Postmodern Openings
ISSN: 2068-0236 | e-ISSN: 2069-9387
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2020, Volume 11, Issue 4, pages: 207-229 | doi:10.18662/po/11.4/231

Ecological Footprint of The Electrical and Energy Industries as Cultural Challenge

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Abstract: Our life, by its biological nature, is in an indestructible dependence on energy. At the same time, energy is an important criterion on which we report the progress of humanity. Historically, progress divides our world into distinct stages, called Industrial Revolutions. Each stage has encompassed more fuels, new technologies, inventions, humans behavioural changes and much more worrying environmental issues. Energy techniques, new extractions and transportation improved in nineteenth and during twenty-century energy consumption, especially electricity, rise significantly with, on the one hand, a continuous influx of fossil fuels and, on the other hand, continuous increase of the quantities of toxic waste, visible or not, from the other industrial branches and human activities, consequences of the energetical progress. The purpose of this paper is to point out some aspects regarding ecological footprints of electrical industry and energy industries during their development and to establish connections between the distinct role of energy in each period of industrialization and its impact on the environment, education, science, arts and cultural dimensions of life.

Keywords: *energy; industrial revolution; ecological footprint; Romanticism; architecture; ecomusicology.*

How to cite: Hreciuc, E. (2020). Ecological Footprint of The Electrical And Energy Industries as Cultural Challenge. *Postmodern Openings, 11*(4), 207-229. doi:10.18662/po/11.4/231

1. Introduction

Our life, by its biological nature, is in an indestructible dependence on energy. At the same time, energy is an important criterion on which we report the progress of humanity. In the economic sense, the term progress consists in the quantity and quality of the material goods produced to be used to satisfy our well-being. The continuous increase of comfort is undoubtedly due to energy, both as resource and quantity used. Historically, progress divides our world into distinct stages, called Industrial Revolutions. Each stage has encompassed more fuels, new technologies, inventions, humans behavioural changes and much more worrying environmental issues. Electricity, the greatest invention, and electrification, the greatest engineering achievement, have a major contribution to the development of electrical and energy industry. Energy techniques, new extractions and transportation improved in nineteenth and during twenty-century energy consumption, especially electricity, rise significantly with, on the one hand, a continuous influx of fossil fuels and, on the other hand, continuous increase of the quantities of toxic waste, visible or not, from the other industrial branches and human activities, consequences of the energetical progress. Environmental impacts, first ignored, then made aware, was finally taken into consideration in all components of societies: civilians, businessmen, politicians, scientists and not at least artists. The concept of ecological footprints (EP) was defined in 1996 by Wackernagel and Rees and most commonly is a sum of calculated land surface for goods, for buildings, garbage, roads, etc. and of forests necessary to absorb noxious, particularly carbon dioxide, as result of burning fuels. (Wackernagel, 2000)

Technically is correct and, recently, there are methods and formula to calculate EP, but looking in-depth to all changes produced by the progress of technologies in ecosystems, we all being part of them, the relationship is no longer so linear. Civilization's advances relied on electrical and energy industry development determined multiple EP as over-population, human rights, indigenous groups assimilation or extinction, energy shortage (as boomerang effect), climate change, soil erosion, species extinctions, epidemic diseases, threaten of warfare, deforestation, desertification, rapid increase of atmospheric level of greenhouse gases, rising of ocean levels and ocean pH. All of these are ecological frightening damages for our future and energy industries progress brought into attention nor negligible cultural challenges.

The purpose of this paper is to point out some aspects regarding ecological footprints of electrical industry and energy industries since the First Industrial Revolution, renamed in the new socio-economic context Industry 1.0, up to the one that is prefigured today as the future, Industry 4.0, and to establish connections between the distinct role of energy in each period of industrialization and its impact on the environment, education, science, arts and cultural dimensions of life.

2. Coal, Air and water pollution, Education for All and Romanticism

The First Industrial Revolution, also called Industry 1.0, historically located between 1760 and 1840, whose debut and primary development takes place in Great Britain, replaces manual, manufacturing work, with a more optimized, mechanized form, using steam engines, produced from burning of primary fuels: wood, coal. The increase of labour productivity outweighed the negative effects on the environment, these not being the object of any thorough study, on the one hand, due to the lack of the necessary tools, and on the other, because the continuous growth of the material production was unstoppable, promising well-being as a reward of the effort made. The first impact of using wood and coal, as first energy resources, was the migration of population from the rural to the urban, which caused changes in the built environment, in life, education, and culture of people. The Open University (www.open.edu) offer a free course to understand "**The world we live in**", in which we found that Tim Jackson in their study "**Material Concerns: pollution, profit and quality of life**", chapter "**Material transitions: the birth of the industrial economy**", points out "the mass migration from countryside to the fast towns and cities where the factories and work were be found". He, also, describes the future benefits of energy use, obtained by burning fossil fuels: development of new industries, development of transport, massive throughput of material, the large increase of material wealth, decreasing the visible negative footprints on environment and humans life. Eric Hobsbawm, in "**The Age of Empire**", wrote, in completion: 'And what cities! … smoke hung over them and filth impregnated them, the elementary public services – water supply, sanitation, street-cleaning, open spaces, and so on – could not keep pace with the mass migration of men into the cities, thus producing, especially after 1830, epidemics of cholera, typhoid and an appalling constant toll of the two great groups of nineteenth-century urban killers – air pollution and water pollution or respiratory and intestinal disease.' (Wackernagel, 2000)

