CARLO GAVAZZI
Automation Components

White paper

Soft starters with mobile generators

How to overcome generator sizing issues and reduce system cost with soft starters

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1.INTRODUCTION

Starting inductive loads such as pumps, fans and compressors can affect the stability of the voltage network due to the high starting currents. In applications where the main source of power is a generator or a backup energy storage system (ESS), proper sizing becomes a challenging task. Unlike utility power, generators provide a finite source of energy both at steady state and during peak demand.

Under sizing of standby power sources may result in frequent trips and reduced lifespan especially if the generator is not properly protected. Even if such problems can be overcome by over sizing the generator, the latter is also problematic as it may lead to several problems within the exhaust side of a diesel powered genset resulting in higher maintenance costs. The optimum power to pull from a generator is 70 – 85% of its rated capacity. [1] Properly sizing generators to ensure they can handle the peak demand during start whilst making sure that the genset is also suitably sized for the steady state operation can be quite challenging.

In recent years portable generator sales have experienced a sharp rise due to a multitude of factors including growing frequency of natural disasters, poor grid infrastructure in undeveloped nations but also due to a new trend related to off grid living where homes are totally powered by standby power sources such as generators and photovoltaic systems or a hybrid of the two technologies.

The global portable generator market is expected to grow with a CAGR of 5.4% (2019-2026) reaching USD 5.87 billion by 2026 [2]. The residential sector has the biggest market share (71.3%) which mainly include gensets below 5 kVA [2]. The diesel powered gensets are the leading type of fuel used for residential due to efficiency while the gasoline is the fastest growing [2].

Portable generator market

Figure 1: Portable generator market [2]

2.STARTING INDUCTION MOTORS

Within residential applications motor loads can include pumps, compressors within heat pump and air-conditioners. In the commercial sector, generators would be used for powering saws, compressors and pumps.

Inductive loads such as motors pose a challenging task in generator sizing calculations. Whereas for linear loads such as heaters and lighting the starting current is equivalent to the running current, for motor loads the starting current, also known as inrush current, is significantly higher than the current during steady state operation. The level of starting current is also depending on the efficiency of the motors.

In Europe, energy efficiency regulations are being revised and by July 2021 motors with power output from 0.75 – 1000 kW must reach efficiency level IE3. As shown in figure 3, the higher the efficiency of the motor, the larger is the level of starting current. For a 10 kW IE2 motor the ratio between the starting current and the rated current is a factor of 6 whereas for an IE3 motor with the same power the factor rises to > 7 resulting in an average of 16% increase in the starting current.

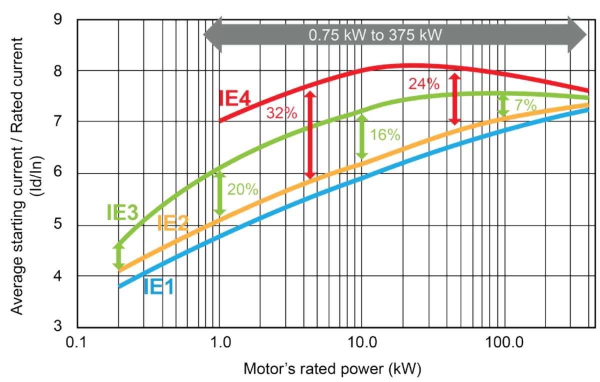

Figure 2: Average starting current of induction motors [3]

Starting a motor load (especially induction motors) via Direct On Line (DOL) will require around six times the rated current. The current remains high until 80% of the speed is reached. The duration of the starting current can vary from a few milliseconds to a couple of seconds depending on the inertia and the type of load connected to the motor shaft.

When connected to an electrical utility, such levels of inrush currents may easily result in an instantaneous voltage dip that may affect other loads such as lighting fixtures. In cases where such motors are started via generators the high inrush currents can cause large voltage dips that may cause the generator to trip.

When considering all these factors, correctly sizing the generator is not that trivial. Motor starting current can also vary depending on changing operating conditions such as differential starting pressures in pumps and compressors.

3.STARTING MOTOR LOADS WITH GENERATORS

Due to the limited power that is available from standby power sources such as generators, common phenomena that end users may experience include frequency and voltage dips.

