Greening Initiatives for the Entertainment Industry

Russell Saunders, CEO
Saunders Electric Incorporated C-10 428325
September 4, 2012

The Entertainment Industry by its very nature has the means to make the greatest impact on global environmental attitudes. In an effort to clarify and contribute to a positive environmental awareness I have compiled information on engine and power generating systems specifications in use today by the entertainment industry. This information is presented here in an attempt to spawn further thought and discussion and should in no way be misconstrued as being a complete singular or final solution to environmental issues.

Tailpipe emissions- the yardstick by which all is measured-

The first and largest polluter in our industry is general transportation and production trucking.

The guidelines established by the EPA and adopted by the California Air Resources Board – C.A.R.B., also known as Tier levels, has greatly reduced tailpipe emissions in California since 1997. Many companies (primarily California based) have been forced by these tier standards to retire and replace their fleets with newer more costly trucks and engines. Additionally in an effort to become more environmentally friendly many companies have tried to convert their fleets to alternative fuels such as biodiesel, bio-fuels, ethanol, etc., with little success and in some cases catastrophic results.

Bio-fuels–

There are numerous debates concerning manufacturing processes, land use, world food prices, and the impact of manufacturing bio fuels. I will not be addressing these issues here rather I will direct our attention to the more practical applications with regard to the entertainment industry.

The application of bio-fuels in older and many newer engines is problematic on several levels.

First and foremost older engines have used standard grade diesel #2 fuel. The fuel system in these engines has built up “scale” on the walls of the fuel tanks and pumps in their fuel delivery system. When bio-fuels are introduced into engines which have only used #2 diesel fuel the scale is chemically cleaned away from the fuel walls and quickly clogs filters and damages pump systems. The “scale breakdown” problem is never fully resolved even over long periods of time. Electronically controlled fuel delivery systems known as 'common rail' and 'unit injector' type systems from the late 1990s onwards may only use biodiesel blended with conventional diesel fuel. These engines have finely metered and atomized multi-stage injection systems that are very sensitive to the viscosity of the fuel. Denser fuel viscosity causes these systems to become very sluggish and non-responsive. The other main issue with older engines is that they use neoprene gaskets and seals. The bio-fuel breaks down the seals causing leaks and engine component failure. Many of newer late model tier rated engines now have ‘viton’ by Dupont and composite type seals/gaskets which are impervious to bio-fuels.

Even with these enhanced design modifications the engine manufacturers across the board will only rate and warranty these newest engines at best to 20% bio/alternative fuels. Bio-fuels also have a low tolerance to colder temperatures and tend to “gel up” in colder weather which requires a fuel preheat system to be installed. The economic situation in the United States has forced companies to maintain their existing fleets beyond their intended turn-over cycles. It is economically more realistic to maintain and continue using their existing fleets. Although the newer tier engines are readily available older fleets will remain viable and in use well into 2020.

The largest drawback to bio-fuels is the lack of availability and certifiable quality standards for trucking companies. Being well aware of the standards established by the EPA I can attest to the fact that bio fuels today remain by and large unregulated and the standards set forth by the EPA are unenforced.

We purchase and use B20 bio-fuels from several Los Angeles based bulk fueling companies. When the bio-fuel is ordered the fueling company takes their fuel truck with diesel #2 and dumps 20% by volume of bio-fuel into the truck. As the truck travels down the road to the delivery site the motion of the tank truck “mixes” the fuels together. We call this “roadway mixing” the distance of travel and road conditions will determine the quality of the final bio-diesel product. It must be noted here that many of the fuel delivery companies deliver these fuels using tractor trucks burning standard diesel#2, thus still contributing to the emissions problem.

Until bio-fuel usage becomes more widespread and is manufactured/distributed on a national scale, quality control will be an issue, especially outside of California. A good article called “issues relating to Bio-fuels” can be found at: http://en.wikipedia.org/wiki/Issues_relating_to_biofuels

The good news is that the bio-fuel consumer market is definitely growing. Once the market is large enough use of Bio-fuels will become more viable. ”In 2010 worldwide bio-fuel production reached 105 billion liters (28 billion gallons US), up 17% from 2009,... bio-fuels have the potential to meet more than a quarter of world demand for transportation fuels by 2050” according to the International Energy Agency.

Engine maintenance-

Bio-fuel based engines require more frequent engine oil changes due to “fuel washing” issues. Bio-fuels cause the oil in the engine to become diluted. This occurs through the cylinder walls of the engine. As the bio-fuels are burned they leave a residue on the walls of the cylinders. This residue is cleaned away and lubricated by the oil system in the engine. The bio-fuels have a greater oil breakdown rate than conventional diesel fuel and cause a “thinning” of the oils resulting in reduced lubricity and greater engine parts wear. This thinning requires shorter maintenance service cycles which in turn significantly increases operations costs, man-hours, filter disposal, and oil disposal.

Conclusion: considering all factors- fuel system issues, higher frequency of maintenance cycles, oil and filter disposal versus improved tail pipe emissions, and limited fleet engine compatibility, it appears that bio-fuel usage has questionable cost benefits.

So what can be done to improve tailpipe emissions now?

Diesel Particulate Matter filters-

In 2012 the EPA has required specific engine types to install a mitigating tailpipe filtration system known as a Diesel particulate filter. This is basically a filtration/catalytic converter muffler style device which super heats the exhaust contents thereby reducing the amount of soot and modifies the carbon and NOX emissions content to lower levels.

