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Connected energy: Super grids: making the right connections for a sustainable future

An attractive investment model for governments and private entities

Imagine a home in Sweden using low-cost electricity generated in part from solar panels in Spain. Or massive wind turbines in Mongolia helping to power a factory in Japan. Super grids could make these and other dreams a reality in the near future, providing ready access to affordable, reliable and sustainable energy for consumers around the world.

The idea of global decarbonization and the move away from fossil fuels toward renewable power generation will only become a reality through rapid acceleration of innovative technologies coupled with some visionary thinking. This is what makes the super grid idea so exciting.

A super grid is not just a "network of networks." Put simply, a super grid is a large scale transmission network that makes it possible to trade high volumes of electricity across great distances. Fossil fuel power plants are typically located in areas close to population centers, which makes it easy to distribute electricity. The same proximity between generation and consumption is often not the case for renewables. Yes, there is a treasure trove of offshore wind in Europe located in the North Sea and solar is in abundance around the Mediterranean Basin, but both are located away from high population centers.

The main issue is therefore trying to move that power from where it can be made cost effectively to where it can be consumed. This has led to the modern incarnation of the super grid and the idea is starting to gain real traction. For example, Greenpeace has released a report claiming that a European super grid could allow the European Union (EU) to reach a 45 percent renewable energy share by 2030.[1]

A key challenge for renewable energy generation is the ability to move that power across long distances. Existing regional grids use interconnectors that support the transmission of alternating current (AC) from power generation plants to local consumers. These grids require a significant amount of energy to move power long distances.Even for short distances, the movement of renewable power can overwhelm existing AC grids. The super grid, on the other hand, uses high voltage direct current (HVDC) that significantly reduces the loss of energy during transmission and helps to deal with the variability of renewable power. A key enabler is the super node. A super node is a piece of technology, or software, that will route power through a series of other super nodes to where it is most needed. It can best be compared to a router in IT systems. Super nodes will allow Europe, for example, to become one, interlinked network which will route power to where it is needed.

A super grid could support multi-directional power flows from multiple energy sources across very large regions.[2] As a result, super grids could improve energy reliability, permit the pooling of resources, and support greater economies of scale.[3] Super grids could also be connected with other super grids. Other benefits of super grids could include greater competition in energy markets, lower prices, and stronger energy security. Also, the Super grid can be a trading tool which will enhance the security of supply of all the countries of the EU.[4]

