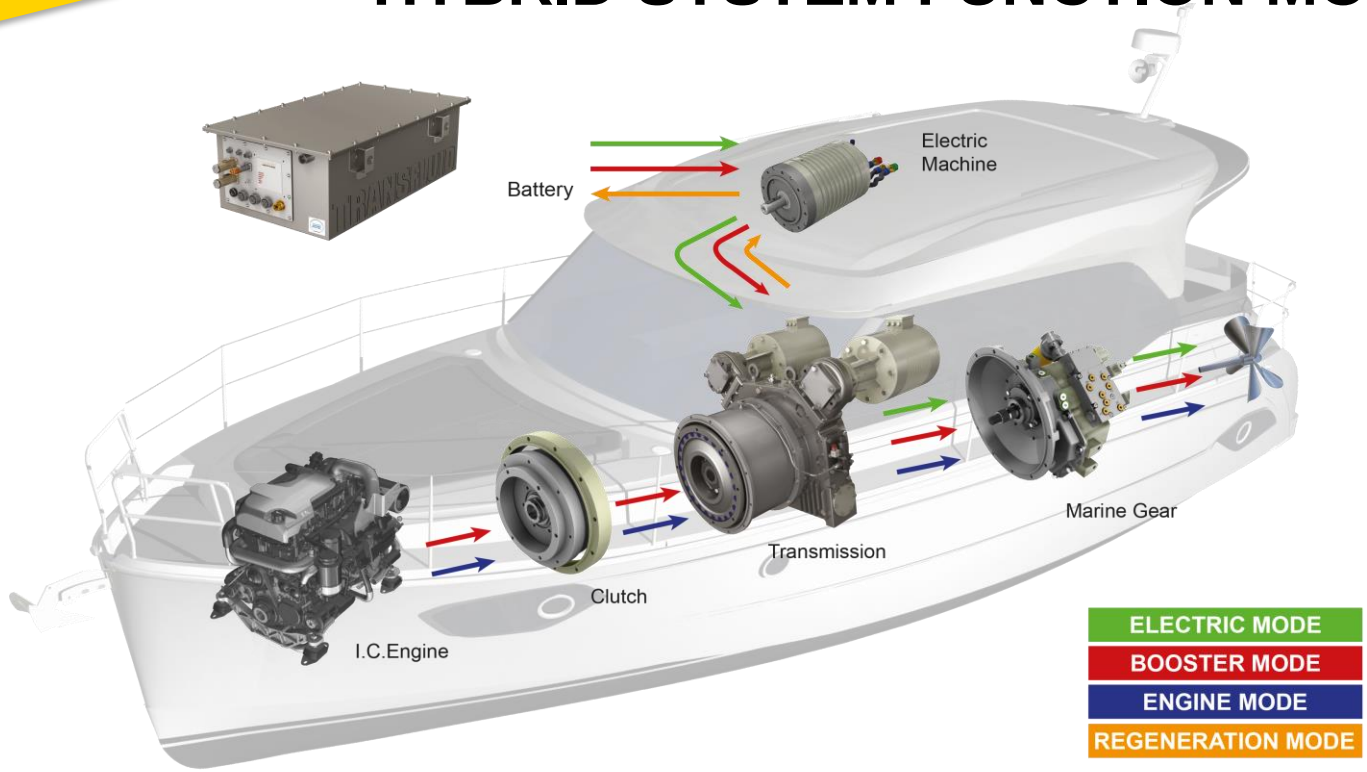
- Smaller e.motor
- More simple electrical system
- Both Diesel and e.motor providing mechanical power to the propeller
- Safety redundant system
- More energetically efficient



