



Electric Motor Efficiency

By Tim Knox
(Törkmar)

Waste not. Want not.

Choosing the right motor and propeller means you can turn your generator off.

**Best way
to kill a cat is with
a large propeller!**



Mistakes made

2 x 20kW Motors

16 x 13" Propeller

Displacement 10,000kg

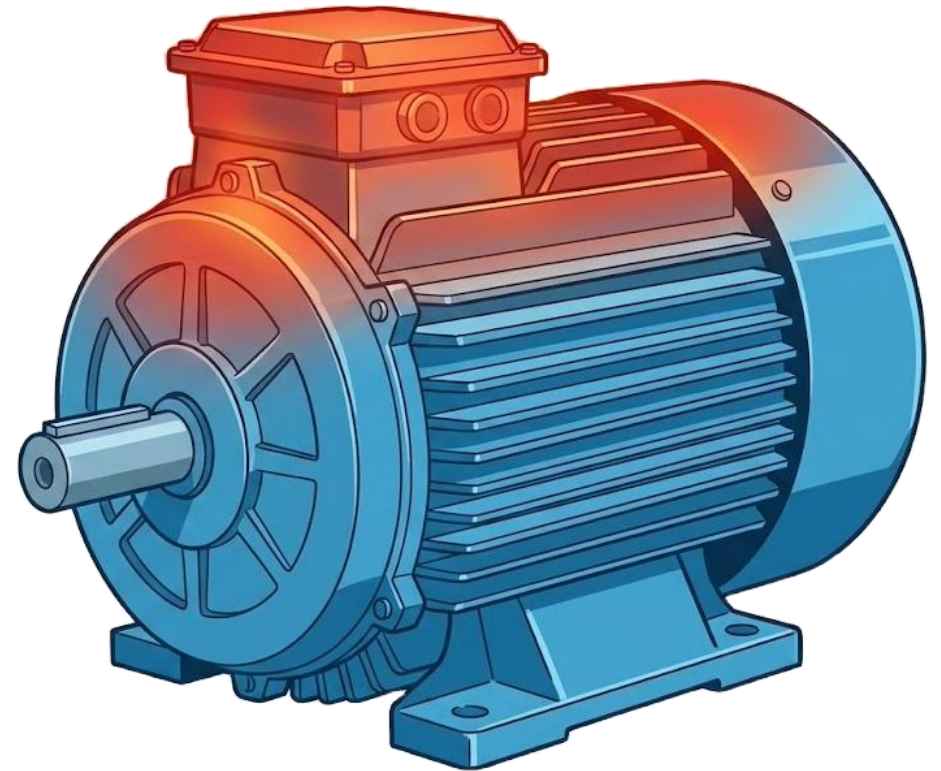
Super efficient hulls

Why did the motors overheat?

