**SOLAR VORTEX** | **RETURN TO THE SOURCE**

SOLAR ART IN THE LANDSCAPE

Inspired by ‘Masdar’, which means ‘Source’ in Arabic language, SOLAR VORTEXcelebrates the Sun as the Source, the most abundant and available renewable energy to our planet, creating an innovative source of on-site energy production and carbon free electricity, that could potentially power the majority of Masdar City and support the future development of surrounding urban areas.

The proposed eight structures of SOLAR VORTEX array portrays the fusion of Sustainable Engineering, Architecture, Landscape Architecture, and creative work of Art. The array is envisioned as iconic landmark of Masdar City, beautifully orchestrated within the captivating landscape of Masdar City Park network and the Desert environment.

HARNESSING THE POWER OF THE SUN

Our Sun is a giant fusion reactor of energy, the center of Solar System, that sustains life on Earth, drives the wind and waves, and that over millions of years powered the transfer of ancient carbon dioxide out of the atmosphere and into the ground, creating a climate habitable to humans.

In harnessing the energy of the Sun, SOLAR VORTEXis designed not only to capture the heat as solar thermal concentrator, but also functions as *fusion reactor* to generate power, a poetic approach to what the Sun is inherently all about.

A hybrid and creative advancement of Concentrated Solar Power (CSP) technology, SOLAR VORTEX combines *Vertical Beam-Down Solar Thermal Concentrator (V-BDSTC)* technology, with the *Integral Molten Salt Reactor (IMSR)* technology.

*Vertical Beam-Down Solar Thermal Concentrator (V-BDSTC) technology*

Typical commercial CSP plants that have been constructed around the world require a large amount of land to build, in thousands of hectares. As an example, the Ivanpah Solar Power Facilty at Mojave Desert, California, United States, occupies over 1,400 hectares of desert land to house CSP facility producing 940 GWh of net annual capacity.

The Beam-Down Solar Thermal Concentrator (BDSTC) is a variation of central CSP plants with Cassegrainian optics method. The BDSTC prototype was constructed in Masdar City in 2009 designed by Tokyo Institute of Technology.

Our site area is approximately 24,510 square-meters (2.45 hectares), located at the heart of Masdar City park network. To overcome the constraint of compact developable land area, our creative and innovative SOLAR VORTEX design proposes for ***Vertical*** Beam-Down Solar Thermal Concentrator (V-BDSTC) with *vertical arrangement* of the elliptical layout of flat heliostat mirrors, gradually spiraling up into three-dimensional hyperbolic helicoid geometry.

With the beam-down optics of capturing and concentrating solar thermal energy, SOLAR VORTEX employs dual systems of three-dimensional mirrors arrangement, first is the ***Collector*** heliostat mirrors, and the second is the ***Reflector*** mirrors. The Collector (or Receiver) mirrors are mounted as retractable devices with heat sensor and automated ability to adjust the angle to track optimum solar thermal capture. The Reflector mirrors are mounted with automated optical sensor with enhanced focusing and aiming ability to reflect and converge optimum solar heat radiation back to the lower focal point, where the molten salt reactor is located. Each of the V-BDSTC component of the SOLAR VORTEX is capable of producing over 600 °C to 800 °C to ignite the underground Integrated Molten Salt Reactor.

*Integral Molten Salt Reactor (IMSR) technology*

The Beam-Down Solar Thermal Concentrator design allows for the development of Integral Molten Salt Reactor (IMSR) to be buried below the ground as sealed vessel built in Zirconium cladding for higher safety measure, which is passively and intrinsically safe. This is the ultimate advantage of SOLAR VORTEX design as fusion reactor to generate immense electricity output.

Molten salt reactors use molten fluoride or chloride salts as a liquid fuel and coolant. This liquid fluoride fuel salt is unaffected by radiation, acted simultaneously as coolant thus simplifies decay heat removal, and works at low pressure and high boiling point. This type of fusion reactor has been identified by the US Department of Energy as one of the advanced new generation of reactors to debut by 2030.

The IMSR component of SOLAR VORTEX in each structure generates high power output, ranging from 15 MWe to 30 MWe of electricity with a thermal-spectrum, graphite-moderated, molten-fluoride-salt reactor system.

ESTIMATE OF ANNUAL CAPACITY

SOLAR VORTEX is a compact urban renewable-energy power plant that is scalable. By design, the structure of the array varies from 25 m diameter by 40 m height, to 50 m diameter by 45 m height above finish ground (maximum height allowed per Masdar Masterplan Guidelines).

Total of eight SOLAR VORTEX array will produce an estimated of 165 MWe. With 27% capacity factor, the array altogether yield approximately **390,000 MWh** of annual capacity.



CONCEPTUAL COST ESTIMATE

The SOLAR VORTEX array has the potential to be a relatively low-cost reactor that can operate safely in new temperature regimes. This means the technology can do more than generate electricity; it also offers potential in alternative markets, such as process heat and thermal storage, which is suitable to harness in the Desert environment.

Terrestrial Power, the manufacturer of IMSR (Integrated Molten Salt Reactor) had estimated the cost to build the reactor in a range of $0.65/watt to $5.00/watt depending on the scale of the electricity power output. These range of costs are still significantly lower and more affordable than the $20 installed cost per watt of installed solar photovoltaic panels as it existed in 1992, the year of the first United Nations Framework on Climate Change meeting (the Earth Summit in Rio de Janeiro).

Below is the Rough Order of Magnitude (ROM) Cost Estimate of SOLAR VORTEX:



With this estimated conceptual cost, the SOLAR VORTEX array which produce 390 GWh annually, will have estimated cost per watt installed at **$1.2**

**ENVIROMENTAL IMPACT STATEMENT.**

SOLAR VORTEX Power Plant with Vertical Beam-Down Solar Thermal Concentrator and Integrated Molten Salt Reactor has higher safety measure. IMSR is operated at atmospheric pressure, and the fuel is molten already, so it cannot meltdown. It doesn’t have chemical reactivity, therefore it will not contaminate a large amount of land. IMSR is able to run up to continuous 30 years of producing energy without refueling, it is a sealed system with no proliferation risk of radiological material proliferation from the core.

The SOLAR VORTEX array is estimated to annually produce 390 GWh of renewable carbon-free electricity that potentially could power the majority of Masdar City and offset 297,000 tones of CO2 emissions each year.

In a much grander vision, Molten Salt Reactors might just turn fusion reactor power into the greenest energy source on the planet. The SOLAR VORTEX that combines Concentrated Solar Thermal Power with Integral Molten Salt Reactor, gives an alternative solution to the need of immense energy generation in form of affordable ultracompact molten salt reactor that could serve the larger part of the world to be totally independent of fossil fuels.

*Source of Research:*

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*https://www.nextbigfuture.com/2018/03/terrestrial-energy-on-track-to-commercial-molten-salt-reactor-competitive-with-natural-gas-prices.html*