



EMERGENCY GENERATORS

GWINNETT AMATEUR RADIO SOCIETY

SEPTEMBER 21, 2021

GENERATORS

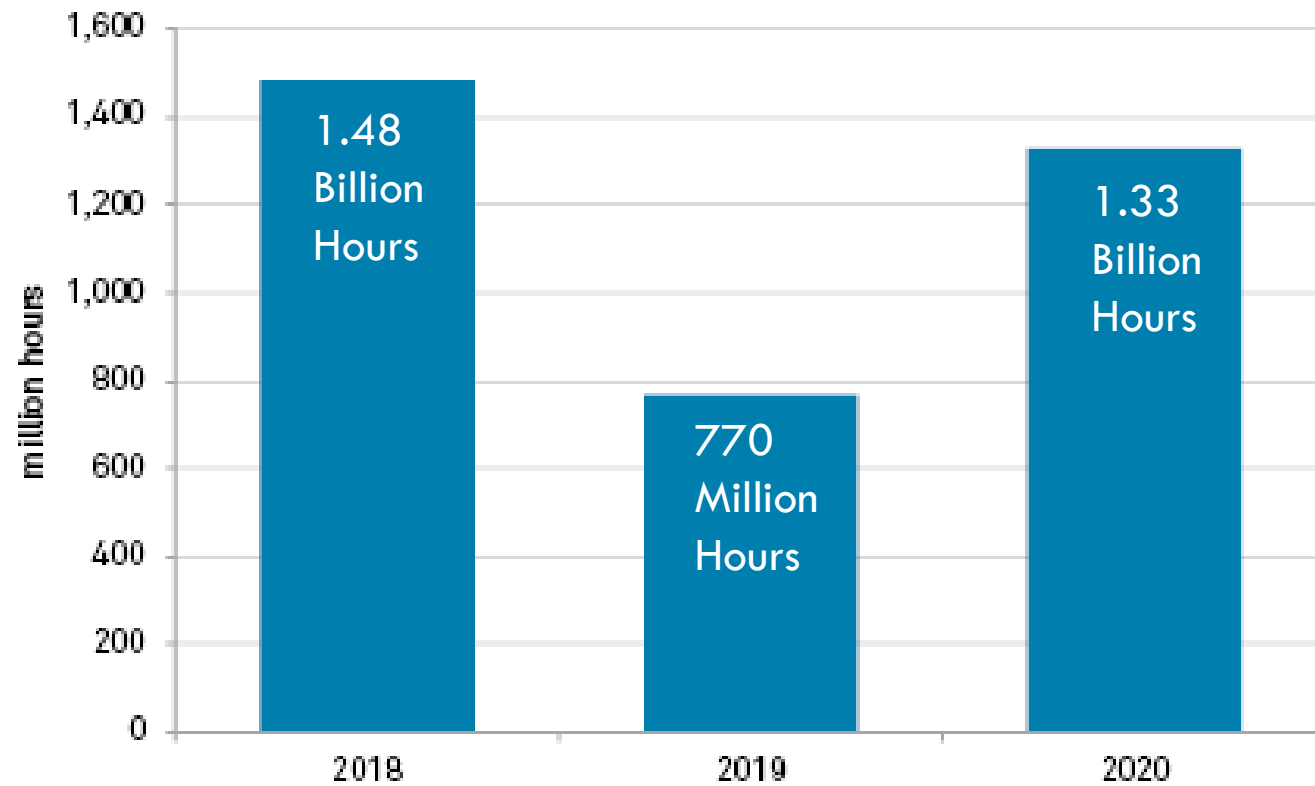
What You Need To Know To Select The Best Option For You

- **What causes power outages?**
- **Type of fuel to use**
- **Types of generators**
- **Generator size**
- **Operations & Safety**
- **Costs**



U.S. POWER OUTAGES IN MILLIONS OF HOURS

US power outages, 2018-2020



Data as of Jan. 18, 2021.
Source: PowerOutage.US

Simple Math
1.33B Hours
Divided by
128M Households
= 10.4 Hr. Avg.

