Energy justice issues in renewable energy megaprojects: implications for a socioeconomic evaluation of megaprojects

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Abstract

Global responses to sustainable development programs that are aimed at tackling climate change have a heightened necessity in the wake of Covid-19 and its impact on vulnerable populations. The UN Sustainable Development Goals to be achieved by 2030 are aimed at achieving a sustainable future for all. The goal of UN Sustainable Development Goal 7 (SDG 7) is to ensure access to affordable, reliable, and sustainable energy for all. Two major global initiatives to move to renewable energy are the use of solar and wind energy. Recent investments in large solar and wind farms fall into the definition of megaprojects not only because of the size of the investment but also the social and environmental issues they create. These large projects are projected to increase in the future and the impact of these projects on stakeholders is also likely to intensify. In this paper we identify stakeholder issues created by large scale solar and windfarms and compare them with issues arising from 'traditional' infrastructure megaprojects (transport, terminals etc.). We also raise issues about the impact of sustainable development megaprojects on the communities in which they are situated. While renewable electricity is viewed as a positive move towards sustainable development of essential infrastructure renewable energy megaprojects are also found to have social justice implications for marginalized populations.

Introduction

With the increased desire of governments and people to move towards a more sustainable future, renewable energy projects have steadily increased around the world. As per data collected by the International Renewable Energy Agency, Table 1 shows the total capacity added by renewable energy projects and the relative contribution made by solar and wind energy

Insert Table 1 about here

Although the growth in solar and wind power has increased considerably over the past decade, renewable energy in 2020 (Q1) still contributed only around 28% of global energy generation while coal and gas supplied 60%. The good news is that the cost of renewable energy is going down and becoming comparable to traditional sources of energy making it a viable alternative. Among renewable energy providers, hydropower has the largest share, contributing nearly 16% towards global energy. Solar and wind energy contribute about 9% (https://www.iea.org/reports/global-energy-review-2020/renewables). Covid-19 has slowed the growth of renewable energy from solar and wind power due to attention of governments being diverted towards mitigation from the effects of the pandemic. It has also made funding for investments scarce. While renewable energy's contribution to global energy increased by 3% in 2019 mainly due to solar and wind power, its growth is expected to be only 1% in 2020 due to slowdowns caused by Covid-19. However, 2021 looks very promising, indicating that we can expect more mega investments in solar and wind energy post Covid-19.

Large-scale solar and wind farms have developed mainly in Asia, especially in China and India, as they are investing heavily on renewable energy. These projects cost several billion dollars and can be classified as mega infrastructure projects. While the growth of renewables has been relatively slower in the West, countries such as Australia plan to invest in large-scale solar projects to be able to export energy to Asia in the form of hydrogen. Although solar power is not very feasible in much of Europe, the Europeans still lead in alternative energy output through the large number of offshore windfarms. However, these large-scale solar and wind projects have started facing stakeholder issues, much as have traditional infrastructure megaprojects, issues that need to be addressed if the contribution of renewable energy is to keep pace with the goals of United Nations Sustainable Development SDG 7.

While some of stakeholder issues are common to both traditional and alternative sources of energy, such as land acquisition and environmental damage, wind and solar projects seem to face more political and regulatory barriers hindering their growth. The proponents of renewable energy blame opposition on misinformation on the environmental effects of renewable energy, calling for more public participation for this sector to grow. While large solar and windfarms require considerable investment and often face opposition from nearby residents, the move towards community-based, smaller projects that can be built more easily, in cooperation with the beneficiaries, seems to be finding more community support than megaprojects.

In this paper, we intend to highlight the importance of these ‘new’ infrastructure megaprojects and the issues they are facing as they have not received the same attention in project management literature as conventional infrastructure megaprojects such as transport, terminals, and large-scale IT projects. Most of the literature on renewable energy appear in journals related to sustainability, energy, conservation, and politics. We start our review with an introduction to how solar and wind farms have developed over the years to become a viable source of energy generation that avoids the environmental issues contributed by conventional energy resources we have become reliant upon.

Solar and Wind Energy

Renewable energy sources include hydropower, solar, wind (on and offshore), geothermal and biofuels. Renewable energy can also be generated by tidal energy, using turbines, barrages or lagoons and there are several examples of these globally, mostly in Europe but there also examples in Russia, China, and South Korea. While nuclear power also contributes to reducing the carbon footprint it is normally not included as a form of renewable energy.

