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Yemen National Energy Strategy

Starting this essay, I need to preface that *creating an energy strategy in Yemen is almost impossible with the country's political climate*. The conflict in Yemen is regarded by many as one of the worst humanitarian crises facing the world currently. Yemen has previously relied on petroleum for the bulk of its total GDP. However, according to the U.S. Energy Information Administration, oil production has been declining since 2001 due to maturing oil fields and subsequent civil unrest (EIA 2020). While this is not the only natural resource that Yemen possesses, it is one of the most important for economic stability. As stated, oil production has been declining since 2001, but the oil industry in Yemen has suffered casualties as a result of the war with outside forces, namely Saudi Arabia. In order to strategize a plan for the environmental restructuration of Yemen, it is important to first identify the more serious issue which is the civil war occurring within the country's territory. For this, it is imperative to know the history behind the conflict.

The civil war in Yemen can be grouped into a series of political uprisings that started in the early 2010s called the Arab Spring. The countries in the Arab Spring include Tunisia, Libya, Egypt, Yemen, Syria, Morocco, and Bahrain. While Yemen is in the midst of war right now, the civil unrest began as a peaceful protest. The protest was in the advocacy of an end to corruption in the government (the president at the time was going into his 34th year) as well as a more equal distribution of wealth (Guardian 2011). In this article from The Guardian in 2011, Tom Finn cites

a female protestor in Yemen who said, “Saleh is trying to portray this as a conflict between him and al-Ahmar's family when really it's between him and the entire Yemeni people” (Guardian 2011). At the time Ali Abdullah Saleh’s troops were engaged in a small skirmish between Sadeq al-Ahmar’s band of revolvers. The overwhelming majority of non-violent protestors had banded together north of the capital Sana’a while troops of al-Ahmar and Saleh battled within the city’s grounds. During this process, Saleh was injured and fled to Saudi Arabia for medical assistance. Upon returning he was once again met with unrest as citizens wanted him to hand over power to his deputy, Abdrabbuh Mansour Hadi (Arab Center Washington DC 2021). Hadi faced similar opposition as a result of a few factors such as dissolving his cabinet and wanting to split Yemen into six sectors (ACWDC 2021). This is where the shift of power took a major turn.

The Houthis, are part of a specific minority called the Zaydi Shiites. Zaydi Shiites are known for praising Zayd bin Ali who was “The great grandson of Ali, Muhammad’s cousin and son-in-law” (Riedel 2017). In the same article, it is explained that Zayd led a revolution in the Umayyad Empire in 740. Most of the Muslims in countries of Islam are Twelver Shiites (Riedel 2017). The problem is that Zaydi Shiites do not believe in this practice of Islam, but rather, they believe that Zayd should be idolized in the procurement of righteousness. Zaydi Shiites have been fighting for power since the ninth century in northern Yemen. During the turmoil of the state, the Houthis (a family of Zaydi Shiites) have risen up to take advantage of the situation in the violent advocacy of their beliefs.

In March of 2015, Saudi Arabia created Operation Decisive Storm which, with the help of the UAE, Morocco, Jordan, Bahrain, Sudan, Kuwait, and Egypt, aimed to disband the party of Houthis in northern Yemen territory (arabcenterdc 2021). Houthis began tensions in the capital of Sanaa as they believed that Hadi was “just a stooge for Saudi Arabia” (Brookings 2017). As a

result, the action was taken by the Houthis to overthrow the government. While the Houthis had a problem with the legitimacy of Saleh even before the original peaceful protests from the Yemeni people, they banded with Saleh against Hadi on account of his military forces (Brookings 2017). After realizing that the mission was futile on the side of the Houthis and introducing the idea to create a deal with Saudi Arabia, the Houthis then assassinated Saleh. The U.S. was included in the coalition created during Operation Decisive Storm as it provided arms for the war in order to get closer intelligence on smaller terrorist groups such as al-Qaeda while preserving peace among nations (Brookings 2017). In all of this turmoil, to make things worse, in January 2018 the Southern Transitional Council of the United Arab Emirates seized control of the southern port cities of Yemen in order to gain an economic advantage in the war and the aftermath (arabcenterdc 2021).