Most outages will
only last a day or
two, but some will
last a couple of
weeks

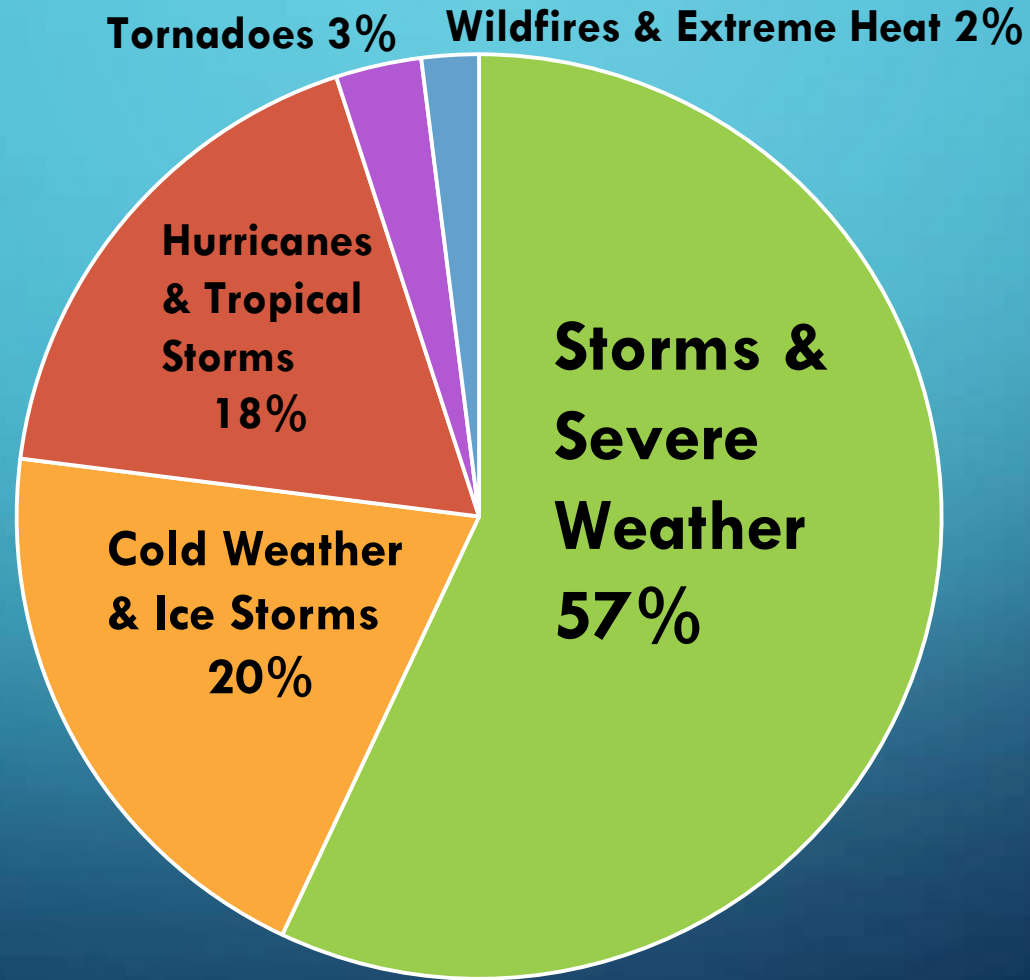
WHAT CAUSES POWER OUTAGES?

Weather
High Power Demand
Aging Transmission Lines
Cyber Attacks
EMP
Coronal Mass Ejection
Construction Digging
Animals

