The Future of Energy #1

One of the biggest challenges for humanity in the 21st Century is to _____ _____ energy to guarantee the _____ of a population of 10 billion, _____ _____ the crises of climate change and an _____ _____. ____ _____ ____ you start investigating this _____, you might be overwhelmed by the complexity and the scale of this issue. Every possible solution _____ ____ ____ _____ and _____, and they often make _____ _____. It requires long-term strenuous effort and a global _____ of all nations and _____ institutions. _____, however, if you feel overwhelmed, you are on the right _____. _____ _____ never be an easy solution, nor a perfect answer. We need to have _____ to _____ the complicated reality, as well as _____ to continuously _____ ____ the problem. Hopefully more people _____ recognize the importance and complexity of this problem _____ _____ expecting technologies and _____ _____ ideologies. That is only beginning to _____ _____ the problem.

One of the biggest challenges for humanity in the 21st Century is to provide sufficient energy to guarantee the prosperity of a population of 10 billion, while addressing the crises of climate change and an ecosystem collapse. As soon as you start investigating this matter, you might be overwhelmed by the complexity and the scale of this issue. Every possible solution has its own flaws and strengths, and they often make intricate trade-offs. It requires long-term strenuous effort and a global alliance of all nations and related institutions. Paradoxically, however, if you feel overwhelmed, you are on the right path. There will never be an easy solution, nor a perfect answer. We need to have courage to accept the complicated reality, as well as perseverance to continuously work on the problem. Hopefully more people properly recognize the importance and complexity of this problem without overly expecting technologies and leaning towards ideologies. That is only beginning to truly solve the problem.

sufficient	十分な		trade-off	妥協、代償、トレードオフ
guarantee	保証する、確約する		strenuous	精力的な、熱心な
prosperity	繁栄		alliance	同盟、連合
address (v)	取り組む		paradoxically	逆説的に
investigate	調査する、研究する		perseverance	忍耐強さ
overwhelm	圧倒する、呆然とさせる		complexity	複雑さ
flaw	短所、欠点		ideology	イデオロギー、観念
intiricate	込み入った、複雑な			

The Future of Energy #2

Probably bioethanol makes the best _____ to understand the complexity of energy problems. Bioethanol is a biofuel _____ _____ the _____ of various organic materials, _____ from sugarcane and corn. It is expected to _____ ____ a carbon-neutral _____ for fossil fuels, since the carbon released during _____ was originally the _____ _____ _____ the _____ by plants. Airplanes and ships cannot be _____ by _____, so some form of clean _____ fuel is essential. But it is often criticized for several reasons. First, it's a trade-off between food production and energy. When _____ are used for biofuels, it obviously reduces food supplies and leads to food price _____. Is it _____ to _____ ____ the price of food for the poor? Second, bioethanol has extremely poor _____-_____. When we _____ a certain energy source, we need to _____ its energy profit _____, or EPR; how much energy is gained from the energy invested. For example, oil _____ energy for _____, refining, and transporting, but we can produce far more energy than the energy invested. The EPR of oil is around 6. In other words, for each _____ ____ energy _____, we get six times the energy ____ _____. Production of bioethanol also _____ some input of energy, such as the use of chemical _____ and refinement, and EPR is estimated to be about a loss of 0.9. It is like investing $100 to get $90. ____ we produce _____ for bioethanol by _____ oil, using oil directly is clearly more _____ than _____ ____ ____ get bioethanol.

Probably bioethanol makes the best case to understand the complexity of energy problems. Bioethanol is a biofuel produced through the fermentation of various organic materials, primarily from sugarcane and corn. It is expected to serve as a carbon-neutral substitute for fossil fuels, since the carbon released during combustion was originally the one absorbed from the atmosphere by plants. Airplanes and ships cannot be powered by batteries, so some form of clean liquid fuel is essential. But it is often criticized for several reasons. First, it's a trade-off between food production and energy. When grains are used for biofuels, it obviously reduces food supplies and leads to food price spikes. Is it acceptable to drive up the price of food for the poor? Second, bioethanol has extremely poor cost-effectiveness. When we evaluate a certain energy source, we need to examine its energy profit ratio, or EPR; how much energy is gained from the energy invested. For example, oil consumes energy for drilling, refining, and transporting, but we can produce far more energy than the energy invested. The EPR of oil is around 6. In other words, for each unit of energy spent, we get six times the energy in return. Production of bioethanol also requires some input of energy, such as the use of chemical fertilizers and refinement, and EPR is estimated to be about a loss of 0.9. It is like investing $100 to get $90. If we produce fertilizers for bioethanol by burning oil, using oil directly is clearly more efficient than using it to get bioethanol.

fermentation	発酵		spike	急上昇
sugercane	サトウキビ		evaluate	評価する
substitute	代替、代理品		examine	調べる
combustion	燃焼		refine	精製する
absorb	吸収する		fertilizer	肥料
supply	供給			

