

Strategies for rehabilitating mercury-contaminated mining lands for renewable energy and other self-sustaining re-use strategies

A high-level review of three sites in Colombia for potential re-use for renewable energy: a report abstract

Alfonso Rodríguez, Paul Bardos, Andy Cundy, Walter Kovalick, Barbara Maco, Angela Rodríguez.

June 2017

R3 Environmental Technology Ltd

Prosperity Fund – UK FCO

Copyright

.

Disclaimer

The authors, supporters, funders, r3 environmental technology ltd and r3 environmental technology Colombia SAS will not be responsible for any loss, however arising, from the use of, or reliance on, the information contained in this report, nor do they assume responsibility or liability for errors or omissions. Readers are advised to use the information contained herein purely as a guide and to take appropriate professional advice where necessary.

Acknowledgements

This report is one of the outputs of the Colombia Prosperity Fund project on “Strategies for rehabilitating mercury-contaminated mining lands for renewable energy and other self-sustaining re-use strategies”

The report was prepared by:

Authors	Organisation
Alfonso Rodriguez	r3 Environmental Technology Colombia SAS, Colombia
Paul Bardos	r3 Environmental Technology ltd, UK
Andy Cundy	University of Southampton / r3 Environmental Technology ltd, UK
Walter Kovalick	Associate of R3 in the USA
Barbara Maco	Associate of R3 in the USA
Angela Rodriguez	r3 Environmental Technology Colombia SAS, Colombia

R3 was assisted in the Colombian case studies by the global manufacturer of solar panels with over 25 years’ experience, including 10 years in Latin America. Additional, detailed high-level assessments performed by the manufacturer outlined the potential of deploying solar energy at the two most promising study sites along with preliminary cost estimates. This additional work was available only to the client for this report.

The authors are grateful to all partners and collaborators for this project, and in particular the people of FCO Colombia, Ministry of Environment of Colombia, Ministry of mining of Colombia, local and regional environmental authorities of Colombia who supported the BOM case study development project and shared its findings with this project.

Executive Summary

The UK Prosperity Fund project in Colombia on Strategies for rehabilitating mercury-contaminated mining lands for renewable energy and other self-sustaining re-use strategies ran from mid-2016 until early 2017. It intended to deliver change by providing a range of science based strategies to rehabilitate mining sites affected by soil mercury pollution in disadvantaged areas and bring them back into productive use focusing on renewable energy opportunities and/or other services as most appropriate. It also supported the Foreign and Commonwealth Office goals of increasing regional stability, facilitating sustainable economic growth, harnessing innovation in particular for low carbon development, supporting OECD accession, and identifying possibilities for new community enterprise.

The aim of this document is to showcase the kind of analysis that can be conducted to determine the preliminary feasibility of siting renewable energy production on both contaminated mining sites as well as an even more viable contaminated site due to more robust solar conditions. Thus, this document provides decision makers in countries facing the reality of remediating and seeking to sustainably reuse brownfields (including mining sites) more insight into how such sites may be evaluated for their potential for renewable energy production.

This Prosperity Fund project adapted UK, EU and US EPA thinking and tools on brownfields rehabilitation for renewable energy and other soft re-uses for gold mining areas impacted by mercury contamination. In particular, this report abstract describes the use of a tool developed by US EPA, “RE-Powering’s Electronic Decision Tree”, to help determine the feasibility of a site to develop a renewable energy project, taking into account its use in contaminated or degraded sites. Other project reports describe innovative low input strategies for land management, sustainable remediation and commercial or community enterprise development (particularly for renewable energy) for mercury contaminated areas. (See additional reports at: http://www.r3environmental.com.co/en/projects.html)

Linking the safe re-use of mining brownfields (following application of low input “gentle” remediation techniques) with the generation of renewables presents a “virtuous” opportunity for land (re)use for several reasons.

- A variety of local energy market arrangements are possible: The approach is scalable--workable from community based projects to large projects with major mining companies.

- The income from renewables can help offset the cost of making the land safe, for example, from mobile mercury species.

- The use of this degraded land is a more sustainable approach to providing renewables than converting habitat or agricultural land over to renewables production.

- Colombia gets a lot of energy for free from the sun compared with many other countries (e.g. the UK).

On the other hand, some limitations and barriers were identified which need to be taken into account when starting a project under the proposed strategy. Some of these are: limited renewable energy incentives with continuing subsidies, market barriers, rules designed for conventional sources, lack of human capital with knowledge of technologies, and regulatory and institutional factors conceived for conventional energy production.

This report provides the results of testing the decision tree at two mining sites in Colombia, Segovia and Tadó, regarding the feasibility of using the sites for the installation of photovoltaic cells. For purposes of comparison and illustration, an additional site contaminated by pesticides, which has a higher level of solar radiation, was selected on the northern coast of Colombia. This site is in Cartagena City. The three sites provide several different levels of possible energy production ranging from on-site use of power by the site owner to the sale of power to off-site buyers or a utility.

1. A Brief Introduction to the Use of Renewable Energy on contaminated sites

1.1 Overview of Renewable Energy

The term “renewable” is generally applied to those energy resources and technologies whose common characteristic is that they are non-depletable or naturally replenishable. Renewable energy is collected from resources which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat (Ellabban, Abu-Rub, & Blaabjerg, 2014). Renewables often provide energy in four important areas: electricity generation, air and water heating/cooling, transportation, and rural (off-grid) energy services (REN21, 2010).