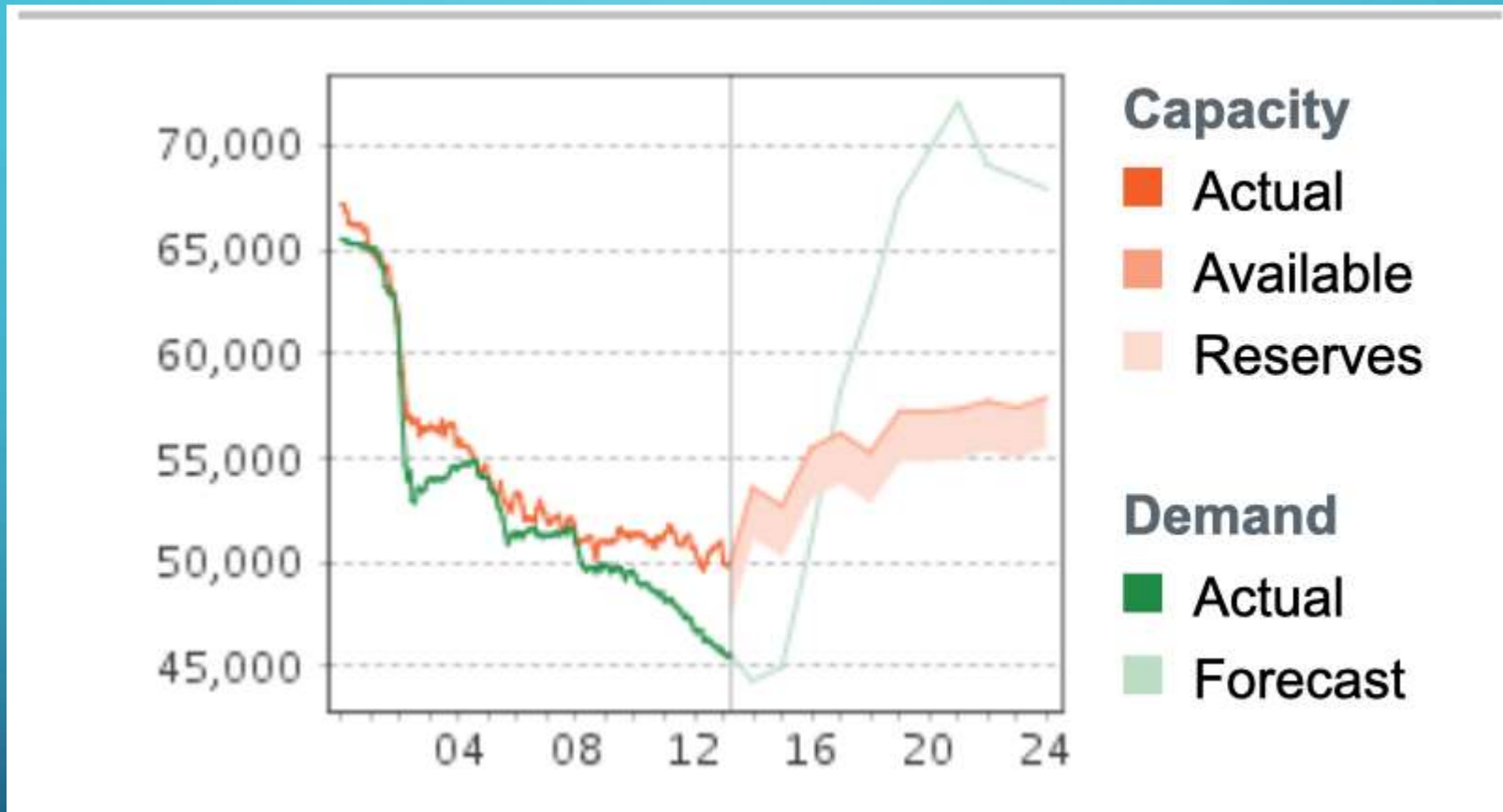


Up to 30% of Power Outages are due to squirrels

WEATHER RELATED CAUSES



HIGH POWER DEMAND



Georgia Power offers a phone app to track capacity & demand

2021
REPORT CARD
FOR AMERICA'S INFRASTRUCTURE



The American Society of Civil Engineers report that many electric transmission and distributions lines were constructed in the 1950s and 1960s with a 50-year life expectancy. The average age is 40 years and 25% are age 50 or more

Dr. Joshua Rhodes of the University of Texas Energy Research Department estimates replacement cost to be 1.5 – 2 Trillion dollars.

