Testimony before the BPU on the Energy Master Plan
Committee Room 11, State House Annex - Trenton
August 13, 2015
By
Michael A. Egenton
Senior Vice President – Government Relations
New Jersey State Chamber of Commerce

Thank you President Mroz for allowing us the opportunity to provide input on the Energy Master Plan ("EMP"). I am Michael Egenton, Senior Vice President, Government Relations for the New Jersey State Chamber of Commerce ("State Chamber").

Since 1911, the State Chamber has been recognized as the independent voice of business in New Jersey. With a broad-based membership ranging from the Fortune 500 companies to small proprietorships, representing every corner of the state and every industry, our members provide jobs for over a million people in New Jersey. We continue to work toward streamlining the regulatory process while striving to maintain the economic vitality of our members and the quality of life that makes New Jersey unique.

Energy is the lifeblood of the economy. Reliable, safe, reasonably-priced and environmentally sound energy supply is essential for New Jersey's economic progress. The State Chamber supports a balanced approach toward achieving the EMP goals that doesn't depend or rely on one method, one technology, one fuel source, or overburden one segment of the economy or group of energy consumers.

We believe the EMP sets very reasonable and attainable goals in its blueprint for New Jersey's energy future. However, since the adoption of the 2011 EMP, New Jersey has experienced a number of events that have affected New Jersey's energy infrastructure in a different manner. To that end, I would like to recognize the State's efforts in adopting programs to harden the power grid in the wake of recent extreme weather events, like Super Storm Sandy.

The reliability and resilience of our energy, along with our transportation systems, are key to our businesses and their operations in the State. We support continued efforts in strengthening, modernizing and updating our aging power grid. We hope the EMP recognizes the need for such investments and like any other long-term solution, the management and financing of such investments require thoughtful but structured, more predictable deliberation.

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The State Chamber believes that the following factors should be considered in this deliberative process:

- **Reliable and Resilient Infrastructure**
  - The EMP should support further efforts to continue resiliency and infrastructure investment progress in the accelerated replacement of aging infrastructure and modernizing our electric system. Infrastructure investments that enhance the reliability and resiliency of the electric and gas systems will benefit all customers and create jobs.
  - The EMP should support the expansion of both electric and natural gas transmission. Improvements to both systems will improve economic efficiency and lower costs to consumers.

- **In-State Generation**
  - The State Chamber believes that competitive wholesale and retail energy markets continue to deliver benefits to the State and that well-structured competitive markets will provide the best pathways to reaching the State's goals.
  - The EMP should also recognize the continuation of a diversified fuel mix and balanced portfolio of generation resources to meet all energy reliability needs of the state, including Nuclear.

- **Nuclear Power**
  - Nuclear is the most vital source of low-cost, clean, carbon-free, baseload electric generation in the State of New Jersey.
  - Nuclear energy continues to be an important part of America's and New Jersey's diverse energy portfolio, providing reliable base load electricity around the clock. Nuclear generation provides nearly 20 percent of our country's electricity and accounts for 52 percent of our annual in-state power generation.
  - The continued operations of Salem and Hope Creek are critical to the reliability of the system, particularly in light of the scheduled retirement of Oyster Creek in 2019.
  - Base load capacity continues to be a priority for the State's energy policy.

- **Natural Gas**
  - Natural gas is economically efficient and is a clean, safe, and reliable source of energy.
  - New Jersey is the least expensive in the nation for residential retail natural gas prices, dropping from 17th most expensive in 2010, according to the U.S. Energy Information Administration (USEIA).
  - Shale gas discoveries throughout the United States have enabled developers to bring significant new domestic natural gas supplies to consumers.
  - Regional Greenhouse Gas Initiative (RGGI) Chairwoman Katie Dykes recently said at an event hosted by the Center for Strategic and International Studies in Washington, DC that "because we made such a rapid transition to natural gas-fired generation in New England, we have work to do to get gas pipeline infrastructure developed to serve that gas generation."

- **B.L. England Power Plant Renovation**
  - The State Chamber continues to support a major project in South Jersey that will provide the B.L. England electric generation plant in Beesley's Point with the natural gas supply it needs to stop burning coal, and pave the way for it to become one of the

cleanest power plants in New Jersey. The project also will provide a critical back-up route for natural gas to more than 142,000 customers in Cape May and Atlantic counties who now depend on a single pipeline.

- The plan, by RC Cape May Holdings, which owns the B.L. England electric generation plant, calls for building a 22-mile, 24-inch high pressure natural gas pipeline from just outside Millville in Maurice River Township, Cumberland County, to Beesley's Point in Upper Township, Cape May County. Once constructed, the new pipeline will provide the area with safe and reliable energy, make homeowners in the area less vulnerable to a service outage and reduce air pollution as designed in the state's 2011 EMP and as required in air pollution regulations.
- Under the plan, the plant will no longer operate on coal and oil. Instead, the project calls for repowering one of the plant's units with a state-of-the-art combined-cycle natural gas turbine, and repowering another unit with natural gas. This will place it among the cleanest power plants in New Jersey.
- Converting this power plant to a clean-burning natural gas facility creates a win on many fronts. It will improve air quality and public health, it will reduce costs for the overburdened taxpayer, it will ensure energy reliability for the southern region of New Jersey, and it will provide a boost to the economy and job creation, all the while avoiding damage to our environment.

➢ **Energy Efficiency**

- The State Chamber recognizes the importance of energy efficiency to achieving business and environmental goals. For businesses, using energy more efficiently saves, money, reduces operating costs, increases competitiveness, and promotes job retention and creation.
- NJ has invested approximately $3.27 billion in renewable energy and energy efficiency development and continues to make such investments.
- In previous years, the State had focused energy efficiency programs and funding on residential customers. The State Chamber would welcome development of additional efficiency programs that aim to incentivize commercial and industrial customers and ultimately deliver the benefits we mentioned.
- We also encourage State and local government to lead by example and pursue efforts to reduce energy demand in government buildings.

➢ **Renewable Energy**

- **Solar** energy is clean, renewable, and sustainable. New Jersey ranks among the top three states in the U.S. for total installed solar capacity.
- We have historically supported the EMP objectives to encourage solar development at sites such as landfills, brownfields, warehouses, and government facilities that provide potential for larger installations, improve economies of scale, and that would return unproductive or underutilized sites to societal use.
- Landfill solar projects are about 40 percent less expensive than a typical residential net metered solar project. This is attributable to the economies of scale that can be realized for labor and procurement and installation of equipment combined with lower cost of capital, lower customer acquisition costs and higher capacity factors that can be realized.
- Several developers over the years have expressed interest in building **wind farms** off the coast of New Jersey. We believe the State must undergo an extensive analysis and

evaluate the economic benefits of any proposed projects. We support the BPU's due diligence process to safeguard the interests of ratepayers, making sure that we avoid any undue economic burdens. We would further suggest that the State engage our local and regional chambers of commerce, particularly the ones along New Jersey's coastal areas, when and if such projects are under consideration.

- **Energy and the Environment**
  - Of the 13 states comprising the PJM transmission region, New Jersey has by far the lowest CO_2 emission rate from its power sector.
  - New Jersey has reduced CO_2 emissions from its power sector by 33 percent from 2001 to 2012.
  - In May 2015, approximately 3,000 MW of old, dirty and inefficient peaker facilities ceased operating in NJ to comply with the NOx Reasonably Available Control Technology (RACT) Rule.
  - New Jersey has already achieved the 2020 target for CO_2 emissions set by New Jersey's Global Warming Response Act.
  - As we provide affordable and clean energy, it is important to note that the State needs to have at its disposal methods and tools available when regional cooperation and collaboration do not provide the necessary end results. The EPA in October 2011 granted **New Jersey's Section 126 petition** to force dramatic reductions of air emissions from GenOn's Portland Generating Station in Northampton County, Pennsylvania. Sulfur dioxide (SO2), mercury and many other contaminants emitted into the air from this facility were carried in the atmosphere across the Delaware River to communities in Warren County, and also negatively impacted air quality in Morris, Sussex and Hunterdon counties. This was the first single-source 126 Petition the EPA has ever granted under the Clean Air Act -- the first time it has granted a petition for a power plant bordering another state. We commend the State regarding the end result – the closure of that facility in Pennsylvania.

- **Energy and the Transportation Sector**
  - As a long serving member of the New Jersey Clean Air Council, an advisory body that provides ongoing input and recommendations to the New Jersey Department of Environmental Protection on air quality issues, we annually issue very detailed reports with specific recommendations. Two of those reports, 2014's ***Reducing Air Emissions Through Alternative Transportation Strategies*** and 2015's ***Air Pollution Knows No Bounds,*** contain several suggestions to enhance the use of alternative fuel vehicles. One such recommendation is to explore public/private partnerships for charging/filling stations that include reasonable cost recovery incentives such as tax incentives and State assistance with permitting and licensing. We would encourage the BPU to review the reports and work with DEP and other stakeholders towards strategic implementation.

- **Fuel Cell Technology**
  - Fuel cells eliminate pollution -- the only byproduct is water. Because fuel cells have no moving parts and do not involve combustion, this technology has the potential to achieve great efficiency. The State Chamber encourages the State to work with and support the research of New Jersey's academic institutions to pursue making fuel cell technology another viable option to our energy demands.

- **Clean Power Plan**
  - While we are still analyzing the overall impact, we are concerned that EPA's proposal could hurt our state and the progress that we have made in reducing carbon dioxide emissions. NJ should be recognized as a leader. We need to make sure that all states are held to the same standards that New Jersey has set for our power producers. Our members have made the cost commitments to install state-of-the-art equipment at their facilities. In the end, we only truly benefit if our regional neighbors and the rest of the nation follow our lead.

The State Chamber appreciates the opportunity to comment and respectfully requests that our views be given proper consideration.

New Jersey Conservation
FOUNDATION

Good afternoon. My name is Tom Gilbert, and I am Campaign Director for Energy, Climate and Natural Resources with the New Jersey Conservation Foundation.

Since 1960, we've saved more than 130,000 acres of land from sprawl development.

Today, we're fighting a new sprawl: energy infrastructure. Simply put, pipelines, transmission lines and transfer stations now threaten thousands of acres of land.

Nowhere is this more apparent than the current rush to build more gas pipelines in New Jersey. The PennEast pipeline alone would cut through 3,300 acres of preserved land, leading to the fragmentation of forests and farms, disturbance to streams and water quality, and the industrialization of the landscape.

The numbers are sobering.

The Wilderness Society estimates that a single 1,000-megawatt coal-fired power plant requires roughly 23,000 acres of land. Only 1,000 acres of land are used for the power plant itself; the rest are needed for mining, waste disposal, transmission lines, rail spurs and more.

There is a better way forward.

As we see it, the Energy Master Plan's focus on energy efficiency and renewables is right on the money, but there is an urgent need to invest more and move much more quickly in these areas.

The best kind of energy is energy we don't use. We need to place an absolute priority on conserving energy. Energy efficiency will save land, save consumers money, reduce emissions, and create jobs.

For example, California's landmark energy efficiency programs have reduced personal electricity use by 40 percent below the national average and resulted in $56 billion in household energy savings. By allowing expenditures to be redirected toward other goals and services, energy efficiency helped create 1.5 million jobs with a total payroll of $45 billion.

According to the National Association of State Utility Consumer Advocates, with or without the Clean Power Plan, states that pursue renewables and energy efficiency will see smaller increases in total electric-system costs through 2030 than they would with any other investment strategy.

The plan can and should do more to promote energy efficiency and renewables. They represent a true win-win for the environment and economy.

Testimony of William F. Brandes
Before the New Jersey Board of Public Utilities

New Jersey Energy Master Plan
August 13, 2015

Good afternoon. My name is William Brandes. I appreciate the opportunity to talk to the Board today about the New Jersey Energy Master Plan.

I have recently retired from the U.S. Environmental Protection Agency (EPA) after a 30 year career, mostly in EPA's Office of Solid Waste in Washington, D.C. I was the first chief of the Energy Recovery and Waste Disposal Branch of that office. I do not represent the Agency here but my comments are the same as those I made many times during my years with EPA. I am currently working as a consultant to the Energy-from-Waste industry.

The last ten years of my career in EPA was focused on how to change from a national strategy on "waste" and getting rid of it to a strategy on ways to use waste materials as commodities in a more sustainable materials management system. We also focused on ways to support increasingly critical carbon reduction efforts to reduce the effects of greenhouse gases from waste management and energy generation.

Key Point

I urge the Board to include in the Energy Master Plan actions that promote the use of municipal solid waste as an energy source. Such actions support an integrated solid waste system, including Energy-from-Waste, and must play a more prominent role in achieving New Jersey's goals to increase renewable energy and reduce greenhouse gases while creating high paying jobs.

Why do I say that?

Every year, nearly 4.4 million tons of New Jersey's trash is sent to landfills, with very little, energy or materials recovery. There are only two principal and proven options when communities dispose of the waste left over after recycling: landfilling or recover energy. Today, 75% of New Jersey waste is sent to landfills because current policies have continued to disadvantage Energy-from-Waste by rewarding landfills, the inferior technology.

Different states as well as most parts of the industrial world, including the European Union and China, have begun to view the non-recycled portion of trash as a resource, not a problem.

Energy-from-Waste is a proven technology that converts municipal solid waste into baseload energy. There are currently 84 such facilities operating in the United States including five in New Jersey.

EfW is widely recognized internationally, including by the US EPA, EU, the Intergovernmental Panel on Climate Change, and the UN, as a source of greenhouse gas mitigation. At EPA, we used Department of Energy models and our own models to estimate that

EfW reduces greenhouse gas emissions by approximately one ton of carbon dioxide equivalents (CO_2e) for every ton of waste processed relative to landfilling, based on national averages. These reductions result from prevention of uncollected fugitive emissions of landfill methane, a greenhouse gas 34 times as potent as carbon dioxide over 100 years; avoiding fossil fuel combustion associated with grid electrical production; and the recovery of ferrous and non-ferrous metals for recycling, which reduces the greenhouse gas emissions associated with the production of these metals from raw materials.

As an economic driver, the construction of one 1500 ton per day energy-from-waste facility can create nearly $1 billion worth of economic activity, create approximately 250 direct construction jobs during the three year construction period. There would be approximately 110 direct and indirect jobs when the facility is operational, and one facility can offset the need for approximately 500,000 barrels of oil a year.

Over my 30 year career at EPA I experienced significant frustration in the direction in which many state renewable energy plans and waste management programs were constructed. At the time my group at EPA began investigating and then promoting EfW, most jurisdictions tended to favor policies that promoted the idea of zero waste at the expense of EfW, arguing that if we just worked at it, we would not need energy recovery facilities because there would be no waste. We are still waiting for jurisdictions to achieve total materials recovery and zero waste. In the meantime, massive carbon emissions have occurred from landfilled municipal solid waste. We will not achieve zero waste, certainly not anytime soon. Yet energy-containing materials continue to be put into landfills. That material will be converted to methane and much of it will be released to the environment.

What we need is realistic energy and carbon reduction strategies that reverse that trend. EfW can and should be an integral part of State energy plans, right now. State carbon reduction goals would benefit, a small but reliable baseload power source would be secure, and local, and wasteful landfilling would be avoided.

Final Point

EPA has just inexorably linked energy production and carbon reduction goals with the recent release of its new Clean Power Plant rule. The rule includes Energy-from-Waste as a mitigation tool that states can take advantage of to meet the new strict carbon reduction requirements. That "linkage" will withstand any legal challenge even if specific aspects of the rule do not. Energy production needs and accompanying carbon emissions impacts are our new, legal reality. Therefore, state energy plans from now on are, by definition, also carbon reduction plans. **Any**, with emphasis on the word any, energy source in such plans that can contribute to carbon reduction must be supported and integrated. EfW is one such power source.

Energy-from-Waste can help New Jersey produce renewable energy 24 hours a day, 7 days a week near the source of consumption, create new, high-paying jobs, all while reducing greenhouse gas emissions and land consumption.

For these reasons, I urge the Board to include in the New Jersey Energy Master Plan specific policies and actions that promote Energy-from-Waste.

IEPNJ
INDEPENDENT ENERGY PRODUCERS OF NEW JERSEY
ADAM KAUFMAN - EXECUTIVE DIRECTOR 609-530-1234

COMMENTS PROVIDED BY HOLLY REED ON BEHALF OF THE INDEPENDENT ENERGY PRODUCERS OF NEW JERSEY ON THE 2011 ENERGY MASTER PLAN (EMP) UPDATE

EMP Public Hearing in Trenton
August 13, 2015

My name is Holly Reed, Vice President of Gabel Associates. I am here today to testify on behalf of the Independent Energy Producers of New Jersey – referred to as IEPNJ.

We appreciate the opportunity to present our views and commend you for your efforts and continued work in this area.

IEPNJ is a not-for-profit trade association that represents New Jersey's generators of electric power. IEPNJ members generate over 80% of the electricity produced in the State. Members include companies that sell electricity into the wholesale market for sale to the state's utilities, which, in turn, sell that power to New Jersey homes and businesses.

As such, members of IEPNJ are active participants in the region's wholesale power market and have a continuing interest in assuring that there are adequate supplies of electricity to fuel the region's growth in an environmentally and economically sound manner.

IEPNJ and its members have been on the forefront of the dramatic changes that continue to transform the power business. Since 1992, IEPNJ has been directly involved in shaping the laws and policies that affect New Jersey's power industry and

has been an active contributor to the State's Energy Master Planning process over the years.

We support New Jersey's direction to create a cleaner, more environmentally advanced energy industry throughout the consumption, transportation, and production chain. The power generation industry is a vital component of this chain and generators are committed to continuous improvements in the efficiency, reliability and environmental performance of its plants. In this regard, the one factor I wish to emphasize is that the most efficient way for New Jersey to achieve its goals is to rely on competitive markets and let them work. Competition forces market participants to respond to competitive pressure by improving efficiency which in turn reduces costs and improves environmental quality. New Jersey's generation fleet has evolved and improved significantly over the years through this process. We recommend that you continue your good work in fostering the competitive energy marketplace.

IEPNJ looks forward to continuing to work with New Jersey to promote policies that encourage the responsible development of generation resources needed to meet New Jersey's demand for power. In addition, we are always available to serve as a resource of information as you think through important issues.

Thank you for the opportunity to submit these comments.

Contact Information:
Holly Reed, Vice President
Gabel Associates
Highland Park, NJ 08904

From: Martine gmail
Sent: Thursday, August 13, 2015 10:56 AM
To: EMPupdate
Subject: Renewable energy!

Categories: Blue Category

I support New Jersey's use of renewable energy and am firmly against any gas pipelines running through the state.

Martine Gubernat

Bridgewater, NJ. 08807

From: paresh trivedi
Sent: Thursday, August 13, 2015 10:39 AM
To: EMPupdate
Subject: Energy Master Plan and Clean Energy Program for Middle class

Categories: Blue Category

Energy Master Plan and Clean Energy Program for Middle class

Clean Energy program has very little impact on middle class. They cannot get like people are in safety net or they cannot afford $34K solar system like 1% or they will not prefer to rent their roof for 4 cents less than current rate. Forget about rate reduction with zero down payments solar installation just pay the rent for roof use per square feet! We do not need any small solar panels on electric pole any more, right?

Some Chinese business person asked me to wait for year and he can give me solar system for $6k. So what is this $34k and $6K.

For energy savings – Energy audits are not done same by every company and that is not fair they need to do each and every aspect of energy audit and give comprehensive report to home owner or business they can do only for work they like to do and rest of the things they assume or just customer has to keep eyes closed on what they submit in their estimate and for getting the rebate. If home owner can do something by himself then also he should be able to get rebate for energy savings he performed.

Need to give wider freedom to home owner or building owner then the energy audit contractor! Also make sure all the services provided by energy audit company for energy audit should be standardized and they need to have check off form and need to give reason why they did not do something which is mention in that form.

Why Utilities vegetation management not taking care of trees near service lines? Also asking for $275 for shutting down electric supply connection if home owner wants to perform tree trimming by themselves???

Regards,

Paresh Trivedi

Mr. huck fairman

princeton, NJ 08540

Aug 14, 2015

Richard Mroz
NJ

Subject: Support Clean Energy in the EMP!

Dear Richard Mroz,

The Energy Master Plan will help shape New Jersey's energy future the next few decades. We need to make sure that the EMP includes ways to reduce our dependence on dirty fossil fuels and open doors for clean, renewable energy. New Jersey used to be a leader in solar and wind power and we can be again but we need the EMP to have aggressive clean energy goals.

The BPU needs to acknowledge climate change and the effect of storm events like Hurricane Sandy. Investing in clean energy is one of the best resiliency strategies for New Jersey. We want the new EMP to have less room for pipelines and oil trains and more room for solar and wind development. We need to return to the stricter goals of the 2008 EMP to see New Jersey as a forerunner in clean energy once again.

The BPU has the opportunity to ensure that all New Jersey residents have the benefit of clean, safe and affordable energy. The EMP should have goals of 30% of our energy to come from renewable sources by 2020 and a 30% reduction in energy use through energy efficiency by 2030. All of our electricity to come from renewable sources and we should be 80% carbon free by 2050. We need to install energy efficiency and clean energy goals into the EMP to ensure that New Jersians' health and economy will benefit from clean energy.

Sincerely,
Mr. huck fairman

Miss Rebecca Canright

Asbury, NJ 08802-2106

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Sincerely,
Miss Rebecca Canright

Ms. Tanya McCabe
[redacted]
Blairstown, NJ 07825-9668

Aug 14, 2015

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Mr. David Lavender

Atco, NJ 08004-1513

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Sincerely,
Mr. David Lavender

[redacted]

From: Colby, Richard [redacted]
Sent: Friday, August 14, 2015 12:37 PM
To: EMPupdate
Subject: Testimony that I'll make at the Hearing Monday at Stockton University
Attachments: BPU-EMP-2015Su-Testimony.doc

Categories: Blue Category

attached and embedded below:

BPU-EMP-Testimony – 17 Aug 2015

From Dick Colby, Community Solar Issues Coordinator for the NJ Chapter of the Sierra Club

[redacted] Fog Harbor City 08215-1319; [redacted]

Asking you (again!) to "enable" the concept of COMMUNITY SOLAR FARMS, developed by non-profit organizations such as the Atlantic County Utilities Authority, using municipal brownfield sites, parking lots, and other appropriate property, and offering solar-farmed electricity on a subscription basis:

There are several reasons why home solar panels wouldn't be appropriate for everyone, most of which apply to my home:

1. I am too old (75) for the payoff period to be economically reasonable.
2. My house is too old (~100 years) for the roof to support panels.
3. The orientation and design of my roof is inappropriate.
4. There are trees that shade my roof.
5. Many people don't own their homes, or can't afford it, or wouldn't be able to organize it.

The objection I got from Vince Maione, President of Atlantic Electric, is that **net metering** isn't up to the job of providing his company with a fair delivery income.

Net metering has been in the news. It is in general use in Europe and Oregon. You presumably have the expertise to evaluate it independently of Atlantic Electric. I suggest you google "smart meters" and "community solar."

I can supply a map of Atlantic County, prepared by the County Planning Office, showing municipal brownfield sites (e.g. abandoned landfills) in relation to nearby high-voltage power lines. My inquiries of County Executive Dennis Levinson have resulted in his "offer" of the ACUA as an appropriate developer and operator of municipal solar farms for each of the 23 municipalities in Atlantic County. Please permit the suggestion that the idea is worthy of at least a trial.

(I also serve on Atlantic County's Environment and Parks Advisory Commission, which advises the Freeholders.)

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NEW JERSEY ENERGY LINK

To: New Jersey Board of Public Utilities
From: Markian Melnyk, President, Atlantic Grid Development LLC
Subject: Comments on New Jersey Energy Master Plan
Date: August 14, 2015

Atlantic Grid Development LLC (AGD), the developer of the New Jersey Energy Link (NJEL) project, appreciates the opportunity to present comments in connection with the Board's update to the New Jersey Energy Master Plan (EMP). NJEL is a proposed high-capacity, 1,000 MW buried transmission cable system transmission system that would connect northern and southern New Jersey. NJEL would reduce congestion on New Jersey's power grid, improve competition in energy supply, lower energy costs, and increase the resiliency of the transmission grid. Our comments focus on long-term energy challenges facing New Jersey and describe how the Board can initiate upgrades to the grid to improve the outcome for New Jersey ratepayers.