As an imprint associated with the benefits of this stage of development, education, based on the universal reform of it, introduced by Comenius in the seventeenth century, is experiencing a major change in approach, being open in particular to mass literacy, although, a good time remains a domain allowed only to the rich. An important landmark, invoked by the industrialists of the time was the scholastic code that wrested responsibility for education from the clergy, enacted and assigned to a Ministry of Education by Frederick William II of Prussia in 1787. Using this document, which passed the responsibility of education in the State hands and requiring all children to attend primary school, the first measures appear and will lead through a coordinated academic structure of education. (Wackernagel, 2000)

The future profile of a coordinate system of education was based, in this stage of development, on two decisions:

- 1833 – two hours of education making a day compulsory for working children in factories; government sustain schools with money
- 1844 –Ragged School Union offers education for every poor child. (Mahatma Ghandi Institute, 2019)

The educational background rapidly flourished, despite all of the inconveniences, and Great Britain offers a model of industrialized society for all European countries, emphasized the indestructible chain energy-education-development-well-being. A new level of education has been faced, the learning and researching studies. In 1794, Ecole Polytechnique appeared in France, and in nineteenth-century Germany, universities introduced the study model based on seminars and laboratories. The Industrial Revolution, by exploiting the first energy resources, opens the way to its connection with formal education, having as supporting a well-structured curriculum, based in particular on science, philosophy, art, and good manners, even though, approached differently for men and women. (BBC, 2020)

The industrialization influenced, in some way, almost every aspect of human life, so, first in Great Britain, after in all Europe, there developed intellectual and artistic actions against this new changing of society, **Romantic Movement**. Its exponents stressed the great values of "nature" in art and language, contrasting the "monstrous" machines and factories. William Blake, John Keats, and Percy Bysshe Shelley were known for their poems focused on the simple, true beauty of nature. William Blake is a symbol of this artistic struggle to defeat "dark satanic mills" and his poem "**And did those feet in ancient time**" –"... **And was Jerusalem built here/ Among these satanic mills**?..." - reveal the tragic human degradation inside the new machines world's existence. In "**Ode to the**

West Wind", Shelley uses wind as a symbol of nature, brings life wherever it goes, instead of a new revolution, brings death wherever it goes –"…**Drive my dead thoughts over the universe/Like wither'd leaves to quicken a new birth!/And, by the incantation of this verse,/Scatter, as from an unextinguish'd hearth/Ashes and sparks, my words among mankind!/Be through my lips to unawaken'd earth**…". In the same manner, Keat's poems are express the admiration for the natural world and consider the astonish landscapes as a mean of escaping the troubles of modern life. "**Ode for a Nightingale**" is just an exceptional example – "...**Forlorn! the very word is like a bell/ To toll me back from thee to my sole self!/Adieu! the fancy cannot cheat so well/As she is fam'd to do, deceiving elf./Adieu! adieu! thy plaintive anthem fades/Past the near meadows, over the still stream,/Up the hill-side; and now 'tis buried deep/In the next valley-glades:/Was it a vision, or a waking dream?/Fled is that music:—Do I wake or sleep?**". (McClinton-Temple, 2011)

Romanticism has played a particularly important role in keeping the human imprint on the "inanimate" transformations of this first step in the progress of humanity.

Another cultural aspect is, according to some considerations in The Art and Popular Encyclopedia, the appearance, in 1830, of the first steps in the **mass media**, by the fact that the newspapers distributed to the crowds, now capable of reading and writing, were accompanied by advertisements for the new one's products appeared on the stage of industrialization. These advertisements are known as popular prints, representing hand-drawn drawings and accompanied by short, easy-to-understand and mind-blowing argumentative texts, capable of influencing the reader's thinking and buying decision as our nowadays consumerism politics.

Kitsch, the by-product of the Industrial Revolution, is a concept related to the mass-production of cultural artefacts and is present, even today, in our lives, named as "fake product" or, why not, "made in". Learning Dictionary's definition for term kitch is art, objects, or design considered to be in poor taste because of excessive garishness or sentimentality, but sometimes appreciated ironically or knowingly. "Kitsch art" is was a response to certain divisions of art during the Industrial Revolution with aesthetics and, despite its humorous and ironic use, Charles Baudelaire in his essays, put together in the volume "**The Painter of Modern Life**", criticized vehemently this kind of practice to reproduce high art. In the essay "**L'Art Mnémonique**" he wrote his concerns about this practice: "**It would be bad to understand. I want to speak of an**

inevitable, synthetic, childish barbarism, which often remains visible in a perfect art (Mexican, Egyptian or Ninevite), and which derives from the need to see things greatly, to consider them especially in the effect of their together. It is not superfluous to observe here that many people have accused of barbarism all the painters whose look is synthetic and the abbreviation". (Wackernagel, 2000) Even today, we often face this "art".

Another notable aspect is The Great Exhibition of 1851. Joseph Paxton built in Hyde Park, in the heart of London, **The Crystal Palace** using new materials – iron, steel, concrete, glass - astonished creative and innovative piece of architecture and engineering, confirming the importance of industrialization to the progress of humanity and the possibilities of an educated mind. (Stein, 2020)

Energy opens a new stage of humankind to demonstrate that human life is not a valuable object, but it is a real value.

3. Light, Inventions, Architecture and Arts

The Second Industrial Revolution, Industry 2.0, also known as the Technological Revolution, between 1870 and 1914, is considered to be a worldwide phenomenon, because its effects have spread from the United Kingdom, where it started, to Continental Europe and North America. At the same time, existing technologies have improved, but new ones have emerged. The production of steel, the appearance of **electricity** and the use of petroleum, have led to important changes, not only in mass production of material goods but also in transport and communications, being, the first step towards the complex process of globalization, in the sense it used today, as process of integration and interaction among all people, companies, governments worldwide.

