Making the Piazza Fountain Net Zero in Energy Needs

It might well be possible to develop a renewable energy system that uses the movement of the hoppers and water in the actual fountain which can be incorporated in the fountain or its associated viewing platforms.[1] However to install a practical system capable of generating enough electricity to power the lighting and water pump requirements of the fountain at a realistic cost it is considered that advantage should be taken of the already fully tried, tested, widely used and relatively cheap technologies of **wind** and **solar** power.

Increasingly these two systems are combined in small scale, so called 'hybrid', installations such as those illustrated in Figures 1. The two systems generally complement each with the solar photovoltaic (PV) panels generating the majority of the electricity on sunny or bright, but relatively calm days, particularly in the summer, while the wind turbine generates most on dull windy days, in winter and at night, the latter being an important additional advantage of wind power.[2]

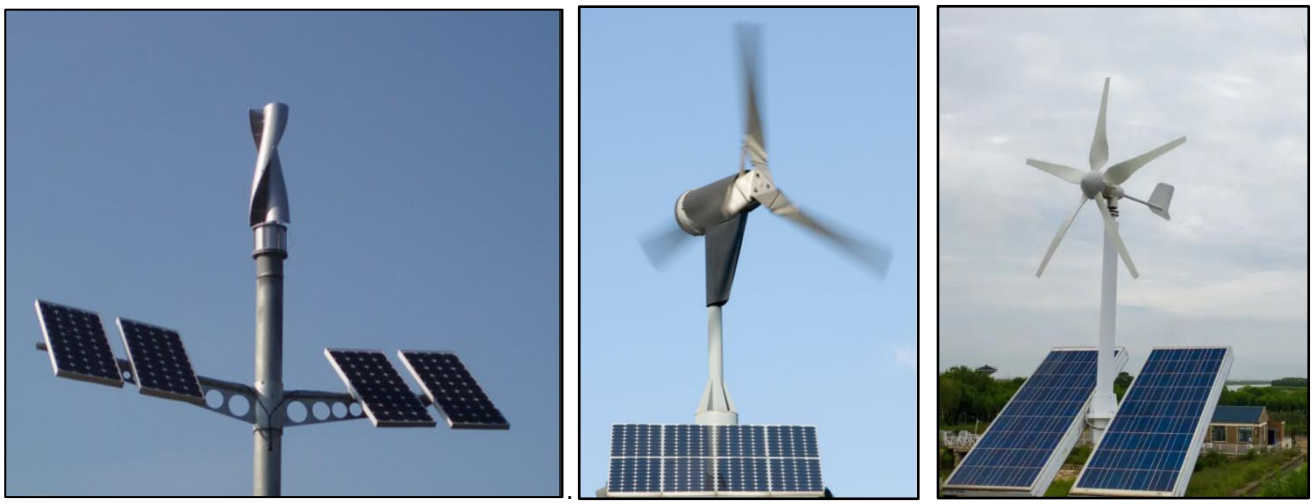

Figure 1: Three examples of 'hybrid' systems combining wind and solar power installations

How these hybrid systems work is illustrated diagrammatically in Figure 2.[3] Both the wind turbine and the PV panels generate DC electricity and are wired to a battery bank which stores the energy ready for use, but the current is first passed through a load controller to ensure that the batteries are not overcharged. To use the stored electricity in the battery bank, it is then wired to an inverter which converts the DC electricity to AC for normal use. Finally the electricity passes through a second controller where, if necessary, it can be boosted with mains electricity from the grid if, for example, the battery bank has run low for any reason.