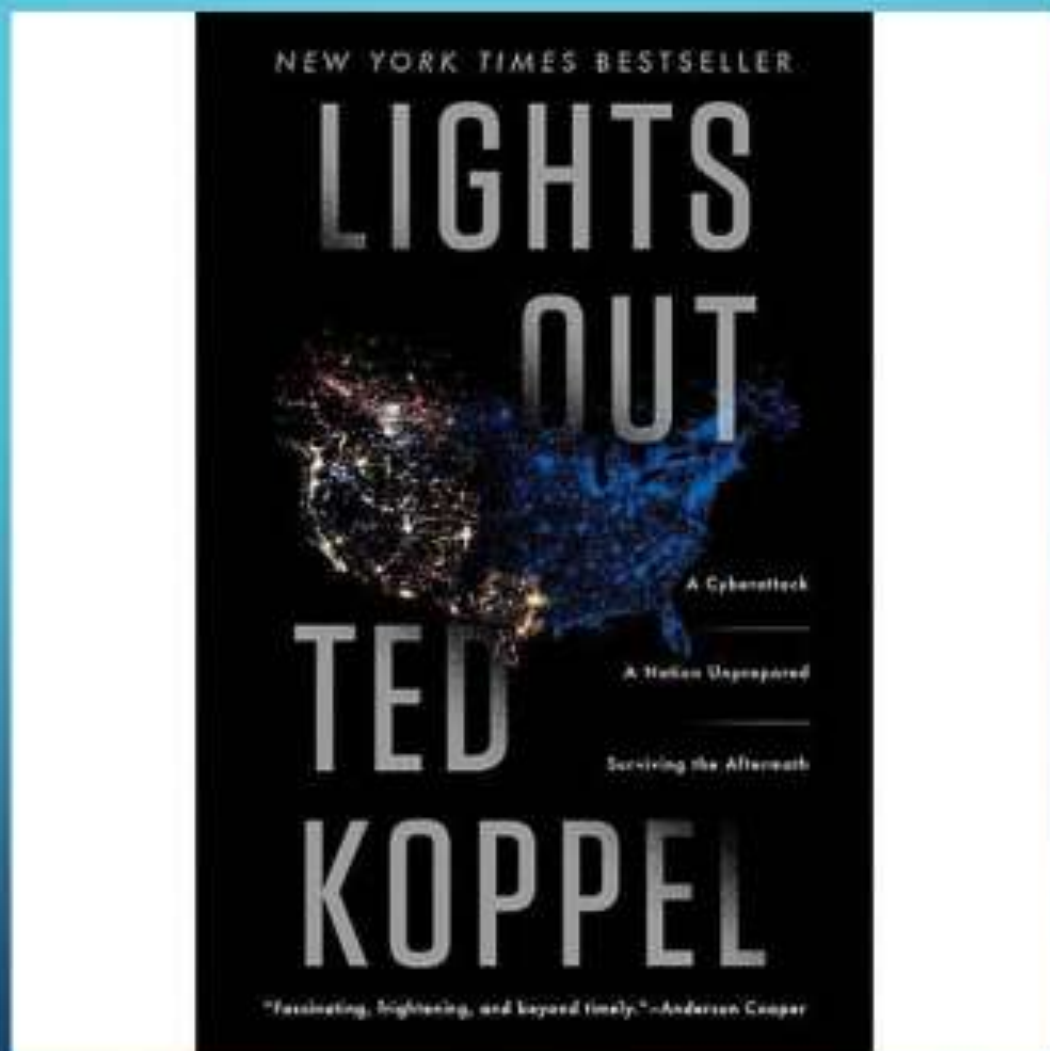
The Infrastructure Bill includes \$73 Billion

NOTABLE POWER GRID CYBER ATTACKS

- **2015 & 2016 – Kiev Ukraine attack by Russia**
- **2017 – Saudi Arabia oil fields attacked by Iran**
- **2017 – Burlington Vermont by Russia**
- **2019 – Russia attack by ???**
- **2020 – European Union “Successful Cyber Intrusion”**
- **2021 - Mumbai India attack by China**

IF YOU WANT TO KNOW MORE

**Cyberattack
A Nation
Unprepared
Surviving
The Aftermath**

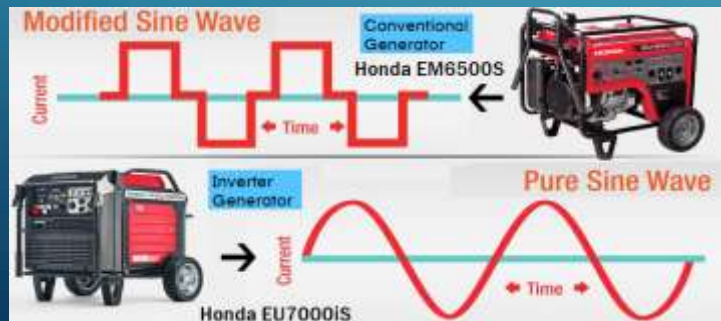


**Interviews with
Top Government
& Industry
Officials**

CONVENTIONAL VS INVERTER

CONVENTIONAL










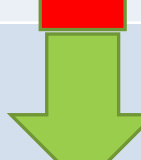


- Invented in 1831 by Faraday
- Produces one block wave of AC power for each rotation of the generator
- To produce US standard 120V/60Hz it must turn at a constant 3600rpm



INVERTER

- Invented in 1987 by Honda
- Step 1 produces AC power which is converted to DC
- Step 2 an electronic inverter converts it back to 120v/60Hz AC power
- This produces a pure sine wave with less harmonic distortion

WHAT DIFFERENCE DOES IT MAKE?