The Technological Revolution was a multirevolutionary process, many revolutions during one name. Chemistry, materials (steel, paper, textile), transportation (cars, rails, airplanes), agriculture, communication, petroleum, electrification are important technological areas wich full-field the social-economic background. Their benefits propelled humanity into an era of living and production. From human development, health, and life longevity, to social improvements and impact on natural resources, public health, energy usage, and sanitation, the effect was profound. It was also a time of vast urbanization, pollution, hard labour, distinct social classes, poor nutrition, and diseases. (Reedy, 2017)

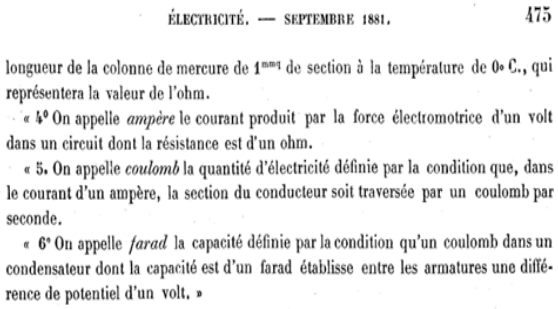
But all these footprints, whether positive or negative, had as their core **electricity**, the common effort during the time, from William Gilbert, Benjamin Franklin, Luigi Galvani, Alessandro Volta, Øërsted, Ampére, Georg Ohm to Michael Faraday or Joseph Henry and the other forgotten contributors. Edison's light bulb (1877-1879, patented in 1880), the first application of electricity, marked the beginning of a new industry, the **electrical industry**, and open the way to science and research. Even today, the incandescent bulb, about which historian Emil Ludwig said that "**it meant that fire had been discovered for the second time, that mankind had been delivered again from the curse of night**", is used to be the symbol for invention and innovation. (Institute for Energy Research, 2020)

From this point of view, the Technological Revolution is also considered a revolution of inventions. Telegraph (1836), transatlantic cable (1866), telephone (1876), phonograph (1877), induction electric motor (1888), cinematograph (1895), are just a few examples. These inventions make it clear why electricity was the most brilliant idea and why electrification will be considered by the National Academy of Engineering **"the most important engineering achievement of XX century"**. (Kelly, 2020)

The first step to providing public electricity supply was in late 1881, based on the agreement between Edison and the City Corporation of Goldaming, UK, when not only the streets of Surrey town were lit with arc lamps powered from an alternator droved by a water wheel, but several shops and premises, too. Direct current was the method Edison used and despite the inefficiency of higher voltage, the danger of direct contact and multiple wires visual pollution, this simple system was considered a success and gave Edison the courage to continue. In 1882, the first central power plant - the Pearl Street Station, NY, USA - connecting generators to business, like The New York Times, and homes through a buried copper wires network and it became a model for the future power industry. Edison became the genius, "**the new Prometeus**", who change night into day and paved with light the future better world. (Kelly, 2020)

Several scientific events had in their centre electricity and his undeniable value to the progress of humanity. Trocadero Palace hosted in 1881 the first event focused exclusively on electricity, The International Exhibition, known as The **International Electricity Exhibition**. The incandescent bulb (Edison), the dynamo (Gramme), the telephone (Bell), Siemen's electric tramway, carrying fifty passengers from the Place de la Concorde to the Palais de l'Industrie, the electrical distribution network

(Deprez), were few attractions, but International Electricians Congress represented the most important moment. According to Conservatoire numérique des Arts et Métiers, the first **International Electricians Congress** was officially decreed by the President of France and took place from September 15th to September 29th. Its historical dimension consisted not only in the fact that it brought together scientists of those times from twenty-eight countries, who presented their achievements, but especially because one of the main goals was to define an **electrical units system**. The congress resolutions established the adoption of a new CGS system and defined the new units of measurement in relation with it, thus their names, **ohm**, **ampère**, **coulomb** and **farad**, entered the universal language of science. Ampère and Coulomb were present and honoured by the association of their name with the intensity, respectively the electric charge. (Fig. 1)



ÉLECTRICITÉ. — SEPTEMBRE 1881. 475

longueur de la colonne de mercure de 1^{mm} de section à la température de 0° C., qui représentera la valeur de l'ohm.

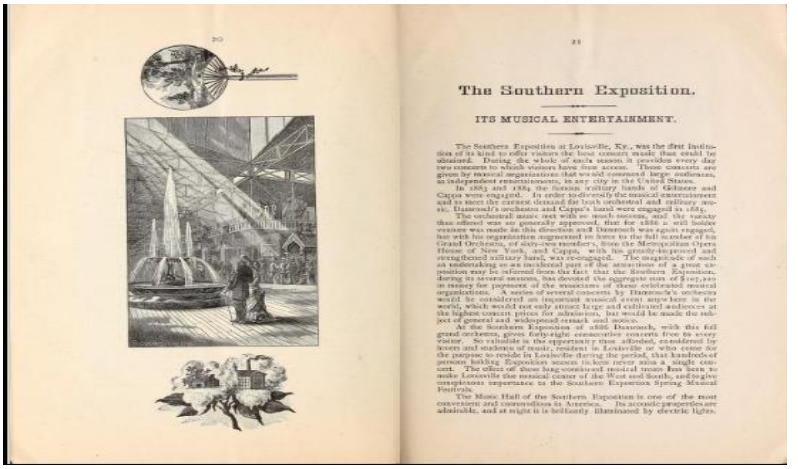
« 4° On appelle *ampère* le courant produit par la force électromotrice d'un volt dans un circuit dont la résistance est d'un ohm.

