

Prepared Testimony of John G. Kappenman
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In Support of Legislation for
FORTIFICATION OF COLORADO'S LIFELINE
INFRASTRUCTURE TO WITHSTAND LARGE- SCALE
ELECTROMAGNETIC DISTURBANCES
April 29, 2015

I would like to thank the Transportation and Energy Committee for the opportunity to provide comments today on the effects of EMP and geomagnetic disturbance on the U.S. electric grid. I have been the Principal Investigator on these important vulnerabilities for the US Congressional EMP Commission, for FEMA under US Presidential Executive Order 13407, for the US National Academy of Sciences, and for a Joint US FERC/DOD/DHS/DOE investigation and series of reports performed over the past 15 years.

In regards to findings of these Blue Ribbon investigations, the conclusion of all the studies has been: the risks are serious and can have far-reaching impacts on the nation. They have the potential to cause widespread blackouts of unprecedented size and duration. In all cases, the most significant concern is the potential for a simultaneous impact and permanent damage to large portions of the electric power system, from which restoration and recovery may be challenging and prolonged.

Over many decades, the US Power Grid has experienced enormous growth in its vulnerability to both Geomagnetic Storm and EMP threats, such that it poses an Un-Recognized Systemic Risk to the Nation. These are Big Footprint threats that can span the continent and were never considered in the design of this Electric Grid. In short, this is potentially the largest and most plausible natural disaster that the U.S. could face, as the loss of electricity for extended durations would mean the collapse of nearly all other critical infrastructures, causing wide-scale loss of potable water, loss of perishable foods and medications, and many other disruptions to vital services necessary to sustain a nation's population.

The severity of the threat from EMP and Geomagnetic Storm impacts to present day electric power grid infrastructures have grown as the size of grids themselves have expanded by nearly a factor of 10 over the past 50 years, while at the same time they have become much more sensitive as microelectronic control systems have supplanted prior generations of electromechanical controls which actually could withstand higher levels of EMP.

There has been no power grid design code that has ever taken into consideration these threat concerns, yet it is possible to remedially apply relatively inexpensive solutions and protocols to harden both the current power grid and to also add hardening to future additions to this critical infrastructure.

Although the Federal Energy Regulatory Commission has asked the electric industry to begin to address only the geomagnetic storm vulnerability, many scientists and engineers (myself included) believe that the NERC/Electric Industry proposed protection standards fall short of the performance required to protect the US from "worst case" geomagnetic storms and would do nothing but continue to silently transfer this risk to the public.

In the face of these threats and lack of action to address them, it is entirely appropriate for citizens of Colorado to ask what are the real risks and how can we best address them. From a public perspective it is reasonable to look at the electricity as being a critical lifeline need. Let me provide for you a quick and

simple analysis of how inadequate that lifeline supply might be immediately after an EMP event across the State of Colorado.

Let's first consider the large coal-fired electric generators. These are modern marvels that convert enormous amounts of furnace boiler energy into electricity via steam. They operate near the temperature and pressure limits of modern day materials they are constructed from and require continuous control of this complex process to insure safe operation. In their furnace boiler systems, the energy liberated in the large furnaces to convert coal to electricity is equivalent to 1 ton of TNT per second going through the furnace boiler. With this much energy involved, the dangers are very evident. Only a few seconds of control system upset caused by an EMP event could lead to vast catastrophic damage and turn a 20 story tall boiler superstructure into an irreparable pile of steaming rubble. I know of no US power plant that has had vital Master Fuel Trip Control Systems hardened against EMP to insure safe shutdown without permanent damage to this infrastructure. It means the difference between rapid recovery and perhaps no possibility of recovery for these vital assets which produce ~60 % of the State's electricity.

The uncertainty of natural gas fuel supply exists for the next largest segment of Colorado electricity supply. As I have noted in the handouts provided here, removing these two components leaves you with only a very small amount of Hydro and Oil fired generation with ½ day of fuel. Total resources perhaps as low as ~5% of normal needs and perhaps so poorly distributed that even this meager lifeline cannot begin to serve a meaningful percentage of the State's population.

You should also realize this is a big footprint event which will similarly affect all of your immediate neighbors. All present disaster recovery plans are predicated on the theme that emergency response will be provided from nearby unaffected regions, but in the case of these scenarios, present recovery plans are entirely unrealistic and outside help from neighboring states should not be counted on.

There are many other aspects of this threat that also need investigation and analysis.