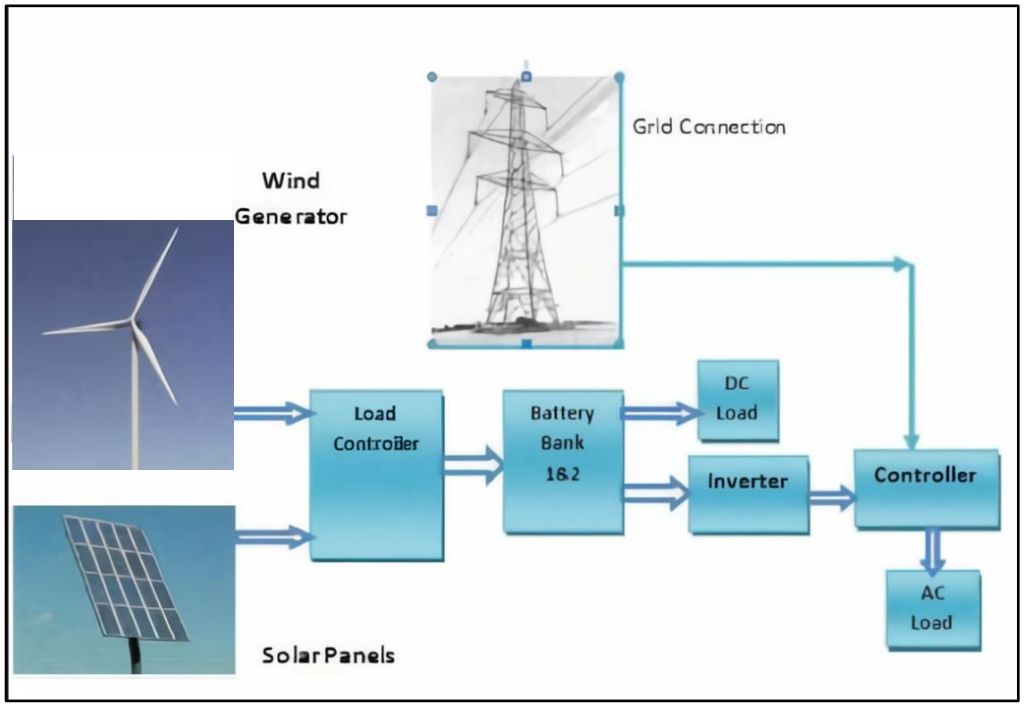

Figure 2: Diagram showing components and wiring of the 'hybrid' system

As the Goree Piazza is surrounded by buildings of up to eleven storeys high, very little sunlight reaches the floor of the piazza, particularly in winter, and for the same reason, the piazza is relatively sheltered.[4] Consequently, it would not be sensible to site a hybrid installation combining both wind and solar energy generators in the actual piazza or on the fountain. The best places to site the installation would be either on the roof of the Corn Exchange building above the Staycity Aparthotel or, being approximately the same height, on the roof of the most easterly of the lift motor rooms of Strand Plaza, above the City-Key Apartments, both highlighted in green in Figure 3.[5]

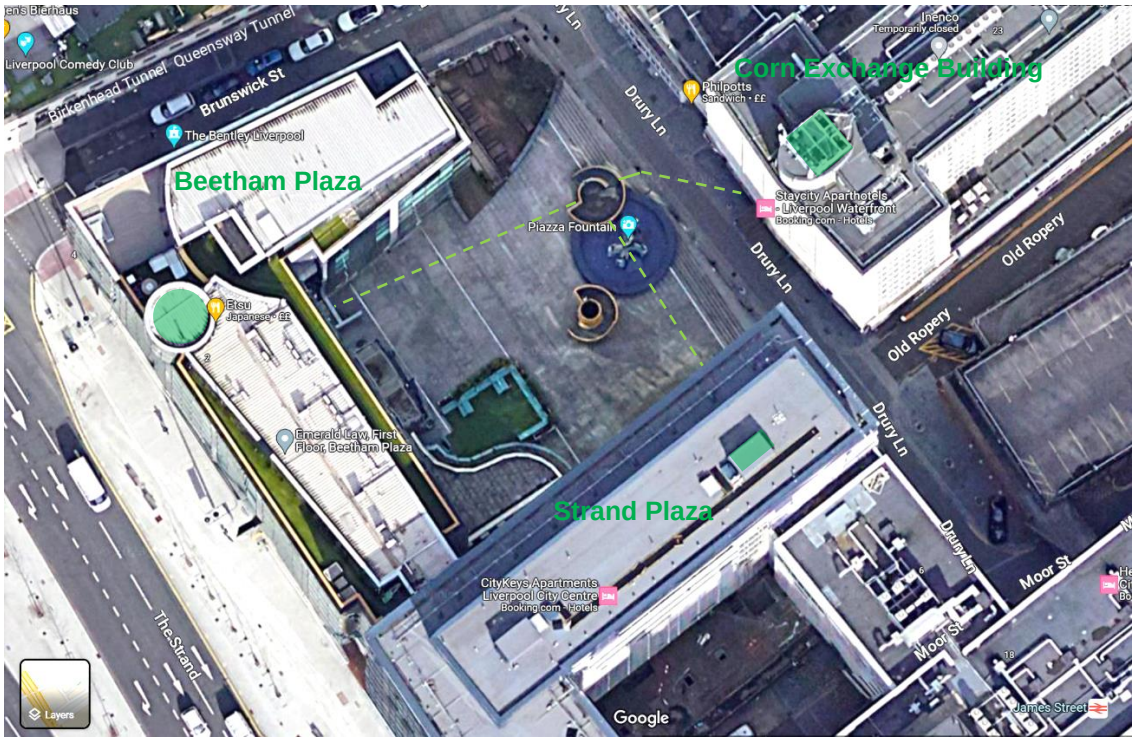

Figure 3: Satellite view of the Goree Piazza, showing 3 possible sites for energy renewables.