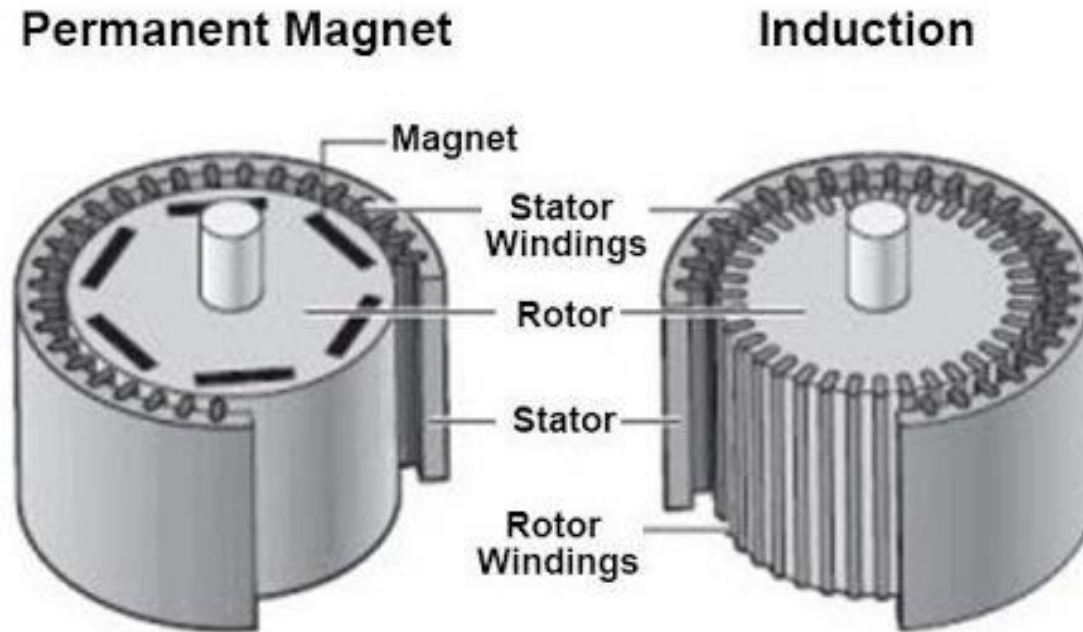


Motor efficiency

If your motor is 90% efficient.
Where does the 10% go?



2 types of electric motor



Which one runs cooler and why?

Mini summary

- ✓ PMAC motors are more efficient
- ✓ Heat is wasted energy

Propellers and RPM

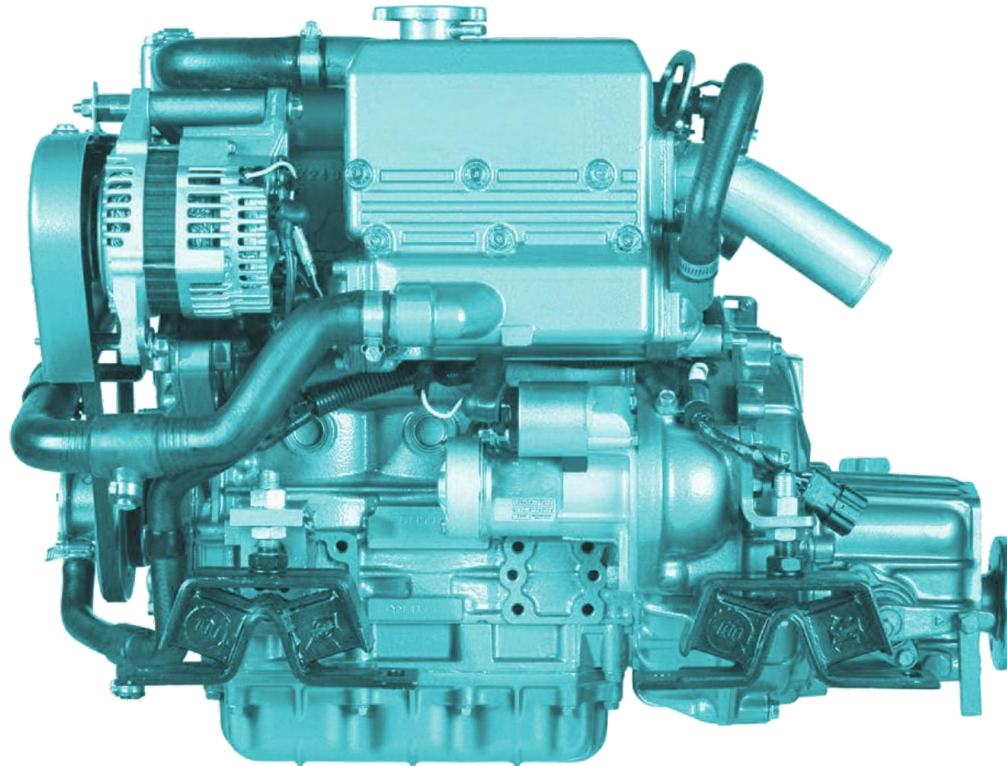
Planing boat RPM 4000-6000 RPM.

Ship RPM 80-120 RPM.

What are narrowboats most like?



Knowledge sometime is a problem.