Diesel Particulate Filters (DPF) efficacy-

"DPFs reduce emissions of particulate matter, hydrocarbons and carbon monoxide by 60 to 90 percent. DPFs must be used with ultra-low sulfur diesel fuel (ULSD – 15 parts per million sulfur)." - http://www.epa.gov/cleandiesel/documents/420f03017.pdf Use of regular diesel fuel in a DPF equipped engines could eventually clog the filter. This could lead to exhaust back-pressure increases and engine damage. The average cost to install a DPF on an existing engine system is approximately $5,000.00 to $10,000.00 depending upon engine type and installation.

The addition of a DPF to these engines comes at a price. The horsepower rating of these engines is reduced, which means that more fuel is consumed to move product the same distance which translates into more tailpipe, albeit cleaner emissions .

Many of the trucks on the road today are horsepower programmable. This is achieved through a programmable chip in the engine electronic control unit (ECU) or "brain". Many trucking companies and owner operators will program their engines to achieve the highest horsepower rating possible from their engines. When properly applied this is a viable practice when you consider that a truck can be required haul up to 80,000 lbs over the continental divide. When this practice is misapplied in an attempt to counter horsepower loss the tailpipe emissions will increase mostly due to accelerated engine component wear of valves and injectors. This misapplied practice can result in shorter engine life and efficiency and will require more frequent maintenance cycles as well as possible engine overhauls.

Steps for a cleaner tailpipe-

1. Comply with the tier standards established by the EPA.
These standards have the greatest impact on tailpipe emissions as is evidenced here in California. The problem is that these standards are regulated and enforced state by state and I have seen very little enforcement outside of California. The economic impact to upgrade their fleets is a large burden on trucking companies.

2. Proper engine maintenance- oil & filter replacement, air filter replacement, and fuel filter replacement keeps the emissions at optimum levels.

3. Possible bio-fuel usage depending upon engine type, age, and fuel history.

It appears that progress is being made in improving tailpipe emissions using bio-fuels but with the varied types of fuels, engines, market saturation, and environmental issues in manufacturing these fuels, this effort will take time during which I believe that more efficient energy systems and engines will become available. Perhaps the most important by-product of these energy debates has been a raised awareness of our environment attitudes and social conscience.

What can we do today in the Entertainment Industry to lessen our environmental impact?

There are many immediate options available to us in mitigating tailpipe emissions. First we need to look at the power systems in current use by the entertainment industry.

Portable power generators

I will be discussing the use of diesel driven systems because that is what is in most prolific use by our industry. While there are exceptions to this rule, the availability and saturation of non-diesel based systems used in the entertainment industry is limited.

a. Stand alone generators ranging in common sizes from 1000KW (1 million watts) diesel units down to small 1KW (1000 watts) gasoline engines. These units are employed usually in the field when the North American power grid (utility/shore power) is not readily available or the grid power has been fully used and more power is needed.

However, this is not always the case...

Quite often when utility/shore power is available a portable generator is still used. I have found that the reasoning is “a matter of convenience”, or “the shore power is not where we need it to be”, or “we never considered it as an option”.

There are options often available to us for alternative cleaner power but we seem to choose to ignore them. Habit seems to dictate the use of portable power generators. The “this is the way we did it before” scenario is more common than not!

There are legitimate times where a portable generator is the best and sometimes only viable option. There are many compelling factors in how to best apply stand-alone generators.

b. Proper sizing- this is one of the most important aspects of power systems design. Sizing a generator or correctly loading generators is critical to tail-pipe emissions. Generator emissions increase significantly when a sustained low load condition is maintained over a long period of time (for example: 30amps of load on a 400amp capable system).While it is common to have varying loads on portable generator systems it is important to **pre-design the end use and application loads for 60% of generator capacity**. This keeps the generator at optimum running condition and allows for the minimum environmental impact. The larger offense of improper generator sizing is regularly committed by our power technicians and electricians. There is not enough time spent on calculating our load demands, designing our power systems, and then installing/ordering the correct size generator for our needs. I have witnessed the use of one megawatt (1 million watt) units where the load demand is actually a fraction, sometimes as low

as 1/5 the capacity of the generator. This misapplication is rendered on a regular basis and contributes significantly to unnecessary tail pipe emissions.

This poor design and improper generator application negatively affects the environment.

Here's why –

Aside from the fact that a larger engine requires and burns more fuel to operate (even at idle and under low loads) a diesel generator systems peak efficiency rating is achieved at around 70% of load capacity. This 70% loading allows the generator to achieve optimum temperature levels for turbo and catalytic system temperature needs which in turn directly affect the amount of tailpipe emissions. By over-sizing or under loading a generator the proper temperature values are not optimized and the efficiency rating drops off dramatically. One of the major effects is that copious amounts of un-burnt (raw) fuel are sent out the tailpipe which is usually evidenced by white smoke. If left un-checked, an over sized generator will begin to accumulate this un-burnt "wet" diesel fuel in the exhaust system and will cause "diesel dribble" which leaks out of the exhaust system joints and directly into the air.

