

**Engine Announcement:
X82-D, X82DF**

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Summary

With this updated Technical Information Note, WinGD announces the launch of the X82-D and X82DF engines, with amended information to delivery schedules and to engine dismantling height.

1 General Information

WinGD, through the pursuit of ongoing development, is proud to introduce the X82-D and the X82DF. These new 820 mm bore engines have a 3,375 mm piston stroke, with speeds ranging from 58 to 84 rpm. Both engines are available from six to nine cylinders with similar overall dimensions. Their design length, compared to the previous X82-B, has been reduced by 5% - 10% (depending on cylinder number), saving valuable space and allowing for flexibility in ship design. These engines are also equipped with the latest engine control system, WiCE, increasing engine control with large data storage capacities and faster data processing.

The performance of the X82-D has been improved compared to the X82-B, with an improving fuel consumption from a higher BMEP as well as an extended engine rating field resulting in a higher power output capability.

The X82DF, the newest dual-fuel engine in the WinGD portfolio, is an Otto cycle engine that uses natural gas as fuel. This makes it Tier III compliant without the need for an expensive waste cleaning process, such as a scrubber or SCR system. The low-emission operation provides clear environmental benefits, such as:

- Close to zero SO_x emissions
- Very Low particle emission
- IMO Tier III compliance of NO_x emissions, without exhaust-gas after treatment

Lean engine operation is possible thanks to the excellent gas fuel mixing provided by the engine's gas admission system. The pre-chamber technology ensures the highest level of combustion stability with minimum pilot fuel consumption. In addition to this, WinGD's proven low-pressure gas concept keeps the price of the fuel gas supply system to a minimum, with low operating costs and robust, maintenance friendly components. The X-DF engine design provides environmental, commercial and operational advantages. Furthermore, gas mode can be used across 95% of the engine's power range, making it possible to continually benefit.

2 X82-D Main Engine Parameters

The layout field of this engine is defined by the power/speed ratings R1, R2, R3 and R4 with a maximum continuous power of 5,500 kW/cylinder at 84 rpm (R1 rating) as shown in Figure 1. The engine can cover an overall power range of 16,560 kW to 49,500 kW.

