From Darkness to Light:

How Sub-Saharan Africa has progressed towards universal access to sustainable energy

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Website Link: https://ayusuf9.github.io/Data-Visualization/

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Project Goals

Access to energy is a basic prerequisite for human development and poverty alleviation in modern life. While global access to electricity has increased from 79% in 2000 to 91% in 2020, regional disparities remain wide. Sub-Saharan Africa in particular, has remained the least electrified region, with its access to electricity increased by a mere 16% from 27% in 2000 to 43% in 2020.

In view of the challenge faced by the global community in achieving universal access to energy, the United Nations General Assembly established Sustainable Development Goal 7 (SDG 7): Affordable and Clean Energy as one of 17 Sustainable Development Goals in 2015. SDG 7 aims to ensure access to affordable, reliable, sustainable and modern energy for all by 2030. Our project aims to provide a comprehensive overview of the progress of Sub-Saharan Africa towards achieving SDG 7 with a focus on examining its access to electricity, renewable energy, as well as international financial flows with respect to the individual indicators of SDG 7. Through the use of interactive visualizations, our project aims to inform policymakers, development practitioners, organizations, and the general public about the current status, challenges and opportunities in Sub-Saharan Africa along its journey towards achieving universal access to electricity and sustainable energy. We hope to raise awareness and inspire both individual and concerted efforts to ensure that no one is left behind in this global quest for sustainable energy for all.

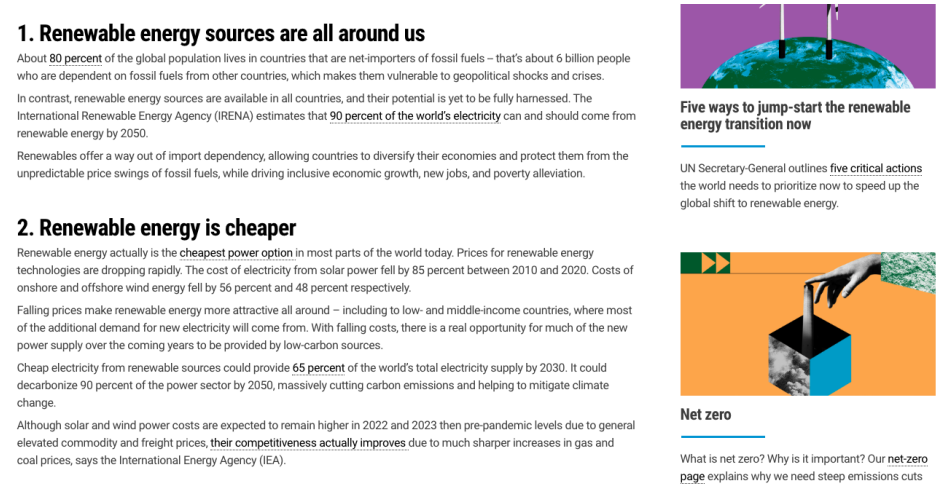
Related Work

1. **Article "Renewable energy–powering a safer future"** (https://www.un.org/en/climatechange/raising-ambition/renewable-energy)

This article introduces key benefits and potentials of renewable energy, and includes several data comparing renewable energy with traditional energy, such as the number of population dependent on fuels, the price drop of renewable energy, and how much electricity could be produced by renewable energy.

Since the potential of renewable energy is part of the narrative of our project–transitioning from the energy poverty in Sub-Saharan Africa to the renewable energy investment and progress–this article provides valuable data points and information to be visualized in our website.

However, all of the data and information in this article are presented merely in text, making it difficult for the audience to have an intuitive understanding. Hence, it also provides opportunities for us to visualize the information in our project.



1. Renewable energy sources are all around us

About 80 percent of the global population lives in countries that are net-importers of fossil fuels – that's about 6 billion people who are dependent on fossil fuels from other countries, which makes them vulnerable to geopolitical shocks and crises.

In contrast, renewable energy sources are available in all countries, and their potential is yet to be fully harnessed. The International Renewable Energy Agency (IRENA) estimates that 90 percent of the world's electricity can and should come from renewable energy by 2050.

Renewables offer a way out of import dependency, allowing countries to diversify their economies and protect them from the unpredictable price swings of fossil fuels, while driving inclusive economic growth, new jobs, and poverty alleviation.

2. Renewable energy is cheaper

Renewable energy actually is the cheapest power option in most parts of the world today. Prices for renewable energy technologies are dropping rapidly. The cost of electricity from solar power fell by 85 percent between 2010 and 2020. Costs of onshore and offshore wind energy fell by 56 percent and 48 percent respectively.

Falling prices make renewable energy more attractive all around – including to low- and middle-income countries, where most of the additional demand for new electricity will come from. With falling costs, there is a real opportunity for much of the new power supply over the coming years to be provided by low-carbon sources.

Cheap electricity from renewable sources could provide 65 percent of the world's total electricity supply by 2030. It could decarbonize 90 percent of the power sector by 2050, massively cutting carbon emissions and helping to mitigate climate change.

Although solar and wind power costs are expected to remain higher in 2022 and 2023 then pre-pandemic levels due to general elevated commodity and freight prices, their competitiveness actually improves due to much sharper increases in gas and coal prices, says the International Energy Agency (IEA).

Five ways to jump-start the renewable energy transition now

UN Secretary-General outlines five critical actions the world needs to prioritize now to speed up the global shift to renewable energy.

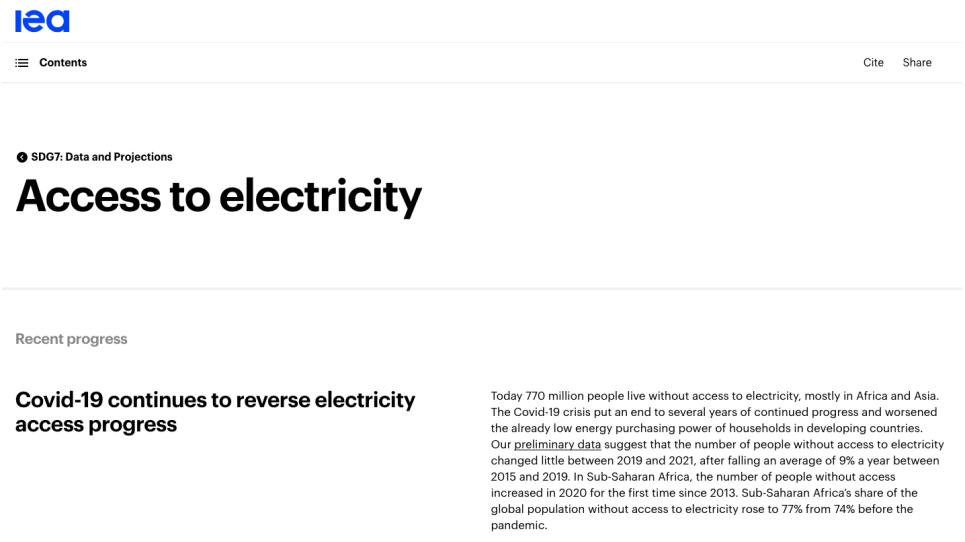
Net zero

What is net zero? Why is it important? Our net-zero page explains why we need steep emissions cuts

2. **Website "IEA–Access to electricity"**

(https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity)

This website provides data sets for the access to electricity of the world by year. Since our project aims at tracking and evaluating the SDG 7 progress in Sub-Saharan Africa, the IEA website provides highly relevant information and examples of visualizations. Users can choose from certain regions or countries, and examine how the access rate has changed over time.



iea

Contents Cite Share

SDG7: Data and Projections

Access to electricity

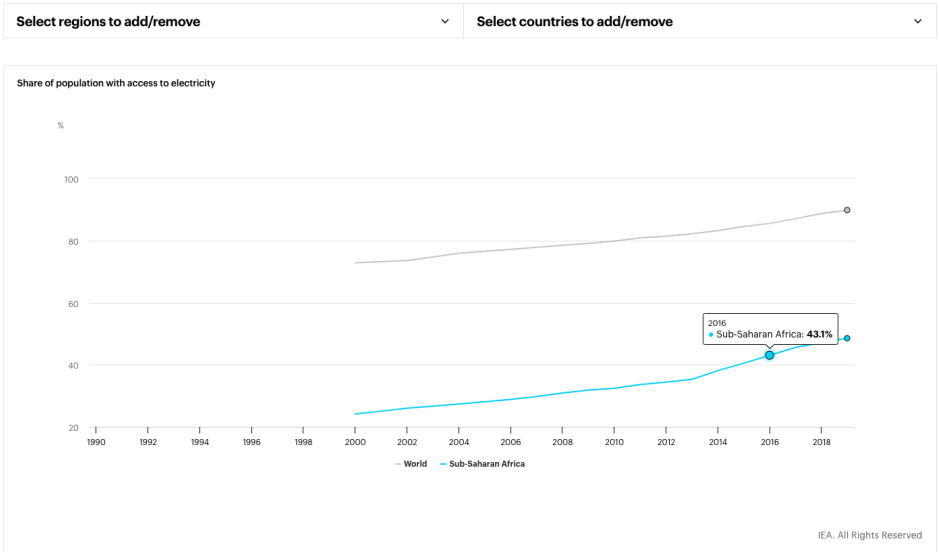
Recent progress

Covid-19 continues to reverse electricity access progress

Today 770 million people live without access to electricity, mostly in Africa and Asia. The Covid-19 crisis put an end to several years of continued progress and worsened the already low energy purchasing power of households in developing countries. Our preliminary data suggest that the number of people without access to electricity changed little between 2019 and 2021, after falling an average of 9% a year between 2015 and 2019. In Sub-Saharan Africa, the number of people without access increased in 2020 for the first time since 2013. Sub-Saharan Africa's share of the global population without access to electricity rose to 77% from 74% before the pandemic.

However, since this website doesn't have a specific focus on any regions of the world, it requires the users to manually select countries of interest. It provides

opportunities for our project to select, group, and highlight regions for the users, as well as extracting and calculating some further information, so that users could have a more focused and in-depth understanding for the progress in Sub-Saharan Africa.

