Electrons have no identity: setting right misrepresentations in Google and Apple's clean energy purchasing

Abstract

Aside dedicated generation, transmission and distribution networks, the hype around corporations and other entities purchasing so called *clean energy* may be considered a deliberate accounting misrepresentation.

Keywords: electricity generation; clean energy; power purchase agreements; renewables

Introduction

A growing and persistent fallacy is appearing; that electrons can be differentiated by "gender" (or source) between fossil based energies (like coal, natural gas and oil) and nuclear or renewable (such as wind and solar), and that affiliating with one means you do not associate with the other. This fallacy, as perpetuated by Eckhouse (2018), amongst others, is hinged on the erroneous assumption that power purchase agreements (PPAs) for green, "clean" energy between corporations and utilities absolve the corporations from the comparatively "sinful" burdens associated with fossil based generation. What is more worrisome though, is the fact that corporations using the banner of renewables as a claim for a pioneering role in the transition towards a low-carbon energy society are often not held to account. In this short communication, we begin by explaining the technical difficulties of remaining "renewables pure". We then give case studies of two organisations – Apple Inc. and Google LLC – who are, arguably, at fault of making such claims.

We zero in on Apple's claim to be 100% renewable-run, especially for its data centres in the United States, arguing that Apple's latest declaration runs afoul of engineering principles. This becomes a case study to illuminate potential hypocrisy around low-carbon energy transitions globally. We also show that Google may too stand guilty of such claims, and highlight the apparent reluctance of big corporations like Apple and Google to take responsibility in internalizing carbon emission reduction. We finally evidence that publicity outlook and financial incentives are underlying causes for this growing "renewables or bust" myth. Our aim throughout is not to name and shame, but to reflect upon the veracity of our 100% renewables systems when fossil fuels still retain a significant stake in global energy systems. The method is a simple, non-systematic comparison between what is technically possible, and what is claimed to be possible.

A background on the electricity network and its standardization

Generally speaking, the electricity grid consists of a generation network, transmission network and the distribution/utilisation network. The generation network consists of generators converting energy in various forms into electricity. For instance, generators at a dam convert the potential energy of water at a height through kinetic energy into electricity. Similarly, thermal power stations utilise fuels such as coal, gas and oils to heat up water into steam that is then used in driving turbines to produce electricity from the generators. The output electricity from the generators varies between *say* 2 kV to about 30 kV and is usually stepped up using alternating current (AC) transformers to transmission level voltages[1] (typically between 115 kV and 765 kV). The transmission network allows for the evacuation of electricity from the generation site to load centres (usually incurring losses that increase with distance). At the load centres, substation transformers are used in stepping down the high voltages which are then transmitted to distribution transformers of residences and industries at appropriate distribution voltages and frequency. In the same vein, the integration of renewables and other sources of electricity like solar, wind and biomass with the conventional electricity grid is done at points of common coupling (PCC) and at appropriate voltages, and is regulated using standards such as IEEE (2018) (for 60 Hz sources) which is a uniform standard for the interconnection and interoperability of distributed energy resources (DERs) with the electric power system (EPS).

Considering the complex nature of the EPS, IEEE (2018) and its suite of sub-standards ensure that at the PCC, the DERs meet with strict criteria with regards to voltage regulation during ride through, voltage and reactive power control, flicker, frequency droop, islanding regulations and interoperability. This is to ensure that the synchronization of the DERs with the EPS does not negatively impact the electricity grid. Furthermore, the synchronization at the PCC facilitates the flow of electric current through the electricity network without differentiating between the source (DERs or the EPS). An analogy to this would be the incorporation of various water sources – recycled waste water, flowing stream, reservoirs, rainfall etc. into a water treatment facility which is then fed into the water supply network of a city. In this scenario, it will be nonsensical to have houses claiming to source their water strictly from recycled wastewater, rainfall or reservoirs. This brings us to the danger of some company's renewables claims.

Apple's Renewables Claims

In its Environmental and Responsibility Reports (Apple 2014; Apple 2015; Apple 2016; Apple 2017), Apple has consistently claimed to have its data centres in the United States run entirely (100%) on renewables, with renewables contributing over 90% of the total energy demand of its data centres and corporate offices worldwide. For example, according to Apple (2014), their data centre in Maiden, North Carolina is powered by up to 39% photovoltaic (PV), 37% from fuel cells and 24% from North Carolina GreenPower. They acknowledge too, that despite these claims, the data centre remains connected to the Duke Energy Carolinas electricity network, which has renewable energy contributing less than 1% (Apple 2014).

According to Apple (2016), their renewable energy sourcing principles include displacement (in which Apple feeds in clean energy that is equivalent to what its facilities take from the grid), additionality (whereby Apple participates in developing additional clean energy sources to feed into the grid), and accountability (for which Apple applies rigorous vetting processes and third-parties to track its energy supply). To some, this would appear a rigorous and positive approach. Yet Apple falls foul of artificially streamlining the process of electricity generation, transmission and distribution.

---

[1] A reason for the high transmission voltages is to reduce power losses on the transmission line.