« 5. On appelle *coulomb* la quantité d'électricité définie par la condition que, dans le courant d'un ampère, la section du conducteur soit traversée par un coulomb par seconde.

« 6° On appelle *farad* la capacité définie par la condition qu'un coulomb dans un condensateur dont la capacité est d'un farad établisse entre les armatures une différence de potentiel d'un volt. »

Fig.1 Original text from International Electricians Congress document
Source: Jamin (1881)

In 1883, 4600 incandescent bulbs, much more its total in all New York, made shine The **Louisville Exposition**, under the close supervision of Luter Stieringer, Edison's collaborator. The exposition was larger and impressive as the occupied surface, as well as its tallest wooden buildings, were erected in America. **The Mayan temple** constructed at half-scale, the electric trolley to encircle all thirteen acres, the largest piano-organ in the world and full-size southern plantation have transformed the exhibition into an unbelievable grandiose event. In Central Park, an **art gallery** exhibited many famous international collections. Visitors could choose between concerts, lectures, theatrical performances or shooting gallery and music hall. **The Great Southern Exposition of Art, Industry and Agriculture**`s book in which were recorded all the events of the exhibition from August 28 to October 23, 1886, we find also those dedicated to music. (Fig. 2)



The Southern Exposition.

ITS MUSICAL ENTERTAINMENT.

Fig.2. The Southern Exposition – ITS MUSICAL ENTERTAINMENT
Source: The Southern Exposition. (1886)

Due to the pavilions with various interesting technological innovations, agricultural machinery exhibits, cultural events, fireworks, glamorous nights and the nearly one million people who passed the threshold, the exhibition was extended until 1887, being opened from august to October. (Bradley, 2011)

France had a great response in 1889 when **L'Exposition Universelle de Paris** opened its doors and its **electrical installation** the largest in the world and electricity was considered the supreme queen. Le Tour Eiffel, the tallest building of the time, it was inaugurated to celebrate the French Revolution's centenary. Its structure entire from steel was the most visible, but the Le Gallerie de Machines was the most impressive being compared to a cathedral due to its glass and steel dome. The dome was disappeared, but Le Tour Eiffel has remained the famous symbol of France with all the violent disapproval of cultural personalities. Guy de Maupassant, Emile Zola, Charles Gounod and other personalities were the signers of a public letter addressed to the French president in which they wrote: **"We come, writers, painters, sculptors, architects, enthusiasts passionate about beauty, hitherto intact, from Paris, protest with all our strength, with all our indignation, in the name of unrecognized French taste, in the name of art and of French history threatened, against the erection, in the heart of our capital, of the useless and monstrous Eiffel Tower, which public malignity, often marked by common sense and a spirit**

of justice, has already named after of "Tower of Babel"[1]. (Maupassant et al., 1887)

The colossal part of metallic architecture was the predominant nature, but the main objective "to contain the whole universe" gave unexpected **cultural dimensions**. One of them was The **Palais des Arts Libéraux** and the **Palais des Beaux-Art** two works which displayed the polychrome decoration by their coloured ceramics, the paint on the iron frames and the dome covered blue formigé, architect Jean-Camille Formigé special colour. (Formigé, 1887)

The major impact was the area of cultures which, under its name "History of human habitation" and its exotic fascination, camouflaged imperialist tendencies and promoted discriminatory concepts regarding so-called savages. Reproductions of homes and architectures of various cultures, divided in five themes: Primitive civilizations, Civilizations born on the invasion of Aryas, Civilization from Roman civilization in the West, Civilizations which are attached to the development of the Roman civilization in the East and Contemporary civilizations of primitive civilizations, brought together the diversity of cultures, traditions and customs from around the world. (Parville, 1889)

Younger America reacted after Tesla patented in 1887 his alternating current idea and George Westinghouse decided to build an operating alternating current plant that seemed to win the battle for spreading power all over the living areas. **The World's Fair: Columbian Exposition**, held in Chicago in 1893 to celebrate the arrival of Christofor Columbus in the New World in 1492, allowed Westinghouse to promote alternative current and his plant idea by using an incandescent lamp with a ground stopper in one end to power three huge spotlights, decorate the buildings and illuminate fountains. In this splendid light, fourteen architectural wonders astonished visitors with their perfect white Beaux Arts's silhouettes, canals and lagoons. People and cultures from forty-six countries featuring six hundred ninety acres and two thousand temporarily neoclassical architecture buildings of which fourteen were considered the most impressive ever seen. Daniel Burhamn's ideas and his city plan were the starting point for an

[1] Original text - "**Ce serait mal me comprendre. Je veux parler d'une barbarie inévitable, synthétique, enfantine, qui reste souvent visible dans un art parfait (mexicaine, égyptienne ou ninivite), et qui dérive du besoin de voir les choses grandement, de les considérer surtout dans l'effet de leur ensemble. Il n'est pas superflu d'observer ici que beaucoup de gens ont accusé de barbarie tous les peintres dont le regard est synthétique et abréviateur**" (Baudelaire, 2010, p. 51)

architectural movement, "Beautiful City", influencing urban architectural concepts around the world. (Nature, 1889)