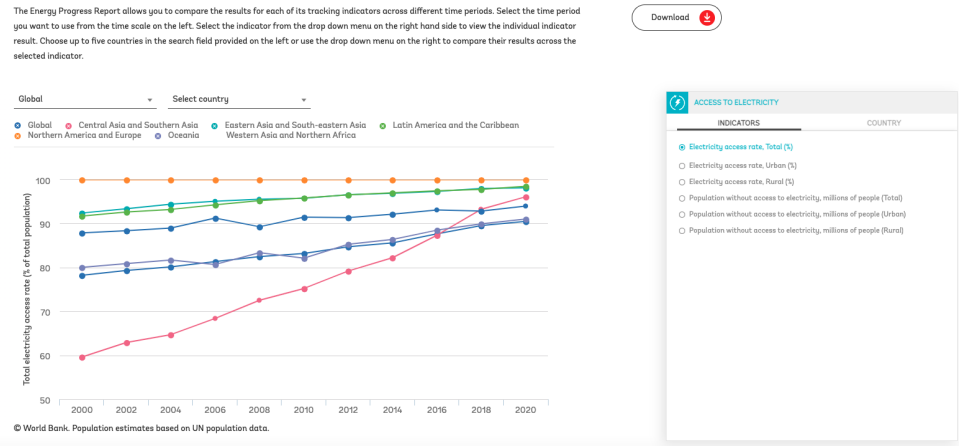


3. **Website "Tracking SDG 7"** (https://trackingsdg7.esmap.org/time)

Similar to the IEA website, this website provides data sets of the SDG 7 indicators across the entire world. Users can switch among indicators, choose from certain regions or countries, and examine how it has changed over time.

However, it has the same limit as the IEA website: it doesn't focus on a specific region of the world, and it lacks a narrative to engage the users. The only format of viz are line charts of different indicators. In addition to grouping, highlighting, and comparing specific regions to enhance the topic, it provides opportunities for our

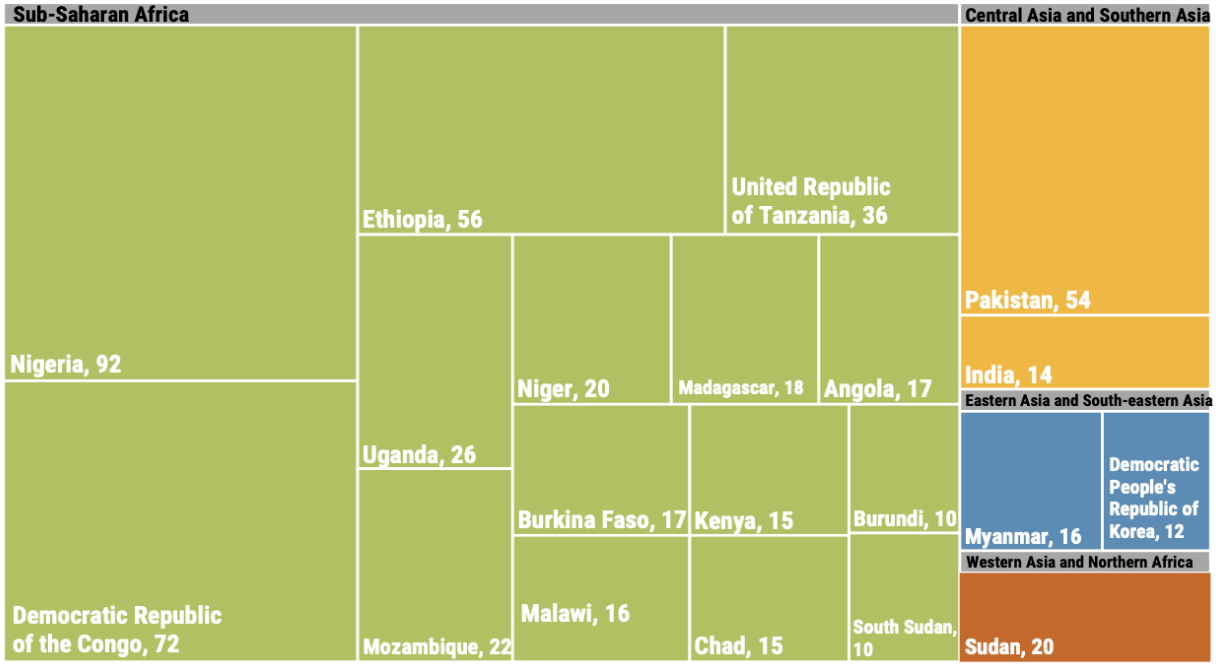
project to use a storytelling strategy and integrate different indicators to engage the audience.



4. **Tracking SDG 7: The Energy Progress Report 2022**
   (https://trackingsdg7.esmap.org/downloads)

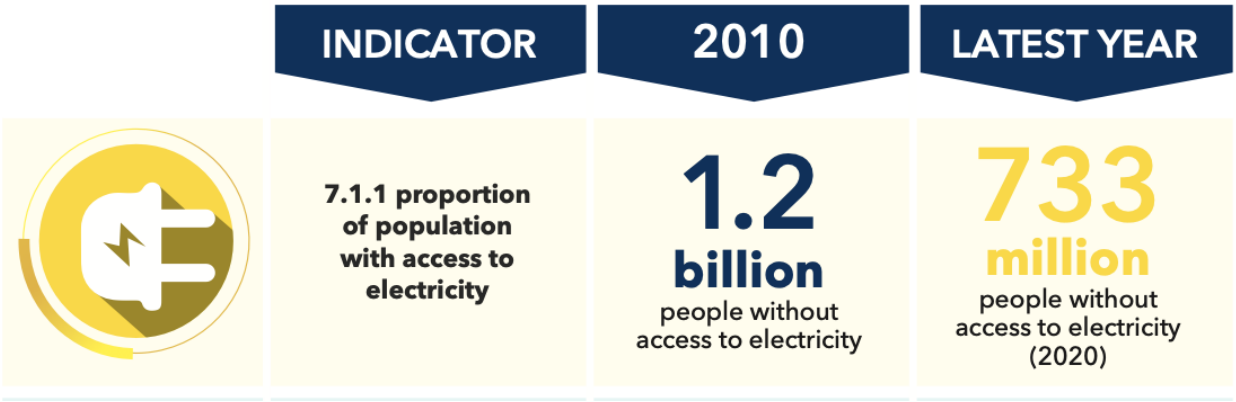
This report is a joint work of the five custodian agencies, including the World Bank, the International Energy Agency, the International Renewable Energy Agency, the United Nations, and the World Health Organization. It provides a comprehensive overview of the progress made towards achieving SDG 7 on a global scale. This report highlights the significant disparities in access to electricity, particularly with Sub-Saharan Africa being the least-electrified region as of 2020. While this report provides a valuable global perspective, it offers a high-level overview that may not fully capture the unique statuses and challenges faced by individual regions. This presents an opportunity for our team to fill in the gap by examining the progress of SDG 7 on a more localized level, by focusing on studying Sub-Saharan Africa's energy development.

FIGURE ES.3 • Number of people without access to electricity in top 20 access-deficit countries, 2020 (millions)



Source: World Bank 2022.
Note: A country's access deficit is the number of people in the country that lack access to electricity.

Furthermore, the report enables our team to gain a better understanding of each of the individual targets and indicators for SDG 7. For example, SDG 7.1 aims to ensure universal access to affordable, reliable, and modern energy services by 2030 and its specific indicator being the proportion of population with access to electricity. This information has been instrumental in guiding the structure and visualizations for our project.



5. Renewable Energy market Analysis: Africa and its Region

(https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jan/IRENA_Market_Africa_2022.pdf?rev=bb73e285a0974bc996a1f942635ca556)

This report was published by IRENA (International Renewable Energy Agency) in 2022. It provides a comprehensive analysis of Africa's renewable energy landscape, both on the regional and sub-regional levels. The report emphasizes the varying energy profiles among different sub-regions in Africa as well as the uneven distribution of financial support, indicating the importance of focusing not only on examining the sustainable development of Sub-Saharan Africa as a whole, but also analyzing the progress of its individual sub-regions within it (i.e. Eastern Africa, Central Africa, Southern Africa, and Western Africa). This report is relevant to our project, in particular, it provides valuable information and data as we examined SDG 7.2 and 7.a on the share of renewable energy in Sub-Saharan Africa as well as the international financial flows in support of its sustainable energy development.

Figure 2.46 Total primary energy supply in Central Africa, by source, 2018

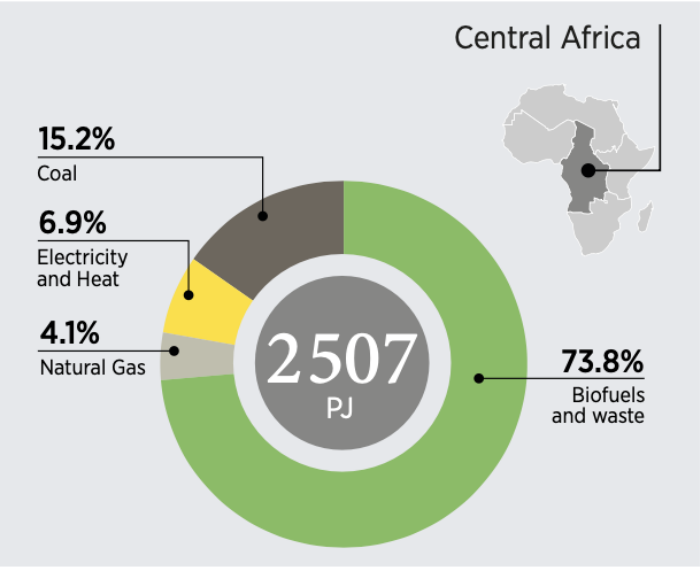
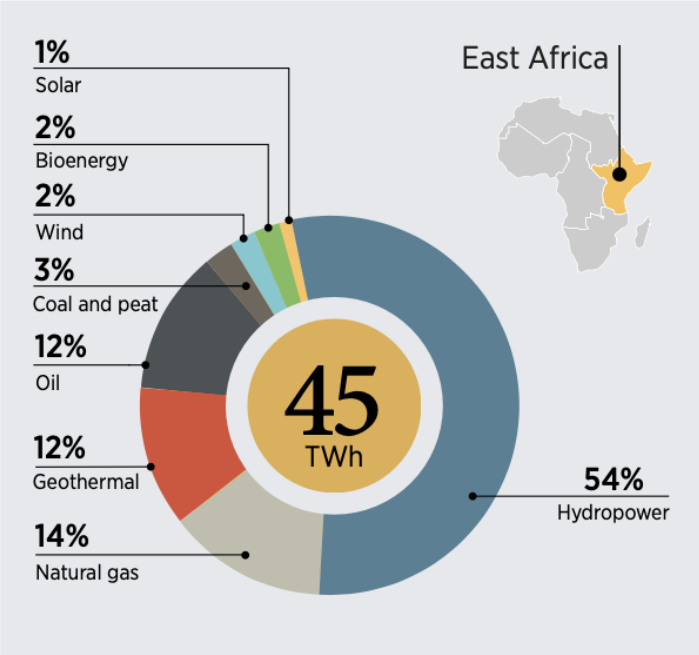
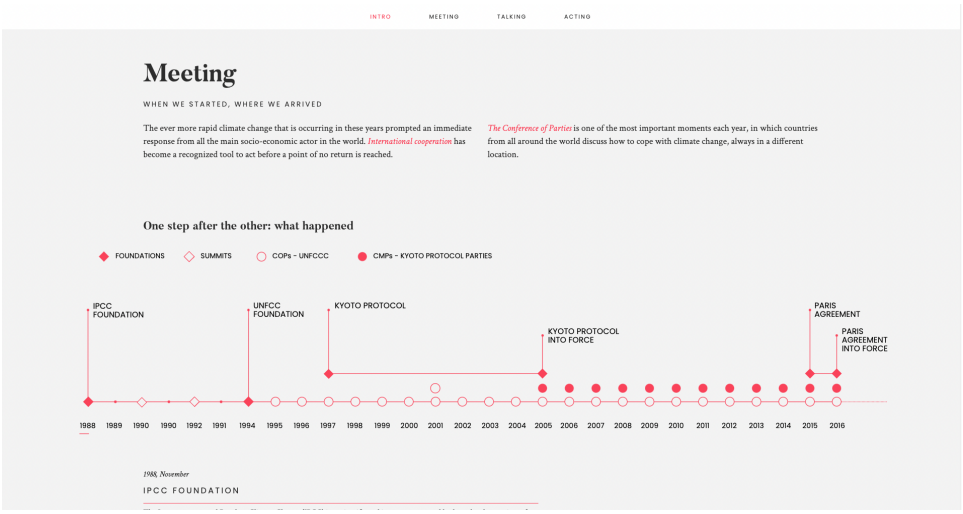


