

Webinar “Renewable hybrid energy solutions: Decarbonising mines, cost reduction and energy security”

Q&A

Answers by Dornier Suntrace, JUWI Renewable Energy and Reuniwatt

RENEWABLE HYBRID PROJECTS

Q. Which level of penetration applies to the projects you mentioned?

A. JUWI: Of the higher penetration projects we have built, Centamin’s Sukari operations are forecasting 40%. Agnew are expecting to see more than 50%, and BHP are starting off at around 30%, with plans to expand in the near future.

A. Dornier Suntrace: We have realized a project with B2Gold in Fekola that has reached 20% fuel savings from Solar plus BESS on a one-year average. The solar penetration is 75% at peak sun hours. The next projects are targeting >30% only using PV and a BESS to stabilize the network during zero engine operation. We are involved in more projects on the 20-25% fuel savings range. On a concept level, we have analysed projects reaching >80% renewable energy share (fuel savings) for off-grid locations in western Africa.

A. Reuniwatt: Several projects were mentioned, with penetration levels of at least 30%.

Q. With grid at \$0.09/kWh (energy, max demand and fixed fees), the off-grid project still looks expensive?

A. Dornier Suntrace: It is always difficult to compare the cost of electricity from a renewable project. If you have to calculate the tariff (or Levelized Cost of Energy - LCOE) based on the life of a mine, which is often around 10-15 years, the tariff is higher compared to a grid-connected PV plant with 25 years of commercial lifespan. The 10 years of difference result roughly in a 40% higher tariff for the 15-year offtake agreement. Accordingly, it is difficult to compare the price against publicly announced tariffs for solar projects, it needs a specific evaluation for the mine.

Q. Is there still a strong case for low penetration at grid-connected sites?

A. Dornier Suntrace: Yes, definitely. Especially since energy costs have gone up everywhere, the “hedging” effect of energy cost by using solar energy has become very visible. If you had a solar plant already, you may have saved significant amounts of money against the cost increase in tariff. Also, as solar is the technology providing the lowest cost of electricity, there is usually also a business case against a grid tariff.

Q. How long do you take to do the analysis for the implementation of a hybrid project?

A. JUWI: Our approach follows the client’s requirements, and we break down analysis into 3 separate levels:

- 1- Pre-feasibility Study, that takes about 2 weeks
- 2- Definitive Feasibility Study - This takes between 1-2 months
- 3- Fixed and Binding (Bankable Study) around 2-3 months.

A. Dornier Suntrace: We usually start with a high-level analysis, which is normally completed in 6-10 weeks. It addresses all relevant aspects, such as the mine's demand profile, solar & wind resources, technology selection, economic analyses and an optimization of the best sizing, the use of storage, etc. It provides all the necessary information to make a conscious decision on the available options and to identify the way to implement the project. There is a very similar approach for off-grid or grid-connected projects, but it addresses the different nature of the business case and the technical requirements.

A. Reuniwatt: The answer is site-specific! However, during the detailed design phase, we can help different types of actors in the sizing of their plants and batteries through "backtests" (historical forecasts). Providing a backtest takes about a month.

Q. What is the energy demand and the total genset capacity of Fekola Mine?

A. Dornier Suntrace: The Fekola Solar project provides 30MW AC with 36MWp installed, and the Battery of 15.4 MWh secures a 45 min for 75% of the solar capacity. The mine has HFO gensets installed in a total capacity of 64MW with 8 engines, of which 6 are usually operated when the solar does not contribute.

Q. What are the first returns on your mining hybrid projects? (Cost efficiency in comparison to the unique use of genset)

A. Dornier Suntrace: Cost efficiency is a mine specific figure, and it cannot be transferred from one location to the other. Key factors that are influencing the cost-efficiency are (i) solar & wind resource, (ii) Capex for the renewable project (iii) revenue: in the off-grid case, the fuel savings are considered as revenue, thus the fuel price and the fuel consumption play a key role.

Numbers show, that the payback periods for renewable projects in off-grid locations can be between 4-6 years.

A. Reuniwatt: Our analyses show that for a ~4MWp plant with a 30% PV penetration, the overall effect of the forecasts is to reduce the consumption of diesel by nearly 40 000 litres, the commercial equivalent of saving between USD 35 000/year and USD 60 000/year when considering a fuel price ranging from USD 0.9/litre to USD 1.5/litre (this represents a diesel operational expenditure reduction of about USD 0.1-0.2/kWh for such a project). The payback period for our sky cameras is less than 3 years.