The **Palace of Fine Arts**, today Art Institute of Chicago, with his Corinthian columns, friezes copies from Parthenon and caryatides on facades, is an architectural artefact and serves to educate young artists. Views and Description of The Columbian Exhibition Building together with Portraiture and Biography of American Celebrities 1983, Press of The Moss Engraving Company, page 23, wrote: **"Around the entire building are galleries forming a continuous promenade, and between this galleries and the navies are the smaller room devoted to private collections of paintings and collections of the different art schools. The main floor of the nave and transept will be devoted to sculptures exclusively, and on its wall of the gallery in space for the display of paintings and haut and based reliefs…The main building is entered by four great portals, richly ornamented with architectural sculptures, and approached by broad flights on steps. The walls of the loggia of the colonnades are highly decorated with mural paintings, illustrating the history and the progress of the arts*." (Architecture, 1893)***

Many more such events could better accentuate the impact of applied electricity on progress in urban architecture and arts not only in America and Europe but throughout the world. But the aspect of national cultural identity in search of which many countries have made efforts to organize such events should not be neglected. Shona Kallestrup, in her article "Romanian 'National Style' and the 1906 Bucharest Jubilee Exhibition", it argues that the whole event took place around this need to identify and officially recognize a national identity style, especially in the visual arts. The article concludes that this style is not a "ethnic nationalism", but a complex expression of Latin identity and Orthodox forms in a vision of an independent Kingdom of Romania. ("Moss Engraving Company", 1893)

According to Nelson Sanjad, researcher at Museum Paraense Emílio Goeldi, Brasil, "the fairs were not only selling goods, they were selling ideas: ideas about the relations between nations, the spread of education, the advancement of science, the form of cities, the nature of domestic life, the place of art in society". (Kallestrup, 2002)

The world's fairs showcased the potential for electric lighting and after 1900 electrification was the main interest all across the world to supply populations with electric power. Ignoring the environmental damages, the number of power station exploded and early transmission lines invaded the sky with its high bodies tide up with letal wires, especially in rural areas.

More power, more changes, new domestic and social life concepts. Urban artificial illuminated spaces of the world's fairs transformed cities into fantastic sparkling glittering appearances. In 1907 the Manhattan centre, name of most important businesses were identified by the electrical signs, today the familiar wide-spreading form of spectacular illumination. Three years later twenty blocks in Broadway, Manhattan, were covered in fiery scintillation advertising. Leisure areas growth up creating fabulous environments such as amusement parks. Scott McQuire in his paper "Urban Space and Electric Light", noticed that 1907s Luna Park on Coney Island was described by Maxim Gorky as a fantastic city all of the fire suddenly rises from the ocean to the sky when its 1.3 million lights start shining. The new skyscraper, Woolworth Building, inauguration in 1913 from White House by pressing a single button was an incredible concert of interior and exterior lights and opened a new era in buildings design. Architectural lighting design became a science able to transform not only the urban spaces into amazing brilliant landscapes in surrounding darkness but also to decorate rooms to respond to its different purposes. (Sanjad, 2017)

Art has made no exception from changes, complementing the spectrum of cultural trends with Modernism. In Europe, the nineteenth and the first two decades of the twentieth century Modernism overthrows the traditions of cultural absolutism and develops in the world of the arts new concepts following the demands of the society invaded by electricity and its innumerable welfare applications. Gustave Courbet scandalized French art with his painting Burial at Ornans (1849-1850), but after 1880 avant-garde artists and their specific and so different movements - surrealism, cubism, futurism, dadaism - came into surprising recognition by art criticism of the time. Some of these artists were involved to promote the necessity and desirability of electricity demonstrating that electricity was already a subject of political interests. At the Museum of Modern Art, "Electric current, 1900-1940", a stylish exhibition, Giacomo Balla's painting "Street Light" (1910-1911) was singular between the posters enriched in electricity commercial messages. Balla, who signed the second manifesto of Futurism in the year when his painting came to life, made the general message of exposition the more believable as the declaration of futurists ends promising to "support and glory in our day-to-day world, a world which is going to be continually and splendidly transformed by victorious Science." (McQuire, 2005)

German and French Modern artists as Lucian Bernard, Jupp Wiertz, Jaques Nathan-Garamond, also depicted aspects of a Europe providing power to citizens. Their advertising works were on service to companies wich even today offer energy and influenced artistical techniques of other

modern movements like Cubism, Russian Constructivism or Dadaism. Art museums around the world are keeping valuable samples of what the impact of electricity on artistic creation meant.

Finally, literature was under electrical waves and "modern text is electrical, plugging into scientific rhetoric which channels flows of energy and information" as Tim Armstrong concludes in his study "Modernism, Technology and the Body: A cultural study". The chapter" Electrifying the body" refers to representative writers and psyhologists include H.G. Wells and Freud, whose metaphorical analogies linked all physical and mental actions, even feelings, with electrical power. (Dragomir, 2000).

Electricity and the first steps towards what is today the electrical and energy industries have left undeniable traces in the history, art and culture of the world and continues to enrich the cultural spectrum of our lives.

4. Petroleum, Green Movements, Ecomusicology and Art Galleries

In 1969, the start of the third Industrial Revolution, the environment was enriched due to Tesla's alternating current with electric power transmission networks on appreciable surfaces as national power networks, most of them part of an unified network system, using fossil fuels and hydropower to generate electricity and at no doubt with worrying ecological footprints.