The main positive factors that make solar and wind power stronger candidates for megaproject development than hydropower is their scalability. Solar panels and wind turbines can be industrially fabricated and assembled on site. Once the site is prepared, the processes are routine, a matter of modular assembly, which means that the more turbines or panels that are sited the marginal cost will decline with frequency of installation. Hydropower, by contrast, is always a one-off development tailored to the specifics of the location in which it is situated. Consequently, as Ansar et al. (2014) establish, hydro-projects invariably run over budget and completion and do not always deliver on their prospectus for reasons that are often site-specific. Hence, hydro-projects afford little in the way of learning that can be carried over from project to project and they cannot be modularized, hence do not become scalable (Flyvbjerg, 2021). He advantage is with solar and wind power as sources of energy.

Solar Power

The use of energy from the sun dates back to 7th Century BC to light fires. Solar power cell technology developed in the 1800s in France and later spread to other parts of the world as photovoltaic cells were developed to be superseded by silicon. Bell Labs in the US (https://www.vivintsolar.com/learning-center/history-of-solar-energy) developed solar cells that used silicon for practical use as a precursor of modern-day solar cells. Solar cells became popular as a portable source of energy during the Space Age in the late 50s, and a solar array was used by NASA in 1964 to deliver 470 watts of electricity. As the price of solar cells dropped and technology improved, they have become viable sources of generating electrical power (https://www.vivintsolar.com/learning-center/history-of-solar-energy).

Solar radiation can be used in two ways to produce solar power (Dunlap 2020). One is by creating heat by the absorption of radiation and the other is to convert solar radiation into electricity using photovoltaic cells. The former can be passive systems used in heating applications and can be used actively. However, large-scale solar projects use concentrated solar collectors, such as a parabolic reflector in grid-connected facilities. One of the largest such facilities produces about 150 MW of power in California. The other way to create solar power is by using solar cells made from silicon dioxide extracted from the earth's crust (Chiras 2017) and assembled together in solar panels to provide large amounts of energy. The largest solar power plant using photovoltaic cells can produce more than 2 GW of power.

While solar power has been mainly used in homes, boats and public buildings, large-scale energy can be produced through the growth of large solar farms. Initially, these large farms were built to deliver power to businesses and to the grid. Recently community-based solar farms serving communities for whom a home installation is not possible have also garnered considerable interest. The capacity of a large solar farm can be sizeable (up to 2000 MW), and the average cost of a 1 MW solar farm could cost around US$ 1 million. So large solar farms such as the top ten listed in Table 2 are really megaprojects.

Insert Table 2 around here

Solar energy does have some shortcomings (Chiras 2017):

- Variability: The sun only shines part of the day while we require power around the clock. Sunlight can also be blocked by clouds or rain in many places. Storage of power from solar energy in batteries is not that efficient as the semiconductors that convert sunlight into electrical energy only capture a fraction of the light received.

- Aesthetics: Some people view solar arrays as ugly, with ill-effects for the aesthetics of a neighbourhood.
- The land below solar collectors cannot be used for agriculture as light is blocked.
- Manufacturing facilities for photovoltaic cells can be sizeable and take space away from other uses.
- There are also end-of-life issues with components of solar farms that require recycling facilities.

Wind Power

Windmills have been used since the 7th century (Shahan 2014) to grind corn, make flour, and pump water. Wind turbines were used to generate power in the later 1800s in Scotland and since then their use to generate power spread to other parts of the world. Combining the output of several windmills to generate power began to be practiced in Denmark, where windmills are a prominent feature of both the land and shallow waters offshore. The 20th century saw the development of wind turbines. Wind power (Chiras 2009) utilizes turbines which usually have three blades attached to a hub that forms the rotor. The rotor is connected to a generator through a shaft. Most wind turbines are called horizontal axis units as the shaft runs horizontal to the ground. Unlike solar farms, which generate DC power, wind turbines generate alternating current but because of the variability of the wind they also need some processing before feeding the energy into a grid. Recently, vertical axis wind turbines have been developed which require less space although they produce less power. Wind turbines are normally mounted on a tower, and they must be strong enough to support the turbine while also withstanding the wind. Placement of wind turbines and the distance between them are both important considerations. The tower needs a large foundation requiring considerable amounts of steel and concrete. Wind systems require wires that run along the tower to an electrical junction box at the bottom. Since wind energy fluctuates, the energy power is usually fed to a controller which has an inverter that helps produce grid-compatible electricity so that the power can be fed into the grid.