Although under different ownerships, these two sites are significantly higher than the alternative roof of Beetham Plaza or any of the immediately adjacent buildings. Therefore they would capture both the maximum amount of sunlight available and the often particularly strong winds that pass over this area of the City. As shown in Figure 4,[6] the highest point of the Corn Exchange Building is already the site of two communication masts, so installing an energy installation behind these would be largely invisible from the street. The wires from this could then be run down a suitable duct in the building and across to the fountain's pump house opposite.

Figure 4: The Corn Exchange Building, showing communication masts

The alternative would be to site the wind turbine and solar panels at approximately the same height on the roof of the lift house closest to the fountain on top of Strand Plaza/Mersey House, as shown in Figure 5.[7] This would again be largely invisible from ground level, being set back from the face of the building overlooking the piazza. As long wiring distances causes a voltage drop, particularly in generally low voltage renewable DC systems, it may be necessary in the case of both schemes to locate the load controller, battery bank and inverter close to the wind turbine and solar panels.[8] These could be located in a lockable container in a high level maintenance room or, if necessary, on the roof. From the inverter the AC wiring would run down the most suitable vertical duct close to the lift and communal stairs down to the lower ground floor basement. Here it could run in a conduit across the ceiling in the plant room situated under the entrance lobby and from there into the top level of the adjacent Beetham Plaza underground carpark and again along the ceiling to finish in the fountain's pump room immediately above, where the final AC controller connected to the mains grid would be located.

Figure 5: NE Elevation of Strand Plaza, showing possible position of installation & wiring runs

Obviously both of these schemes would need the agreement of the building's owners and in the case of Strand Plaza possibly also of the leaseholders of the adjacent penthouses. If neither of these was forthcoming or the possible rental costs of using these buildings was too high, the other alternative would be to locate the wind turbine on the roof of the round section of the penthouses of Beetham Plaza and the solar panels also there or nearby. Although, as shown in Figure 6,[9] this site is significantly lower than the other two possible locations, because this part of the building projects slightly out over the Strand, it should still catch most if not all of the wind blowing over the area as well as capturing an equal amount of sunlight as the other two schemes.

If there is no suitable space for the load controller, battery bank and inverter on the higher floors of the building, these could again be located in a container on the roof alongside the 'hybrid' installation. From here the AC wiring can probably be run down from the penthouse above the Strand in an existing vertical duct, which is located close to the communal stairs and lifts, all the way down to the first, highest level of the basement carpark. The wiring can then be simply run in a conduit along the ceiling of the upper levels of the carpark to the pump house, thereby avoiding the need to take up any of the piazza paving (Figures 7 & 8).[10] However, because the wind turbine and solar panels would be much more prominent in this position on the roof of Beetham Plaza than in the case of the other two possible sites, and closer to the Three Graces, obtaining planning permission for their installation might be more difficult .

Figure 6: Facades along the Strand showing third possible position for a wind turbine and solar panels