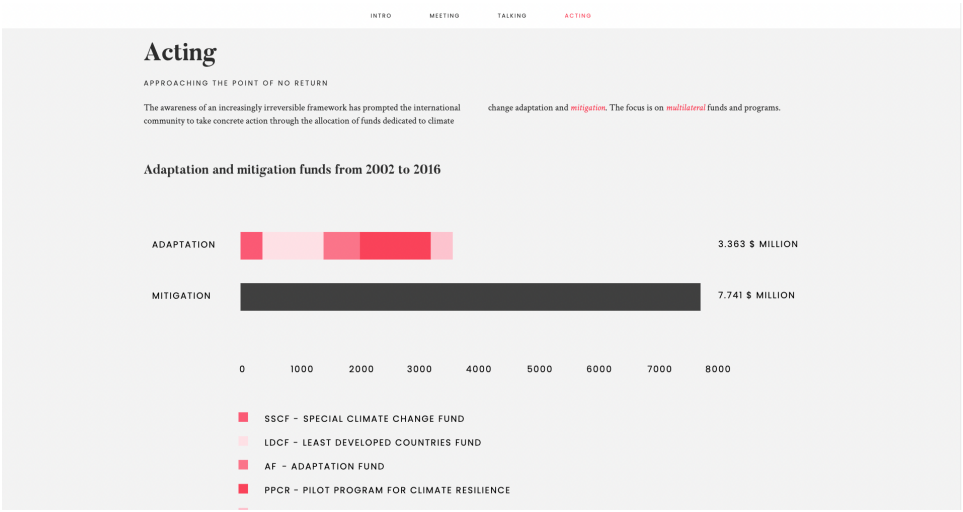
Figure 2.40 Electricity generation in East Africa, by source, 2019



6. **The Point of No Return: How The World Is Adapting To Climate Change** (https://densitydesign.github.io/teaching-dd12/es01/group01/)

This website showcases a visualization project on climate change, more specifically, it examines the international financial flows dedicated to climate change adaptation and mitigation. While this project has a very different focus as compared to ours, it nonetheless serves as an invaluable reference that has inspired the structure and design of our website. For instance, it begins with a high-level overview of the current situation of climate change, which we found very useful in engaging the audience and enabling them to quickly understand the problem space. Moreover, the website has a very consistent design throughout, with the color palette being used consistently and a layout with clear visual hierarchy.





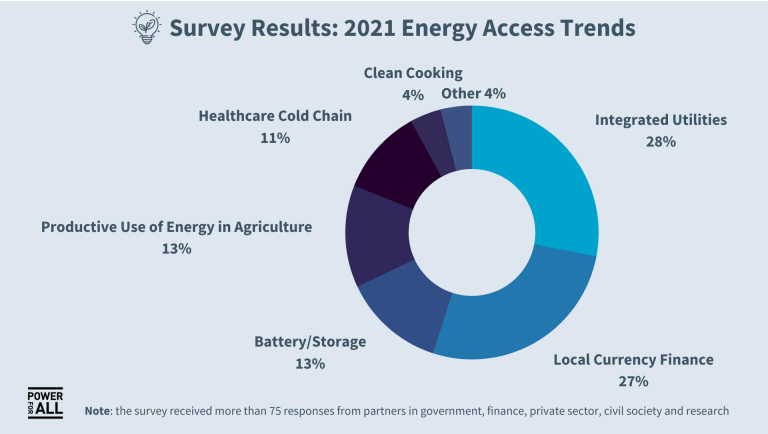
7. The Top Trends for Energy Access in 2021

([Trends for energy access and distributed renewable energy in 2021. (powerforall.org)](powerforall.org))

In this project, the deployers looked at Power for All's 2021 annual top trends for energy access. Power for All is an organization that works to promote decentralized renewable energy as a key solution to global energy access. In 2021, they asked their partners and leading market analysts for their input on the top trends for energy access in the coming year.

The top trends they identified include:

The link between energy access and universal healthcare: Energy access is essential for providing basic healthcare services, such as lighting, neonatal warming, sterilization, and internet access. In 2021, there will be a major focus on solving this systemic challenge.

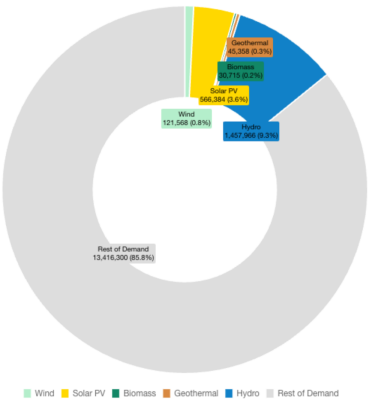


Tariffs and the integrated energy tangle/tango: Tariffs are a major barrier to energy access, especially in off-grid markets. In 2021, there will be a focus on developing integrated energy markets that can help to reduce tariffs and make energy more affordable.

The growing importance of end-user demand in driving energy access: End-users are increasingly demanding access to clean, affordable energy. In 2021, there will be a focus on understanding and responding to end-user demand in order to drive energy access.

These trends are important because they highlight the challenges and opportunities that lie ahead in the fight for energy access. By understanding these trends, we can better develop and implement policies and programs that will help to ensure that everyone has access to the energy they need to live a healthy and productive life.

8. **ISEP Energy Chart is a data visualization project that uses data analysis to interpret the rapid development of renewable energies.**
   (https://isep-energychart.com/en/)

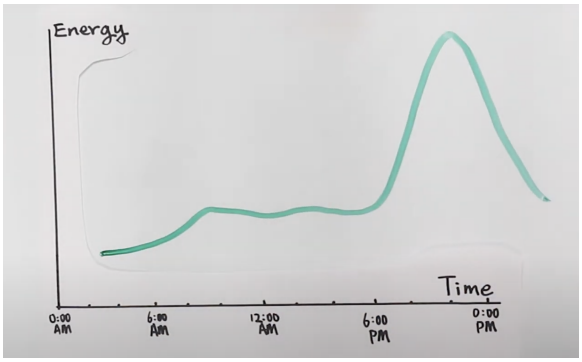


Renewable Energy Share in Electricity - Nationwide - Electricity Generation[MWh]

Wind	121,568	0.8%
Solar PV	566,384	3.6%
Biomass	30,715	0.2%
Geothermal	45,358	0.3%
Hydro	1,457,966	9.3%
Total Renewable Energy(MWh)	2,221,991	14.2%
Area Demand(MWh)	15,638,291	100.0%

The project was started in 2016 by the Institute for Sustainable Energy Policies (ISEP) in Japan. overall , the project collects its data on renewable energy generation and consumption from all over Japan. It also uses data analysis to visualize the trends in renewable energy development. The project provides insights into the factors that are driving the rapid development of renewable energies in Japan and is used by policymakers, researchers, and the general public to understand the role of renewable energies in Japan's energy future.

9. **Know Your Energy Numbers (KYEN)**
   (https://kyen.stanford.edu/)



The Know Your Energy Numbers (KYEN) is a set of programs created by researchers at Stanford University and Oregon State University to teach young people and families about their household energy usage and how to save energy. One of the programs is Energy Data Visualization for Fremont junior high and high school students. In this online course, students use their household's electricity data to learn how to visualize data, save energy, and present results using Tableau, a software tool that helps people see and understand data.

Description of Viz

Main Narrative

Viz Walkthrough video:
https://drive.google.com/file/d/1n1lBQ_2ao1gSCY1XZlknU1_IyW2W4PcW/view?usp=sharing

Our project has a homepage that introduces the context and overall progress of SDG 7 targets and 4 detail pages that visualize the progress for each SDG 7 target. We adopted a storytelling approach and introduced a Persona called Lea, a woman born in Sub-Saharan Africa, to weave the information and the viz. Lea helps to explain the obscure terms and engage the audience emotionally.

The homepage introduces the topic and shares the overall progress of SDG 7 targets in Sub-Saharan Africa. It starts with the comparison between the energy poverty status quo in 2000 and 2020–users can switch between the two years' data by dragging the section. It then introduces the Persona, who will be narrating the following story to the audience. Then the homepage introduces important global events and the SDG 7 targets, which will navigate users to the detail pages. Following the SDG 7 targets, there is a table showcasing the change from 2000 to 2020 of each SDG 7 target. At the end, the Persona calls for more actions that can help the energy goals in Sub-Saharan Africa.