To produce a large amount of power a number of wind turbines are installed in an area which is windy on a regular basis. They can be located onshore or offshore. Large wind farms can produce a considerable amount of electricity as seen in Table 3. To get an idea of the size of these large wind farms, the Gansu wind farm has 7000 wind turbines in the Gobi Desert. A wind turbine costs in the region of US$ 3 to 4 million dollars installed. So, a windfarm of the size of Guansu qualifies as a megaproject as well.

Insert Table 3 around here

Table 3 lists onshore wind farms. There are also several offshore wind farms mostly in Europe, with the Walney wind farm in the UK, which was built in 2012, having a capacity of 659 MW. One of the largest proposed wind farms is the Asian Energy Renewal Hub planned to be built in Western Australia with a capacity of 7500 MW. The Asian Energy Renewal Hub is a unique project that combines solar and wind power to deliver 26,000 MW of power. It will make use of the variability in solar- and wind-generated power to smooth out fluctuations, producing clean and economical energy for people in the Pilbara region and it will support the traditional owners with jobs, skills, and revenue. It will also produce green hydrogen on a large scale for which there are markets in Australia and overseas.

There are also some shortcomings to wind energy:

- Variability and reliability: Wind does not blow consistently. Winds may also be strong only for a few days or only during some seasons.
- Economic: Legitimate concerns about their proximity to homes in terms of their effects on property values.
- Inconvenience: They are a source of noise pollution for those near to them. The moving blades pose issues of possible interference with telecommunications.
- Safety: Ice thrown from turbines after an ice build-up is a potential hazard. Risk of epileptic seizures in individuals who have photosensitive epilepsy.
- Environment: Offshore wind farms are opposed to by fishermen who feel that the space they have to fish is restricted and believe that fish are affected by the structure and electromagnetic sound generated by underground cables. Fear of bird and bat mortality from windfarms,
- Aesthetics: When they are located in coastal areas that serve as a tourist attraction, locals are concerned about aesthetics and noise affecting tourism.

For instance, Díaz and Soares (2020) view wind power as depicting ‘powerful images of nature and modernity working together’ (p. 601) but also point out that wind farms can be viewed negatively, turning wildernesses into industrial power-producing facilities with an adverse impact on natural aesthetics as well as regional cultural values that can have a negative effect on businesses such as tourism. They point to the rise of an environmental justice movement that sees widespread recourse to wind power as ‘technological fixes to solve the climate energy crisis’ (p. 602).

Avila (2018), identifies that wind energy expansion often occurs in the global south through the privatization, compulsory purchase or leasing of indigenous land without consultation, with negative effects on livelihoods and cultural identities. Rural and peri-urban communities regard the claims made for green energy to be an excuse for land conversion to industrial energy zones, with negative aesthetic and lifestyle effects. Windmills established in nature conservation areas affect biodiversity while in coastal areas offshore wind farms cause harm to tourism, leisure, or aesthetics.

A brief review of the barriers and challenges as well as successful experience with solar and wind power is presented from a recent sample of relevant literature in Tables 4 and 5.

Insert Tables 4 and 5 about here

After an initial analysis of the literature, the contributions were broadly classified in terms of political, economic, sociotechnical, institutional, and societal issues. We have also classified them in terms of the continents on which the issues arise: Asia, Africa, South America, North America, Europe, and Australasia. There were negligible issues concerning solar power in Europe nor did any arise from wind power in Africa. Europe does not have much capacity for large-scale solar power whereas in Africa the use of renewable energy, focusing on solar power, is still in the early stages of development. Political, institutional, and economic issues seemed to dominate issues in Asia, Africa, and South America whereas socio-technical and societal issues seem to dominate in North America and Australasia. While China has been a big investor in renewable energy not many issues have been reported in the literature due to positive government support for initiatives in renewable energy.