Transmission is Needed to Drive Down the Cost of Energy for New Jersey Ratepayers

Historically, New Jersey's electricity costs have been among the top 10 highest in the country and 20-50%+ higher than the US average.[1] An increased supply of natural gas used to fuel electric generators has provided a measure of temporary relief to ratepayers, but structural problems remain in the State's power markets that continue to cause ratepayers to pay more than necessary for power.

New Jersey's Large Energy Users presented the issue clearly in connection with the previous revision to the EMP. These conditions continue today. The state's energy infrastructure is old and much of it is operating at capacity. Aging generating plants are retiring and transmission constraints prevent much-needed additional power supplies from reaching the New Jersey market. Concentration (*i.e.*, market power) within the energy market blocks competing suppliers from delivering reasonably-priced energy to consumers. The Large Energy Users Coalition called for more State engagement to actively support new electric generation and transmission facilities:

> *It is no secret that the high cost of energy in New Jersey threatens the State's economic competitiveness and hurts consumers of all rate classes. . . . Our power supply is provided by a generation fleet that is aging . . . and also has been significantly depleted by a series of plant retirements . . . Moreover, transmission constraints limit the amount of power that can be imported from the west to make up for generation shortfalls . . . The higher energy costs in New Jersey are driven, in large part, by the related problems of the State's congested electric transmission systems and concentrated generation market . . . Transmission constraints prevent necessary imports and function to increase energy costs as more expensive localized power plants are dispatched to deliver power within constrained areas . . . To address these concerns, the Energy Master Plan should commit the State to actively supporting, through*

[1] US Energy Information Administration: http://www.eia.gov/state/?sid=NJ#tabs-5

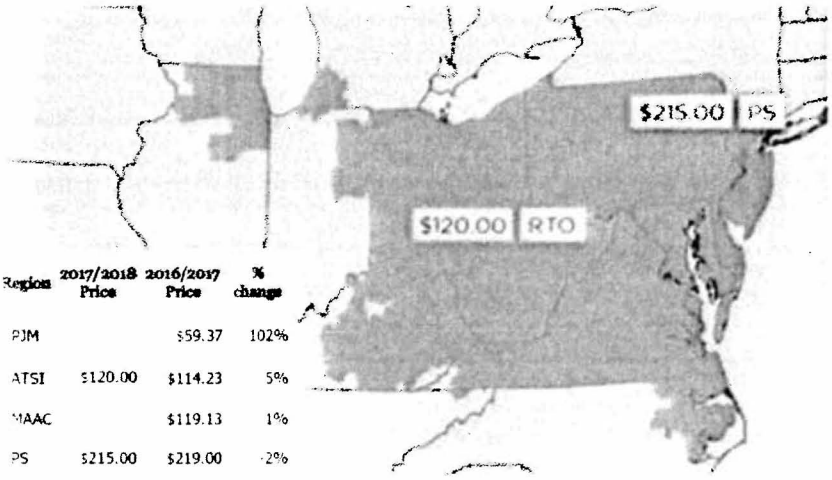
various means, immediate investment in new supply resources and transmission facilities for electric and natural gas within New Jersey.[2]

The term "transmission constraint" can refer to a piece of equipment that restricts power flows, to an operational limit imposed by PJM or the local utility to protect reliability, or to a lack of transmission capacity to deliver electricity from existing or potential generation sources. In layman's terms, New Jersey suffers from chokepoints in the electric grid that stifle the free flow of electricity and prevent competition in the power sector from delivering cheaper energy to New Jersey businesses and households. The zone operated by PSEG stands out. PJM Interconnection (PJM), the region's high-voltage grid operator, found that during the 2016/2017 capacity auction PSEG was the only zone in which prices increased. In PJM's words, prices increased because PSEG is "historically transmission constrained" and because not much of the new generation in PJM was sited in the PSEG zone. Since transmission constraints block power imports, the shale gas revolution and the growth in gas-fired generation in other parts of the PJM footprint is not benefitting consumers in the PSEG zone.

The only [zone] in which prices increased, PSEG, is historically transmission constrained, and did not attract much of the new entry and uprates that are internal to PJM and could not fully benefit from the new entry in other parts of PJM and the increased imports due to the transfer limits into PSEG.[3]

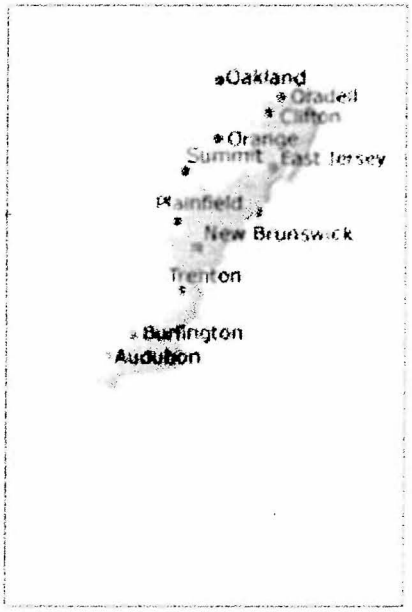
PJM data shows the impact of transmission constraints on New Jersey ratepayers. Their report from the 2017/2018 capacity auction shows that the price in the PSEG zone is about $347 million per year more than ratepayers would pay if the market was operating freely with unconstrained transmission access to the PSEG zone.[4] The yearly cost is calculated by multiplying the load in the PSEG zone, 10,011 MW, times the $95/MW-day that the cost in the PSEG zone exceeds the cost elsewhere in PJM, times 365 days.

Capacity Auction Clearing Prices 2017/2018



Region	2017/2018 Price	2016/2017 Price	% change
PJM		$59.37	102%
ATSI	$120.00	$114.23	5%
MAAC		$119.13	1%
PS	$215.00	$219.00	-2%

Prices in MW-day (Source: PJM Interconnection, LLC)



[2] Comments of NJ Large Energy Users Coalition on the NJ Energy Master Plan July 25, 2008 at 24-26, http://nj.gov/emp/home/docs/pdf/080608_NJLEUC_GoldenbergS.pdf

[3] http://www.pjm.com/~/media/markets-ops/rpm/rpm-auction-info/2016-2017-base-residual-auction-report.ashx

[4] http://www.pjm.com/~/media/markets-ops/rpm/rpm-auction-info/2017-2018-base-residual-auction-report.ashx

The map above shows the results of the PJM capacity auction covering the 2017/2018 capacity year. The states/areas under PJM control are shown in blue. With one exception, the capacity clearing price set by the auction was $120/MW/day.[5] All generating plants in the blue area that cleared the auction will earn that payment for being available to serve the power demands of the ratepayers in PJM. Ratepayers in southern and northwestern New Jersey will pay this capacity price.

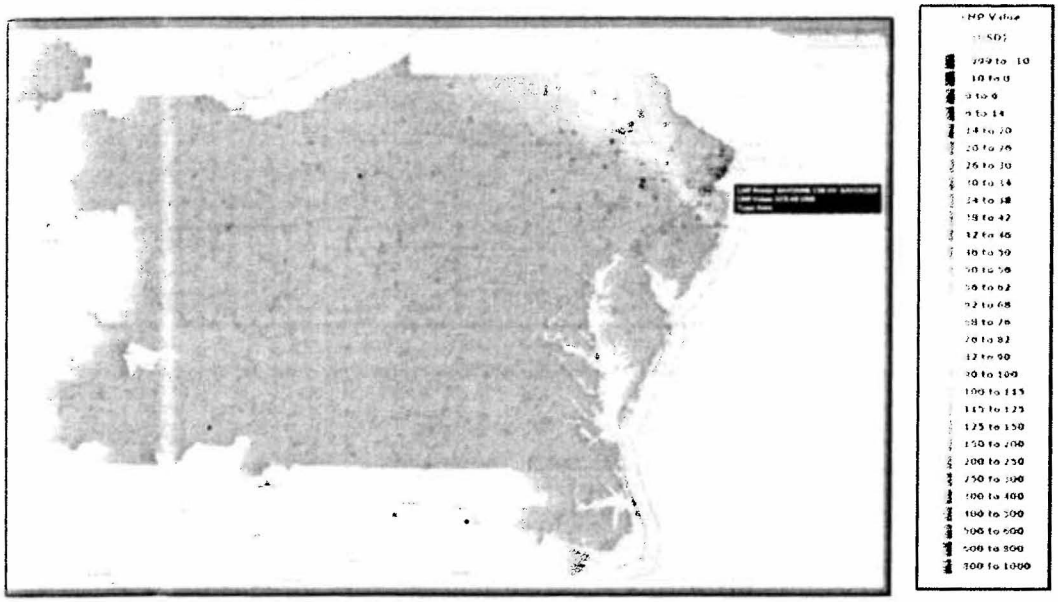
However, the PSEG zone (shown in green as "PS" on the map) is an exception. Generating capacity located in that zone will receive $215/MW/day, or $95/MW/day more than PJM generating capacity in other zones. The auction produced this result due to transmission constraints that caused the PSEG zone to separate from PJM's other zones. In effect, the PSEG zone is treated like an electrical island and a separate mini-auction sets capacity prices there, while the main auction within PJM sets the price for PJM's other zones. This problem has a big economic impact on New Jersey because PSEG zone prices affect most of New Jersey's largest cities and a significant majority of the State's population and businesses, as shown on the right hand map above.

The electrical "islanding" of the PSEG zone leaves ratepayers dependent on old, polluting, high-cost generating plants. PJM evaluates the expected demand of consumers in its various zones (which are utility service areas or sub-areas) and calculates the amount of power that needs to be transferred into that zone to retain reliability. This target is called the capacity emergency transfer objective (CETO). Then PJM looks at the maximum physical ability of the transmission lines serving that zone to move power into the zone. PJM calls this the capacity emergency transfer limit (CETL), and it represents the highest, safe level of power transfer into the zone. When the transfer limit (CETL) is too close to the transfer need or objective (CETO), then PJM requires that zone to break apart from, or separate from, the larger PJM capacity market. When PJM makes a zone into a separate "island" that zone must provide sufficient generation from within the zone to meet its demand, since transfers into the zone cannot be relied on to meet the demand. The PSEG zone has this problem. The transfer limit into the PSEG zone does not provide a safe margin above the transfer objective. As a result, the PSEG zone relies on capacity native to the PSEG zone (77% of which is owned by PSEG) to meet demand. That capacity includes old, inefficient and costly generating plants which set a much higher capacity market clearing price than the generation fleet that serves other areas of the PJM footprint. New Jersey ratepayers in the State's most populous areas (i.e., the PSEG zone) then are stuck paying a much higher price than would apply if competition in the broader PJM market set the price.

The grid constraints that prevent capacity from being imported into the PSEG zone also affect energy imports. Energy market prices (in $/megawatt-hour) fluctuate based on factors such as demand (peaking on a daily and seasonal basis) and transmission congestion. PJM manages the energy market auctions that procure commitments (in the near term, e.g., day ahead, hour ahead) to supply energy as needed to meet fluctuating demand from consumers.

A typical pattern in energy prices resulting from a constrained grid is shown in the map below. Orange in northern New Jersey reflects high cost energy and blue to the south and west is low cost. New Jersey's transmission connections to the south and west need to be stronger to create a path for lower cost power to reach the highest cost parts of the State.

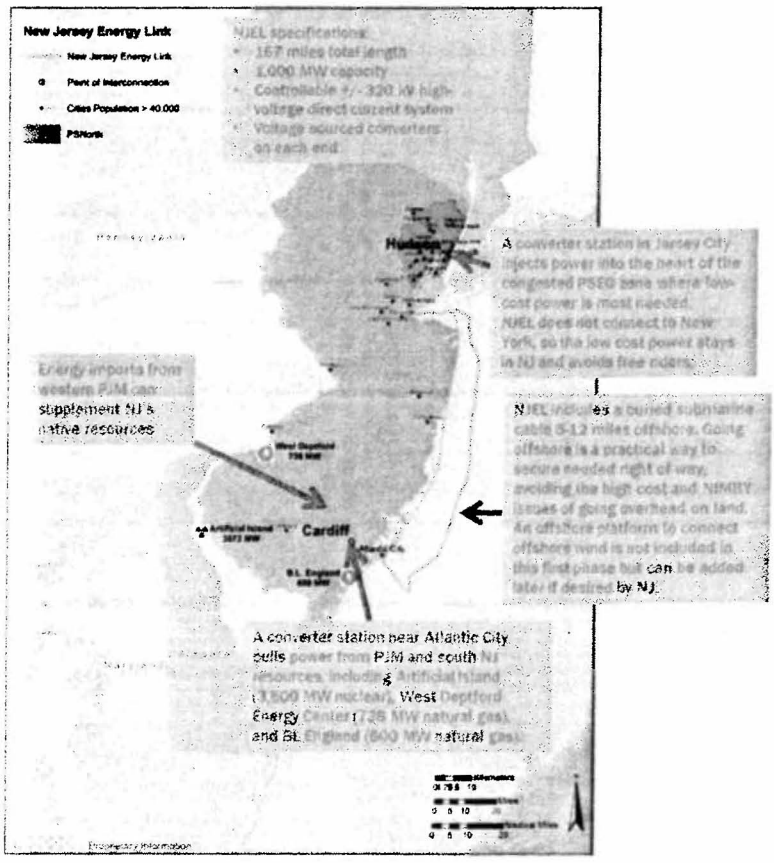
[5] http://www.pjm.com/~/media/markets-ops/rpm/rpm-auction-info/2017-2018-base-residual-auction-report.ashx



Source: PJM Interconnection, "LMP Contour Map". Accessed: 15:15hr, December 13, 2013.

Ratepayers Would Benefit from More Transmission into Northern New Jersey

NJEL creates a path for more energy and capacity to reach the high-cost northern part of the State. Increased supply would improve competition and drive down prices for ratepayers. NJEL would transmit power from plentiful existing resources in southern New Jersey, including Artificial Island which hosts the largest nuclear power station in the region and provides the lowest-cost generation in the State, as well as imports from other parts of PJM. NJEL would employ a high-capacity, 1,000 MW buried transmission cable system to transmit power into northern New Jersey during typical operation. NJEL is controllable and bi-directional, so in exceptional circumstances when southern New Jersey requires additional power, flows on NJEL can be reversed and generating capacity in the north would supply the south.



Many years ago utility planners recognized the need for a transmission line to connect southern New Jersey to the north. The project, called the Seashore Loop, was abandoned when it became clear that securing the right of way would be impossible. NJEL is a modern solution that takes advantage of federal submerged lands for the right of way. This is particularly wise when considering the multi-year permitting delays on the Susquehanna-Roseland transmission project – which was merely an expansion of a line along an existing right of way. Securing right of way for any overhead transmission project is difficult, expensive, and time-consuming, particularly in New Jersey. Going underground and offshore, as NJEL does, is just more practical and good public policy since it avoids the high cost,

NIMBY objections, and the environmental impact of overhead transmission lines on land.

Although the current NJEL project does not include an offshore platform to connect with offshore wind, future offshore wind farms could connect to the NJEL circuit. An offshore transmission connection would simplify and reduce the cost of building offshore wind farms, which savings would accrue to ratepayers. In this way, NJEL achieves another goal of the EMP which is to support achievement of the State's renewable energy portfolio standards.

Reliability and emergency preparedness also would be improved. NJEL uses a buried cable system that is much more protected from damage during severe weather and other threats than overhead transmission lines. The security experts at The Chertoff Group reviewed NJEL for its contribution to making the power grid, and the other infrastructure and institutions that depend on reliable power, more secure. The Chertoff Group noted the principal mitigation recommendation from the North American Electric Reliability Corporation (NERC) to make the grid secure:

> *Strengthen the inherent redundancy, flexibility and capacity of the bulk power system to reduce the likelihood of unmitigated impacts on the system...Lessen the potential impacts of an attack, natural disaster, or accident by introducing system redundancy and resiliency, reducing asset dependency, or isolating downstream assets.*

The Chertoff Group found that an undersea, buried cable system like NJEL is more resistant to physical attack, severe weather, and geomagnetic disturbances than the vulnerable and exposed land based grid. To be clear, NJEL on its own will not keep the lights on in a neighborhood if a storm knocks down distribution wires, but NJEL does provide a robust connection between southern and northern New Jersey that allows the grid operator many more options to respond during emergency conditions. NJEL would make the State's exposed grid more secure.

New Jersey Should Use Available PJM Processes to Improve the State's Transmission Grid

Solving New Jersey's high electricity cost problem requires action. Unfortunately, State action to promote generating plant construction with LCAPP did not work due to challenges from generators who claimed that the state was interfering with the federally-regulated wholesale energy market.

State action to support new transmission infrastructure, however, could not be blocked by generators. PJM provides a federally-approved mechanism in its tariff known as the State Agreement Approach that any state may use to advance transmission projects that achieve public policies, including resiliency, energy affordability and meeting renewable energy goals. State support for NJEL and similar transmission facilities is not interference with competitive markets. Like other transmission facilities, NJEL would be operated as a nondiscriminatory public carrier and access to the transmission line would be managed by PJM, an independent entity that promotes competitive energy markets. NJEL unblocks the transmission highways and lets more generators access the wholesale energy and capacity markets; improving competition to the benefit of ratepayers. In short, NJEL is pro-competitive and fully consistent with federal law and PJM's tariff.

For all these reasons, we urge the Board to take a more proactive role by encouraging and supporting transmission projects, like NJEL, using PJM's procedures which permit the State to take control of its energy destiny.

NJUA
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August 14, 2015

VIA ELECTRONIC MAIL
Irene Kim Asbury
Secretary of the Board
New Jersey Board of Public Utilities
44 South Clinton Avenue
Trenton, NJ 08625
EMPUpdate@bpu.state.nj.us

Re: Comments on Energy Master Plan

I write on behalf of the energy utility members of the New Jersey Utilities Association (NJUA), specifically, Atlantic City Electric Company, Jersey Central Power & Light Company, New Jersey Natural Gas Company, Pivotal Utility Holdings, Inc. d/b/a Elizabethtown Gas, Public Service Electric and Gas Company, Rockland Electric Company, and South Jersey Gas Company in response to the request for comments on the NJ Energy Master Plan (EMP). NJUA represents 16 investor-owned utilities that provide electric, natural gas, telecommunications, water and waste water services to residential and business customers throughout the State. We appreciate the opportunity to offer comments on the EMP. These comments reflect the consensus views of the above-referenced energy company members. As the New Jersey Board of Public Utilities (BPU) conducts its hearings and receives comments with respect to the EMP, we ask that you consider the following:

Energy Distribution System Infrastructure Resiliency

In 2011, the Administration stated that the EMP is the "Administration's strategic vision for the use, management, and development of energy in New Jersey over the next decade" which includes emphasis on "improving grid reliability" and recommendations that focus on "initiatives and mechanisms which set forth energy policy to drive the State's economy forward."[1] Since the adoption of the 2011 EMP, New Jersey has experienced a number of large storms. Ranging from hurricanes, ice and heavy snow, a derecho, and extremely severe thunderstorms, each weather event has affected New Jersey's energy infrastructure in a different manner. Additionally, each storm has brought with it an increased focus by policymakers on investor-owned utility response to customer outages and the infrastructure's ability to withstand destructive weather conditions. As such, NJUA respectfully recommends that the updated EMP include, as a central element of the Administration's strategic vision, support for implementation of programs and regulatory cost recovery mechanisms that enable New Jersey energy companies to effectively and efficiently increase resiliency.

[1] 2011 EMP, pg. 3.

It is estimated that the average annual cost of power outages nationwide caused by severe weather events is between $18 billion and $33 billion per year.[2] It follows that in a year with significant storms, the costs would be much higher.[3] The economic effects of Hurricane Irene and Superstorm Sandy in particular have prompted NJUA energy companies to look more comprehensively and strategically at storm hardening and resilience of transmission and distribution systems.[4] In addition, a number of the companies have sought BPU approval to implement programs through which they have, in the aggregate, invested billions of dollars to protect and strengthen electric and gas systems. These programs have created thousands of jobs and have enabled construction of improvements designed to mitigate economic losses that will occur in relation to future storms. NJUA believes the EMP should direct that when the BPU evaluates the cost of proposed investment in utility infrastructure, the economic cost of *not* making that investment should also be considered.[5] The true costs of service interruptions may take a number of forms, including "lost wages, spoiled inventory, [and] delayed production ..."[6] Investment in energy utility resilience should be seen as likely to mitigate utility programmatic costs over time, resulting in significant savings to the State's economy and reducing the hardship and inconvenience customers experience as a result of outages.

NJUA suggests that the EMP encourage the BPU to continue to consider, where appropriate and with utility input, implementation of innovative cost recovery mechanisms for infrastructure investment that allows the utility timely recovery of investments as they are made. For example, the BPU may consider implementing rate adjustment mechanisms, which may refer to trackers, riders, or other types of mechanisms that allow for the timely recovery of investments for one or more specific expenditure items outside of base rates. Rate adjustment mechanisms can be designed to expire when the specific amount of cost recovery is satisfied and therefore may be particularly useful for storm response and resiliency programs,[7] as well as other programs supported by the EMP, such as renewable energy programs.[8]

It should be noted that some NJUA energy members have received approval of petitions to implement accelerated capital investment recovery programs using rate adjustment mechanisms such as trackers

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[2] *Economic Benefits of Increasing Electric Grid Resilience to Weather Outages* (August 2013), pg. 3. Prepared by the President's Council of Economic Advisers and the U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability, with assistance from the White House Office of Science and Technology, http://energy.gov/sites/prod/files/2013/08/f2/Grid%20Resiliency%20Report_FINAL.pdf

[3] See ibid. at 3 finding that the cost estimates related to Sandy ranged from $27 billion to $52 billion nationally.

[4] NJUA notes that issues related to generation of power is not typically the cause of widespread outages, but rather such outages are caused by damage to transmission and distribution systems during severe weather events. See *Hardening and Resiliency: U.S. Energy Industry Response to Recent Hurricane Seasons.* (August 2010), pg. 43. Prepared by the U.S. Department of Energy, Office of Electricity Delivery and Energy Reliability. https://www.oe.netl.doe.gov/docs/HR-Report-final-081710.pdf

[5] See Center for Energy, Economic and Environmental. Policy (CEEEP) study, *Analyzing the Costs and Benefits of Electric Utility Hardening Efforts in Response to Severe Weather*, (October, 2014), pg. 41, http://ceeep.rutgers.edu/wp-content/uploads/2014/10/FF-Session-Utility-Hardening-Economic-Efficiency-and-CBA.pdf. Also see Mantell, Nancy, Joseph J. Seneca, Michael L. Lahr, Will Irving, *The Economic and Fiscal Impact of Hurricane Sandy in New Jersey*. Rutgers Regional Report, Number 34, January 2013. (Rutgers Study). The study noted that some of these impacts would be mitigated if the State received repair and recovery funding, including funding related to gas and electric utility expenditures, pg. 15.

[6] *Economic Benefits of Increasing Electric Grid Resilience to Weather Outages,* pg. 3.

[7] See ibid. at 21, 22, and Appendix A.

[8] See generally "Alternative Regulation for Emerging Utility Challenges: An Updated Survey", (January 2013), Edison Electric Institute, http://www.eei.org/issuesandpolicy/stateregulation/Documents/innovative_regulation_survey.pdf

and other recovery mechanisms that result in timely recovery of investments.[9] Those petitions were filed and approved in response to the State's call for the BPU and New Jersey's investor-owned energy utilities to aid in economic recovery.[10]

The U.S. Pipeline and Hazardous Materials Safety Administration[11] has supported such programs where implemented for natural gas pipeline replacement. Similar programs have been utilized to accelerate repair and replacement of natural gas infrastructure in many other states.[12] NJUA encourages the BPU to review and implement elements of other state programs that may be useful in furthering the Administration's policies and energy company objectives. Investment in the natural gas delivery system would enable improvements in natural gas efficiency, one of the 2011 EMP goals. Upgrading systems to elevated pressures supports use of modern high efficiency natural gas appliances, and encourages development of emerging technologies. The BPU has a history of support for these projects but there is considerable work to be done.

