# Renewable Power Systems Sing to the Same Tune (Text Version)

This is the text version of the video Renewable Power Systems Sing to the Same Tune.

[Insert YouTube video: <https://youtu.be/RbAAdWq415U>]

[Song playing, wave file visualized in front of power hardware]

**>>Narrator**: Do you hear it? It’s the sound of a changing grid. Well, it’s actually Mozart, but it’s coming from a power inverter, and these devices are changing the grid. NREL is injecting musical frequencies into inverters to show a powerful research capability. By injecting a range of frequencies, engineers can discover which devices are causing stability issues on the grid and how to bring them into harmony.

**>>Shahil Shah, Senior Power Systems Engineer, NREL:** So, maintaining a stable grid with all the renewables is perhaps the biggest challenge that we are facing to go up to 100% renewable. We can figure out the variableness of wind and PV by putting more storage or building up the capacity. How do we make sure that all these complex devices are going to work together in a friendly manner?

**>>Narrator:** Solar and wind need to be in-sync with the grid.

**>>Shahil:** And so they create a lot of vibrations or oscillations, just like mechanical structures, but we don’t see them. This can create disruptive behavior. It has happened all around the world in power systems with high levels of renewables. So mechanical engineers, they have tools to understand vibration in their structures, like we do vibration testing of blades of wind turbines, of wings of airplanes, buildings and bridges. But electrical engineers, they don’t have such tools based on measurement, and we are going to need such tools to understand stability of a future power system where we will have a high amount of renewables.

**>>Narrator:** NREL has developed an impedance measurement tool to study grid stability.

[Text on screen: Impedence: the response of a circuit at different frequencies.]

**>>Shahil:**This capability allows us to do that. And we’ll need similar software tools and testing systems. That is what excites me the most, already seeing the value of this. Many manufacturers coming to us to test their inverters and wind turbines using this capability, which they cannot do anywhere else in the world.

**>>Narrator:** Why did these resources start singing?

**>>Przemyslaw Koralewicz, Research Engineer, NREL:** What I was always interested in is how does this inverter sound when we go through different frequencies. So I would often go out and listen to the inverters, and get a feeling for which one was more audible and which one was less. We do a lot of impedance scanning, and we develop tools that allow us to quickly switch between frequencies that we are injecting into the grid. Pretty much, to generate music, we use exactly the same tools. It probably didn’t take me more than 2 hours to implement that, and I really had a lot of fun developing that.

**>>Narrator:** The songs are performed by megawatt-power hardware, sitting beneath wind turbines and solar arrays.

**>>Przemyslaw:** So the National Renewable Energy Laboratory is unique from the point of view of equipment we have here, including our very large grid simulator, which allows us to play very dynamic oscillations and analyze devices that we have on our site. We also have a very fast and robust medium-voltage data acquisition system that we utilize to achieve that. And of course we also have the know-how and highly skilled researchers that are able to help with analysis.

**>>Shahil:** So this unique capability can excite wind turbines, PV inverters, all this new equipment that we are putting on the grid, at new frequencies, and really understand how they vibrate. We can use this characterization to understand whether they will be friendly with the grid or there will be some disruptions.

[Animated NREL logo with the words "To learn more, visit [nrel.gov/grid](https://www.nrel.gov/grid/index.html)."]