Renewable energy resources exist over wide geographical areas, in contrast to other energy sources, which are concentrated in a limited number of countries. Rapid deployment of renewable energy and energy efficiency is resulting in significant energy security, climate change mitigation, and economic benefits (Agency, 2012). The continuing dynamic nature of renewable energy markets, technologies, and cost reductions promises an energy future very different from what we have seen in the past decade.

Policy makers concerned with development of the national grid system will focus on those renewable energy resources that have established themselves commercially and are cost effective for on-grid applications. Colombia has begun the process of promoting the use of renewable energy, issuing Law 1715 of 2014, which opens a door to opportunities for projects in this direction.

In the U.S., the reuse of restored contaminated land for energy production has brought together two highly valued goals. The U.S. EPA offers the following explanation for its commitment to this enterprise:

“Revitalized properties present opportunities for meeting the land needs of the hundreds of new energy facilities anticipated to be developed in the coming decades. Through focused site screening and identification, interagency coordination, and partnerships with the utility sector and communities, the EPA can help restore contaminated lands while helping to further domestic energy security.”

1.2 Renewable Energy on Contaminated sites and Brownfields

Renewable energy development projects are frequently directed toward open spaces (i.e., “green”, or pristine environments). Alternatively, siting renewable energy development on contaminated lands gives them a beneficial and appropriate reuse purpose that also directs the siting of renewable energy facilities *away* from pristine lands, thus preserving the land carbon sink and preventing natural resources damages. It furthermore promotes economic/programmatic efficiencies in energy and clean-up processes. Additional benefits of renewable energy on brownfield sites includes the following;

1. Offsets GHG, SO_2, and NO_2 emissions as well as particular matter
2. Enhances energy security as we face greater energy needs

3. Help communities become more resilient in the face of extreme weather events and climate change impacts because of greater self-sufficiency and an ability to support the community's needs temporarily without access to outside resources.

Additional reasons for pursuing renewable energy projects may include:

- Taking stress off undeveloped lands (greenfield sites) for construction of new energy facilities;
- Using existing transmission capacity and infrastructure of formerly developed lands;
- Providing economically viable reuse to sites with significant clean-up costs or low real estate development demand;
- Spurring needed investment in both urban and rural communities, and creating jobs
- Creating job-training opportunities and ultimately careers in clean energy industries (and other sectors associated with climate resiliency) for low-income and under- or unemployed residents (US EPA, 2016)
- Economic and environmental benefits without traditional solar access through community solar programs such as "Shared Solar". These programs also offer an Opportunity to Enhance Sustainable Development on Landfills and Other Contaminated Sites.
- According to US EPA, "With community solar, projects between 50kW and 2,000 kW are often viable because numerous off site subscribers can purchase shares of a solar installation rather than hosting the installation themselves" (US EPA,2016)

Efforts in the US to identify the renewable energy potential of impaired lands and provide supporting resources for communities, landowners and developers have yielded impressive results. From a 2006 baseline of seven (7) projects with a total capacity of 7.5 MW, by 2016 190 renewable energy installations have been installed on contaminated lands, landfills, and mine sites, with a cumulative installed capacity of just over 1,172 megawatts (MW). (US EPA 2016). Furthermore, publicly available, stakeholder-reported information indicates that communities have saved millions of dollars in energy costs, created construction jobs, and received new property tax revenue as a result of reusing impaired sites for renewable energy.

1.3 Examples of renewable energy production on former mining lands

Three examples of renewable energy on mining lands are:

1.3.1 Chevron Questa Mine (US)

Chevron, the potentially responsible party, coordinated with federal and local environmental ministries during clean-up planning, enabling construction of a 1-megawatt (MW) concentrated photovoltaic (CPV) solar facility over 20 acres of the site. The 175-panel facility has been operating since April 2011. Today, it is the largest facility of its kind in the United States. A local energy cooperative purchases the energy through a 20-year purchase agreement. The solar facility generates enough electricity to power about 300 homes.

1.3.2 Avalon Solar Facility (US)

In Southern Arizona, a public private partnership redeveloped an ASARCO mine property for a utility-scale solar array. The project, called the Avalon Solar Facility will deliver 35 MW of clean energy for the local utility under a 20-year power purchase agreement.

As part of this report's assessment, we used resources from the U.S. RE-Powering America initiative (see below).

1.3.3 Wheal Jane's solar farm (UK)

A former Tin mine in the South West of UK, at Wheal Jane, Truro, was turned into the first and biggest solar farm to date by the installation of 5,680 solar panels in a 7.2 Acre plot that provides 1,437 MWh of electricity a year, which is enough to power the equivalent of 430 homes in the area.

This work was made by Lightsource Renewable Energy Ltd, in collaboration with Solarcentury and funded by Octopus Investments[1].

By the end of July 2011, Wheal Jane's Solar Farm was connected to the grid in Cornwall, after two months of design and construction. The project was part of the plans underway for a 60,000 sq.ft. business park in that reclaimed mine site; whose siting took into account a balance between needs for clean energy of the local community and the maintenance of the site's landscape. Moreover, the partnership employed local contractors to carry out the work, preparing the land, supplying fencing and installing the solar panels, indicating a social awareness at the same time.