Additionally the presence of un-burnt fuel also has adverse effects on the engines injector systems, valves, and catalytic systems. This causes the engine efficiency to drop off dramatically and will require more frequent maintenance cycles to keep the engine at proper operational values. More frequent engine maintenance cycles results in more disposal of oils and filters which are also an environmental issue.

c. Balancing system loads- equally important is proper phase load balancing. Admittedly this is sometimes difficult to do considering the nature of power distribution systems, lighting queues and the propensity for lighting systems load balancing to constantly change but, every attempt should be made to balance loads as is best possible. Generators run more efficiently with balanced loading thus have optimum tail pipe emissions and fuel usage.

d. Proper maintenance and Load banking-

A generator that has repeatedly been subjected to under loading will have poor functional response to applied loads. This causes a plethora of problems not the least of which is very slow power response to a high load demand such as a heavy lighting queue which on a poorly maintained unit would result in an auto safety shut down turning off the generator to protect itself from damage.

A critical part of generator maintenance is load banking. A load bank system is essentially a large space heater which places a heavy demand on the generator alternator (electrical windings) and engine (internal combustion) systems. When a load bank is properly applied (approximately 80-90% of generator capacity) for a 20-40 minute average duration the generator will dispel out the tailpipe any carbon build up in the cylinders and exhaust system and will reveal to the maintenance technician any issues with both the electrical and internal combustion (engine) components. This load banking also allows the generator to come up to temperature testing the cooling system, and assists in clearing the fuel delivery and injector system of any build up. This all in turn provides for an optimal tail-pipe

emission. Load banking should be applied to all generator sets at a maximum 500 hour use interval, more frequent load banking is required when under loading has occurred. Load banking is the truest test of a generator performance evaluation.

Standard maintenance of generators will always include proper oil and filter changes, air filter replacement, coolant checks, general mechanical parts inspections, as well as load banking.

All of these applications must be accounted for when using portable power generators. When these applications are ignored or left unattended the generator tail pipe emissions are severely affected.

Paralleled gensets

On occasion redundant power is desired. This is done by connecting two generators together with paralleling cables. This configuration provides for two possibilities:

A. Redundant 100% back-up power – if one of the generators drops off line the second is already on the circuit and continues to power the load. Commonly used in critical power scenarios.

B. Additional prime power is needed – after the initial generator is installed it is determined that additional power is needed. Instead of taking out the first generator and replacing it with a larger capacity unit a second unit can be connect in parallel to facilitate the additional loads.

As with stand alone single units these paralleled units must be properly maintained and load banked to ensure optimal tailpipe emissions.

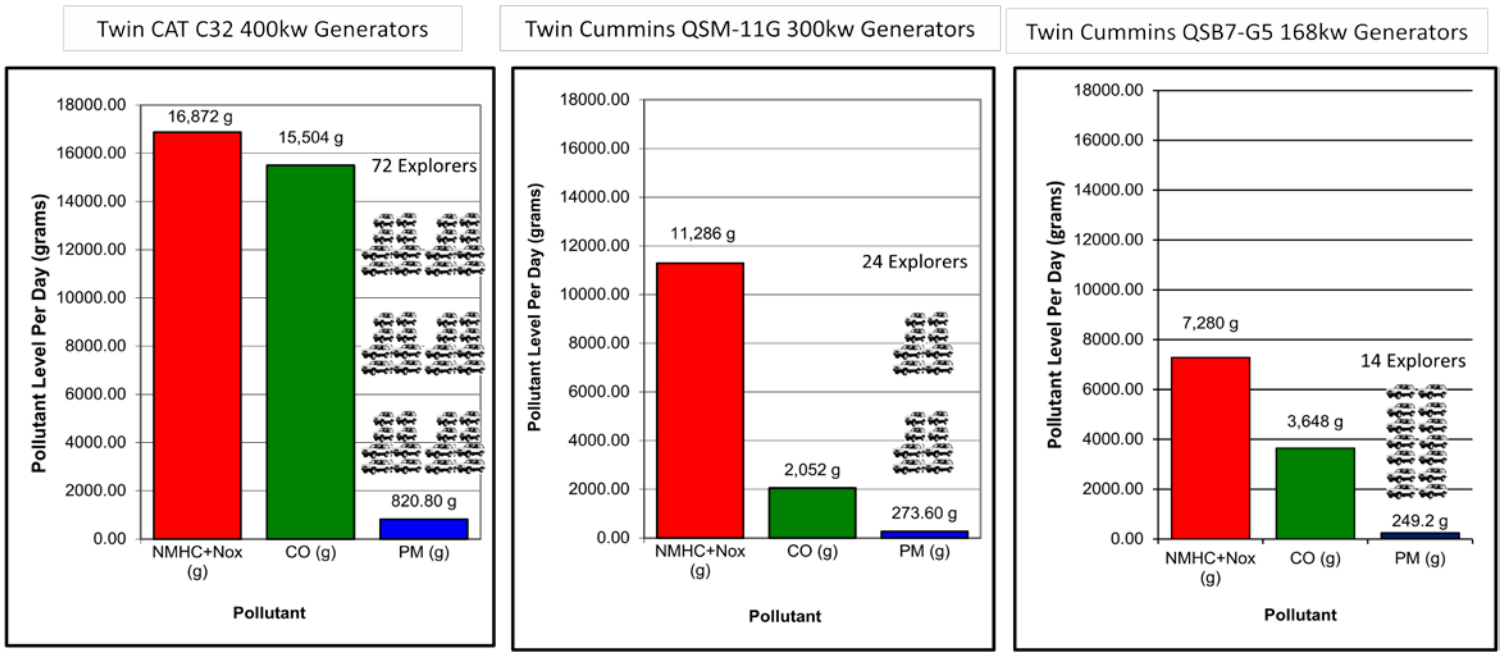
The problem of improper loading is more common than not. The reason for this over sizing of generator power systems is not completely clear. Perhaps poor pre-production design load calculating, or the over sized generator was the one that was available, or tradition “that’s the generator we used the last time” has become commonplace.