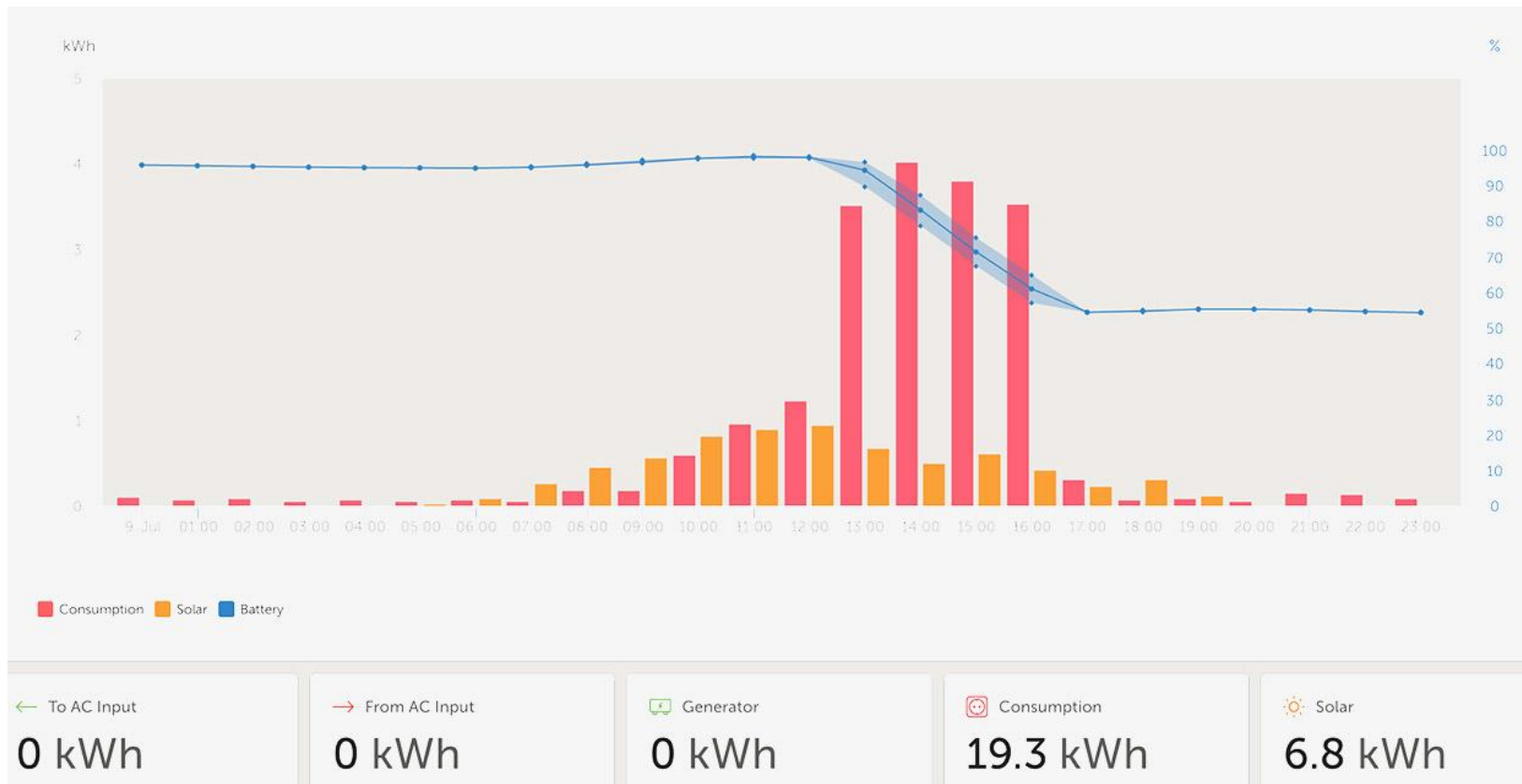


Equivalent Propeller sizing chart

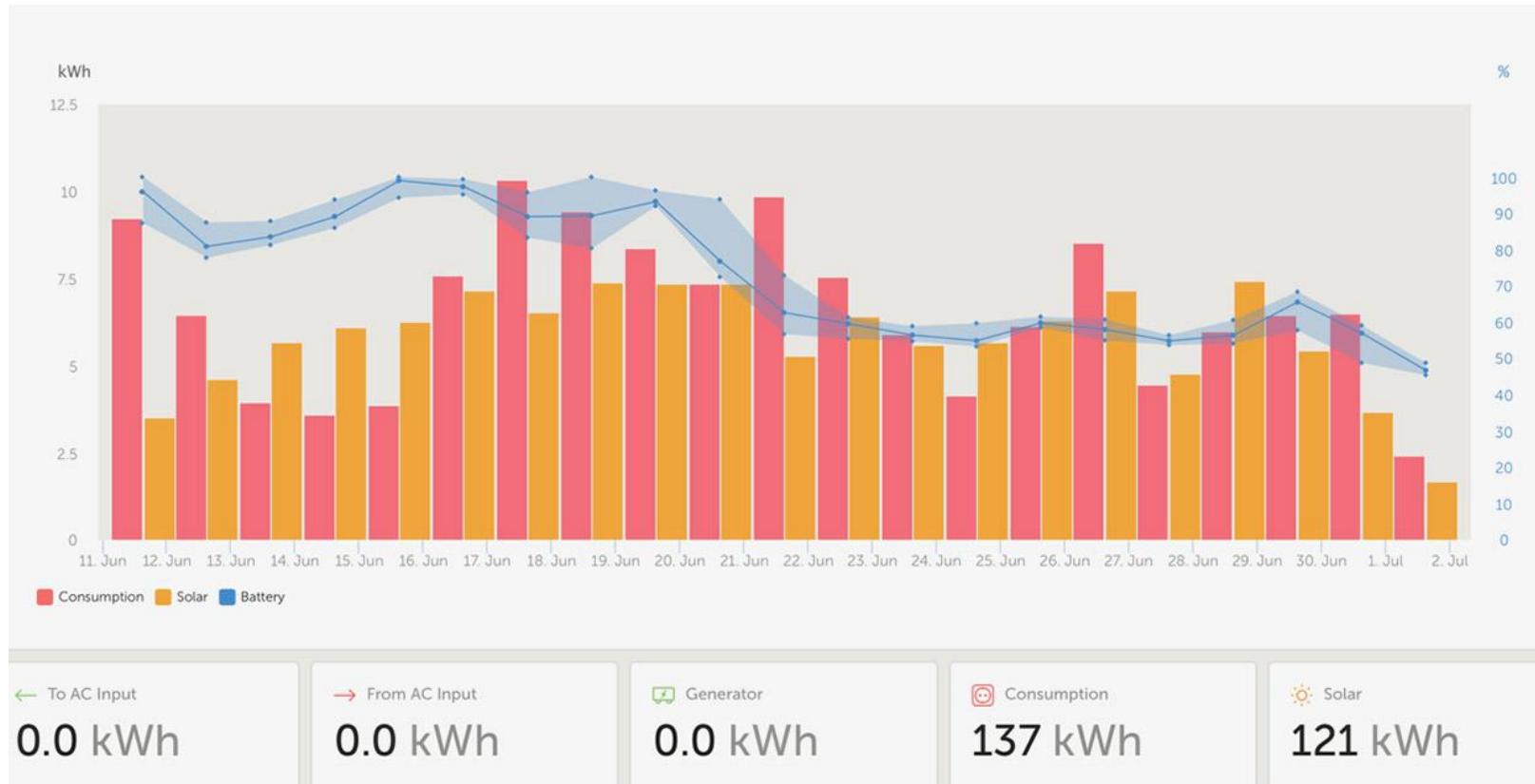
Use this Chart to compare Propellers of different sizes but using their "LOAD" Numbers.
For example, using the Chart you can see that a 15X7 (70000) is almost equal to
an 11X5 (73205) Propeller with the same Load number will turn very close to the same RPM
on a given engine using the same brand and type of propeller.
(Prop Load = Prop Diameter "4 x Prop Pitch") -- From AHA magazine 1994. Wayne Armstrong