In furtherance of the Administration's goal to promote economic development, create jobs, and ensure reliability[13], NJUA respectfully recommends that the EMP clearly convey support for continued implementation of capital investment programs with appropriate cost recovery mechanisms for both electric and natural gas utilities. NJUA does not suggest endorsement of any one type of cost recovery or rate adjustment mechanism but recommends strongly a flexible approach that enables each utility to request the manner and timing of implementation of any such mechanism. Utility company discretion will be critical to ensure that investments are appropriately aligned with investor incentives and to enable compliance with statutory requirements,[14] as well as EMP directives.

Protecting Critical Energy Infrastructure

NJUA applauds the Administration for including the protection of critical energy infrastructure as a top priority in the updated EMP. NJUA member companies recognize that threats to the system, ranging from cyber-attacks, physical attacks, and of course severe weather, are real. As such, the companies are actively engaged in updating best practices to enhance physical and cyber security. Specifically, the companies, along with the BPU's Reliability and Security Staff and the New Jersey Department of Homeland Security, are part of a work group formed to develop best practices related to electric and

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[9]See I/M/O the Proceeding for Infrastructure Investment and a Cost Recovery Mechanism for All Gas and Electric Utilities, BPU Docket Nos. EO09010049 and GO09010054 and examples of associated orders: South Jersey Gas – Docket No. G0O09010051 (April 2009), PSE&G – Docket No. EO11020088, Elizabethtown Gas – Docket No. GO09010053 (April 2009), New Jersey Natural Gas – Docket Nos. EO09010049, GO09010052, and GR07110889 (April 2009), and Atlantic City Electric Docket Nos. EO09010049, and GO09010054.

[10]See, for example, BPU Docket Nos. EO09010049, GO09010052, and GR07110889, regarding New Jersey Natural's investment program, citing the State's request of New Jersey's investor-owned energy utilities to accelerate capital investments and efficiency programs as a means to support economic development and job growth. The State requested that the utilities provide company-specific program proposals, with associated cost recovery and rate mechanisms.

[11]See *White Paper on State Pipeline Infrastructure Replacement Programs*, (December 2011). Prepared by the U.S. Pipeline and Hazardous Materials Safety Administration for submission to the National Association of Regulatory Commissioners.

[12]Some public utility commissions, like the BPU, have utilized their traditional ratemaking authority to implement such programs. Other commissions have specific statutory authority to approve the programs. A comprehensive list of these programs is available at http://opsweb.phmsa.dot.gov/pipelineforum/pipeline-materials/state-pipeline-system/state-replacement-programs/

[13] 2011 EMP, pg. 1.

[14] See N.J.S.A. 48:2-13 and 48:2-23.

natural gas security. The group is currently working on a revision to the State's Electric & Natural Gas Security Best Practices which will include a section on cyber security. NJUA energy members look forward to development of best practices in this area and will continue to work collaboratively in addressing this important matter. In addition, the electric distribution companies are appreciative of the opportunity to work with the BPU on efforts related to the more than 100 measures issued by the BPU following Hurricane Irene and Superstorm Sandy.[15] Additionally, each NJUA member energy company continues to work proactively to improve system reliability, security, and communications.

Expansion of Natural Gas Pipeline and Electric Transmission Systems

NJUA respectfully recommends that the updated EMP convey support for the expansion of both electric and natural gas transmission. Improvements to both systems will improve economic efficiency and lower costs to consumers. The expansion and reinforcement of the electric transmission system will enhance reliability, reduce congestion, and lower prices. Electric transmission development is primarily driven by regional planning processes managed by PJM Interconnection and its stakeholders, but the State can support transmission by expediting siting and permitting processes, and supporting appropriate equity returns and incentives to attract capital investment. The expansion and reinforcement of the gas pipeline transmission system, through both interstate and intrastate projects, will lower rates[16] and ensure service reliability. Further, the expansion of gas pipelines would lessen New Jersey's reliance on oil and address the Administration's concerns regarding price volatility in the oil markets.[17]

Given that the projected outlook for the production of domestic natural gas, in particular from the Marcellus Shale, has and continues to be highly favorable,[18] the Administration was correct to assert in the 2011 EMP that New Jersey's pipeline and natural gas infrastructure is likely to be strengthened by newly proposed pipelines.[19] While it is the case that approvals regarding interstate pipelines are under the purview of the Federal Energy Regulatory Commission, NJUA urges the Administration to support approval of NJUA member companies' intrastate pipeline proposals which will improve reliability and reduce costs in the long-term.

Alternative Fuel Vehicles

NJUA supports policies that advance utilization of alternative fueled vehicles such as compressed natural gas (CNG) and electric vehicles (EVs). Recent data shows that transportation emissions account for approximately 27% of total U.S. carbon emissions and that proportion is likely to grow.[20] CNG and EVs have the potential to significantly reduce emissions from the transportation sector and to reduce dependence on foreign oil, as recognized in the 2011 EMP.[21] NJUA energy members have been proactively engaged in developing alternative fuel technology and building infrastructure that supports the use of CNG and EVs for their fleets and employees. Some companies have made refueling service

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[15] See BPU Docket Nos. EO11090543 and EO12111050, respectively.
[16] See PennEast Pipeline Project Economic Impact Analysis Drexel University School of Economics and Econosult Solutions, (February 2015).
[17] 2011 EMP, pgs, 58-59.
[18] U.S. Energy Information Administration, *Natural Gas Weekly Update*, Week ending July 1, 2015, http://www.eia.gov/naturalgas/weekly/archive/2015/07_02/index.cfm
[19] 2011 EMP, pg. 58.
[20] U.S. Environmental Protection Agency, *U.S. Greenhouse Gas Inventory Report*: 1990-2013
[21] 2011 EMP, pg. 9.

available to the public and are seeking to expand that effort. NJUA encourages the Administration to include the State's energy utilities in efforts to further integrate these new technologies into the marketplace.

Net Metering Considerations

As noted by the New Jersey Office of Clean Energy, net metering in New Jersey "enables customers to obtain **full retail credits** on their utility bill for each kWh of electricity their system produces up to 100% of their electricity usage over the course of a year...All electric utility companies regulated by the NJBPU ... must offer net metering to retail customers that generate electricity through renewable systems"[22] (emphasis added). According to the National Conference of State Legislatures, forty-four states and Washington, D.C. have authorized net metering, and utilities in three additional states have implemented net metering.[23]

The proliferation of net metered distributed generation, particularly solar (PV) generation[24], has led to a growing concern nationally about a "cost shift" from net-metered to non-net-metered customers. Notably, non-net-metered customers are more likely to be those who can least afford to pay higher utility bills, such as seniors and low-income households.

This cost shift is described eloquently in a 2015 MIT study entitled "The Future of Solar Energy":

> "...most U.S. utilities bundle distribution network costs, electricity costs, and other costs and then charge a uniform per-kWh rate that just covers all these costs. **When this rate structure is combined with net metering...the result is a subsidy to residential and other distributed solar generators that is paid by other customers on the network.**"[25]
>
> "Since network costs do not decrease with greater PV penetration – on the contrary, they may even increase, as we have seen – the tariff that has to be applied to each kWh consumed to recover network costs has to increase. The prosumers with PV systems, who are responsible for both the reduction in overall kWh sales and for the increase in network costs, avoid a big portion of the cost...On the other end, customers without distributed generation systems fully absorb the impact of higher tariffs – an outcome likely to be perceived as unfair."[26]

The 2011 Energy Master Plan contained an early reference concerning this now-nationally recognized problem in its statement that "these behind-the-meter solar programs are costly for non-participants, i.e.,

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[22] http://www.njcleanenergy.com/renewable-energy/programs/net-metering-and-interconnection

[23] National Conference of State Legislatures, *Net Metering Policy Overview and State Regulatory Updates (rev. 12-18-2014)* (2014) http://www.ncsl.org/research/energy/net-metering-policy-overview-and-state-legislative-updates.aspx

[24] "In the past half-dozen years, U.S. PV Capacity has expanded from less than 1,000 MW to more than 18,000 MW. Recent growth has been aided in part by a 50%-70% drop in reported PV prices..." Excerpt from Massachusetts Institute of Technology, *The Future of Solar Energy, an Interdisciplinary MIT Study* (2015), http://mitei.mit.edu/system/files/MIT%20Future%20of%20Solar%20Energy%20Study_compressed.pdf

[25] Massachusetts Institute of Technology, *The Future of Solar Energy, an Interdisciplinary MIT Study* (2015), http://mitei.mit.edu/system/files/MIT%20Future%20of%20Solar%20Energy%20Study_compressed.pdf

[26] Ibid.

ratepayers who do not host a solar installation, yet pay for the subsidies in their monthly electric bills."[27] Particularly with the MIT and other studies now firmly backing the 2011 EMP's statement, NJUA respectfully requests that the EMP be amended to recognize the real shift in costs of the electrical grid from net-metered to non-net-metered customers. NJUA further requests that the EMP direct the BPU to explore ways to address or compensate for the cost shift, in order to ensure a continued, smooth, and equitable deployment of behind-the-meter distributed generation throughout the State.

Microgrids

There has been a growing interest in New Jersey in the use of microgrids, including as a primary focus of the Energy Resilience Bank established in 2014. A microgrid "is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode."[28]

NJUA's members understand the importance of protection of critical facilities from outages caused by severe weather events, such as Superstorm Sandy and recognize the State's interest in exploring microgrids in these limited applications. As previously discussed, the EMP should remain focused on promotion of the resiliency of the centralized transmission and distribution infrastructure serving the entire State. However, to the extent that there is interest and benefit to exploring microgrids in certain applications, the EMP should emphasize the importance of utilities being "at the table" during the development of all microgrids and microgrid policies to ensure that all customers retain access to reliable service at the least possible cost, that microgrids are built, interconnected, and operated with public safety firmly in mind, including the appropriate use of sectionalizing equipment, and that regulatory policy and tariff issues are appropriately addressed. Additionally, in cases where a microgrid would serve customers using existing distribution infrastructure, the EMP should provide, as current law requires, that utilities continue to own and operate this infrastructure to ensure public safety, appropriate consumer protections, and effective restoration.

Energy Efficiency

The 2011 EMP states that "the most cost-effective way to reduce energy costs is to use less" and "reducing energy costs through conservation and EE lessens the cost of doing business and enhances economic development."[29]

The State of New Jersey offers a portfolio of state-run EE programs, funded through utility collections, which are available to the citizens of New Jersey. A number of NJUA's member companies offer supplemental EE programs that are very active and successful, and also support promotion of the statewide Clean Energy Program.

However, it is important that the EMP recognize the inherent financial disincentives for utilities to promote conservation and EE, given the interaction between lost sales and traditional rate structures and recovery methods. The EMP should recognize the need for appropriate rate design and/or financial

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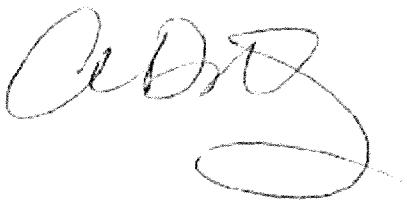
[27] 2011 EMP, pg, 5.
[28] Lawrence Berkeley National Laboratory, *Microgrid Definitions* https://building-microgrid.lbl.gov/microgrid-definitions
[29] 2011 EMP, pgs. 111-112

incentives for utility participation and support of EE in order to enhance utility participation and alignment with the EE goals of the EMP.

Conclusion

In conclusion, we appreciate the opportunity to work with the BPU in enhancing the goals of the 2011 EMP consistent with industry and technological developments and in consideration of the changing economic landscape since the 2011 EMP was adopted. NJUA is available to serve as a resource for information or to facilitate discussions between BPU and Administration Staff and member companies. A number of our member companies will also be providing more specific comments for your review. Thank you for your consideration.

Respectfully,



Andrew Hendry
President and Chief Executive Officer
New Jersey Utilities Association

From: Beverly Solomon <
Sent: Friday, August 14, 2015 2:06 PM
To: EMPupdate
Subject: Energy Master Plan Update

To Whom It May Concern,

I was very disappointed when the Governor, despite his supposed reputation to the contrary, broke his word given in 2009 to be a strong advocate for clean energy, a green economy and environmental responsibility when his administration adopted the 2011 Energy Master Plan.

However, now that the BPU is considering updating that plan, you can correct those mistakes. Please do everything in your power to advance the following policies now and remember even if you're in the minority on the BPU today, your opinion expressed strongly today can help build for a better tomorrow:

* Accelerate NJ's transition to a safe, clean energy economy using existing technology through aggressive but attainable goals -- 30% increase in efficiency by 2030 and relying on 100% fossil free energy production by 2050

* Just say no to the construction and expansion of new oil and gas industries and facilities in NJ

* Incentivize clean energy technology making the Garden State a hotbed for manufacturing, research and development, installation and maintenance of green technologies to create sustainable jobs

* Reduce existing equity and environmental justice issues by ensuring vulnerable communities especially benefit as we transition from a dirty to a clean economy.

Beverly Solomon
Haddonfield, NJ 08033

From: Lou Matlack [redacted]
Sent: Friday, August 14, 2015 10:58 PM
To: EMPupdate
Subject: Energy Master Plan Update

To Whom It May Concern,

I was very disappointed when the Governor, despite his supposed reputation to the contrary, broke his word given in 2009 to be a strong advocate for clean energy, a green economy and environmental responsibility when his administration adopted the 2011 Energy Master Plan.

However, now that the BPU is considering updating that plan, you can correct those mistakes. Please do everything in your power to advance the following policies now and remember even if you're in the minority on the BPU today, your opinion expressed strongly today can help build for a better tomorrow:

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* Incentivize clean energy technology making the Garden State a hotbed for manufacturing, research and development, installation and maintenance of green technologies to create sustainable jobs

* Reduce existing equity and environmental justice issues by ensuring vulnerable communities especially benefit as we transition from a dirty to a clean economy.

Lou Matlack
[redacted]
Bernardsville, NJ 07924

[redacted]

From: Sierra Club <information@sierraclub.org> on behalf of Ben Rich <sierra@sierraclub.org>
Sent: Friday, August 14, 2015 3:37 PM
To: EMPupdate
Subject: Make Clean Energy a Priority for 2015

Aug 14, 2015

EMP comments EMP Comments

Dear EMP comments Comments,

The Energy Master Plan will help shape New Jersey's energy future in
2015 and beyond. As the president of the Board of Public Utilities you have the power to help make dirty energy a thing of the past. I urge you to make clean energy a priority for the 2015 EMP.

The BPU has the opportunity to ensure that all New Jersey residents have the benefit of clean, safe and affordable energy. Dirty fossil fuels are putting New Jerseyans at risk of disastrous explosions, dire health consequences and dangerous climate impacts. The EMP is your chance to set a safe, 21st century energy strategy New Jersey.

The Board of Public Utilities should establish the following goals for the 2015 EMP:

A major reduction in NJ's reliance on coal by retiring PSEG Hudson and Mercer coal fired power plants.

Work to ensure New Jersey is compliant with the EPA Clean Power Plan.

Establish binding energy savings targets.

Stop the expansion of natural gas pipelines throughout the state.
Natural gas is a stopgap energy source because it is less expensive, but it's harmful impacts to local ecology is just as bad as coal.

Encourage the use of electric vehicles powered by solar with incentive programs, especially for condo associations and apartment complexes.

Sincerely,

Ben Rich

[redacted]
Montclair, NJ 07042-2913

Ms. T Cho
[redacted]
Jersey City, NJ 07306-4643

Aug 14, 2015

Richard Mroz
NJ

Subject: Support Clean Energy in the EMP!

Dear Richard Mroz,

The Energy Master Plan will help shape New Jersey's energy future the next few decades. We need to make sure that the EMP includes ways to reduce our dependence on dirty fossil fuels and open doors for clean, renewable energy. New Jersey used to be a leader in solar and wind power and we can be again but we need the EMP to have aggressive clean energy goals.

The BPU needs to acknowledge climate change and the effect of storm events like Hurricane Sandy. Investing in clean energy is one of the best resiliency strategies for New Jersey. We want the new EMP to have less room for pipelines and oil trains and more room for solar and wind development. We need to return to the stricter goals of the 2008 EMP to see New Jersey as a forerunner in clean energy once again.

The BPU has the opportunity to ensure that all New Jersey residents have the benefit of clean, safe and affordable energy. The EMP should have goals of 30% of our energy to come from renewable sources by 2020 and a 30% reduction in energy use through energy efficiency by 2030. All of our electricity to come from renewable sources and we should be 80% carbon free by 2050. We need to install energy efficiency and clean energy goals into the EMP to ensure that New Jersians' health and economy will benefit from clean energy.

Sincerely,
Ms. T Cho

Ms. Laurie Cleveland

Hopewell, NJ 08525-1004

Aug 14, 2015

Richard Mroz
NJ

Subject: Support Clean Energy in the EMP!

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I live in a town that is plagued with dangerous oil trains and threatened with and ecologically devastating pipeline. Our continued reliance on fossil fuels that are devastating to the environment and limited in supply is foolhardy and irresponsible. We cannot continue depending on fossil fuels when it's clear that they contribute to global warming and pollute our air water and soil. Additionally dependence on fossil fuels put our nation at risk. As if these reasons weren't enough to support clean energy, our knowledge that the earth's supply of fossil fuels is finite. We must begin the transition to renewable energy now.

The BPU needs to acknowledge climate change and the effect of storm events like Hurricane Sandy. Investing in clean energy is one of the best resiliency strategies for New Jersey. We want the new EMP to have less room for pipelines and oil trains and more room for solar and wind development. We need to return to the stricter goals of the 2008 EMP to see New Jersey as a forerunner in clean energy once again.

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Sincerely,
Ms. Laurie Cleveland

Ms. Ellen Columbus

Island Heights, NJ 08732-1026

Aug 14, 2015

Richard Mroz
NJ

Subject: Support Clean Energy in the EMP!

Dear Richard Mroz,

The Energy Master Plan will help shape New Jersey's energy future the next few decades. We need to make sure that the EMP includes ways to reduce our dependence on dirty fossil fuels and open doors for clean, renewable energy. New Jersey used to be a leader in solar and wind power and we can be again but we need the EMP to have aggressive clean energy goals.

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Sincerely,
Ms. Ellen Columbus

Mr. Greg Krawczyk

Princeton Junction, NJ 08550-1657

Aug 14, 2015

Richard Mroz
NJ

Subject: Support Clean Energy in the EMP!

Dear Richard Mroz,

The Energy Master Plan will help shape New Jersey's energy future the next few decades. We need to make sure that the EMP includes ways to reduce our dependence on dirty fossil fuels and open doors for clean, renewable energy. New Jersey used to be a leader in solar and wind power and we can be again but we need the EMP to have aggressive clean energy goals.

The BPU needs to acknowledge climate change and the effect of storm events like Hurricane Sandy. Investing in clean energy is one of the best resiliency strategies for New Jersey. We want the new EMP to have less room for pipelines and oil trains and more room for solar and wind development. We need to return to the stricter goals of the 2008 EMP to see New Jersey as a forerunner in clean energy once again.

We need wind energy! Before Christie came along, New Jersey was poised to be the first state in the nation with offshore wind. Offshore wind projects could provide 1/3 of our energy needs and provide 3,000 megawatts worth of energy by 2020, which is in the EMP.

The BPU has the opportunity to ensure that all New Jersey residents have the benefit of clean, safe and affordable energy. The EMP should have goals of 30% of our energy to come from renewable sources by 2020 and a 30% reduction in energy use through energy efficiency by 2030. All of our electricity to come from renewable sources and we should be 80% carbon free by 2050. We need to install energy efficiency and clean energy goals into the EMP to ensure that New Jersians' health and economy will benefit from clean energy.

Sincerely,
Mr. Greg Krawczyk

Ms. Virginia Tamuts

Mays Landing, NJ 08330-4147

Aug 14, 2015

Richard Mroz
NJ

Subject: Support Clean Energy in the EMP!

Dear Richard Mroz,

The Energy Master Plan will help shape New Jersey's energy future the next few decades. We need to make sure that the EMP includes ways to reduce our dependence on dirty fossil fuels and open doors for clean, renewable energy. New Jersey used to be a leader in solar and wind power and we can be again but we need the EMP to have aggressive clean energy goals.

The BPU needs to acknowledge climate change and the effect of storm events like Hurricane Sandy. Investing in clean energy is one of the best resiliency strategies for New Jersey. We want the new EMP to have less room for pipelines and oil trains and more room for solar and wind development. I might add that development of the molten salt reactor that uses "spent" nuclear fuel needs to be advanced to put it into the mix as it would stop destroying water life and start using the 270,000 tons of highly radioactive waste that continues to be a financial problem and a storage nightmare. We need to return to the stricter goals of the 2008 EMP to see New Jersey as a forerunner in clean energy once again.

The BPU has the opportunity to ensure that all New Jersey residents have the benefit of clean, safe and affordable energy. The EMP should have goals of 30% of our energy to come from renewable sources by 2020 and a 30% reduction in energy use through energy efficiency by 2030. All of our electricity to come from renewable sources and we should be 80% carbon free by 2050. We need to install energy efficiency and clean energy goals into the EMP to ensure that New Jersians' health and economy will benefit from clean energy.

Sincerely,
Ms. Virginia Tamuts

Mr. Brian Murray

Matawan, NJ 07747-1336

Aug 14, 2015

Richard Mroz
NJ

Subject: Support Clean Energy in the EMP!

Dear Richard Mroz,

The Energy Master Plan will help shape New Jersey's energy future the next few decades. We need to make sure that the EMP includes ways to reduce our dependence on dirty fossil fuels and open doors for clean, renewable energy. New Jersey used to be a leader in solar and wind power and we can be again but we need the EMP to have aggressive clean energy goals.

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Sincerely,
Mr. Brian Murray

Ms. Jennie Sabato

somers point
Somers Point, NJ 08244

Aug 14, 2015

Richard Mroz
NJ

Subject: Support Clean Energy in the EMP!

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Sincerely,
Ms. Jennie Sabato

Mrs. janice papenberg

Riverton, NJ 08077-1238

Aug 14, 2015

Richard Mroz
NJ

Subject: Support Clean Energy in the EMP!

Dear Richard Mroz,

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I am an average citizen, but I try to keep updated on the latest regarding our environmental. It is so important that informed decisions are made concerning how to keep our air clean and healthy for future generations. Studies have shown that fossil fuels are not the answer. New Jersey should be looking more into the use of wind and solar power to take care of our needs - for the sake of our children and our grandchildren

The BPU has the opportunity to ensure that all New Jersey residents have the benefit of clean, safe and affordable energy. The EMP should have goals of 30% of our energy to come from renewable sources by 2020 and a 30% reduction in energy use through energy efficiency by 2030. All of our electricity to come from renewable sources and we should be 80% carbon free by 2050. We need to install energy efficiency and clean energy goals into the EMP to ensure that New Jersians' health and economy will benefit from clean energy.

Sincerely,
Mrs. janice papenberg

Mr. Fred Reimer

Ogdensburg, NJ 07439-1012

Aug 14, 2015

Richard Mroz
NJ

Subject: Support Clean Energy in the EMP!

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Sincerely,
Mr. Fred Reimer

Mr. RAYMOND CLARK

Neptune, NJ 07753-5664

Aug 14, 2015

Richard Mroz
NJ

Subject: Support Clean Energy in the EMP!

Dear Richard Mroz,

The Energy Master Plan will help shape New Jersey's energy future the next few decades. We need to make sure that the EMP includes ways to reduce our dependence on dirty fossil fuels and open doors for clean, renewable energy. New Jersey used to be a leader in solar and wind power and we can be again but we need the EMP to have aggressive clean energy goals.