Petroleum, the miraculous resource because of its multiple direct or derivate uses, must be under consideration. Crude oil production increased significantly from 1900 to 1950 when paraffin was refining and its chemical potential has been demonstrated. Not only the energy industry was fueled to produce more electricity or heat, but by refining petroleum, "mother of utilities", other industries developed and grew immediately. Gasoline, synthetic fabrics, **plastics** and farmaceuticals generate new directions to consolidate humanity well-being and destroy the stability of ecosystems and to put modern life into high-tech progress. In 1970 petrochemical industry, transportation, electronics, medicine, food, textile was largely dependent on oil and, by coincidence or not, the oil went into a major crisis. It was the moment, incidentally or not, when for the first time ecological footprints as air and water pollution, deforestation and ecosystems degradation have been considerate important by governmental and nongovernmental organizations. Public environmental movements developed dramatically on 22 April 1970. Americans celebrate the first Earth Day and television was an important instrument to influence people's attitude. Adam Rome in the paper "The Genius of Earth Day" noticed: there were "groups that had been fighting

individually against oil spills, polluting factories and power plants, raw sewage, toxic dumps, pesticides, freeways, the loss of wilderness and the extinction of wildlife united on Earth Day around these shared common values." Concepts such as clean air, clean water and endangered species have entered the common language of new "green" fighters and political parties. (Armstrong, 1998).

Nowadays, Earth Day is important only as a symbol of ecological education in schools, but throughout history has marked the debut of "green" political decisions and it has been shaped into a real cultural quality manifestation. Many artists, painters, carvers, poets, musicians, include the environmental causes in their works. Concerts and music, whatever its forms, have always attracted the most audiences and their songs are still in the collective memory. Pop, rock, blues, soul or experimental avant-garde composers, songwriters and singers adopted green awareness in their creations. It was a real challenge to choose, but I selected a few songs and a few words. "Be the Rain" performed by Neil Young and Crazy Horse, a cappela doo-wop band, put on a vicious connection the governments and petroleum companies: **Don't care what the governments say/"they're all bought and paid for anyway"/Save the planet for another day/"hey big oil, what do you say?" Marvin Gaye, the "Prince of Soul", point the disasters of oil into the oceans in his "Mercy Mercy Me (The Ecology)": "Oil wasted on the oceans and upon our seas/Fish full of mercury/Oh, mercy mercy me/Oh, things ain't what they used to be". "One of the greatest songwriters ever"(The Rolling Stones), Joni Mitchell was an idealist environmentalist and her rithms sounds better even in folk, pop, rock or jazz. "Big Yellow Taxi" reflects ugly urban spaces:" Don't it always seem to go/That you don't know what you've got/Till it's gone/They paved paradise/And put up a parking lot". Tom Lehrer, a PhD mathematician, playing hilarious "Pollution" and invite the public to "See the halibuts and the sturgeons/ Being wiped out by detergents./ Fish gotta swim and birds gotta fly,/ But they don't last long if they try." "Don't Go Near the Water" warns The Beach Boys rock band in the lyrics: "Oceans, rivers, lakes and streams/ Have all been touched by man/ The poison floating out to sea/ Now threatens life on land". Soundgarden are also in full agreement there are "Hands All Over the coastal waters/ The crew men thank her/ Then lay down their oily blanket/ Hands all over the inland forest/ In a striking motion trees fall down/ Like dying soldiers".**

These exemplified lyrics are part of a beginning, musical environmental activism. Each major change in the energy industry, of course, to meet the growing societies' demands, would have to add new subjects in musicians expression. Malcolm Williamson (1931-2003), a gifted Australian composer, protested against the Tasmanian dam in 1982 with Symphony No. 6 which quickly became a cross-border manifesto and is considered the first "transcontinental" symphony. (Rome, 2010).

It is not at all surprising that in the context of the development of industries connected with energy industry by their dependence on electricity, musicologists have approached the increasingly clear and devastating effects on the environment. By the 1980s and 1990s, the interdisciplinary approaches were not a surprise. Hollis Taylor and Andrew Hurley, Australian researchers identified in "Music and Environment: Registering Contemporary Convergencies" themes that linked music to the environment as acoustic ecology, ecomusicology, environmental ethnomusicology, archeomusicology, zoomusicology, biomusicology, music and technological environment. Acoustic ecology "concern itself with thoughtful, artistic, and activist responses to human sonic detrifus (or sound pollution) that would rebalance and restore degraded acoustic ecosystems." World Soundscape Project (1971) and Handbook for Acoustic Ecology (1978) are two references they consider related to acoustic ecology and its initiators Hildegard Westerkamp and Barry Truax. Truax studied al fields of acoustic - environmental acoustics, noise acoustic, electro-acoustic, psychoacoustics, music, linguistic, soundscape – during twenty years and he concludes that a soundscape composer has to re-integrate the soundscape of the listener with the environment. Composer and sound ecologist Hildegard Westerkampf include environmental attributes – noise-silent, loud-subtle – in her works as radiophonic events, mixed media sculptures, spans installations, music for film. According to them, Anthony Magen designed in 2009 "soundwalks", so acoustic ecology goes to architecture. (Absolutely personal remark: For sure they never knew about or ever admired the superb blue paintings in The Lost Steps Hall of Iaşi University opened in 1897 and decorated between 1968 and 1978 by Sabin Bălaşa, the master of unicorns and cosmic silhouettes.) "Caspian Oilfields ("Drilling"), "Snowdonia Woodland" (landfill wasted gases), "Sounds from Dangerous Places" (Chernobyl), "Bradwell Nuclear Power Station" defined Peter Cusak as "sonic journalist" and forced him to underline that "environmental sound provides to citizens becomes worrying". Ecomusicology was a response to all these results. Allen S. Aaron identified the term as a "critical study of music and environment", a new discipline, a link between ecocriticism and musicology which has

come to the attention of academic circles (Canada, United States, Norway, Germany) since 2000. (Taylor & Hurley, 2002)