1.4 Renewable Energy in Colombia

The analysis and technical work developed by the Mining and Energy Planning Unit (UPME) project in 2015 focus on five opportunity niches for Colombia, which have been identified as areas of potential that the country can develop if it is proposed (UPME, 2015):

- The development of wind projects in areas of high potential, starting with the department of La Guajira.
- Large scale development of distributed solar PV systems at small and medium scale.
- The development of cogeneration projects based on the use of biomass for energy purposes.
- Development of geothermal projects in areas of high potential such as the Ruiz volcanic massif area.
- The deployment of projects with unconventional energy sources, especially through hybrid generation schemes, as an energy solution in Non-interconnected areas.

Taking into account the priorities and opportunities identified by the national government in relation to renewable energy, our project is fully adapted to the needs of the country.

In addition to the above, the reuse of land contaminated by mercury due to artisanal mining is another alternative to strengthen the national plan and generate alternative business to local

[1] http://www.solarcentury.com/nl/persberichten/solarcentury-turns-old-tin-mine-into-solar-power-plant/

communities. In other words, all these sites can be considering as a potential site for renewable energy projects.

Although there may be the possibility of implementing projects with different renewable energy sources such as biomass, wind and geothermal, our focus is the use of solar radiation from these sites for the installation of photovoltaic panels.

Since 2002, several institutions in Colombia such as the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM) and the Unit of Energy and Mining Planning (UPME), have been working permanently in the development of a national atlas of solar radiation, which identifies the potential areas in Colombia versus the possibility of establishing renewable energy by photovoltaic cells. Figure 1 show the annual average of radiation in Colombia.

Although there is some variation for some months of the year, the north coast of Colombia is the area that receives the most radiation in the year. Figure 2 show the highest radiation in the month of July.

In general, Colombia has good solar energy potential in the whole territory, with a daily average multiyear of around 4.5 kWh/m^2 (highlighting the peninsula of La Guajira, with an average value of 6.0 kWh /m^2 and Orinoquía, with a slightly lower value), conducive to proper use. Other zones like Choco and Antioquia also have a good daily average of radiation. These two departments contain the largest number of artisanal gold mining and where pollution problems have been evidenced.

Both mining sites analysed in this project --Segovia (Antioquia) and Tadó (Choco)-- are in the range of 4.0 – 4.5 KWh/m^2 with a variation of the range between 5.0 and 5.5 KWh/m^2 as a high value.

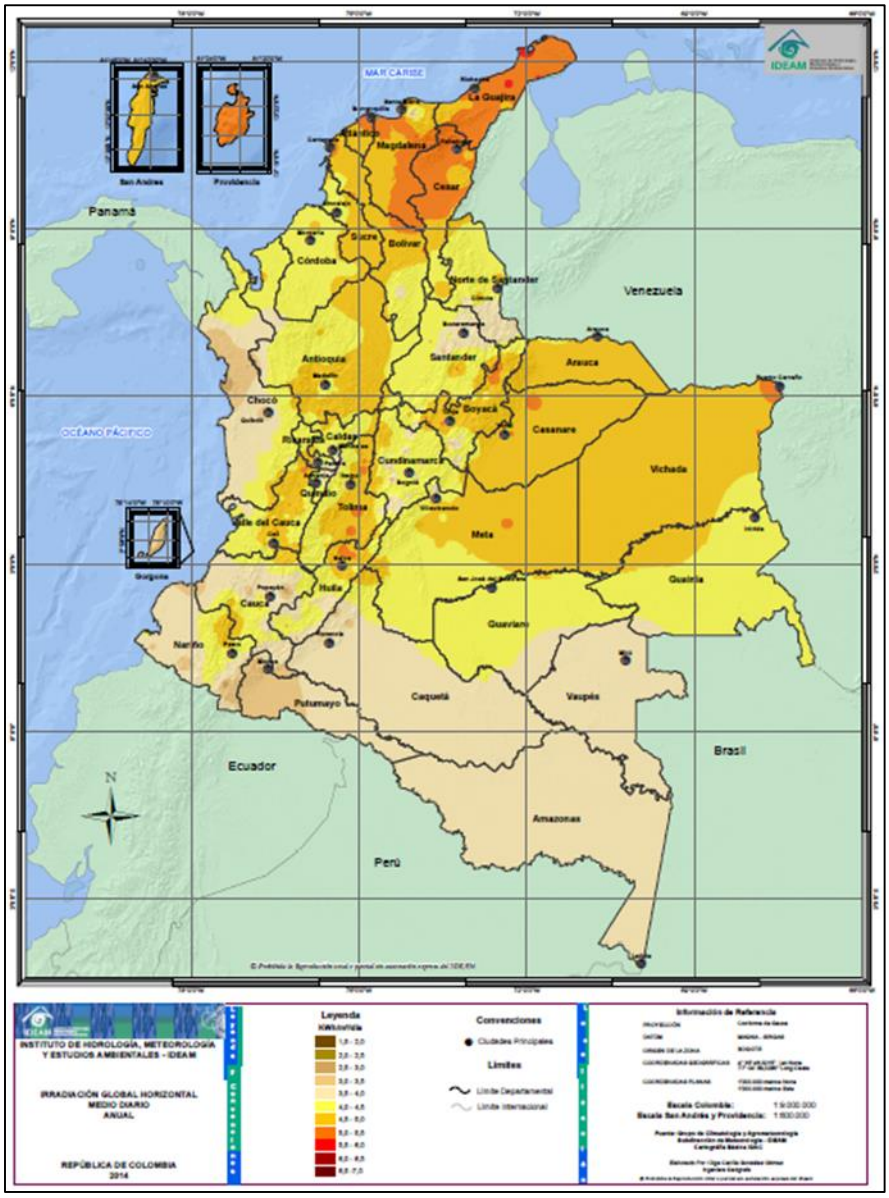

Figure 1. Solar map of Colombia. Annual Average. Kwh/m2 (IDEAM, 2015)