Attempting to be “greener” by using other low impact systems such as solar, Liquefied Petroleum Gas(LPG) systems, and bio fuels in conjunction with over sized generation systems, while admirable, cannot offset the gross effect of over sized systems on the environment. See figure 1.

The grievous insult committed by genset over-sizing is best mitigated by simply *not doing it*. Proper power design and systems implementation are the answer.

Figure 1.

Comparative Paralleled Configurations



Using generators that are properly sized for the end use comes with several benefits: reduced fuel costs and less tailpipe emissions being predominant factors. Cleaner, appropriately sized generators are a more sustainable reliable option.
Emissions data is from the California Air Resources Board Executive Order emissions certifications

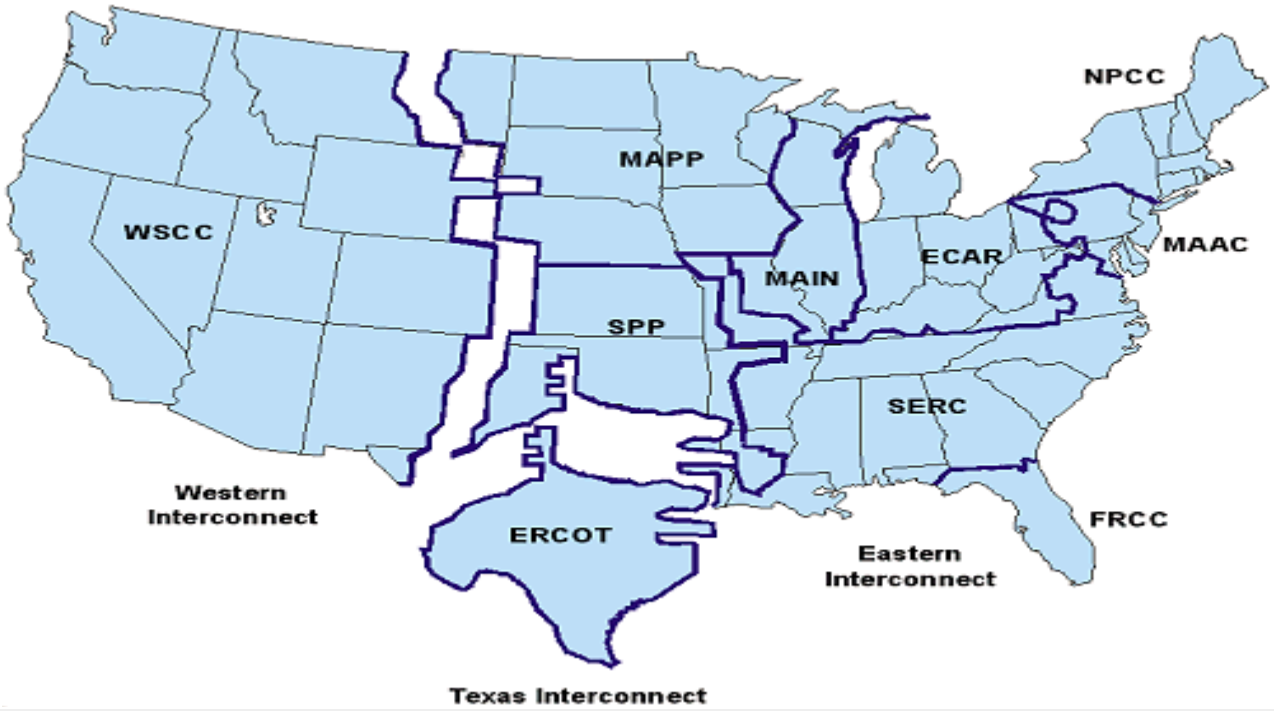
Figure 1 above shows comparative tailpipe emissions of ford explorers traveling at 60mph per day versus equivalent kilowatt size of paralleled generators. We can see the effect that properly sizing our generators will have a positive environmental impact.

So what can we do to significantly improve our environmental impact? First we need a short review on the North American Power Grid...

North American Power Grid

The North American Power Distribution Grid, called "the Grid" is a network of numerous power plants from Miami to Washington State and all points in between which are electrically interconnected via long distance transmission power lines. There are actually three power grids operating in the 48 contiguous states: (1) the Eastern Interconnected System (for states east of the Rocky Mountains), (2) the Western Interconnected System (from the Pacific Ocean to the Rocky Mountain states), and (3) the Texas Interconnected System. These systems generally operate independently of each other, although there are connected links between them. Major areas in Canada are totally interconnected with our Western and Eastern power grids, while parts of Mexico have limited connection to the Texas and the Western power grids.