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Sincerely,
Mr. RAYMOND CLARK

From: Sierra Club <information@sierraclub.org> on behalf of Lisa Hanckel <sierra@sierraclub.org>
Sent: Saturday, August 15, 2015 1:13 PM
To: EMPupdate
Subject: Make Clean Energy a Priority for 2015

Aug 15, 2015

EMP comments EMP Comments

Dear EMP comments Comments,

The Energy Master Plan will help shape New Jersey's energy future in
2015 and beyond. As the president of the Board of Public Utilities you have the power to help make dirty energy a thing of the past. I urge you to make clean energy a priority for the 2015 EMP.

The BPU has the opportunity to ensure that all New Jersey residents have the benefit of clean, safe and affordable energy. Dirty fossil fuels are putting New Jerseyans at risk of disastrous explosions, dire health consequences and dangerous climate impacts. The EMP is your chance to set a safe, 21st century energy strategy New Jersey.

The Board of Public Utilities should establish the following goals for the 2015 EMP:

1.) Eliminate NJ's reliance on coal by retiring PSEG Hudson and Mercer
2.) Ensure New Jersey's compliance with the EPA Clean Power Plan
3.) Establish binding energy savings targets
4.) Stop the expansion of natural gas pipelines throughout the state
5.) Stop the transportation of crude oil into and out of New Jersey

Sincerely,

Lisa Hanckel
Boulder, CO 80305-5220

Mr. Eric Johnson
[redacted]
Ewing, NJ 08628-3251

Aug 15, 2015

Richard Mroz
NJ

Subject: Support Clean Energy in the EMP!

Dear Richard Mroz,

The Energy Master Plan will help shape New Jersey's energy future the next few decades. We need to make sure that the EMP includes ways to reduce our dependence on dirty fossil fuels and open doors for clean, renewable energy. New Jersey used to be a leader in solar and wind power and we can be again but we need the EMP to have aggressive clean energy goals.

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Alternative Energy is proving to not only be the energy of the future, it is the ENERGY OF NOW!!! Oil glut is driving oil/coal/gas/fossil fuels (worth) down. But even moreso, one has to admit that oil/etc is the biggest part of Climate Change and pollution, bad health, significant dollars spent in cleanups around the nation (note Chris Christies pandering and caving to Exxon). All Americans spend inordinate $$$$ to support these billionaires, corporations, Big Oil, Big Coal, Big Etc,then turn around to support the cleanups these environmental "PIGS" dump onto our earth.

We need alternative energy! It will not only support our way into the future, it will support us now and reduce the need for costly cleanups, health problems but also fuel our research into a better, cleaner future. We still have a long way to go to get into a full array Alternative Energy efficiency and effectiveness but that means there will be significant growth of this industry, which of course means, significant job opportunity. Let's turn this thing around and start thinking of our future and not our past. Time to look forward not stick our heads in the sand.

The BPU has the opportunity to ensure that all New Jersey residents have the benefit of clean, safe and affordable energy. The EMP should have goals of 30% of our energy to come from renewable sources by 2020 and a 30% reduction in energy use through energy efficiency by 2030. All of our electricity to come from renewable sources and we should be 80% carbon free by 2050. We need to install energy efficiency and clean energy goals into the EMP to ensure that New Jersians' health and economy will benefit from clean energy.

Sincerely,
Mr. Eric Johnson

Ms. CAROL JONES

Basking Ridge, NJ 07920-3024

Aug 15, 2015

Richard Mroz
NJ

Subject: Support Clean Energy in the EMP!

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Sincerely,
Ms. CAROL JONES

Ms. Barbara Andrew

Princeton, NJ 08540-7417

Aug 15, 2015

Richard Mroz
NJ

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Sincerely,
Ms. Barbara Andrew

Ms. Anneliese Lipinski

Somerset, NJ 08873-2321

Aug 15, 2015

Richard Mroz
NJ

Subject: Support Clean Energy in the EMP!

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Sincerely,
Ms. Anneliese Lipinski

[redacted]

From: Henry Stock [redacted]
Sent: Saturday, August 15, 2015 8:09 PM
To: EMPupdate
Subject: Opinions on Energy Policy in NJ

Expires: Thursday, February 11, 2016 12:00 AM

Categories: Blue Category

I approve of the use of technology to improve the resilience of the energy grid. However, I disapprove of the emphasis on technologies like solar and wind energy to the extent that they get subsidized while other forms of energy bear the full cost plus the cost of the subsidies. Wind energy is a) not constant and subsequently requires major backup systems and b) has its own problems like such as the number of birds that get killed by wind turbines. Solar is a miniscule amount of power compared to our needs. Why are we not building nuclear power plants?

I suggest that you look into nuclear power from Thorium as opposed to uranium. Thorium power is far safer and far more efficient than uranium. Thorium eliminates virtually all of the nuclear waste problem because it is 98% efficient as opposed to the uranium plants that have an efficiency rating of maybe 7 or 8 %. It burns virtually all of its fuel. There is no by product with which to create weapons. Thorium is far more common in the earth's crust such so it should be cheaper to use as well. Thorium plants do not need to be as large and could be ideal for serving local areas thus lessening the need for long distance power lines. They do not need the massive containment building of other nuclear power plants because of the way they produce power, e.g. you don't need active cooling systems, and you don't have to worry about massive amounts of high pressure steam.

Do not tax us to promote your favorite energy alternative. Let each energy source stand on its own in the economy and promote all forms of energy equally. Give power companies the ability to write off upgrades to their plant and equipment more rapidly if you want to encourage investment in a more modern grid. If you want people to invest in solar power then let them write of that cost as a business expense over a relatively short period of time. Let them write off investments in energy efficiency such as replacing old lights with new LED lights, or replacing old furnaces with more efficient ones, or other old appliances. The tax write off method assures you that the improvements have been made before the state bears any loss of income and only those that achieve results get the benefits as opposed to what happened in Morris and Sussex Counties where contractor got tax payer dollars but did not complete the work. As a tax payer, that is what I am concerned about.

But don't get into gimmicks and don't subsidize anybody! Make them invest their own money and make them get the financing on the open market. Tax payers should not be bearing that cost.

Henry J. Stock
[redacted]
Morristown, NJ 07960-5954
[redacted]

From: Jim DeProspero
Sent: Saturday, August 15, 2015 3:49 PM
To: EMPupdate

Categories: Blue Category

My family and the good people of NJ can't afford higher energy bills!!!!! We have high property taxes, high tolls, high pension costs, high auto insurance rates. If you add to our expenses then productive people will leave the state in droves. You're getting close to that taxation saturation point!! Wake up!
Jim DeProspero
Rivet Vale NJ

From: Wanna [redacted]
Sent: Saturday, August 15, 2015 4:01 PM
To: EMPupdate
Subject: Comment on NJ's EMP

Categories: Blue Category

Please do everything possible to reduce production, transportation and consumption of dirty fuels in NJ. We cannot continue to abuse and poison our planet; we are already suffering the consequences of this careless abuse and it will only get worse. The unstable weather we're now experiencing from global warming puts our food system at risk. As a coastal state, many of our homes are at risk from rising sea levels. Our water supply is also at risk from sea water intrusion. These risks need to be addressed and mitigated.

I also wish to see us move away from unsafe nuclear energy. As we learned from Fukushima, in the event of widespread and long term power outages, the cooling rods pose a great risk for radiation exposure. Nuclear energy puts everyone at great risk. Please move towards shutting down the existing plants.

Instead, we should direct all efforts towards clean, renewable energy. Convert more parking lots, roads and rooftops to solar farms. Passive House standards have been used in Germany for over 25 years and has reduced their dependency on dirty fuels. There is no reason why it cannot be implemented and supported in NJ. I would like to see NJ residents less dependent on the public utilities in the event of an extended power outage as we saw during Superstorm Sandy. More passive homes would make us more resilient during the unstable times we now live in.

We need to encourage more renewable energy research and businesses to reside in NJ. We have a lot of large buildings and campuses that are empty or underutilized. There's Fort Monmouth and Atlantic City. Please reach out and provides incentives for renewable research & businesses to invest in NJ. Let's make NJ the leader in renewable energies.

There is no time to waste in this matter. We must do everything possible to make this transition happen without delay. We need strong measures to correct our current trajectory.

Thank you,
Wanna Chin

Eatontown, NJ

[redacted]

From: Diane Burke
Sent: Saturday, August 15, 2015 3:32 PM
To: EMPupdate
Subject: NJ Energy Master Plan

Categories: Blue Category

To The NJ Board of Public Utilities,

I recommend a plan to build future homes and buildings with more conscious sustainable architecture. I recommend a standard of building called Passive House, Passivhaus in German. They are a standard of buildings that employ super-insulation, triple-pane insulated glazing windows, and with that reduce it's ecological footprint. This building standard can cut energy use by at least 90% or more. I recommend updating NJ building codes so that there is a streamlined permitting process for houses built to these standards.

Passive House's super-insulation significantly reduce the heat transfer through the walls, roof and floor compared to conventional buildings. The building envelopes under the PH design standard are extremely airtight. They are also designed so that the air exchange with exterior is done by controlled ventilation through a heat-exchanger in order to minimize heat loss (or gain). They require little energy for heating and cooling.

In addition, Passive House design needs little to no fossil fuel/natural gas. This would mean our dependance on fossil fuel could be significantly lowered. With less demand for fossil fuel, we are moving in the direction of a smaller CO2 footprint , no need for additional pipelines going through NJ and fracking demands.

This way of building in the future helps to meet one or more of the following goals of the NJ Energy Master Plan, in the following ways:

- reducing energy expenditures
-creates energy efficiency and energy conservation and reduces peak demand

I also recommend meeting the goal by giving tax incentive for investing in homes that reach the standards of Passive Houses.

Passive House design has the capacity to move NJ towards energy-efficiency goals quickly. For more information visit www.phius.org.

Thank you,
Diane Burke

Rumson, NJ 07760

From:
Sent: Saturday, August 15, 2015 2:23 PM
To: EMPupdate
Subject: Comments on Energy Master Plan

Categories: Blue Category

Although solar & wind sound like great sources of clean energy their use is not as inexpensive as oil & natural gas. Without taxpayer subsidies solar & wind would not be cost efficient. Therefore, please continue to rely on oil & natural gas for 100% of NJ needs. Thank you.

From: Eileen Leonard [redacted]
Sent: Saturday, August 15, 2015 1:13 PM
To: EMPupdate
Subject: Energy Master Plan Update

Categories: Blue Category

To Whom It May Concern,

Please advance the following policies now:

Speed up NJ's transition to a safe, clean energy economy using existing technology through aggressive but attainable goals -- 30% increase in efficiency by 2030 and relying on 100% fossil free energy production by 2050

Say no to the construction and expansion of new oil and gas industries and facilities in NJ

Promote the Garden State as a center for the manufacturing, research and development, installation and maintenance of green technologies that can create sustainable jobs

Reduce existing equity and environmental justice issues by ensuring vulnerable communities especially benefit as we transition from a dirty to a clean economy.

Eileen Leonard

Maplewood, NJ 07040

From: Philip Sloan
Sent: Saturday, August 15, 2015 12:13 PM
To: EMPupdate
Subject: AFFORDABLE ENERGY FOR NEWJERSEY

Categories: Blue Category

As a member of the New Jersey Chapter of Americans for Prosperity, I completely agree with Mr.Proto's testimony before your Board on August 11, 2015. Therefore, I would strongly suggest that his testimony be seriously considered by your Board. Thank You.

From: Nancy Burwell
Sent: Saturday, August 15, 2015 11:20 AM
To: EMPupdate
Subject: NJ's Energy Master Plan

Categories: Blue Category

Our energy bills are already too high. Solar panels and wind turbines are expensive and unreliable. Without taxpayer subsidies these "renewable" sources would fail in the energy marketplace. NJ has the 10th highest electricity rates in the nation. If your goals are met, our bills will be even higher and these higher costs will affect our economy as a hidden tax on every product and service we buy in NJ. Is your real goal to encourage even more people to leave NJ than are already leaving due to the high cost of living?

Nancy Burwell

Morristown, NJ 07960

From: Tom Musarra
Sent: Saturday, August 15, 2015 11:17 AM
To: EMPupdate
Subject: EMP

Categories: Blue Category

Ladies and Gentlemen,

Thank you for this opportunity to comment on the energy plan for New Jersey. I want to tell you that I am strongly opposed to government subsidies for certain sources of energy. I don't think it's the government's job to give money to businesses deemed preferable by politicians. That leads to corruption like the Solyndra loans and it takes resources away from jobs the government should be doing such as police work.

Sincerely,

Tom Musarra
Whippany

From: jaime schunkewitz
Sent: Saturday, August 15, 2015 9:26 AM
To: EMPupdate
Subject: Submission of Comment for EMP Update
Attachments: Yakymenko et al 2015.pdf

Categories: Blue Category

Dear BPU,

Low-intensity pulsed microwaves emited by wireless smart utility meters are silent killers, notwithstanding the propaganda from the FCC. Scientific evidence is attached.

"Abstract

This review aims to cover experimental data on oxidative effects of low-intensity radiofrequency radiation (RFR) in living cells. Analysis of the currently available peer-reviewed scientific literature reveals molecular effects induced by low-intensity RFR in living cells; this includes significant activation of key pathways generating reactive oxygen species (ROS), activation of peroxidation, oxidative damage of DNA and changes in the activity of antioxidant enzymes. It indicates that among 100 currently available peer-reviewed studies dealing with oxidative effects of low-intensity RFR, in general, 93 confirmed that RFR induces oxidative effects in biological systems. A wide pathogenic potential of the induced ROS and their involvement in cell signaling pathways explains a range of biological/health effects of low-intensity RFR, which include both cancer and non-cancer pathologies. In conclusion, our analysis demonstrates that low-intensity RFR is an expressive oxidative agent for living cells with a high pathogenic potential and that the oxidative stress induced by RFR exposure should be recognized as one of the primary mechanisms of the biological activity of this kind of radiation."

Dianne Soloman, Thomas N. Walker and their cohorts are complicit in "willful blindness" by ignoring the truth

Stop the roll-out of wireless smart utility meters now. if you must, use phone or internet lines to transmit data.

The Board does not have consent to install a wireless device on my property.

Best Regards,
Jaime Schunkewitz

Califon, NJ 07830.

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REVIEW ARTICLE

Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation

Igor Yakymenko[1], Olexandr Tsybulin[2], Evgeniy Sidorik[1], Diane Henshel[3], Olga Kyrylenko[4] and Sergiy Kyrylenko[5]

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Abstract

This review aims to cover experimental data on oxidative effects of low-intensity radiofrequency radiation (RFR) in living cells. Analysis of the currently available peer-reviewed scientific literature reveals molecular effects induced by low-intensity RFR in living cells; this includes significant activation of key pathways generating reactive oxygen species (ROS), activation of peroxidation, oxidative damage of DNA and changes in the activity of antioxidant enzymes. It indicates that among 100 currently available peer-reviewed studies dealing with oxidative effects of low-intensity RFR, in general, 93 confirmed that RFR induces oxidative effects in biological systems. A wide pathogenic potential of the induced ROS and their involvement in cell signaling pathways explains a range of biological/health effects of low-intensity RFR, which include both cancer and non-cancer pathologies. In conclusion, our analysis demonstrates that low-intensity RFR is an expressive oxidative agent for living cells with a high pathogenic potential and that the oxidative stress induced by RFR exposure should be recognized as one of the primary mechanisms of the biological activity of this kind of radiation.

Keywords

Cellular signaling, cancer, free radicals, oxidative stress, radiofrequency radiation, reactive oxygen species

History

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Introduction

Intensive development of wireless technologies during the last decades led to a dramatic increase of background radiofrequency radiation (RFR) in the human environment. Thus, the level of indoor background RFR in industrialized countries increased 5,000-fold from 1985 to 2005 (Maes, 2005). Such significant environmental changes may have a serious impact on human biology and health. As a proof of such impact, a series of epidemiological studies on the increased risk of tumorigenesis in "heavy" users of wireless telephony exists (Hardell et al., 2007, 2011; Sadetzki et al., 2008; Sato et al., 2011). Some studies indicate that long-term RFR exposure in humans can cause various non-cancer disorders, e.g., headache, fatigue, depression, tinnitus, skin irritation, hormonal disorders and other conditions (Abdel-Rassoul et al., 2007; Buchner & Eger, 2011; Chu et al., 2011; Johansson, 2006; Santini et al., 2002; Yakymenko et al., 2011). In addition, convincing studies on hazardous effects of RFR in human germ cells have been published (Agarwal et al., 2009; De Iuliis et al., 2009).

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All abovementioned studies dealt with the effects of low-intensity RFR. This means that the intensity of radiation was far below observable thermal effects in biological tissues, and far below safety limits of the International Commissions on Non-Ionizing Radiation Protection (ICNIRP) (ICNIRP, 1998). To date, molecular mechanisms of non-thermal effects of RFR are still a bottleneck in the research on the biological/health effects of low-intensity RFR, although recently many studies have been carried out on metabolic changes in living cells under low-intensity RFR, and comprehensive reviews were published (Belyaev, 2010; Consales et al., 2012; Desai et al., 2009; Yakymenko et al., 2011). In the present work, we analyze the results of molecular effects of low-intensity RFR in living cells and model systems, with a special emphasis on oxidative effects and free radical mechanisms. It might seem paradoxical that, despite being non-ionizing, RFR can induce significant activation of free radical processes and overproduction of reactive oxygen species (ROS) in living cells. We believe that the analysis of recent findings will allow recognition of a general picture of the potential health effects of already ubiquitous and ever-increasing RFR.

Radiofrequency radiation

RFR is a part of electromagnetic spectrum with frequencies from 30 kHz to 300 GHz. RFR is classified as non-ionizing,

which means that it does not carry sufficient energy for ionization of atoms and molecules. A part of RFR with the highest frequencies (300 MHz to 300 GHz) is referred to as microwaves (MWs). MW is RFR with the highest energy, which can potentially generate the highest thermal effects in the absorbing matter.

The main indexes of RFR are (i) frequency (Hz); (ii) intensity or power density (PD) of radiation (W/m^2 or μW/cm^2); (iii) its modulated or non-modulated nature; and (iv) continuous or discontinuous pattern of radiation. For the absorbed RFR energy, a parameter of specific absorption rate (SAR) is used (W/kg). The most common digital standard of RFR for mobile communication is still GSM (Global System for Mobile communication), which utilizes frequencies at about 850, 900, 1800 and 1900 MHz. This radiation is frequency modulated, with channel rotation frequency of 217 Hz, and belongs to the radiation of the pulsed mode (Hyland, 2000).

As to the international safety limits, the ICNIRP recommendations restrict intensity of RFR to 450–1000 μW/cm^2 (depending on the frequency of radiation) and the SAR value to 2 W/kg, as calculated for human heads and torsos (ICNIRP, 1998). These indexes were adopted by ICNIRP based on the behavioral response of laboratory rats, which were exposed to gradually increased intensities of RFR to determine the point at which the animals became thermally distressed (Gandhi et al., 2012).

Low-intensity RFR is referred to as radiation with intensities which do not induce significant thermal effects in biological tissues. Accordingly, any intensity of RFR under the ICNIRP limits can be referred to as low-intensity. In this paper we will analyze only the effects of low-intensity RFR.

Physical/biophysical effects of low-intensity RFR in living cells

RFR, especially MW, can produce thermal effects in matter due to interaction with charged particles, including free electrons, ions or polar molecules, inducing their oscillations in electromagnetic field. The thermal effect of MW can be seen when warming food in the microwave. The effect strongly depends on the intensity of radiation and is mostly negligible under low-intensity RFR conditions. On the other hand, energy of RFR/MW is insufficient not only for the ionization of molecules, but even for activation of orbital electrons. Hence, RFR was often assessed as a factor producing only thermal effects. Nevertheless, evident biological effects of low-intensity RFR promoted research on physical mechanisms of non-thermal biological effects of this kind of radiation.

A biophysical model of a forced-vibration of free ions on the surface of a cell membrane due to external oscillating electromagnetic field (EMF) was proposed (Panagopoulos et al., 2000, 2002). According to the authors, this vibration of electric charges can cause disruption of the cellular electrochemical balance and functions.

A "moving charge interaction" model was proposed for low-frequency EMF (Blank and Soo, 2001). The authors explained activation of genes and synthesis of stress proteins under EMF exposure due to interaction of the field with moving electrons in DNA (Blank and Soo, 2001; Goodman and Blank, 2002). They also demonstrated that EMF increased electron transfer rates in cytochrome oxidase and accelerated charges in the Na,K-ATPase reaction. Moreover, they demonstrated acceleration of the oscillating Belousov–Zhabotinski reaction in homogeneous solutions due to the application of low-frequency EMF (Blank and Soo, 2003).

An ability of low-strength magnetic fields to trigger onset- and offset-evoked potentials was demonstrated (Marino et al., 2009). Effectiveness of a rapid magnetic stimulus (0.2 ms) has led the authors to a conclusion on direct interaction between the field and ion channels in plasma membrane. A plausible mechanism of overproduction of free radicals in living cell due to electron spin flipping in confined free radical pairs in magnetic field of RFR was proposed (Georgiou, 2010).

A significant effect of low-intensity RFR on ferritin, an iron cage protein present in most living organisms from bacteria to humans, was revealed (Céspedes and Ueno, 2009). Exposure of ferritin solution to low-intensity RFR significantly, up to threefold, reduced iron chelation with ferrozine. The authors explained that magnetic field of RFR plays a principle role in the observed effect, and that this effect is strongly non-thermal. The non-thermal mechanism of the interaction of RFR magnetic fields with ferritin is supposedly mediated by an inner super-paramagnetic nanoparticle ($9H_2O \times 5Fe_2O_3$ with up to 4500 iron ions), which is a natural phenomenon intrinsic to the cells. It results in reduction of input of iron chelates into the ferritin cage. The authors underlined the potential role of ferritin malfunction for oxidative processes in living cell due to the participation of Fe^{2+} ions in the Fenton reaction, which produces hydroxyl radicals. In this respect, it is interesting to point to the results of an *in vitro* study with RFR exposure of rat lymphocytes treated by iron ions (Zmyslony et al., 2004). Although RFR exposure (930 MHz) did not induce detectable intracellular ROS overproduction, the same exposure in the presence of $FeCl_2$ in the lymphocyte suspensions induced a significant overproduction of ROS.

Another set of studies indicates on a possibility of changes in protein conformation under RFR exposure. Thus, low-intensity 2.45 MHz RFR accelerated conformational changes in β-lactoglobulin through excitation of so-called collective intrinsic modes in the protein (Bohr and Bohr, 2000a, 2000b), which suggests a principal ability of RFR to modulate the non-random collective movements of entire protein domains. Similarly, a frequency-dependent effect on intrinsic flexibility in insulin structure due to applied oscillating electric field was demonstrated (Budi et al., 2007). Moreover, macromolecular structure of cytoskeleton was significantly altered in fibroblasts of Chinese hamster after the exposure to modulated RFR of the GSM standard (Pavicic and Trosic, 2010). Thus, a 3 h exposure of fibroblasts to modulated RFR (975 MHz) led to significant changes in the structure of microtubules and actin microfilaments, which have polar cytoskeleton structures, while non-polar vimentin filaments reportedly stayed unchanged. Taking into account an extensive regulatory potential of cytoskeleton on cell homeostasis, these data could obviously add to the nature of the biological effects of RFR.

It was shown that ornithine decarboxylase (ODC) can significantly change its activity under low-intensity RFR exposure (Byus et al., 1988; Hoyto et al., 2007; Litovitz et al., 1993, 1997; Pautraj et al., 1999).

In addition, so-called "calcium effects" under RFR exposure in living cells have been demonstrated (Dutta et al., 1989; Paulraj et al., 1999; Rao et al., 2008), which include a significant increase in intracellular Ca^{2+} spiking. Taking into account that calcium is a ubiquitous regulator of cellular metabolism, these data point to a possibility that non-thermal RFR can activate multiple Ca^{2+}-dependent signaling cascades.