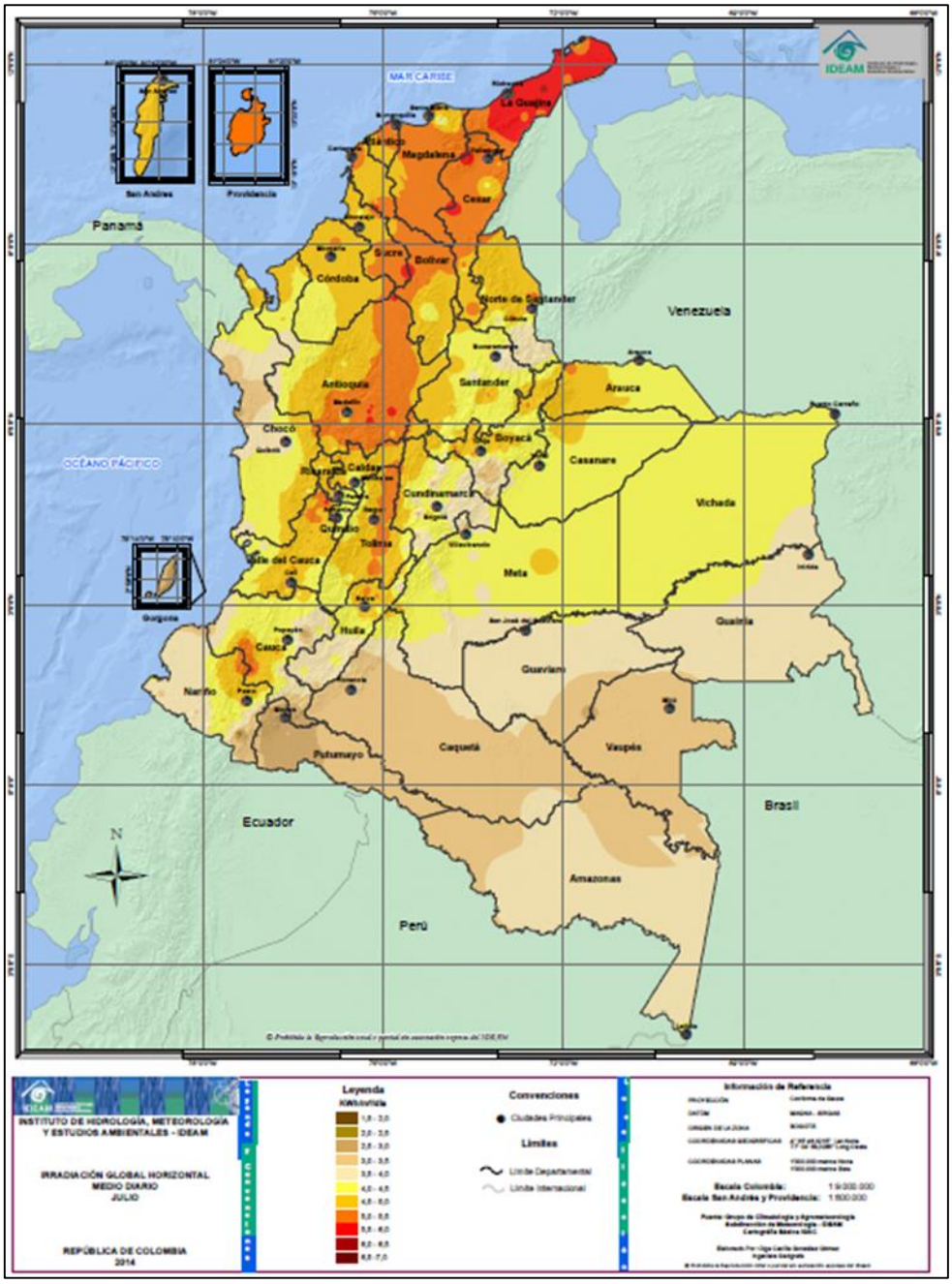

Figure 2. Solar Map Colombia. Month July. KWh/m2 (IDEAM, 2015)

2 The US EPA decision tree tools for wind and solar energy

The US EPA has developed a tool call *"RE-Powering's Electronic Decision Tree"* to help in determining the feasibility of a site to develop a renewable energy project, taking into account its use in contaminated or degraded sites (https://www.epa.gov/re-powering/re-powerings-electronic-decision-tree).

We have tested this tool at two sites in Colombia, Segovia and Tadó, so as to be able to show the feasibility of using the sites for the installation of photovoltaic cells. In order to make a comparative analysis, an additional site contaminated by pesticides is selected that is part of the northern coast of Colombia, which has a higher level of radiation. This site is in Cartagena City.

The decision tree tool is intended to engage non-experts in renewable energy to screen potentially contaminated or underutilized sites or landfills for whether they are good candidates for solar PV or wind projects. It is built so that more knowledgeable professionals can quickly navigate through the decision tree, and less experienced stakeholders can access additional information as they make their way through the questions. *The tool is not intended to replace or substitute the need for a detailed site-specific assessment that would follow this kind of initial screening* (US EPA, 2016).