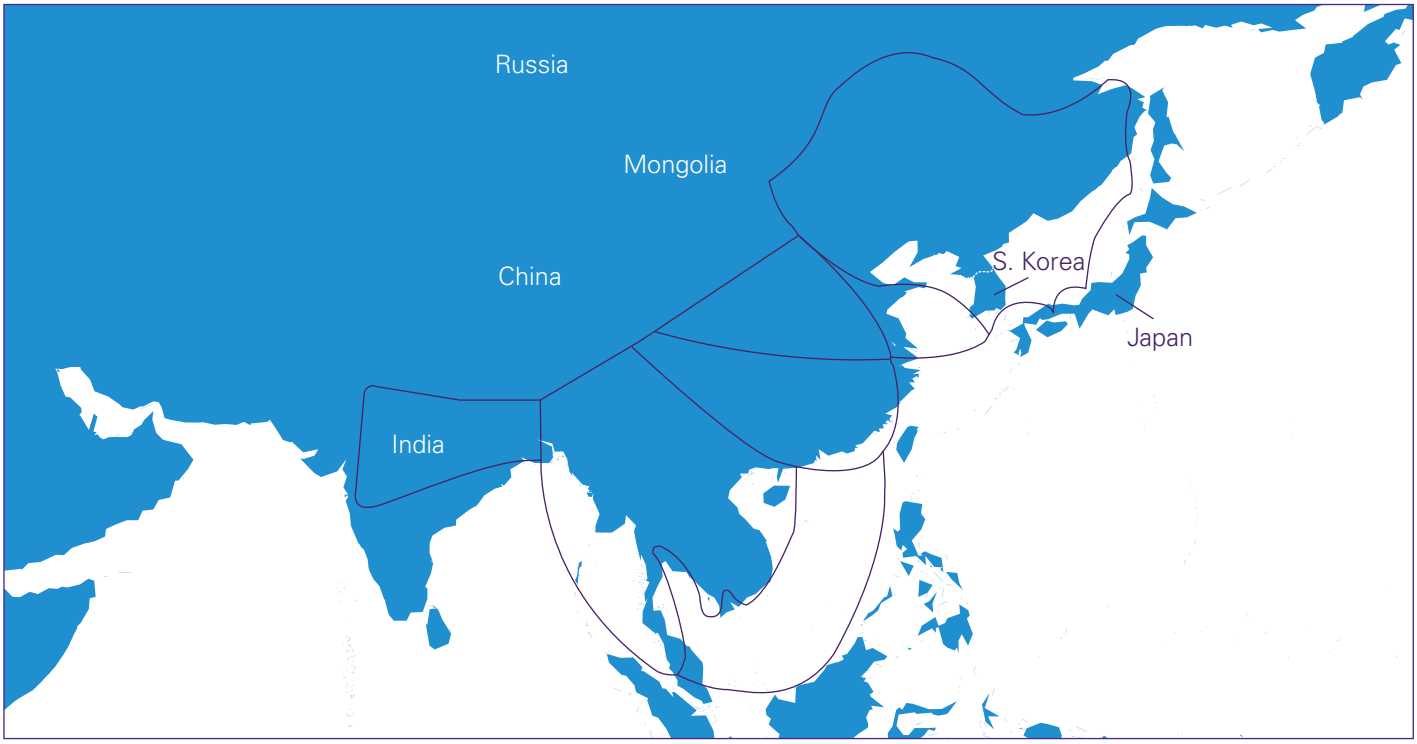
If Europe and the world are to meet the climate change targets set in the Paris Agreement, visionary concepts such as super grids can be a part of the ultimate solution.

Super grid concepts: Across Europe

Source: An engineering vision for a New Europe, Mainstream Renewable Power, http://mainstreamrp.com/an-engineering-vision-for-a-new-europe/

[1] Do we need to build a European supergrid to secure our energy supply?, The Guardian, 19 June 2014,
[2] Developing the Super-Grid, Energy Ireland, http://www.energyireland.ie/developing-the-super-grid/
[3] Technical Aspects of Grid Interconnection, UN, https://www.un.org/esa/sustdev/publications/energy/chapter2.pdf
[4] Friends of the Supergrid

Across Asia



Source: Renewable Energy Institute, https://www.renewable-ei.org/en/asg/about/

Critical challenges remain

As with any large, complex infrastructure project, implementing a super grid will involve finding ways to address a number of critical challenges.

Funding will invariably be a significant obstacle. Estimates for super grid development range well into the trillions of dollars, principally for the construction of the grid.[5] Given the scale of this cost, private capital will be essential in making the super grid happen.It also follows that creating the right regulatory and policy environment will be crucial in attracting private capital, and this brings its own challenges. However, lessons have already been learned from the private development of wind and solar energy. The goal will be to replicate this model on a much bigger scale.[6]

Geopolitical issues could also be a concern in different parts of the world, especially since super grids would almost invariably cross national boundaries. In terms of a European super grid, a coalition among governments in Europe will be required to make this a reality, although the momentum is already there in the context of the Paris Climate Agreement and the European Union (EU) 2020 Strategy.

In the same way, different regulatory and tax regimes involving multiple countries would have to be reconciled and possibly adjusted. Questions of ownership involving utilities, Governments and investors might also become an issue. Onshore battery storage will also be a key component in delivering this solution. In addition, the growing use of electric vehicles around the world could create a spike in demand for electricity that might change the location and scale of development.

What the experts say about renewable energy and super grids

Dr. Eddie O'Connor, Chairman of Mainstream Renewable Power

Founded in 2008 by Dr. Eddie O'Connor, Mainstream Renewable Power is an independent global developer that delivers large-scale wind and solar power plants to the world's emerging economies. Dr. O'Connor is the inventor of the European super grid concept.

How much renewable energy will Europe need in the future?

