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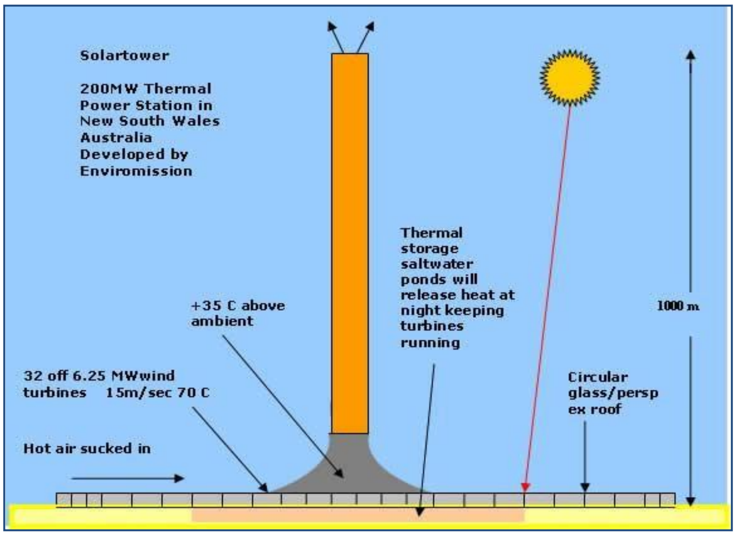
Flow through a Solar Updraft Tower

PHOENICS Demonstration Case

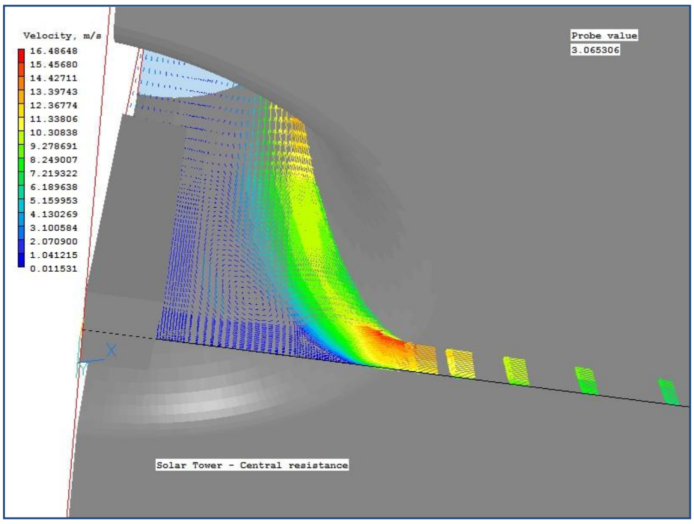


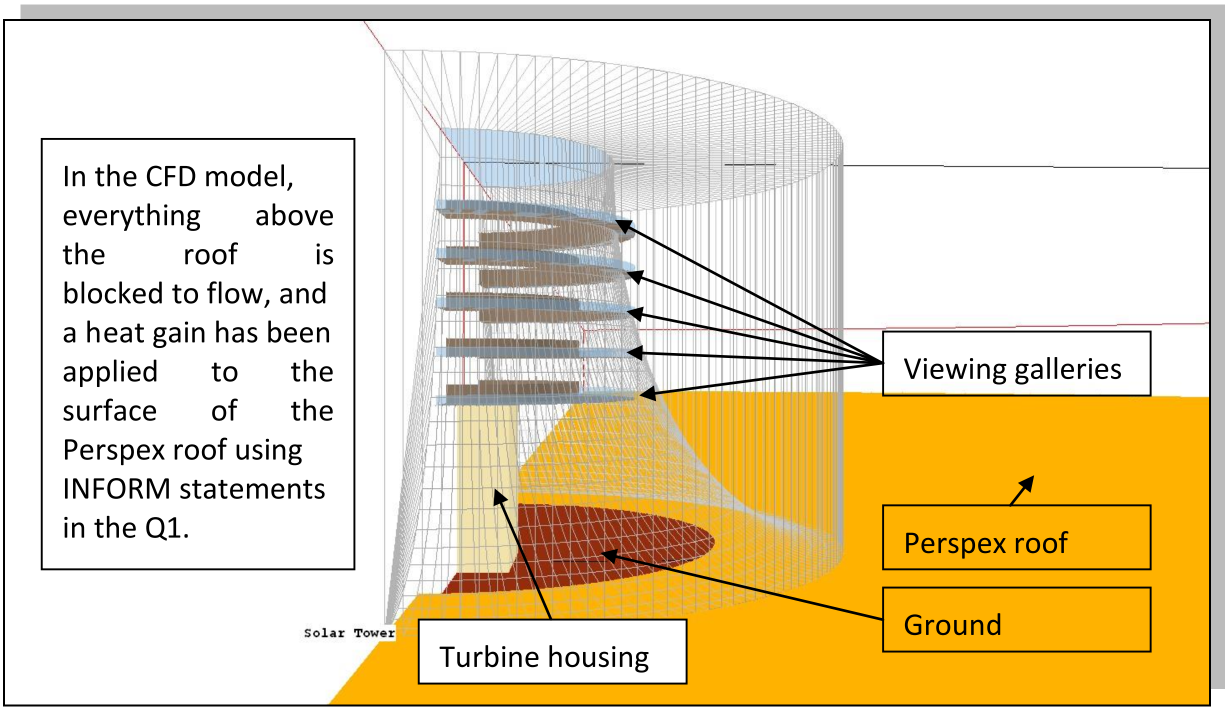
A Solar Updraft Tower is a relatively low cost, low tech, renewable energy system for generating electricity from solar power.