HYBRID SYSTEM CONFIGURATION



HYBRID SYSTEM FUNCTION MODES

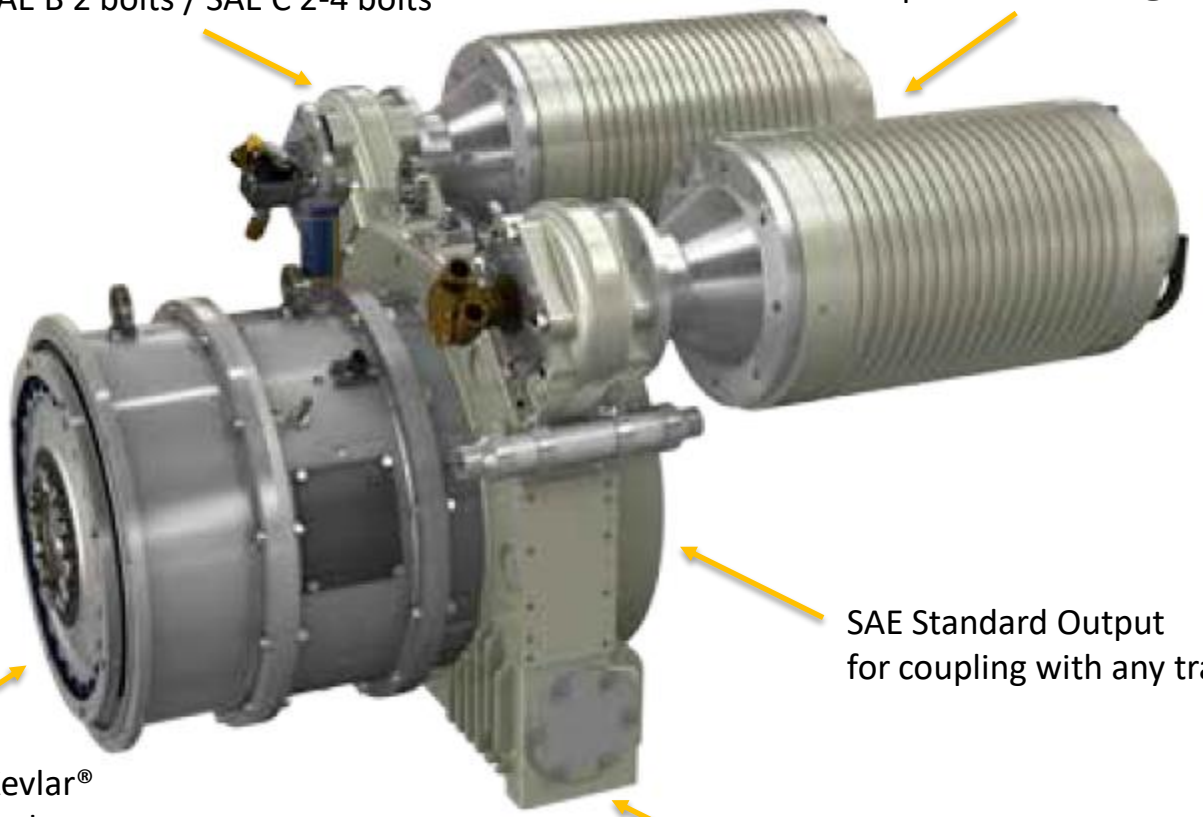


- **Electric Propulsion** – to drive or sail at zero emissions.
- **Booster** – allowing the electric motor during acceleration to assist the Diesel engine.
- **Engine Propulsion** – using the electric machine as a generator to recharge batteries.
- **Regeneration -** using the electric machine as a generator to recharge batteries.
- **+ (Additional power source)** – to power other auxiliaries such as: hotel loads, pumps etc.

HYBRID MODULE OVERVIEW

Up to 4 heads PTO/PTI
SAE B 2 bolts / SAE C 2-4 bolts

Permanent Magnets Electric Machines
Up to 2 x 130 kW@3000rpm peak power

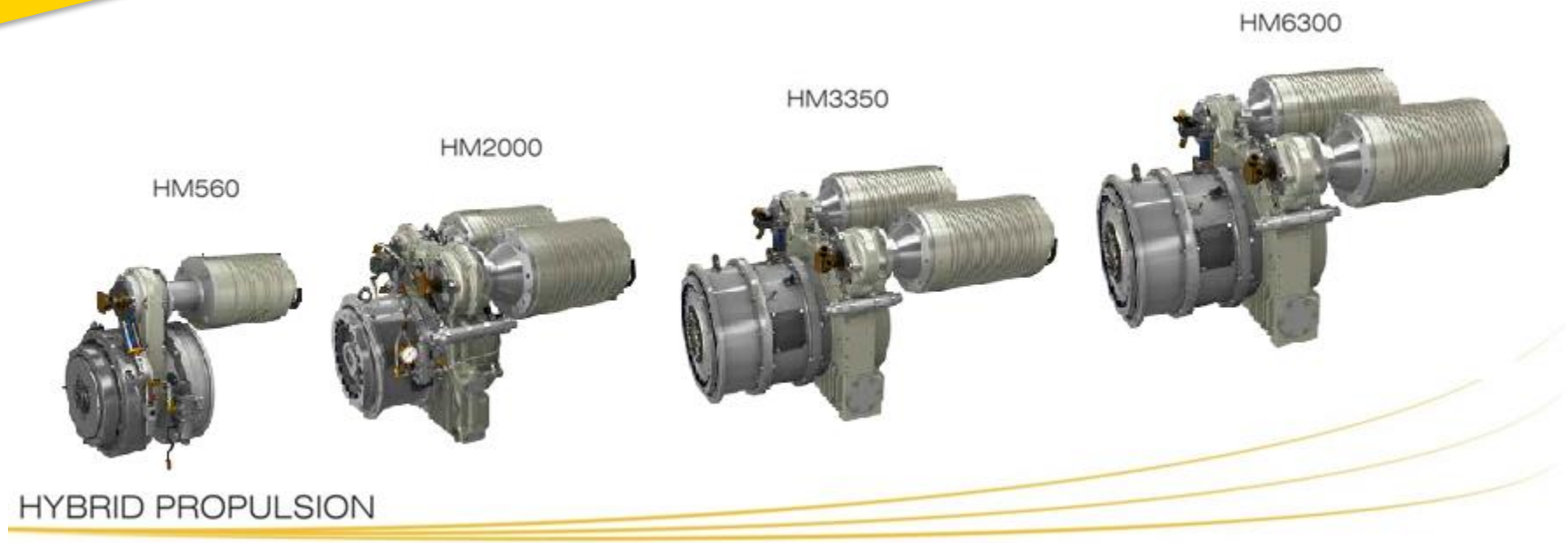


SAE Standard Output
for coupling with any transmission

Input Clutch, dry Kevlar®
discs oil-air operated
SAE Standard Input

Split Power Drive

HYBRID MODULES RANGE



HM450/HM560

Input & Output standard:	SAE 5 – 8''/ 4 – 10''
Max input Diesel power:	100/180 kW @ 3500 rpm
Max input electric power:	35 kW @ 3000 rpm
Longitudinal dimension:	290/305 mm
Weight:	95/120 kg