Finally, an ability of low-intensity MW to dissociate water molecules was demonstrated in model experiments years ago (Vaks et al., 1994). In these experiments, MW of 10 GHz with radiated power 30 mW produced a significant level of H_2O_2 in deionized water (and also in $MgSO_4$ solution) under stable temperature conditions. According to the authors, a kinetic excitation of liquid water associates $C(H_2O)$ upon the absorption of MW leads to subsequent viscous losses due to friction between moving clusters of water molecules. It results in partial irreversible decomposition of water, including breaks of intramolecular bonds (H–OH) due to a mechanochemical reaction, and generation of $H^{\bullet}$; $OH^{\bullet}$; H^{+} and OH^{-} groups. Among these, the hydroxyl radical ($OH^{\bullet}$) is the most aggressive form of ROS, which can break any chemical bond in surrounding molecules (Halliwell, 2007). The authors assessed that this type of mechanochemical transformation in water could be responsible for 10^{-4}–10^{-8} relative parts of the total MW energy absorbed. Given the fact that the water molecules are ubiquitous in living cells, even a subtle chance for dissociation of water molecules under low-intensity RFR exposure could have a profound effect on tissue homeostasis. It is of note here that one $OH^{\bullet}$ radical can initiate irreversible peroxidation of many hundreds of macromolecules, e.g. lipid molecules (Halliwell, 1991). Taken together, these data show that non-thermal RFR can be absorbed by particular charges, molecules and cellular structures, and in this way can potentially induce substantial modulatory effects in living cell.

Generation of reactive oxygen species under RFR exposure in living cells

NADH oxidase of cellular membrane was suggested as a primary mediator of RFR interaction with living cells (Friedman et al., 2007). Using purified membranes from HeLa cells, the authors experimentally proved that the exposure to RFR of 875 MHz, 200 $\mu W/cm^2$ for 5 or 10 min significantly, almost threefold, increased the activity of NADH oxidase. NADH oxidases are membrane-associated enzymes that catalyze one-electron reduction of oxygen into superoxide radical using NADH as a donor of electron, thus producing powerful ROS. This enzyme has been traditionally known due to its role in induction of oxidative burst in phagocytes as a part of immune response. Yet, later the existence of non-phagocytic NAD(P)H oxidases was revealed in various types of cells, including fibroblasts, vascular and cardiac cells (Griendling et al., 2000). Obviously, the presence of superoxide-generating enzyme in many types of non-phagocytic cells points to the considerable regulatory roles of ROS in living cells. On the other hand, an ability of low-intensity RFR to modulate the activity of the NADH oxidase automatically makes this factor a notable and potentially dangerous effector of cell metabolism. Notably, the authors pointed out that the acceptor of RFR is different from the peroxide-generating NADPH oxidases, which are also found in plasma membranes (Low et al., 2012).

The other powerful source of ROS in cells is mitochondrial electron transport chain (ETC), which can generate superoxide due to breakdowns in electron transport (Inoue et al., 2003). It was demonstrated that generation of ROS by mitochondrial pathway can be activated under RFR exposure in human spermatozoa (De Iuliis et al., 2009). The authors revealed a dose-dependent effect of 1.8 GHz RFR exposure on ROS production in spermatozoa, particularly in their mitochondria. The significantly increased level of total ROS in spermatozoa was detected under RFR with SAR = 1 W/kg, which is below the safety limits accepted in many countries. It was demonstrated recently in our laboratory that the exposure of quail embryos *in ovo* to extremely low-intensity RFR (GSM 900 MHz, 0.25 $\mu W/cm^2$) during the initial days of embryogenesis resulted in a robust overproduction of superoxide and nitrogen oxide radicals in mitochondria of embryonic cells (Burlaka et al., 2013). It is not clear yet which particular part of ETC is responsible for the interaction with RFR. To date, three possible sites of generation of superoxide in ETC have been shown: the ETC complex I (Inoue et al., 2003), complex II (Liu et al., 2002), and complex III (Guzy and Schumacker, 2006). A significant inverse correlation between mitochondrial membrane potential and ROS levels in living cell was found (Wang et al., 2003). As the authors underlined, such a relationship could be due to two mutually interconnected phenomena: ROS causing damage to the mitochondrial membrane, and the damaged mitochondrial membrane causing increased ROS production.

In addition to the well-established role of the mitochondria in energy metabolism, regulation of cell death is a second major function of these organelles. This, in turn, is linked to their role as the powerful intracellular source of ROS. Mitochondria-generated ROS play an important role in the release of cytochrome c and other pro-apoptotic proteins, which can trigger caspase activation and apoptosis (Ott et al., 2007). A few reports indicate on activation of apoptosis due to low-intensity RFR exposure. In human epidermoid cancer KB cells, 1950 MHz RFR induced time-dependent apoptosis (45% after 3 h) that is paralleled by 2.5-fold decrease of the expression of ras and Raf-1 and of the activity of ras and Erk-1/2 (Caraglia et al., 2005). Primary cultured neurons and astrocytes exposed to GSM 1900 MHz RFR for 2 h demonstrated up-regulation of caspase-2, caspase-6 and Asc (apoptosis associated speck-like protein containing a card) (Zhao et al., 2007). Up-regulation in neurons occurred in both "on" and "stand-by" modes, but in astrocytes only in the "on" mode. We should underline that, in that study an extremely high biological sensitivity to RFR was demonstrated, as a cell phone in the "stand-by" position emits negligibly low-intensity of radiation (up to hundredths $\mu W/cm^2$).

Based on the analysis of available literature data, we identified altogether 100 experimental studies in biological models which investigated oxidative stress due to low-intensity RFR exposures. From these 100 articles, 93 studies (93%) demonstrated significant oxidative effects induced by

low-intensity RFR exposure (Table 1–3), while 7 studies (7%) demonstrated the absence of significant changes (Table 4). The total number includes 18 *in vitro* studies, 73 studies in animals, 3 studies in plants and 6 studies in humans. Majority of the research was done on laboratory rats (58 studies, with 54 positive results), while 4 studies out of 6 in humans were positive. From the *in vitro* studies, 17 were positive (94.4%), including 2 studies on human spermatozoa and 2 studies on human blood cells.

Most of the studies utilized RFR exposure in MW range, including a use of commercial or trial cell phones as sources of radiation. The power densities of RFR applied in positive studies varied from 0.1 $\mu W/cm^2$ (Oksay et al., 2014) to 680 $\mu W/cm^2$ (Jelodar et al., 2013) and SAR values varied from 3 $\mu W/kg$ (Burlaka et al., 2013) to the ICNIRP recommended limit of 2 W/kg (Naziroglu et al., 2012a; Xu et al., 2010). Exposure times in positive studies varied from 5 min (Friedman et al., 2007) to 12.5 years, 29.6 h/month (Hamzany et al., 2013).

The most often used indexes of oxidative stress analyzed in the studies were ROS production, levels of lipid peroxidation (LPO)/malondialdehyde (MDA), protein oxidation (PO), nitric oxides (NO_x), glutathione (GSH), activity of antioxidant enzymes (superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GSH-Px)). It is important that some studies directly pointed to induction of free radicals (superoxide radical, NO) as a primary reaction of living cells to RFR exposure (Burlaka et al., 2013; Friedman et al., 2007). As we pointed out earlier, direct activation of NADH oxidase (Friedman et al., 2007) and the mitochondrial pathway of superoxide overproduction (Burlaka et al., 2013; De Iuliis et al., 2009) have been experimentally proven. Besides, a significant overproduction of nitrogen oxide was revealed in some studies (Avci et al., 2012; Bilgici et al., 2013; Burlaka et al., 2013), although it is unclear whether an induction of expression of NO-synthases or direct activation of the enzyme took place. It is however clear that significantly increased levels of these free radical species (superoxide and nitrogen oxide) in cells due to RFR exposure result in an activation of peroxidation and repression of activities of key antioxidant enzymes. It is indicative that many studies demonstrated effectiveness of different antioxidants to override oxidative stress caused by RFR exposure. Such effects have been reported for melatonin (Ayata et al., 2004; Lai and Singh, 1997; Oktem et al., 2005; Ozguner et al., 2006; Sokolovic et al., 2008), vitamin E and C (Jelodar et al., 2013; Oral et al., 2006), caffeic acid phenethyl ester (Ozguner et al., 2006), selenium, L-carnitine (Turker et al., 2011) and garlic (Avci et al., 2012; Bilgici et al., 2013).

It is worthwhile to emphasize a strict non-thermal character of ROS overproduction under RFR exposure described in the cited reports. As low as 0.1 $\mu W/cm^2$ intensity of RFR and absorbed energy (specific absorption rate, SAR) of 0.3 $\mu W/kg$ were demonstrated to be effective in inducing significant oxidative stress in living cells (Burlaka et al., 2013; Oksay et al., 2014). This observation is particularly important as the modern international safety limits on RFR exposure are based solely on the thermal effects of radiation and only restrict RFR intensity to 450–1000 $\mu W/cm^2$ and SAR to 2 W/kg (ICNIRP, 1998). Moreover, studies where high (thermal) intensities of RFR have been used could not reveal oxidative effects (Hong et al., 2012; Kang et al., 2013; Luukkonen et al., 2009), which might point to the variety of molecular mechanisms for different radiation intensities.

Taken together, the analysis of the contemporary scientific literature on the biological effects of RFR persuasively proves that the exposure to low-intensity RFR in living cells leads to generation of significant levels of ROS and results in a significant oxidative stress.

Oxidative damage of DNA under RFR exposure

To date more than hundred papers have been published on mutagenic effects of RFR and most of them revealed significant effects (Ruediger, 2009). There is a substantial number of studies which demonstrated the formation of micronuclei (Garaj-Vrhovac et al., 1992; Tice et al., 2002; Zotti-Martelli et al., 2005) or structural anomalies of metaphase chromosomes (Garson et al., 1991; Kerbacher et al., 1990; Maes et al., 2006) in living cells due to low-intensity RFR exposure. However, majority of the studies on the mutagenic effects of RFR successfully used a comet assay approach (Baohong et al., 2005; Belyaev et al., 2006; Diem et al., 2005; Kim et al., 2008; Lai and Singh, 1996; Liu et al., 2013a). Particular studies identified specific marker of oxidative damage of DNA, 8-hydroxy-2'-deoxyguanosine (8-OH-dG) (Burlaka et al., 2013; De Iuliis et al., 2009; Guler et al., 2012; Khalil et al., 2012; Xu et al., 2010). Thus, the level of 8-OH-dG in human spermatozoa was shown to be significantly increased after *in vitro* exposure to low-intensity RFR (De Iuliis et al., 2009). Likewise, we demonstrated that the exposure of quail embryos *in ovo* to GSM 900 MHz of 0.25 $\mu W/cm^2$ during a few days was sufficient for a significant, two-threefold, increase of 8-OH-dG level in embryonic cells (Burlaka et al., 2013).

It would be logical to assume that most mutagenic effects due to the RFR exposure are caused by oxidative damage to DNA, as the overproduction of ROS in living cells due to RFR exposure was reliably documented. It is known that superoxide itself does not affect DNA. The most aggressive form of ROS, which is able to affect the DNA molecule directly, is hydroxyl radical (Halliwell, 2007). The hydroxyl radicals are generated in cell in the Fenton reaction ($Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + OH^{\bullet} + OH^{-}$) and in the Haber–Weiss reaction ($O_2^{\bullet-} + H_2O_2 \rightarrow O_2 + OH^{\bullet} + OH^{-}$) (Valko et al., 2006). On the other hand, increased concentration of NO in addition to superoxide in the RFR-exposed cells can lead to the formation of other aggressive form of ROS, peroxynitrite ($ONOO^{-}$), which can also cause DNA damage (Valko et al., 2006).

Free radicals induced under the RFR exposure can perturb cellular signaling

Taking into account the abovementioned data, we can state that the exposure to RFR leads to overproduction of free radicals/ROS in living cell. Certainly, free radicals can induce harmful effects via direct damage due to oxidation of biological macromolecules. To that, it becomes clear nowadays that free radicals/ROS are an intrinsic part of the cellular signaling cascades (Forman et al., 2014). Thus, hydrogen peroxide appears as a second messenger both in

Table 1. Publications which reported positive findings on oxidative stress caused by RFR exposure of cells *in vitro*.

Reference	Biological system exposed	RFR exposure	Statistically significant effects reported*
(Agarwal et al., 2009)	Human spermatozoa	Cell phone RFR, in talk mode, for 1 h	Increase in reactive oxygen species (ROS) level, decrease in sperm motility and viability.
(Campisi et al., 2010)	Rat astroglial cells	900 MHz (continuous or modulated), electric field 10 V/m, for5, 10, 20 min	Increase in ROS levels and DNA fragmentation after exposure to modulated RFR for 20 min.
(De Iuliis et al., 2009)	Human spermatozoa	1.8 GHz, SAR = 0.4–27.5 W/kg	Increased amounts of ROS.
(Friedman et al., 2007)	HeLa membranes	875 MHz, 200 μW/cm^2, for 5 and 10 min	Increased NADH oxidase activity.
(Hou et al., 2014)	Mouse embryonic fibroblasts (NIH/3T3)	1800-MHz GSM-talk mode RFR, SAR = 2 W/kg, intermittent exposure (5 min on/10 min off) for 0.5–8 h	Increased intracellular ROS levels.
(Kahya et al., 2014)	Cancer cell cultures	900 MHz RFR, SAR = 0.36 W/kg, for 1 h	Induced apoptosis effects through oxidative stress, selenium counteracted the effects of RFR exposure.
(Lantow et al., 2006a)	Human blood cells	Continuous wave or GSM signal,SAR = 2 W/kg, for 30 or 45 min of continuous or 5 min ON, 5 min OFF	After continuous or intermittent GSMsignal a different ROS production was detected in human monocytes compared to sham.
(Lantow et al., 2006b)	Human Mono Mac 6 and K562 cells	Continuous wave, GSM speaking only, GSM hearing only, GSM talk, SARs of 0.5, 1.0, 1.5 and 2.0 W/kg.	The GSM-DTX signal at 2 W/kg produced difference in free radical production compared to sham.
(Liu et al., 2013b)	GC-2 cells	1800 MHz, SAR = 1; 2 W/kg,5 min ON, 10 min OFF for 24 h	In the 2 W/kg exposed cultures, the level of ROS was increased.
(Lu et al., 2012)	Human blood mononuclear cells	900 MHz, SAR = 0.4 W/kg, for 1–8 h	The increased level of apoptosis induced through the mitochondrial pathway and mediated by activating ROS and caspase-3.
(Marjanovic et al., 2014)	V79 cells	1800 MHz, SAR = 1.6 W/kg, for 10, 30 and 60 min	ROS level increased after 10 min of exposure. Decrease in ROS level after 30-min treatment indicating antioxidant defense mechanism activation.
(Nazıroğlu et al., 2012b)	HL-60 cells	2450 MHz, pulsed, SAR = 0.1–2.5 W/kg,for 1, 2, 12 or 24 h	Lipid peroxide (LPO) levels were increased at all exposure times.
(Ni et al., 2013)	Human lens epithelial cells	1800 MHz, SAR = 2; 3; 4 W/kg	The ROS and malondialdehyde (MDA) levels were increased.
(Pilla, 2012)	Neuronal cells and human fibroblasts	27.12 MHz, pulsed, electric field 41 V/m, 2 min prior to lipopolysaccharide administration or for 15 min	Increased level of nitric oxide (NO).
(Sefidbakht et al., 2014)	HEK293T cells	940 MHz, SAR = 0.09 W/kg, for 15, 30, 45, 60 and 90 min	ROS generation increased in the 30 min exposed cells. A sharp rise in catalase (CAT) and superoxide dismutase (SOD) activity and elevation of glutathione (GSH) during the 45 min exposure.
(Xu et al., 2010)	Primary cultured neurons	1800 MHz, pulsed, SAR = 2 W/kg, for 24 h	An increase in the levels of8-hydroxy-2′-deoxyguanosine (8-OH-dG).
(Zmyślony et al., 2004)	Rat lymphocytes	930 MHz, PD of 500 μW/cm^2, SAR = 1.5 W/kg, for 5 and 15 min	Intracellular ROS level increased in exposed $FeCl_2$ treated cells compared with unexposed $FeCl_2$ treated cells.

*All effects were statistically significant (at least $p < 0.05$) as compared to control or sham exposed groups.

insulin signaling and in growth factor-induced signalling cascades (Sies, 2014). These species are also implicated in biochemical mechanism of oxidation of ethanol and in other metabolic processes (Oshino et al., 1975) and is also required for initiation of wound repair (Enyedi and Niethammer, 2013). In addition, ROS at relatively low concentrations can modulate inflammation via activation of NF-kB pathway (Hayden and Ghosh, 2011). Therefore, even subtle exposures to RFR with generation of hardly detectable quantities of free radicals can have their meaningful biological consequences.

We could ascertain the signaling effects of moderate levels of free radicals from our experiments in quail embryos irradiated with the commercial cell phone. Thus, we were able to show that the prolonged exposures of embryos *in ovo* led to robust repression of their development (Tsybulin et al., 2013), which was concomitant with

Table 2. Publications which reported positive findings on oxidative stress caused by RFR exposure of animals and plants.

Reference	Biological system exposed	RFR exposure	Statistically significant effects reported*
(Akbari et al., 2014)	Rat whole body	RFR from base transceiver station	Glutathione peroxidase (GSH-Px), SOD, and CAT activity decreased and level of MDA increased. Vitamin C reduced the effect.
(Al-Damegh, 2012)	Rat whole body	Cell phone RFR, 15, 30, or 60 min/day for 2 weeks	Levels of conjugated dienes, LPO and CAT activities in serum and testicular tissue increased, the total serum and testicular tissue GSH and GSH-Px levels decreased.
(Avci et al., 2012)	Rat whole body	1800 MHz, SAR = 0.4 W/kg, 1 h/day for 3 weeks	An increased level of protein oxidation (PO) in brain tissue and an increase in serum NO. Garlic administration reduced protein oxidation in brain tissue.
(Ayata et al., 2004)	Rat whole body	900 MHz, 30 min/day for 10 days	MDA and hydroxyproline levels and activities of CAT and GSH-Px were increased, andsuperoxide dismutase (SOD) activity was decreased in skin. Melatonin treatment reversed effect.
(Aynali et al., 2013)	Rat whole body	2450 MHz, pulsed, SAR = 0.143 W/kg,60 min/day for 30 days	LPO was increased, an administration of melatonin prevented this effect.
(Balci et al., 2007)	Rat whole body	"Standardized daily dose" of cell phoneRFR for 4 weeks	In corneal tissue, MDA level and CAT activity increased, whereas SOD activity was decreased. In the lens tissues, the MDA level was increased.
(Bilgici et al., 2013)	Rat whole body	850–950 MHz,SAR = 1.08 W/kg,1 h/day for 3 weeks	The serum NO levels and levels of MDA and the PO in brain were increased. An administration of garlic extract diminished these effects.
(Bodera et al., 2013)	Rat whole body	1800 MHz, GSM, for 15 min	Reduced antioxidant capacity both in healthy animals and in those with paw inflammation.
(Burlaka et al., 2013)	Quail embryo *in ovo*	GSM 900 MHz, power density (PD) of 0.25 μW/cm^2, SAR = 3 μW/kg, 48 sec ON - 12 sec OFF, for 168–360 h	Overproduction of superoxide and NO, increased levels of thiobarbituric acid reactive substances (TBARS) and 8-OH-dG, decreased SOD and CAT activities.
(Burlaka et al., 2014)	Male rat whole body	Pulsed and continuous MWin the doses equivalent to the maximal permitted energy load for the staffs of the radar stations	Increased rates of superoxide production, formation of the iron-nitrosyl complexes and decreased activity of NADH-ubiquinone oxidoreductase complex in liver, cardiac and aorta tissues 28 days after the exposure
(Cenesiz et al., 2011)	Guinea pig whole body	900; 1800 MHz RFR from base station antennas, 4 h/day for 20 days	Difference in guinea pigs subjected to 900 and 1800 MHz for plasma oxidant status levels. NO level changed in 900 MHz subjected guinea pigs, as compared to the control.
(Cetin et al., 2014)	Pregnant rats and offspring	900; 1800 MHz RFR, 1 h/day during pregnancy and neonatal development	Brain and liver GSH-Px activities, selenium concentrations in the brain and liver vitamin A and β-carotene concentrations decreased in offspring.
(Dasdag et al., 2009)	Head of rats	900 MHz, 2 h/day for 10 months	The total antioxidant capacity and CATactivity in brains were higher than that in the sham group.

(*continued*)

Table 2. Continued

Reference	Biological system exposed	RFR exposure	Statistically significant effects reported*
(Dasdag et al., 2012)	Head of rats	900 MHz, cell-phones-like, 2 h/day for 10 months	Protein carbonyl level was higher in the brain of exposedrats.
(Dasdag et al., 2008)	Rat whole body	900 MHz, PD of 78 $\mu W/cm^2$, 2 h/days for10 months.	Increased levels of MDA and total oxidative status in liver tissue.
(Deshmukh et al., 2013)	Rat whole body	900 MHz, 2 h/day, 5 days a week for 30 days	The levels of LPO and PO were increased.
(Esmekaya et al., 2011)	Rat whole body	900 MHz, pulsed, modulated, SAR = 1.2 W/kg, 20 min/day for 3 weeks	The increased level of MDA and NOx, and decreased levels of GSH in liver, lung, testis and heart tissues.
(Furtado-Filho et al., 2014)	Rat whole body	950 MHz, SAR = 0.01–0.88 W/kg,30 min/day for 21 days during pregnancy (or additionally 6 or 15 days of postnatal period)	Neonatal rats exposed in utero had decreased levels of CAT and lower LPO, and genotoxic effect.
(Gufer et al., 2012)	Rabbit infant whole body	GSM 1800 MHz, 15 min/day for 7 days (females) or 14 days (males)	LPO levels in the liver tissues of females and males increased;liver 8-OH-dG levels of females were increased.
(Guney et al., 2007)	Rat whole body	900 MHz, 30 min/day for 30 days	Endometrial levels of NO and MDA increased,endometrial SOD, CAT and GSH-Px activities were decreased.Vitamin E and C treatment prevented these effects.
(Gurler et al., 2014)	Rat whole body	2450 MHz, 3.68 V/m, 1 h/day for 30 days	Increased 8-OH-dG level in both plasma and brain tissue whereas it increased PO level only in plasma. Garlic prevented the increase of 8-OH-dG level in brain tissue and plasma PO levels.
(Ilhan et al., 2004)	Rat whole body	900 MHz, from cell phone,1 h/day for 7 days	Increase in MDA, NO levels, andxanthine oxidase (XO) activity, decrease in SOD and GSH-Px activities in brain. These effects were prevented by Ginkgo bilobaextract treatment.
(Jelodar, et al., 2013)	Rat whole body	900 MHz, PD of 680 $\mu W/cm^2$, 4 h/day for 45 days,	The concentration of MDA was increased and activities of SOD, GSH-Px and CAT were decreased in rat eyes. An administration of vitamin C prevented these effects.
(Jelodar et al., 2013)	Rat whole body	900 MHz, daily for 45 days	Increased level of MDA and decreased antioxidant enzymes activity in rat testis.
(Jing et al., 2012)	Rat whole body	Cell phone RFR, SAR = 0.9 W/kg,3 x 10; 30 or 60 min for 20 days during gestation	After 30 and 60 min the level of MDA was increased, the activities of SOD and GSH-Pxwere decreased.
(Kerman & Senol, 2012)	Rat whole body	900 MHz, 30 min/day for 10 days	Tissue MDA levels were increased. SOD, CAT and GSH-Pxactivities were reduced. Melatonin treatment reversed these effects.
(Kesari et al., 2010)	Male rat whole body	Cell phone RFR, SAR = 0.9 W/kg,2 h/day for 35 days	Reduction in protein kinase activity, decrease in sperm count and increase in apoptosis.
(Kesari et al., 2011)	Rat whole body	900 MHz, pulsed, SAR = 0.9 W/kg,2 h/day for 45 days	Increase in the level of ROS, decrease in the activities of SOD and GSH-Px,and in the level of pineal melatonin.
(Kesari et al., 2013)	Rat whole body	2115 MHz, SAR = 0.26 W/kg,2 h/day for 60 days	The level of ROS, DNA damage and theapoptosis rate were increased.
(Khaki et al., 2012)	Rat whole body	1800 MHz, electric field 15–20 V/m, for2 h	Elevations in the levels of 8-OH-dG in urine.