Discussion

The Association of Southeast Nations (ASEAN) policy is to achieve 23% of total energy sourced from renewables by 2025. Yudha and Tjano's (2019) analysis of renewable energy projects in ASEAN, with a focus on Indonesia, identified only slow progress towards this objective. some of the issues that emerged as significant in the Indonesian context were the lack of a national authority tasked with planning and formulating long-term energy policies. Collaboratively, several ministries need to work together as well as with a national regulator to resolve any disputes arising out of pricing and such inter-organizational collaboration is not easy. Renewables are still viewed as risky and untested technologically, with mechanisms being needed to attract financial sponsors with an appetite for risk. Green jobs are still a novelty in the country and there is little established training in place to produce the skills required nor are the technologies well known or understood by investors and local manufacturers/assemblers. Moreover, the appropriate legal frameworks to cover renewable energy have yet to be produced.

Elsewhere in Asia, Umamaheswaran and Seth (2015), commenting on solar and wind power in India, where renewable energy projects have flourished, note that the government is not doing enough. While it has provided instruments to help create a market for renewable electricity generation it should do more to shift investment to renewable energy by introducing regulation for banks to set aside a portion of their investments for environment-friendly investments and promote the issue of infrastructure debt fund (similar to conventional infrastructure projects) green bonds and other securitized products.

Based on the work of Sovacool & Ratan (2012) on the acceptance of solar power (in Germany and the US) and wind power (in Denmark and India), nine factors motivating investors and users to embrace renewable energy were identified as issues of socio-political, market and community acceptance (p. 5272). For renewable energy to become socially and politically acceptable there has to be national leadership supporting a narrative of transition to renewables as well investment in government-sponsored research institutes. Legal and regulatory frameworks and standards have to be prepared. Government can aid market acceptance by making installation and production costs competitive through incentives and the establishment of strong national centres of infrastructure production. Additionally, capital markets have to be open to low-cost domestic financing. Communities can be encouraged to accept installation and use solar or wind power through campaigns that establish their green credentials as compared to traditional sources of energy.

An NGO in Australia called the Wind Energy Alliance (Ecogeneration 2018) has the support of communities in Australia through delivering financial security to farmers through establishing wind farms which helps to maintain a social license to operate. Importantly, community members are included in planning these wind farms from which they receive equitable shares. Community information programmes help to dispel erroneous myths that are sometimes held by people unfamiliar with the technologies. Grassroots campaigns are important in establishing legitimacy. Joshi and Yenneti (2020) identified how grassroot innovations from communities who want to invest in renewable energy helped produce outcomes that were successful for the community (p. 12). Villages in India that have no access to electricity, due to lack of infrastructure such as cables, are eager to create their own energy using solar farms. Grassroots campaigns aid identification of social development goals and objectives and the development of local strategies to mobilize financial, technological, and human resources. Community leadership, supported by mainstream groups, strengthens community networks.

Thus far, megaproject possibilities have been discussed in largely positive terms in relation to their ecological and social benefits compared to the use of fossil fuels. However, a number of critics have reservations about who really benefits from the widespread adoption of solar and wind power. McCauley et al. (2019) presents an energy justice framework that addresses distributional, procedural and recognition inequalities . For these researchers, it is the resistance against large-scale renewable energy projects, fraught with conflict and sustainability concerns, which raises the question of energy justice. What is important is identifying an energy life cycle in terms of its benefits and costs that includes the "key questions as they relate to energy for *whom* and for *what* at *whose cost*?" (McCauley et al., 2019, p. 917). There are several dimensions to these issues of justice. First here matters of distributional justice, that often have legacy issues associated with them. Low carbon energy often ends up being installed on land and in communities degraded by past fossil fuel infrastructures which have made land cheap and easily exploited, often in areas associated with past social deprivation or adjacent to protected indigenous land.

Energy justice requires that communities be involved in energy choices for the future. Mundaca et al. (2018) studied low carbon energy systems in Samsø (Denmark) and Feldheim (Germany) in which the legitimacy of the outcomes was seen to depend on the legitimacy and inclusiveness of the processes of community consultation. In Saskatchewan Canada, processes of deliberative dialogue were used to engage community members in dialogue with developers and designers of a solar power project, to ensure energy justice.