HM3350

Input & Output standard:	SAE 1 – 14''
Max input Diesel power:	620 kW @ 2300 rpm
Max input electric power:	200 kW @ 3000 rpm
Longitudinal dimension:	690 mm
Weight:	560 kg

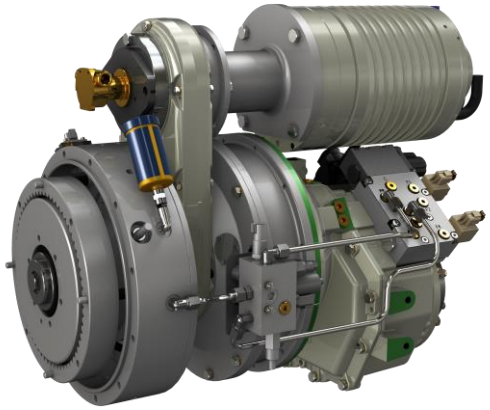
HM2000

Input & Output standard:	SAE 3 – 11,5''
Max input Diesel power:	435 kW @ 3300 rpm
Max input electric power:	150 kW @ 3000 rpm
Longitudinal dimension:	458 mm
Weight:	350 kg

HM6300

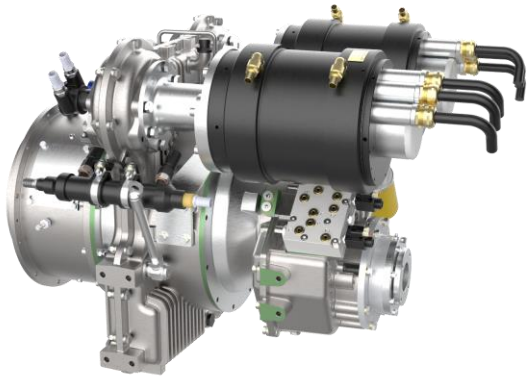
Input & Output standard:	SAE 1 – 14'' / SAE 0 – 18''
Max input Diesel power:	1230 kW @ 2300 rpm
Max input electric power:	200 kW @ 3000 rpm
Longitudinal dimension:	777 / 830 mm
Weight:	900 kg

ADDITIONAL HYBRID TRANSMISSIONS



HTM700

Input standard:	SAE 4 – 10''
Max input Diesel power:	140 kW @ 3200 rpm (about 560/1,25 Nm)
Max input electric power:	35 kW @ 3000 rpm
Marine gear:	Revermatic 11-700 RBD
Reduction ratio:	1,40 – 1,88 – 2,25
Weight:	220 kg

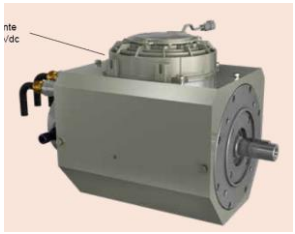


HTM1000

Input standard:	SAE 3 – 11,5''
Max input Diesel power:	175 kW @ 3200 rpm (about 700/1,25 Nm)
Max input electric power:	150 kW @ 3000 rpm
Marine gear:	Revermatic 11-700 RBD
Reduction ratios:	1,40 – 1,88 – 2,25
Weight:	450 kg

ELECTRIC MACHINES RANGE

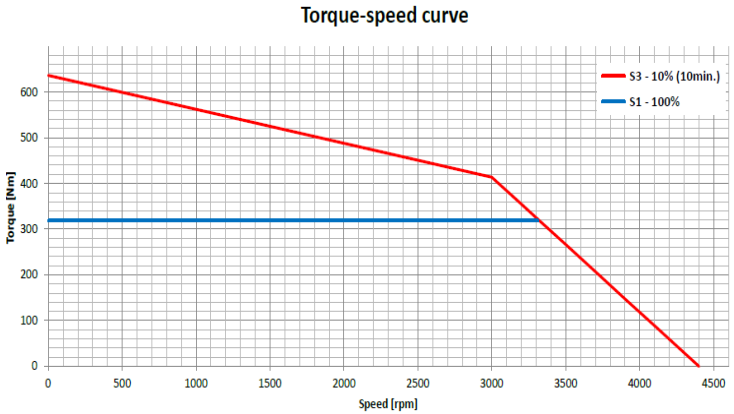
E. MACHINE	MOTOR MODE Power (continuos) kW (hp)	MOTOR MODE From battery A max	GENERATION MODE Power kW (hp)	GENERATION MODE From battery A max
EM180-8	8 (11)	87	7 (10)	84
EM180-12	12 (16)	140	10 (14)	124
EM220-20	20 (27)	215	17 (23)	185
EM220-35	35 (48)	190	33 (45)	119
EM300-50	50 (68)	176	49 (67)	177
EM300-75	75 (100)	271	72 (98)	266
EM300-100	100 (134)	270	97 (132)	251



Air cooled

Liquid cooled

- Permanent Magnet Synchronous [electric machines](), 100% Made in Italy
- Wide range of power available
- Air forced or liquid cooling available



TRANSFLUID BATTERY SYSTEMS

TYPE APPROVAL: project # A0402415

With extension to NMA (Norwegian Maritime Authority)

DNV

Sjøfartsdirektoratet
Norwegian Maritime Authority

Energy efficiency is an important issue in the management of a hybrid propulsion system.
The energy storage system in hybrid applications must be the synthesis among the best available technology, the total energy requirement and a reasonable cost.
Transfluid is the owner of the Type Approval certification for LiFePO4 batteries.