Quite a lot. Super grids will support our access to renewable energy, and that will be great because we are going to need higher levels of renewable energy in the future. One of the big movements in the European energy industry today is in the increased use of electric vehicles. It's safe to say that virtually all ground transport will be electrified by 2050. That means that you're going to have probably in the order of 1,000 terawatts hours a year of electricity just for ground transport.

So what does that mean in terms of additional demand? If we're going to replace the 50 percent of fossil fuels that we now use in Europe for electric generation, then look no further than wind and solar. In round numbers, we will need about 360,000 megawatts of wind energy to be built, and we will need about 360,000 megawatts of solar energy.

[5] Let's Build a Global Power Grid, IEEE Spectrum, 28 July 2015, https://spectrum.ieee.org/energy/the-smarter-grid/lets-build-a-global-power-grid
[6] Feasibility Study: Synchronous Interconnection of the IPS/UPS, UCTE Study Group, 7 December 2008

Where do you see the greatest source of renewable energy?

Very clearly, in the North Sea. It's the energy treasure trove for Europe. It has phenomenal wind speeds — 10 meters a second — and it's a huge area. We're getting a 55 percent capacity factor in the North Sea at the moment with current technology, which provides about eight megawatts. The North Sea is also quite shallow, so it's actually very cheap to build offshore wind farms. The other advantage is that relatively few people live in the area, so local objections to development are minimal.

What political regime is needed to allow the super grid to exist?

EU policy on energy is designed to ensure the functioning of the energy market; ensure security of supply; promote energy efficiency and energy saving and the development of new and renewable forms of energy; and promote the interconnection of energy networks.

Given that all electricity systems are national entities, individual nations would have to agree to a super grid proposal. For many of them this agreement would take into account the fact that much of a nation's generation would take place beyond its boundaries.

Security of the transmission system would be an important consideration for nations. The current situation has almost all generation located within national boundaries, so security is not such a large issue. The concept of interdependency and trust, which originally drove the formation of the EU, would need to be re-affirmed in the case of electricity.

Teruyuki Ono, Executive Director of Renewable Energy Institute

Since its foundation in 2011, REI has worked to establish Asia Super Grid, a major initiative aimed at interconnecting electric power systems of Asian countries to enable mutual benefits by exchanging abundant natural renewable energy resources, such as wind, solar and hydropower.[7] Before joining REI, Mr. Ono served as a senior official of Tokyo Metropolitan Government, responsible for environmental policy.

What are your thoughts about an Asia Super Grid based on your experiences as a leader in environmental policy and in dealing with environmental problems?

The Japanese electric power industry has been reluctant to expand the use of renewable energy for a long time, and one of the excuses is — "Since Japan is a country of islands and has no international electricity transmission network like in Europe, we cannot introduce large volume of variable renewable energy. "The realization of the Asia Super Grid connecting Japan and South Korea, China, and Japan and Russia with subsea transmission lines will make such excuses impossible, enabling us to dramatically expand the use of renewable energy in Japan.

In your opinion, what is the biggest challenge for developing the Asia Super Grid?

The biggest challenge is the lack of political consensus among the governments of the concerned countries toward the realization of the Asia Super Grid, but all the countries other than Japan are positive. I think that the stance of the Japanese government would change as political tensions ease in East Asia.

What kind of future infrastructure plans will be necessary in order to ensure the success of the Asia Super Grid concept?

The infrastructure necessary to realize the Asia Super Grid is several international grids and several transformer substations. These are normally constructed in Europe and the United States, so no special infrastructure is required. The technical and business know-how already exists. The only thing we need is the will to make it a reality.