The Future of Energy #3

Talking about energy is _____ _____ ___ talking about the economy. We _____ _____ the future of energy without taking the _____ _____ into _____. _____ a variety of _____ _____ fossil fuels, we are still largely dependent on them _____ because they are so _____. This might be hard to believe, but oil is actually cheaper than a soft drink. The price of oil is _____ _____, _____ ____ ____ _____ usually less than $1 per litter. This is _____ because its _____ costs, such as those resulting _____ environmental damage, are not reflected in the oil price. Customers _____ less expensive products, and so do companies. It is unrealistic to go _____ each and every consumer, _____ _____ ____ _____ the carbon footprint of products and choose eco-friendly ones _____ ____ they are expensive. Rather, we should _____ a market condition _____ people voluntarily and _____ take _____ actions. In the past, we've _____ _____ one source of energy to another because the new one was cheaper and more powerful. For example, _____ we stopped burning firewood and started using coal, it was because coal provided a lot more _____ more _____ _____ wood. If products with high carbon emission are _____, both consumers and businesses will _____ avoid them. What we _____ need is two kinds of innovation: technological innovation to make sustainable energy cheaper, such as _____ the efficiency of solar power generation, and _____ innovation to make carbon-_____ energy more expensive, including a carbon _____.

Talking about energy is virtually equal to talking about the economy. We cannot discuss the future of energy without taking the market principle into account. Despite a variety of concerns about fossil fuels, we are still largely dependent on them primarily because they are so inexpensive. This might be hard to believe, but oil is actually cheaper than a soft drink. The price of oil is constantly fluctuating, but it has been usually less than $1 per litter. This is partly because its external costs, such as those resulting from environmental damage, are not reflected in the oil price. Customers prefer less expensive products, and so do companies. It is unrealistic to go around each and every consumer, persuading them to examine the carbon footprint of products and choose eco-friendly ones even if they are expensive. Rather, we should create a market condition where people voluntarily and willingly take preferable actions. In the past, we've moved from one source of energy to another because the new one was cheaper and more powerful. For example, when we stopped burning firewood and started using coal, it was because coal provided a lot more heat more efficiently than wood. If products with high carbon emission are costly, both consumers and businesses will spontaneously avoid them. What we truly need is two kinds of innovation: technological innovation to make sustainable energy cheaper, such as improving the efficiency of solar power generation, and policy innovation to make carbon-emitting energy more expensive, including a carbon tax.

virtually	実質的に		preferable	好ましい、適した
principle	原理		emission	排出、放出
fluctuate	変動する		spontaneously	自発的に
external	外部の、外側の			

The Future of Energy #4

As of 2023, there is no _____ solution to energy problems. Renewable energy sources, particularly solar and wind _____, are considered to be the _____, but they _____ _____ disadvantages. The _____ _____ is _____ _____ are _____-_____ sources of energy. Obviously, solar panels and wind turbines cannot _____ _____ the night and on windless days, _____. Seasonal _____ also _____ serious challenges. The amount of sunlight that hits the earth's surface _____ across the four seasons, and the variation depends on how far the place is from the _____. Parts of Canada and Russia get about 12 times less sunlight in winter than in summer. _____ the _____ _____ the renewables _____ _____, electricity demand is relatively _____. In order to fill those gaps, _____ we have to use other reliable sources _____, such as thermal or nuclear power, or to store electricity in _____. The _____ is extremely _____. _____ a _____ future where Tokyo gets all its electricity necessary _____ wind and solar power _____. One August, Tokyo is _____ by a massive typhoons that _____ for three days. They cannot _____ solar energy _____ the storm, and the winds are so strong that they will ____ the wind turbines _____ ____ they aren't shut down. How many _____ would they need in order to power Tokyo for three days, until the typhoon passes and they can _____ solar and wind power _____? The answer is more than 14 million _____; more _____ capacity than the world produces in seven years. The _____ cost will be about ¥3 trillion _____, _____ _____ the lifetime of the _____. Considering the cost of _____, we will have to utilize thermal or nuclear power to _____ the fluctuation of solar and wind, which _____ the next question of whether to choose the risk and cost of carbon emission or _____ _____ _____ _____ nuclear fuel. The energy issue always _____ trade-offs between various factors such as environmental impacts, _____, generation costs, and so on.