Frequency dip is when enough power (kW) cannot be supplied by the engine, hence causing reduction in revolutions per minute (RPM). Whereas the majority of the loads can tolerate a mild frequency dip, a severe drop in the RPM may cause high oscillations on the motor shaft that creates increased levels of mechanical stress and it may also cause a motor to stall completely because of the drop in the rotational speed.

Induction motors have a torque-speed characteristic as shown in figure 3. When starting an induction motor a certain level of torque is required to get the motor to start rotating. At around 80% of the motor's synchronous speed the accelerating torque of the motor increases sharply until the point known as the breakdown torque is reached.

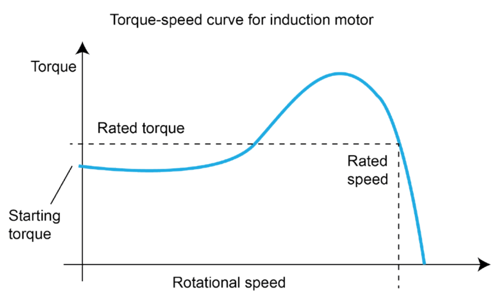

Figure 3: Torque-speed characteristic of induction motors

Depending on the frequency dip level and duration, the rpm on the motor shaft can drop to a point where there will not be enough load accelerating torque. As a consequence, a higher current will be drawn by the motor resulting in a generator tripping due to overcurrent.

Voltage dips occur when there is a high inrush current demand for a short duration. Factors such as line impedance, length of cables and stability of the power source can contribute to the level and severity of voltage dips. Motors can normally tolerate voltage dips in the region of 20 – 30%. However, a sustained low voltage condition can reduce the lifetime of motors due to the increased current and temperature within the motor coils. If generators are not properly sized to handle the steady state conditions, the output voltage from the genset may be lower than the acceptable voltage required by specific loads.

The high inrush current will cause disturbances on the voltage and frequency which may prevent from starting the load. Voltage dips can harm other equipment connected with the same system supply or cause mis operation of contactor and mechanical relays; therefore, correct generator sizing is crucial. Motor starting contactors and control relays can handle a 35% voltage dip but some may start to chatter at lower levels of voltage dips. Small frequency change can cause malfunction for certain equipment like Uninterruptible Power Supply (UPS). 30% voltage dip results in almost 50% reduction of starting kVA.

4.SIZING A GENERATOR

The most difficult interaction between a generator set and its load is during motor starting. Moreover, there is not a single standard that gives the basis for all necessary validation work. Currently the industry depends on the hardware evaluation based on NEMA MG1 Part 32 and NFPA 110 [4].

Two main fundamental criteria when sizing a generator for motor starting are instantaneous voltage dip and voltage recovery during motor starting [5]. Extensive field experience shows that the voltage recovery is mainly a function of the exciter size rather than the alternator size and hence it does not represent the generator's ability to start the motor. The main criteria should be what is the required Locked Rotor Kilo Volts Ampers (LRKVA) at the maximum instantaneous voltage dip. Also, MIL and NEMA standards state that initial voltage dip is the main criteria to use in generator sizing [5].
When reducing the maximum step up voltage during initial start-up or the maximum allowable frequency dip, it is required to increase the size of the generator.

Motor loads are the biggest issue when it comes to generator sizing. When it comes to sizing calculations, different generator manufacturers have different approaches leading to different final results. The load summation procedure is the most practical to use.

Load summation method [10]:

Step 1: Sum the running kW (RkW) of motor loads (except the largest motor)

A] List the running kW (RkW) for all the motor loads that will be connected to the generator. The RkW is the kW rating declared on the motor nameplate.

B] Exclude the largest motor load from the above list

Step 2: Calculate the starting kW of the largest motor load

A] For the largest motor load add the starting kW (SkW)

B] As a good approximation, the starting kW (SkW) can be calculated as follows:

- Single phase motors: SkW = Vline x L.R.A. x 0.8
- Three phase motors: SkW = √ 3 x Vline x L.R.A. x 0.8,

where L.R.A. is the locked rotor Amps of the motor (available on the motor nameplate)

C] Convert the SkW to starting kVA (SkVA) by the following formula: SkVA = SkW ÷ 0.8

Note: The 0.8 is a good reference value for the motor power factor (P.F.)