Feature	Conventional	Inverter
Fuel Cost		
Efficiency		
Power		
Cost		
Noise		
		

COMPARISON

CONVENTIONAL

- **Straight AC power**
- **Available 700 – 150,000 watts**
- **Runs full throttle**
- **Significantly less initial cost for equal power output**
- **Less complex**

INVERTER

- **AC converted to DC inverted to AC**
- **Available 1000 – 7000 watts**
- **Variable Speed based on load**
- **Quieter**
- **Smaller & lighter**
- **Clean, consistent power**
- **Can be run in parallel**
- **More expensive**



WHICH IS BEST?

Depends on your use
and budget



WHICH TYPE FUEL ?

- **Gasoline**
- **Diesel**
- **Natural Gas**
- **Liquid Petroleum Gas (LPG)/Propane**
- **Dual Fuel (Gasoline or Propane)**
- **Multiple Fuel (Gasoline / Propane / Natural Gas)**

GASOLINE POWER

PRO

- Lowest initial Cost
- Wide availability



CON

- Refueling danger due to spillage on a hot engine
- Fuel storage fire issues
- Fuel degrades over time
- E0 gas hard to find, E10 gas gums up the carburetor
- Constant 3600 rpm speed

DIESEL FUEL

PRO

- Long standing proven technology
- Runs at 1800 rpms instead of 3600 rpms
- Longer run time & durability
- Low storage fire risk

CON

- Higher initial costs
- Diesel degrades over time
- Emission regulations require ultra-low sulfur diesel which is less stable
- Rising fuel costs



LPG/PROPANE

PRO

- Fuel stored on site
- Unlimited shelf-life
- Runs clean without carburetor fouling



CON

- Constant 3600 rpm run speed
- Power output less than a gas or diesel fueled generator
- Fuel tanks only filled to 80% capacity

NATURAL GAS

PRO

- No fuel storage issues
- No refueling issues
- Low fuel costs
- Some run at 1800 rpms
other at 3600 rpms

CON

- Fuel supply delivery
outside your control
- In an emergency
delivery is subject to
prioritization and
containment



DUAL & MULTI-FUEL

PRO

- Take advantage of preferred fuel type, with a back-up capacity if that fuel is unavailable
- Better manage refueling issues



CON

- Higher initial cost
- Power is 10% less when running on natural gas or propane
- Storing multiple fuels more complex

COMPARING FUEL COSTS

Factor	Gasoline	Diesel	Propane	Natural Gas
Generator Size	5 kW	20kW	20kW	22kW
Unit Cost	\$2.98/gal	\$3.15/gal	\$2.75/gal	\$0.65/ccf
Use/Hr.	0.75 gal	1.6 gal	1.89 gal	2.28ccf
Cost/Hr.	\$2.24	\$5.04	\$5.20	\$1.48
Cost/Day	\$53.64	\$120.96	\$124.74	\$35.57
Cost/kWh	\$0.45	\$0.25	\$0.26	\$0.07

SIZING YOUR GENERATOR



- **Make a list of the items that need to be powered by the generator.**
- **Make a note of the running and starting wattage of the respective items.**
- **Total the wattage requirements using the starting wattage for items that require them.**
- **Allow at least 25% above the running wattage total**
- **Note best fuel efficiency is running at 50% load**

EXAMPLES TO CONSIDER



Basic Items

	Running Watts	Starting Watts
Refrigerator w/freezer	700	2200
Deep Freezer	500	1500
Six 75w light bulbs	450	
Radio 30A power supply	300	
Phone charger	20	
TOTAL Needed	4470 Watts	

Optional Items

Laptop	200 watt
10,000 BTU Room A/C	1200/3600
Box Fan	200
Microwave	1200
Coffee Maker	1000
Space Heater	1800
TV 27"	500
DVD	100

SMALL INVERTOR 2000W

CHOOSE WHAT YOU CAN RUN



Basic Items

	Running Watts	Starting Watts
Refrigerator w/freezer	700	2200
Deep Freezer	500	1500
Six 75w light bulbs	450	
Radio 30A power supply	300	
Phone charger	20	
TOTAL Needed	4470 Watts	