Energy justice is a key theme that is rarely addressed by the majority of politicians and planners. Caldazilla and Mauger (2018) look at energy justice issues created by solar and wind power in Chile, India, Kenya, and Mexico, and how to combat them. They note that large-scale solar and wind energy projects do not always respect the interests of vulnerable communities or cultural and archaeological landscapes in their siting and design (Yenneti & Day, 2015). Instances where this is the case are replete in less developed countries. Oaxaca in South Mexico, with a significant indigenous population, has considerable wind potential. The installation of wind power in Oaxaca has been designed to export electricity from where the wind farms are located to industrial users in other parts of Mexico and not to the local community, who cannot afford electricity. Ecological sustainability benefits industrially dirty production elsewhere and disadvantages the poor peasants on whose land use it intrudes. The situation is similar in the region near Lake Turkana in Kenya with high levels of poverty and low levels of literacy, which also has high wind potential and Africa's largest wind farm development. The project has significant and adverse social impacts as a massive influx of job seekers has brought social issues of alcoholism, violence, and prostitution, as well as land grabs occurring without compensation to local communities.

In both Mexico and Kenya developments have had a detrimental effect on the indigenous population. The developers have often used 'blunt, outrageous and racist' statements about the indigenous population and refused to accept proposals for a community-owned wind farm and ridiculed the idea as infeasible because the communities can never raise the finance required. In Kenya, while the wind power company states that it adheres to international standards to manage environmental and social risks, it fails to recognize the ethnic groups as indigenous, thus denying them adequate compensation.

Procedural Justice is often denied. Participation and access to indigenous communities was not ensured in Oaxaca. False assemblies were set up to sign project documents without inviting the right people. Translation was not provided from Spanish for indigenous people to follow what was being said. The situation was similar in Kenya where adequate information and participation was denied. The developer claimed to have had community meetings but provided no proof of consultations.

The Government of Gujarat in India invested in a massive megaproject to create a solar park near Charnaka (where the sun shines for more than 300 days of the year, in a region largely comprising a farming and cattle herding community (Yenneti & Day, 2015; 2016; Yenneti et al., 2016). Many of the pastoral farmers sold their land for next to nothing and only worked on the solar farm during its construction. Promises of new local infrastructure were not kept and most of the solar energy was exported. The developments in Gujarat affected the Rabari community who are not low caste but do lack land and education. When representatives of the community were negotiated with the Government, they were from the educated castes and did not represent the views of the marginalized Rabaris. In Charnaka, only a written notice was given for land acquisition despite a large percentage of the population being illiterate. Only one meeting was organized with them after protests, showing a lack of procedural justice.

Munro, van der Horst and Healy (2017) suggest rethinking the UN SDG 7 goal based on issues at renewable energy developments in Sierra Leone, which posed problems for energy justice and equitable development. They refer to Sovacool and Dwarkin's (2014) notion of 'energy justice' based on philosophical debates on ethics and 'environmental justice' (Robbins 2012). In Sierra Leone, while the Government's policy aligns with the goals of SDG 7 there are issues with procedural and recognition justice. As an example, treating firewood as a problematic fuel, especially for women and children who handle it most of the time, creates a socio-economic cost for the country. Charcoal production has similar concerns. LPG is promoted as a renewable energy, but it is produced by foreign companies like Total and BP, thus displacing the energy market from domestic self-sufficiency to import dependence and creates a recognition justice issue rooted in modernist development ideology crafted by policy elites with no inputs from those who consume domestic fuels (Munro, van der Horst and Healy (2017, p. 639).

While justice issues have been a prominent stakeholder issue in renewable megaprojects, they also exist in conventional projects but are not discussed in those terms in project management literature.

Examples of such issues can be found in other literature on these megaprojects. Blanca et al. (2021) found that ‘Indigenous groups continue to experience injustices in relation to tourism development, management, and marketing despite calls for equity, justice, and fairness in sustainable tourism’ (p. 373), citing the example of the Mayan Train Megaproject in Southern Mexico which, for a 1525 km railway line with fifteen stations, was expected to cost US$6 to 8 billion and cut through forests in five states exploiting natural and cultural resources of local inhabitants to benefit the government and tourism operators. In Brazil, a superport industrial complex at the Farol de São Tomé in the municipality of Campos dos Goytacazes did not take the effects of environmental degradation, industrial waste disposal and prevention of accidental contamination into consideration, creating environmental justice issues for the local marine fishing community (Ditty & de Rezende 2013). Another example is the Dharavi Slum Redevelopment Project covering 239 hectares and housing a million poor people, who have been affected by the expansion of Mumbai in India (Boano et al. 2011). This large-scale development has created tensions ‘between top-down urban strategies and bottom-up strategies of spatial adaptation and urban activism’ (p. 311). Lehtonen (2014) argues that these issues will become more prevalent if the social aspects of megaprojects are not taken into consideration. He suggests that more attention needs to be paid to ‘environmental justice’ (p. 98) to evaluate the social dimension of megaprojects. In a book on the socioeconomic evaluation of megaprojects, Lehtonen et al. (2017) point out that current approaches to the social dimension using techniques such as checklists are insufficient to address issues of justice ‘such as the respective roles and duties of and, on the one hand, the state as a guardian of the general interest and, on the other, sub-national actors that are often torn between their responsibilities towards the state and those towards their local constituencies’ (p.8). From a brief review of justice issues created by conventional megaprojects it appears that these are not addressed adequately even in those projects nor discussed in detail in the project management literature.