PROP	LOAD	PROP	LOAD	PROP	LOAD	PROP	LOAD	PROP	LOAD
5 x 3	1875	11 x 4	58544	16 x 4	282144	21 x 4	777924	26 x 4	1827904
5 x 4	2500	11 x 5	73205	16 x 5	327680	21 x 5	972405	26 x 5	2284880
5 x 5	3125	11 x 6	87846	16 x 6	393216	21 x 6	1166886	26 x 6	2741856
5 x 6	3750	11 x 7	102487	16 x 7	458752	21 x 7	1361367	26 x 7	3198832
5 x 7	4375	11 x 8	117128	16 x 8	524288	21 x 8	1555848	26 x 8	3655808
5 x 8	5000	11 x 9	131769	16 x 9	589824	21 x 9	1750329	26 x 9	4112784
5 x 9	5625	11 x 10	146410	16 x 10	655360	21 x 10	1944810	26 x 10	4569760
5 x 10	6250	11 x 11	161051	16 x 11	720896	21 x 11	2139291	26 x 11	5026736
6 x 3	3600	11 x 12	175692	16 x 12	786432	21 x 12	2333772	26 x 12	5483712
6 x 4	5184	12 x 4	82944	17 x 4	334084	22 x 4	937924	27 x 4	2125764
6 x 5	6400	12 x 5	103680	17 x 5	417605	22 x 5	1171280	27 x 5	2657205
6 x 6	7776	12 x 6	124416	17 x 6	501126	22 x 6	1405536	27 x 6	3198846
6 x 7	9072	12 x 7	145152	17 x 7	584647	22 x 7	1639992	27 x 7	3720887
6 x 8	10368	12 x 8	165888	17 x 8	668168	22 x 8	1874448	27 x 8	4251529
6 x 9	11664	12 x 9	186624	17 x 9	751689	22 x 9	2108904	27 x 9	4792969
7 x 3	7200	12 x 10	207360	17 x 10	835210	22 x 10	2343360	27 x 10	5214410
7 x 4	9604	12 x 11	228096	17 x 11	918731	22 x 11	2577816	27 x 11	5845851
7 x 5	12005	12 x 12	248832	17 x 12	1002252	22 x 12	2811072	27 x 12	6377292
7 x 6	14406	13 x 4	114244	18 x 4	419904	23 x 4	1119364	28 x 4	2450624
7 x 7	16807	13 x 5	142805	18 x 5	524880	23 x 5	1399205	28 x 5	3073280
7 x 8	19208	13 x 6	171366	18 x 6	629856	23 x 6	1679046	28 x 6	3687936
7 x 9	21609	13 x 7	199927	18 x 7	734832	23 x 7	1958887	28 x 7	4302592
8 x 3	12288	13 x 8	228488	18 x 8	839808	23 x 8	2238728	28 x 8	4917248
8 x 4	16384	13 x 9	257049	18 x 9	944784	23 x 9	2518569	28 x 9	5531904
8 x 5	20480	13 x 10	285610	18 x 10	1049760	23 x 10	2798410	28 x 10	6146560
8 x 6	24576	13 x 11	314171	18 x 11	1154736	23 x 11	3078251	28 x 11	6761216
8 x 7	28672	13 x 12	342732	18 x 12	1259712	23 x 12	3358092	28 x 12	7375872
8 x 8	32768	14 x 4	153664	19 x 4	521284	24 x 4	1327104	29 x 4	2829124
8 x 9	36864	14 x 5	192080	19 x 5	651605	24 x 5	1658880	29 x 5	3536405
8 x 10	40960	14 x 6	230496	19 x 6	781926	24 x 6	1950656	29 x 6	4243686
9 x 4	26244	14 x 7	268912	19 x 7	912247	24 x 7	2322432	29 x 7	4950947
9 x 5	32805	14 x 8	307328	19 x 8	1042568	24 x 8	2654208	29 x 8	5658248
9 x 6	39366	14 x 9	345744	19 x 9	1172889	24 x 9	2985984	29 x 9	6365529
9 x 7	45927	14 x 10	384160	19 x 10	1303210	24 x 10	3317760	29 x 10	7072810
9 x 8	52488	14 x 11	422576	19 x 11	1433531	24 x 11	3649536	29 x 11	7780091
9 x 9	59049	14 x 12	460992	19 x 12	1563852	24 x 12	3981312	29 x 12	8487372
9 x 10	65610	15 x 4	202500	20 x 4	640000	25 x 4	1562500	30 x 4	3240000
10 x 4	40000	15 x 5	251125	20 x 5	800000	25 x 5	1953125	30 x 5	4050000
10 x 5	50000	15 x 6	303750	20 x 6	960000	25 x 6	2343750	30 x 6	4860000
10 x 6	60000	15 x 7	356375	20 x 7	1120000	25 x 7	2734375	30 x 7	5670000
10 x 7	70000	15 x 8	409000	20 x 8	1280000	25 x 8	3125000	30 x 8	6480000
10 x 8	80000	15 x 9	461625	20 x 9	1440000	25 x 9	3515625	30 x 9	7290000
10 x 9	90000	15 x 10	514250	20 x 10	1600000	25 x 10	3906250	30 x 10	8100000
10 x 10	100000	15 x 11	566875	20 x 11	1760000	25 x 11	4296875	30 x 11	8910000
10 x 11	110000	15 x 12	607500	20 x 12	1920000	25 x 12	4687500	30 x 12	9720000