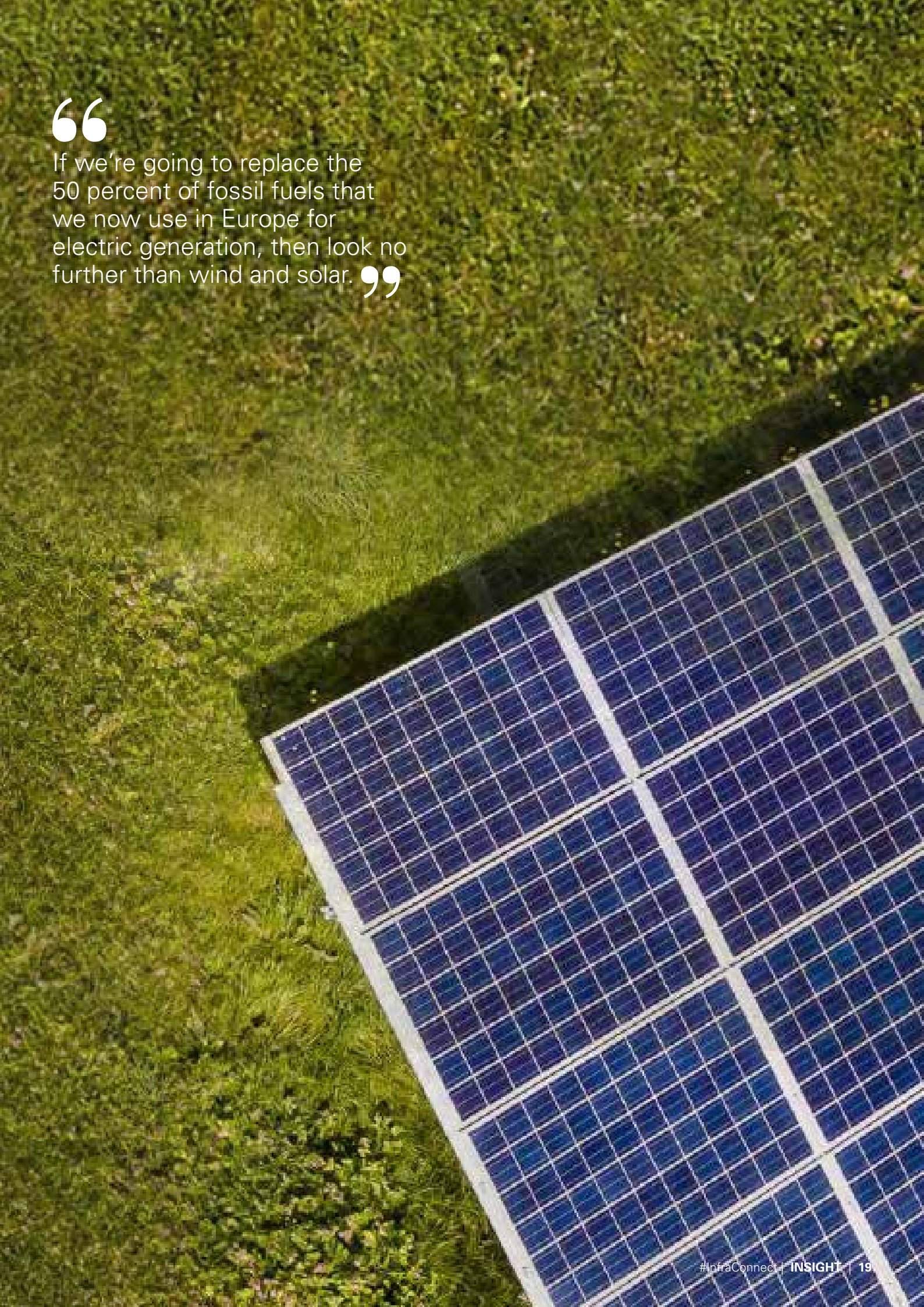
What is required of infrastructure planners, owners and operators for the Asia Super Grid to succeed?

Existing energy companies that own the domestic power grid in Japan might take the proposal of an international grid as a threat to their vested interests. However, when power production is separated from distribution in Japan in 2020, I believe that transmission companies will see the construction of an international grid as a new frontier for their business. I would like them to have a vision for investing in the future of the transmission business.

Conclusion

The future has arrived for super grids. The concept is technically sound, the investment model is feasible, and the imperative to develop and connect super grids into existing infrastructure for sustainability is now undeniable. A European super grid would play a key role in cutting carbon emissions and making the most efficient use of valuable renewable energy resources. The key challenges around ownership, regulation and cost are not insurmountable, particularly in an environment where the levels of interconnection are already increasing and the movement toward full decarbonization is gathering pace. Clearly, the infrastructure industry will be a major player in this arena. ■

[8] About Asia Super Grid (ASG), Renewable Energy, https://www.renewable-ei.org/en/asg/about/



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