Key Views

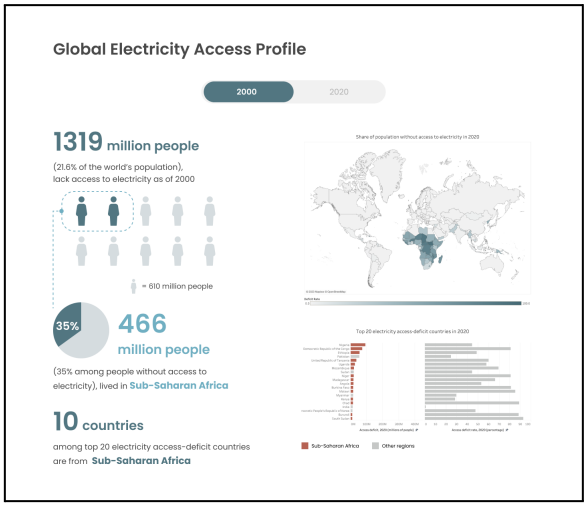
SDG Goals & Energy Poverty in Africa

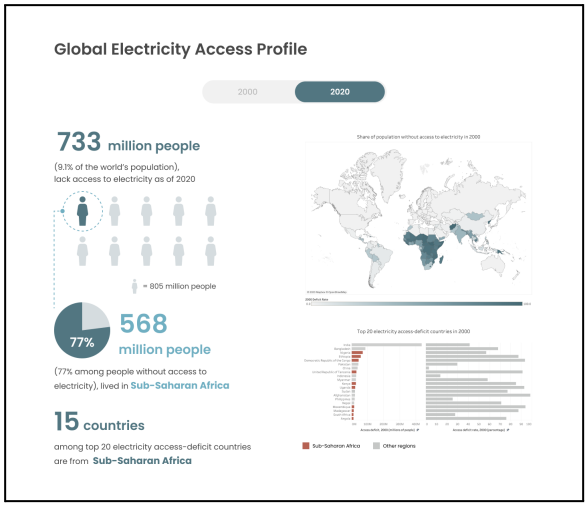
The hero section of the homepage presents the title of the project, "From Darkness to Light: How Sub-Saharan Africa has progressed towards universal access to sustainable energy". A background image of a world map which highlights Sub-Saharan Africa as well as a power plug icon are used to provide the audience with some initial context of the project.
The hero section is followed by a short introduction paragraph which gives information on the importance of access to energy, together with a brief global energy access overview which highlights regional disparities with Sub-Saharan Africa being the least electrified region.

Global Electricity Access Profile

The section following the introduction paragraph is dedicated to provide a more detailed global profile of electricity access. In order to enable understanding of the

global progress in electrification, we include the global electricity access profile in 2000 and 2020 with a particular focus on highlighting the situation in Sub-Saharan Africa. A combination of infographic and visualizations are used to present the information in a clear and engaging manner. The infographic gives high-level information such as how many people in the world and in Sub-Saharan Africa lack access to electricity, how many countries among top 20 electricity access-deficit countries are from Sub-Saharan Africa. On the other hand, the two visualizations, including a choropleth map to visualize the share of population with access to electricity and a bar chart to visualize the top 20 electricity access-deficit countries, aim to give more granular information. The visualizations are interactive, with tooltips that allow users to view specific data points as they hover over the graphs. A toggle menu is included for users to switch between the two views for comparison. The overall intent of the section is to suggest how Sub-Saharan Africa has remained the least electrified region across the globe.

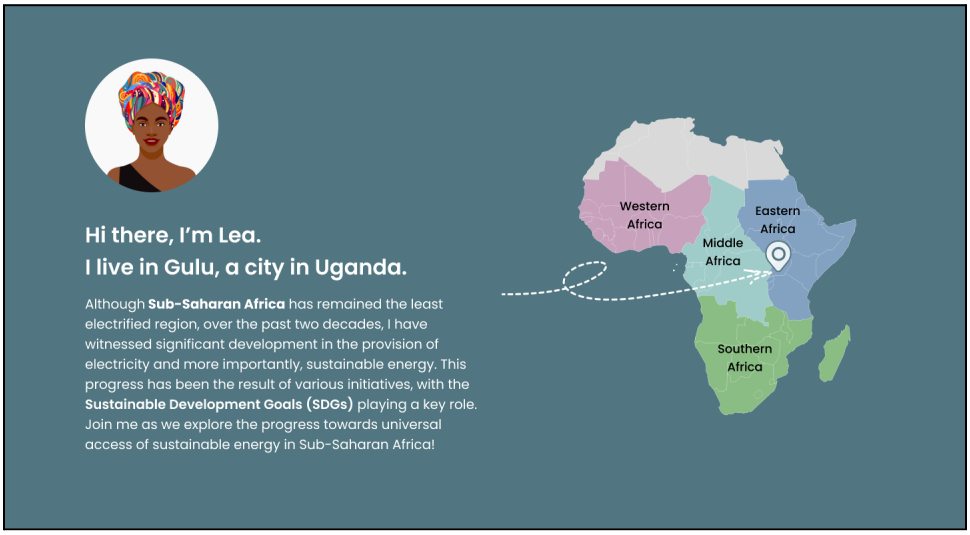




Persona

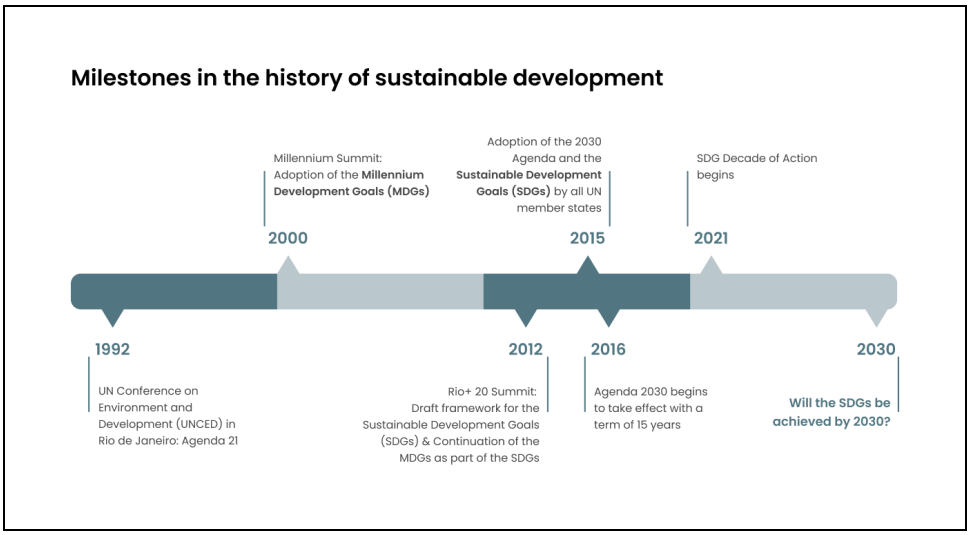
Next, we introduce our persona, Lea, a woman who was born and lives in Sub-Saharan Africa, to weave the information and the viz. Lea helps to

contextualize the information presented and engage the audience emotionally. Additionally, a map of Sub-Saharan Africa is used to introduce users to the four sub-regions in Sub-Saharan Africa: Western Africa, Middle Africa, Easter Africa, and Southern Africa. These regions are used to track progress in the visualizations throughout the website. The map also indicates the colors that will be used to represent each region in the subsequent visualizations.



Milestones in the history of sustainable development

Following the introduction of the persona, we use a timeline to provide a high-level overview of the concerted efforts in place to promote sustainable development around the world. Specifically, the timeline is used to introduce “Sustainable Development Goals (SDGs)” established by the United Nations and how it has set global targets that are to be achieved by 2030.



SDG 7 - Global Targets for 2030

In the next section, we delve deeper into the Sustainable Development Goals, with a particular focus introducing SDG7 in relation to our project, which aims to ensure access to affordable, reliable, sustainable and modern energy for all by 2030. This section introduces users to the four specific targets of SDG7 which we used to track progress of Sub-Saharan Africa towards universal access to electricity and sustainable energy. Users can click on each of the four targets which will navigate them to the corresponding page we designed for more information.

Progress Track for SDG goals

SDG 7.1 Access to Electricity

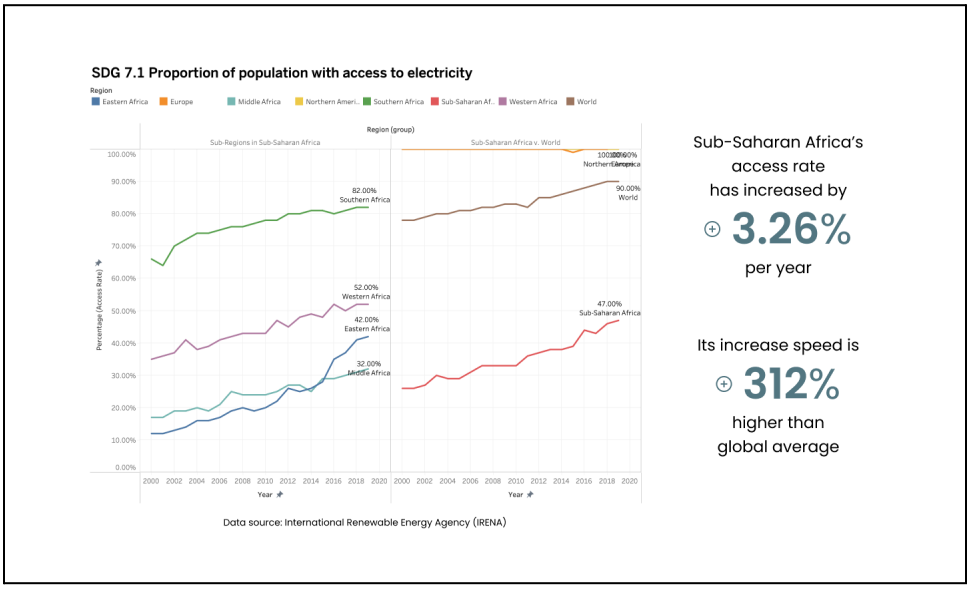
In this section, we wanted to visualize how Sub-Saharan Africa has progressed towards the SDG 7.1 target–universal access to electricity.

In the first viz, we visualized the indicator over years in a line chart so that the audience could easily learn the progress pattern of the regions.

We also divided the data into two groups: 1) Worldwide level–comparing Sub-Saharan Africa with the world average and two developed regions: Europe and North America; 2) Sub-regional level–comparing the four subregions of Sub-Saharan Africa: Easter, Middle, Western, and Southern Africa. By categorizing the data, the audience could understand two layers of message: 1) Sub-Saharan Africa has made significant progress in increasing its proportion of population with access to electricity: though the subregional development was disproportionate, all regions showed a steady increase; 2) However, it was still way behind the world–the

developed regions like Europe and North America has long reached a 100% access rate and Sub-Saharan Africa is still below world average.