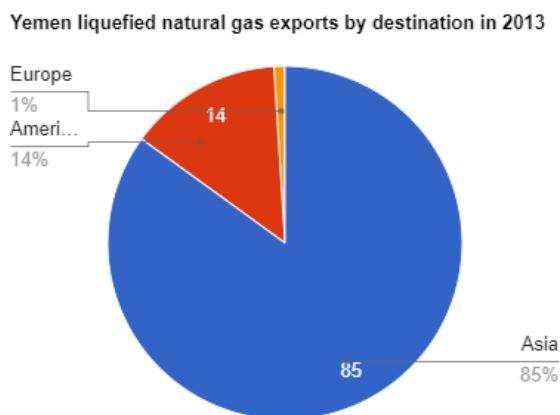
In the present day, the war is still raging on and there does not seem to be a light at the end of the tunnel for the conflict unless the parties of the war sign an armistice. However, with tensions escalating, the war is approaching higher death tolls for both Yemen and Saudi Arabia. Not only are the citizens in Yemen becoming innocent martyrs to destruction through the various bombings carried out as a part of Operation Decisive Storm, but many are also surviving on diminished rations. Citizens of Yemen are also dying as a result of inadequate access to crucial resources such as water and food. Both sides of the war are also taking a hit in their energy sector as the main targets of attack are oil tankers and reserves. This will have implications down the line for Yemen as oil accounts for much of the GDP and has been diminishing throughout the years, but I will illustrate this later in my essay. Meanwhile, the U.S. government is facing a major backlash as arms that have been provided for Operation Decisive Storm have accounted for many of the civilian casualties in Yemen. This may have also had implications for the war

and the future state of Yemen depending on how much influence the U.S. public and media have on the militaristic operations in alliance with Saudi Arabia. Now that I have identified the core problem that the country is facing, I can proceed with a layout of current decisions as well as my own strategy. I need to preface that some of the data may be reliant on findings before the civil war in Yemen since it has been treacherous for outside data-gathering agencies to find information.

As stated earlier in the essay, while it is not one of the top producers in the general middle east, Yemen relies on oil for many of its domestic needs as well as a means of generating wealth for the country in terms of exports. Right now, Yemen's oil and natural gas sectors are overseen by the Ministry of Oil and Minerals (MOM). Still, much of the oil production is accounted for by foreign operators, namely Nexen, which "is a subsidiary of the China National Offshore Oil Corporation" (EIA 2020). According to the International Monetary Fund, "Figures show that 63% of government revenues came from the hydrocarbons sector between 2010-2012, and that hydrocarbons accounted for 89% of total export revenues." (EIA 2020). Asia is a crucial source of wealth for Yemen as "more than three-fourths of Yemen's petroleum products went to destinations in China" (EIA 2020). However, in the same article by the EIA, officials state that oil production in Yemen has been falling and that the country is trying to replace export revenues and domestic use of oil with domestic use and export revenues from natural gas, specifically liquified natural gas (LNG).

The country switched focus from oil and gas around 2009 and since has been advocating for the replacement of oil with natural gas for domestic consumption. Before this, much of the natural gas produced had been injected back into oil extraction operations (EIA 2020). In fact, in 2009, 98% of the natural gas extracted was repurposed to extract oil. Yemen has been making

strides as natural gas production rose almost 13 times the level of extraction in 2009. Regardless, this process has been halted by the war, but the country will have a tough time implementing measures to switch prominent energy from oil to natural gas. Another reason for this is the fact that Yemen also exports a lot of the LNG it has, especially to Asia, which can be seen in this



graph:

It is reported by the

EIA that in 2013, around 90% of the LNG produces was exported. Furthermore, a model from the EIA from 2013 shows that 80% of the electricity in Yemen is generated through oil while only 20% is natural gas. In the same subsection of the article, it is reported that energy security needs to be fixed before the switch becomes feasible as data from the World Bank illustrated that only about 40% of the Yemeni population has access to this electricity. In a report by the International Energy Charter titled “Energy Investment and Business Climate Report for Observer Countries,” the authors illustrate Yemen’s plans for a more sustainable country, writing, “Yemeni government policy on renewable energy is to optimize the use of energy from domestic sources, increase renewable energy in electricity generation to 15 to 20 percent by 2025, and promote sustainable development within the electricity sector” (IEC 2016). The initiative has been started by the UN with the introduction of the Enhanced Rural Resilience in Yemen project

giving jobs to a decentralized workforce to help them advocate for solar in the country (UN 2017). Similarly, the Mocha Wind Park Project is proposed to erect wind turbines throughout the country. However, the biggest environmental threat to the sustainability of the country is the water supply.

Even before the civil war, Yemen had problems with water security. In an article written for *The Century Foundation* written in 2020, authors Helen Lackner and Abulrahman al-Eryani detail the severity of the lack of action. In the article, the authors state that the World Bank estimated in 2010 that groundwater reserves would be depleted by 2040 and that 90 percent of the water in Yemen is for agriculture. While the authors state that water conservation sectors have been created through the Water Law (sprouted in 2002 and finalized in 2011) these agencies have had relatively little influence (Lackner, al-Eryani 2020). Furthermore, under Saleh's rule, the extraction of fossil aquifers has continued thus creating an even more pressing issue for the country. These problems are exacerbated by the fact that Yemen's population is steadily increasing, the sea is beginning to rise, and rainfall in the country is becoming extremely volatile with some years seeing floods from sustained downpours while other years see barely any rainfall (Lackner, al-Eryani 2020).

Another main problem that needs to be addressed immediately before any plans for sustainability in the country can become feasible in the slightest is the looming threat of a giant oil tanker off the coast of Yemen. In an article of April of this year, the UN details the threat of one of history's largest oil spills from the vessel called FSO Safer. In the article, the authors explain why the tanker is one of the biggest threats to the energy security of the country as it contains over 1.1 million barrels of oil which is "four times the amount of the Exxon Valdez - the tanker that caused one of the greatest environmental disasters in United States' history" (UN

2022). Both parties in the war have advocated a project to rebuild a new tanker to replace the FSO Safer, which has not been repaired since the beginning of the conflict in 2015, however, the UN wrote that the plan needed funding (80 million) by September to start the project as threats of leaks or bombings increases every day.

Clearly, Yemen has a multitude of problems threatening all sectors of life from the economy to domestic safety to environmental sustainability. It is clear that besides the replacement of the FSO Safer, curtailing the war is the top priority for the environmental safety of the country. For this, there is no clear answer, especially because the civil war is one of beliefs. If the country wants to get back on track with environmental goals, the first step is to either create an armistice, successfully defeat the Houthi rebels, or reintroduce a splitting of the country into sectors of influence (The idea proposed by Hadi before the Houthi takeover). If this problem is not solved, the country will disintegrate before any environmental security action can be taken. Already, the news is constantly sprouting about reserves and pipelines targeted by both the Saudi Arabia coalition and the Houthis. If nothing is solved aggression will continue to escalate with more serious implications for the Yemeni people. While this problem is not as simple as that, it wouldn't be a National Energy Strategy if I did not focus on the environmental problems Yemen is facing aside from the war.