Conclusions and further research

It is clear from the discussions above that it is important to address social justice issues in all megaprojects. In this article, we have focused on energy justice issues in renewable energy megaprojects. What can be done to alleviate these?

The literature on energy justice also points to ways in which these can be tackled, which provides some useful ideas that can be adopted to all megaprojects where justice issues need to be considered. One way these have been addressed in renewable energy projects is through social innovations.

For example, Hiteva and Sovacool (2017) explain how business model frameworks that can help in innovations for energy through social innovation can address energy justice. They discuss four cases that have worked towards achieving energy justice at various levels as shown in Table 6:

Insert Table 6 about here

Caldazilla & Mauger (2018) have suggested three measures to take care of energy justice issues:

1. Facility siting to be carefully considered, including technical viability but also social and environmental impacts by spreading developments around. Decentralizing community-based renewable energy projects should also be promoted to provide sustainable energy to local communities.

2. Carrying out compulsory environmental and social impact assessments instead of just declaring solar and wind as environmentally good energy.
3. Encouraging collaborative governance, public participation and transparency allowing local deliberations, including with marginalized populations.

Sovacool (2013) has proposed a framework to address energy justice issues with an explanation on how these have been used in all energy projects (not just renewable energy megaprojects) that could guide governments and organizations to invest in renewable energy initiatives. The principles are:

Availability: People deserve to receive sufficient energy of high quality

Affordability: People should not pay more than 10% of their income towards energy services

Due process: Due process should be observed, and human rights should be respected in the production and use of energy

Information: High-quality information should be provided in a fair and transparent manner regarding energy to stakeholders for informed decision making.

Prudence: Energy resources should not be depleted rapidly

Intergenerational equity: People have a right to access energy services fairly

Intergenerational equity: We should ensure that future generations would be able to enjoy a good life by ensuring that energy systems we develop do not inflict damage to our world

Responsibility: Nations have the right to protect their natural environment and minimize energy-related threats.

While megaprojects to deliver renewable energy are being built, due consideration should also be given to smaller scale local and cooperative initiatives that can enhance social justice. Building big is not always the best solution. Sovacool and Cooper (2013) challenge the argument made by Flyvbjerg et al. (2003) that four strategies (transparency, performance specifications, stable regulatory regime, and risk capital) to establish accountability can improve the performance of megaprojects. Based on case studies of large energy megaprojects Sovacool and Cooper (2013) argue that the first three strategies can exacerbate megaproject challenges while the fourth may prevent any from being built. They argue that in considering investing in megaprojects 'trade-offs between, for instance, public participation and economic performance render imprudent investments in any project that is designed to achieve both values' (p. 326). Therefore, the success of megaprojects should be defined more in terms of the chosen balance of values, and realising that it is not always about achieving consensus among stakeholder success of megaprojects should be defined more in terms of the chosen balance of values, and realising that it is not always about achieving consensus among stakeholders. They suggest using a framework 'for prioritizing project objectives and a clear roadmap for how to proceed when competing values create intractable challenges' (p. 226). They argue that megaproject failure is inevitable advocate choosing 'smaller more appropriate distributed generation and renewable energy projects that are eminently scalable' (p. 228).

These discussions on energy justice and renewable energy megaprojects could pave the way for further inquiry into project organising, in what Gearldi and Söderlund (2017) argue are macro-level concerns about projects such as social and environmental justice issues. This could include studying what impact projects have on society, extending our knowledge of projects from an emancipatory perspective, to appreciate that while trying to do good we could end up doing more harm by not considering issues of ethics and justice.