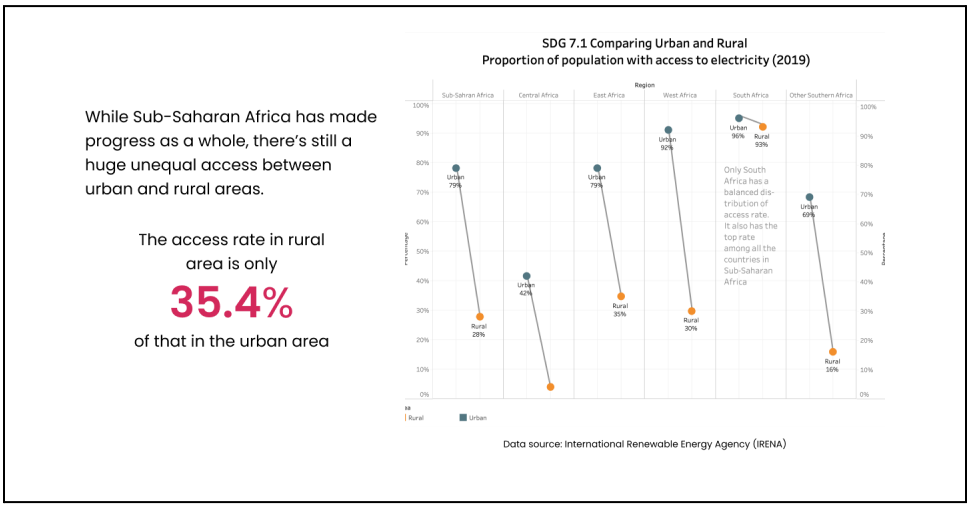
With that being said, the growth rate of Sub-Saharan Africa is still significant. We calculated the growth rate and compared it to that of the world average, and added these two numbers on the right to enhance the message that Sub-Saharan Africa has made significant progress.



Meanwhile, the gap between urban and rural areas was also a topic worth noticing in the SDG 7.1 target. We plotted the disparage between urban and rural areas in 2019 in a slope graph, which could show the audience how huge the gap was–the slope graph was very effective and clear to convey the message as tested in the usability study. The color and labels helped distinguish the two areas and provided more details in the chart.

We included the data of Sub-Saharan Africa as a whole and in its four sub-regions so that the audience could compare regional differences. South Africa was extracted from Southern Africa since it had very different national conditions and was extracted in several similar research as well.

To enhance the message that the rural area was far behind the urban area, we also calculated the ratio of the two areas and added this information on the left to strengthen the impression.

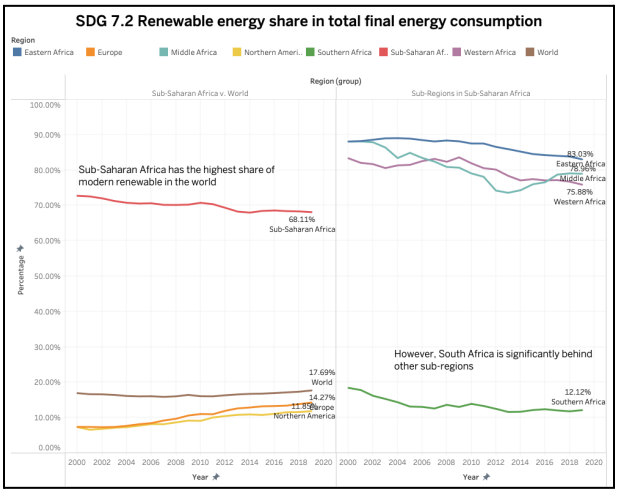


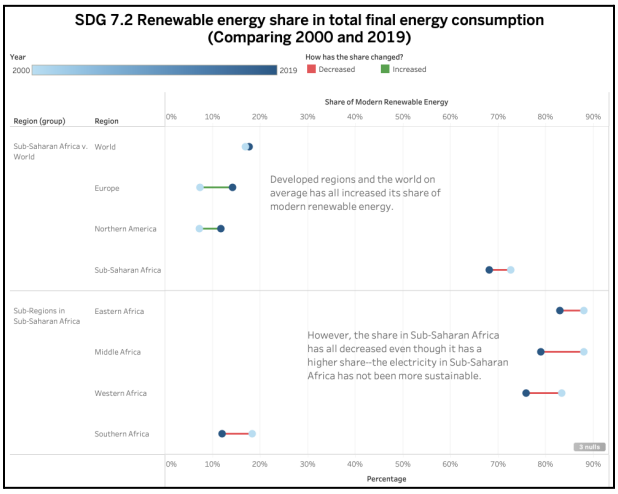
SDG 7.2 Share of Renewable Energy in Final Total Consumption

In this section, we wanted to visualize how Sub-Saharan Africa has progressed towards the SDG 7.2 target–increasing the share of renewable energy in the total consumption of energy.

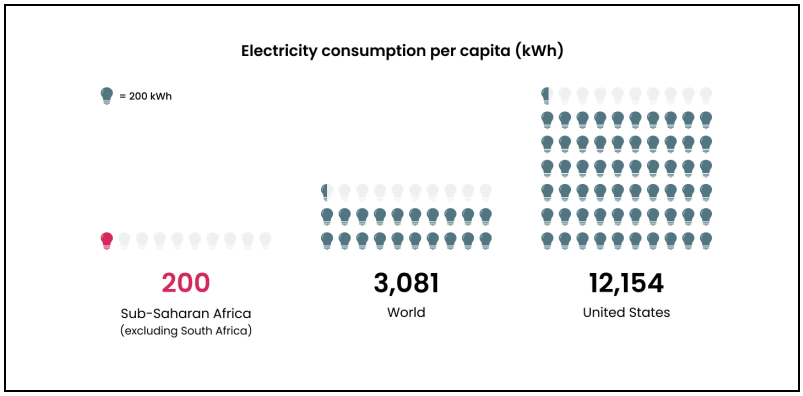
In the first viz (on the right below), we visualized the indicator over years and divided the data into two groups in the same way as in SDG 7.1 section. Hence, the audience can not only discover how Sub-Saharan Africa itself has progressed over time, but also understand that it was surprisingly significantly above world average, and detect that there was a disproportionate development among the sub-regions. During the EDA, we also discovered that Sub-Saharan Africa had a very high share–even higher than the developed regions–the share actually decreased over time, which indicated that Sub-Saharan Africa hadn't made their energy structure more sustainable. Meanwhile, though the share of the developed regions were lower than that of Sub-Saharan Africa, it had shown a trend of steady increase. To

call attention to this issue and enhance this message, we plotted a barbell chart to visualize the change of the share of renewable energy in 2000 and 2020 (on the left below). The barbell chart made it easy for the audience to not only compare the data among regions, but also detect whether the share has increased or not. We also used colors and annotations to strengthen the message.



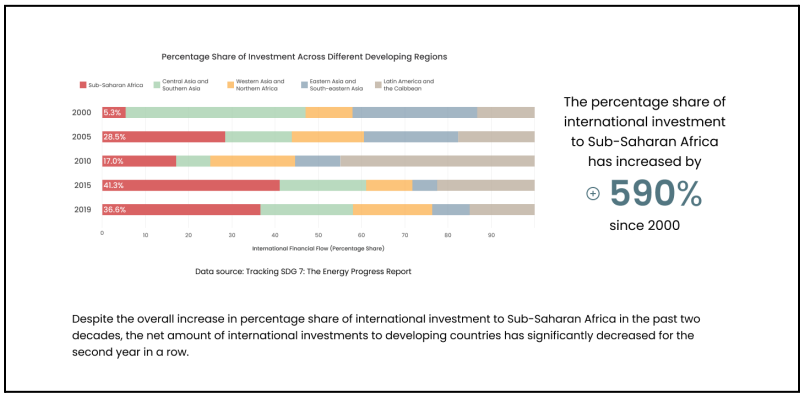


Besides, we also discovered that the high share of renewable energy might be misleading to the audience–leaving a message that Sub-Saharan Africa had a far better situation in terms of sustainable energy supply. However, the high share might be due to a relative low amount of total energy consumption. Hence we searched for supplementary data to complete this message and used isotypes to visualize the electricity consumption per capita comparing Sub-Saharan Africa, World, and United States in order to inform the audience that Sub-Saharan Africa still had limited energy resources. We chose to visualize the data on an individual basis because it could be more relatable to the audience.



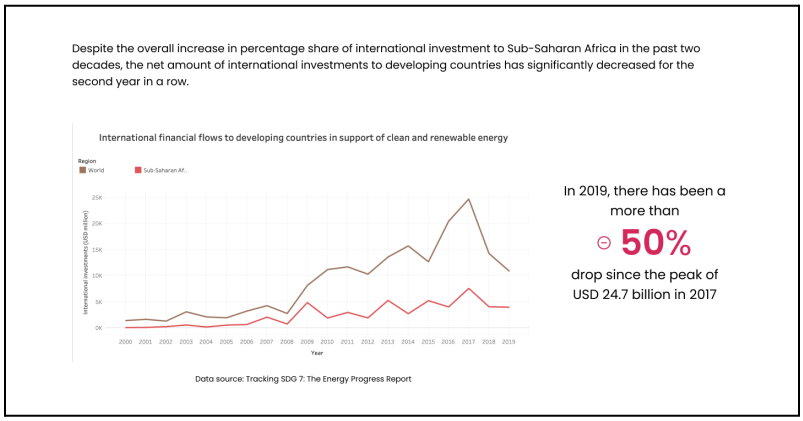
SDG 7.a

In this section, we wanted to visualize the amount of global investment in energy infrastructure and clean energy Sub-Saharan Africa has received. The SDG 7.a target is evaluated by the international financial flows to developing countries in support of renewable energy development. We started by visualizing the percentage share of investment across different developing regions since 2000. The visualization highlights how the percentage share of international investment to Sub-Saharan Africa has significantly increased since 2000, supporting our argument of how Sub-Saharan Africa, as the least electrified region, has a pressing need for concerted efforts to facilitate its energy development.



In order to provide a more comprehensive analysis, we also visualized the net amount of international investments to Sub-Saharan Africa, which indicates that

there is a significant drop since the peak in 2017. This emphasizes the need for continuous efforts to ensure sustainable energy development for all in the region.