Optional Items

Laptop	200 watt
10,000 BTU Window A/C	1200/3600
Box Fan	200
Microwave	1200
Coffee Maker	1000
Space Heater	1800
TV 27"	500
DVD	100

MEDIUM GENERATOR 4500W

CHOOSE WHAT YOU CAN RUN



Basic Items

	Running Watts	Starting Watts
Refrigerator w/freezer	700	2200
Deep Freezer	500	1500
Six 75w light bulbs	450	
Radio 30A power supply	300	
Phone charger	20	
TOTAL Needed	4470 Watts	

Optional Items

Laptop	200 watt
10,000 BTU Window A/C	1200/3600
Box Fan	200
Microwave	1200
Coffee Maker	1000
Space Heater	1800
TV 27"	500
DVD	100

LARGER GENERATOR 7000W

CHOOSE WHAT YOU CAN RUN



Basic Items

	Running Watts	Starting Watts
Refrigerator w/freezer	700	2200
Deep Freezer	500	1500
Six 75w light bulbs	450	
Radio 30A power supply	300	
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Optional Items

Laptop	200 watt
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Coffee Maker	1000
Space Heater	1800
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DVD	100

SHOULD PORTABLE GENERATOR BE GROUNDED

OSHA states the frame of a portable generator need not be grounded (connected to earth) and that the frame may serve as the ground (in place of the earth),

IF

The generator supplies only equipment cord and plug connected equipment through receptacles mounted on the generator 1926.404(f)(3)(i)(A)



The noncurrent carrying metal parts of equipment are bonded to the generator frame AND the equipment grounding conductor terminals that are part of the generator are bonded to the generator frame.

1926.404(f)(3)(i)(B)



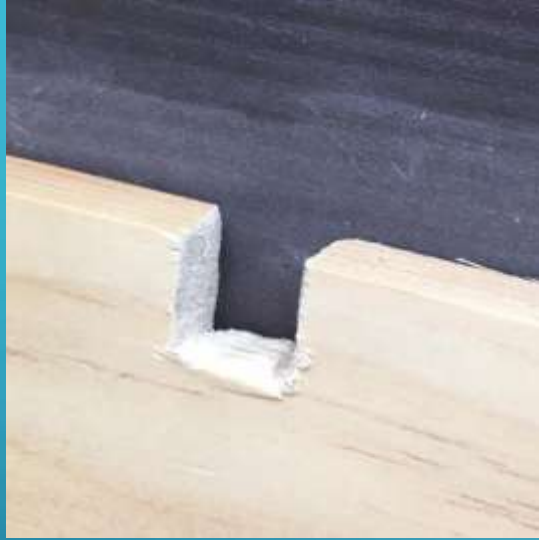
DEVICE REQUIREMENTS & MAX CORD LENGTH BY WIRE GAUGE

Amps	Watts	#10	#12	#14	#16
10A	1200	250'	150'	100'	50'
20A	2400	125'	75'	50'	-
30A	3600	65'	-	-	-



Make Sure the Power Cord is Rated for Outdoor Use

HOW TO RUN YOUR POWER CORDS THROUGH THE WINDOW



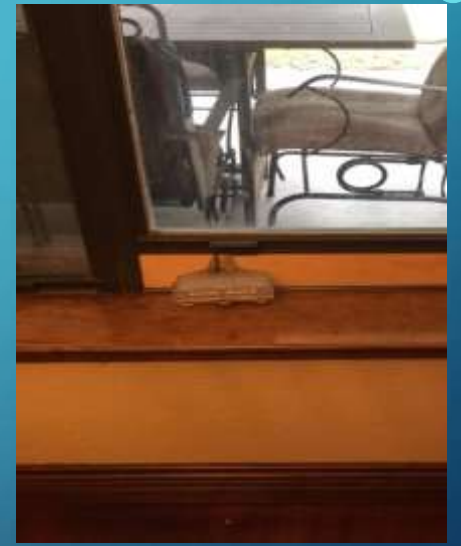
**Cut a notch
in a board**



**Sized to fit the
power cord**



**Cut the board
To fit the
window**



**Temporary
Power
outlet**

PORTABLE GENERATOR SAFETY

DANGER

Using a generator indoors **CAN KILL YOU IN MINUTES.**

Generator exhaust contains carbon monoxide. This is a poison you cannot see or smell.