Alexander Redhing, a reputed ecomusicologist, consider the subject not just a "**hot topic**" of the green movements but rather an instrument to encourage any part of any society from individuals to corporations to look at their actions and interests from aesthetics as philosophy of beauty. Ecomusicologists have to promote among all musicians the aesthetics of the environment, in sounds, text and other and /or other musical means. (Challe, 2015)

"Plague and the Moonflower", Richard Harvey's Oratorio, was an "ecological love story for celebrating the Millenium" on Exeter Festival in 1999, a unique spectacle, apocalyptic "as men's red-eyed demon poisons earth, sea and sky, an ethereal beauty unfolds its delicate petals…" A full orchestra, chorus of children and adults, electronic keyboards, folk instruments and a powerful libretto (Ralph Steadman) astonished the audience and gave humanity an "environmental cantata" the chance of resurrection – beauty environment in the purest Kantian sense. **(**Harvey & Steadman, 1989)

Luke Blackburn, a young American composer, continues to bring his experiences as a traveller with childhood memories from the shores of the Atlantic Ocean and to create highly original ecomusical compositions. On his website (https://www.luke-blackburn.com) he promotes the "awareness of endangered species and preserving ocean ecosystems" offering "Ecomusic conservation as an artistic practice". "Sea Sparkle", "Exocotidae", "Escapades for a Sandpiper", "Frosted Mirage" are examples of his innovative creations for solo instruments, as clarinet, chamber music or large ensemble wich depict fascinated sceneries and suffering ecosystems.(Harbourfront Centre, n.d.).

In "Handbook of Ecocriticism and Ecology" edited by Hubert Zapf, Allen finished his contribution to analyze "Ecomusicology from Poetic to Practical" in the words: "Ecomusicology, as with ecocriticism, contributes to understanding the cultural roots of the environmental crisis and promoting change". (Zapf, 2019)

Changes in the energy background come after cultural "green" movements became more vocal since 1970 and consistent actions of environmentalist organizations determine governments to take the position and adopt strategies to stop and decrease degradation. United Nation Conference on Human Environment put on public debate, in 1972 environmental consequences of burning fossil fuels and 50% of European electricity production was from oil. Two years later Great Britain and other

European countries financing in renewable energy research and development. Initially geothermal and hydropower and later wind farm came on stream. Nuclear power plants also became important for the energy efficiency of chain reactions under computer's control and the Atomic Age was reborn despite the Hiroshima and Nagasaki first historical disaster in 1945. The Atomic Age is growing rapidly and over a period of 30 years it dominates the interests of electricity suppliers and just as quickly it has a meteoric reverse. Since 2010, Germany shut down most of reactors (10 from 17) and replaces the electricity requirement with the one obtained for wind and solar technologies, on the one hand, because disastrous events like Three Miles Island (1979), Chernobyl (1986) and Fukushima (2011) raised the issue of security, and on the other, the challenges of storing radioactive waste were unanswered. The spectrum of renewable energies has been enriched in recent years with technologies for the use of waves and tide, with the transformation of municipal waste into heat and electricity, but the war with petroleum is far from over. Oildollars are a trade currency and their footprints are light up even the Arabian Desert.

Surprisingly, the West seems to be turning more and more towards restoring ecosystems and integrating into them the built environment continuously expanding. Authorities and energy companies are trying to give cultural connotations to the components that remind of the steps taken towards the modern world. The transformation of power plants in art galleries or cultural centres happens in all countries where renewable energies take place of polluting ones.

The Ice House, a Power Plant built-in 1926 in Harbourfront, Canada to serve with heat and refrigeration for Toronto Terminal Warehouse, finished his initial work in 1976. Harbourfront Corporation gave it cultural destination after its renovation for seven years, from 1980 to 1987. The Power Plant with its exterior façade and smockstake both restored opened generous spaces, on 1 May 1987, for the artists and public. Cultural diversity was from the beginning the main concept of today's Harbourfront Centre Theatre and many special events confirmed it and continue to confirm. Ambitious exhibitions peered Canadian and international arts. The Fleck Clerestory Commission Program enriched its cultural value with international award-winning publications to accompany the work of artists and most of all by" positioning the gallery in the dialogue of local and global contemporary art practices" promoted the innovative idea that the artists' works evoke the" involvement with significant social issues confronting humanity today, and their profound desire to push formal boundaries to

tackle them." Public and educational programs complete the dynamic of this idea and give access to contemporary art to all which are interested.

Stara Elektrarna, the first power station in Ljubljana, Slovenia, built-in 1898, proclaimed in 1988 as immovable cultural and historical heritage, was completely renovate(Ministry of Culture and Electro Ljubljana, owner), keeping its original brick exterior walls, in 2004 and able to host dance and theatre performances, most contemporary arts performing, debates and lectures, multimedia events, concerts. A part of the chimney, the turbine and some old measuring equipment were conservated in the foyer. (CaixaForum, 2004)

Old Medioina Electric Power Station is since 2008 an architectural icon of Paseo del Prado, Madrid Spain. Its apparently levitating silouhette, preserving the original façade, endowed with a vertical garden – 15,000 plants covered 460 square meters of walls - joined the three famous museums: Prado, Thyssen and Reina Sofia. Today, **CaixaForum Madrid** encompassing contemporary, modern and ancient art exhibition halls, an auditorium and multipurpose conference rooms, art and poetry festivals, multimedia centre, special educational programs and workshops for students and family. (CaixaForum, 2008)