SDG 7.b Energy Capacity Per Capita

In this section, we wanted to visualize how Sub-Saharan Africa has progressed towards the SDG 7.b target–expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries. The SDG 7.b target is evaluated by the indicator of installed renewable energy-generating capacity (in watts per capita).

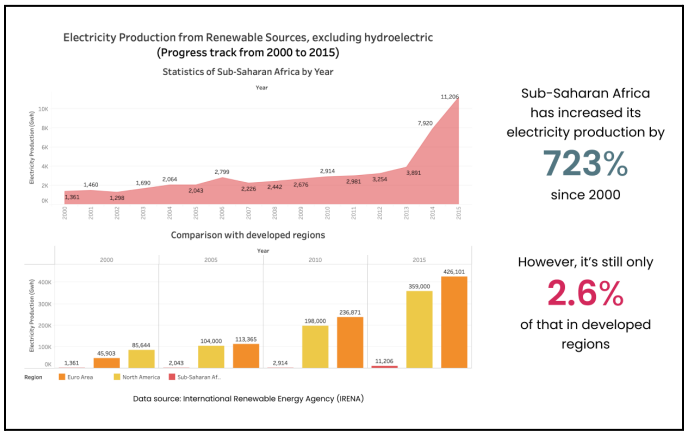
To amplify the story, we decided to start from a regional level–visualizing the total amount of electricity produced by renewable sources and then move forward to the individual level.

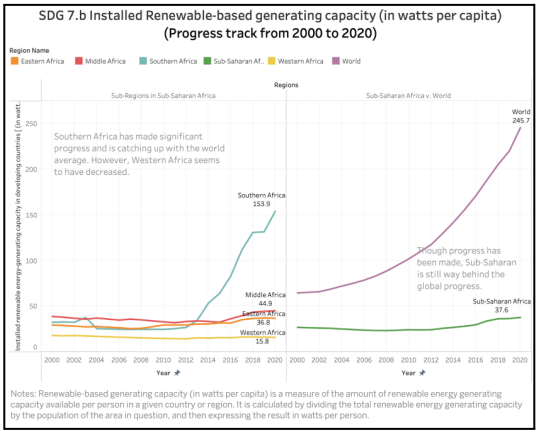
In terms of the total amount of electricity produced by renewable sources (on the left below), we first plotted the change of Sub-Saharan Africa over time in an area chart with labels for the audience to know the exact information of each year. We then plotted out the data of Sub-Saharan Africa, Euro Areas, and North America in a bar chart to show that even though Sub-Saharan Africa has significantly increased its renewable energy production over time, it was still greatly behind the developed regions. We have tested using a line chart as well as including all the past years before arriving at the final design. However, we discovered that since the gap

between the data was huge, and the line for Sub-Saharan Africa was almost invisible compared to that of the developed regions. Including too many years will also make the chart overwhelming to the audience. Hence, we adopted a bar chart with only key years (2000, 2005, 2010, 2015[1]) to visualize.

In order to enhance the message of the significant progress of Sub-Saharan Africa and the huge gap between it and the developed regions, we calculated the growth and proportion and added on the right to strengthen the information.

In terms of the progress track for SDG 7.b itself (on the right below), we visualized the indicator over years and divided the data into two groups[2] in the same way as in SDG 7.1 section. Hence, the audience could tell the trend and make several comparisons. To avoid clusters, only the end data (Year 2020) was shown in the label while the audience could hover on each data point to read the details. The color legend was in consistency with other charts in the website and the label also included the name of each region so that the audience would not need to constantly match the legend with the viz. We also added annotations to describe the trends and footnotes explaining the indicator to help the audience understand.

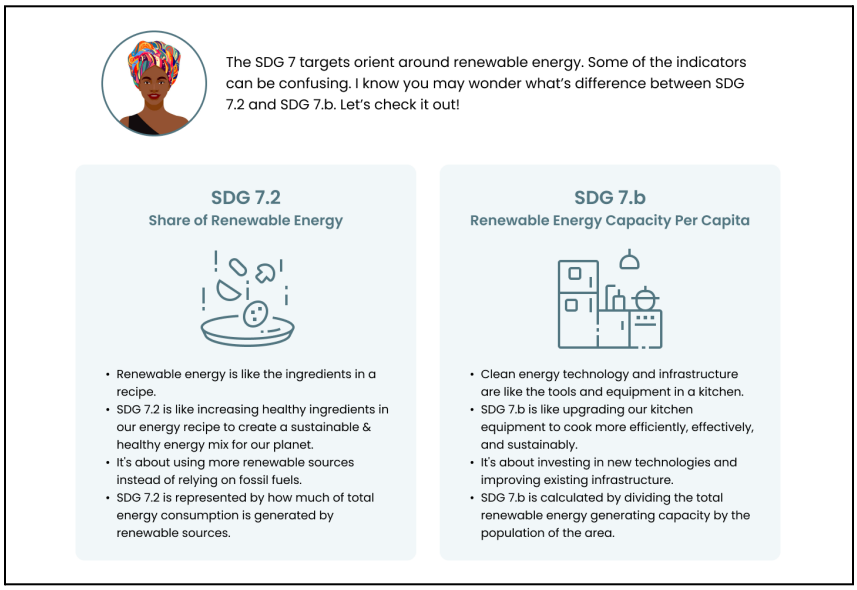




[1] The data for 2020 was lacking in the dataset.

[2] The data for Europe and North America were lacking due to that SDG 7.b specifically focused on the indicator in developing countries.

While doing research on the SDG 7 targets, we came across confusion regarding the nuance difference among the terms and targets. The usability study and critique also showed that the audience were confused and felt like they were viewing similar information. To help the audience understand the terms and distinguish the concepts from each other, we added a section using the persona to explain the nuance between the most similar targets: SDG 7.2 and SDG 7.b–we used analogies and icons to convey the message, and used bullet points covering the same aspects (the analogy of the focused object–the indicator, the analogy of the SDG target, the explanation for the actions, the explanation for the indicator).



Overall Comparison between 2000 and 2020

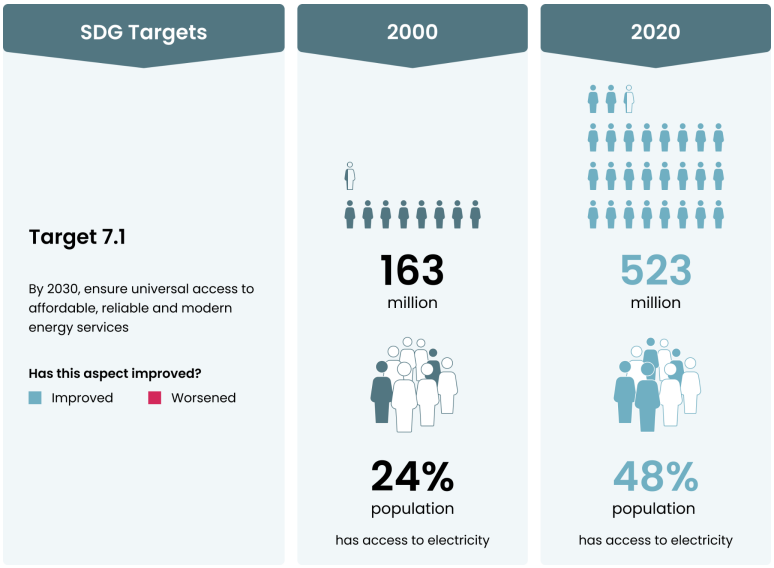
From usability testing, we discovered that our previous design lacked a summary for all the progress track over years. Since plotting the change over years involved too many details, we decided to extract the information of two specific years and make an overall comparison covering all SDG 7 targets at the end of the website. Years 2000 and 2020 were selected because:

1) 2020 was the most up-to-date year available in the data set.

2) 2000 was the year when the Millennium Summit and the Adoption of the Millennium Development Goals (MDGs) took place. MDGs were the predecessor of SDGs and covered similar topics and 20 years provided a sufficient length of time to evaluate the change.

In the final comparison, we wanted to make the information clear, concise, yet vivid and easy to measure. We used a table that matched the data with a clear explanation of each SDG target and compared 2000 and 2020 side by side. We also used a combination of isotypes, visuals, and pie charts to visualize the amount and scale of each number. The isotypes were designed according to the meaning of the indicator, such as a person icon for number of population, a lightning icon for electricity production, a gear with lightning icon for electricity efficiency, a dollar icon for the amount of money (financial flows), and a light bulb icon for electricity generation capacity.

Moreover, since some of the indicators are hard to comprehend, and not all indicators follow the rule that "the higher the indicator, the better the situation," we added notes to clarify the confusion and used color coding (blue and red) to indicate whether Sub-Saharan Africa has improved in each target.

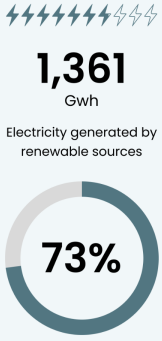


Target 7.2

By 2030, increase substantially the share of renewable energy in the global energy mix

1,361
Gwh

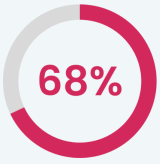
Electricity generated by renewable sources



Share of final total energy consumption from renewables

11,206
Gwh

Electricity generated by renewable sources (2015)



Share of final total energy consumption from renewables (2019)

Target 7.3*

By 2030, double the global rate of improvement in energy efficiency
*The lower the indicator (MJ/USD), the better the capacity

8.6
MJ/USD

Installed renewable energy-generating capacity

6.3
MJ/USD

Installed renewable energy-generating capacity

Target 7.a

By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology

75
Million USD

International financial support of clean energy research, development, & production

3,984
Million USD

International financial support of clean energy research, development, & production (2019)

Target 7.b

By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programs of support

32.4
watts per capita

Installed renewable energy-generating capacity

11,206
watts per capita

Installed renewable energy-generating capacity

Data Used

Energy Poverty in Africa

- SDG 7.1 Access to Electricity
    - Electricity access rate, Total (%) (from 2000 to 2020)
    - https://trackingsdg7.esmap.org/downloads
- SDG7: Targets and Indicators
    - https://sdgs.un.org/goals/goal7

Progress Track for SDG goals

- SDG 7.1 Access to Electricity
    - Electricity access rate, Total (%) (from 2000 to 2020)[3]
    - Electricity access rate, Urban (%) (2020)
    - Electricity access rate, Rural (%) (2020)
- SDG 7.2 Renewable Energy
    - Benefits and potentials of renewable energy[4]
        - Economic benefits of renewable energy:
            - Price drops of renewable energy (Percentage): https://www.un.org/en/climatechange/raising-ambition/renewable-energy

[3] Country level data (48 Sub-Saharan African countries excluding Sudan due to lack of data) is also used for this indicator

[4] These data sets were used in the version for usability testing. Since the testing showed that the website was a bit long and not cohesive to its theme, this part of "potentials of renewable energy" was removed in the final design.

