1. Introduction and Background

In the Democratic Republic of Congo (DRC), estimates indicate that as little as 13.5% to 16% of the population has access to electricity. This hampers the country's economic development and leaves millions impoverished; it also hampers industry and the mining sector. For decades, the DRC government has prioritized the development of the proposed Inga 3 Dam to deliver needed energy for mines and generate foreign revenue. However, this project has been repeatedly stalled because of its complexity, expense, and environmental and social impacts.

The good news is that DRC has other options. DRC has abundant, low-cost and accessible wind and solar potential that's sufficient to not only replace but surpass energy supplied by the proposed Inga 3 Dam – and at a lower cost. This brief details the potential for solar photovoltaic (PV) and wind resources in the Democratic Republic of Congo. It presents some of the findings from a detailed technical assessment that evaluated solar and wind generation as alternatives to hydropower from Inga 3.

2. Study Findings

A. DRC has enough potential wind

and solar generation capacity to meet the country's pressing needs with quick wins

DRC has an abundance of wind and solar potential: 70 GW of solar and 15 GW of wind, for a total of 85 GW. This is more than double the expected generation from Inga 3. The 85 GW does not represent the entirety of DRC's potential; instead, the researchers identified utility- scale potential generation that also meets grid connection design criteria[1]. Therefore, the 85 GW is all located within 25 kilometres of existing and planned transmission lines[2]. The majority of the total potential (62 GW) is located within existing transmission corridors in the Katanga Province.

There is enough solar PV potential in the mining regions to generate power for the bulk of their operations. However, further investigation to identify specific projects to complement existing and planned sites for cost-competitive solar generation is still needed[3].

B. The case for solar and wind generation over hydroelectric power

I. Solar and wind will provide affordable,

cost-competitive electricity

Solar PV and wind power would be cost competitive in DRC, with nearly 60 GW of solar PV potential located along existing transmission lines at a total of LCOE[4] of less than 6 U.S. cents per kWh. In addition, nearly all the potential generation would cost less than 8 U.S. cents per kWh. This beats even the World Bank's wildly optimistic cost projection of between 7 and 8 cents per kWh for electricity from Inga 3, a number that excludes other operations and infrastructure costs or likely cost overruns.

Mining companies could save vast sums by turning to solar. In the mining areas, more than half (52%) of the potential solar PV generation would cost less than 7 cents per kWh; mining companies are currently paying an estimated 12 cents per kWh to generate their own power. Wind power would be slightly more costly, with only 10% of the potential generation costing less than 15 cents per kWh. This cost data is available for the identified 25 km^2 project areas (i.e. within 25 km of transmission lines) in the International Rivers study.

The researchers expect investment costs to harness wind and solar to be minimal because:

- Research has shown that solar PV systems added to pre-existing diesel mini grids reduce the cost of new PV installations by 30% to 50%[5];
- With increasing technological advances, the costs for solar PV and wind generation are declining. This trend is projected to continue; and
- Wind and solar projects can be

deployed much more quickly than hydropower, which reduces costs. Wind projects can typically be built in one to three years, and most solar PV projects take one year to construct. Large hydropower projects like Inga 3 can take decades to build, coupling vast upfront investments with ballooning costs over the years.

II. The potential solar PV and wind capacity

can be used for both centralised and distributed generation

Solar and wind power are more flexible technologies than hydropower. Experts indicate that under least-cost electrification scenarios,

[1]The estimates are heavily discounted (75% for solar PV and 90% for wind) to cater for localised data that was not available. It is therefore possible that the potential generation could be much higher. Also, this potential is grid quality and utility scale generation suitable for both central and micro grid applications. [2] Siting projects within 25km of transmission lines is preferred to deliver utility scale and grid connected resources. It also reduces planning barriers and risks associated with project development. [3]The land use and land cover constraints were relaxed for the mining areas estimates. [4]The levelized cost of electricity (LCOE) is the amount per kilowatt hour (kWh) required to bring power into the grid. It includes costs of generation, access the power such as roads and transmission lines as well as equipment and maintenance. [5]Szabo, S; Moner-Girona, M; KougiasR.B. and Bodis K. 2016 Identification of advantageous electricity generation options is sub- Saharan Africa integrating existing resources. Nature Energy 1, no 10 (September): nenergy2016140. ISSN: 2058-7546, accessed 23 July 2017. https://www.nature.com/articles/nenergy/201640. Cited in the International Rivers Report 'Renewable Riches: How wind and solar could power the DRC and South Africa'.

