How to Save on Energy Costs When Using FDM 3D Printing Technology

Energy prices never get lower, and with global climate change, those prices will likely only increase. And although FDM® 3D printing technology offers cost efficiencies compared with traditional manufacturing, like any industrial equipment, it consumes energy, which costs money. However, there are ways to reduce your printer's energy cost footprint, and they're relatively easy to implement. This solution brief will show you how to lower your FDM printers' energy consumption and, as a result, your energy bill.

Solution Brief

stratasys

Practice Good DFAM (Design for Additive Manufacturing)

Before we even consider the printer, there are a few things you can do to reduce your part's weight and build time. There is a direct link between these factors and energy consumption because printers consume more energy during active printing than when idle. As such, designing for shorter build times will often yield the greatest savings.

It's very tempting to design parts big and blocky, just like you're used to for CNC manufacturing. But for additive manufacturing, you can take a very different approach. Take a look at the ULTEM™ 1010 resin composite form tools in Figure 1. The shell-style tool uses less material, prints in less time, and uses less energy compared to the sparse-style tool. By taking advantage of 3D printing's design freedom and considering different design options, you can positively impact your results, including reducing the energy required to produce them.

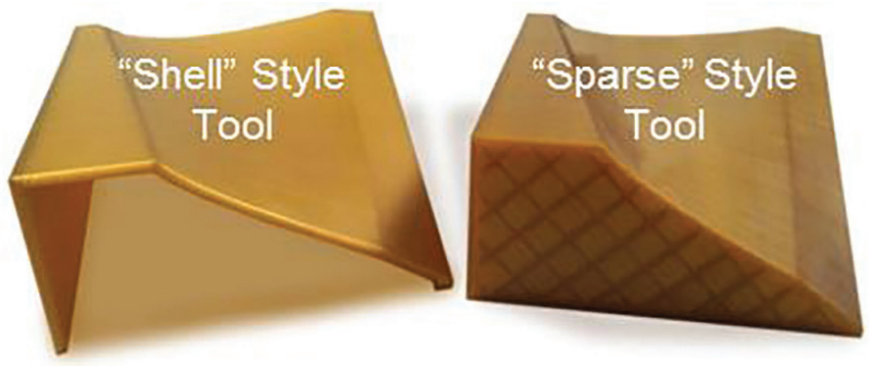
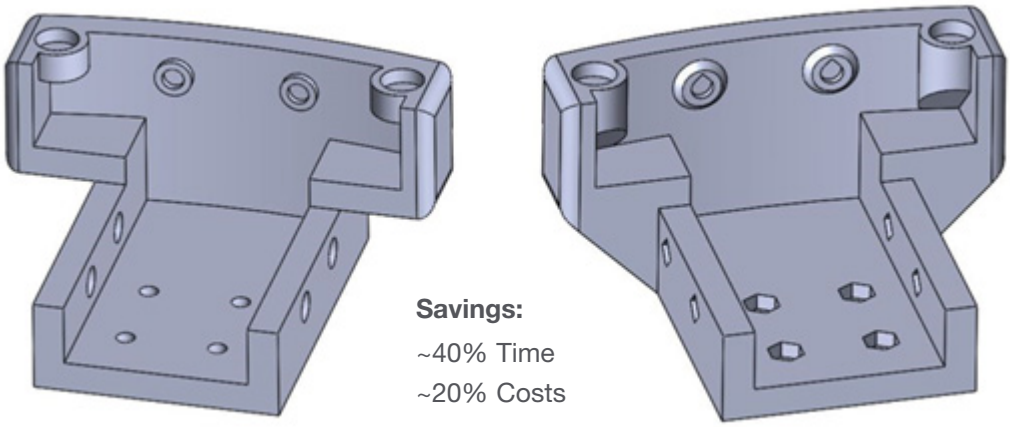


Figure 1. Two styles of the same FDM composite forming tool.

Additionally, support material can be eliminated or significantly reduced through clever design. The parts in Figure 2 are nearly identical except for how specific features are designed. Adding self-supporting angles where possible means there's no need for soluble support because the model material is "self supporting" – a key feature of FDM technology. As you can see in the figure, the savings can add up.



Savings:
~40% Time
~20% Costs

Print Time	4 hrs, 54 mins
Model Material (cm^3)	130.392
Support Material (cm^3)	33.662

Print Time	2 hrs, 57 mins
Model Material (cm^3)	128.337
Support Material (cm^3)	6.522

Figure 2. Both parts are essentially the same, but the part on the right has features that incorporate self-supporting angles, which require less support material.