Step 3: Non-motor loads (e.g. lamps)

A] Sum all the kW corresponding to to the non-motor loads connected to the generator

Step 4: Sum up all the loads: RkW of motor loads, SkW of largest motor load, kW of all non-motor loads

Step 5: Select generator: The generator kW rating shall equal to or larger than the sum of all the above loads.

As one can observe, a high L.R.A value, will result in a higher over-sizing of the generator. If a smaller generator is used, there is a high chance that the generator will trip due to the high starting surge (SkW) required during the motor starting phase.

Let us consider a quick example using a typical 5 ton single-phase heat pump with a running current of 24 AAC.

Parameter		DOL start
Running kW	RkW	5 kW
Locked rotor amps	LRA	152.5 A
Starting kW	SkW	230 x 152.5 x 0.8 = 28 kW
Generator size		28 kW (or larger)

Table 1: Generator sizing example with DOL starter

5.SOFT STARTERS AND VARIABLE FREQUENCY DRIVES

Soft starters are electronic devices that use silicon-controlled rectifiers (SCRs) to reduce the initial starting current of induction motors. Most soft starters use the principle known as phase angle control to reduce the initial voltage applied on the motor shaft and increase this gradually depending on a set of parameters that can be set by the end user. Soft starters are normally used to reduce mechanical and electrical stresses on motors and couplings during motor starts and stops.

When using soft starters, the inrush current is reduced by an average of 40 – 65% with respect to a direct on line (DOL) start. Such a reduction in the starting current reduces both voltage and frequency dips especially when the available power source is limited.

With respect to generators, soft starters can bring several benefits including cost savings on the final installation. By controlling the motor acceleration during start-up, limiting the starting torque and reducing the starting current, the loading on the genset during motor starts is reduced. The lower starting current reduces the starting kilo Volt Amperes (SkVA) and starting kilo Watt (SkW) requirement. The starting kVA/kW will determine the generator size required. Having a 300% current limit results in reducing the starting kVA by 50%.

One disadvantage of switching SCRs is that these cause voltage distortions. To compensate for this the generator needs to be oversized.

Most of the soft starters available today on the market use the principle of hybrid switching. With this switching topology the SCRs are only triggered during the initial stage of the motor start. Once the motor reaches full speed the load current is conducted by the integrated electro-mechanical relays resulting in less heat dissipation and no disturbance on the voltage. Hence, for hybrid switching soft starters there is no need to oversize the generators because the voltage distortion will only last a few seconds during motor start-up.

Harmonic voltage distortion is caused when the load has impedance changes with the applied voltage [7]. These are called non-linear type of loads and due to the impedance change the current will not be a sine wave but will have a certain amount of voltage distortion. Harmonics do take up capacity of the generator and create unnecessary heat. Filter devices or upsizing the generator are two ways how this can be addressed [7].

Harmonics is a phenomenon associated with variable frequency Drives (VFDs) due to the high frequency switching of the power semiconductors (IGBTs). High levels of harmonics induce voltage drops on the reactance of the generator.
This implies adding a sizing factor on the generator in order to keep the voltage distortion to an acceptable level that of 15% (or less) total harmonic distortion (THD). According to the IEEE 519 THD should be limited to a maximum of 10% [7]. For a six-pulse VFD, the generator sizing should be around double the kW of the drive [6]. If the VFD is a Pulse Width Modulation (PWM) type or has an input filter to limit the current distortion within less than 10% then the generator sizing should be 1.4 times the kW rating of the drive [6].

Another important parameter to consider when sizing a genset is the start-up sequence. Starting several motor loads concurrently will contribute to an increase SkVA ultimately requiring an over-rated generator that can handle a very high peak demand. Whenever possible, sequential starting of loads, especially the inductive type, can result in a lower rated genset size. When this is not possible, starting the largest motor load first can be a suitable alternative to limit the SkVA required when all loads are connected.

6.CARLO GAVAZZI SOFT STARTERS

Carlo Gavazzi has a wide range of soft starters for both three-phase and single-phase induction motors. Single phase motors can be split in three main types: Permanent Split Capacitor (PSC), Capacitor Start Induction Run (CSIR) and Capacitor Start Capacitor Run (CSCR). PSC motors are typically used in low starting torque applications such as fans, pumps and also scroll compressors. CSIR can be found in applications such as low power rotary compressors and CSCR type motors are then used in applications that require a high starting torque – wastewater pumps and compressors.