15% to 55% of DRC's population in the DRC should receive electricity via the national grid[6]. Grid power can serve a more geographically diverse spread of customers, despite the fact that the bulk of the solar PV is located in the southeast and wind in the east of the country.

Distributed generation in various forms, however, would be more cost effective for the remainder of the population. Reports show that distributed solar PV and mini hydro are the dominant cost-competitive alternatives to grid connections in the DRC5. Mini hydro potential is abundant in the DRC, with estimates of 2 to 3 GW[7]. Data sources are available that can facilitate further evaluation of various distributed generation options. They can also be used to compare distributed and centralised generation as well as most suitable technology applications for particular communities[7].

III. The protection of the environment and

livelihoods has been considered

These estimates of generation potential have taken into account protected areas, forest cover, populated areas and farmland. Thus, the solar and wind development would not adversely affect the environment, social capital, agricultural productivity and people's livelihoods.

3. The variability and uncertainty of solar and wind generation can be managed

Many utilities that are contemplating increased solar and wind generation voice concerns about the natural variability of these power sources: The sun doesn't always shine, and the wind doesn't always blow. The good news is that in recent years, grid operators have made technological advances and developed growing expertise in this field. They've developed operational strategies that facilitate grid stability when wind and solar generation are incorporated, enabling utilities to incorporate much higher percentages of variable
renewables into their grids. These strategies enable systems to respond to the variability of both demand and generation. Specifically:

• Advanced forecasting techniques assist in the prediction of renewable energy amounts available;

• Power systems incorporate faster (sub- hourly) scheduling and dispatch of generators closer to real time;

• Frequent scheduling closer to actual dispatch means renewable energy generation and demand forecasts will be more accurate, thus reducing scheduling errors and idle reserve capacity requirements; and

• Flexible plants that can cope with the increased variability in net demand to maintain grid stability. These types of hydropower plants are already available in large amounts in the DRC's electricity infrastructure.

Lastly, it is important to note that the DRC's unique location gives it the potential to connect to other countries in the region to share generation resources and bring further stability to the larger grid. It could thus be a catalyst for solar PV and wind generation in the region.

communities

SOLAR AND WIND POWER | Will benefit all

[6]This is according to the DRC's energy access model of the United Nations Department of Social and Economic Affairs. [7]Mentis, D; Howells,M, Rogner, H, Korkovelos,A, Siyal S, Broad, O; Zepeda, E and BrazilianM. 2016. Lighting up the world: The first global application of the open source, spatial electrification toolkit (ONSSET) 18:14161.April. Cited in the International River Report '*Renewable Riches: How wind and solar could power the DRC and South Africa*'.

4. The Evidence is Scientific, Thorough and Objective

The researchers used the *Multi-criteria Analysis and Planning for Renewable Energy* (MapRE) method to evaluate the potential energy from solar and wind resources and identify the best project sites with high generation potential. The method uses high-quality datasets to identify viable renewable energy sites that can provide the cheapest, grid-scale power generation. MapRE was used together with a previous study on the potential of grid-based solar and wind power in the DRC.

The datasets used for the different requirements in MapRE were:

- Solar potential: The Solargis, a world wide dataset of solar PV electricity output potential that was made available by the world Bank in 2017.
- Wind potential: Datasets by Vaisala. These are published in the International Renewable Energy Agency (IRENA)

Global Atlas.

• Transmission Infrastructure: For planned and existing resources, the Africa Infrastructure Country Diagnosis (AICD) together with the DRC's national electricity company Société Nationale d'Electricité (SNEL).

• Road network: Dataset from the Inventory and Forest Management Department in the DRC.

• Conservation areas: World Protected Areas Database, Forest Atlas of the DRC for protected areas, Global Forest Watch for intact forest landscapes and the World Resources Institute for intact high conservation value.

• Land use and land cover: The European Space Agency's (ESA).

(April 2019)

Acknowledgements International Rivers acknowledges the researchers and experts, Drs Ranjit Deshmukh, Ana Mileva and Grace Wu, who gathered and analysed the data presented in the report *"Renewable Riches – How Wind and Solar Could Power the DRC and South Africa."*