NEVER use inside a home or garage, **EVEN IF** doors and windows are open.



Only use **OUTSIDE** and far away from windows, doors, and vents.

KEEP THE GENERATOR DRY



- **Keep outlets 100% dry**
- **Maintain air flow**
- **Be sure the enclosure can handle the elements and wind**

GASOLINE REFUELING SAFETY

- Turn the generator off and let it cool for 2 minutes before taking off the gas cap
- Do not let gas spill on the hot engine
- Do not overfill



CONNECTING TO THE GENERATOR

1. Start the generator
2. Allow it to run for 2-5 minutes to stabilize
3. Plug in the highest draw item
4. Allow the engine to stabilize
5. Repeat plugging in one item at a time, followed by allowing the engine to stabilize



STOPPING THE GENERATOR

1. Turn off and unplug each electric load, one at time
2. Run the generator at no load for several minutes
3. Turn off the fuel valve until fuel starvation has stopped the engine
4. Turn off the engine switch

Continue if a gasoline engine

5. Remove the spark plug cap
6. Crank the engine to drain any gasoline from the carburetor jets
7. Clean the carburetor
8. Drain the fuel tank



PORTABLE GENERATOR RUN TIME

- Generator will last for 1000 to 2000 hours before engine replacement
- Continuous run time limited to 6-12 hours, before you must let it cool down
- One option is to have 2 generators and switch back and forth every 8 hours.

HOME STANDBY GENERATORS



- **Air Cooled Critical Circuits 7.5 – 15kW**
- **Air Cooled Whole House 17 – 22kW**
- **Liquid Cooled Whole House 24 – 60kW**
- **Liquid Cooled Generators Cost \$10K Extra**
- **Requires a Manual or Auto Transfer Switch**

HOME GENERATOR DETAILS

- Allow extended run time
- Can run your whole house or only critical circuits
- May Include your A/C
- Requires a starting battery
- Maybe air cooler or water-cooling
- Requires a transfer switch which must be installed by a licensed electrician



AUTO TRANSFER SWITCH



1. ATS detects utility outage
2. IF power still out after 10 seconds, auto engine start
3. Engine warms for 5 - 20 seconds, depending on temperature
4. Generator starts and is at full capacity in 5 seconds
5. ATS switches to generator power

IMPACT OF LOAD ON FUEL COSTS

GEORGIA NATURAL GAS FOR 22KW GENERATOR

		Fuel			
	12 mo. fixed	Consumption	Cost	Cost	Cost
	Cost/therm	Per Hour	Per Hr.	Per Day	17 Days*
½ Load	\$.65	228cft.	\$1.42	\$34.08	\$579.36
Full Load	\$.65	309cft.	\$2.01	\$48.20	\$819.40

* Texas Snowmageddon = 17 days

Available Sizes By Brand

**Google
Generator Calculator
to determine
operating size**

Air Cooled
Critical Circuit

Air Cooled
Whole House

Liquid Cooled
Whole House

Generac	Kohler	Cummins	Briggs & Stratton
7.5kW			
10kW	10kW		10kW
	12kW	13kW	12kW
14kW	14kW		
15kW			
18kW			17kW
20kW	20kW	20kW	20kW
22kW			
24kW	24kW		
25kW			25kW
27kW			
30kW	30kW	30kW	30kW
32kW			
36kW			
38kW	38kW		
45kw			
48kW	48kW		
60kW	60kW		