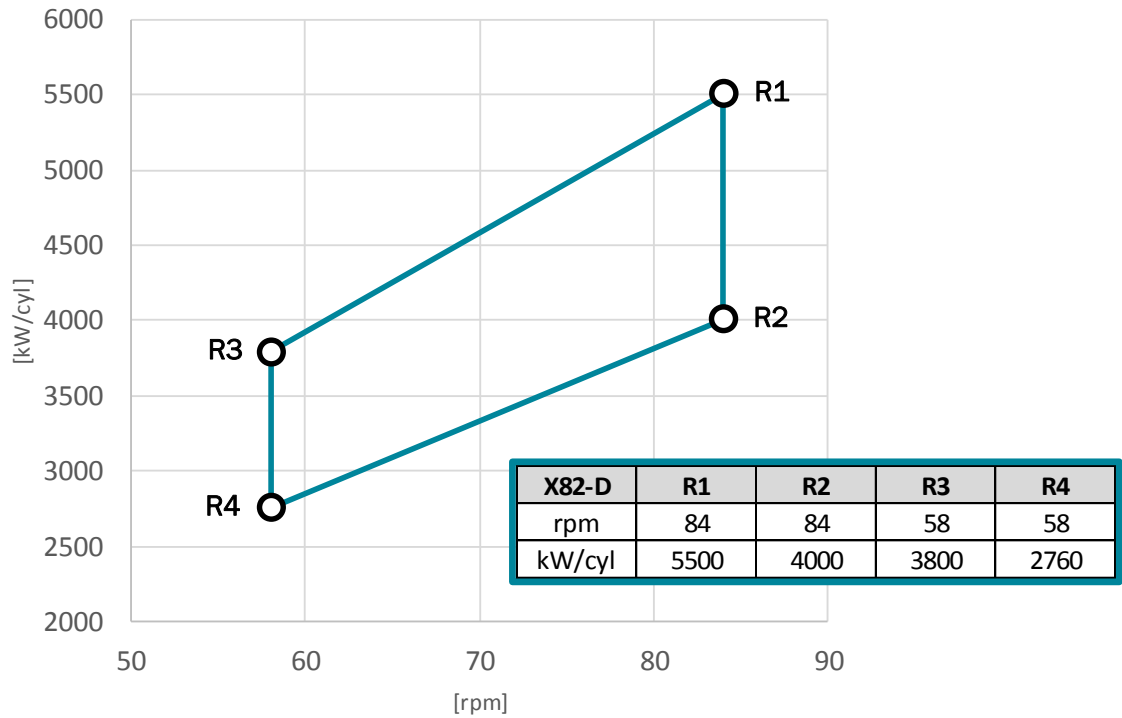


Figure 1: X82-D layout field

X82-D engine data is provided below in Table 1. Additional information can be seen in Appendix A: X82-D Outlines.

For an engine rating field comparison of all 820 mm bore engines or all engines in the WinGD portfolio, please refer to Appendix C: Rating Field Comparison.

Table 1: X82-D engine data

Engine Type	X82-D
Cylinder bore	820 [mm]
Piston stroke	3375 [mm]
Number of cylinders:	6 to 9
Power/cylinder, R1 MCR	5500 [kW]
Engine speed, R1	84 [1/min]
Engine speed, R3	58 [1/min]
Mean eff. pressure @ R1/R3	22.0 [bar]
Mean piston speed @ R1	9.5 [m/s]
BSFC – Brake Specific Fuel Consumption @ R1 (standard tuning)	162.3 [g/kWh]

Improvements in engine performance have reduced the BSFC of the X82-D across its entire load range. Considering 7X82-D with a CMCr of 24,700 kW at 67 rpm the improvement in consumption is shown in the graphs in Figure 2.

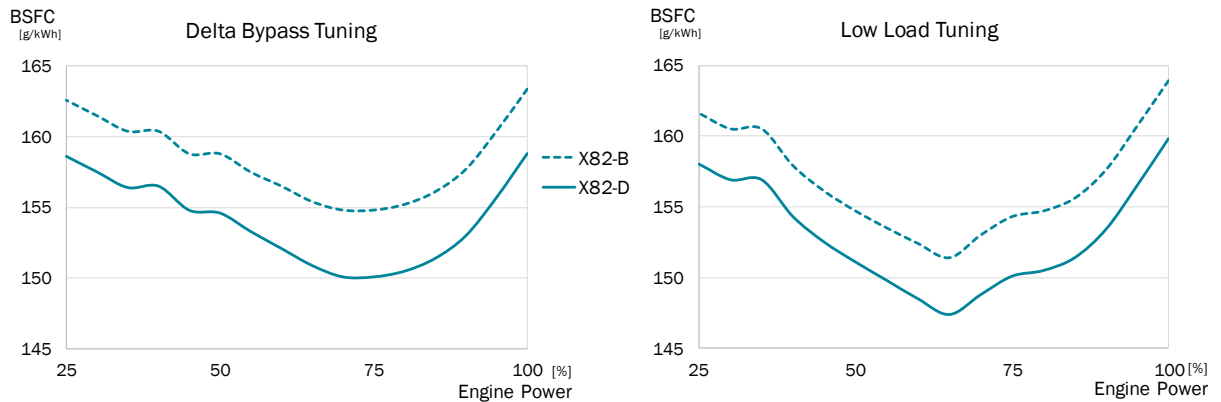


Figure 2: 7X82-D fuel consumption comparison, across engine load for DBT (left) & LLT (right)

This improvement in engine performance is further highlighted in the Table 2 and Table 3 below. These comparisons between the 7X82-B and the 7X82-D show the day savings in consumption and cost when considering the use of VLSFO, as shown in the tables.