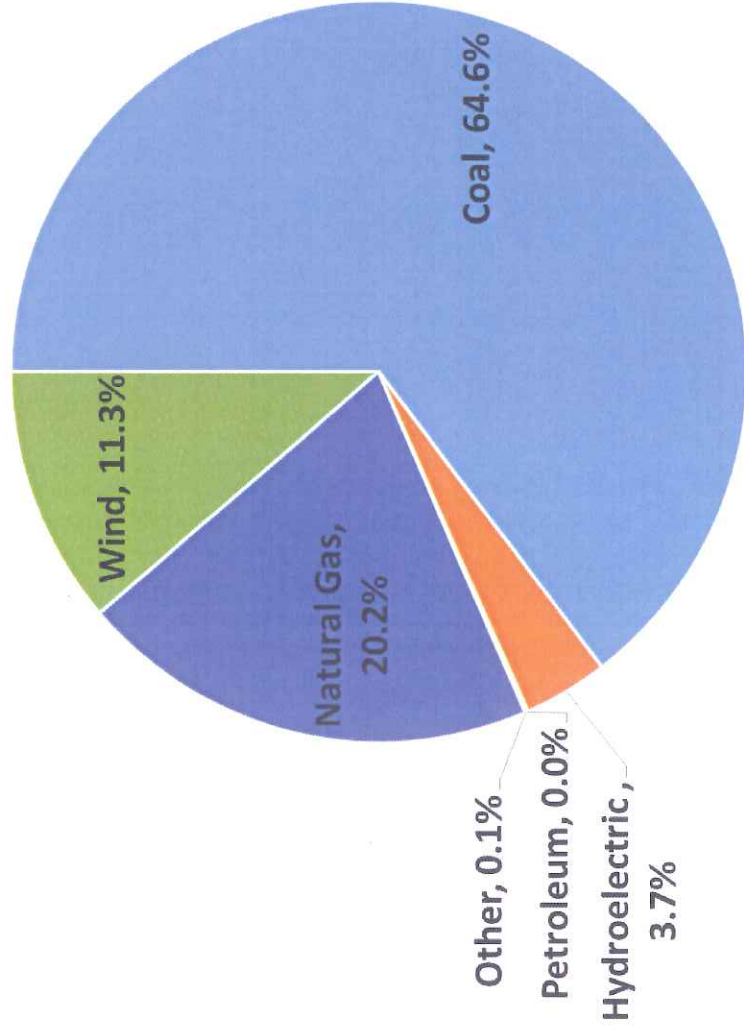
For example: NERC/Power Industry have standards which are tacitly encouraging the utility companies to remove existing Electromechanical controls which were inherently EMP-Hardened (and which customers have already paid for) with microelectronic versions that are now vulnerable to both EMP and Cyber attack. Why aren't these Electromechanical controls being maintained as a dual system for EMP & Cyber resiliency at virtually no-cost?

All of these design decisions are controlled exclusively by the electric industry with little or no public awareness or transparency on the costs and engineering trade-offs. We also know they are not considering these threats properly as well. The public interests must be balanced in a transparent way with real discussions about what's at stake.

The Electric Industry gridlock has paralyzed proper Grid planning on this vital lifeline for the public. Therefore the public is best served by the actions of state legislators to actively engage the industry in the long-term planning and resiliency analysis necessary to create a strong state and more resilient power grid infrastructure. This will be the best and only way to help identify and target small but appropriate actions that can be taken to prevent these disaster scenarios from ever being allowed to unfold.

Thank you for allowing me to share these concerns with the Committee.