Q. Why are there so many fluctuations of the genset in your simulation with a stable demand?

A. Dornier Suntrace: The load in the mine is effectively fluctuating around a stable average load, and these load changes are covered by all gensets. When renewables are generating electricity, it results in additional fluctuations imposed on the gensets, however smoothed out by the use of the battery storage.

Q. Why does the high RE penetration case still present the best case with such high RE curtailment?

A. Dornier Suntrace: Actually, the highest RE penetration case is the worst of these cases, however still below 6 years of payback. In my presentation, the difference between cases 3 and 4 is still contributing a lot of additional fuel savings, that keeps the payback period short. Further increasing the RE penetration will surely result in reducing the economic benefit.

The question, however, is not always to install the lowest cost RE solution, but rather to find the largest RE penetration at an acceptable economic level. And as such, a payback period of 6 years against a 13-year lifespan of a mine looks like a good business case.

Q. Do you propose the AHEAD simulation platform for your customers?

A. Dornier Suntrace: The AHEAD tool is not a commercial software, it is rather a sophisticated internal tool and embedded in our advisory services. This tool allows us to analyse a large range of scenarios in a very efficient manner. And it also ensures that we can adapt the settings to different use cases as necessary. The AHEAD tool has proven to be a valuable simulation for all different types of hybrid scenarios: off-grid, grid-connected, different load profiles, integration of solar & wind & energy storage, time-of-day tariff, peak shaving, load shifting, etc... It includes a financial model, and as such, enables us to look at the economic benefits alongside the technical benefits, such as RE-share and CO₂-savings. The services we can provide specifically include the simulation of hybrid concepts based on the AHEAD tool.

Q. How real is hydrogen today?

A. Dornier Suntrace: As shown in my presentation, it would be interesting to check whether the excess energy from oversized RE in high penetration cases can be used in hydrogen applications and, for example, stored as fuel for the gensets which then generate power based on hydrogen derivatives during low RE periods (seasonal storage). However, the state of hydrogen technology in the mining context is in pilot testing stage, and there are no actual cost figures available to see in which scenario it may make commercial sense. I am convinced that electrification will move quickly towards reliable and economic solutions, and thus hydrogen will remain a solution for the last 10-20% of RE penetration.

ENERGY STORAGE

Q. Do batteries operate off grid? If yes, what is the response time to transfer between sources?

A. Dornier Suntrace: Batteries are even more important in off-grid scenarios, as they are providing the spinning reserve when engines are not operating, they can perfectly be used for frequency and voltage support in electrical island networks and have a fast response (milli-seconds).

Q. What is the lower limit of the battery discharge?

A. JUWI: In most of the projects we have built, we are using Lithium-Ion Battery's in either NMC or LFP chemistry's. The Discharge rate is dependant on the project, and varies widely. The LFP chemistry can supply a discharge current of 1C and some cells can supply more than 10C while the discharge current for NMC cells is typically 1-2C.

A. Dornier Suntrace: This depends on the type of battery used, and the application and use case. The specific data can be found with the respective suppliers. In the case of a battery connected to mining operations, the function of the battery is to provide safety to cover for a sudden load drop at the solar plant, and also for delayed ramping up of engines. Accordingly, the battery is not fully discharged or charged during operation based on this use case.

Q. Battery storage capacity seems to be the biggest challenge with solar power generation. How is the research in this area going?

A. JUWI: Battery technology is growing rapidly, and we are re-modelling and rethinking our designs every 12 months at the moment. As mentioned above, we are using Lithium-Ion Battery's in either NMC or LFP chemistry's in most projects, but we are also working on projects with Vanadium Flow Technology.

A. Dornier Suntrace: Battery storage itself is not a big challenge, but the cost of battery storage is to some extent. Battery research is going into multiple directions, on one side to achieve a higher energy density, as required for mobile applications (EV, phones, etc.) and also for higher reliability, which may be more important for grid-scale storage. We expect that in the future, the cost of battery storage will come down a lot, and this will enable lower cost case for solar and storage with high penetration RE.

FORECASTS

Q. What is the risk that a solar drop is missed or incorrectly forecasted, and causes a mine blackout?

A. JUWI: The risk is not only with the forecasting but also with the technical solution, for example a battery can work as a safety buffer to accommodate any unexpected (or unattended) drop in solar power.