Table 2: Fuel comparison and saving for DBT

Delta Bypass Tuning			MDO of 42.7 MJ/kg		VLSFO of 42.0 MJ/kg & price of 475 USD/ton		Daily Savings with 7X82-D	
			7X82-B	7X82-D	7X82-B	7X82-D		
Power [%]	Power [kW]	Speed [rpm]	BSFC [g/kWh]		Daily Fuel Consumption [tons/day]		[tons]	[USD]
100	24,700	67.0	163.1	158.4	98.3	95.5	2.8	1345
90	22,230	64.7	157.4	152.7	85.4	82.8	2.5	1211
80	19,760	62.2	155	150.3	74.7	72.5	2.3	1076
70	17,290	59.5	154.6	149.9	65.2	63.2	2.0	942
60	14,820	56.5	156.3	152.0	56.5	55.0	1.6	739
50	12,350	53.2	158.7	154.5	47.8	46.6	1.3	601
40	9,880	49.4	160.4	156.4	38.7	37.7	1.0	458
30	7,410	44.9	161.5	157.5	29.2	28.5	0.7	344
25	6,175	42.2	162.6	158.6	24.5	23.9	0.6	286

Table 3: Fuel comparison and saving for LLT

Low Load Tuning			MDO of 42.7 MJ/kg		VLSFO of 42.0 MJ/kg & price of 475 USD/ton		Daily Savings with 7X82-D	
			7X82-B	7X82-D	7X82-B	7X82-D		
Power [%]	Power [kW]	Speed [rpm]	BSFC [g/kWh]		Daily Fuel Consumption [tons/day]		[tons]	[USD]
100	24,700	67.0	163.6	159.4	98.6	96.1	2.5	1202
90	22,230	64.7	157.3	153.1	85.3	83.0	2.3	1082
80	19,760	62.2	154.5	150.3	74.5	72.5	2.0	962
70	17,290	59.5	152.8	148.6	64.5	62.7	1.8	842
60	14,820	56.5	152.2	148.4	55.0	53.7	1.4	653
50	12,350	53.2	154.7	151.0	46.6	45.5	1.1	530
40	9,880	49.4	157.9	154.3	38.1	37.2	0.9	412
30	7,410	44.9	160.5	156.9	29.0	28.4	0.7	309
25	6,175	42.2	161.6	158.0	24.3	23.8	0.5	258

Based on the values in Table 2 and Table 3, and with the engine operating scenario shown below, the daily and yearly fuel savings (assuming a running time of 6000 RH/year) have been calculated.

Table 4: 7X82-D operating scenario with resulting fuel and cost saving, for DBT & LLT

Power [%]	Operating Scenario		VLSFO of 42.0 MJ/kg & price of 475 USD/ton			
	DBT	LLT	7X82-B [tons]	7X82-D [tons]	Savings with 7X82-D [tons] [USD]	
100	1%	1%				
90	4%	4%				
80	12%	8%				
70	28%	12%				
60	25%	28%				
50	10%	25%				
40	8%	10%				
30	4%	4%				
25	8%	8%				

Delta Bypass Tuning			VLSFO of 42.0 MJ/kg & price of 475 USD/ton			
			7X82-B [tons]	7X82-D [tons]	Savings with 7X82-D [tons] [USD]	
Daily fuel consumption			56.8	55.1	1.6	773
Yearly fuel consumption			14,190	13,784	406.7	193,206

Low Load Tuning			VLSFO of 42.0 MJ/kg & price of 475 USD/ton			
			7X82-B [tons]	7X82-D [tons]	Savings with 7X82-D [tons] [USD]	
Daily fuel consumption			52.1	50.8	1.3	623
Yearly fuel consumption			13,018	12,691	327.7	155,654

3 X82DF Main Engine Parameters

The layout field of this engine is defined by the power/speed ratings R1, R2, R3 and R4 with a maximum continuous power of 4,320 kW/cylinder at 84 rpm (R1 rating) as shown in Figure 3. The engine can cover an overall power range of 14,940 kW to 38,800 kW.