Tidal Thames



London to Bristol



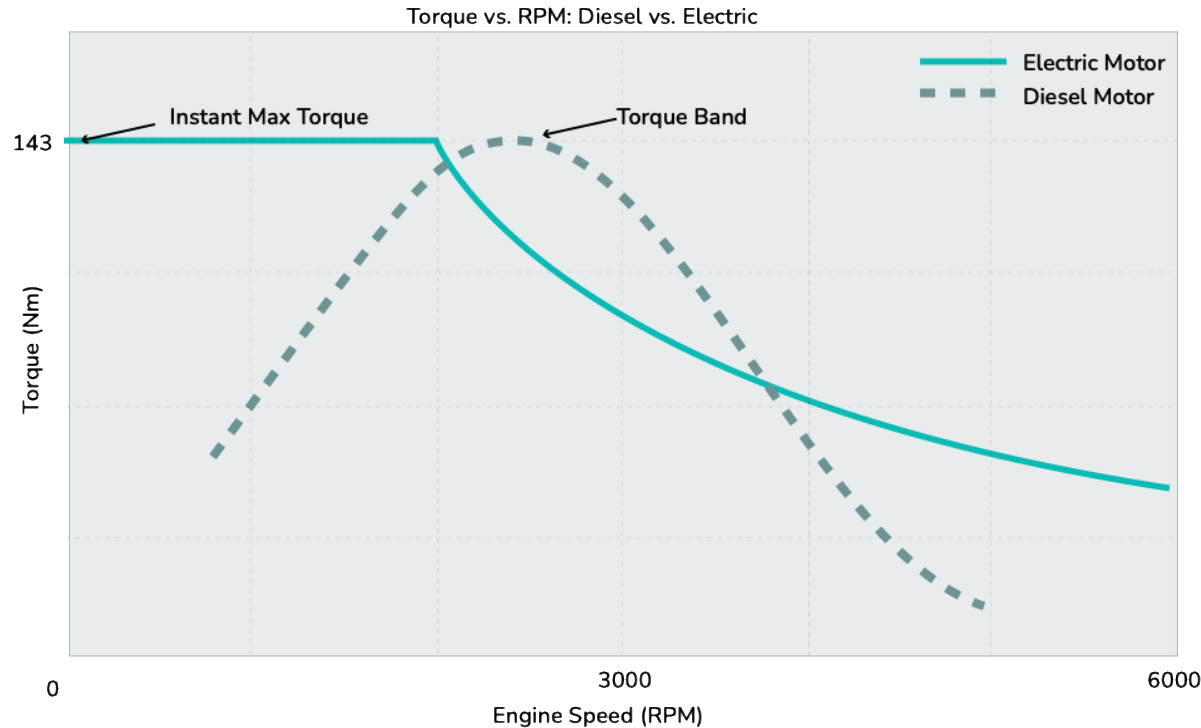
What is torque

The ability to twist something

- Nuts and bolts.
- Propellers.
- Jam jars.



Torque curve diesel and electric motors.



Question: Shouldn't prop size be different?

Why did the motors overheat?



They were AC induction motors.
We assumed 20kW means a lot of torque.