The Main Interconnections of the U.S. Electric Power Grid and the 10 North American Electric Reliability Council Regions

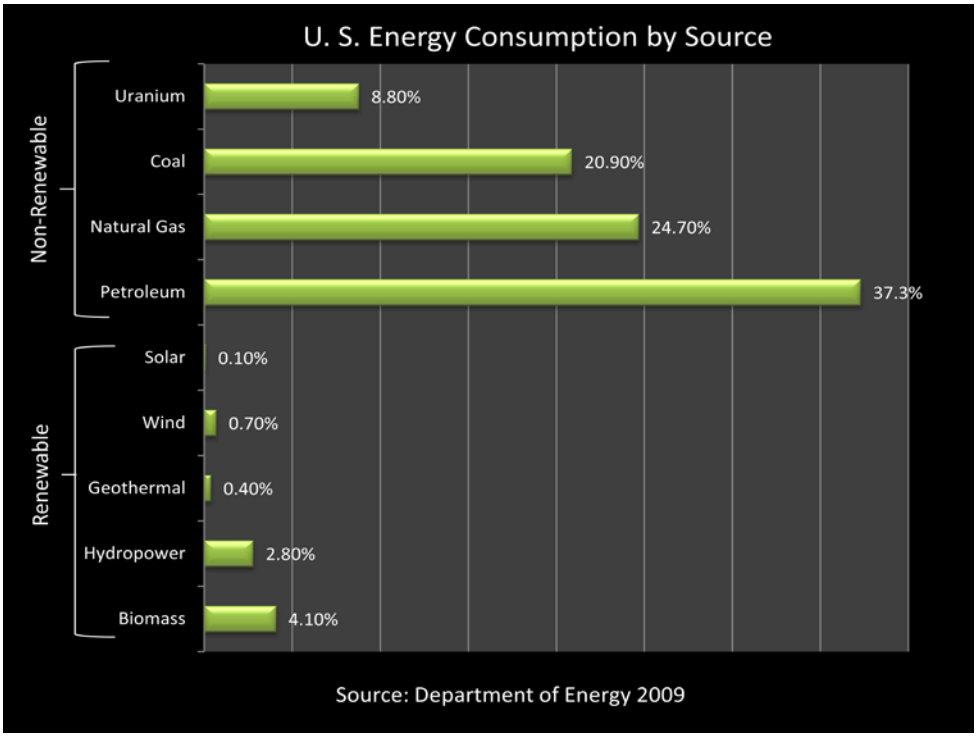


ECAR - East Central Area Reliability Coordination Agreement
ERCOT - Electric Reliability Council of Texas
FRCC - Florida Reliability Coordinating Council
MAAC - Mid-Atlantic Area Council
MAIN - Mid-America Interconnected Network
MAPP - Mid-Continent Area Power Pool
NPCC - Northeast Power Coordinating Council
SERC - Southeastern Electric Reliability Council
SPP - Southwest Power Pool
WSCC - Western Systems Coordinating Council
Note: The Alaska Systems Coordinating Council (ASCC) is an affiliate NERC member.
Source: North American Electric Reliability Council.

This “grid” is supplied by various types of power producing plants consisting of non-renewable resources such as coal and nuclear combined with renewable resources such as Hydro and Wind generating farms. This homogenous power grid would be better described as the North American **“Hybrid” power Grid**, especially considering the growth of alternative environmentally friendly power plants which have come onto the grid in the last ten years.

As of 2009, the Grid was estimated to be approximately 10% renewable generating sources. “Renewable energy sources are expected to grow slowly over the next couple of decades, increasing at a rate of 2.9 percent per year until 2035, according to the Energy Information Administration (EIA).” – Institute of Energy Research 2012.

Percentage of power generation contributors on the North American Grid Distribution System



California is by far the renewable power production leader of the world. “For the first six months of 2012, California generated one fifth of its electricity from renewable sources. The California Public Utilities Commission just released its first/second quarter 2012 renewable energy progress report to the Legislature, and it claims that **20.6% of the state's power demand was met with wind, solar, geothermal, and other non-nuclear clean energy sources**... California's legislature established a Renewable Portfolio Standard (RPS) which requires utilities to produce 33% of their power from clean sources by 2020. The law is working precisely as intended—analysts expect to see an even bigger jump in the second half of this year.” – Brian Merchant/Tree Hugger Aug.3, 2012.

When available, the power Grid by comparison turns out to be the “greenest” power option for the entertainment industry. The only drawback to using the grid is usually one of convenience, accessibility, and engineering coordination with the location venue.

By comparison a portable diesel generator is often perceived as more convenient, readily accessible and adaptable to location. The drawback to using diesel or bio-diesel driven generators is that their tailpipe emission cannot currently compete with the North American power grid emission standard. A generator which uses B20 diluted diesel fuel is gaining just a small decrease in tailpipe emissions as opposed to the California grid 20.6% clean power production.

This power grid is already on line and available for our use. By continuing to follow traditional production power methods (generators as a sole power source) regardless of how efficient or clean the generators may be the entertainment industry is still adding to the environmental emissions levels. I am sad to say that even when viable grid power is available production electricians and lighting technicians still choose to use portable diesel power generators for their power needs.

By not using the utility power grid we are committing the Ultimate Environmental Sin!