(continued)

Table 2. Continued

Reference	Biological system exposed	RFR exposure	Statistically significant effects reported*
(Kismali et al., 2012)	Rabbit whole body (non-pregnant and pregnant)	1800 MHz, GSM modulation, 15 min/day for 7 days	Creatine kinases levels' changes.
(Koc et al., 2013)	Male rat whole body	Cell phone RFR at calling or stand-by	Oxidative stress detected at both calling and stand-by exposures
(Koylu et al., 2006)	Rat whole body	900 MHz	The levels of LPO in the brain cortex and hippocampus increased.These levels in the hippocampus were decreased by melatonin administration.
(Koyu et al., 2009)	Rat whole body	900 MHz	The activities of XO, CAT and level of LPO increased in liver.XO, CAT activities and LPO levels were decreased by caffeic acid phenethyl ester (CAPE) administration.
(Kumar et al., 2014)	Rat whole body	Cell phone 1910.5 MHz RFR, 2 h/day for 60 days day (6 days a week).	Increase in LPO, damage in sperm cells and DNA damage.
(Lai & Singh, 1997)	Rat whole body	2450 MHz, pulsed, PD = 2 mW/cm^2, SAR = 1.2 W/kg	Melatonin or spin-trap compound blocked DNA strand breaks induced by RFR exposure in rat brain cells.
(Luo et al., 2014)	Rat whole body	900 MHz imitated cell phone RFR, 4 h/day for 12 days	Contents of liver MDA and Nrf2 protein increased, contents of liver SOD and GSH decreased
(Maskey et al., 2009)	Rat whole body	900/1800 MHz,GSM,1 h/day for 28 days	Increase in LPO and decreased GSH content in the testis and epididymis.
(Manta et al., 2013)	Drosophila whole body	1880–1900 MHz, DECT modulation, SAR = 0.009 W/kg, for 0.5–96 h	Increase in ROS levels in male and female bodies, a quick response in ROS increase in ovaries.
(Marzook et al., 2014)	Rat whole body	900 MHz from cellular tower, 24 h/day for 8 weeks	SOD and CAT activities were reduced in blood, sesame oil reversed the effect
(Meena et al., 2013)	Rat whole body	2450 MHz, PDof 210 $\mu W/cm^2$, SAR = 0.14 W/kg, 2 h/day for 45 days	Increased level of MDA and ROS in testis. Melatonin prevented oxidative stress.
(Megha et al., 2012)	Rat whole body	900; 1800 MHz, PD of 170 $\mu W/cm^2$, SAR = 0.6 mW/kg, 2 h/day, 5 days/ week for 30 days	The levels of the LPO and PO were increased; the level of GSH was decreased.
(Meral et al., 2007)	Guinea pig whole body	890–915 MHz,from cell phone, SAR = 0.95 w/kg, 12 h/day for 30 days (11 h 45 min stand-by and 15 min spiking mode)	MDA level increased, GSH level and CAT activity weredecreased in the brain. MDA, vitamins A, D_3 and E levels and CAT enzyme activity increased, and GSH level was decreased in the blood.
(Mortavi et al., 2014)	Rat whole body	Test cellphone RFR, SAR = 1.13 W/kg, 2 h/day for 60 days	Increments in conjugated dienes, protein carbonyls, total oxidant status and oxidative stress index along with a reduction of total antioxidant capacity levels.
(Naziroglu & Gumral, 2009)	Rat whole body	2450 MHz,60 min/day for 28 days	Decrease of the cortex brain vitamin A, vitamin C and vitamin E levels.
(Naziroglu et al., 2012a)	Rat whole body	2450 MHz, 60 min/day for 30 days	LPO, cell viability and cytosolic Ca^{2+} values in dorsal root ganglion neurons were increased.
(Oksay et al., 2014)	Rat whole body	2450 MHz, pulsed, PD of0.1 $\mu W/cm^2$, SAR = 0.1 W/kg, 1 h/day for 30 days	LPO was higher in exposed animals. Melatonin treatment reversed the effect.
(Oktem et al., 2005)	Rat whole body	900 MHz, 30 min/day for 10 days	Renal tissue MDA level increased, SOD, CAT and GSH-Px activities were reduced. Melatonin treatment reversed these effects.
(Oral et al., 2006)	Rat whole body	900 MHz, 30 min/day for 30 days	Increased MDA levels and apoptosis in endometrial tissue.Treatment with vitamins E and C diminished these changes.

(continued)

Table 2. Continued

Reference	Biological system exposed	RFR exposure	Statistically significant effects reported*
(Ozguner et al., 2005a)	Rat whole body	900 MHz, 30 min/day for 10 days	Heart tissue MDA and NO levels increased, SOD, CAT and GSH-Px activities were reduced. CAPE treatmeat reversed these effects.
(Ozguner et al., 2006)	Rat whole body	900 MHz, from cell phone	Retinal levels of NO and MDA increased, SOD, GSH-Px and CAT activities were decreased.Melatonin and CAPE treatment prevented effects.
(Ozguner et al., 2005b)	Rat whole body	900 MHz	Renal tissue MDA and NO levels increased, the activities of SOD, CAT and GSH-Px were reduced. CAPE treatment reversed these effects.
(Ozgur et al., 2010)	Guinea pig whole body	1800 MHz,GSM, SAR = 0.38 W/kg, 10 or 20 min/day for 7 days	Increases in MDA and total NO(x) levels and decreases in activities of SOD, myeloperoxidase and GSH-Px in liver. Extent of oxidative damage was proportional to the duration of exposure.
(Ozgur et al., 2013)	Rabbit whole body	1800 MHz, pulsed, 15 min/day for 7 days in pregnant animals, for 7 or 15 days in infants	The amount of LPO was increased in the prenatal exposure group.
(Özorak et al., 2013)	Rat whole body	900; 1800; 2450 MHz, pulsed, PD of 12 $\mu W/cm^2$ SAR = 0.18; 1.2 W/kg, 60 min/day during gestation and 6 weeks following delivery	At the age of six weeks, an increased LPO in the kidney and testis, and decreased level of GSH and total antioxidant status.
(Qin et al., 2014)	Male mouse whole body	1800 MHz, 208 $\mu W/cm^2$, 30 or 120 min/d for 30 days	Decreased activities of CAT and GSH-Px and increasedlevel of MDA in cerebrum. Nano-selenium decreased MDA level, and increased GSH-Px and CAT activities.
(Ragy, 2014)	Rat whole body	Cell phone 900 MHz RFR, 1 h/d for 60 days	Increase in MDA levels and decrease total antioxidant capacity levels in brain, liver and kidneys tissues. These alterations were corrected by withdrawal of RFR exposure during 30 days.
(Saikhedkar et al., 2014)	Rat whole body	Cell phone 900 MHz RFR, 4 h/d for 15 days	A significant change in level of antioxidant enzymes and non-enzymatic antioxidants, and an increase in LPO.
(Shahin et al., 2013)	Mouse whole body	2450 MHz, PD of 33.5 $\mu W/cm^2$, SAR = 23 mW/kg, 2 h/day for 45 days	An increase in ROS, decrease in NO and antioxidant enzymes activities.
(Sharma et al., 2009)	Plant(mung bean) whole body	900 MHz, from cell phone, PD of 8.55 $\mu W/cm^2$; for 0.5; 1; 2, and 4 h	Increased level of MDA,H_2O_2 accumulation and root oxidizability, upregulation in the activities of SOD, CAT, ascorbate peroxidases, guaracol peroxidases and GSHreductases in roots.
(Singh et al., 2012)	Plant (mung bean) whole body	900 MHz,from cell phone	The increased level of MDA, hydrogen peroxide and proline content in hypocotyls.
(Sokolovic et al., 2008)	Rat whole body	RFR from cell phone, SAR = 0.043–0.135 W/kg, for 20, 40 and 60 days	An increase in the brain tissue MDA and carbonyl group concentration. Decreased activity of CAT and increased activity of xanthine oxidase (XO). Melatonin treatment prevented the effects.

(*continued*)

Table 2. Continued

Reference	Biological system exposed	RFR exposure	Statistically significant effects reported*
(Sokolovic et al., 2013)	Rat whole body	900 MHz, SAR = 0.043-0.135 W/kg,4 h/day for 29; 30 or 60 days.	The level of LPO and PO, activities of CAT, XO, number of apoptotic cells were increased in thymus tissue. An administration of melatonin prevented these effects.
(Suleyman et al., 2004)	Rat whole body	Cell phoneRFR,SAR = 0.52 W/kg,20 min/day for 1 month	MDA concentration was increased in brains.
(Tkalec et al., 2007)	Plant Lemna minor (duckweed)	400 and 900 MHz, 10, 23, 41 and 120 V/m, for 2 or 4 h	LPO and H_2O_2 content increased. CAT activity increased, pyrogallol peroxidase decreased.
(Tkalec et al., 2013)	Earthworm whole body	900 MHz, PD of 30–3800 $\mu W/cm^2$, SAR = 0.13–9.33 mW/kg, for 2 h	The protein carbonyl content was increased in all exposures above 30 $\mu W/m^2$. The level of MDA was increased at 140$\mu W/cm^2$.
(Tok et al., 2014)	Rat whole body	2450 MHz, Wi-Fi RFR, 60 min/day for 30 days	Decreased GSH-Px activity. GSH-Px activity and GSH values increased after melatonin treatment.
(Tomruk et al., 2010)	Rabbit whole body	1800 MHz, GSM-like signal, 15 min/day for a week	Increase of MDA and ferrous oxidation in xylenol orange levels.
(Tsybulin et al., 2012)	Quail embryo *in ovo*	900 MHz, fromcell phone, GSM, PD of 0.024–0.21 $\mu W/cm^2$, intermittent for 14 days	Increased level of TBARS in brains and livers of hatchlings.
(Turker et al., 2011)	Rat partial body	2450 MHz, pulsed, SAR = 0.1 W/kg,1 h/day for 28 days	The increased level of LPO, the decreased concentrations of vitamin A, vitamin C and vitamin E. There was a protective effect of selenium and L-carnitine.
(Türedi et al., 2014)	Pregnant rat whole body	900 MHz, 13.7 V/m, 50 $\mu W/cm^2$, 1 h/day for 13–21 days of pregnancy	MDA, SOD and CAT values increased, GSH values decreased in exposed pups.
(Yurekli et al., 2006)	Rat whole body	945 MHz, GSM, PD of 367 $\mu W/cm^2$, SAR = 11.3 mW/kg	MDA level and SOD activity increased, GSH concentration was decreased.

*All effects were statistically significant (at least $p < 0.05$) as compared to control or sham exposed groups.

Table 3. Publications which reported positive findings on oxidative stress caused byRFR exposure of humans.

Reference	Biological system exposed	RFR exposure	Statistically significant effects reported*
(Abu Khadra et al., 2014)	Human male head	GSM 1800 MHz from cell phone, SAR = 1.09 W/kg, for 15 and 30 min	SOD activity in saliva increased.
(Garaj-Vrhovac et al., 2011)	Human whole body	3; 5.5; 9.4 GHz, pulsed, from radars	Increased level of MDA, decreased level of GSH.
(Hamzany et al., 2013)	Human head/whole body	RFR from cell phone a mean time of 29.6 h/month for 12.5 years	Increase in all salivary oxidative stress indices.
(Moustafa et al., 2001)	Human male body	Cell phone in a pocket in standby position, for 1; 2 or 4 h	Plasma level of LPO was increased, activities of SOD and GSH-Px in erythrocytes decreased.

*All effects were statistically significant (at least $p < 0.05$) as compared to control or sham-exposed groups.

significant overproduction of superoxide radical and NO radical, increased rates of lipid peroxidation and oxidative damage of DNA (Burlaka et al., 2013; Tsybulin et al., 2012). Notably, shorter exposures instead led to enhancement in embryonic development (Tsybulin et al., 2012, 2013). We demonstrated the favorable effects of shorter exposures also on the molecular level. Thus, after the short-time RFR exposure the DNA comets in embryonic cells were significantly shorter than in the control non-irradiated embryos, pointing to activation of mechanisms maintaining the integrity of DNA. The "beneficial" consequences of the irradiation could be explained by hormesis effect (Calabrese, 2008). However, one could hypothesize that the "beneficial" effects of the irradiation could be explained by the signaling action of free radicals induced at levels below the damaging concentrations. Obviously, any seemingly beneficial effect of external environmental impact should be treated with caution and possibly minimized before careful evaluation of the long-term consequences. Altogether, this gives a clear warning of the adverse health effects of

Table 4. Publications which reported no significant oxidative effectsafter RFR exposure.

Reference	Biological system exposed	RFR exposure	Effects reported
(Hook et al., 2004)	Mammalian cells *in vitro*	835.62 MHz (frequency-modulated continuous-wave, FMCW) and 847.74 MHz (code division multiple access, CDMA), SAR = 0.8 W/kg, for 20–22 h	FMCW- and CDMA-modulated RFR did not alter parameters indicative of oxidative stress.
(Ferreira et al., 2006a)	Rat whole body	800–1800 MHz, from cell phone	No changes in lipid and protein damage, and in non-enzymatic antioxidant defense in frontal cortex or hippocampus.
(Ferreira et al., 2006b)	Pregnant rat whole body	RFR from cell phone	No differences in oxidative parameter of offspring blood and liver, but increase in erythrocytes micronuclei incidence in offspring.
(Dasdag et al., 2003)	Rat whole body	Cell phone RFR, SAR = 0.52 W/kg, 20 min/day for 1 month	No alteration in MDA concentration.
(Demirel et al., 2012)	Rat whole body	3G cell phone RFR, "standardized daily dose" for 20 days	No difference in GSH-Px and CAT activity in eye tissues, in MDA and GSH levels in blood.
(Khalil et al., 2014)	Human head/whole body	Cell phone RFR (talking mode) for 15 or 30 min	No relationship between exposure and changes in the salivary oxidant/antioxidant profile.
(de Souza et al., 2014)	Human head/whole body	Cell phone RFR	No difference in the saliva from the parotid gland exposed to cell phone RFR to the saliva from the opposite gland of each individual.

low-intensity RFR, which could be evoked both by the direct oxidative damage and by disturbed cellular signaling.

Oxidative effects and non-cancer health effects of RFR

A new medical condition, so-called electrohypersensitivity (EHS), in which people suffer due to RFR exposure, has been described (Johansson, 2006). Typically, these persons suffer from skin- and mucosa-related symptoms (itching, smarting, pain, heat sensation), or heart and nervous system disorders after exposure to computer monitors, cell phones and other electromagnetic devices. This disorder is growing continuously: starting from 0.06% of the total population in 1985, this category now includes as much as 9–11% of the European population (Hallberg and Oberfeld, 2006). In Sweden, for example, EHS has become an officially recognized health impairment.

To that, a high percentage, up to 18–43% of young people, has recently been described to be suffering from headache/earache during or after cell phone conversations (Chu et al., 2011; Yakymenko et al., 2011). Likewise, a number of psychophysical and preclinical disorders including fatigue, irritation, headache, sleep disorders, hormonal imbalances were detected in high percent of people living nearby cell phone base transceiver stations (Buchner and Eger, 2011; Santini et al., 2002).

An allergy reaction to RFR in humans has been confirmed by a significant increase in the level of mast cells in skin of persons under exposure to electromagnetic devices (Johansson et al., 2001). Likewise, higher level of degranulated mast cells in dermis of EHS persons has been detected (Johansson, 2006). In turn, the activated mast cells can release histamine and other mediators of such reactions which include allergic hypersensitivity, itching, dermatoses, etc. Importantly, an implication of ROS in allergic reactions is rather clear nowadays. For example, in case of airway allergic inflammation, the lung cells generate superoxide in nanomolar concentrations following antigen challenges (Nagata, 2005). Then, mast cells generate ROS following aggregation of FcεRI, a high-affinity IgE receptor (Okayama, 2005). In addition, pollen NADPH oxidases rapidly increase the level of ROS in lung epithelium (Boldogh et al., 2005); and removal of pollen NADPH oxidases from the challenge material reduced antigen-induced allergic airway inflammation. Thus, it seems plausible that EHS-like conditions can be attributed at least partially to ROS overproduction in cells due to RFR exposures.

Oxidative effects and potential carcinogenicity of RFR

During recent years, a number of epidemiological studies indicated a significant increase in incidence of various types of tumors among long-term or "heavy" users of cellular phones (Yakymenko et al., 2011). Briefly, reports pointed to the increased risk in brain tumors (Cardis et al., 2010; Hardell and Carlberg, 2009; Hardell et al., 2007), acoustic neuroma (Hardell et al., 2005; Sato et al., 2011), tumors of parotid glands (Sadetzki et al., 2008), seminomas (Hardell et al., 2007), melanomas (Hardell et al., 2011) and lymphomas (Hardell et al., 2005) in these cohorts of people. To that, a significant increase in tumor incidence among people living nearby cellular base transceiver stations was also reported (Eger et al., 2004; Wolf and Wolf, 2007). Similarly, experimental evidences of cancer expansion in rodents caused by long-term low-intensity RFR exposure were published (Chou et al., 1992; Repacholi et al., 1997; Szmigielski et al., 1982; Toler et al., 1997). To that, activation of ODC was detected in RFR-exposed cells (Hoyto et al., 2007). ODC is involved in

processes of cell growth and differentiation, and its activity is increased in tumor cells. Although overexpression of ODC is not sufficient for tumorigenic transformation, an increased activity of this enzyme was shown to promote the development of tumors from pre-tumor cells (Clifford et al., 1995).

Significant overproduction of ROS leads to oxidative stress in living cells, induces oxidative damage of DNA and can cause malignant transformation (Halliwell and Whiteman, 2004; Valko et al., 2007). It is known that in addition to mutagenic effects, ROS play a role as a second messenger for intracellular signaling cascades which can also induce oncogenic transformation (Valko et al., 2006). Earlier we hypothesized (Burlaka et al., 2013) that low-intensity RFR exposure leads to dysfunctions of mitochondria, which result in overproduction of superoxide and NO, and subsequently to ROS-mediated mutagenesis. To that, it is well established that oxidative stress is associated with carcinogenesis: for instance, the oxidative stress elicited by Membrane-Type 1 Matrix Metalloproteinase is implicated in both the pathogenesis and progression of prostate cancer (Nguyen et al., 2011). Similarly, a progressive elevation in mitochondrial ROS production (chronic ROS) under both hypoxia and/or low glucose, which leads to stabilization of cells via increased HIF-2alpha expression, can eventually result in malignant transformation (Ralph et al., 2010). These data, together with the strong experimental evidences on activation of NADH oxidase under RFR exposure (Friedman et al., 2007) suggest that low-intensity RFR is a multifactorial stress factor for living cell, significant feature of which is oxidative effects and potential carcinogenicity as a result.

Conclusions

The analysis of modern data on biological effects of low-intensity RFR leads to a firm conclusion that this physical agent is a powerful oxidative stressor for living cell. The oxidative efficiency of RFR can be mediated via changes in activities of key ROS-generating systems, including mitochondria and non-phagocytic NADH oxidases, via direct effects on water molecules, and via induction of conformation changes in biologically important macromolecules. In turn, a broad biological potential of ROS and other free radicals, including both their mutagenic effects and their signaling regulatory potential, makes RFR a potentially hazardous factor for human health. We suggest minimizing the intensity and time of RFR exposures, and taking a precautionary approach towards wireless technologies in everyday human life.

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References

Abdel-Rassoul, G., El-Fateh, O. A., Salem, M. A., et al. (2007). Neurobehavioral effects among inhabitants around mobile phone base stations. *Neurotoxicology* 28:434–440.

Abu Khadra, K. M., Khalil, A. M., Abu Samak, M., et al. (2014). Evaluation of selected biochemical parameters in the saliva of young males using mobile phones. *Electromagn. Biol. Med.* 32:72–76.

Agarwal, A., Desai, N. R., Makker, K., et al. (2009). Effects of radiofrequency electromagnetic waves (RF-EMW) from cellular phones on human ejaculated semen: An in vitro pilot study. *Fertil. Steril.* 92:1318–1325.

Akbari, A., Jelodar, G., Nazifi, S. (2014). Vitamin C protects rat cerebellum and encephalon from oxidative stress following exposure to radiofrequency wave generated by BTS antenna mobile. *Toxicol. Mechanisms Methods* 24:347–352.

Al-Damegh, M. A. (2012). Rat testicular impairment induced by electromagnetic radiation from a conventional cellular telephone and the protective effects of the antioxidants vitamins C and E. *Clinics* 67:785–792.

Avci, B., Akar, A., Bilgici, B., et al. (2012). Oxidative stress induced by 1.8 GHz radio frequency electromagnetic radiation and effects of garlic extract in rats. *Int. J. Radiat. Biol.* 88:799–805.

Ayata, A., Mollaoglu, H., Yilmaz, H. R., et al. (2004). Oxidative stress/mediated skin damage in an experimental mobile phone model can be prevented by melatonin. *J. Dermatol.* 31:878–883.

Aynali, G., Nazıroglu, M., Celik, O., et al. (2013). Modulation of wireless (2.45 GHz)-induced oxidative toxicity in laryngotracheal mucosa of rat by melatonin. *Eur. Arch. Oto-Rhino-Laryngol.* 270: 1695–1700.

Balci, M., Devrim, E., Durak, I. (2007). Effects of mobile phones on oxidant/antioxidant balance in cornea and lens of rats. *Curr. Eye Res.* 32:21–25.

Baohong, W., Jiliang, H., Lifen, J., et al. (2005). Studying the synergistic damage effects induced by 1.8 GHz radiofrequency field radiation (RFR) with four chemical mutagens on human lymphocyte DNA using comet assay in vitro. *Mutat. Res.* 578:149–157.

Belyaev, I. (2010). Dependence of non-thermal biological effects of microwaves on physical and biological variables: Implications for reproducibility and safety standards. *Eur. J. Oncol. Library* 5: 187–217.

Belyaev, I. Y., Koch, C. B., Terenius, O., et al. (2006). Exposure of rat brain to 915 MHz GSM microwaves induces changes in gene expression but not double stranded DNA breaks or effects on chromatin conformation. *Bioelectromagnetics* 27:295–306.

Bilgici, B., Akar, A., Avci, B., et al. (2013). Effect of 900 MHz radiofrequency radiation on oxidative stress in rat brain and serum. *Electromagn. Biol. Med.* 32:20–29.

Blank, M., Soo, L. (2001). Electromagnetic acceleration of electron transfer reactions. *J. Cell Biochem.* 81:278–283.

Blank, M., Soo, L. (2003). Electromagnetic acceleration of the Belousov–Zhabotinski reaction. *Bioelectrochemistry* 61:93–97.

Bodera, P., Stankiewicz, W., Zawada, K., et al. (2013). Changes in antioxidant capacity of blood due to mutual action of electromagnetic field (1800 MHz) and opioid drug (tramadol) in animal model of persistent inflammatory state. *Pharmacol. Rep.* 65: 421–428.

Bohr, H., Bohr, J. (2000a). Microwave-enhanced folding and denaturation of globular proteins. *Phys. Rev. E* 61:4310–4314.

Bohr, H., Bohr, J. (2000b). Microwave enhanced kinetics observed in ORD studies of a protein. *Bioelectromagnetics* 21:68–72.

Boldogh, I., Bacsi, A., Choudhury, B. K., et al. (2005). ROS generated by pollen NADPH oxidase provide a signal that augments antigen-induced allergic airway inflammation. *J. Clin. Investig.* 115: 2169–2179.

