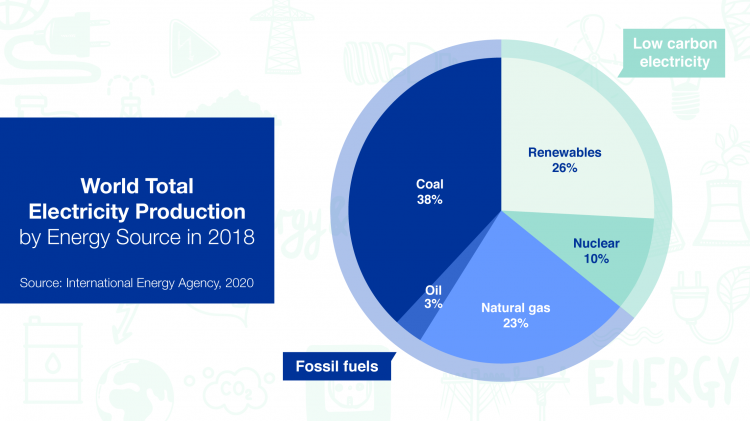
Introduction:

For centuries, coal has been key to the industrial revolution around the world. While coal played a major role in the development of the modern world, it is also the primary reason behind climate change: according to 2019 data from the [International Energy Agency](https://www.iea.org/data-and-statistics/data-product/greenhouse-gas-emissions-from-energy) (IEA), coal burning is responsible for more than 40 per cent of global carbon emissions and more than 75 per cent of emissions from electricity generation. To meet the goals of the Paris Agreement and limit global warming to no more than 1.5°C compared to pre-industrialized levels, the phase out of coal is critical.

**What is the clean energy transition?**

The clean energy transition means shifting energy production away from sources that release a lot of greenhouse gases to those that release little to no greenhouse gases. The challenge of the clean energy transition is twofold – to eliminate the entrenched use of unabated fossil fuels, while scaling up low-carbon sources such as renewables, like hydro, solar and wind, as well as nuclear. Coal remains the largest source of electricity generation globally and a major source of energy for industry, including steel manufacturing and heating.

Places like the Canadian province of Ontario, which has been [coal-free since 2014](https://www.ontario.ca/page/end-coal) thanks to an energy mix mainly comprised of nuclear energy and hydropower, is an example of what can be accomplished.



Coal and nuclear power plants both operate to produce heat to create steam that drives electricity-generating turbines. While coal provides more than a third of global electricity generation, nuclear power is equipped to fill the void resulting from coal plant closures and can provide round-the-clock baseload power in all weather conditions to complement wind and solar, whose electricity generation at any given time depends on the weather. Baseload power refers to the minimum amount of electric power needed to supply the electrical grid at any given time.

In 2003, the Ontario provincial government committed to phase out all of its nearly 9000 MW of coal capacity, or 25 per cent of their electricity generation at the time, over the following 12 years. Ontario refurbished and restarted two units at Pickering Nuclear Generating Station for 1030 MW and four units at Bruce Nuclear Generating Station for 3000 MW; 5500 MW each of non-hydro renewables and natural gas capacity were also added to Ontario's supply mix.

More than 90 per cent of the electricity production of this province of 14.5 million people is now free of carbon emissions, and its energy mix ensures the stability of its electricity grid and security of supply with both baseload and intermittent energy sources. Nuclear power plants are particularly well suited to support variable renewables such as solar and wind due to their ability to operate flexibly, adjusting output according to demand and the availability of energy from other grid sources.

**Nuclear power and residential applications**

Beyond energy generation and industrial applications, coal is also used to heat homes and businesses that use coal-fired boilers. Nuclear power can play a major role here, too, as it can provide heating, process heat, desalination and hydrogen production beyond electricity production. The Haiyang Nuclear Power Plant in China, for example, is expected to provide heat to the entire city of Haiyang, a coastal city in Shandong province that has a population of about 670 000, [by the end of 2021](http://www.chinadaily.com.cn/a/202101/08/WS5ff7c851a31024ad0baa15b9.html), and the Beznau Nuclear Power Plant in Switzerland has supplied district heating for decades to residents in the region.