The system uses a combination of the "chimney" and "greenhouse" effects to drive a wind turbine housed in the tower's base. Air is heated though solar gain through the inclined Perspex roof (or even through plastic sheeting) of a vast greenhouse surrounding the base of a tall chimney.

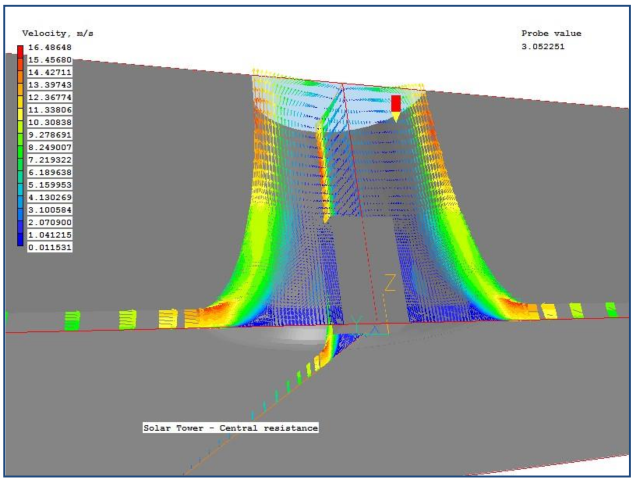
The air is drawn towards its centre and the resulting convection causes air to rise rapidly up, through the tower, driving one or more turbines. A secondary benefit, of course, is that the greenhouse can still be used for growing produce!

In this PHOENICS demonstration case, the grey cone sits at the centre of a large cylinder (about 6Km in diameter) representing a Perspex covering, 3m high at the perimeter and 15m high at the base of the cone. The perimeter is open to let in air. The grey cone is 300m in diameter at its base and 200m at the top, and 250m high. There is a turbine at the top of the cone (and a tall chimney above that - but it's not present in this model.). The internal of the cone is quite complicated but, for demonstration purposes, represented simply as a blockage. [There is also a thermal storage reservoir underneath the tower complex to keep the turbine running overnight, but this is ignored within the CFD model.]