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Table 1 – Increase in renewable energy production over the past decade

Capacity MW	2010	2015	2019	% increase
World Wind Energy	180,846 MW	416,241 MW	622,408 MW	244%
World Onshore Energy	177,790 MW	404,523 MW	594,253 MW	234%
World Offshore Energy	3,056 MW	11, 717 MW	28,155 MW	821%
World Solar Energy	41,545 MW	222, 091 MW	584,842 MW	1308%
Total World Renewable Energy	1,223,533 MW	1,874,079	2,532,866 MW	107%

Table 2: Major projects to deliver energy from solar farms

(Source: https://en.wikipedia.org/wiki/List_of_photovoltaic_power_stations

Location	Name	Capacity	Year completed
India	Bhadia Solar Park	2245 MW	2020
China	Huanghe Hydropower Hainan Solar Park	2200 MW	2020
India	Pavagada Solar Park	2050 MW	2019
Egypt	Benban Solar Park	1650 MW	2019
China	Tengger Desert Solar Park	1547 MW	2016
UAE	Noor Abudabhi (Sweihan)	1177 MW	2019
UAE	Mohammed bin Rashid Al Maktoum Solar Park	1013 MW	2020
India	Kurnool Ultramega Solar Park	1000 MW	2017
China	Datong Solar Power Running Base	1000 MW	2016 (Expected to increase to 3 GW)
India	NP Kunta	900 MW	2020 (Planned 1500 MW)

Table 3 – Large wind farms (Wikipedia)

Location	**Name**	**Capacity**	**Year**
China	Gansu Wind Farm	8000 MW	Expected to increase to 12,710 MW by 2020
China	Zhang Jikou	3000 MW	Date N/A
China	Urat Zhonqi, Byannur City	2100 MW	Date N/A
China	Hami Wind Farm	2000 MW	Date N/A
China	Damao Qi, Batou City	1600 MW	Date N/A
India	Muppandal Wind Farm	1500 MW	1986
United States	Alta (Oak Creek-Mojave)	1320 MW	2019
India	Jaisalmer Wind Park	1064 MW	2001
China	Hongshagang, Miknquin County	1000 MW	Date N/A
China	Kailu, Tongliao	1000 MW	Date N/A

Table 4: Issues from Solar Power Literature					
Region/Issue	**Political**	**Economic**	**Socio-Technical**	**Institutional**	**Societal**
Asia	*Western India:* Concern that only large actors receive support of industrial-scale solar. Smaller actors get left out. (Sareen & Kale 2018). *Iran:* Lack of coordination between government bodies hinders progress (Madvar et al. 2018).	*Western India:* Large solar farms are viewed as expensive compared with spatially distributed smaller parks as they also reduce last mile costs in delivering energy (Sareen & Kale 2018).		*Iran:* Institutions involved in solar energy development (industry, academia, and government) do not collaborate well. (Madvar et al. 2018).	
Africa	*North Africa:* Risks to private investment due to bureaucracy, corruption, unstable regulations, lack of guarantees to investors as fear of force majeure	*Tanzania:* Lack of support for private investors to build large-scale solar power projects as well as lack of skills among local people to support the industry (Aly et al. 2019).			

	(Komendantova et al. 2012). *Tanzania:* Single-digit tariff cap in Tanzania due to political considerations inhibits investment in Solar. Agencies responsible to promote solar power in Tanzania also faced political interference in making right decisions (Aly et al. 2019).				
South America	*Brazil:* Price set for titled land by the Government was deemed unfair (Frate & Brannstrom 2017).	*Brazil:* Availability of skilled labour for installation and upkeep.			

North America			*Ivanpah, California:* Solar power facilities in the Mojave Desert faced several issues as GIS mapping using Google neglected the opinions of local people on place making locals feel that using technology to assess suitable landscape favoured technology to alter land (Moore and Hackett 2016).		*Long Island, New York:* Community engagement won community support to develop mixed use solar energy in agricultural farms. In addition, educational outreach to communities helped to build trust by increased transparency to financing and funding. In Ivanpah, use of technology to justify land appropriation resulted in lack of public participation creating barriers (Schelly et al. 2019).
Europe					
Australasia			Concern was expressed about end-of-life of solar panels as a waste management issue which goes against		

			the principles of a circular economy. In addition, the need for onshore recycling capability was created opposition (Salim et al. 2019).		