Apple's additionality principle oversimplifies the complex responsibilities involved in electricity system planning and operation. By reducing their PPAs to simple addition and subtraction, Apple appears to (perhaps deliberately) overlook the complex issues of reactive power compensation, real time demand/supply balancing, voltage regulation and line losses compensation. Indeed, it is common sense that when a grid link is present, electricity generated in one spot cannot be directed to one specific user, meaning there is no way to prove that wind farm X is supplying facility Y. In reality then, considering the effect of weather variation on the power production of its PV and wind power plants, Apple inherently relies on the conventional and "dirty" grid to handle the issues of intermittency associated with PV and wind production and to support its operations. In so doing, they incorrectly remove the need for additional investments in support infrastructure and storage facilities were data centres to be run exclusive of the conventional grid.

Google's Guilt

Such an argument can be made with reference to other companies too. In 2016, Google stated that they also expected to start sourcing 100% of the electricity needs of their data centres from renewable energy sources (Google 2016). Eric Schmidt (executive chairman of Alphabet) highlighted Google's investments of over $2 billion in clean energy projects since 2007, including investments in Google's carbon neutrality drive while also advocating for a strong and effective outcome at the 21st United Nations Conference of the Parties (COP21) climate change conference in Paris (Schmidt 2015). Yet it is ironic that despite Google's hype with regards to its strides in fostering low-carbon energy transitions, they admit that it is not feasible for its data centres to operate off the conventional electricty grid (Google 2013). In fact, quoting verbatim from a company report, they state – "*The plain truth is that the electric grid, with its mix of renewable and fossil generation, is an extremely useful and important tool for a data centre operator, and with current technologies, renewable energy alone is not sufficiently reliable to power a data centre*" (Google 2013: 2). Here, a mismatch between aspirational and attainable goals arises.

Apple and Google's actions and the spill-over effects

We do not set out to antagonise Apple and Google; if anything, we sincerely commend their investment efforts in supporting the development of renewable energy projects which, when we consider how large these organisations are, certainly go some way towards reaching the targets XXX by the XXX. However, we do condemn bold attempts at simplifying the transition process to low-carbon energy sources. In such cases, claims of being "100% renewable", or at least striving for that goal, has the potential to falsely influence the perception of the larger society with regards to the feasibility of rapid low-carbon energy transitions. We further argue that in light of grid limitations and the continued presence of fossil fuel technologies, such claims remain insincere and must not be encouraged. Indeed, the dangers of such statements are widespread. By either intentionally or inadvertently engaging in accounting misrepresentation, these corporations create the impression that associated problems of stochasticity, intermittency and storage which continue to plague the full exploitation of renewables are insignificant [2].

[2] We ground this argument (which we acknowledge to be contentious) in established and peer reviewed evidence as presented in Clack et al. (2017), where it was surmised that the reliable operation of the electricity grid involves myriad challenges beyond just matching total

Through PPAs and by externalising the associated problems of renewables, corporations can also avoid the penalty of carbon taxes by claiming renewable energy credits (RECs). Moreover, these corporations enjoy having the associated costs of integrating their renewable energy sources subsidized by the residential users who must bear the brunt of rising energy bills. In Germany, for instance, the exemption of privileged electricity consumers (industries) in 2015 from EEG surcharge to the tune of 4.8 billion euros (107 TWh in electricity terms), increased the energy burden of other electricity consumers, particularly private households with energy intensive industries benefiting the most from the merit order effect (Fraunhofer 2018). This resulting effect of increased energy burden including the extended and associated issues of equitability and creation of more energy poor households have been highlighted by Weber and Cabras (2017), Frondel et al (2015) and Marz (2018). Such actions, in our opinion, are inimical to the successful evolution of low-carbon energy transitions that must enshrine concepts of and consciousness of justice (Jenkins et al., 2018; McCauley and Heffron, 2018). It may thus be argued that in massively investing in PPAs while still depending on the conventional grid for offsetting their electricity needs, Apple and Google (as well as other large corporations and entities) inadvertently externalised injustice outcomes[3].

Energy stores, not stories

Google admits that it will be infeasible to operate their data centres outside of the conventional 'dirty' grid because, (1) power production from renewable energy sources are stochastic and intermittent, and (2) its data centres must operate 24/7 and not intermittently. However, Google and Apple now claim to *meet* the energy needs of their data centres 100% from renewables through the so-called additionality and displacement principles. By engaging in accounting misrepresentation, these corporations oversimplify the operations of electricity grids and low-carbon energy transition processes. While PPAs have helped in promoting investments in renewable energy projects and creating jobs, they may inadvertently create associated or knock-on challenges that corporations externalize and shift to other grid electricity consumers.

Low-carbon energy transitions are not 'plug and play processes', instead they are characterised by potential problems bordering on energy security, synchronization and

---

generation to total load. Clack et al. (2017) offer that the electricity grid's reliable operation is complicated by its AC nature, with real and reactive power flows and the need to closely maintain a constant frequency. In addition, allowance must be provided to accommodate generator failures (usually achieved through operational and planning reserves).