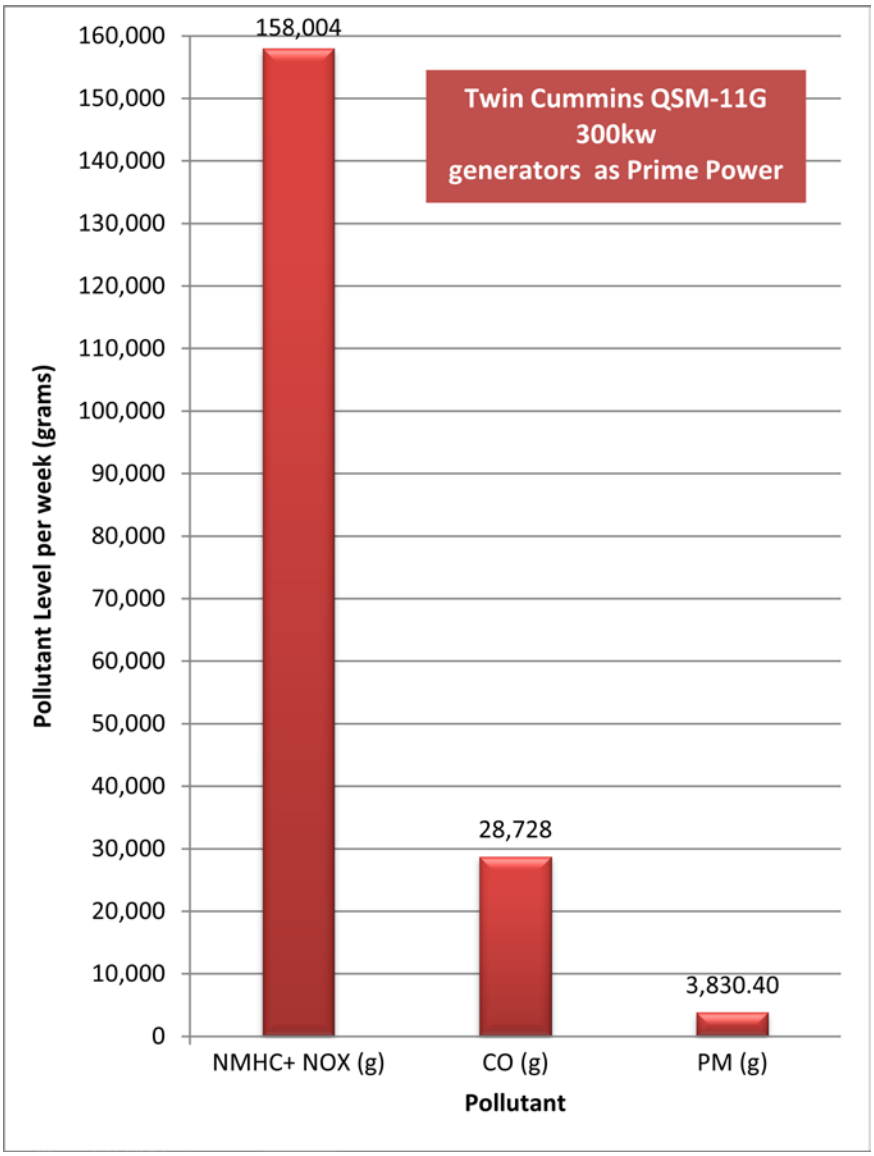
The Grid power has already been produced and is on-line and available. More importantly, we have already paid into the environmental "bank account" by producing the grid power. Here's the "rub" – we cannot efficiently store this Grid power so we must "use it or lose it". If we choose not to use the Grid, then the negative environmental "tally" is doubled by the additional tailpipe emissions from our generators.

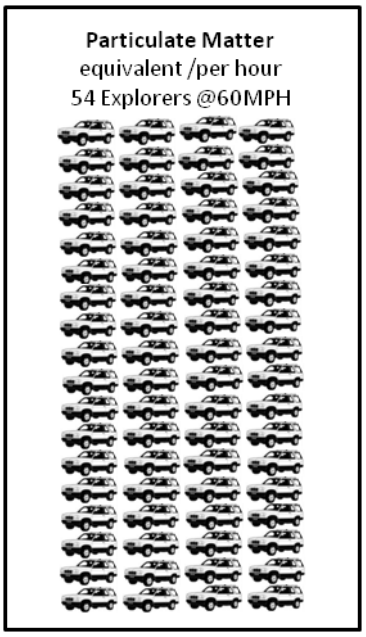
In order to improve our environmental attitude and effectiveness we will need to re-think our priorities beginning with pre-engineering our production power methodologies and applications. This will require us to involve power experts early in the planning stage.

There are several systems available to facilitate the usage of the power grid and still meet critical power needs.

1. The first and obvious choice is to simply use the Grid as a sole non-backed-up power source. It is "greener" than virtually all portable power systems save some solar, fuel cells, and Liquefied Petroleum Gas (LPG) systems which we will discuss later in this article. By and large I have found that on the major lots and production facilities we as an industry do use the available grid power- but not always. It is with off lot production sites that we automatically shift power over to generator systems instead of pre-engineering for grid power usage. To facilitate using the grid power on off site locations would require an additional step by our electrical departments and a working knowledge of facilities power systems, a step in which most productions do not invest. I do not want to over simplify this point as it requires a working knowledge of multiple voltage systems, transformer configurations, and electrical code applications. As I stated earlier we will need to re-think and reapply ourselves to this goal.

There have been numerous occasions on the major production lots and venues where the grid power is readily available but not used! Instead large power generating systems are brought in under the design premise of providing back-up power for critical power needs. Under this scenario large diesel generator systems are used as a 24/7 prime power source and then additional back-up generators are connected to the prime generators as a total redundant power system. The amount of tailpipe emissions generated in a 7 day period by two 300KW generators can be equal to 9,072 ford explorers running at 60mph as can be seen in Figure 2 below.