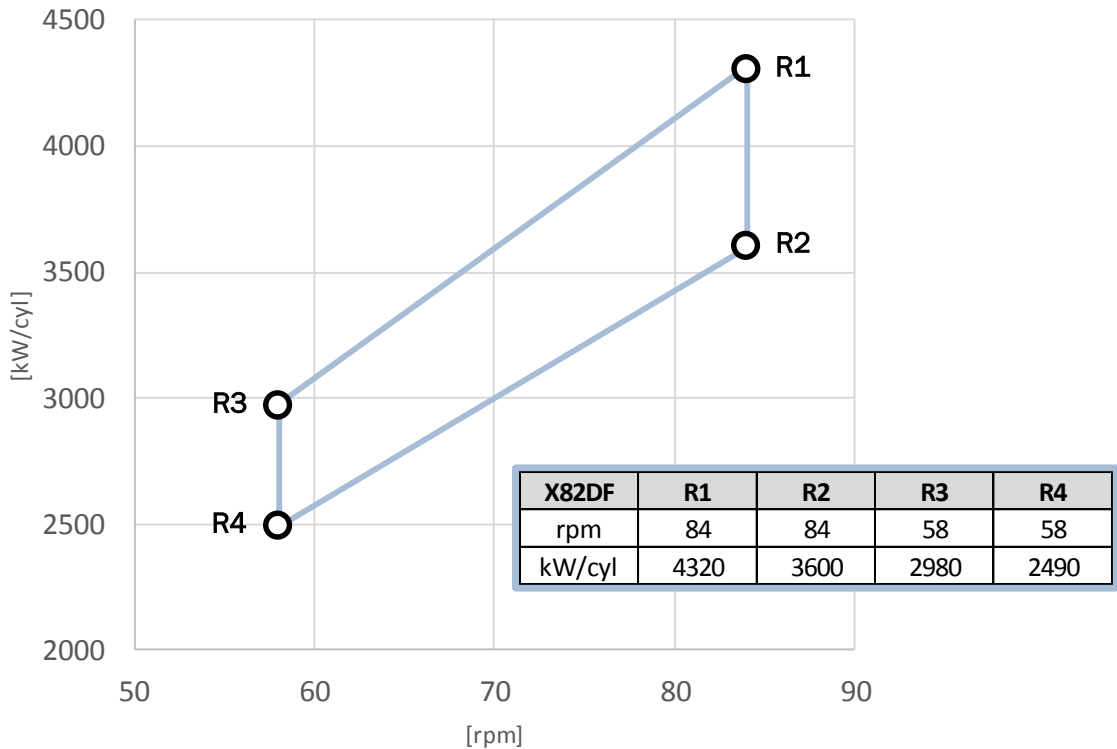


Figure 3: X82DF layout field

X82DF engine data is provided below in Table 5. Additional information can be seen in Appendix B: X82DF Outlines.

For an engine rating field comparison of all 820 mm bore engines or all engines in the WinGD portfolio, please refer to Appendix C: Rating Field Comparison.

Table 5: X82DF engine data

Engine Type	X82DF
Cylinder bore	820 [mm]
Piston stroke	3375 [mm]
Number of cylinders	6 to 9
Power/cylinder, R1 MCR	4320 [kW]
Engine speed, R1	84 [1/min]
Engine speed, R3	58 [1/min]
Mean eff. pressure @ R1/R3	17.3 [bar]
Mean piston speed @ R1	9.5 [m/s]
BSEC – Brake Specific Energy Consumption @ R1	7115 [kJ/kWh]
BSGC – Brake Specific Gas Consumption @ R1	141.8 [g/kWh]
BSPC – Brake Specific Pilot (fuel) Consumption @ R1	0.6 [g/kWh]

4 Scheduling

The first configuration for the X82DF is the 7-cylinder version, the below mentioned availability is therefore based on this configuration's scheduling. It is assumed that the 7X82-D will also be the first to be produced, however, this depends on order confirmation.

Although engine data is available for all configurations on the GTD program, scheduled availability for other cylinder configurations is dependent on order confirmation dates.

X82-D Availability

For the X82-D, the Marine installation drawings (MIDS) and the Marine installation manual (MIM) will be available by the end of 2019. The final engine delivery will be approximately 21 months from the confirmed order date.