            - Price increases of non-renewable energy (Percentage): https://www.scoperatings.com/ratings-and-research/research/EN/170861
        - Carbon footprint of renewable and non-renewable energy
            - Average life-cycle CO2 equivalent emissions of each type of energy (CO2/KWhPV) and predictions: https://impactful.ninja/the-carbon-footprint-of-renewable-energy/
    - Renewable Energy share in Total Final Energy Consumption (%) (from 2000 to 2020)
    - Total amount of electricity generated by renewable energy (from 2000 to 2020)[5]
- SDG 7.a International Financial Flows
    - Electricity access rate, Total (%) (from 2000 to 2019)
- SDG 7.b Renewable capacity per capita
    - Installed renewable electricity-generating capacity in developing countries (in watts per capita)[6]

If not otherwise specified, the source of all the data above comes from International Renewable Energy Agency (IRENA)[7], and including the following regions:

- Sub-regional level within Sub-Saharan Africa:
    - Eastern Africa
    - Middle Africa
    - Western Africa

[5] The data source is: https://ourworldindata.org/renewable-energy#how-much-of-our-primary-energy-comes-from-renewables
[6] The data for Northern America and Europe is missing in this dataset
[7] https://trackingsdg7.esmap.org/

    - Southern Africa
- Worldwide level
    - Sub-Saharan Africa
    - World
    - Northern America
    - Europe

Tools Used

The foundation of the webpage was built using HTML5, which allowed us to create a structured and organized layout. We used semantic tags, including <header>, <nav>, <section>, and <footer> etc.. to define the layout and enhance the page's accessibility and responsiveness for cross platform browser and devices. The use of HTML5 also enabled us to include various content elements, such as headers, infographics and embedded visualizations.

To make the various web page more interactive and dynamic, JavaScript was incorporated. This allowed for the addition of various effects and user interactions, including responsive and sticky navigation menus, sticky menu bars, hover-on effects for buttons and animations.

CSS was used and utilized to customize the appearance of the overall webpage, including colors, fonts, and layout. This allowed us to create a consistent look and feel throughout the site. In addition, we implemented responsive design principles by using CSS media queries to ensure that the webpage functioned optimally across different devices and screen sizes.

Tableau - Data Visualization Integration: For this project, Tableau visualizations were integrated into the webpage by virtue of using Javascript and HTML5 embeddings to enhance the webpage's value and appeal for people to be able to

seamlessly view and interact with the Tableau charts. Various charts, graphs, and other visualizations were created using Tableau to provide users with valuable insights and information on Energy Access. Using Tableau's JavaScript API, we embedded these visualizations directly into the webpage, ensuring they were responsive and interactive.

Throughout the implementation of this project, we successfully designed the landing page that combined HTML5, JavaScript, CSS, and Tableau visualizations to create an engaging and informative platform to provide a great deal of insights to viewers. The use of these tools enabled the implementation of a visually appealing, interactive, and accessible landing page on various devices. Lastly, GitHub was utilized as a platform to easily manage and deploy the codes as well as to manage different files and assets seamlessly.

Results

Overview

In our usability testing, we focused on evaluating:

- Whether our website could effectively convey the message of the topic
- Whether our visualization could enable the audience to detect extrema, discover patterns of the renewable energy and electricity progress in Sub-Saharan Africa, and make comparisons among the sub-regions and between Sub-Saharan Africa and other developed parts of the world
    - How confident are the participants in understanding the viz and analyzing the data in this progress.

- Whether our website (narrative) could engage the audience, and what emotional feelings it had on the audience

Test Setup

For our usability study, we identified tasks from understanding the main theme to evaluating and describing key views. The high-level tasks are as follows (Each tasks were paired with sub-tasks, asking the users to detect extrema, discover patterns, or make comparisons):

- Task 1: Understanding the context
- Task 2: Learning about the investment and efforts (How does the investment for renewable energy look like?)
- Task 3: Learning about the progress
    - Task 3.1: How has people's access to electricity been improved?
    - Task 3.2: How has the renewable energy share of total energy been improved?

In terms of measuring, conducting, and recording the results:

- We used both quantitative and qualitative measures to evaluate the clarity and legibility of our website.
- We also adopted a method of comparing the pre-testing and post-testing to understand if our website can successfully convey our message and increase the awareness.
- We used the timer to record the quantitative measurements.
- We used the pre-testing survey, post-testing survey, and interview questions to acquire the quantitative data.

Results

Quantitative measures

Measures		Participant 1	Participant 2	Participant 3
Time used to go through the entire website		17 min 06 s (with careful critique)	11 min 30 s (general read through with occasional comments)	12 min 33 s (in general)
Time used to make sense of the focused viz	Key View 1 (Task 2)	3 min 6 s	2 min 54 s	2 mins 46 s
	Key View 2 (Task 3.1)	1 min 36 s	2 min 02 s	1 min 2 s
	Key View 3 (Task 3.2)	1 min 24 s	1 min 55 s	0 min 49 s

In terms of the time used to go through the entire website and complete the tasks, we discovered that there was too much information in our website, and that some titles were missing or confusing, making it difficult for the audience to find useful information.

Qualitative measures

Measures		Participant 1	Participant 2	Participant 3
Familiarity with the SDG goals	Pre-test	2	2	2
	Post-test	3	4	4
Familiarity with the energy	Pre-test	1	2	3

status quo in Sub-Saharan Africa	Post-test	4	4	4
Confidence in answering the task questions	Task 1	4	4	4
	Task 2	3	5	3
	Task 3.1	4	4	3
	Task 3.2	4	3	4
Willingness to take actions	Post-test	3	5	3
Engagement with the Viz	Post-test	3	4	4

It showed that our website had included useful information that effectively increased the audience's knowledge of the topic, and our narrative was engaging and could increase their awareness and willingness to contribute. However, some of the charts were not clear enough, making the participants not confident enough to analyze the information.

Discussion

Website Design & Narrative

Overall, the website design is clear and engaging to the users. The narrative of telling a story of an African woman helps the audience to understand the topics and emphasize with the people in Sub-Saharan Africa.

However, the website is quite long and the audience feels a bit of information overload. Besides, the title and labels are quite long and not very clear right now, and some of the charts are missing, which makes it hard for the audience to get the point. It might be helpful to cut down on some content, iterate on the titles and text, and rearrange the layout of the website to make it more user friendly.

Usability of Visualization

There were two main problems with the usability of visualization:

1. The titles, axis, and legends were missing or not informative enough. It would also be helpful if the viz can have more labels of the exact data of each region in each year.
2. Many of the charts looked similar to each other in terms of its content and data–this resulted from several reasons:
    a. The SDG 7 goals are quite abstract and some of the terms are confusing to people who are not familiar with this topic. To solve this problem, we planned to include more explanatory annotations and use isotypes or other visual design to distinguish the terms.
    b. The viz didn't follow a clear structure or categorization of the SDG 7 goals. To solve this problem, we planned to restructure our website and match the viz clearly to its corresponding SDG 7 target.

There were other potentials to make the visualization more informative:

1. Include interactions in the viz such as tooltips and highlighting to enable the audience to gain detailed information.
2. Enhance the idea of "progress track" and comparison in the entire structure of the website.

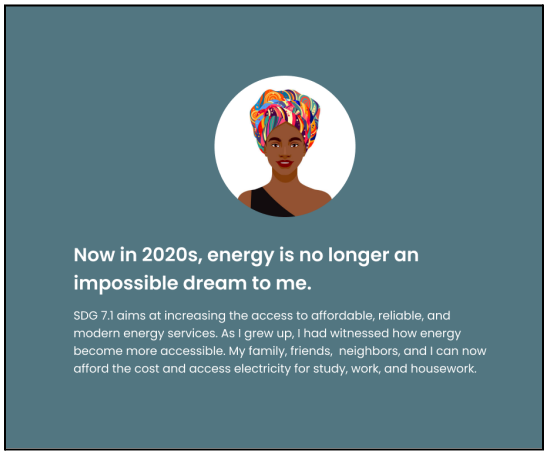
Iterations

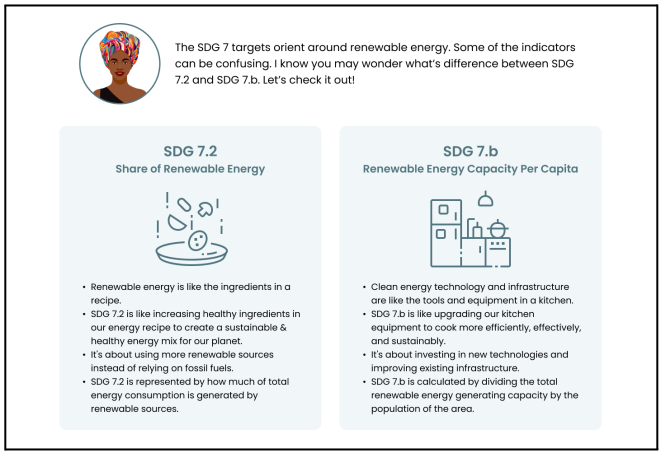
Based on the usability study and critique from the teaching team, we made several major improvements:

1. Enhance the structure of SDG 7 targets and provide clearer explanations to help the audience comprehend.

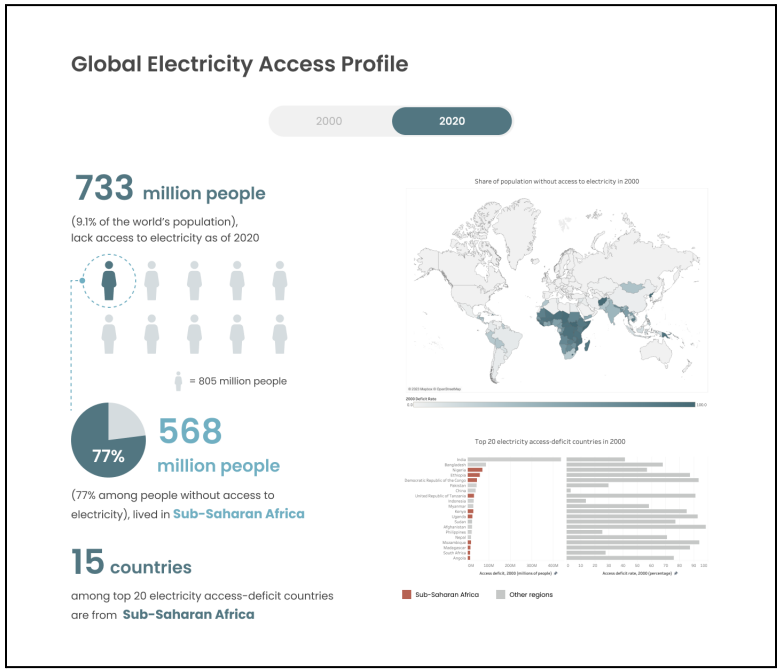
a. Use SDG 7 as buttons to navigate the users to the detail page of each target. The progress track viz will be embedded in each detail page. Hence, the website is shorter in length and takes less time to browse. The audiences can choose to view the section that interests them most.