- 4000 lifespan cycles at 80% DOD
- 2000 lifespan cycles at 90% DOD
- Protected, reliable and safe
- Best €/kWh/cycle ratio
- Internal BMS dedicated
- CANbus Open communication protocol

GENERAL SPECIFICATIONS

Capacity Ah	Contin. discharge A	Pulse discharger A	Continuous charge A	Pulse charge A	Operating Temperature °C	Box Material	Protection class
100	100	200	80	120	-20 / 60	SS316L	IP65
200	200	400	160	240			
300	300	600	240	360			
400	400	800	320	480			
600	600	1200	480	720			
800	800	1600	640	960			

48V

Energy kWh	Architecture	Dimension Single Box **	Number Of Modules	Total Weight
10.3	Single Module	620x677 h352 mm	1	130 kg
20.5	2P	620x677 h352 mm	2 + MCR*	267 kg
30.8	3P	620x677 h352 mm	3 + MCR*	397 kg
41.0	4P	620x677 h352 mm	4 + MCR*	527 kg

96V

Energy kWh	Architecture	Dimension Single Box **	Number Of Modules	Total Weight
9.6	Single Element	506x876 h293 mm	1	130 kg
19.2	Single Element	619x955 h352 mm	1	230 kg
28.8	3P	506x876 h293 mm	3 + MCR*	394 kg
38.4	2P	619x955 h352 mm	2 + MCR*	467 kg
57.6	3P	619x955 h352 mm	3 + MCR*	697 kg
76.8	4P	619x955 h352 mm	4 + MCR*	927 kg

144V

Energy kWh	Architecture	Dimension Single Box **	Number Of Modules	Total Weight
30.8	3S	620x677 h352 mm	3	390 kg
61.4	3S - 2P	620x677 h352 mm	6 + MCR*	787 kg
92.2	3S - 3P	620x677 h352 mm	9 + MCR*	1177 kg
122.9	3S - 4P	620x677 h352 mm	12 + MCR*	1567 kg

288V

Energy kWh	Architecture	Dimension Single Box**	Number Of Modules	Total Weight
28.8	3S	506x876 h293 mm	3	390
57.6	3S	619x955 h352 mm	3	690
86.4	3S - 3P	506x876 h293 mm	9 + MCR*	1170
115.2	3S - 2P	619x955 h352 mm	6 + MCR*	1380
172.8	3S - 3P	619x955 h352 mm	9 + MCR*	2070
230.4	3S - 4P	619x955 h352 mm	12 + MCR*	2760

384V

Energy kWh	Architecture	Dimension Single Box**	Number Of Modules	Total Weight
38.4	4S	506x876 h293 mm	4	520
76.8	4S	619x955 h352 mm	4	920
115.2	4S - 3P	506x876 h293 mm	12 + MCR*	1560
153.6	4S - 2P	619x955 h352 mm	8 + MCR*	1840
230.4	4S - 3P	619x955 h352 mm	12 + MCR*	2760
307.2	4S - 4P	619x955 h352 mm	16 + MCR*	3680

* MCR dimensions: 300x350xh160 mm, weight: 7 kg

** Indicative dimensions. Ask for official drawing

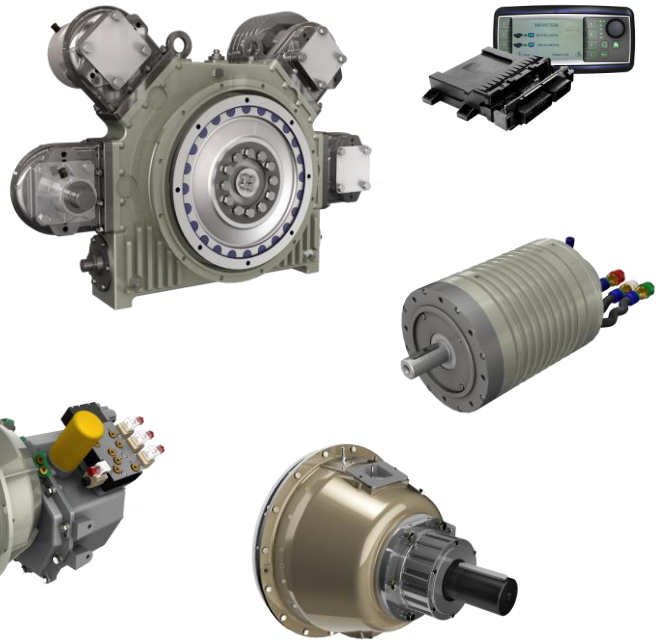
TRANSFLUID HYBRID FEATURES SUMMARY

Combining some of the traditional products, with several thousands of applications for each single component, let Transfluid design a new range of products:

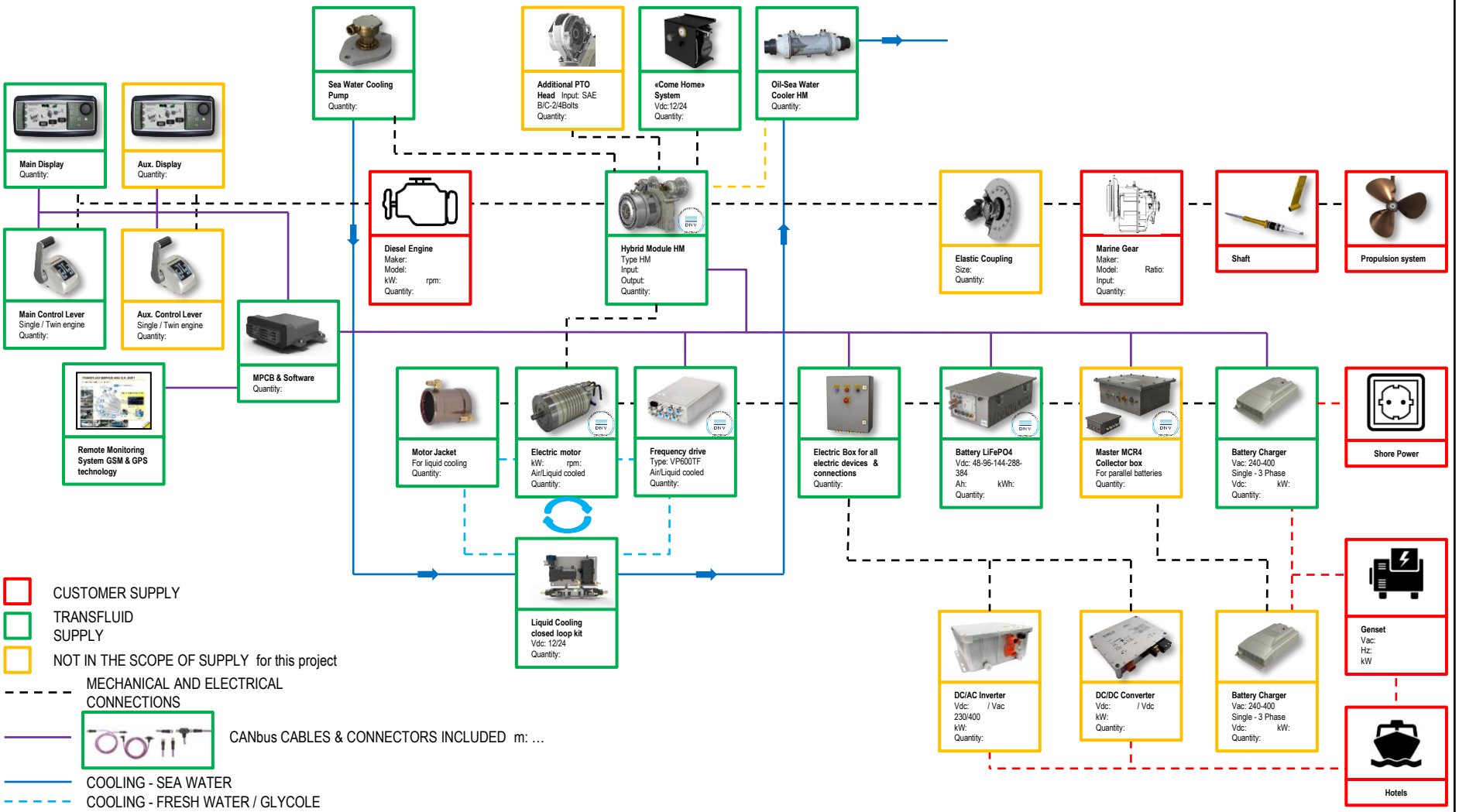
HYBRID TRANSMISSIONS

Main features are:

- Standard SAE input and output
- Input Clutch, dry Kevlar® discs oil-air operated
- Split Power Drive to accommodate E.Machine and other implements
- E.Machine AC synchronous with permanent magnets (high efficiency)
- Internal combustion engine up to 1230 kW (1650 hp)
- Electric Machine peak power up to 260 kW (350 hp)
- Booster ability to reduce ICE consumption
- Battery recharging
- Small dimensions to easy fit and retrofit



Transfluid Hybrid System configuration



- Customer:
- Project:
- Quotation:
- Hybrid System: HM3350/6300 ..... + ...kWh
- Date:

TRANSFLUID® industrial & marine

drive with us

Bellmarine® powered by Transfluid

HYBRID SYSTEM CONTROLS

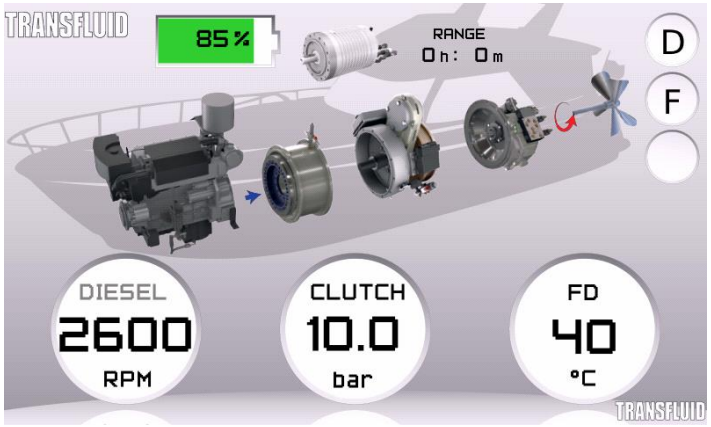
Control Lever

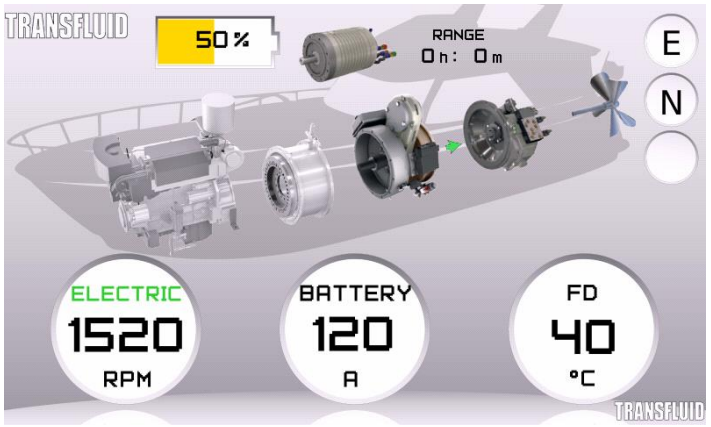
Easy control through Transfluid's lever. Shifting between Electric mode and Diesel mode is completely controlled by our logic; it works in any lever position, just press "Diesel" button and transition is made. Press Electric to shift back to E.mode.
Booster and Regeneration modes are available from the side of the knob: Booster, works holding the button pressed; Regeneration, works just pressing the button once.

No automatic transition available, this is a precise choice for SAFETY reasons.
Control is always in charge of the Captain!

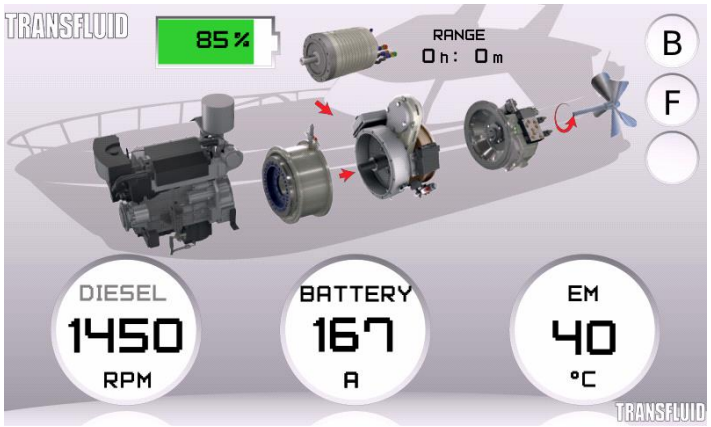
HYBRID SYSTEM CONTROLS

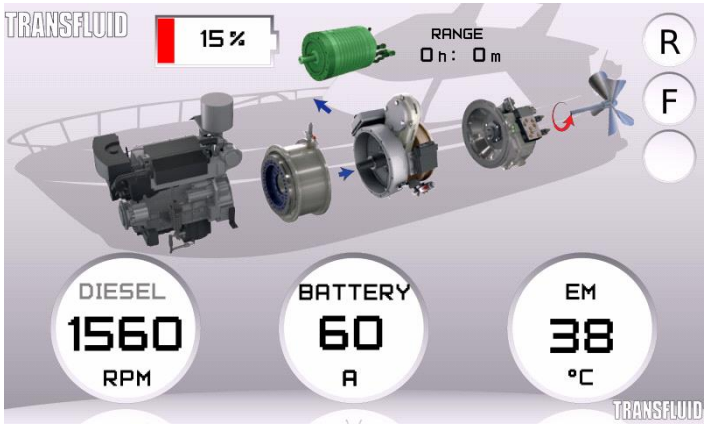
Multi-function smart display





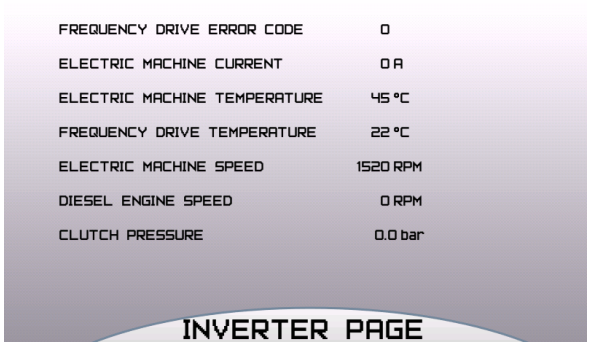
The Display with several different pages, shows all working modes: Diesel, electric, booster, regeneration. Indication of range in electric mode. Master clutch pressure and current absorption or regenerated. Gearbox or HM temperature. Battery state of charge.