As of 2023, there is no perfect solution to energy problems. Renewable energy sources, particularly solar and wind power, are considered to be the favorites, but they have inherent disadvantages. The prominent downside is that they are weather-dependent sources of energy. Obviously, solar panels and wind turbines cannot operate during the night and on windless days, respectively. Seasonal variations also pose serious challenges. The amount of sunlight that hits the earth's surface varies across the four seasons, and the variation depends on how far the place is from the equator. Parts of Canada and Russia get about 12 times less sunlight in winter than in summer. While the supply from the renewables dramatically fluctuates, electricity demand is relatively stable. In order to fill those gaps, either we have to use other reliable sources complementarily, such as thermal or nuclear power, or to store electricity in batteries. The latter is extremely costly. Imagine a hypothetical future where Tokyo gets all its electricity necessary from wind and solar power alone. One August, Tokyo is hit by a massive typhoons that last for three days. They cannot harness solar energy during the storm, and the winds are so strong that they will rip the wind turbines apart if they aren't shut down. How many batteries would they need in order to power Tokyo for three days, until the typhoon passes and they can utilize solar and wind power again? The answer is more than 14 million batteries; more storage capacity than the world produces in seven years. The purchase cost will be about ¥3 trillion annually, averaged over the lifetime of the batteries. Considering the cost of batteries, we will have to utilize thermal or nuclear power to adjust the fluctuation of solar and wind, which poses the next question of whether to choose the risk and cost of carbon emission or those with preserving spent nuclear fuel. The energy issue always involves trade-offs between various factors such as environmental impacts, reliability, generation costs, and so on.

inherent	固有の、生まれつきの		stable	安定的な
prominent	顕著な、傑出した		reliable	信頼性のある
downside	否定的な側面		complimentarily	補完的に
respectively	それぞれ、各々		harness	動力化する、利用する
vary	異なる		rip	引き裂く、剥ぎ取る
equator	赤道		preserve	保存する

The Future of Energy #5

Nobody wants to experience 2020 _____. _____ to the COVID-19 pandemic, we were _____ ____ our homes, a lot of businesses went _____, and millions of people _____ their jobs. _____ all this _____, the _____ of economic activities _____ ____ only a 4.5% decrease in _____ _____ compared to the previous year. The _____ is that the energy issue cannot be _____ by simple saving _____ _____. Of course, it is important to cut _____ ____ _____. _____ ___ _____ never be enough. Rather, we will need more energy consumption in the future. The world population is going to reach 10 billion, and a billion people _____ don't have _____ access to electricity. There is a strong _____ between a country's ____ _____ income and the amount of energy used by its people. As _____ _____, we have to provide reading light to study in the evenings, _____ to _____ _____, and infrastructure to _____ clean and cheap water for all of us on this planet. The world _____ more energy so that all of us _____, including the _____, but we need to do this _____ releasing any more _____ _____. This is impossible _____ _____ technologies. Therefore, we have to _____ more resources into Research and Development, _____ to improve the capacity and cost performance of _____, increase the efficiency of renewables, make nuclear _____ commercially _____, _____ a smart grid that enables efficient _____ of _____ within a community by _____ energy _____ and _____, and so on. At the same time, a number of studies _____ _____ _____ well-being and income do not _____ beyond a _____ point. _____ energy supply is essential to ensure the _____ of us all, but _____ consumption of energy does not necessarily make us happier. Therefore, human society needs to _____ in two ways; technological maturity to power everyone reliably and sustainably, and psychological maturity to find happiness _____ ____ _____ we already have.

Nobody wants to experience 2020 again. Due to the COVID-19 pandemic, we were confined to our homes, a lot of businesses went bankrupt, and millions of people lost their jobs. Despite all this agony, the suspension of economic activities led to only a 4.5% decrease in carbon emissions compared to the previous year. The implication is that the energy issue cannot be solved by simple saving efforts alone. Of course, it is important to cut down on waste. But it will never be enough. Rather, we will need more energy consumption in the future. The world population is going to reach 10 billion, and a billion people still don't have reliable access to electricity. There is a strong correlation between a country's per capita income and the amount of energy used by its people. As humanitarian duties, we have to provide reading light to study in the evenings, refrigeration to store vaccines, and infrastructure to ensure clean and cheap water for all of us on this planet. The world requires more energy so that all of us thrive, including the poorest, but we need to do this without releasing any more greenhouse gasses. This is impossible with existing technologies. Therefore, we have to invest more resources into Research and Development, specifically to improve the capacity and cost performance of batteries, increase the efficiency of renewables, make nuclear fusion commercially viable, establish a smart grid that enables efficient redistribution of power within a community by monitoring energy demand and supply, and so on. At the same time, a number of studies suggest that our well-being and income do not correlate beyond a certain point. Sufficient energy supply is essential to ensure the welfare of us all, but abundant consumption of energy does not necessarily make us happier. Therefore, human society needs to mature in two ways; technological maturity to power everyone reliably and sustainably, and psychological maturity to find happiness out of what we already have.

confine	監禁する		humanitarian	人道的な
bankrupt	破産した、倒産した		refrigeration	冷蔵、冷却設備
agony	苦痛、苦悩		thrive	栄える、よく育つ
suspension	一時的停止、中断		viable	実現可能な
implication	示唆、含意		redistribution	再配分
correlation	相関関係		mature	成熟した
per capita	一人あたり			