A. Reuniwatt: The use of our sky cameras within hybrid projects allows to reduce the additional over-spinning reserve, or additional “emergency” gensets ignited at all times, while avoiding blackouts. For instance, the forecasts derived from the instruments allow to prevent unnecessary starts of a genset when the actual spinning reserve is able to absorb the incoming 2-minute PV ramps. The anticipation of solar power ramp rates results in less frequent starts/stops of gensets and allows to keep a lower number of online gensets during the day, compared to a baseline control strategy without forecasting. In addition, frequent start/stops are prevented. The reduced number of gensets needed during the entire period translates into an increased mean load applied on the gensets (about a 10% increase), translating into higher fuel economy due to a more efficient load redistribution on the gensets. The alarm for the drop can be defined as more or less sensitive, according to the client's expectations.

Q. Did you already receive feedback on the savings resulting from forecasts?

A. Reuniwatt: Every project is different, and the savings strongly depend on the size of the plant as well as on the number of gensets. However, as explained earlier, forecasts help reduce the consumption of diesel/oil on site by thousands of litres every year.

Q. What is an example of metrics you are using to define objectives?

A. Reuniwatt: We will evaluate the performance in terms of statistical metrics like nMAE (normalised Mean Absolute Error) or nRMSE (normalised Root Mean Squared Error). However, we can consider more operational metrics like drop detection and effective savings.

Q. Do we need an employee from Reuniwatt to install the camera on site?

A. Reuniwatt: No, the installation is done without a Reuniwatt employee on site. To make it as straightforward as possible, we provide all necessary information beforehand (installation manual, product characteristics and if needed, advice regarding the structure to support the equipment on site).

Q. What is the typical error for minutes/hours/days forecasting? Is the accuracy the same for any location worldwide?

A. Reuniwatt: The accuracy of the forecasts strongly depends on several parameters: the local climate, the concerned time horizon, and the metric used. Therefore, a single answer does not work for any place in the world. The accuracy depends on a lot of variables, but nevertheless, some systems/methods can keep the accuracy level doing some on-site adjustments.

GENERAL QUESTIONS

Q. In which countries do you provide your services? Do you have dedicated teams for each area?

A. JUWI: JUWI are a global company with offices in most regions. EMEA and APAC (Cape Town, Brisbane and Perth) are heavily focused on Mining and Off-Grid, with dedicated teams.

A. Dornier Suntrace: We provide our services worldwide. Currently we have dedicated teams for the different topics that we cover, mostly out of Germany. Dornier Group has offices in several regions (Europe, MENA Region and Central Asia) and we can use this infrastructure to support projects in these regions. We will surely expand our global presence during the next years.

A. Reuniwatt: We provide solutions worldwide: we currently have projects in nearly 50 countries, on all continents. Our headquarters are in Reunion Island (Indian Ocean) and we have two offices in mainland France (Paris and Toulouse).

Q. Where can I learn more about hybrid systems, and about batteries and genset integration?

A. JUWI: Feel free to contact me directly, and I can put you in touch with our Hybrid design team, who can answer any questions.

A. Dornier Suntrace: You are most welcome to get in touch and speak to myself or other members of our industrial decarbonization team. You can also check for some of our presentations on youtube (<https://www.youtube.com/@suntracegmbh2122>) or our website (<https://dornier-group.com/en/service/services-in-the-mining-sector/>).

A. Reuniwatt: You can find our white papers and previous webinars [in our resource centre](#). For example, we have discussed "[Hybrids: A Path from Intermittency to Stability](#)" with BayWa r.e. and Wärtsilä.

Q. What opportunities for students/interns do you have?

A. JUWI: JUWI have multiple intern programs, and can provide students with many opportunities.

A. Dornier Suntrace: We always offer internships and working student contracts to various students, from engineering and economics, but also meteorological or GIS based backgrounds. In selected cases we also support bachelors or master thesis for the students in our teams. Please check our job offerings at <https://dornier-group.com/en/career/experienced-professionals/> selecting "Dornier Suntrace GmbH"

A. Reuniwatt: Reuniwatt offers student internships in meteorology, machine learning and related topics. To find out more, take a look at our internship page: <https://reuniwatt.com/en/master-student-internships-data-science-for-renewables/>

Q. How can I contact you?

A. If you have questions concerning the content of this webinar you can contact our speakers [Dave Manning](#), [Martin Schlecht](#), [Marion Lafuma](#), and moderator [Robbie Louw](#) directly– we are happy to answer your questions!

For any other questions, be sure you will be forwarded to the right counterpart when contacting us here:

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