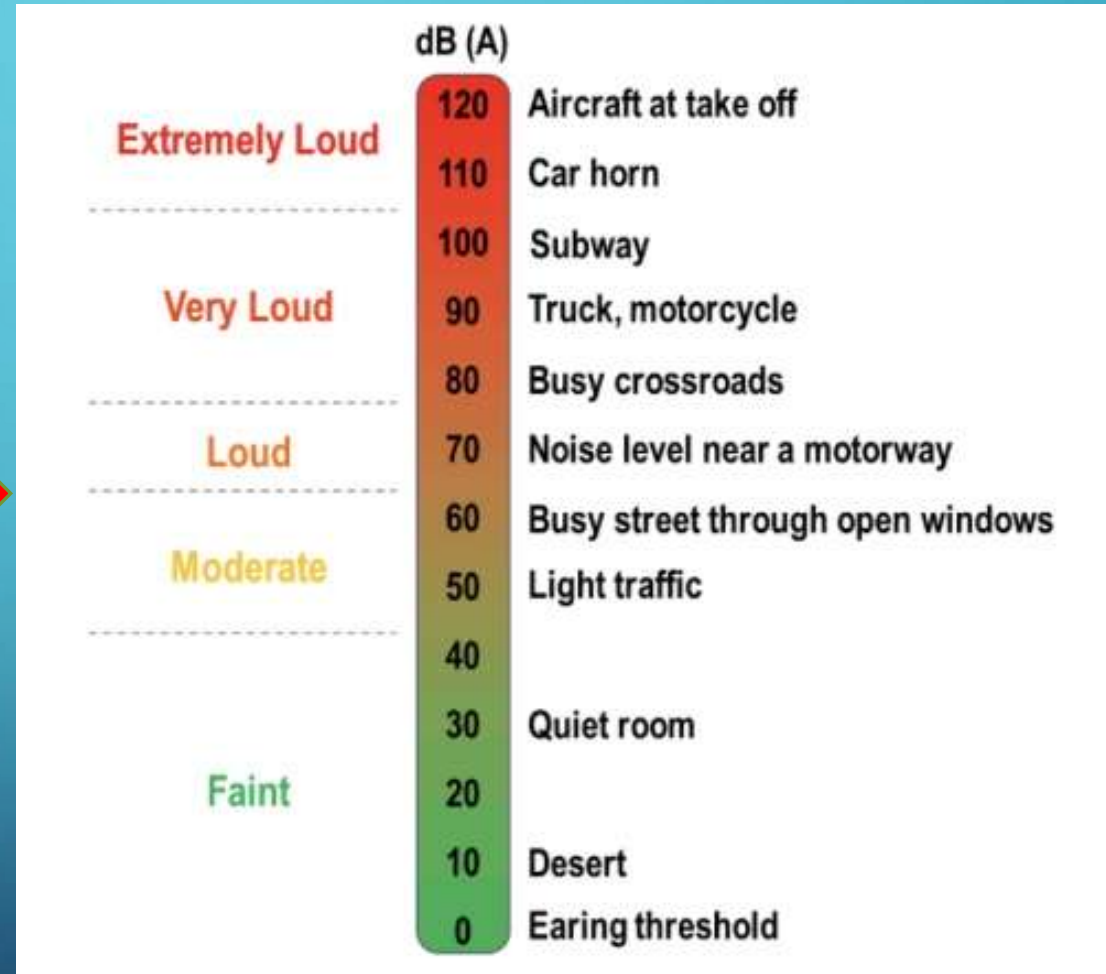


NOISE LEVEL

**Home Standby
Generators
Are Rated at
64dB to 69dB
At 21 feet**



**70 dB is 10 Times
Louder than 60 dB**



GENERATOR PLACEMENT



- Must be 5 feet from a window
- Must be 5 feet from the gas meter
- Distance between generator, gas meter and breaker box is a major factor in installation costs
- Gas line must be 1" or larger
- Noise level factors (distance to neighbors, brick vs shrubs)
- Is gas meter near electric meter?

WHOLE HOUSE GENERATOR MAINTENANCE

Bi-Weekly Auto Test Run

- Programmed to run at day/time certain to keep engine lubricated & battery tested
- Run Time 5 minutes
 - 3600 rpm for 10 sec.
 - 2400 rpm for 30 sec.
 - 1800 rpm for 4 min. 20 sec.

Run Time Maintenance

- After 200 hrs. run time
 - Change oil & filter
 - Check battery electrolyte level
- After 400 hrs. run time
 - Change air filter
 - Check sparkplug gaps or replace if necessary

BASIC PLANNING COSTS

Installation Costs Major Factor



GENERATOR	WATTAGE	TYPICAL COST
Recreational Inverter	Up to 2000W	\$650-\$1500
Mid Size Inverter	Up to 3500W	\$870-\$1500
Large Inverter	Up to 7000W	\$1250-\$4600
Portable Generator	Up to 7500W	\$790-\$1400
Home Standby Generator	Up to 22Kw	\$8000-\$15,000
Diesel	10Kw-24Kw	\$15000-\$25,000



What if you
don't have
a generator?





QUESTIONS/COMMENTS