State of Colorado Electric Energy Production by Fuel Type



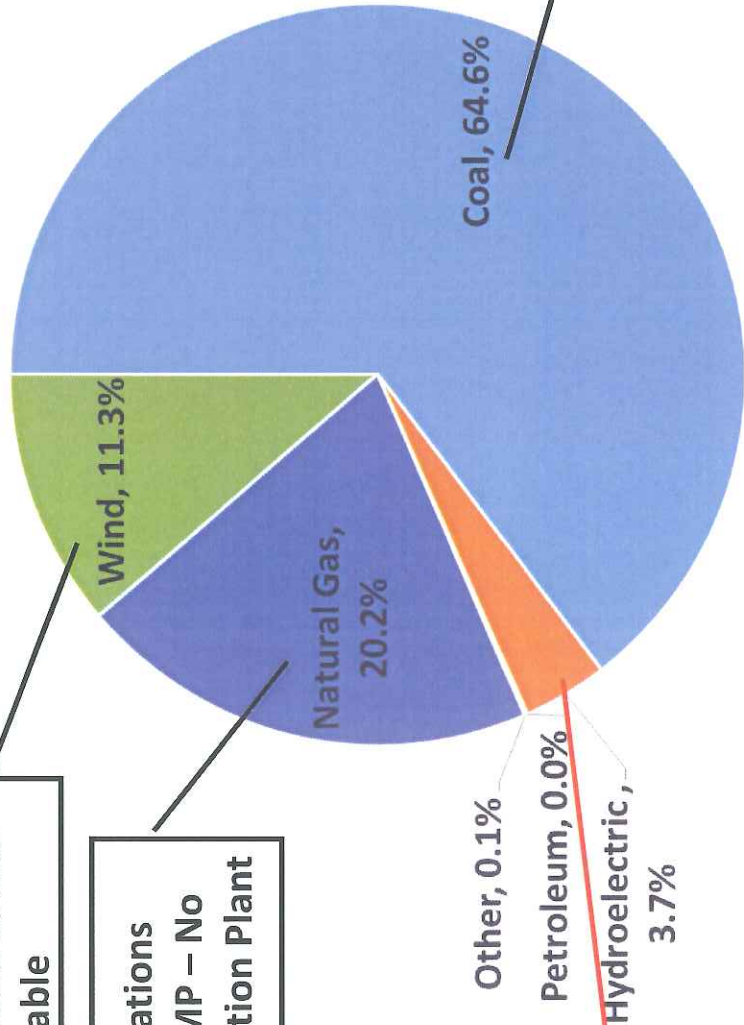
Data Source: US DOE: Energy Information Agency 2012

State of Colorado Electric Energy Production by Fuel Type

Intermittent, Remote & Non-Dispatchable

Gas Pipeline Operations Disrupted due to EMP – No Fuel Stored at Generation Plant

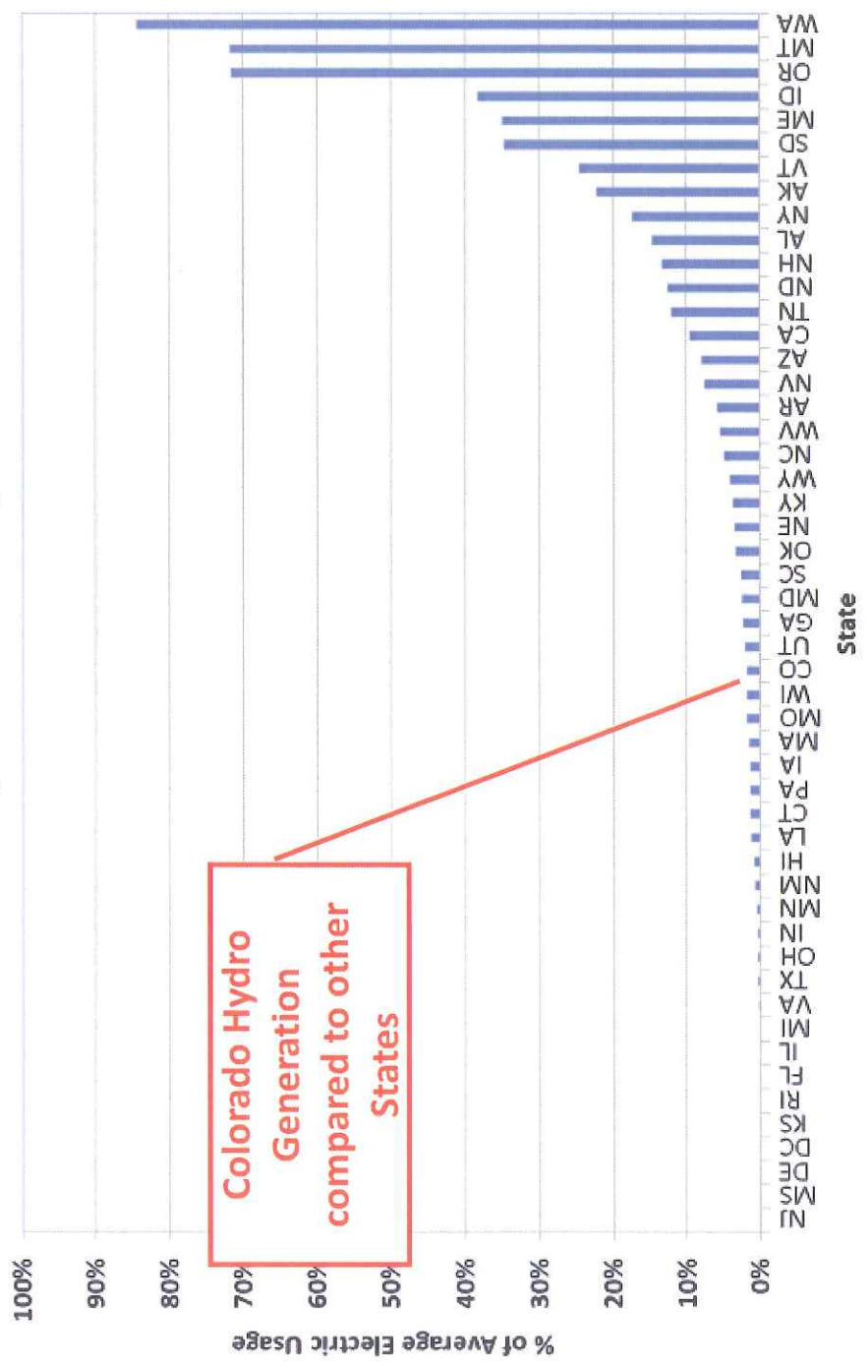
Petrol & Hydro Generation is likely Only Post-EMP Generation