X82DF Availability

For the X82DF, the yard installation drawings (MIDS) and the installation manual (MIM) are available. The delivery of the first ordered engines are scheduled for December of 2020.

Appendix A: X82-D Outlines

X82-D

IMO Tier II & Tier III (SCR)

Cylinder bore	820 mm
Piston stroke	3375 mm
Speed	58–84 rpm
Mean effective pressure at R1	22.0 bar
Stroke / bore	4.12

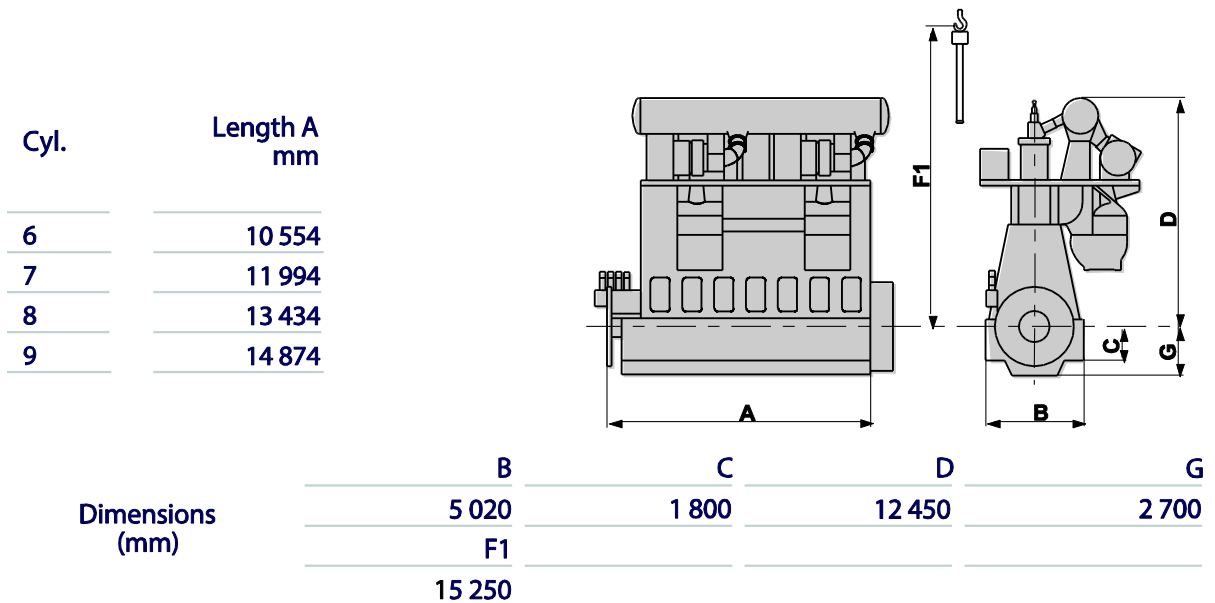


Figure 4: X82-D Engine definition

Table 6: Extract from drawing DAAD062687d “Standard Engine Data” Design group 0800

X82-D					BSEC Brake Specific Energy Consumption [kJ/kWh]
Rating Field Corners	Speed [rev/min]	Engine Power [kW/cyl]	Mean Piston Speed [m/s]	Mean Effective Pressure [bar]	
R1	84	5500	9.5	22	7116
R2	84	4000	9.5	16	6871
R3	58	3800	6.5	22	7215
R4	58	2760	6.5	16	6971
					Consumption (+5% tolerance) at 100% Power