CSCR and CSIR motors need a start capacitor to provide sufficient starting torque. Start capacitors are very susceptible to voltage fluctuations and temperature. In fact, they are one of the most critical components within a single-phase motor. On the other hand, although PSC motors do not require a start capacitor, the motor starting current on these motors can be as high as 7-8 times the motor rated current. Once again, these factors have to be considered during the selection and sizing of generators.

Carlo Gavazzi has recently launched an innovative dynamic motor soft starter, HDMS [9]. The HDMS is a single-phase soft starter that uses a proprietary control strategy that allows end user to eliminate the start capacitor for most applications. The HDMS uses advanced power module technology (IGBTs) with a hybrid switching topology to minimise voltage distortion and reduce heat dissipation during motor operation. Apart from removing the need of a start capacitor, the HDMS provides an average of 70% reduction in the motor starting current when compared to a DOL start. The exceptional current reduction is one of the factors that can minimise the need for oversizing generators. If we consider once more the same example of the 5 ton heat pump.

Parameter		HDMS start
Running kW	RkW	5 kW
Locked rotor amps	Soft start	46 A
Starting kW	SkW	230 x 46 x 0.8 = 8.5 kW
Generator size		8.5 kW (or larger)

Table 2: Generator sizing example with HDMS soft starter

As shown in table 2, the generator size that would be required when a soft starter like HDMS is installed would be significantly smaller or will avoid the need of significantly oversizing the generator.
In cases where a higher torque is required to start the load, a booster kit solution can be used. The booster kit consists of start capacitor (with low capacitance value – typically < 60 µF) and an electro-mechanical relay, controlled by HDMS, to engage and disengage the start capacitor.

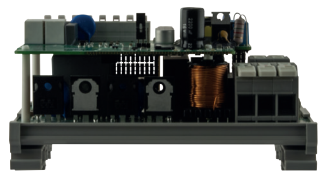

Figure 4: HDMS - High Dynamic Motor Starter

7.CASE STUDY

Scenario: A Paguro 6.5 kW generator [8] was installed on a boat supplying two air-conditioning units, fridge freezer, lights and other accessories connected to the generator's output. The compressors within the air-conditioning system were equipped with a hard start kit (HSK). A hard start kit is a combination of a start capacitor and voltage sensing electro-mechanical relay that help to lower the starting current by providing additional starting torque through the start capacitor – typically around 100 – 300 µF. Without the HSK the compressors in the air-conditioning units could not start when having unbalanced pressures due to the tripping of the generator as shown in figure 5. During the starting of the compressor, the voltage dropped by 80% for the whole duration of the start attempt – see figure 5.

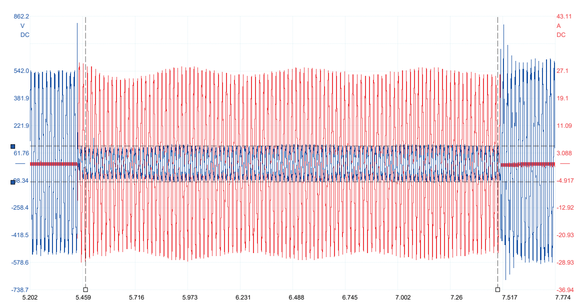

Figure 5: DOL start without hard start kit (Red-Input current, Blue- System voltage)

Problem: The generator was tripping frequently especially during the start of the air-conditioning units.
The trips were caused by the high inrush current demand by the compressors that was creating severe voltage sags. Figure 6 shows the start when an HSK was installed. There was still a voltage drop of 35% during the initial phase of the compressor start. This voltage sag was due to the high current (35 A pk) drawn from the genset.