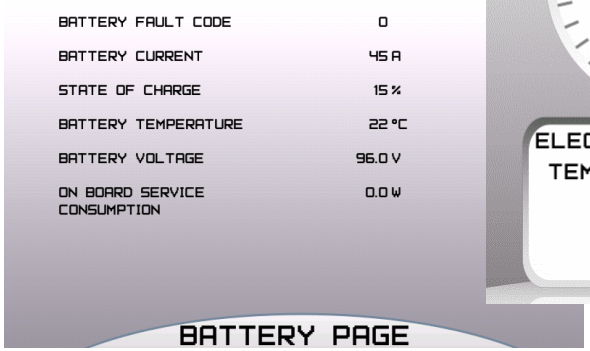


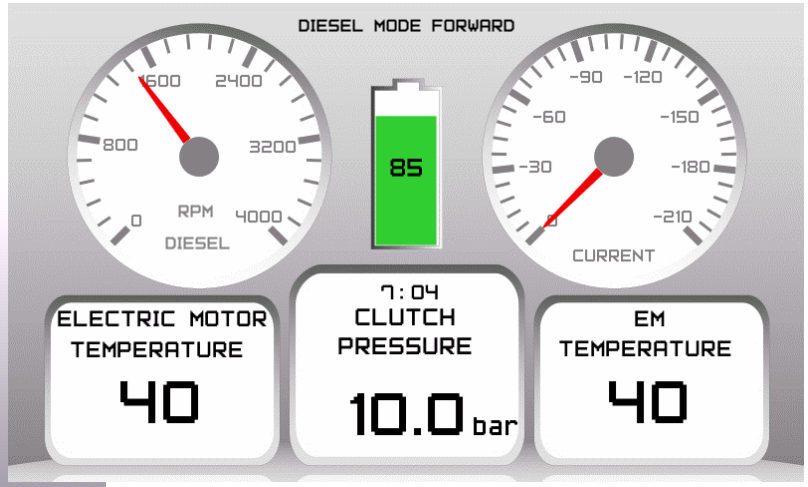


HYBRID SYSTEM CONTROLS

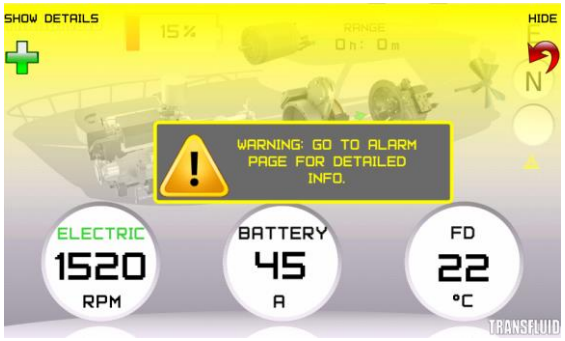
Multi-function smart display

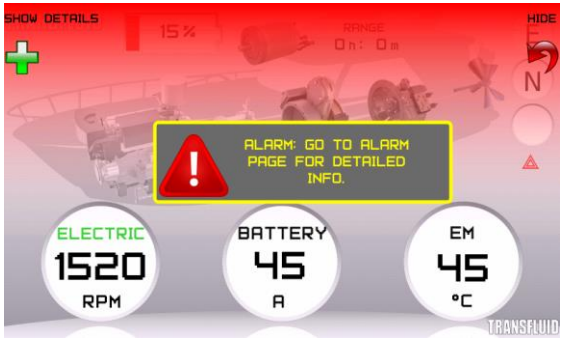


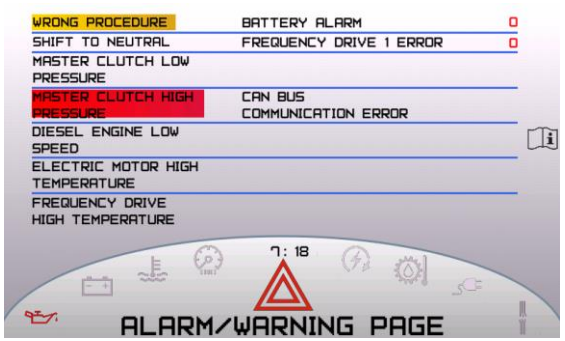




The Display dashboard shows the most important parameters: Gearbox and HM oil temperature. Battery state of charge. Diesel or E.Machine rpm. Oil pressure and current. Lever position and throttle percentage. E.Machine and Frequency Drive temperature. There are specific pages for Battery, E.Machine, Frequency Drive, alarms and warnings.