The tool addresses the following types of sites:

- Potentially Contaminated Sites (Superfund, Brownfield, RCRA, mine site)
- Landfill (Municipal Solid Waste, Construction and Demolition or similar unit)
- Underutilized (Abandoned parcels, parking lots, buffer zones)
- Rooftop (Solar PV only; Commercial / Industrial roofs)

This informational resource will help ascertain whether potential barriers to a solar or wind project exist at a site of interest. It provides:

- A step-by-step walk through of key considerations for renewable energy development at the site;
- Suggested resources to help answer screening questions to gauge the site's potential; and
- Reports summarising answers to the screening questions, initial findings regarding suitability and other comments about the site.

Positive findings from the screening should create confidence regarding the site's suitability and should serve to generate interest and commitment from affected stakeholders (US EPA, 2016).

The tool was used in its entirely, although for some questions assumptions were made because the information was not available. Also, some American parameters did not apply to Colombia. R3 Environmental also used the decision tools to help build capacity of Colombian-based organizations. This model can apply to other sites in Colombia and throughout Latin America.

Annex 1 provides the results of testing the decision tree at two mining sites in Colombia, Segovia and Tadó, so as to show the feasibility of using the sites for the installation of photovoltaic cells. For purposes of comparison and illustration, an additional site contaminated

by pesticides, which has a higher level of solar radiation, was selected on the northern coast of Colombia. This site is in Cartagena City. The three sites provide several different levels of possible energy production ranging from on-site use of power by the site owner to the sale of power to off-site buyers or a utility.

The key findings for these sites are that both mining sites satisfied general criteria for renewable energy requirements related to solar radiation and site topography. However, Tado site reported a high retail price of electricity of 0,18 US$/KWh compared with Segovia Site of 0,14 US$/KWh. Cartagena Is the most viable site for the development of projects in renewable energy with the best options of solar radiation and accessibility of the city. Additionally, Cartagena has a better social development than the two mining sites.

3. Overall findings

This report abstract provides decision makers with more detailed information on the logic and rationale for considering renewable energy (particularly photovoltaic) production as a sustainable and valuable reuse of contaminated mining sites and other brownfields.

It summarises the preliminary screening analysis that can be conducted by country officials and other stakeholders to assess the potential feasibility of deriving the additional benefits of energy production on potentially and/or contaminated sites.

First, using renewable energy screening tools developed by the USEPA and practiced by Colombian scientists, the potential of deploying solar energy was assessed at three pilot sites. The analysis included such factors such as the solar resource, infrastructure, and owner interest and site readiness. The FCO project was the first time the USEPA Decision tools were adapted for use in Spanish and outside of the U.S.

R3 was able to provide detailed answers to most of 25 questions posed by the USEPA screening tool. All three pilot sites satisfied the criteria for General Site Characteristics, Redevelopment Considerations, Load Assessment and Financials. Key ingredients for successful deployment at the most promising site included abundant solar resource, support of owner and governmental officials and site clea-nup. As recommended by the USEPA, r3 proposes detailed site-specific assessments to occur in phase II of this project to follow these initial screenings.

Additional high level assessments by a global renewable energy company outlined the potential for deploying solar energy at the two most promising pilot sites. Simulation reports estimated generation of 33600 MWh/year at the most promising site (Cartagena) site.

The report also outlines community enterprise development opportunities as they relate to renewable energies including solar gardens and job creation.

Renewable energy on Brownfields can help Colombia achieve international climate change commitments and national goals including Colombia’s 2050 Energy Plan, particularly the design of decentralized, resilient energy infrastructure.

Further, “For low and middle income countries facing resource constraints (such as Colombia), initially linking site remediation to sites with existing severe human health impacts and also

the reuse and redevelopment of contaminated land can harnesses financial drivers from the marketplace."2

R3 conferred with the Institute of the Americas who is very familiar with the critical needs to deploy renewable energy on large scale in Colombia. In 2016 the Institute offered recommendations to bring renewable energy projects to fruition;

- Engage stakeholders early (World Café)
- Demonstrate social benefits to the community (r3 project tools)
- Develop public/private partnership agreements for financing, construction and management.

The r3 project team is well positioned in expertise and partner networks to successfully develop and manage these projects. Further, capacity building by the r3 team for both the public and private sector can increase the number of practitioners and the availability of gentle remediation and renewable energy options for rehabilitating brownfields in Latin America and around the world.

This report is a companion to the other documents produced under the sponsorship of the Foreign and Commonwealth Office Prosperity Fund project entitled Strategies **for rehabilitating mercury- contaminated mining lands for renewable energy and other self-sustaining re-use strategies.** All the reports from the project can be found at: http://www.r3environmental.com.co/en/projects.html

[2] "Financing Mechanisms for Addressing Remediation of Site Contamination produced by the World Bank with external contributions from the Council of Development Finance Agencies.)