[3] We make this perhaps controversial assertion based on the fact that electricity usage in data centres is estimated to be about 1.5% of global electricity consumption (Wahlroos et al 2017). Large corporations thus minimize energy costs by investing in PPAs with lock-in prices, which makes them immune to grid electricity price fluctuations – occasioned by the increasing integration of renewables. Injustice is thus created as the actions of these corporations externalize the consequences of grid-integrated renewable energy projects (which is ultimately borne by the residential consumers); this whilst they enjoy the stability and resilience of the conventional grid, which is to a large extent supported by other consumers (Fraunhofer 2018).

demand/supply balancing of the renewable energy sources in low-carbon energy transitions. Thus, there is a further challenge if we truly are to be 100% renewable. Corporations must go beyond additionality and displacement to begin exploring the possibility of *on-site* electricity displacement. Rather than *sowing wild oats all over the landscape* under the guise of encouraging renewable energy proliferation, research and investments are needed in the continued development of effective storage and other associated technologies that can help in fully harnessing the potentials of renewables at site level. In the global north in particular, the grid experiences excess generation, creating the challenges of variable pricing, demand/supply balancing and network stability. With the ability to store the excess power that has been produced, stability in pricing and energy security can be guaranteed in low-carbon energy transitions.

Conclusions

There is no doubt that significant progress is being made globally with respect to the deployment of variable renewable energy (VRE) sources. However, fossil-based sources still constitute the bulk of global generation capacity. It is thus a distraction for corporations worldwide to distance themselves from the inherent problems of fossil based generation sources through carefully crafted contracts on power purchases and other accounting misrepresentations. Indeed, by externalizing the insidious effects of fossil fuels on the environment, large may corporations may inadvertently impoverish consumers (especially the poor) who must continue to bear the brunt of policy initiatives such as carbon pricing that seek to incentivise a faster diffusion of renewable energy technologies.

Low-carbon energy transitions should not have selective winners or losers, and, singular carbon mitigation efforts and uncoordinated investments in VRE achieve nothing if their effects get eroded elsewhere. A concerted approach to decarbonising the global energy system is thus needed that ensures value for investments in VRE and comparable electricity costs that do not exacerbate *global, systems-wide* injustice. By continuing to engage in PPAs while still depending on the conventional grid for meeting their energy needs, Apple and Google we argue are capable of precipitating energy injustice for residential consumers and detracting from essential drives towards energy storage. In short, whatever their route cause, and whether by fault or intention, so called 100% renewable-run claims do not bode well for the realistic attainment of truly low-carbon energy transitions.

References

Apple (2014), Environmental Responsibility Report (FY2013).

Apple (2015), Environmental Responsibility Report (FY2014).

Apple (2016), Environmental Responsibility Report (FY2015).

Apple (2017), Environmental Responsibility Report (FY2016).

Clack, C. T. M et al. (2017), Evaluation of a proposal for reliable low-cost grid power with 100% wind, water, and solar, Proceedings of the National Academy of Sciences. 114(26), 6722-6727.

Eckhouse, B. (2018), 'Apple's Entire Business Is Now Being Powered With Clean Energy', *Bloomberg.*

Fraunhofer ISE (2018), Recent facts about photovoltaics in Germany.

Frondel, M. et al (2015), The burden of Germany's energy transition: An empirical analysis of distributional effects, Economic Analysis and Policy, 45, 89-99, ISSN 0313-5926.

Google (2013), Google's Green PPAs: What, How, and Why. Available online at: https://static.googleusercontent.com/media/www.google.com/en//green/pdfs/renewable-energy.pdf Accessed on: 23.5.18.

Jenkins, K., Sovacool, BK. and McCauley, D., 2018, 'Humanizing sociotechnical transitions through energy justice: An ethical framework for global transformative change', Energy Policy 117: 66-74.

IEEE (2018), IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces," in *IEEE Std 1547-2018 (Revision of IEEE Std 1547-2003).*

März, S. (2018), Assessing the fuel poverty vulnerability of urban neighbourhoods using a spatial multi-criteria decision analysis for the German city of Oberhausen, Renewable and Sustainable Energy Reviews, 82, Part 2, 1701-1711, ISSN 1364-0321.

McCauley, D. and Heffron, R. (2018), Just transition: Integrating climate, energy and environmental justice, Energy Policy, 119, 1-7, ISSN 0301-4215.

Schmidt, E. (2015), Rising to the climate challenge, *Google blog*.

Wahlroos, M., Pärssinen, M., Manner, J. and Syri, S. (2017), Utilizing data center waste heat in district heating – Impacts on energy efficiency and prospects for low-temperature district heating networks, Energy, 140, Part 1, 1228-1238, ISSN 0360-5442.

Weber, G. and Cabras, I. (2017), The transition of Germany's energy production, green economy, low-carbon economy, socio-environmental conflicts, and equitable society, Journal of Cleaner Production, 167, 1222-1231, ISSN 0959-6526.