Buchner, K., Eger, H. (2011). [Changes of clinically important neurotransmitters under the influence of modulated RF fields—A long-term study under real-life conditions]. *Umwelt-Medizin-Gesellschaft* 24: 44–57.

Budi, A., Legge, F. S., Treutlein, H., et al. (2007). Effect of frequency on insulin response to electric field stress. *J. Phys. Chem. B.* 111: 5748–5756.

Burlaka, A., Selyuk, M., Gaturov, M., et al. (2014). Changes in mitochondrial functioning with electromagnetic radiation of ultra high

frequency as revealed by electron paramagnetic resonance methods. *Int. J. Radiat. Biol.* 90:357–362.
Burlaka, A., Tsybulin, O., Sidorik, E., et al. (2013). Overproduction of free radical species in embryonal cells exposed to low intensity radiofrequency radiation. *Exp. Oncol.* 35:219–225.
Byus, C. V., Kartun, K., Pieper, S., et al. (1988). Increased ornithine decarboxylase activity in cultured cells exposed to low energy modulated microwave fields and phorbol ester tumor promoters. *Cancer Res.* 48:4222–4226.
Calabrese, E. J. (2008). Hormesis: Why it is important to toxicology and toxicologists. *Environ. Toxicol. Chem.* 27:1451–1474.
Campisi, A., Gulino, M., Acquaviva, R., et al. (2010). Reactive oxygen species levels and DNA fragmentation on astrocytes in primary culture after acute exposure to low intensity microwave electromagnetic field. *Neurosci. Lett.* 473:52–55.
Caraglia, M., Marra, M., Mancinelli, F., et al. (2005). Electromagnetic fields at mobile phone frequency induce apoptosis and inactivation of the multi-chaperone complex in human epidermoid cancer cells. *J. Cell. Physiol.* 204:539–548.
Cardis, E., Deltour, I., Vrijheid, M., et al. (2010). Brain tumour risk in relation to mobile telephone use: Results of the INTERPHONE international case-control study. *Int. J. Epidemiol.* 39:675–694.
Cenesiz, M., Atakisi, O., Akar, A., et al. (2011). Effects of 900 and 1800 MHz electromagnetic field application on electrocardiogram, nitric oxide, total antioxidant capacity, total oxidant capacity, total protein, albumin and globulin levels in guinea pigs. *Kafkas Üniv. Vet. Fakultesi Dergisi* 17:357–362.
Cespedes, O., Ueno, S. (2009). Effects of radio frequency magnetic fields on iron release from cage proteins. *Bioelectromagnetics* 30: 336–342.
Ceran, B., Nazıroglu, M., Celik, Ö., et al. (2014). Liver antioxidant stores protect the brain from electromagnetic radiation (900 and 1800 MHz)-induced oxidative stress in rats during pregnancy and the development of offspring. *J. Matern.-Fetal Neonat. Med.* 72:1915–1921.
Chou, C. K., Guy, A. W., Kunz, L. L., et al. (1992). Long-term, low-level microwave irradiation of rats. *Bioelectromagnetics* 13:469–496.
Chu, M. K., Song, H. G., Kim, C., et al. (2011). Clinical features of headache associated with mobile phone use: A cross-sectional study in university students. *BMC Neurol.* 11:115.
Clifford, A., Morgan, D., Yuspa, S. H., et al. (1995). Role of ornithine decarboxylase in epidermal tumorigenesis. *Cancer Res.* 55: 1680–1686.
Consales, C., Merla, C., Marino, C., et al. (2012). Electromagnetic fields, oxidative stress, and neurodegeneration. *Int. J. Cell Biol.* 2012: 683897.
Dasdag, S., Akdag, M. Z., Kizil, G., et al. (2012). Effect of 900 MHz radio frequency radiation on beta amyloid protein, protein carbonyl, and malondialdehyde in the brain. *Electromagn. Biol. Med.* 31:67–74.
Dasdag, S., Akdag, M. Z., Ulukaya, E., et al. (2009). Effect of mobile phone exposure on apoptotic glial cells and status of oxidative stress in rat brain. *Electromagn. Biol. Med.* 28:342–354.
Dasdag, S., Bilgin, H., Akdag, M. Z., et al. (2008). Effect of long term mobile phone exposure on oxidative-antioxidative processes and nitric oxide in rats. *Biotechnol. Biotechnol. Equip.* 22:992–997.
Dasdag, S., Zulkuf Akdag, M., Aksen, F., et al. (2003). Whole body exposure of rats to microwaves emitted from a cell phone does not affect the testes. *Bioelectromagnetics* 24:182–188.
De Iuliis, G. N., Newey, R. J., King, B. V., et al. (2009). Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLoS One* 4: e6446.
de Souza, F. T., Silva, J. F., Ferreira, E. F., et al. (2014). Cell phone use and parotid salivary gland alterations: No molecular evidence. *Cancer Epidemiol. Biomarkers Prevent.* 23:1428–1431.
Demirel, S., Doganay, S., Turkoz, Y., et al. (2012). Effects of third generation mobile phone-emitted electromagnetic radiation on oxidative stress parameters in eye tissue and blood of rats. *Cutan. Ocul. Toxicol.* 31:89–94.
Desai, N. R., Kesari, K. K., Agarwal, A. (2009). Pathophysiology of cell phone radiation: Oxidative stress and carcinogenesis with focus on male reproductive system. *Reprod. Biol. Endocrinol.* 7:114.
Deshmukh, P. S., Banerjee, B. D., Abegaonkar, M. P., et al. (2013). Effect of low level microwave radiation exposure on cognitive function and oxidative stress in rats. *Indian J. Biochem. Biophys.* 50: 114–119.
Diem, E., Schwarz, C., Adlkofer, F., et al. (2005). Non-thermal DNA breakage by mobile-phone radiation (1800 MHz) in human fibroblasts and in transformed GFSH-R17 rat granulosa cells in vitro. *Mutat. Res.* 583:178–183.
Dutta, S. K., Ghosh, B., Blackman, C. F. (1989). Radiofrequency radiation-induced calcium ion efflux enhancement from human and other neuroblastoma cells in culture. *Bioelectromagnetics* 10: 197–202.
Eger, H., Hagen, K., Lucas, B., et al. (2004). [Influence of the proximity of mobile phone base stations on the incidence of cancer]. *Environ. Med. Soc.* 17:273–356.
Enyedi, B., Niethammer, P. (2013). H_2O_2: A chemoattractant? *Methods Enzymol.* 528:237–255.
Esmekaya, M. A., Ozer, C., Seyhan, N. (2011). 900 MHz pulse-modulated radiofrequency radiation induces oxidative stress on heart, lung, testis and liver tissues. *Gen. Physiol. Biophys.* 30:84–89.
Ferreira, A. R., Bonatto, F., de Bittencourt Pasquali, M. A., et al. (2006a). Oxidative stress effects on the central nervous system of rats after acute exposure to ultra high frequency electromagnetic fields. *Bioelectromagnetics* 27:487–493.
Ferreira, A. R., Knakievicz, T., Pasquali, M. A., et al. (2006b). Ultra high frequency-electromagnetic field irradiation during pregnancy leads to an increase in erythrocytes micronuclei incidence in rat offspring. *Life Sci.* 80:43–50.
Forman, H. J., Ursini, F., Maiorino, M. (2014). An overview of mechanisms of redox signaling. *J. Mol. Cell Cardiol.* 73:2–9.
Friedman, J., Kraus, S., Hauptman, Y., et al. (2007). Mechanism of short-term ERK activation by electromagnetic fields at mobile phone frequencies. *Biochem. J.* 405:559–568.
Furtado-Filho, O. V., Borba, J. B., Dallegrave, A., et al. (2014). Effect of 950 MHz UHF electromagnetic radiation on biomarkers of oxidative damage, metabolism of UFA and antioxidants in the livers of young rats of different ages. *Int. J. Radiat. Biol.* 90:159–168.
Gandhi, O. P., Morgan, L. L., de Salles, A. A., et al. (2012). Exposure limits: The underestimation of absorbed cell phone radiation, especially in children. *Electromagn. Biol. Med.* 31:34–51.
Garaj-Vrhovac, V., Fucic, A., Horvat, D. (1992). The correlation between the frequency of micronuclei and specific chromosome aberrations in human lymphocytes exposed to microwave radiation in vitro. *Mutat. Res.* 281:181–186.
Garaj-Vrhovac, V., Gajski, G., Pažanin, S., et al. (2011). Assessment of cytogenetic damage and oxidative stress in personnel occupationally exposed to the pulsed microwave radiation of marine radar equipment. *Int. J. Hyg. Environ. Health.* 214:59–65.
Garson, O. M., McRobert, T. L., Campbell, L. J., et al. (1991). A chromosomal study of workers with long-term exposure to radiofrequency radiation. *Med. J. Austral.* 155:289–292.
Georgiou, C. D. (2010). Oxidative stress-induced biological damage by low-level EMFs: Mechanism of free radical pair electron spin-polarization and biochemical amplification. *Eur. J. Oncol.* 5:63–113.
Goodman, R., Blank, M. (2002). Insights into electromagnetic interaction mechanisms. *J. Cell Physiol.* 192:16–22.
Griendling, K. K., Sorescu, D., Ushio-Fukai, M. (2000). NAD(P)H oxidase: Role in cardiovascular biology and disease. *Circ. Res.* 86: 494–501.
Guler, G., Tomruk, A., Ozgur, E., et al. (2012). The effect of radiofrequency radiation on DNA and lipid damage in female and male infant rabbits. *Int. J. Radiat. Biol.* 88:367–373.
Guney, M., Ozguner, F., Oral, B., et al. (2007). 900 MHz radiofrequency-induced histopathologic changes and oxidative stress in rat endometrium: Protection by vitamins E and C. *Toxicol. Ind. Health* 23: 411–420.
Gürler, H. Ş., Bilgici, B., Akar, A. K., et al. (2014). Increased DNA oxidation (8-OHdG) and protein oxidation (AOPP) by low level electromagnetic field (2.45 GHz) in rat brain and protective effect of garlic. *Int. J. Radiat. Biol.* 90:892–896.
Guzy, R. D., Schumacker, P. T. (2006). Oxygen sensing by mitochondria at complex III: The paradox of increased reactive oxygen species during hypoxia. *Exp. Physiol.* 91:807–819.
Hallberg, O., Oberfeld, G. (2006). Letter to the editor: Will we all become electrosensitive? *Electromagn. Biol. Med.* 25:189–191.
Halliwell, B. (1991). Reactive oxygen species in living systems: Source, biochemistry, and role in human disease. *Am. J. Med.* 91: 14S–22S.

Halliwell, B. (2007). Biochemistry of oxidative stress. *Biochem. Soc. Trans.* 35:1147–1150.
Halliwell, B., Whiteman, M. (2004). Measuring reactive species and oxidative damage in vivo and in cell culture: How should you do it and what do the results mean? *Br. J. Pharmacol.* 142:231–255.
Hamzany, Y., Feinnesser, R., Shpitzer, T., et al. (2013). Is human saliva an indicator of the adverse health effects of using mobile phones? *Antioxid. Redox. Signal.* 18:622–627.
Hardell, L., Carlberg, M. (2009). Mobile phones, cordless phones and the risk for brain tumours. *Int. J. Oncol.* 35:5–17.
Hardell, L., Carlberg, M., Hansson Mild, K. (2005). Case-control study on cellular and cordless telephones and the risk for acoustic neuroma or meningioma in patients diagnosed 2000–2003. *Neuroepidemiology* 25:120–128.
Hardell, L., Carlberg, M., Hansson Mild, K., et al. (2011). Case-control study on the use of mobile and cordless phones and the risk for malignant melanoma in the head and neck region. *Pathophysiology* 18:325–333.
Hardell, L., Carlberg, M., Ohlson, C. G., et al. (2007). Use of cellular and cordless telephones and risk of testicular cancer. *Int. J. Androl.* 30: 115–122.
Hardell, L., Carlberg, M., Soderqvist, F., et al. (2007). Long-term use of cellular phones and brain tumours: Increased risk associated with use for > or = 10 years. *Occup. Environ. Med.* 64:626–632.
Hardell, L., Eriksson, M., Carlberg, M., et al. (2005). Use of cellular or cordless telephones and the risk for non-Hodgkin's lymphoma. *Int. Arch. Occup. Environ. Health* 78:625–632.
Hayden, M. S., Ghosh, S. (2011). NF-kappa B in immunobiology. *Cell Res.* 21:223–244.
Hong, M. N., Kim, B. C., Ko, Y. G., et al. (2012). Effects of 837 and 1950 MHz radiofrequency radiation exposure alone or combined on oxidative stress in MCF10A cells. *Bioelectromagnetics* 33:604–611.
Hook, G. J., Spitz, D. R., Sim, J. E., et al. (2004). Evaluation of parameters of oxidative stress after in vitro exposure to FMCW- and CDMA-modulated radiofrequency radiation fields. *Radiat. Res.* 162: 497–504.
Hou, Q., Wang, M., Wu, S., et al. (2014). Oxidative changes and apoptosis induced by 1800-MHz electromagnetic radiation in NIH/3T3 cells. *Electromagn. Biol. Med.* 34:85–92.
Hoyto, A., Juutilainen, J., Naarala, J. (2007). Ornithine decarboxylase activity is affected in primary astrocytes but not in secondary cell lines exposed to 872 MHz RF radiation. *Int. J. Radiat. Biol.* 83:367–374.
Hyland, G. J. (2000). Physics and biology of mobile telephony. *Lancet* 356:1833–1836.
ICNIRP. (1998). Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz). *Health Phys.* 74:494–522.
Ilhan, A., Gurel, A., Armutcu, F., et al. (2004). Ginkgo biloba prevents mobile phone-induced oxidative stress in rat brain. *Clin. Chim. Acta.* 340:153–162.
Inoue, M., Sato, E. F., Nishikawa, M., et al. (2003). Mitochondrial generation of reactive oxygen species and its role in aerobic life. *Curr. Med. Chem.* 10:2495–2505.
Jelodar, G., Akbari, A., Nazifi, S. (2013). The prophylactic effect of vitamin C on oxidative stress indexes in rat eyes following exposure to radiofrequency wave generated by a BTS antenna model. *Int. J. Radiat. Biol.* 89:128–131.
Jelodar, G., Nazifi, S., Akbari, A. (2013). The prophylactic effect of vitamin C on induced oxidative stress in rat testis following exposure to 900 MHz radio frequency wave generated by a BTS antenna model. *Electromagn. Biol. Med.* 32:409–416.
Jing, J., Yuhua, Z., Xiao-qian, Y., et al. (2012). The influence of microwave radiation from cellular phone on fetal rat brain. *Electromagn. Biol. Med.* 31:57–66.
Johansson, O. (2006). Electrohypersensitivity: State-of-the-art of a functional impairment. *Electromagn. Biol. Med.* 25:245–258.
Johansson, O., Gangi, S., Liang, Y., et al. (2001). Cutaneous mast cells are altered in normal healthy volunteers sitting in front of ordinary TVs/PCs – results from open-field provocation experiments. *J. Cutan. Pathol.* 28:513–519.
Kahya, M. C., Naziroğlu, M., Çiğ, B. (2014). Selenium reduces mobile phone (900 MHz)-induced oxidative stress, mitochondrial function, and apoptosis in breast cancer cells. *Biol. Trace Elem. Res.* 160: 285–293.
Kang, K. A., Lee, H. C., Lee, J. J., et al. (2013). Effects of combined radiofrequency radiation exposure on levels of reactive oxygen species in neuronal cells. *J. Radiat. Res. (Published online)*:rrt116.
Kerbacher, J. J., Meltz, M. L., Erwin, D. N. (1990). Influence of radiofrequency radiation on chromosome aberrations in CHO cells and its interaction with DNA-damaging agents. *Radiat. Res.* 123: 311–319.
Kerman, M., Senol, N. (2012). Oxidative stress in hippocampus induced by 900 MHz electromagnetic field emitting mobile phone: Protection by melatonin. *Biomed. Res.* 23:147–151.
Kesari, K. K., Kumar, S., Behari, J. (2010). Mobile phone usage and male infertility in Wistar rats. *Indian J. Exp. Biol.* 48:987–992.
Kesari, K. K., Kumar, S., Behari, J. (2011). 900-MHz microwave radiation promotes oxidation in rat brain. [Research Support, Non-U.S. Gov't]. *Electromagn. Biol. Med.* 30:219–234.
Kesari, K. K., Meena, R., Nirala, J., et al. (2013). Effect of 3G cell phone exposure with computer controlled 2-D stepper motor on non-thermal activation of the hsp27/p38MAPK stress pathway in rat brain. *Cell Biochem. Biophys.* 68:347–358.
Khalil, A. M., Abu Khadra, K. M., Aljaberi, A. M., et al. (2014). Assessment of oxidant/antioxidant status in saliva of cell phone users. *Electromagn. Biol. Med.* 32:92–97.
Khalil, A. M., Gagaa, M. H., Alshamali, A. M. (2012). 8-Oxo-7, 8-dihydro-2'-deoxyguanosine as a biomarker of DNA damage by mobile phone radiation. *Hum. Exp. Toxicol.* 31:734–740.
Kim, J. Y., Hong, S. Y., Lee, Y. M., et al. (2008). In vitro assessment of clastogenicity of mobile-phone radiation (835 MHz) using the alkaline comet assay and chromosomal aberration test. [Research Support, Non-U.S. Gov't]. *Environ. Toxicol.* 23:319–327.
Kismali, G., Ozgur, E., Guler, G., et al. (2012). The influence of 1800 MHz GSM-like signals on blood chemistry and oxidative stress in non-pregnant and pregnant rabbits. *Int. J. Radiat. Biol.* 88: 414–419.
Koc, A., Unal, D., Cimentepe, E. (2013). The effects of antioxidants on testicular apoptosis and oxidative stress produced by cell phones. *Turk. J. Med. Sci.* 43:131–137.
Koylu, H., Mollaoglu, H., Ozguner, F., et al. (2006). Melatonin modulates 900 Mhz microwave-induced lipid peroxidation changes in rat brain. *Toxicol. Ind. Health* 22:211–216.
Koyu, A., Ozguner, F., Yilmaz, H., et al. (2009). The protective effect of caffeic acid phenethyl ester (CAPE) on oxidative stress in rat liver exposed to the 900 MHz electromagnetic field. *Toxicol. Ind. Health* 25:429–434.
Kumar, S., Nirala, J. P., Behari, J., et al. (2014). Effect of electromagnetic irradiation produced by 3G mobile phone on male rat reproductive system in a simulated scenario. *Indian J. Exp. Biol.* 52: 890–897.
Lai, H., Singh, N. P. (1996). Single- and double-strand DNA breaks in rat brain cells after acute exposure to radiofrequency electromagnetic radiation. *Int. J. Radiat. Biol.* 69:513–521.
Lai, H., Singh, N. P. (1997). Melatonin and a spin-trap compound block radiofrequency electromagnetic radiation-induced DNA strand breaks in rat brain cells. *Bioelectromagnetics* 18:446–454.
Lantow, M., Lupke, M., Frahm, J., et al. (2006a). ROS release and Hsp70 expression after exposure to 1,800 MHz radiofrequency electromagnetic fields in primary human monocytes and lymphocytes. *Radiat. Environ. Biophys.* 45:55–62.
Lantow, M., Schuderer, J., Hartwig, C., et al. (2006b). Free radical release and HSP70 expression in two human immune-relevant cell lines after exposure to 1800 MHz radiofrequency radiation. *Radiat. Res.* 165:88–94.
Litovitz, T. A., Krause, D., Penafiel, M., et al. (1993). The role of coherence time in the effect of microwaves on ornithine decarboxylase activity. *Bioelectromagnetics* 14:395–403.
Litovitz, T. A., Penafiel, L. M., Farrel, J. M., et al. (1997). Bioeffects induced by exposure to microwaves are mitigated by superposition of ELF noise. *Bioelectromagnetics* 18:422–430.
Liu, C., Duan, W., Xu, S., et al. (2013a). Exposure to 1800 MHz radiofrequency electromagnetic radiation induces oxidative DNA base damage in a mouse spermatocyte-derived cell line. *Toxicol. Lett.* 218: 2–9.
Liu, C., Gao, P., Xu, S.-C., et al. (2013b). Mobile phone radiation induces mode-dependent DNA damage in a mouse spermatocyte-derived cell line: A protective role of melatonin. *Int J Radiat Biol.* 89: 993–1001.

Liu, Y., Fiskum, G., Schubert, D. (2002). Generation of reactive oxygen species by the mitochondrial electron transport chain. *J. Neurochem.* 80:780–787.

Low, H., Crane, F. L., Morre, D. J. (2012). Putting together a plasma membrane NADH oxidase: a tale of three laboratories. *Int. J. Biochem. Cell Biol.* 44:1834–1838.

Lu, Y. S., Huang, B. T., Huang, Y. X. (2012). Reactive oxygen species formation and apoptosis in human peripheral blood mononuclear cell induced by 900 MHz mobile phone radiation. *Oxid. Med. Cell Longev.* 2012:740280.

Luo, Y.-p., Ma, H.-R., Chen, J.-W., et al. (2014). [Effect of American Ginseng Capsule on the liver oxidative injury and the Nrf2 protein expression in rats exposed by electromagnetic radiation of frequency of cell phone]. *Zhongguo Zhong xi yi jie he za zhi Zhongguo Zhongxiyi jiehe zazhi = Chin. J. Integr. Tradit. Western Med.* 34: 575–580.

Luukkonen, J., Hakuhinen, P., Maki-Paakkanen, J., et al. (2009). Enhancement of chemically induced reactive oxygen species production and DNA damage in human SH-SY5Y neuroblastoma cells by 872 MHz radiofrequency radiation. *Mutat. Res.* 662:54–58.

Maes, A., Collier, M., Verschaeve, L. (2000). Cytogenetic investigations on microwaves emitted by a 455.7 MHz car phone. *Folia Biol.* 46: 175–180.

Maes, W. (2005). *[Stress Caused by Electromagnetic Fields and Radiation]*. Neubeuern, Germany: IBN.

Mailankot, M., Kunnath, A. P., Jayalekshmi, H., et al. (2009). Radio frequency electromagnetic radiation (RF-EMR) from GSM (0.9/1.8GHz) mobile phones induces oxidative stress and reduces sperm motility in rats. *Clinics* 64:561–565.

Manta, A. K., Stravopodis, D. J., Papassideri, I. S., et al. (2013). Reactive oxygen species elevation and recovery in Drosophila bodies and ovaries following short-term and long-term exposure to DECT base EMF. *Electromagn. Biol. Med.* 33:118–131.

Martino, A. A., Carrubba, S., Frilot, C., et al. (2009). Evidence that transduction of electromagnetic field is mediated by a force receptor. *Neurosci. Lett.* 452:119–123.

Marjanovic, A. M., Pavicic, I., Trosic, I. (2014). Cell oxidation–reduction imbalance after modulated radiofrequency radiation. *Electromagn. Biol. Med. (Published online).* 13:1–6.

Marzook, E. A., Abd El Moneim, A. E., Elhadary, A. A. (2014). Protective role of sesame oil against mobile base station-induced oxidative stress. *J. Radiat. Res. Appl. Sci.* 7:1–6.

Meena, R., Kumari, K., Kumar, J., et al. (2013). Therapeutic approaches of melatonin in microwave radiations-induced oxidative stress-mediated toxicity on male fertility pattern of Wistar rats. *Electromagn. Biol. Med.* 33:81–91.

Megha, K., Deshmukh, P. S., Banerjee, B. D., et al. (2012). Microwave radiation induced oxidative stress, cognitive impairment and inflammation in brain of Fischer rats. *Indian J. Exp. Biol.* 50:889–896.

Meral, I., Mert, H., Mert, N., et al. (2007). Effects of 900-MHz electromagnetic field emitted from cellular phone on brain oxidative stress and some vitamin levels of guinea pigs. *Brain Res.* 1169: 120–124.

Motawi, T., Darwish, H., Moustafa, Y., et al. (2014). Biochemical modifications and neuronal damage in brain of young and adult rats after long-term exposure to mobile phone radiations. *Cell Biochem. Biophys.* 70:845–855.