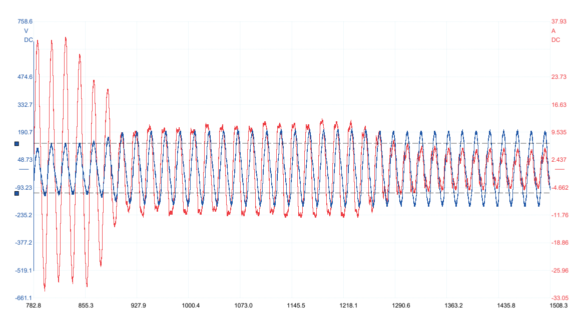

Figure 6: Compressor start with HSK (Red - Input current, Blue - System voltage)

Solution: The HSK was replaced with the HDMS. The compressors in this installation were CSCR type. At balanced pressures the HDMS started the air-conditioning units without problems. Within this specific application, there was no pressure balancing mechanism and the compressors could start with a differential pressure. To overcome this, a booster kit was installed together with the HDMS to reduce further the compressor starting current and minimise voltage dips.
The start capacitor for the booster kit was 40 μF. Figure 7 shows how the HDMS managed to start the compressors under unbalanced pressures. There was a minimal voltage dip of 8% and the starting current was reduced by a further 30% compared to the HSK performance as shown in table 1.

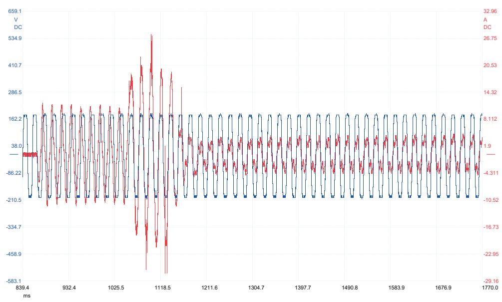

Figure 7: HDMS with booster kit Start with unbalanced pressures (Red - Input current, Blue - System voltage)

Parameter	DOL	HSK	HDMS
Voltage dip	80%	35%	8%
Inrush current (rms)	20 A	20 A	13.5 A
Successful start	No	Yes	Yes

Table 3: HSK vs HDMS - Voltage dip and Inrush current

Benefits: After installing the HDMS, there were no further generator trips and hence there was no need for over-sizing the generator. The voltage dip was considerably reduced as a result of a lower starting current when installing the soft starter. Compared to the hard start kit, the HDMS provided the following benefits:

- Eliminates generator trips
- Savings on total system cost
- Generator upsizing not required
- Increased load lifetime

Considering the above application, we will analyse the possible scenarios that a typical end user would be faced with.

Scenario 1: Selecting a larger generator (8.5 kW)

To solve the problem of the frequent generator trips, one of the options could have been that of selecting a larger generator in the first place. A larger generator would have provided the necessary SkVA to start the compressors but it would have been oversized during steady state operation resulting in higher running costs and more maintenance on the generator. Table 4 shows the total system cost for this scenario.

Scenario 1	
Equipment required	**System cost**
Generator: Paguro 8500	€ 9,525
2 x Hard start kit (HSK)	€ 100
Total	**€ 9,625**

Table 4: Initial cost for generator and starting kit

Scenario 2: Introducing a second generator

A potential option could have been to introduce a second 6.5 kW generator to handle the peak demand when required. Excluding the issues related to space constraints and the additional wiring required, it is clear that the cost of a second generator would be the costliest option.

Scenario 2	
Equipment required	**System cost**
Generator: Paguro 6500	€ 17,128
2 x Hard start kits (2x Paguro 6.5 kW)	€ 100
Total	**€ 17,228**

Table 5: Initial cost for setup with two generators

Scenario 3: Installing a HDMS soft starter

As already discussed in the previous sections, motor loads cause a high transient current during the starting phase. Soft starters regulate the voltage on the motor during start and reduce the current demand from motor loads. Introducing the HDMS soft starter resulted in sufficient start current reduction that there was no need to over-size the generator. As a secondary benefit, the effect of reducing the voltage dip from 35% to 8% ensured that there was no voltage disturbance on the other loads powered by the genset.

Scenario 3	
Equipment required	**System cost**
Generator: Paguro 6500	€ 8,564
2 x HDMS soft starters	€ 600
2 x booster kit	€ 100
Total	**€ 9,264**