Assuming that there is a light at the end of the tunnel in terms of the end of the civil war, the next issue is the water crisis. Already, non-profit organizations such as Unicef and Islamic Relief USA have started missions to provide Yemeni citizens with clean water but Yemen cannot rely on this charity forever. I think the root of this problem relates back to the lack of power that the Ministry of Water and Environment, as well as the National Water Resources Authority, have under the Water Law that was finalized in 2011. Although the most recent information on the

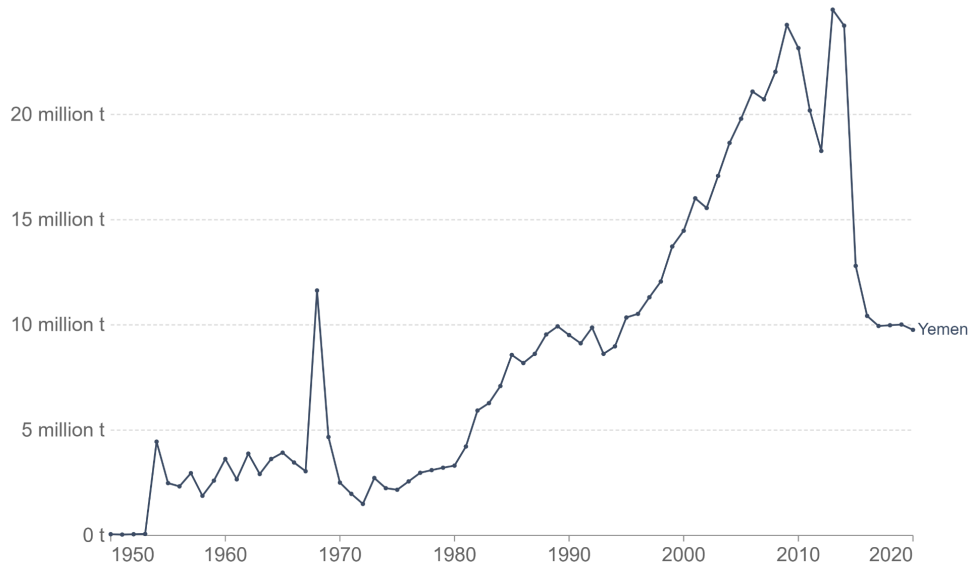
state of affairs for these sectors dates back to the end of Saleh's ruling, it can be credibly assumed that not much has changed as a result of the bigger conflict. If these agencies had more power, the prime objective would be to de-centralize focus around crop production and reallocate a fraction of the 90% of agricultural use water towards the citizens in the country. On top of that, these agencies either need to build more efficient pipelines to villages outside of major cities and/or allocate more resources to water access and transport throughout major cities. Right now, immigration into cities has already started as the citizens in the countryside have limited access to water with the long periods in between shipments. Another issue is the rising sea level near coastal cities. According to the article for *The Century Foundation*, increased water levels have led to the higher salt content in the aquifers of three prominent coastal cities including Hodeida, Lahj, and Abyan (Lackner, al-Eryani 2020). Therefore, the best plan would be to allocate more funds to the sector so that the desalination process can be streamlined. Of course, this would mean hiring more specialized workers and funds taken from another sector, but the caveats of this proposition will be expanded later in the essay.

The next issue is the transition to renewable energy sources, namely solar and wind, as the country is naturally gifted with high UV levels and strong winds. Before I do propose a strategy for this change, I should first state that Yemen's pollution itself is not a major threat to global warming. In fact, according to figures from Our World in Data, annual carbon dioxide emissions in Yemen are around 10 million tons in 2019 while annual emissions in Saudi Arabia were around 600 million (ourworldindata 2019). Saudi Arabia produces approximately 60 times more carbon dioxide with a difference of only 5 million in population compared to Yemen which has about 29.8 million citizens. This means that in terms of carbon emissions, Yemen is relatively low compared to a powerhouse like Saudi Arabia even with populations that are

relatively close. The graphs below exhibit this data:

Annual CO₂ emissions

Carbon dioxide (CO₂) emissions from the burning of fossil fuels for energy and cement production. Land use change is not included.