Table 5: Issues from Wind Power Literature					
Region/Issue	**Political**	**Economic**	**Socio-Technical**	**Institutional**	**Societal**
Asia		*China:* Local residents want the owners to prioritize local employment (Yue et al. 2015).			*China:* No large anti-wind power movement in China. However, the general public attitude is 'Not in my backyard but not far away from me'. Some concerns about noise pollution and visual impact (Yue et al. 2015).
Africa					
South America		*Brazil:* Failing because of grid. Power distributors, grid managers and suppliers concerned with costs of transmission lines affecting auction prices, low short circuit capacity.			*Brazil:* Benefits: Displaces environmentally damaging power stations and leads to job creation. Barriers: Impeded access to fishing areas, damaged local infrastructure and homes, intimidation,

		Issues related to return on investment, licensing procedures, investments (Frate & Brannstrom 2019)			and belief that it has very little local benefits (Frate & Brannstrom 2019).
North America					*Canada, Ontario:* Cancellation of project by residential neighbourhoods, wildlife groups, dairy farmers, and local cultural and historical preservation society. Issues: Noise pollution, loss of migratory birds, health concerns, reduction in milk production due to overhead transmission lines, visual pollution affecting tourism (Jami & Walsh 2014).
Europe	*Spain:* Procedural and distributive justice	*Sweden:* Doubt regarding its profitability as it is subsidized. Unconvinced about	*Sweden:* People who support technological development and economic growth	*Netherlands:* Policy actors and wind-power developers blame public instead of	*UK:* Fishers felt that siting wind farms on fishing grounds eroded opportunities of their

	issues (Upham and Perez 2007). *UK*: Local vs global: While macroeconomic issues, energy and climate are the focus at national level, risks and benefits are the concerns in local areas (Gray et al. 2005).	significance and benefits (Upham & Perez 2007).	supportive (Upham & Perez 2007).	building institutional capital through open planning practices (Wolsink 2007). *UK:* Insufficient information provided to locals by developers (Gray et al. 2005).	livelihood. (Wolsink 2007) *Spain:* Developer seen as a foreign investor seeking benefit from Spanish land. People are wary of environmental disasters from previous megaprojects. People prefer to preserve land for future generations than monetary compensation. Community-focused wind projects were favoured to large-scale development (Upham & Perez 2007).

					Sweden: Not convinced that wind power is actually efficient. Eyesore affecting scenery for those who believe it affects the meaning they attach to their homes (Waldo 2012). *UK:* Visual impact even on offshore installations due to lack of fit with current surroundings. Local context and place attachment that people have, especially for places that are considered beautiful. Fear and harm to local environment to

					fishing and recreational industry. Lack of belief that wind power will have any effect on climate change (Gray et al. 2005).
Australasia	*Australia* Regional governments welcomed economic growth (Hall et al. 2012).				*Australia:* Support from farmers who earned an income from compensation. Concerns about aesthetics and noise, Distributional justice in balancing benefits and impacts on those affected. Procedural justice by providing honest, transparent, and unbiased information and not enticing communities by donating to community

					organizations as tacit support. Place attachment expressing concerns about visual changes to place and landscape (Hall et al. 2012).

Table 6: Energy Justice at Multiple Levels

Location of Business	**Scale and Operation**	**How energy justice is achieved**
Manchester, UK	*Local Scale*: Carbon Co-op, a community group in Manchester, UK, run by householders who have set up a not-for-profit company.	Ensures reduced household energy usage, enhanced access to energy services and benefits, and participatory energy decision-making and vision building.
Nottingham , UK	*Sub-national Scale*: Robin Hood Energy, owned by Nottingham City Council is a not-for-profit company offering low-cost energy to households and tackling poverty.	Provides energy and heat comfort to vulnerable communities and low-cost energy and easy switching arrangements.
Dutch Company operating in East Europe	*Regional Scale*: Dutch company in the East European Market (RenEsco) finances deep renovations with a minimum price guarantee for energy exceeding operational costs and debt obligations. Captures value by using energy performance.	Low cost (no collateral), energy saving (guarantee for 20 years) and flat owners' share profits of RenEsco.
UK registered firm	Yansa, registered in the UK, focuses on wind energy development by creating large-scale community wind farm projects and reinvesting profits in the community. Works with institutional investors to lower overall financial cost and risk.	Reinvestment of profits for community benefit and following locals to decide on that social and environmental returns are delivered.