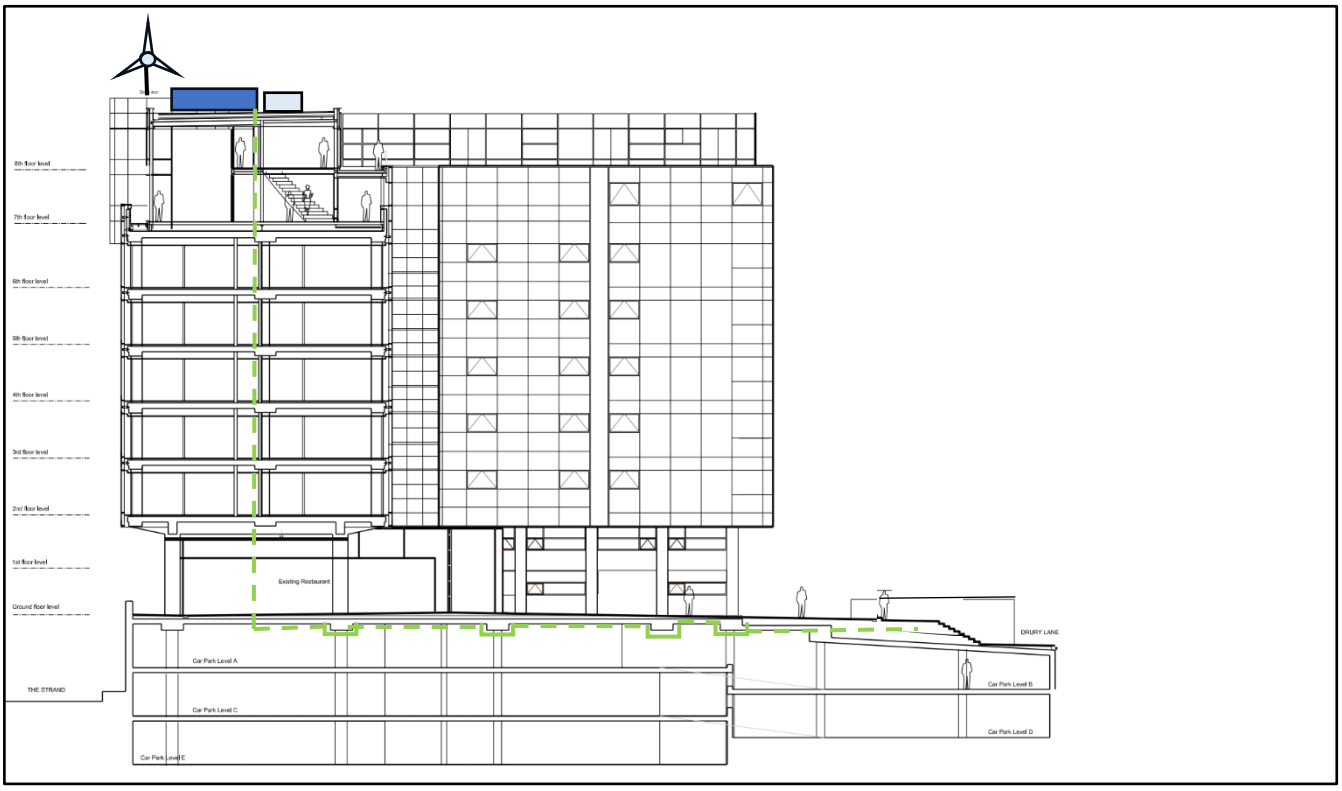

Figure 7: **Section through Beetham Plaza and the piazza showing renewables and possible wiring line**

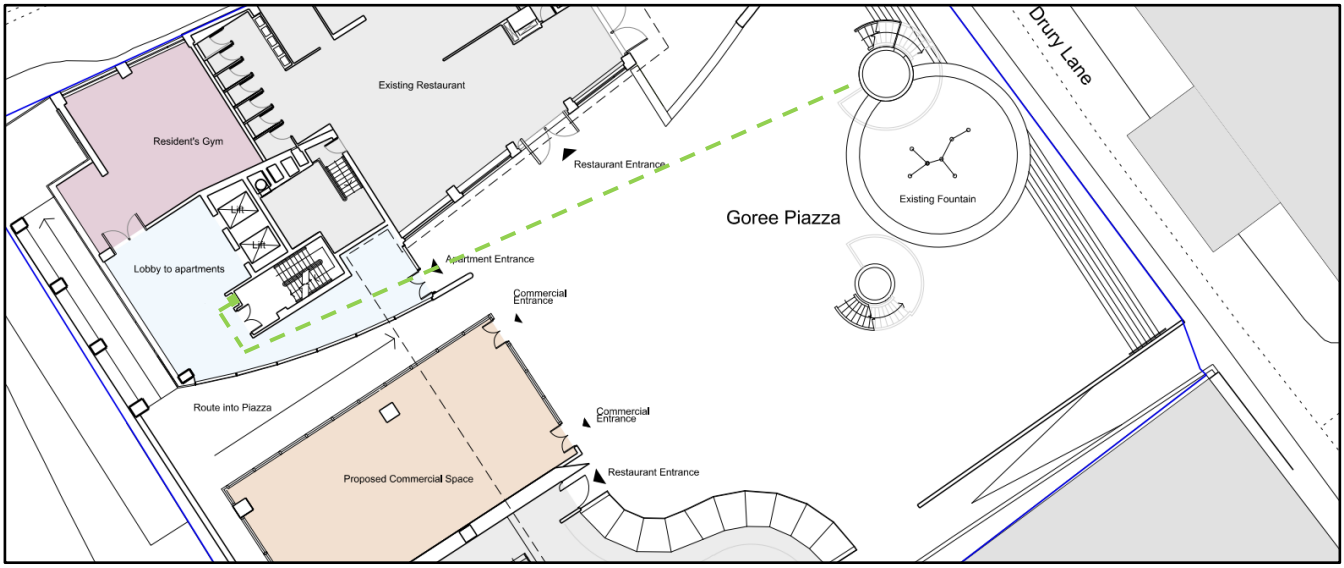

Figure 8: **Ground floor plan showing possible wiring line on carpark ceiling below**