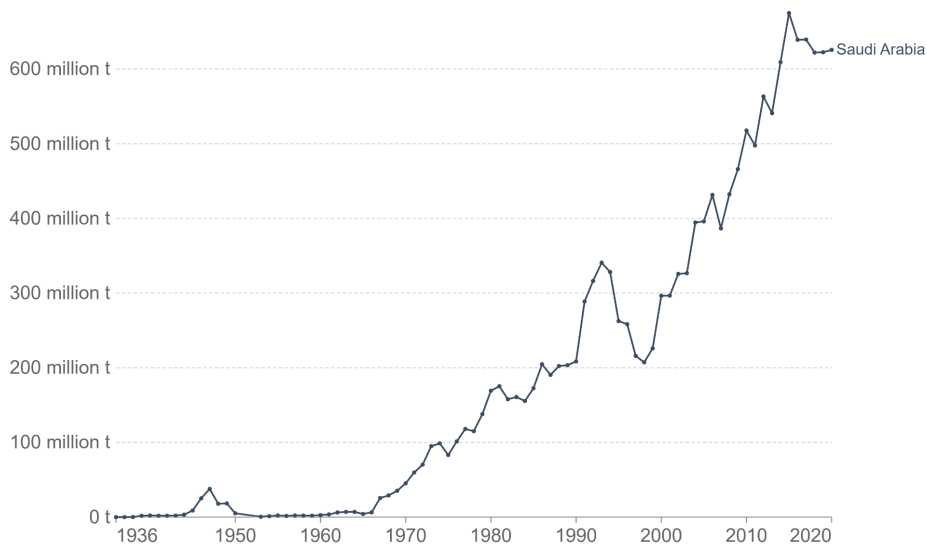
Source: Global Carbon Project

OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

(Yemen)

Annual CO₂ emissions

Carbon dioxide (CO₂) emissions from the burning of fossil fuels for energy and cement production. Land use change is not included.



Source: Global Carbon Project

OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

(Saudi Arabia)

Yemen has leeway when it comes to a clean energy transfer. This may be in part the reason that the projections for renewable energy are set at 15-20% by 2025. Nevertheless, it is

important that Yemen is steadfast in its focus on renewable energy for domestic sustainability. Data from World Bank illustrated earlier in this essay revealed that only about 40% of citizens have access to electricity. Because of the potential for solar and wind energy, the implementation of these resources would allow the country to increase the electricity available to its citizens. In an article written by Andrew Raven for the *International Finance Corporation*, he states that more than 50% of the population is reliant on solar power for their daily needs. These grids are being targeted by the Saudi Arabian coalition, however, they are crucial for individual families as well as shops, schools, and hospitals (Raven 2021). As mentioned earlier the UN has already started the Enhanced Rural Resilience in Yemen project as a means of supplying paying jobs while implementing solar power on a wider scale. As already stated, new agencies were created to accommodate the Water Law that was finalized in 2011. In 2009, the Yemeni government created the Electricity Law in which the Ministry of Electricity and Energy oversaw the operations for renewable energy implementation (IEC 2016). That said, I think it would be beneficial for the UN to communicate with this sector closely if not transferring the EERRY into the Ministry's hands.

I have presented viable solutions for a campaign toward an energy secure country but there is still the question of finances and approval from the government of Yemen as well as its citizens. To restate, none of these solutions are possible without a stop to the war, however with an assumed end in sight there are logical ways to address the obstacles above.

The first problem stated was the issue of the FSO Safer, solutions are already underway as this is a pressing matter. According to a UN article on the issue, authors state that there are already strides being made with the planning. It is stated that "The plan has received the backing of the Yemeni Government, based in Aden, while a memorandum of understanding has been

signed with the *de facto* authorities in the capital, Sanaa, who control the area where the FSO Safer is located” (UN 2022). Furthermore, the authors of the article also stated that a pledging conference is said to be held this month to address how to raise funds. Because an oil spill would affect all trade around the Yemen/Oman peninsula, I think it would be in the best interest of all countries attending the conference to contribute agreed-upon amounts to reach the \$80 million needed for a new tanker. To carry out this objective the countries may utilize different methods whether that be higher taxation, charitable donations, reallocation of funds from a set of sectors in the countries’ economies, or a combination of these factors. Again, because of the urgency, this problem is already on track for a viable solution that we can see implemented in the near future.