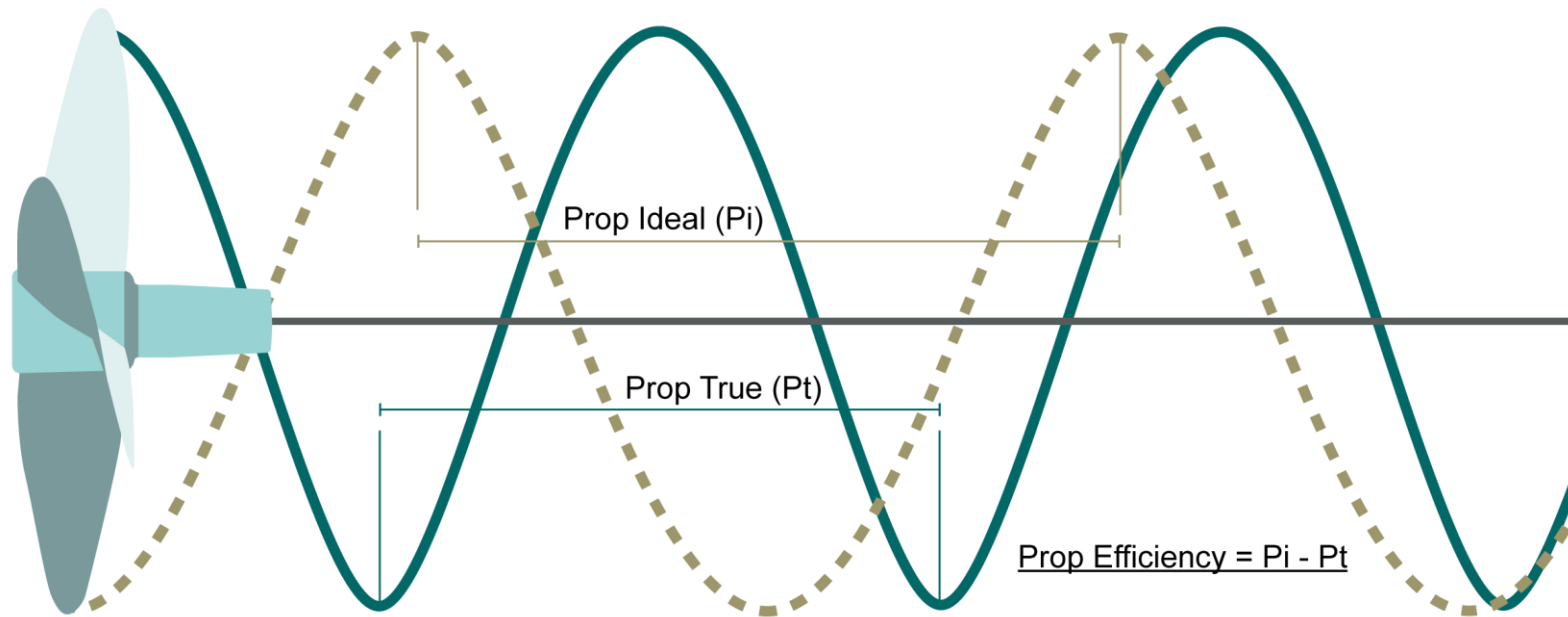
We had to reduce pitch.



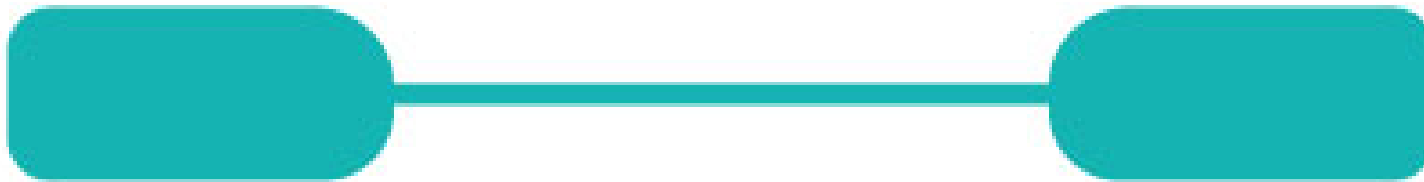
Kilowatts don't really
tell you much about a motor.

Ask about the torque.

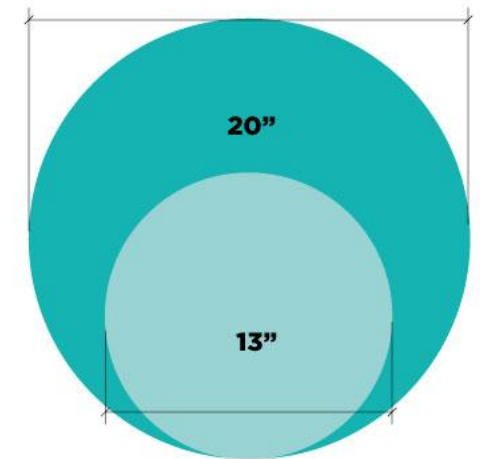
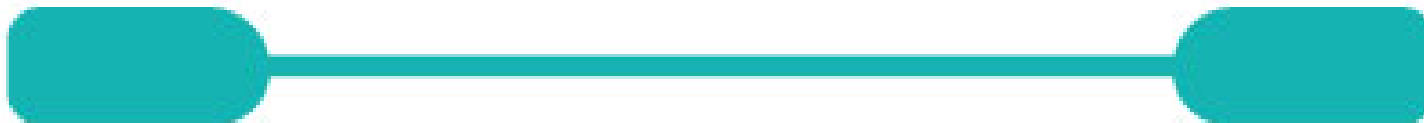
What propeller goes best with your narrowboat?



Why is a large prop important.