Annex 1

Segovia assessment

Chart 1. Segovia assessment on the US EPA decision tree tools

EPA Item/Question	Segovia, Antioquia
Site Address	El Planchón Mine
Brief Site Description	A currently exploited artisanal gold mine located at one of the most active municipalities in regards of this kind of economic activity but in an artisanal and illegal way. The specific site is relatively near to the municipality's centre; moreover, it is in the urban area.
Geographical Coordinates	7°5'28,21" N; 74°42'6,84" W 7.09117, -74.7019
Solar resource at the site (greater than 3.5 kWh/m2/day) or better?	Between 4.5 and 5 KWh/m^2/day according to the Colombian Atlas of Wind and Solar energy
Site Topography the slope of the land less than 6 degrees? Or can the site be easily graded?	The site has a slope of less than 6 degrees
Wind Speed Measurement	The Wind Energy Density at 80 meters Height is between 64-125 w/m^2 according to the Colombian Atlas of Wind and Solar energy.
Initial Findings – EPA Tool	Satisfied Criteria on General Site Characteristics, Redevelopment Considerations and Load Assessment and Financial. Need Additional information to assess the item of Contamination and Landfill Issues
Next Steps identified by EPA Tool	---
Contaminated Site Considerations, Status and Readiness	Yet to be investigated in detail
Distance to existing infrastructure (Transmission and/or distribution lines)	The distance is less than 1 mile.

EPA Item/Question	Segovia, Antioquia
Distance to graded roads less than 1 mile?	About 2 Km (equal to 1,24 miles) to the principal road in good conditions, but 463 m (0,29 miles) to a road with tolerable conditions.
Usable acreage for a ground mounted system greater than 2 acres?	The area available for PV in the Segovia site is approximately 0,703 Ha or 1,7372 Acres (according to a rough estimate based on satellite images of Google Earth that do not have very good resolution in the area), and the perimeter is about 340 m.
Is the usable rooftop space greater than 30.000 square feet?	Yes
Owner's interest in investing in and/or selling or leasing the site to enable development of solar PV?	Yes. But he and the whole community might need a better explanation of the process and pros-cons.
Is there an existing redevelopment plan for the site or is one being developed?	No. The site is currently being used to extract gold from the mine.
Will a community visioning process be part of the site's redevelopment?	The community would involve into the PV installation project, mainly the people working on the mine.
Is the site free of land use exclusions or restrictions that would preclude the use of solar PV on the usable acreage or rooftop?	Yes, in the land management plan of Segovia, any restriction for photovoltaic uses are mentioned.
Will the building on site remain (not be demolished)?	Yes, at least while the mine is still working.
Is the building less than or equal to 3 stores in height?	Yes, it is 1 store height.
Will the existing roof remain (not need to be replaced) over the next 25 years?	Maybe it will need to be replaced before 25 years from now. The material it's made on, didn't look in perfect conditions.

EPA Item/Question	Segovia, Antioquia
Is there a landfill or similar unit on the site being considered as part of a solar PV installation?	Not that the owner knows of.
Has the site been assessed for environmental contamination?	Only by our sampling, which was made on July 27th, 2016.
Is remediation complete or nor required on the usable acreage?	Maybe a remediation is required but there is not one being executed.
Is Remediation in progress?	No.
Does the site owner, developer, or lessee meet requirements for liability protection under applicable federal and/or state law?	No laws available about liability requirements in Colombia nor Antioquia.
Is there a need for additional funding to pursue assessment and/or remediation?	Yes. The owner by his own can't afford the previous assessment and/or the remediation.
Will the facility with on-site energy load be operational for at least 20 years?	I can't tell because I would need to know maybe the expected performance.
Is virtual Net metering allowed by the local utility?	Colombian regulations permit only the "sale" of the renewable electric energy that is left over from the generation by natural persons to the conventional electricity grid, converting them into a kind of credit or balance in favour of the electric energy bill. Colombian law 1715 of 2014.
Is the retail price of electricity greater than 8 cents/KWh?	Yes, its approximately 0,14 US$/KWh, according to the unit cost of providing the service at stratum 3 on residential use by EPM (Public Companies of Medellin).
Is Aggregate net metering allowed by the local utility?	There is no such concept in the Colombian law 1715 of 2014, which is the only current law about renewable energies.

EPA Item/Question	Segovia, Antioquia
Is the retail price of electricity for off-site operations greater than 8 cents/KWh?	Yes, its approximately 0,14 US$/KWh, according to the unit cost of providing the service at stratum 3 on residential use by EPM (Public Companies of Medellin).
Feasible project Arrangements	Serves owner's on-site energy load. Serves owner's off-site energy load(s).

Tadó Assessment

Chart 2. Todó assessment on the US EPA decision tree tools

EPA Item/Question	Abandoned Mine Tadó
Site Address	The site is located at the rural area of Tadó
Brief Site Description	The site is an abandoned gold mining area about 8 years ago, and covers an area of almost 1 Km^2. It is identified to be a potentially contaminated site due to the previous mining activity. Some areas are still being mined, in both artisanal and more mechanical technologies.
Geographical Coordinates	5°13'21,48" N; 76°39'9,48" W 5,2226 N; -76,6526 W
Solar resource at the site (greater than 3.5 kWh/m2/day) or better?	Between 4 and 4,5 KWh/m^2/day according to the Colombian Atlas of Wind and Solar energy
Site Topography the slope of the land less than 6 degrees? Or can the site be easily graded?	The site has a slope of less than 6 degrees.
Wind Speed Measurement	The Wind Energy Density at 80 meters Height is between 125-216 w/m^2 according to the Colombian Atlas of Wind and Solar energy.
Initial Findings – EPA Tool	The General site characteristics and load assessment and financial have satisfied the criteria of the decision tree. On the other hand, the redevelopment considerations and the Contamination and landfill issues need additional information to be assessed. Hence, there may not be enough information to make an initial judgement whether the site is a good candidate for renewable energy development or not.