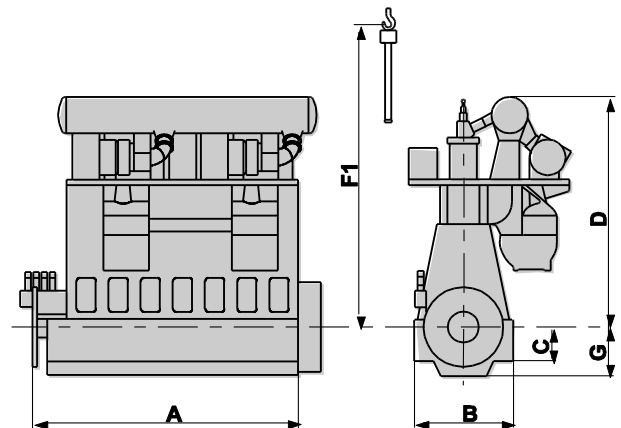
Appendix B: X82DF Outlines

X82DF

IMO Tier III in gas mode

Cylinder bore	820 mm
Piston stroke	3375mm
Speed	58-84 rpm
Mean effective pressure at R1	17.3 bar
Stroke / bore	4.12

Cyl.	Length A mm
6	10 554
7	11 994
8	13 434
9	14 874



Dimensions (mm)	B	C	D	G
	5 020	1 800	12 450	2 700
	F1			
	15 150			

Figure 5: X82DF Engine definition

Table 7: Extract from drawing DAAD112643 "Standard Engine Data" design group 0800

X82DF						Gas Mode		Diesel Mode
Rating Field Corners	Speed [rev/min]	Engine Power [kW/cyl]	Mean Piston Speed [m/s]	Mean Effective Pressure [bar]	BSEC Brake Specific Energy Consumption [kJ/kWh]	BSGC & BSPC Brake Specific Gas & Pilot (Fuel) Consumption [g/kWh]		BSFC Brake Specific Fuel Consumption [g/kWh]
R1	84	4320	9.5	17.3	7116	141.8	0.6	181.1
R2	84	3600	9.5	14.4	6871	136.8	0.7	179.1
R3	58	2980	6.5	17.3	7215	143.8	0.6	181.1
R4	58	2490	6.5	14.4	6971	138.8	0.7	179.1
Consumption (+5% tolerance) at 100% Power								

