



## ROAD MAP FOR THE FUTURE

According to a recent study, scientists have published a detailed road map to move 139 countries to 100 percent renewable energy by 2050. Energy experts at Stanford University reported that using wind, solar, geothermal, and water (hydropower, tidal, and wave) energy to electrify all economic sectors that need power to operate – including the electric grid itself, transportation, heating and cooling, industrial and the agriculture, forestry, and fishing industries – would significantly reduce energy consumption, decrease deaths from air pollution, create millions of jobs, stabilize energy prices and have Quadrillion of Rupiahs (1 Quadrillion equal with 1.000 Trillion) on health care and climate-related costs.

Mark Jacobson, director of Stanford University's Atmosphere and Energy Program said that they have individual plans for each of the 139 countries and these represent more than 99 percent of all of the emissions worldwide. The study looked at the world's energy needs, beginning with 2012 and projecting out to 2050. In 2012, the world used 12.105 terawatts (TW) of energy, which is equal to 12.105 trillion watts. By 2050, the world will need 20.604TW if nothing changes and every country continues with the same approach it currently uses to meet energy demand, the researchers wrote in the study.

However, if those same business sectors were turning into renewable energy sources in order to electrify their all of their power requirements, the world would need just 11.804TW to meet global power demands, according to the study. This is because electricity is more efficient than combustion, according to the researchers.

Jacobson offered an example: In an electric car, he said, 80 to 82 percent of the electricity used goes toward moving the car; the rest is wasted as heat. In a gasoline-powered vehicle, on the other hand, only 17 to 20 percent of the energy in the fuel goes toward moving the car, and the rest is wasted as heat, he said.

Energy is also needed to mine, refine, and transport fossil fuels. As such, switching to 100 percent renewable energy would eliminate these energy-intensive and environmentally destructive processes, the report authors said.

In their study, Jacobson and his colleagues show how wind, water, geothermal and solar power can meet the worldwide demand for 11.804TW of energy while avoiding the predicted global temperature increase of 1.5 degrees Celsius above preindustrial levels by 2050. The researchers outline how doing so would save the lives of 4 million to 7 million people who might have otherwise died from diseases caused by air pollution, save countries more than 300 Quadrillion Rupiahs overall in health and climate costs, and produce a net increase of more than 24 million long-term jobs.

The overall cost of transitioning to an infrastructure of 100 percent renewable energy – a plan that sees countries moving first to 80 percent renewable energy by 2030 – may, at first glance, seem cost-prohibitive, but Jacobson and his team have crunched those numbers too.

Jacobson said that, when averaged over all countries, the cost of building renewable energy systems, including storage and transmission, is 8.9 cents per kilowatt-hour (kWh). In a world that doesn't transition and keeps the current fossil-fuel system, the cost is 9.8 cents/kWh.

And that doesn't include the cost to society.

### **CLIMATES CHANGE'S PRICE**

Fossil-fuel energy comes with health- and climate-related costs. The authors estimate that by 2050, countries will spend upwards of 400 Quadrillion Rupiahs per year in costs for environmental, property, and human health issues related to global warming, including floods, real-estate destruction, agricultural loss, drought, wildfires, heat stress and stroke, air pollution, influenza, malaria, dengue fever, famine, ocean acidification, and more. And if the world takes no action to address climate change and ice continues to melt at Earth's poles at the current pace, 7 percent of the world's coastlines will be underwater.

Jacobson said the total societal cost of renewable energy – which includes the cost of health and climate issues, as well as the direct cost of energy for wind, water and solar power – is about one-fourth that of fossil fuels. "In other worlds, you reduce the total cost to society by about 75 percent," he said. "The cost benefits of this are huge."

According to the study, several countries are already moving toward a renewable energy portfolio to meet 100 percent of their power demands for all business sectors. The list includes Tajikistan (76.0 percent), Paraguay (58.9 percent), Norway (35.8 percent), Sweden (20.7 percent), Costa Rica (19.1 percent), Switzerland (19.0 percent), Georgia (18.7 percent), Montenegro (18.4 percent) and Iceland (17.3 percent).

"With this information, we're giving confidence to countries that they can be self-sufficient," Jacobson said. "I'm hoping that different countries will commit to 100 percent renewable energy [by 2050] and 80 percent by 2030."

The study was published online in the Journal Joule on August 23<sup>rd</sup>.