EPA Item/Question	Abandoned Mine Tadó
Next Steps identified by EPA Tool	Collect the information needed to answer the skipped questions and return to the decision tree. Pursue conversations with the appropriate professionals (government agency representatives, engineers, property managers, etc.).
Is the usable acreage for a ground mounted system greater than 2 acres?	Yes, it is 116,01 acres approximately, according to an estimate based on satellite images of Google Earth. And the perimeter is 555 m.
Is the distance to transmission and/or distribution lines less than 1 mile?	Around 0.31 miles between the abandoned mine and the town.
Is the distance to a graded road less than 1 mile?	Yes, it is approximately 0.1 miles.
Is the site owner(s) interested in investing in and/or selling or leasing the site in order to enable development of solar PV?	This question was skipped because this topic hasn't already been investigated. The former owner has not been very active in the area for some time, as mentioned by the community leaders who showed us the site.
Is there an existing redevelopment plan for the site or is one being developed?	This question was skipped because the community is very interested in redeveloping the site, but they don't have a clear idea of what the next steps should be nor which opportunities adapt best, so there is not a plan.
Will a community visioning process be part of the site's redevelopment?	Yes. The community is a key fact in the development of the site. They have a vision that could be an opportunity to propose a RE project, but it would require consultation and a community participation process.
Is the site free of land use exclusions or restrictions that would preclude the use of solar PV on the usable acreage or rooftop?	Yes. The site is not located on environmentally sensitive or preservation areas, restrictions around airports nor sites of historical or cultural significance.
Is there a landfill or similar unit on the site being considered as part of a solar PV installation?	No, there is no landfill on the site.

EPA Item/Question	Abandoned Mine Tadó
Has the site been assessed for environmental contamination?	Preliminary information only has been provided. Formal site investigation has yet to be carried out.
Is remediation complete or not required on the usable acreage?	No. There is no remediation plan in progress as long as we know. Moreover, it must be considered that, due to the big area of the site, there are areas that are currently abandoned but others are still being exploited.
Is remediation in progress?	This answer was skipped as a result of it is maybe in progress but, according to the community leaders, no additional progress has been evident since a time. As mentioned before, it is focused on phytoremediation.
Are remediation activities actively disturbing or going to disturb the usable acreage of solar PV?	This question was skipped due to there is not many data available about the current or planned remediation activities on the site and how it would disturb the usable acreage. It would be an important item next step to investigate.
Is the local utility or other energy provider interested in buying power from a renewable energy project at the site?	Yes. Colombian regulations permit only the “sale” of the renewable electric energy that is left over from the generation by natural/individual persons to the conventional electricity grid, converting them into a kind of a credit or balance in favour of the electric energy bill. Law 1715 of 2014.
Will the facility with on-site energy load be operational for at least 20 years?	Yes. The system would serve a population that is actually growing, so it’s expected that the on-site load will be operational in the long-term.
Is net metering allowed by the local utility?	Yes. Colombian regulations allow the net metering by the law 1715 of 2014, where utility customers could be credited for power supplied to the grid by a solar PV System in excess of the site’s electricity needs.
Is the retail price of electricity for on-site operations greater than 8 cents/KWh?	Yes. The retail price is 0,18 US$/KWh according to the unit cost of providing the service at residential use by DISPAC (Public energy of Chocó).
Is aggregate net metering allowed by the local utility?	No. There is not actual clear regulations on this topic.
Feasible project arrangements	Sell power to utility, serves owner’s on-site energy load.

Cartagena Assessment

Chart 3. Cartagena assessment on the US EPA decision tree tools

EPA Item/Question	Colombiatón, Cartagena
Site Address	The site is located at the exit of the city of Cartagena de Indias, on the road to Turbaco, on the right bank of the Troncal de Occidente (31 Street) and behind the Transelca substation (formerly Corelca, now Electricaribe). The direct influence area of the property is constituted by the neighbourhoods Villa Corelca, Ciudadela 2000 and Simón Bolívar.
Brief Site Description	The initial property is known as La Algodonera, which belonged to the National Cotton Federation (Federalgodon) and is currently owned by Banco de Colombia SA (Bancolombia), who intended to start the Colombiatón project which consists on the construction of 1200 homes of social interest (VIS). The total land consists of 44 Ha, of which approximately 20 Ha were used in the construction of the Ciudadela 2000 project and the remaining 22 Ha belongs to the Colombiatón project, known as the Santa Elena land. In the area of the initial site there is a security confinement that stores in a temporary and long term an estimated 22,726 m3 of containers with obsolete pesticide residues and soils contaminated with pesticides. Likewise, traces of heavy metals like Cadmium and Lead appear that do not correspond to the nature of the confined residues. The results of the studies reported by Bancolombia in 2014 (and which continue to report on a regular basis according to the authorities' request) show that the confinement system has worked so far, according to design considerations. The owner of the property (Bancolombia) is interested in the remediation due to the request of the environmental authorities since 1999. In fact, to date, on-site remediation efforts (Oxidation using alkaline solution of Sodium Persulfate) have been made by the company “Uribe Torres Consultores” but the environmental authority has not received the final report to deem sufficiency.
Geographical Coordinates	10°22’27,2” N; 75°28’6,2” W 10.37422, -75.46839
Solar resource at the site (greater than 3.5 kWh/m2/day) or better?	Between 5 and 5,5 KWh/m^2/day according to the Colombian Atlas of Wind and Solar energy
Site Topography the slope of the land less than 6 degrees? Or can	The site has a slope of less than 6 degrees