Table 6: Initial cost for installation with HDMS soft starters

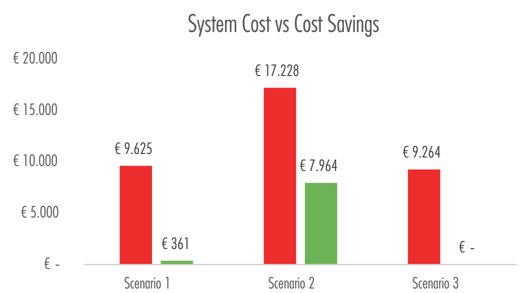

Figure 8: Comparison on the system cost and resulting savings

The chart in figure 8 summarises the costs and relative savings for the 3 scenarios that were considered. As can be seen, installing the HDMS soft starter provides an immediate saving compared to all the other options that were available. Compared to Scenario 1, that of oversizing the generator, the saving would be that of 361 Eur thereby providing an immediate payback even without considering the lower running costs of operating a lower power genset. This case study shows how to overcome the difficulty posed by motor loads in proper generator sizing. Soft starters can help to minimise the peak demand thereby reducing the problematic effects of voltage dips that could create both mechanical and electrical stresses on the connected loads.

8.CONCLUSION

Use of standby power sources such as generators is increasing at a rapid pace due to various factors including natural disasters and off the grid living. Properly sizing generators for the connected loads is very critical to ensure that gensets operate at their best efficiency. Both under sizing and over sizing of generators is not recommended. Under sizing may result in frequent generator trips, severe voltage dips and may reduce generator lifetime. Over sizing may also bring additional maintenance costs apart from the higher initial and running costs.

Even though various established methods for generator sizing exist, when gensets are coupled to motor loads there is an additional level of complexity. Motors absorb a high current during the start-up phase. Therefore, generators have to be properly sized with respect to their starting kVA in addition to the steady state power. In applications with motor loads, oversizing of generators might be required. Inevitably, oversizing of generators is a costly choice and may incur further running costs.

Electronic devices such as soft starters reduce starting current of motors by an average of 40 – 65% during the start-up phase by regulating the output voltage. With hybrid switching soft starters, voltage disturbance is minimal so there is no adverse effect on generator sizing. On the contrary, soft starters can help end users save costs by avoiding the need to oversize generators and eliminating voltage dips.

As shown in the case study within this paper, utilising a HDMS soft starter can bring significant cost savings to the overall system cost. The results obtained on a system with two air-conditioning units powered by a 6.5 kW generator show how the soft starter reduced the voltage dip level from 80% to just 8%. The level of current reduction that was achieved allowed the end user to keep the existing generator with no further modifications.

9.REFERENCES

[1] Murphy D., "Basic Sizing for Mobile Generators". White Paper, Available from https://www.generac.com/Industrial/professional-resources/news-whitepapers/whitepapers Accessed on 11/11/20

[2] Fortune Business Insights, Power & Renewables, Portable Generator Market, "Portable Generator Market Size, Share and Global Trend by Fuel (Diesel, Gas and Others), Power Rating (Below 5kVA, 5-15kVA, 15-45kVA, 45-75kVA), by Application (Residential, Commercial, and Others), and Regional Forecast, 2019 to 2026", Available from: https://www.fortunebusinessinsights.com/industry-reports/portable-generator-market-100155 Accessed on 14/08/2020.

[3] ee publishers, "IE3-IE4 motors: selecting the right control and protection components", Available from: https://www.ee.co.za/article/ie3-ie4-motors-selecting-the-right-control-and-protection-components.html Accessed on 13/08/2020.

[4] Olson G., "Specifying & Validating Motor Starting Capability". White Paper, Cummins.

[5] Krueger D., Van Maaren R. " Sizing generators for motor starting". White Paper, Available from: https://www.kohler-sdmo.com/EN/Documents/download/110 Accessed on 12/08/2020.

[6] Bey L. A., "Sizing Gensets for large motor starting", Available from: https://www.ecmweb.com/basics/article/20885994/sizing-gensets-for-large-motor-starting Accessed on 16/08/2020.

[7] Slavens R., "Sizing Considerations for Commercial and Industrial Generators". White Paper, Generac.

[8] Advance Yacht Systems, "Paguro 6500", Available from: https://www.advanceyacht.co.uk/marine-generators-paguro/paguro-6500 Accessed on 21/08/2020.

[9] Demicoli J., "New soft starter technology eliminates start capacitors in single phase motor applications.". White paper, Carlo Gavazzi.

[10] Generator Sizing Guide, Technical Data TD00405018E, Available from: https://www.eaton.com/ecm/groups/public/@pub/@electrical/documents/content/td00405018e.pdf, Accessed on 21/08/2020

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