Source: As reflected in the EPA's "Green Vehicle Guide,"

Dual 300kw generators produce as much particulate matter *per hour* as 54 Ford Explorers driving on the highway at 60mph. This would equal 9,072 ford explorers per week

Figure 2. Twin 300KW generator tailpipe emissions per week

Emissions data is from the California Air Resources Board Executive Order emissions certifications

Figure 2 above shows a twin 300 KW generator system. On many productions larger generating systems are employed, sometimes 2 or 3 times larger than what is shown in Figure 2. Subsequently the tailpipe emissions are proportionally increased.

The rational for this type of back-up methodology has been based on the premise that this is the only way to achieve 100% redundant power *or* the production engineers don't trust the grid power system. In today's power market place this could not be further from the truth.

Most likely the reasons for using total diesel generated prime and back-up power are a lack of knowledge and experience with grid power systems. Simply put, these generators are what are provided by the power vendor (It is what they have, it is what they know, and it is what they understand) so they use it!

In defense of my electrical brethren there are some situations where the size of the generator is forced upon them. Quite often the power plant is a truck mounted unit which comes with the grip package and is not easily sized to need.

So, what can we do about it?

....Use the Utility Grid system whenever possible.

There are several systems available to facilitate 100% back-up power using the grid as a prime source. These systems are used for critical power components i.e. computer based systems, programmed lighting controls, sensitive audio and video equipment, for live transmission and broadcast events.

Grid power with manual back-up generators.

1(a) Manual Transfer Switch

This system employs a manual transfer switch which allows the power technician to select which power source the production will use (Utility/shore power or generator).

Pros: This system allows the production to stay on the “green” grid system and still have a back-up power generator on the circuit in the event of a grid black out.

Cons: This system is not redundant power and will allow the Grid black out to be “seen” by the production equipment. Once a black out occurs a technician is required to make the transfer. All loads must be manually stepped back onto the generator so as not to overload the back-up generator which requires a technician to be on site.

1(b) Automatic Transfer Switches

These switches are very similar to the manual systems in application but with additional automatic controls to transfer the production loads over to a back-up generator in the event of a grid black out.

Pros: This system allows the production to stay on the “green” grid system and does not require a power technician to make the transfer. It is also very fast in determining the transfer cycle. Some systems will passively synchronize the two power systems before making the transfer.

Cons: Auto transfer systems have a plethora of issues, most notably they do not allow for a smooth step loading onto the generator system which usually results in large frequency and voltage variance during the transition cycle. This is unacceptable to most computer based equipment and can cause hard drive failures.

2. Co-generation synchronous systems – these generator systems connected in conjunction with the power Grid allow the productions to use the grid for initial set-up and rehearsals as necessary. On critical broadcast and tape days a generator can be brought on line in parallel/conjunction with the Grid to ensure that a black out or brown out will not affect the production. These systems allow the introduction of a back up on line generator to be brought onto the power Grid without any interruption of the production's power.

This type of system has been in use in the entertainment industry since 1994 and was awarded a Technical Emmy award by the Academy of Television Arts and Sciences in 1995.

Pros: This system allows the production to stay on the "green" grid system and does not require a power technician to make the transfer. It allows a back-up power generator to be brought onto the power system transparently at will and shares the load burden as directed by the technician.

Cons: Some tailpipe emissions from generator for short usage period, but significantly reduced. See Figure 3.

Figure 3.