EPA Item/Question	Colombiatón, Cartagena
the site be easily graded?	
Wind Speed Measurement	The Wind Energy Density at 80 meters Height is between 343 – 512 w/m^2 according to the Colombian Atlas of Wind and Solar energy.
Initial Findings – EPA Tool	Satisfied Criteria on General Site Characteristics, Redevelopment Considerations and Load Assessment and Financial. Need Additional information to assess the item of Contamination and Landfill Issues
Next Steps identified by EPA Tool	Collect information needed to answer the skipped questions and return to the decision tree. Pursue conversations with the appropriate professionals (government agency representatives, engineers, property managers, etc.)
Distance to existing infrastructure (Transmission and/or distribution lines)	The distance is less than 1 mile. This is assumed based on the location mentioned above (near to the urban area) and an approximate measure in Google Earth.
Distance to graded roads less than 1 mile?	0,525 miles or 845 m.
Usable acreage for a ground mounted system greater than 2 acres?	Of the initial property area (108,7 acres), the Colombiatón project is currently planned for 54 acres. There is no current information about slope, obstacles or shaded area. There is a security confinement in the property.
Owner's interest in investing in and/or selling or leasing the site to enable development of solar PV?	The site owner (Bancolombia) has expressed intentions to donate the land but is legally bonded to it because of the remediation obligation.
Is there an existing redevelopment plan for the site or is one being developed?	The owner bought the property with the plan of constructing social interest houses but soil pesticides contamination was discovered, so the plan in the first instance is to remediate these soils.
Will a community visioning process be part of the site's redevelopment?	Bancolombia has led a social work with the community but mostly directed to give information about the site contamination and the remediation that is being done.

EPA Item/Question	Colombiatón, Cartagena
Is the site free of land use exclusions or restrictions that would preclude the use of solar PV on the usable acreage or rooftop?	Yes, in the land management plan of Cartagena de Indias, any restriction for photovoltaic uses are mentioned.
Is there a landfill or similar unit on the site being considered as part of a solar PV installation?	As mentioned above, some site area is used for security confinement for long-term temporary storage of obsolete pesticide containers and pesticide contaminated soils.
Is the landfill or portions of the landfill being considered for solar PV closed consistent with applicable requirements?	Given that the landfill is being used for temporary and long-term storage, it is not clear whether Bancolombia will extract or keep using the security landfill or an enclosure that meets the requirements will be made.
Are the oversight agency the site owner and the site operator amenable to a solar PV installation on the landfill?	Yes, the site owner might be interested. The community might need more explanation of pros and cons. And the oversight agency (ANLA) requires as a prerequisite the completion of the remediation process.
Has the landfill settled uniformly (or is expected to settle uniformly)?	Haven't found information on this.
Will a solar PV installation violate existing erosion control plans or vegetative cover specifications?	No. The site has no vegetative cover specifications and there is no erosion plan.
Do the piping and collection systems have sufficient weight-bearing capacity to support added weight from a solar PV system and construction equipment?	Haven't found information on the consistency of the soils present in the site. Nevertheless, if many houses were going to be constructed, the soil might meet the characteristics required about weight bearing.
Is a solar PV system compatible with the operation & maintenance (O&M) of	Yes, but we might need some clarifications regarding the design.

EPA Item/Question	Colombiatón, Cartagena
leachate and landfill gas collection infrastructure?	
Will a Solar PV installation require modifications to drainage patterns or otherwise impact the storm water management plan?	Yes. There is no storm water management plan found within the case file.
Has the site been assessed for environmental contamination?	Since 1999 the site has been investigated on contamination. However, this information has yet to be collated as a formal site investigation report and risk assessment.
Is remediation complete or nor required on the usable acreage?	Bancolombia reports that the remediation process was finalized in April 2014 but the bank has not submitted any further reports indicating sampling results that meet requirements established by the National Environmental Licensing Agency (ANLA). In addition, since the remediation activities carried out by ERM generated hazardous wastes, a farthest warehouse has been used to store waste, However, by October 2015, ANLA still notes that there are 17 tanks stored.
Is the local utility or other energy provider interested in buying power from a renewable energy project at the site?	Colombian regulations permit only the “sale” of the renewable electric energy that is left over from the generation by natural persons to the conventional electricity grid, converting them into a kind of credit or balance in favour of the electric energy bill. Law 1715 of 2014.
Is virtual Net metering allowed by the local utility?	Yes. Per the same law mentioned above (Law 1715 of 2014)
Is the retail price of electricity greater than 8 cents/KWh?	Yes, in fact is approximately 0,13 US$/KWh per the unit cost of providing the service of Electricaribe. According to the Rates, subsidies and contributions for 2017 of the company Electricaribe, the unit cost of providing the electricity service in Cartagena corresponds to 0,123 US$/KWh as a result of applying the price for Client Owned Assets.
Is there a potential sponsor for a community solar project?	Bancolombia would surely be the sponsor maybe in the collaboration with the community.

EPA Item/Question	Colombiatón, Cartagena
Feasible project Arrangements	Sell power utility Sell power to off-site Buyer or collection of buyers.