Conclusions

By locating the wind turbine and solar PV panels on the highest roof of the respective buildings, all three schemes would provide major advantages over using these or other renewable systems on or adjacent to the Piazza Fountain:-

1) Being widely used, solar and wind power are now the cheapest renewable energy sources, according to the International Renewable Energy Agency (IRENA) and other research projects, with wind also being the most efficient.[11]
2) By virtue of their location, the size of the turbine and number of PV panels can be made sufficiently large to generate enough electricity to fully satisfy all the energy needs of the water pumps and lighting of the fountain.
3) In all 3 schemes, the solar panels would catch the maximum amount of sunlight available, with no possibility of the panels being overshadowed.
4) Similarly, in the first 2 schemes, the turbine would catch the full force of the prevailing winds in the area and in the case of the third scheme, at the very least, most of the wind.
5) Also in the first two schemes, the wind turbine and solar power installations would be largely invisible from ground level.
6) Above all, every one of these schemes would allow the Piazza Fountain to be fully restored to its original appearance and performance, without this being compromised in any way by the addition of renewables on or immediately adjacent to the fountain.

Because of the latter, the chosen scheme would not necessarily need to be undertaken with the actual restoration of the fountain, but could be undertaken later using specific energy efficiency grants. However, in preparation for such a scheme, it will be important for the restoration to include the replacement of the existing water pumps with particularly high energy efficient ones and for the new lighting for the fountain to be also highly energy efficient. By so minimising the energy load of the fountain, the size of the proposed wind turbine and number of solar panel can then be reduced to thereby allow an even more affordable fully net zero renewable scheme with a relatively short payback period.

End Notes and References

[1] Such schemes were briefly discussed at the online meeting of the Piazza Fountain Working Group held on the 1st September 2023.

[2] Energy Saver (2023), *Hybrid Wind and Solar Electric Systems*, U.S. Department of Energy, Washington, at Hybrid Wind and Solar Electric Systems | Department of Energy.

[3] A-S.T.Hussain et al (2014), *Hybrid Wind Solar Controller System*, Research Gate, June 2014

[4] On the NE the Corn Exchange Building housing StayCity Apartments is 10 storeys with additional high oval roof structures, SE Strand Plaza is 11 storeys with additional low roof structures, SW & NW, Beetham Plaza is 9 storeys above the piazza level and on the NW across Brunswick Street the new Vista Residences apartments also overlooking the piazza are 10 storeys high.

[5] Google, Satellite View of Beetham Plaza and the Goree Piazza.

[6] Google, Street View from Brunswick Street close to the entrance of Beetham Plaza carpark.

[7] Brock-Carmichael (2017), *Strand Plaza, Liverpool, Proposed East Elevation,* Drawing Number L(05)005, 17/02/2017, sent by the late Michael Cosser to the author with email dated 20/5/2019 – renewables added by author 04/09/2023.

[8] Calculator.net (2023), *Voltage Drop Calculator*, at Voltage Drop Calculator. Set to AC single phase 240 volts by 30 amps this gives only a 2% voltage drop over 100 metres, compared to a nearly 14% drop when set to DC and 24 volts by 20 amps and other factors such as the wiring gauge are kept equal.

[9] Google, Street View from the lower part of Brunswick Street on the opposite side of the Strand near the Pier Head.

[10] Liverpool City Council (2021), Planning Application Ref. No. 19F/1113, Planning Portal attachments – P19-023-02-05-003 Existing Courtyard North Elevation and P19-023-02-03-004 Proposed Ground Floor, 14/07/2021 – renewables added by author 04/09/2023.

[11] Len Calderone (2020), *What is the Cheapest Form of Energy?,* Altenergymag.com, 28/04/2020.and Born to Engineer, *What are the Most Efficient Forms of Renewable Energy?,* based on the cost of the fuel (i.e. zero) and the cost of production.