b. Utilize the persona to provide explanatory information. The persona will introduce each SDG 7 target at the beginning of each tab. It's also used to clarify some confusing terms (as discovered in the usability study)

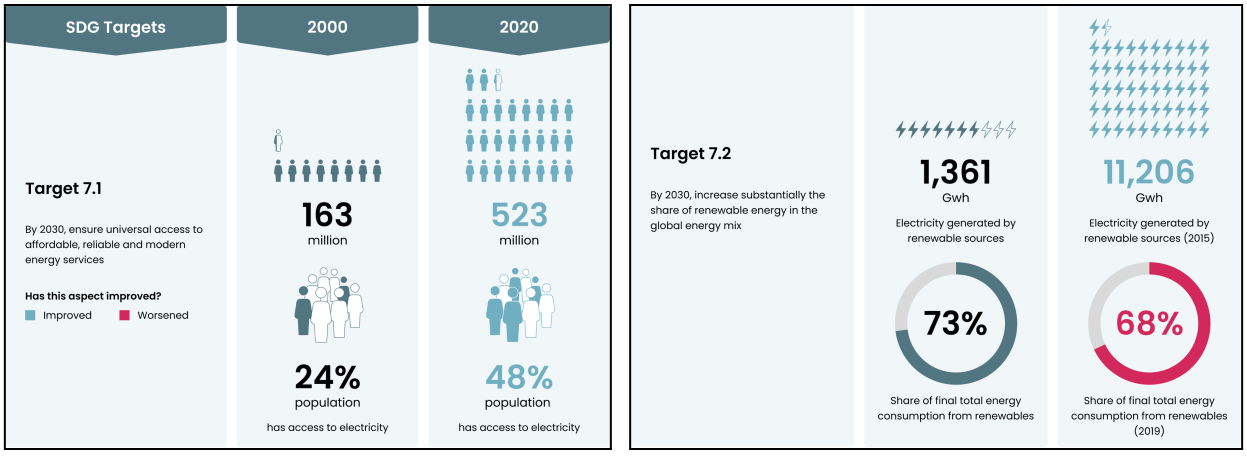




2. Enhance the comparison of 2000 and 2020 to show the progress
    a. Enable the audience to switch between 2000 and 2020 to see the overall situation of Sub-Saharan Africa

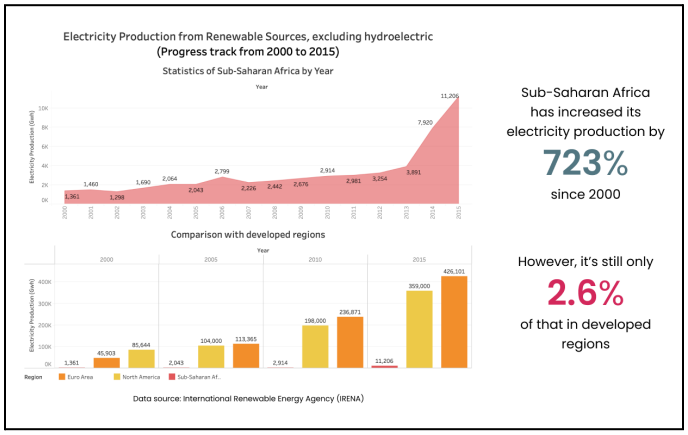


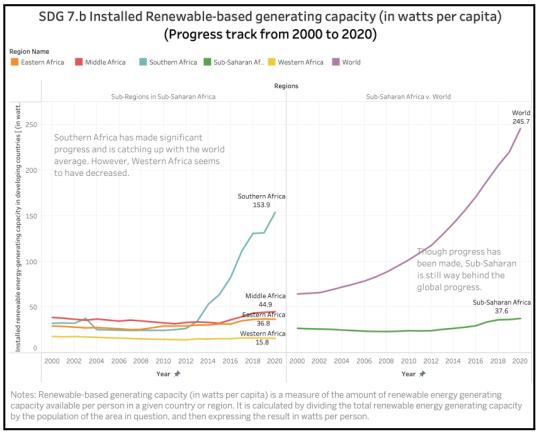
    b. Include a comparison using isotypes to visualize the sharp contrast between 2000 and 2020 at the end of the website.



3. Improve the quality of each viz:
    a. Unify the color legends and font sizes in the tableau viz.

b. Provide clear titles for each chart indicating the specific SDG 7 target and its relevant indicator. Include explanations for indicators if the terms are hard to understand.
c. Add annotations within the chart to show the pattern worth noticing.
d. Pull out interesting or significant data points (such as increase rate, comparisons, etc.) to help the audience understand the trend.





Contribution

Project Phase	Task	Yitian Li	Natalie Chan	Yusuf Abdul
Preparation	Theme discussion, finding data sets and references	33%	33%	33%
Visualizations	Homepage– Global Electricity Access Profile 2000 Infographics	5%	90%	5%
	Homepage - Share of population with access to electricity in 2000	5%	90%	5%
	Homepage - Top 20 electricity access-deficit countries in 2000	5%	90%	5%
	Homepage– Global Electricity Access Profile 2020 Infographics	5%	90%	5%

	Homepage - Share of population with access to electricity in 2020	5%	90%	5%
	Homepage - Top 20 electricity access-deficit countries in 2020	5%	90%	5%
	Homepage - Milestones in the history of sustainable development	5%	90%	5%
	Homepage - SDG 7 Targets	5%	90%	5%
	Homepage–Overall Comparison between 2000 and 2020 (Infographics)	90%	5%	5%
	Homepage–Call to Action (“And you can help!”)	90%	5%	5%
	SDG 7.1–Proportion of population with access to electricity (Progress track from 2000 to 2020)	90%	5%	5%
	SDG 7.1–Comparing urban and rural proportion of population with access to electricity (2019)	90%	5%	5%
	SDG 7.2–Renewable energy share in total final energy consumption (Progress track from 2000 to 2020)	90%	5%	5%
	SDG 7.2–Renewable energy share in total final energy consumption (Comparing 2000 and 2019)	90%	5%	5%
	SDG 7.2–Electricity consumption per capita (kWh)	15%	80%	5%
	SDG 7.a-Percentage share of investment across different developing regions	5%	90%	5%
	SDG 7.a-Investment financial flows to developing countries	5%	90%	5%
	SDG 7.b–Electricity production from renewable sources (Progress Track from 2000 to 2015)	90%	5%	5%

	SDG 7.b–Installed renewable-based generating capacity (in watts per capita)	90%	5%	5%
	SDG 7.b–Explanation and comparison between SDG 7.2 and SDG 7.b	90%	5%	5%
Usability Test	Write Script	80%	10%	10%
	Conduct Testing	33%	33%	33%
	Synthesize Findings	33%	33%	33%
Website	Narrative + Text	45%	45%	10%
	Design	45%	45%	10%
	Implementation	5%	5%	90%
Final Write Up	Integrate design and contribute to each one's assigned sections	40%	40%	20%
Project Management	Attend weekly meeting to discuss project and critique	33%	33%	33%
Overall Contribution		33%	33%	33%

Appendix:

Code

https://github.com/ayusuf9/Data-Visualization

Links to Tableau Charts

1. Homepage–Map of share of population without access (2000): https://public.tableau.com/views/Homepagemap2000/Homepage2000AccessDeficitMap?:language=en-US&:display_count=n&:origin=viz_share_link
2. Homepage–Top 20 energy deficit countries (2000): https://public.tableau.com/views/Homepage2000top20/Homepage2000Top20AccessDeficitCountries?:language=en-US&:display_count=n&:origin=viz_share_link
3. Homepage–Map of share of population without access (2020): https://public.tableau.com/views/Homepage2020map/Homepage2020AccessDeficitMap?:language=en-US&:display_count=n&:origin=viz_share_link
4. Homepage–Top 20 energy deficit countries (2020): https://public.tableau.com/views/Homepage2020_top20/Homepage2020Top20AccessDeficitCountries?:language=en-US&:display_count=n&:origin=viz_share_link
5. SDG 7.1–Proportion of population with access to electricity (Progress track from 2000 to 2020): https://public.tableau.com/views/sdg-7_1Proportionofpopulation2000to2020/SDG7_1?:language=en-US&:display_count=n&:origin=viz_share_link
6. SDG 7.1–Comparing urban and rural proportion of population with access to electricity (2019): https://public.tableau.com/views/sdg-7_1-UrbanvRural/sdg7_1-UrbanvRural?:language=en-US&:display_count=n&:origin=viz_share_link
7. SDG 7.2–Renewable energy share in total final energy consumption (Progress track from 2000 to 2020):

https://public.tableau.com/views/sdg-7_2RenewableEnergyShare/SDG7_2?:language=en-US&:display_count=n&:origin=viz_share_link

8. SDG 7.2–Renewable energy share in total final energy consumption (Comparing 2000 and 2019): https://public.tableau.com/views/sdg-7_2RenewableShare2000v_2019/SDG7_2Change_1?:language=en-US&:display_count=n&:origin=viz_share_link
9. SDG 7.a-Investment financial flows to developing countries: https://public.tableau.com/views/7_ainternationalfinancialflows/7_aInternationalfinancialflows?:language=en-US&:display_count=n&:origin=viz_share_link
10. SDG 7.b–Electricity production from renewable sources (Progress Track from 2000 to 2015): https://public.tableau.com/views/sdg-7_b-ElectricityProduction/ElectricityProductionwoText?:language=en-US&:display_count=n&:origin=viz_share_link
11. SDG 7.b–Installed renewable-based generating capacity (in watts per capita): https://public.tableau.com/views/sdg-7_b-InstalledRenewable-basedGeneratingCapacity2000to2020/SDG7_bDashboard?:language=en-US&:display_count=n&:origin=viz_share_link