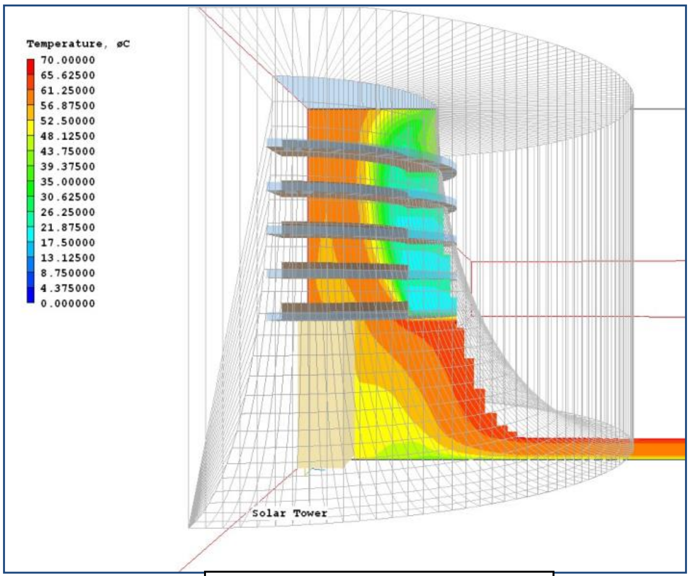


The image shows the inside of the tower. There are 5 floors inside with viewing galleries, each with a wall at the inner end and an ANGLED-OUT at the outer edge. The ANGLEDOUTs intersect the blockage of the tower and provide fixed-pressure boundaries where they intersect.

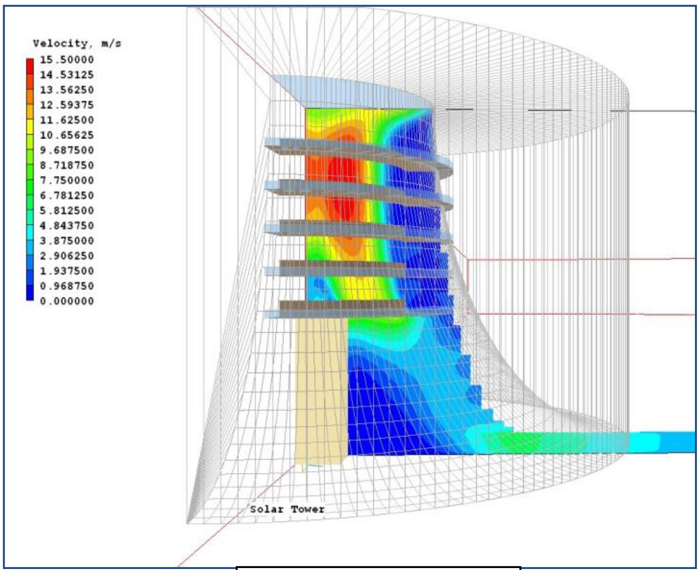


InForm is used to apply the heat sources to hidden blockages, HEAT & HEAT2. The STOREd variable MARK is set to 1 in all cells which are fluid and have a solid above them (i.e. on the next Z plane). Fluid cells are identified as having the property marker PRPS < 100, and solid cells as having PRPS>99. The heat is then applied to all cells with MARK=1.

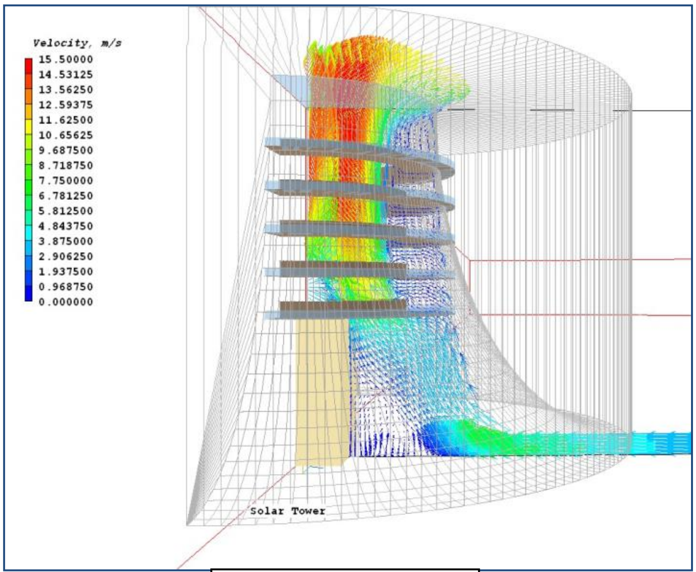
In a similar fashion, in HEAT2 MARK is set to 2 in all cells which are fluid but have a solid in the next Y cell outwards. The heat is then applied to all cells with MARK=2. The HEAT2 object covers the whole X extent of the domain, but could easily be limited to a small section. If there is an external wind, then ANGLED-IN objects can be placed on the up-wind side of the internal floors (opposite the ANGLED-OUTs) and the external wind set as the inflow velocity.



Temperature contours



Velocity contours



Velocity vectors

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