As the world moves on from coal, communities that previously relied on coal for their economic prosperity must be considered. In Canada, the Canada Coal Transition Initiative has funded a transition centre and a heavy equipment operator training programme, among other efforts to ensure that coal workers are not left behind. The clean energy transition also provides an opportunity for job creation in a range of disciplines, particularly 9 million jobs in energy supply by 2030, [according to the IEA](https://www.iea.org/commentaries/the-importance-of-focusing-on-jobs-and-fairness-in-clean-energy-transitions).

**What is the role of the IAEA?**

* The IAEA fosters sustainable [nuclear energy development](https://www.iaea.org/about/organizational-structure/department-of-nuclear-energy). The IAEA produces [scientific and technical publications](https://www.iaea.org/publications/search/type/nuclear-energy-series), facilitates [technical cooperation projects](https://www.iaea.org/projects/technical-cooperation-projects/3290?type=3721&status=3723) and [coordinates research projects](https://www.iaea.org/projects/coordinated-research-projects/3290?type=3720&status=5017).
* The IAEA establishes and promotes [international standards](https://www.iaea.org/resources/safety-standards) and guidance for the safe and secure use of nuclear energy to protect people and the environment.
* The IAEA assists countries in [planning their energy strategies](https://www.iaea.org/topics/energy-planning), including whether to include nuclear energy. The IAEA provides objective information on the [economic and environmental aspects](https://www.iaea.org/topics/economics/energy-economic-and-environmental-analysis) of sustainable energy with analyses and comparative assessments designed to explore the benefits and disadvantages of different energy technologies according to a country’s specific geographical and socioeconomic context.
* The IAEA provides technical and economic assessment of the contribution of nuclear power to climate change mitigation, including the contribution that nuclear investments make towards economic growth and job creation.
* The IAEA supports existing and new nuclear programmes around the world by providing technical support and knowledge management. Through the [Milestones Approach](https://www.iaea.org/topics/infrastructure-development/milestones-approach), the IAEA provides technical expertise and guidance to countries that want to develop a nuclear power programme as well as to those who are decommissioning theirs.
* The IAEA collaborates with other international organizations, such as the IEA and [World Association of Nuclear Operators](https://www.iaea.org/newscenter/news/iaea-and-wano-team-up-to-support-new-and-expanding-nuclear-power-programmes) (WANO), to support activities involving nuclear power and the clean energy transition.

Literature review:

To avert a dangerous level of global warming, it has become inevitable to reverse the global GHG emission trend and ensure it reaches net zero by mid-century. Though energy is the primary driver of economic growth, most of the global emissions arise from energy use. It is therefore imperative that the global energy system is decarbonized. In the light of the growing global emission pattern, world leaders agreed in Paris, to pursue efforts to keep the global average temperature increase well below 2 C above preindustrial levels and to further strive to limit the temperature increase to 1.5 C above pre-industrial levels. To reach this target, governments, corporate organizations, and individuals have a key role to play. Key approach to achieve net zero emission include removal of carbon from the atmosphere via afforestation/ reforestation, enhanced mineral weathering, or direct capture of CO2 from the air. Emission trading as well as emission reduction through energy efficiency and use of renewable energy sources represent some of the core approaches.

The maritime sector has had a long and successful history with the use of fossil fuels, such as heavy fuel oil (HFO) and marine diesel oil (MDO). However, this might change with the increasing focus of society on sustainability, climate change (i.e. the Paris Agreement) and air quality. The air quality near harbours is lower than in other locations due to the vessels emitting pollutant emissions, such as nitrogen oxides (NOX), sulphur oxides (SOX) and particulate matter (PM). The maritime sector currently emits only a small percentage (3-4%) of the global CO2 emissions. However, if no action is taken, this can grow substantially increase due to the emission reduction of other sectors and the projected increase of global shipping. To counteract this, the IMO has established an initial CO2 reduction target of about 50% by 2050. This seems far away, but to achieve this target, steps will have to be taken sooner rather than later. In this paper, the path towards a maritime sector that is carbon neutral and has (near) zero emissions will be discussed. In order to achieve this, clean technologies and logistics of alternative fuels need to be put in place and policies need to be established to support these technologies and logistics. This paper also describes the necessity to start with the required changes as soon as possible due to the typically long lifetime and thus slow replacement of vessels. The alternative drive systems and energy carriers (fuels) of the future will be assessed based on their readiness for implementation and environmental impact. The effect of policies on the viability will also be illustrated. The approach will be based on the total costs of ownership for each alternative as there is a trade-off between the technology, investment & operational costs and emission legislation.