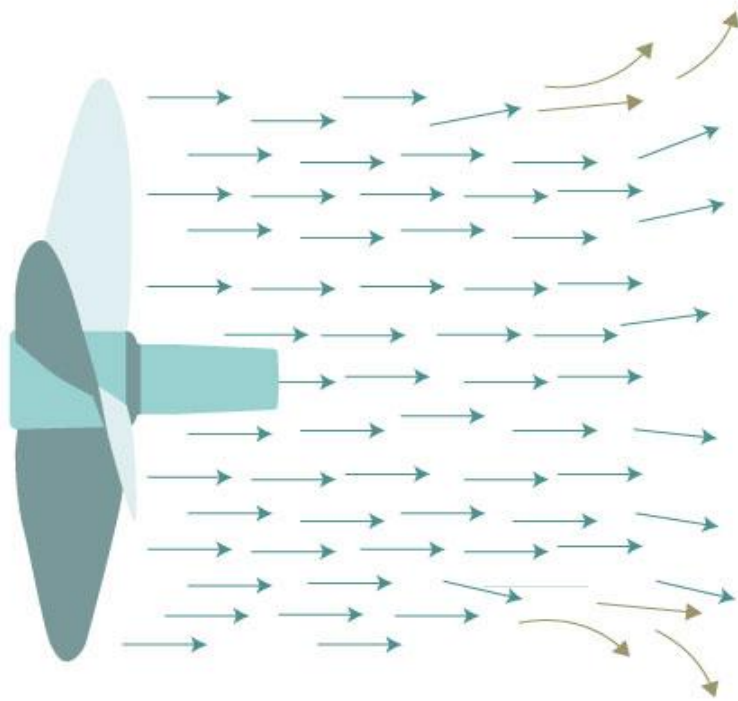


1 large paddle gives more thrust than 2 small paddles

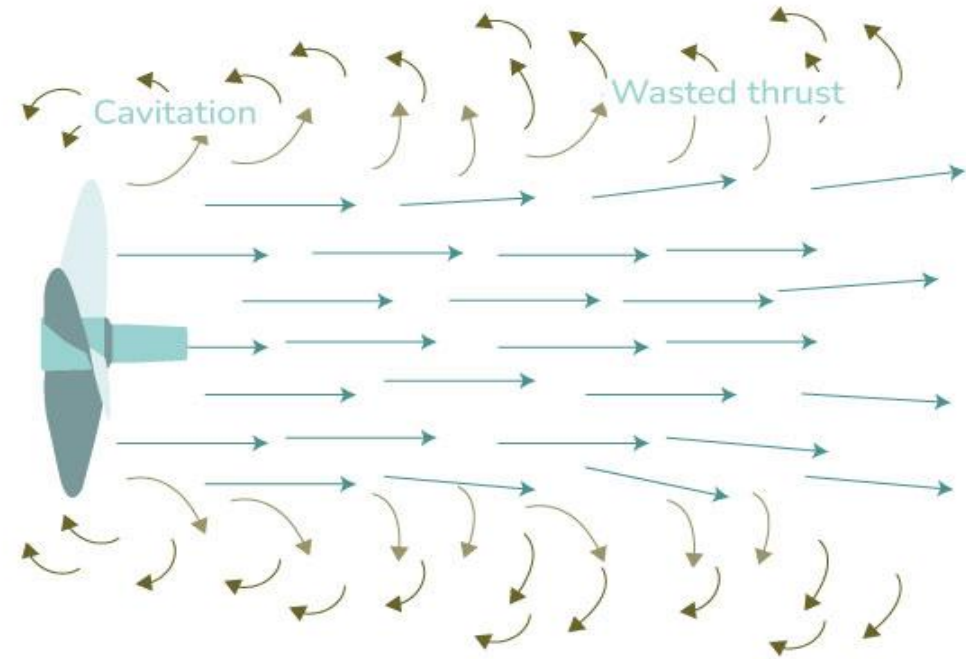


136.7% bigger

Watching water



Large Propeller



Small Propeller

How much power should I need to move my boat.

You only need between 0.8kW and 1.2kW on a normal canal

- Speed of about 2.5 to 3mph.
- At least this amount of power from your solar.
- Able to chat at normal volume, hear the birds and sneak up on paddleboarders.



Questions to ask.

What propeller
do I want?

Do I have space
for it?

Is my propeller
shaft of sufficient
diameter?

Will my motor
have the torque
for this prop?

I turn the
generator off.




Bon voyage and thank you.

Tim Knox

törkmar