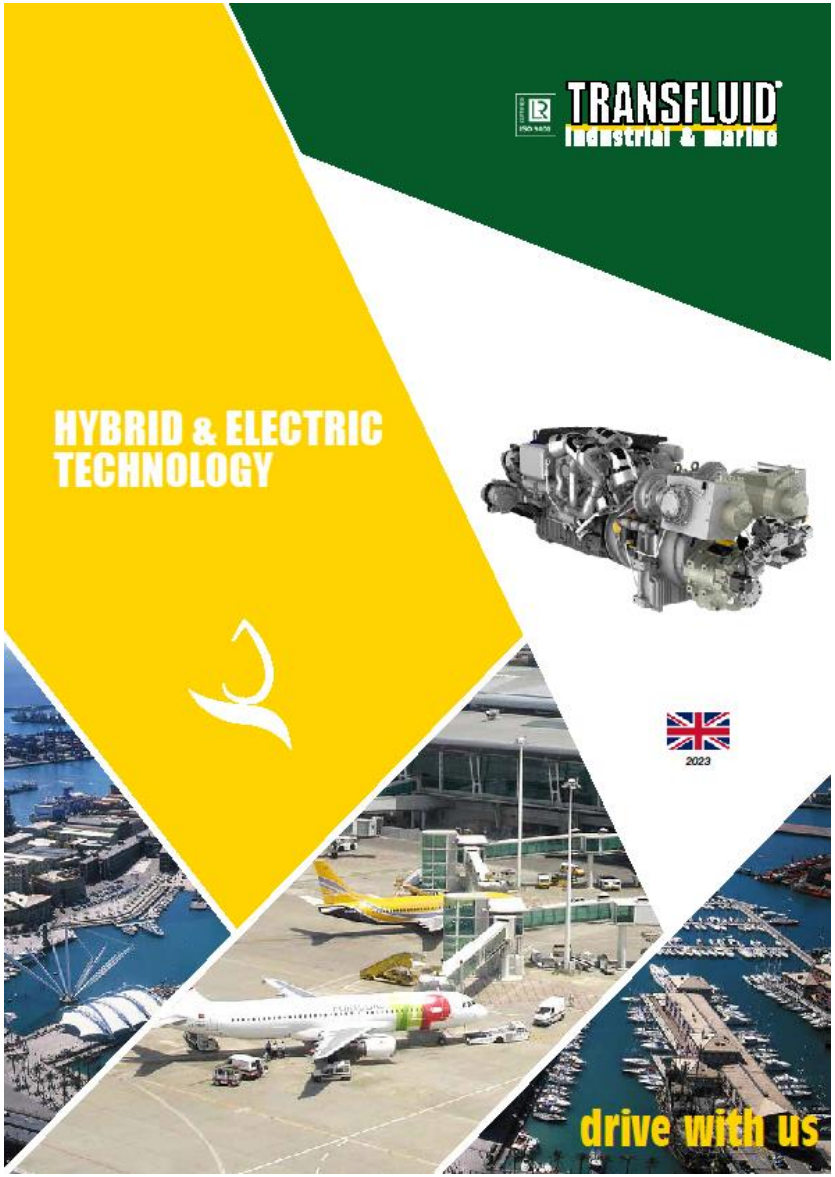






CATALOGUE

https://www.transfluid.eu/downloads/



HYBRID SYSTEM SELECTION

Step 2: Hybrid Module
Made by Transfluid

Hybrid Module is selected based on the Diesel model and rated output:

T [Nm] = kW / rpm x 9550 x 1,25(**)

Hybrid Module	Bell Housing Flywheel	Max Input Power [kW]	Max Input Speed [rpm]
HM450	SAE 5 – 8''	100	3500
HM560	Borg Warner (*) SAE 4 – 10'' SAE 3 – 11,5'' (*)	180	3500
HM2000	SAE 3 – 11,5'' SAE 2 – 11,5'' (*)	435	3300
HM3350	SAE 1 – 14''	620	2300
HM6300	SAE 1 – 14'' (*) SAE 0 – 18''	1230	2300

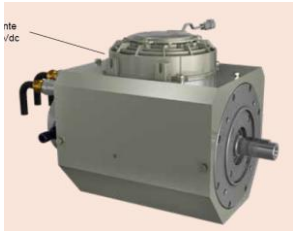
(*) Adapter needed
(**) Service factor

HYBRID SYSTEM SELECTION

Step 3: Electric Machine
Made by Transfluid

Electric machine(s) are selected according to the power request:

E. MACHINE	WEIGHT kg (lbs)	MAX SPEED rpm	BATTERY Vdc	HYBRID TRANSMISSION
EM 180-8	25 (55)	3000	102	HM450
EM180-12	35 (76)	3000	102	HM560-HTM700
EM 220-20	55 (120)	3000	102	HM560-HTM700-HM2000
EM 220-35	80 (175)	3000	307	HM560-HM2000-HM3350
EM 300-50	135 (295)	3000	307	HM2000-HM3350-HM6300
EM 300-75	185 (404)	3000	307	HM2000-HM3350-HM6300
EM 300-100	195 (425)	3000	409	HM3350-HM6300



Air cooled

Liquid cooled

We usually have two different scenarios:

1. Customer directly asks for a precise power need in electric mode;
2. Customer asks for a minimum speed to be achieved in electric mode, here we can use a bit of experience based on previous references and making a rough estimation via an empiric formula BUT WE DO NOT GUARANTEE ANY SPEED PERFORMANCE!

HYBRID SYSTEM SELECTION

Step 4: Batteries
Made by Transfluid

Battery selection is based on expected range:

Battery Capacity [Ah] = (Continuous rating [A]) x (Requested range [h]) / (Max DoD%)
Battery energy [kWh] = Battery Capacity [Ah] x Battery Voltage [Vdc]

Capacity Ah	Contin. discharge A	Pulse discharger A	Continuous charge A
100	100	200	80
200	200	400	160
300	300	600	240
400	400	800	320
600	600	1200	480
800	800	1600	640

DoD%
80%
90%

According to the absorbed current [A_{dc}] of the electric motor both in Continuous and Intermittent duties it is fixed the minimum battery size based on max continuous and intermittent discharge capacity of the LFP battery:

- 1C > Continuous duty
- 2C > Intermittent duty

Also **regeneration power** is limited by the battery size, it's set at 0,5C.