Moustafa, Y. M., Moustafa, R. M., Belacy, A., et al. (2001). Effects of acute exposure to the radiofrequency fields of cellular phones on plasma lipid peroxide and antioxidase activities in human erythrocytes. *J. Pharm. Biomed. Anal.* 26:605–608.

Nagata, M. (2005). Inflammatory cells and oxygen radicals. *Curr. Drug Targets* 4:503–504.

Naziroglu, M., Celik, O., Ozgul, C., et al. (2012a). Melatonin modulates wireless (2.45 GHz)-induced oxidative injury through TRPM2 and voltage gated Ca(2+) channels in brain and dorsal root ganglion in rat. *Physiol. Behav.* 105:683–692.

Naziroglu, M., Cig, B., Dogan, S., et al. (2012b). 2.45-Gz wireless devices induce oxidative stress and proliferation through cytosolic Ca(2)(+) influx in human leukemia cancer cells. *Int. J. Radiat. Biol.* 88:449–456.

Naziroglu, M., Gumral, N. (2009). Modulator effects of L-carnitine and selenium on wireless devices (2.45 GHz)-induced oxidative stress and electroencephalography records in brain of rat. *Int. J. Radiat. Biol.* 85: 680–689.

Nguyen, H. L., Zucker, S., Zarrabi, K., et al. (2011). Oxidative stress and prostate cancer progression are elicited by membrane-type 1 matrix metalloproteinase. *Mol. Cancer Res.* 9:1305–1318.

Ni, S., Yu, Y., Zhang, Y., et al. (2013). Study of oxidative stress in human lens epithelial cells exposed to 1.8 GHz radiofrequency fields. *PLoS One.* 8:e72370.

Okayama, Y. (2005). Oxidative stress in allergic and inflammatory skin diseases. *Curr. Drug Targets* 4:517–519.

Oksay, T., Naziroğlu, M., Doğan, S., et al. (2014). Protective effects of melatonin against oxidative injury in rat testis induced by wireless (2.45 GHz) devices. *Andrologia* 46:65–72.

Oktem, F., Ozguner, F., Mollaoglu, H., et al. (2005). Oxidative damage in the kidney induced by 900-MHz-emitted mobile phone: Protection by melatonin. *Arch. Med. Res.* 36:350–355.

Oral, B., Guney, M., Ozguner, F., et al. (2006). Endometrial apoptosis induced by a 900-MHz mobile phone: Preventive effects of vitamins E and C. *Adv. Ther.* 23:957–973.

Oshino, N., Jamieson, D., Sugano, T., et al. (1975). Optical measurement of catalase-hydrogen peroxide intermediate (compound-i) in liver of anesthetized rats and its implication to hydrogen-peroxide production in situ. *Biochem. J.* 146:67–77.

Ott, M., Gogvadze, V., Orrenius, S., et al. (2007). Mitochondria, oxidative stress and cell death. *Apoptosis* 12:913–922.

Ozguner, F., Altinbas, A., Ozaydin, M., et al. (2005a). Mobile phone-induced myocardial oxidative stress: Protection by a novel antioxidant agent caffeic acid phenethyl ester. *Toxicol. Ind. Health.* 21:223–230.

Ozguner, F., Bardak, Y., Comlekci, S. (2006). Protective effects of melatonin and caffeic acid phenethyl ester against retinal oxidative stress in long-term use of mobile phone: A comparative study. *Mol. Cell Biochem.* 282:83–88.

Ozguner, F., Oktem, F., Ayata, A., et al. (2005b). A novel antioxidant agent caffeic acid phenethyl ester prevents long-term mobile phone exposure-induced renal impairment in rat. Prognostic value of malondialdehyde, N-acetyl-beta-D-glucosaminidase and nitric oxide determination. *Mol. Cell Biochem.* 277:73–80.

Ozgur, E., Guler, G., Seyhan, N. (2010). Mobile phone radiation-induced free radical damage in the liver is inhibited by the antioxidants N-acetyl cysteine and epigallocatechin-gallate. *Int. J. Radiat. Biol.* 86: 935–945.

Ozgur, E., Kismali, G., Guler, G., et al. (2013). Effects of prenatal and postnatal exposure to gsm-like radiofrequency on blood chemistry and oxidative stress in infant rabbits, an experimental study. *Cell Biochem. Biophys.* 67:743–751.

Özorak, A., Naziroğlu, M., Çelik, Ö., et al. (2013). Wi-Fi (2.45 GHz)- and mobile phone (900 and 1800 MHz)-induced risks on oxidative stress and elements in kidney and testis of rats during pregnancy and the development of offspring. *Biol. Trace Elem. Res.* 156: 221–229.

Panagopoulos, D. J., Karabarbounis, A., Margaritis, L. H. (2002). Mechanism for action of electromagnetic fields on cells. *Biochem. Biophys. Res. Commun.* 298:95–102.

Panagopoulos, D. J., Messini, N., Karabarbounis, A., et al. (2000). A mechanism for action of oscillating electric fields on cells. *Biochem. Biophys. Res. Commun.* 272:634–640.

Pauliraj, R., Behari, J., Rao, A. R. (1999). Effect of amplitude modulated RF radiation on calcium ion efflux and ODC activity in chronically exposed rat brain. *Indian J. Biochem. Biophys.* 36:337–340.

Pavicic, I., Trosic, I. (2010). Interaction of GSM modulated RF radiation and macromolecular cytoskeleton structures. *Paper presented at the 6th International Workshop on Biological Effects of Electromagnetic Fields.*

Pilla, A. A. (2012). Electromagnetic fields instantaneously modulate nitric oxide signaling in challenged biological systems. *Biochem. Biophys. Res. Commun.* 426:330–333.

Qin, F., Yuan, H., Nie, J., et al. (2014). [Effects of nano-selenium on cognition performance of mice exposed in 1800 MHz radiofrequency fields]. *Wei sheng yan jiu = J. Hygiene Res.* 43:16–21.

Ragy, M. M. (2014). Effect of exposure and withdrawal of 900-MHz-electromagnetic waves on brain, kidney and liver oxidative stress and some biochemical parameters in male rats. *Electromagn. Biol. Med. (Published online).*:1–6.

Ralph, S. J., Rodriguez-Enriquez, S., Neuzil, J., et al. (2010). The causes of cancer revisited: "Mitochondrial malignancy" and ROS-induced oncogenic transformation – Why mitochondria are targets for cancer therapy. *Mol. Aspects Med.* 31:145–170.

Rao, V. S., Titushkin, I. A., Moros, E. G., et al. (2008). Nonthermal effects of radiofrequency-field exposure on calcium dynamics in stem cell-derived neuronal cells: Elucidation of calcium pathways. *Radiat. Res.* 169:319–329.

Repacholi, M. H., Basten, A., Gebski, V., et al. (1997). Lymphomas in E mu-Pim1 transgenic mice exposed to pulsed 900 MHZ electromagnetic fields. *Radiat. Res.* 147:631–640.

Ruediger, H. W. (2009). Genotoxic effects of radiofrequency electromagnetic fields. *Pathophysiology* 16:89–102.

Sadetzki, S., Chetrit, A., Jarus-Hakak, A., et al. (2008). Cellular phone use and risk of benign and malignant parotid gland tumors – A nationwide case-control study. *Am. J. Epidemiol.* 167:457–467.

Saikhedkar, N., Bhatnagar, M., Jain, A., et al. (2014). Effects of mobile phone radiation (900 MHz radiofrequency) on structure and functions of rat brain. *Neurol. Res.* 36:1072–1079.

Santini, R., Santini, P., Danze, J. M., et al. (2002). Study of the health of people living in the vicinity of mobile phone base stations: I. Influences of distance and sex. *Pathol. Biol.* 50:369–373.

Sato, Y., Akiba, S., Kubo, O., et al. (2011). A case-case study of mobile phone use and acoustic neuroma risk in Japan. *Bioelectromagnetics* 32:85–93.

Sefidbakht, Y., Moosavi-Movahedi, A. A., Hosseinkhani, S., et al. (2014). Effects of 940 MHz EMF on bioluminescence and oxidative response of stable luciferase producing HEK cells. *Photochem. Photobiol. Sci.* 13:1082–1092.

Shahin, S., Singh, V. P., Shukla, R. K., et al. (2013). 2.45 GHz microwave irradiation-induced oxidative stress affects implantation or pregnancy in mice, Mus musculus. *Appl. Biochem. Biotechnol.* 169:1727–1751.

Sharma, V. P., Singh, H. P., Kohli, R. K., et al. (2009). Mobile phone radiation inhibits *Vigna radiata* (mung bean) root growth by inducing oxidative stress. *Sci. Total Environ.* 407:5543–5547.

Sies, H. (2014). Role of metabolic H_2O_2 generation: Redox signaling and oxidative stress. *J. Biol. Chem.* 289:8735–8741.

Singh, H. P., Sharma, V. P., Batish, D. R., et al. (2012). Cell phone electromagnetic field radiations affect rhizogenesis through impairment of biochemical processes. *Environ. Monitor. Assess.* 184: 1813–1821.

Sokolovic, D., Djindjic, B., Nikolic, J., et al. (2008). Melatonin reduces oxidative stress induced by chronic exposure of microwave radiation from mobile phones in rat brain. *J. Radiat. Res. (Tokyo).* 49: 579–586.

Sokolovic, D., Djordjevic, B., Kocic, G., et al. (2013). Melatonin protects rat thymus against oxidative stress caused by exposure to microwaves and modulates proliferation/apoptosis of thymocytes. *Gen. Physiol. Biophys.* 32:79–90.

Suleyman, D., M. Zulkuf, A., Feyzan, A., et al. (2004). Does 900 MHZ GSM mobile phone exposure affect rat brain? *Electromagn. Biol. Med.* 23:201–214.

Szmigielski, S., Szudzinski, A., Pietraszek, A., et al. (1982). Accelerated development of spontaneous and benzopyrene-induced skin cancer in mice exposed to 2450-MHz microwave radiation. *Bioelectromagnetics* 3:179–191.

Tice, R. R., Hook, G. G., Donner, M., et al. (2002). Genotoxicity of radiofrequency signals. I. Investigation of DNA damage and micronuclei induction in cultured human blood cells. *Bioelectromagnetics* 23:113–126.

Tkalec, M., Malaric, K., Pevalek-Kozlina, B. (2007). Exposure to radiofrequency radiation induces oxidative stress in duckweed Lemna minor L. *Sci. Total. Environ.* 388:78–89.

Tkalec, M., Stambuk, A., Srut, M., et al. (2013). Oxidative and genotoxic effects of 900 MHz electromagnetic fields in the earthworm Eisenia fetida. *Ecotoxicol. Environ. Saf.* 90:7–12.

Tok, L., Naziroğlu, M., Doğan, S., et al. (2014). Effects of melatonin on Wi-Fi-induced oxidative stress in lens of rats. *Indian J. Ophthalmol.* 62:12–15.

Toler, J. C., Shelton, W. W., Frei, M. R., et al. (1997). Long-term, low-level exposure of mice prone to mammary tumors to 435 MHz radiofrequency radiation. *Radiat. Res.* 148:227–234.

Tomruk, A., Guler, G., Dincel, A. S. (2010). The influence of 1800 MHz GSM-like signals on hepatic oxidative DNA and lipid damage in nonpregnant, pregnant, and newly born rabbits. *Cell. Biochem. Biophys.* 56:39–47.

Tsybulin, O., Sidorik, E., Brieieva, O., et al. (2013). GSM 900 MHz cellular phone radiation can either stimulate or depress early embryogenesis in Japanese quails depending on the duration of exposure. *Int. J. Radiat. Biol.* 89:756–763.

Tsybulin, O., Sidorik, E., Kyrylenko, S., et al. (2012). GSM 900 MHz microwave radiation affects embryo development of Japanese quails. *Electromagn. Biol. Med.* 31:75–86.

Türedi, S., Hancı, H., Topal, Z., et al. (2014). The effects of prenatal exposure to a 900-MHz electromagnetic field on the 21-day-old male rat heart. *Electromagn. Biol. Med. (Published online).*:1–8.

Turker, Y., Naziroğlu, M., Gumral, N., et al. (2011). Selenium and L-carnitine reduce oxidative stress in the heart of rat induced by 2.45-GHz radiation from wireless devices. *Biol. Trace Elem. Res.* 143: 1646–1650.

Vaks, V. L., Domrachev, G. A., Rodygin, Y. L., et al. (1994). Dissociation of water by microwave radiation. *Radiophys. Quant. Electron.* 37:85–88.

Valko, M., Leibfritz, D., Moncol, J., et al. (2007). Free radicals and antioxidants in normal physiological functions and human disease. *Int. J. Biochem. Cell Biol.* 39:44–84.

Valko, M., Rhodes, C. J., Moncol, J., et al. (2006). Free radicals, metals and antioxidants in oxidative stress-induced cancer. *Chem. Biol. Interact.* 160:1–40.

Wang, X., Sharma, R. K., Gupta, A., et al. (2003). Alterations in mitochondria membrane potential and oxidative stress in infertile men: A prospective observational study. *Fertil. Steril.* 80:844–850.

Wolf, R., Wolf, D. (2007). Increased incidence of cancer near a cell-phone transmitter station. In F. Columbus (Ed.), *Trends in Cancer Prevention* New York: Nova Science Publishers, Inc. pp. 1–8.

Xu, S., Zhou, Z., Zhang, L., et al. (2010). Exposure to 1800 MHz radiofrequency radiation induces oxidative damage to mitochondrial DNA in primary cultured neurons. *Brain. Res.* 1311:189–196.

Yakymenko, I., Sidorik, E., Kyrylenko, S., et al. (2011). Long-term exposure to microwave radiation provokes cancer growth: Evidences from radars and mobile communication systems. *Exp. Oncol.* 33: 62–70.

Yakymenko, I., Sidorik, E., Tsybulin, O., et al. (2011). Potential risks of microwaves from mobile phones for youth health. *Environ. Health* 56: 48–51.

Yurekli, A. I., Ozkan, M., Kalkan, T., et al. (2006). GSM base station electromagnetic radiation and oxidative stress in rats. *Electromagn. Biol. Med.* 25:177–188.

Zhao, T. Y., Zou, S. P., Knapp, P. E. (2007). Exposure to cell phone radiation up-regulates apoptosis genes in primary cultures of neurons and astrocytes. *Neurosci. Lett.* 412:34–38.

Zmyślony, M., Politanski, P., Rajkowska, E., et al. (2004). Acute exposure to 930 MHz CW electromagnetic radiation in vitro affects reactive oxygen species level in rat lymphocytes treated by iron ions. *Bioelectromagnetics* 25:324–328.

Zotti-Martelli, L., Peccatori, M., Maggini, V., et al. (2005). Individual responsiveness to induction of micronuclei in human lymphocytes after exposure in vitro to 1800-MHz microwave radiation. *Mutat. Res.* 582:42–52.

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From: Sierra Club <information@sierraclub.org> on behalf of William Mason <sierra@sierraclub.org>
Sent: Sunday, August 16, 2015 8:42 PM
To: EMPupdate
Subject: Make Clean Energy a Priority for 2015

Aug 16, 2015

EMP comments EMP Comments

Dear EMP comments Comments,

The Energy Master Plan will help shape New Jersey's energy future in
2015 and beyond. As the president of the Board of Public Utilities you have the power to help make dirty energy a thing of the past. I urge you to make clean energy a priority for the 2015 EMP.

The BPU has the opportunity to ensure that all New Jersey residents have the benefit of clean, safe and affordable energy. Dirty fossil fuels are putting New Jerseyans at risk of disastrous explosions, dire health consequences and dangerous climate impacts. The EMP is your chance to set a safe, 21st century energy strategy New Jersey.

The Board of Public Utilities should establish the following goals for the 2015 EMP:

1.) Eliminate NJ's reliance on coal by retiring PSEG Hudson and Mercer
2.) Ensure New Jersey's compliance with the EPA Clean Power Plan
3.) Establish binding energy savings targets
4.) Stop the expansion of natural gas pipelines throughout the state
5.) Stop the transportation of crude oil into and out of New Jersey

I personally campaigned door-to-door daily in order to save our state's water resources in 1952 and 1953 by purchasing the "Wharton Tract". You may recall that Wharton wanted to sell our water to Philadelphia and our Legislature stopped him from doing that then.
Most recently there have been several large leaks, spills and other accidents that have caused huge pollution problems. If these pipelines spill it won't just contaminate local LAND but will almost certainly totally defile our AQUIFER for ALL of us and future generations for the sake of profits to be earned by only a select few individuals.
PLEASE don't allow this to happen no matter what our absentee Governor wants.

Most Sincerely,
William J. Mason, a native-born Jerseyan

Sincerely,

William Mason
[redacted]
Haddon Heights, NJ 08035-1730

Mr. Joel Scharf

Martinsville, NJ 08836-2236

Aug 16, 2015

Richard Mroz
NJ

Subject: Support Clean Energy in the EMP!

Dear Richard Mroz,

The Energy Master Plan will help shape New Jersey's energy future the next few decades. We need to make sure that the EMP includes ways to reduce our dependence on dirty fossil fuels and open doors for clean, renewable energy. New Jersey used to be a leader in solar and wind power and we can be again but we need the EMP to have aggressive clean energy goals.

The BPU needs to acknowledge climate change and the effect of storm events like Hurricane Sandy. Investing in clean energy is one of the best resiliency strategies for New Jersey. We want the new EMP to have less room for pipelines and oil trains and more room for solar and wind development. We need to return to the stricter goals of the 2008 EMP to see New Jersey as a forerunner in clean energy once again.

The BPU has the opportunity to ensure that all New Jersey residents have the benefit of clean, safe and affordable energy. The EMP should have goals of 30% of our energy to come from renewable sources by 2020 and a 30% reduction in energy use through energy efficiency by 2030. All of our electricity to come from renewable sources and we should be 80% carbon free by 2050. We need to install energy efficiency and clean energy goals into the EMP to ensure that New Jersians' health and economy will benefit from clean energy.

Sincerely,
Mr. Joel Scharf

Mrs. Denise Scholz
[redacted]
Bayonne, NJ 07002-4719

Aug 16, 2015

Richard Mroz
NJ

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Sincerely,
Mrs. Denise Scholz

Mrs. Judy Del Russo

Oaklyn, NJ 08107-2409

Aug 16, 2015

Richard Mroz
NJ

Subject: Support Clean Energy in the EMP!

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Sincerely,
Mrs. Judy Del Russo

[redacted]

From: Jim and Beth Branigan
Sent: Sunday, August 16, 2015 2:02 PM
To: EMPupdate
Subject: Gas Pipelines & NJ's New Energy Plan

Categories: Blue Category

Hello,
I agree with the NJ Conservation Foundation's position on building new gas pipelines across NJ:

"Instead of locking our state into long-term reliance on natural gas, the Energy Master Plan should catalyze a rapid transition to renewables and energy efficiency as the best means to meet the state's energy needs and lower carbon emissions. Superstorm Sandy showed us very clearly what our coastal state has at stake from climate change.

Renewables and energy efficiency also offer greater economic opportunities, since they generate more sustained jobs and economic activities than those associated with pipeline construction."

Likewise, I believe that land which was preserved in perpetuity by NJ taxpayers should not be used for pipelines.

Thank you. Beth B. Branigan

[redacted]
Whippany, NJ 07981

From: Karl Stehle
Sent: Sunday, August 16, 2015 11:36 AM
To: EMPupdate
Subject: Reinstate the RGGI immediately

Categories: Blue Category

Dear Utility Board,
New Jersey must be reinstated immediately in the RGGI which transcends political lines. We "were proud" that NJ was number two in solar, behind California, but are currently number seven.

There is no rationale for Gov. Christie pulling out of the RGGI financially or morally (Greenhouse Gases). What is worse, we have lost 4500 jobs in solar and Gov. Christie can now claim to be a "jobs reducer", not a "jobs creator"!

We are retired teachers from West Milford, NJ and urge the Board to reinstate NJ in the RGGI immediately! Thank you for the opportunity to voice our concerns.
Sincerely,
Norma and Karl Stehle

From: Carol Quintana [redacted]
Sent: Sunday, August 16, 2015 8:53 AM
To: EMPupdate
Subject: Energy Master Plan Update

To Whom It May Concern,

I was very disappointed when the Governor, despite his supposed reputation to the contrary, broke his word given in 2009 to be a strong advocate for clean energy, a green economy and environmental responsibility when his administration adopted the 2011 Energy Master Plan.

However, now that the BPU is considering updating that plan, you can correct those mistakes. Please do everything in your power to advance the following policies now and remember even if you're in the minority on the BPU today, your opinion expressed strongly today can help build for a better tomorrow:

* Accelerate NJ's transition to a safe, clean energy economy using existing technology through aggressive but attainable goals -- 30% increase in efficiency by 2030 and relying on 100% fossil free energy production by 2050

* Just say no to the construction and expansion of new oil and gas industries and facilities in NJ

* Incentivize clean energy technology making the Garden State a hotbed for manufacturing, research and development, installation and maintenance of green technologies to create sustainable jobs

* Reduce existing equity and environmental justice issues by ensuring vulnerable communities especially benefit as we transition from a dirty to a clean economy.

Carol Quintana

[redacted]
Hoboken, NJ 07030

From: Barbara Eames
Sent: Sunday, August 16, 2015 8:44 AM
To: EMPupdate
Cc: Proto Mike; Krickus John
Subject: Master Plan

Categories: Blue Category

To those it may concern -

I live in Morris County, where the scam that is solar power has collapsed, leaving taxpayers holding the bag for millions of dollars of bonds, while SREC credits have collapsed, and federal 1603 credits are set to expire in December of next year. If that happens, taxpayers will be left holding the bag for even more costs for unreliable and costly solar power.

A solar convention in Boston this past March recommended that solar companies lobby their congressmen to extend the 1603 subsidies, or the industry would collapse, and 150,000 jobs would be lost. How is that going to work for government and private entities who have already constructed solar farms to get them serviced? A search of 1603 credit stories shows this problem goes way back to 2010 when the credits were created and Solyndra collapsed. The story hasn't changed five years later.

The only way the solar industry can survive at this point in time is with huge taxpayer subsidies, and this fact is being proven not only in Morris County, but across NJ and the rest of the country.

Panels that "fell" (????!!!!) off a canopy at Mennen Arena in Morris Plains have not yet been replaced for since winter of 2014 because of "incompatibility" problems of the the replacement panels with the existing system. Thank goodness only a car and not a person was damaged when they fell from the roof.

I believe solar technology will improve in the future, making solar power more efficient and viable - but we are NOT there yet, and it is an efficient boondoggle that we can ill afford. The panels in Morris County are warranted for a lifetime of 15 years, but as they decrease in efficiency each year, who knows how much power they will be producing by year 15? In the meantime, I believe they will become functionally obsolete, as more efficient panels are produced.

We have had other problems in Morris County as well, with roof collapses because of snow. And no one seems to be talking about the toxic chemicals in them and disposal problems AND costs, or the reluctance of fire departments to fight fires in buildings with panels because of electrical and other risks to firefighters. Aesthetically, solar farms are a visual blight on communities as well, and they seem to be popping up everywhere.

In addition, New Jersey produces much of its electricity from nuclear, which emits NO greenhouse gases, and another large percentage from natural gas, that is also low in carbon emissions. Only 4% of our power comes from coal. Why penalize states that are already complying in reducing carbon emissions and cause the price of electricity to skyrocket further?

It's just another reason to leave the pathetic state of NJ, that is already causing people to flee because of the high price of everything and our distinction as the #1 state in sales, property, and income taxes.

There are good reasons NOT to endorse a master plan that requires the taxpayer to further subsidize non-viable energy, rather than letting the market determine the most efficient way to produce power.

If most people understood the components of the BPU's energy plan and the associated costs, your hearings would be filled with people objecting. And solar companies, already subsidized, do not qualify as members of the public when it comes to testifying before your body.

Thank you for your attention to this matter.

Barbara Eames
Whippany, NJ