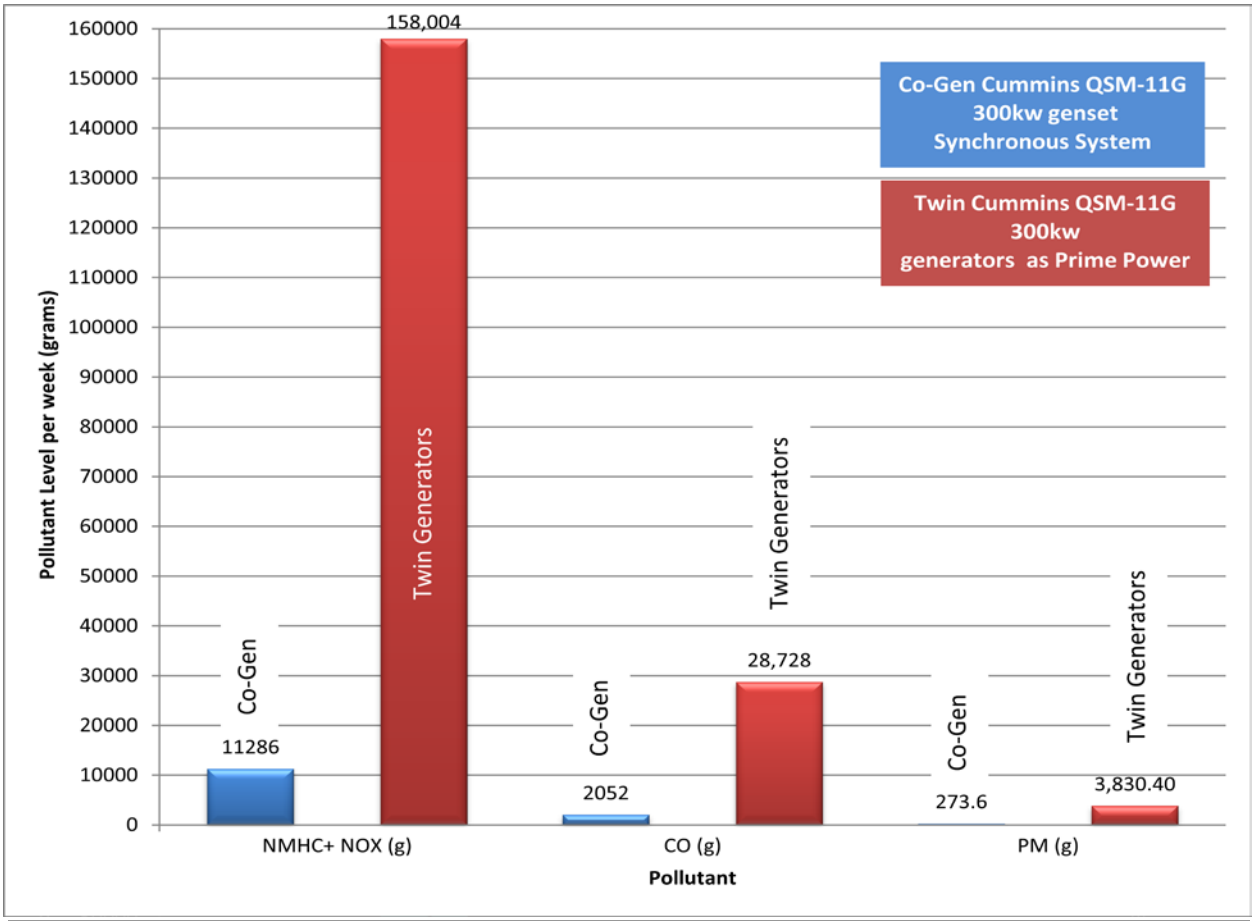


Figure 3 above shows a comparison of tailpipe emissions between a co-gen system (blue) and twin generators (red) comparably sized. Note the disparity in emissions levels when used under the same load conditions. A co-gen system uses the Grid power as the primary power source and only brings a generator on line when redundant power is needed whereas the twin generators must run 24/7

3. UPS/Sync System – These systems employ the use of uninterruptible power supplies (UPS) and automatic transfer systems (ATS). A UPS system takes the Grid power as an input and converts it to a direct current power type (same as a car battery) and marries this newly created DC power with an on-board battery bank. The UPS then takes these combined power sources – the DC grid power and the battery bank – and inverts (changes) it back to the traditional alternating current (AC power) type power.

Should a Grid black out occur this married/doubled power source uses the battery banks to power the customer loads while an automatic transfer system starts a standby generator and transfers the load to the generator. Once the Grid power returns to normal and the blackout is over the system transfers the customer loads back onto the grid source and shuts down the backup generator. This is done without any power interruption to the production loads.

Pros: With the use of UPS systems the generator(s) doesn't turn on until a black out condition occurs. This means *zero % tailpipe emissions* until the generator is placed into service during a power blackout.

Cons: Minimal tailpipe emissions from generator for short usage period battery maintenance – batteries in UPS system will need to be recycled after 5-7 years usage.

The Co-generation and UPS systems are the greenest sustainable production oriented power systems on the market today that employ the use of the power Grid.

Future power technologies

There are several alternative fuel systems in the works. One of the most promising is Fuel Cells.

Fuel Cell Technologies- absolutely the cleanest way to produce renewable power is by way of Hydrogen Fuel Cells. These systems have been rated by the C.A.R.B. as a zero emissions device. The only "tailpipe" emissions are warm air and water vapor.

We have partnered with the Department of Energy and Sandia National Labs on a Light tower fuel cell system. There are currently several Alpha units available free of charge to production companies. Multiquip is one of several partners involved with this project. You can print out a H2-light brochure at: http://www.multiquip.com/multiquip/pdfs/MQ_H2LT_brochure_2011_03_11_DataId_25153_Version_1.pdf

These units have been used for pre-production set up lighting needs at the Academy Awards, Golden Globes, SAG Awards, and several other events in the Los Angeles area. Larger power units are currently under design/build and are slated to be available to the market soon.

We have also employed the use of 5KW Fuel Cells as a clean power alternative at numerous Red Carpet events in Los Angeles. These units provide standard 120V power with 0% tailpipe emissions.

There are several clean power alternatives which are available to our industry such as Solar (photo-voltaic) systems and liquid petroleum gas (LPG) generators. These systems when properly applied are one of the cleanest renewable power systems on the market. They are limited in their power capacity and as such have not been properly embraced by our industry. They are a very good alternative to “base camp” power sources and remote applications that have small power requirements.

The Solar Photo Voltaic systems main drawback is reduced efficiency on cloudy days and obviously non power production capability at night. Additionally energy storage in the form of batteries, for night time power conversion, is in need of technological improvement e.g. efficiency, recharge rate, disposal, and longevity.

The most cost effective, efficient and greenest options available today for production power needs are Grid co-gen and Grid UPS-sync systems.

Where the Grid is not available and stand alone or paralleled generators are the order of the day, then careful attention must applied to the proper generator sizing and distribution loads to help minimize tailpipe emissions. Applying solar Photo Voltaic systems, Hydrogen Fuel Cells, and LPG systems whenever possible will also help offset our carbon footprint.

In order to make a positive environmental impact and effect a sustainable positive change, it is time to *stop talking* about the environmental issues and begin *taking action* by applying the best available power systems to our productions. Only then will we begin improving our environmental attitude and effectiveness.

Each of us can contribute, as every action taken is cumulative and important to improving our environment.