Plant Control Systems & Major Damage due to EMP

Data Source: US DOE: Energy Information Agency 2012

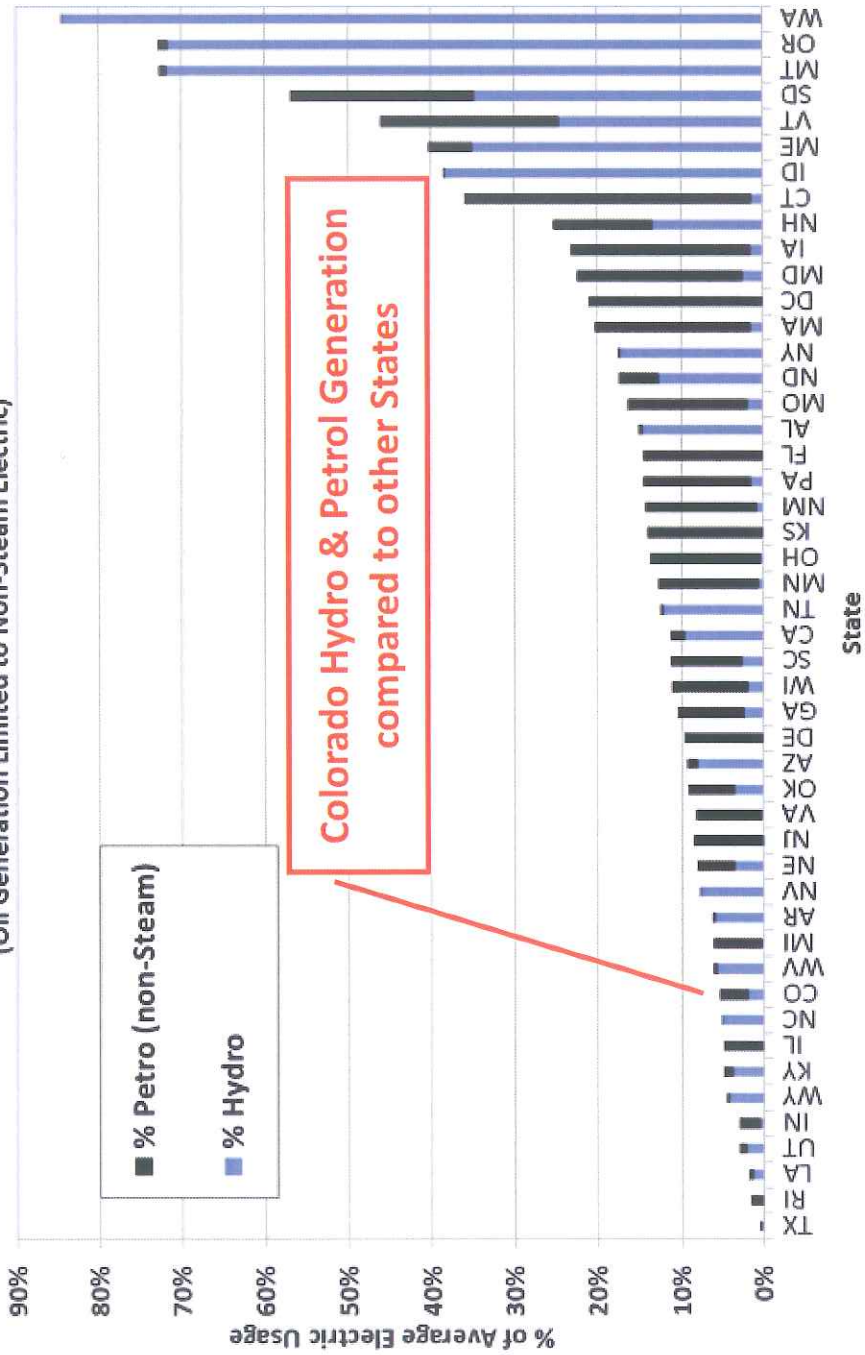
Available Hydro Generation per State



Colorado Hydro Generation compared to other States

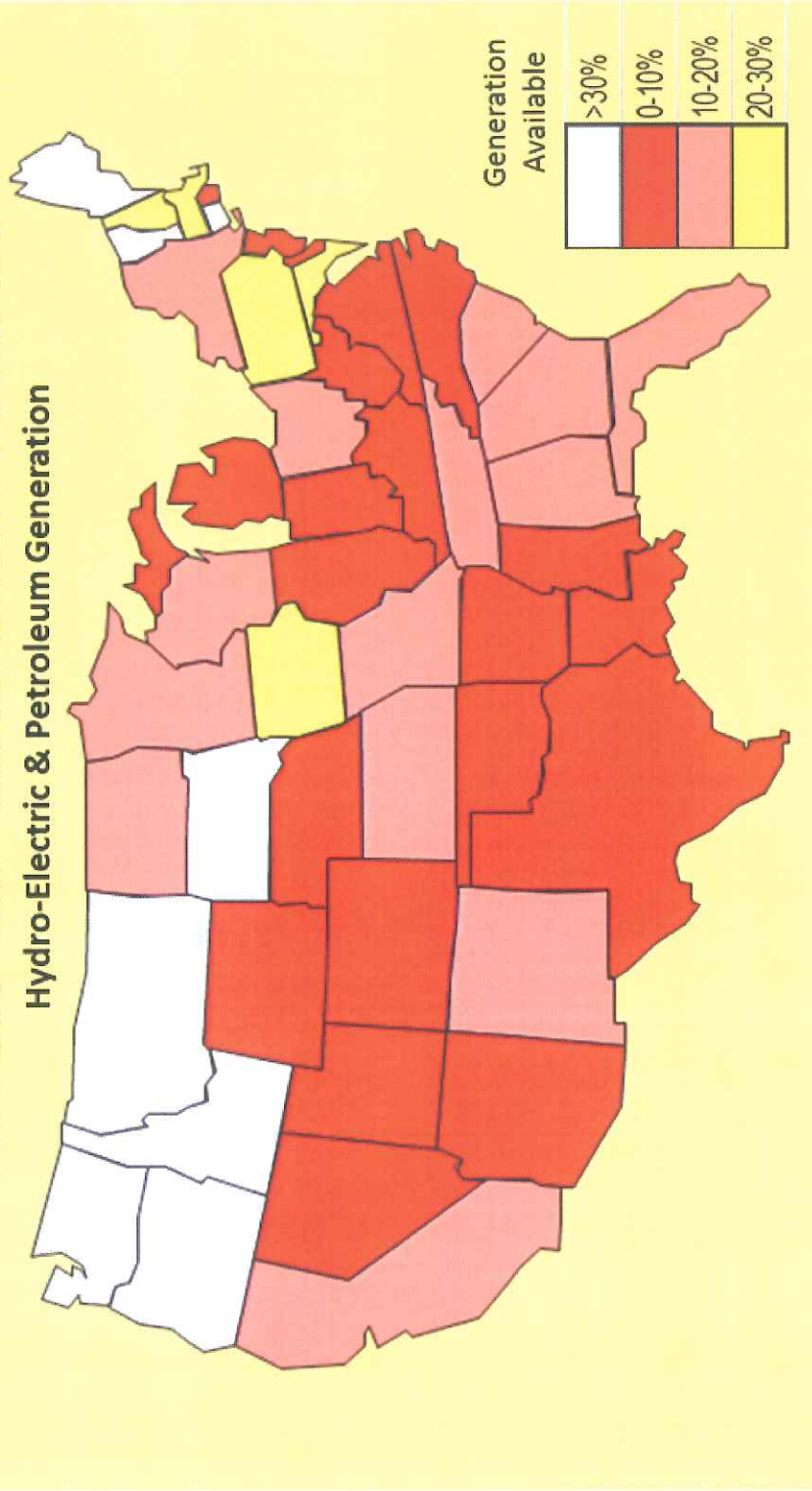
Available Hydro & Oil Generation per State

(Oil Generation Limited to Non-Steam Electric)



US Post-EMP Generation Resources

Hydro-Electric & Petroleum Generation



Map of Hydro-Electric & Petroleum Only Emergency Generation Capacity Ratio to average electric energy usage
States Surrounding Colorado have similar Post-EMP Deficiencies and can provide no Outside Assistance to Colorado
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