The next problem I offered a solution for was the issue of the water crisis within Yemen. I stated that there should be a transfer of responsibility from charitable organizations like Unicef into the hands of the Ministry of Water and Environment and the National Water Resources Authority. Alongside this solution, more water should be allocated for societal use among civilians instead of towards agriculture. This problem has more unknown than the issue of the FSO Safer as the war thwarted any plans to legitimize the power of the agencies listed above because agricultural production is the second biggest contributor to Yemen’s total GDP next to oil. Assuming that the war is solved, the best plan of action would be for government legislation to be enacted in order to legitimize the agencies. This way, the officials of the agencies could personally oversee the water consumption and reallocate water to communities in need in the prioritization of subsistence farming and personal intake. Garnering domestic support for this project would be facilitated by the fact that Saleh’s agriculture regime was really in support of his own gain. The MWE and NWRA would need to create legislation that listed specific goals

for the country as agriculture is still a factor in the economy even if the exports of agricultural items are relatively low compared to the GDP accumulated through the oil trade. There would need to be a replacement for the money lost with fewer agricultural products, but I think that if the agencies start by taking only a fraction of the water away from the agriculture sector at a time, solutions might sprout on goods or services that could replace agriculture products.

The most ambiguous issue that I offered a solution to is the transfer to renewable energy. It is clear that the Yemeni government has made small steps toward the direction of renewable energy but it still has a ways to go. Again, luckily the country does some leeway as it produces much less pollution compared to countries like Saudi Arabia, Russia, the U.S., etc. The main obstacle would be figuring out a way to garner public support for a project that would undoubtedly be detrimental to the Yemen economy in the short run. As I stated earlier in the essay, Yemen's oil accounts for 89% of the country's total exports. Furthermore, in an article written for *Chatham House*, an independent policy institute, author Peter Salisbury reveals that 70 to 80 percent of government revenue is earned through the production of crude oil (Salisbury 2011). This data is from 2011 which means that there have no doubt been major shifts in the amount of oil produced as well as the amount of foreign investment in the oil industry as a result of the civil war in Yemen. In a way, Yemen has already fell victim to the Dutch disease because of how much the country relies on oil for revenue. Because of this any attempts to pull focus away from this sector would undoubtedly cause damage to the overall economy. In a country where major oil reserves and pipelines have been targeted through war, switching away from oil has been made an even more difficult process as many citizens still rely on oil for electricity and transportation, even if those citizens make up a fraction of the total Yemeni population. The country has already set up the goal of 15-20% renewable energy by 2025 as well as an Electricity