Appendix C: Rating Field Comparison

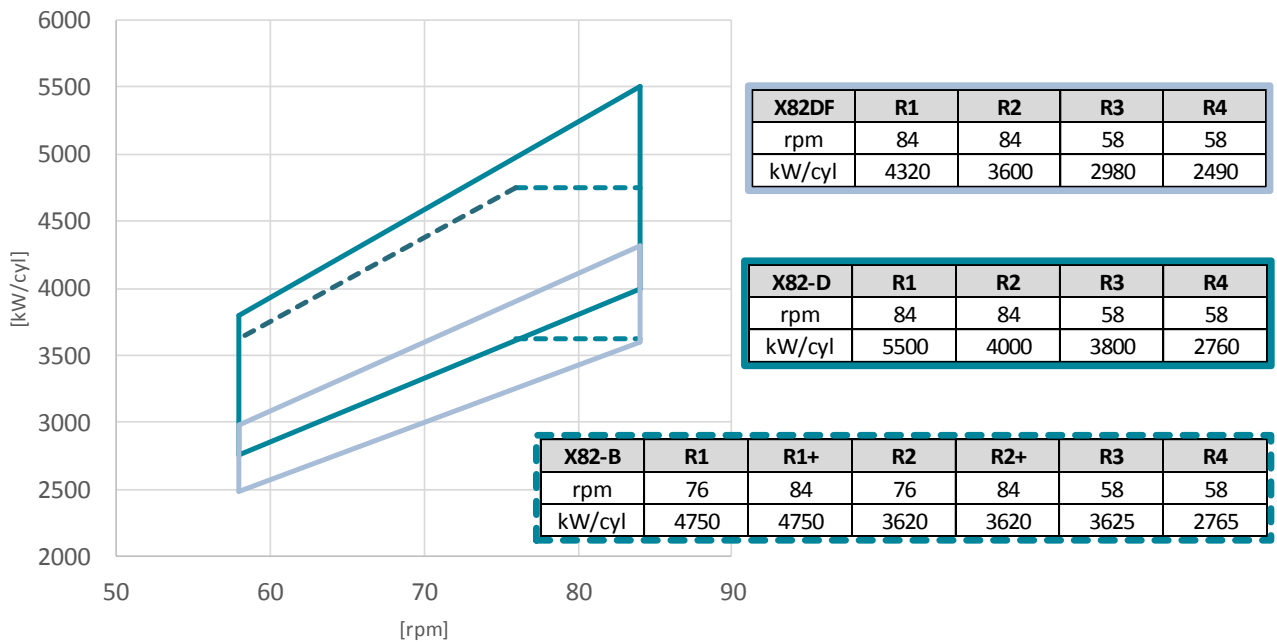


Figure 6: Rating field comparison of X82 family

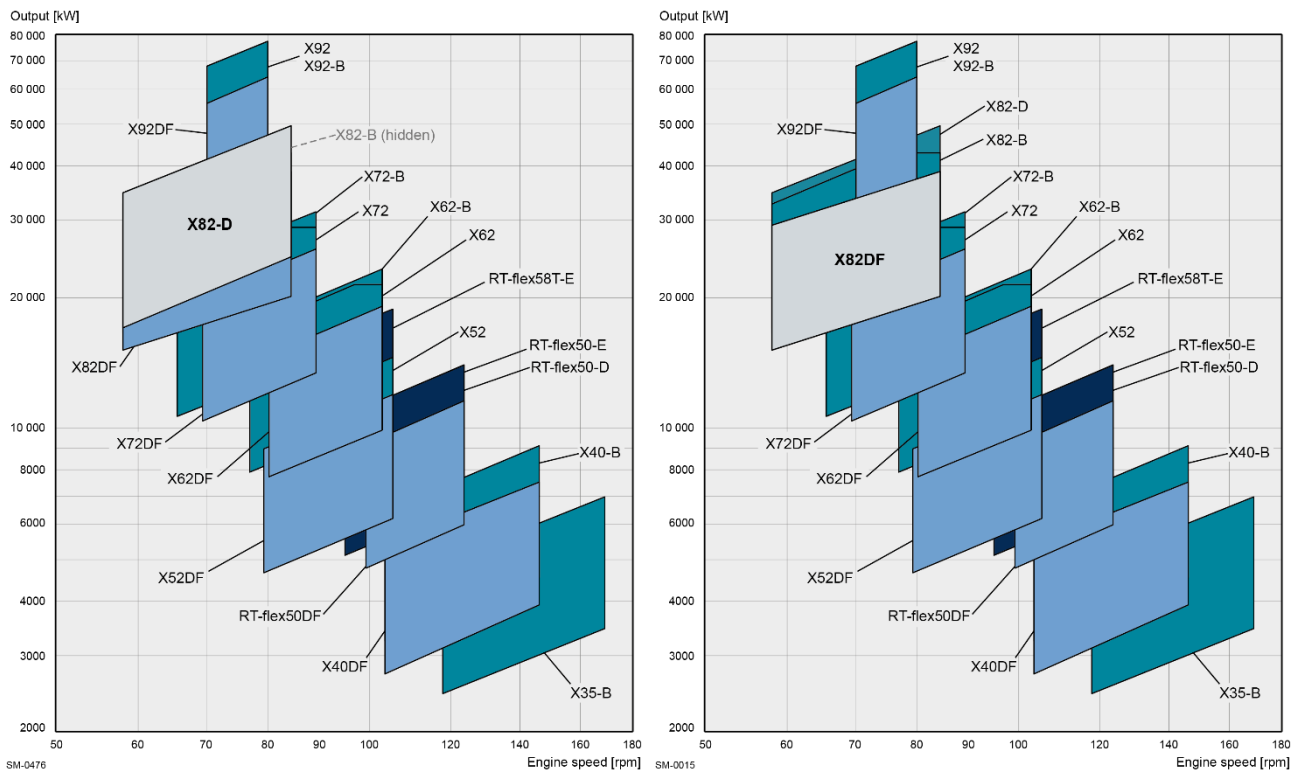


Figure 7: WinGD engine portfolio, highlighting the X82-D (left) and X82DF (right)