Due to the depletion of fossil fuels and the degradation of the ecological balance, the transition of mobility to new ways of propelling means of transportation is one of the toughest themes of sustainability, debated as such and by scientific research. At the same time technological research has already proposed several forms of vehicle powering and the manufacturers have even offered the market a significant number of electrically propelled vehicles - the option with the greatest technical and economic potential for everything that will mean future transportation of people and freight. Unfortunately, the development of electrical mobility to its quasi-state is dependent on increasing the capacity of supplying enough electricity from the power industry. The objective of our study is to develop a model for the utilization of nuclear energy in view of the global expansion of e-mobility applications. In the context of increased demand for electricity - due to new e-mobility technologies and applications, nuclear power can become the most efficient and constant form of electricity generation. The research methodology is based on qualitative analyzes of new emobility applications and their diversification tendencies, but also on quantitative analysis based on a specialized questionnaire. The novelty of the research finds its exemplification in attempts to explain the importance of nuclear energy in the new context of climate change and at the same time proposing a hypothesis regarding the possible maintenance and / or refurbishment of nuclear power plants.

After the courses about Energy and environmental engineering combined with current events, new energy is a very important research object which can not to be ignored. In China, fossil fuels are the major energy resources, it is cheap and high versatility, but when using fossil fuels, it will not only emit fine particles, but also destroy the ecological environment. Nuclear energy has many other advantages within the government’ s focus. This article analyzes the possibility that the nuclear energy can replace fossil fuels.

CONCLUSION AND RECOMMENDATIONS:

Humanity will have to systematically reduce its dependence on the large-scale combustion of fossil fuels for energy production over the coming decades, with the aim of completing this transformation before the end of this century. In doing so, all energy sources may be considered and some will be deployed in useful ‘niche’ applications. However, only [nuclear power plants](https://www.sciencedirect.com/topics/engineering/nuclear-power-plant) are capable of sustainably and reliably supplying the large quantities of clean and economical energy needed to run industrial societies with minimal emission of [greenhouse gases](https://www.sciencedirect.com/topics/physics-and-astronomy/greenhouse-gases). Nuclear energy meets all the criteria of sustainability as defined by the U.N. Brundtland Commission [[1]](https://www.sciencedirect.com/science/article/pii/S2214993714000050" \l "bb0005).

In a first phase, the world's industrial nations should take the lead in transforming the major part of their stationary electrical energy generating capacity from fossil-fuel based to nuclear-fission based. With a long-term energy policy and proper incentives, this could be achieved within a few decades (as was already done by France). Such a transformation could drastically reduce the global rate of greenhouse-gas emission with respect to both atmospheric carbon-dioxide and methane.

[Renewable energy sources](https://www.sciencedirect.com/topics/engineering/renewable-energy-source) (primarily wind and solar) will not be able to supply the needed large quantities of energy sustainably, economically and reliably. In addition, renewable energy sources with fossil-fired [backup power](https://www.sciencedirect.com/topics/engineering/back-up-power) will in many cases not contribute towards reduction of greenhouse-gas emissions. Distorting the market with subsidies and by legislation to attract intermittent energy technologies into applications for which they are not well suited is economically wasteful. Also, replacing stand-alone coal-fired stations with stand-alone gas-fired stations will, in many cases, not result in a reduction in the rate of emission of greenhouse gases due to (often poorly quantified) problems of methane leakage. Countries that depend on imported natural gas should be aware that they carry full responsibility for their part of the global consequences due to atmospheric leakage of methane associated with their part of the imported gas, including the leakage taking place outside their borders.

One solution to avoid ‘free riding’ would be a grid-connection fee, to be imposed on countries with a large intermittent generating capacity, for the purpose of compensating adjacent countries for the use of their interconnected electric grids as back-up power, and for having to accept surplus intermittent energy at times when it is not needed, thus forcing their base-load power plants to operate in an uneconomic ‘accommodative’ mode.

[Intermittent energy sources](https://www.sciencedirect.com/topics/engineering/intermittent-power) with stored-energy facilities might, in some cases be economically viable, particularly for isolated locations without access to an electric grid. But the ‘heavy lifting’ in terms of replacing the global use of coal, oil and gas must come from a large-scale deployment of [nuclear fission](https://www.sciencedirect.com/topics/engineering/nuclear-fission) energy, with a goal for full fuel recycling for maximum long-term sustainability of this critical zero-carbon energy source.