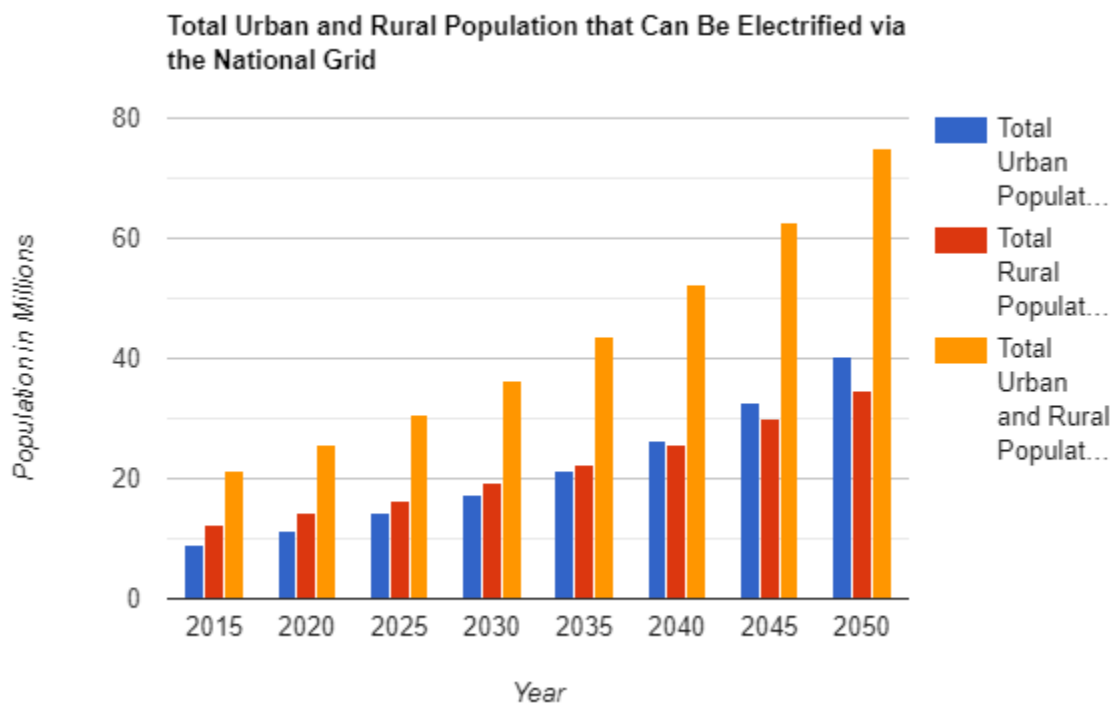
Law, but even more important, the government (specifically the Ministry of Electricity and Energy) needs to make this process feasible for the struggling population by creating job campaigns where workers can be taught and paid to set up/operate wind turbines and solar panels as well as repair and enlarge the grids that have been targeted by bombings in the civil war. This campaign would require both private and public as well as foreign and domestic investors in order to be able to function properly to keep Yemen on track to be able to provide power for the whole population. In this regard, it will be fruitful to create and understand energy projections in Yemen during the next 20 years.

For this part of the essay, I will rely on standards and data already set out by the the *International Energy Charter* in a study titled “Conflict Reconstruction Strategy Study for the Electricity and Energy Sector of Yemen.” The article was written in 2019 by Dr. Towfick Sufian, the Energy Charter Secretariat of Yemen. In this reconstruction strategy, Dr. Sufian proposes 3 strategy scenarios:

1. (minimum requirement) which would require average electrical energy per capita (AEEPC) to be 402 Watt-hours (Wh)/year
2. (medium requirement) which would require AEEPC to be 730Wh/year
3. (high requirement) which would require AEEPC to be about 1,460 Kilawatt-hours/year

These scenarios are based on expectations for the year 2050 and require nuanced power output to cities and rural areas. As Dr. Sufian details, Yemen has a very rugged and mountainous terrain and thus details specific propositions for rural and urbanized portions of Yemen. For these projections I will be mainly focusing on cities and towns that can be connected to the main power grid of Yemen. As stated earlier, 50% of the population is already reliant upon personal solar power. Additionally, as a result of the water crisis, there is already mass immigration into

the major cities due to the increased access to water. For these reasons, it is important to assume that through the help of UN and later assistance from the Ministry of Electricity and Energy, citizens in rural areas will have access to solar photovoltaics (PV) as the water extraction process for subsistence farming has already seen a mass transfer from diesel fueled pumps to solar fueled pumps. This would still be a large scale project as Dr. Sufian notes that 80 million citizens could realistically be connected to the main power grid while it is projected that just over 20 million citizens would need to find their own source of electricity. The graph below shows the projections that Dr. Sufian created for citizens that could be connected to the main power grid by 2050:



While fossil fuels are the main source of electricity, Yemen has amazing potential in terms of renewable energy resources. Another table by Dr. Sufian shows the potential for all renewable energy resources in Yemen:

		Technical Potential	Technical Potential
Resources	Theoretical Potential (MW)	Gross (MW)	Practical (MW)
Solar CSP	2,446,000	1,426,000	18,600
Wind	308,722	123,429	34,286
Geothermal	304,000	29,000	2,900
Solar Thermal	3,014 (MW thermal)	378 (MW thermal)	278 (MW thermal)
Biomass (Landfill Gas)	10	8	6
Total	3,061,746	1,578,815	56,070

Source: MOEE “Renewable energy Strategy and Action Plan Study Report” - 2008

Dr. Sufian goes on to reveal how with Solar SCP and Wind alone, “Yemen can generate the electricity needed for all sectors of development until the year 2100” (Sufian 2019). However, many of these numbers are speculative and stand to change with the implications of the civil war. Dr. Sufian follows these details by referring to the three strategy scenarios and labeling the power plants that could provide energy (the power plants include a mix of unsustainable and sustainable plants). However, the subsequent question that needs to be addressed is how to help citizens that rely on fossil fuels for their energy turn to solar and other options. For this, Dr. Sufian produces a range of ideas such as the “cancellation of all types of taxes and custom duties on photovoltaic system components,” establishment of unified pricing for the PV systems, monitoring of the market, and promotion of solar energy and environmental advocacy (Sufian 2019). On the end of funding, Dr. Sufian proposes that energy generation and distribution should not solely be limited to the public sector and offers a range of possible investors ranging from the Yemeni government all the way to non-Arab investors. The project for a switch to renewable energy would not be possible without investors. Although there are proposals for major strides in

the coming years, it is also important to remember that Yemen will continue to rely on oil exports in order to fund their country. That said, if investors (both public and private) can help with the funding for the renewable energy project, citizens only need to keep an open mind while slowly substituting any fossil fuel engines for Solar PVs. These plans seem feasible with the possible end to the war in sights, however there is still the problem of water that cannot be overlooked in the projections for the next twenty years.

As I detailed earlier in my essay, water is the most pressing concern of the country behind the FSO Safer. However, Dr. Sufian does not detail this threat in his exposition article. In fact, there are not many feasible answers for this problem. As I stated earlier in this essay, there are a couple ideas I have in mind including a reallocation of water away from agriculture. Before this happens there needs to be a legitimization of the agencies overseeing water consumption: “The MWE and NWRA would need to create legislation that listed specific goals for the country as agriculture is still a factor in the economy even if the exports of agricultural items are relatively low compared to the GDP accumulated through the oil trade.” These groups would need to make it known that it is crucial to give priority to the water sector in the face of many other environmental issues. Yemen is expected to run out of water by 2050 and if there is no water, any solution to environmental sustainability becomes null. All of the work that Dr. Sufian conducted would not matter as it can reasonably be assumed that there would be mass emigration from the country, therefore leaving few workers to maintain major power plants and initiatives. This brings me to my conclusion.

It is clear that the environmental case for Yemen is a complicated one with many nuances. In theory this paper could be over 100 pages with how many problems the country is facing today. Much of the information I provided may not be enacted if the war in Yemen

continues, however, this paper was written on the assumption that a plan would be procured to help opposed forces see eye to eye. The main three problems in the country are the FSO Safer, the lack of energy security of water, and the transition to a country run by renewable energy. There are already set plans for the replacement of FSO Safer and a transition to renewable energy, however, these are reliant upon resilience, responsibility, and funding. If laws and agencies are not abided by, the country will have no opportunity to create a better future for itself. Furthermore, if there is no outside funding or personal investment from the government, the world will see Yemen deteriorate over the next 20 years with deaths reaching higher and higher totals. It will not be an easy journey by any means but the main solution is for the Yemeni government as well as the citizens to remain steadfast in their diligence to make the country a habitable community for generations to come.

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