Suvilahti, located in Sörnäinen, Helsinki, Finland is an old energy production area. Two gasometers nine buildings, a steam turbine and a gas power plant covered the energy need of inhabitants over more than eighty years – electricity from 1909 to 1976 and gas from 1910 to 1994. The early 1980s a wires producer Kiinteistö Oy Kapelitaio started repairs and renovation the facilities of old Power Plant and first cultural projects came into artists' consideration. KOM Theatre and a film studio marked a new powerful beginning the power of culture. Old Suvilahti energy area became an important venue for photographers, writers, artists, outdoor activities as concerts, interactive exhibitions and nowadays expands its interests to production companies and advertising agencies. In his thesis for obtaining the master's degree in architecture, "A Design Strategy for Transforming an Old Power Plant into a Cultural Center", Sung-O Park proposes creatively and originally new possibilities of renovation, restoration and arrangement of spaces and buildings in Suvilahti. "Exhibition Narrative", from 46 to 51 pages, he designed floor plans for each building, connections and hubs. His proposal highlights an original way of structuring the interior and exterior spaces as a historical course of the evolution of the electrical and energy industries. Digital gallery with projections, interactive media, and real-time experimental scale models, man-made energy by machines, use of nature such as gravity, water flow, and wind, automation, future of new power

plants, possibility of new intervention in power plant design, use of microscopic green algae, design of a future power plant that will turn coal into a hydrogen gas rather than burning it directly, interactive media telling stories about how man-powered energy, fossil fuels and renewable energy, about global warming and impacts on the environment, the increase of the human population, high demand, limited natural resources, industrialization and the machine age, the air and water pollution are just a few themes of his proposal. This example emphasizes that arts, architecture, science and particularly electrical and energy technologies became stronger and benefic interconnected for the future.(Park, 2009; Suvilahti, 2008)

Luckenwalde Coal Power Plant, Germany is considered an Electric Temple of Cultures because is a hybrid concept an art museum and renewable energy plant. This new concept, Kunstrom or art-powered electricity, means artworks which use solar, wind, biomass to produce power. Bringing renewable energies and art to the fore was a collective idea when Performance Electrics GmbH bought in 2017 the abandoned coal power built-in 1913 and shut down in 1989. The mission was to produce" sustainable energy powered by art" into a" functional sculpture". The words of artistic director Pablo Wendel have reached the philosophical depth of energy: "After all energy is the purest metaphor for art, it exists!"

On September 14, 2019, E-WERK offered the protagonists of the fifth Power Night and the public a tenth square meter area completely renovated and revived. The original machines were adapted to use unconventional renewable energies and now producing sustainable electricity. First floor, Turbine Hall, hosted exhibitions on its three hundred and fifty square meters. The third and fourth floor have been adapted for affordable artists accommodation. This interesting architectural, engineering and artistic approach at the same time presents an extraordinary potential for the promotion of contemporary art and a model of technical ingenuity and creativity. (Alle, 2019)

To balance the advantage of European countries in transforming the disused power plants China made from an old power plant a "first three-star Green Building". **Nanshi Power Plant** contributed to the rise of local industry with many years of operation, from 1897 to 2007, being the first to provide electricity. A new life was given in 2010 when its 165 meters chimney surprised exhibitors and visitors at the Shanghai World Expo with his working thermostat. Named Pavilion of Future the renovated power plant restructured the architects' thinking about the future cities. In 2012 became "the first state-run museum dedicated to contemporary art and also home to the Shanghai Biennale" known as Power Plant of Art (PSA). Its

impressive dimension – forty-two square meters area, twenty-seven meters internal height – allow the exhibitions to reach a total range of fifteen thousand square meters. Even the chimney could be used as independent exhibition place being part of Shanghai's world-famous skyline. PSA represents the generator of new urban culture, a platform for public learning about contemporary art, a generous space to promote cooperation and knowledge, a bridge between different schools of art and culture and an inspirational source for artists and architects. (Shanghai Biennale, 2012)

During the twenty-century, the development of the electrical and energy industries was unprecedented and also the diversity of ecological footprints. As a result, accelerating progress included a green education and diverse cultural responses, even innovative and highly visible and vocal. In the rising twenty-one century, energy and culture reached convergence, and humanity hoped to reduce the negative effects on the environment and the individual.

5. Conclusions

The progress of humanity has been linked to energy resources and especially to electricity. During the nineteenth and twenty-century the development of electrical and energy industries improved the comfort and well-being and produced worrying ecological issues. Every stage of development generated reactions, events and cultural movements. At the same tine, each cultural response has influenced energy industries. Scientists, researchers and engineers had to take into consideration not only energy efficiency but the motivation to reduce environmental degradation and to promote a durable design of energy chains. To include art in energy projects became a declared need for all those working in the energy field. Future technologies have to be designed so that the environment is no longer attacked by random construction at the vast degradation of the wildlife whose role in maintaining the health of the planet is indisputable. The informational progress has suggested the idea of chaining components as microgrids, Internet of Things and Big Data control to increase the efficiency of production and use of energy. Researches in finding the most efficient renewable resources and the green education of consumers are an extremely serious topic, and the implementation of optimal solutions in green energy industries are increasingly visible. Nowadays, architects, artists and engineers work in multidisciplinary teams using their knowledge and creativity to reconsider the concepts, to integrate technologies in living systems to create sustainable techno-ecosystems.

Future energy technologies, their ecological footprints and tackling new cultural challenges will probably surprisingly.

Haruki Murakami, my favourite writer says "life is a metaphor". Perhaps all these cultural challenges induced by technological innovation, not only in the energy field, will help us build this metaphor.

Until then, "the only constant in life is change"(Heraclitus) and we have to face it.

Acknowledgement

The images used are public on the Internet and are used for example.

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