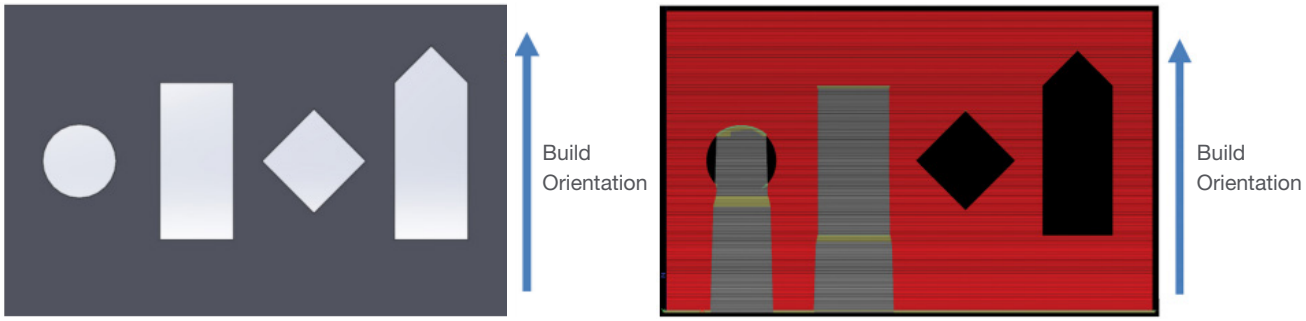


Figure 3. Feature design impacts how much or how little support material is needed.

The left side of Figure 3 shows two ways internal features can be designed in an FDM part. The right side of the figure shows the amount of support material in gray needed to build the hole and square-topped slot. However, by using a diamond shape instead of a round hole and a sloped “roof” on the slot, no support material is needed. (The diamond can be reamed to the proper shape post-print).

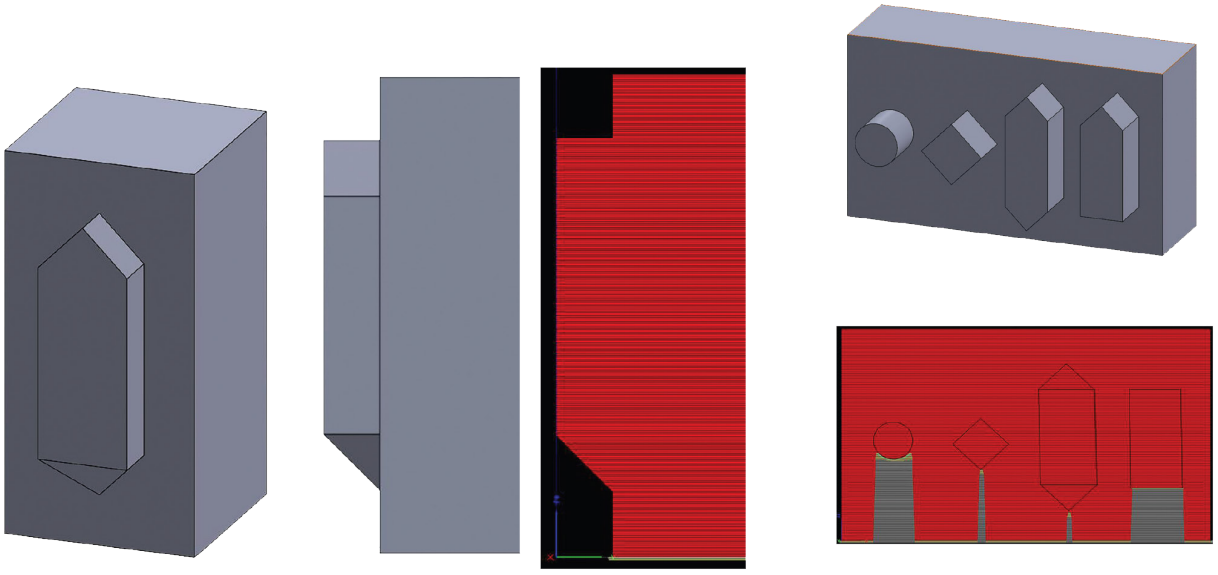


Figure 4. External features that govern whether support is needed.

The same principle applies to external features. Figure 4 shows how these same shapes drive the need for support material, shown in gray. Round shapes and flat surfaces relative to the build direction need support, whereas shapes with self-supporting angles require little to no support material.

Replace Support with Model Material

For faster prints on Fortus® systems such as the Fortus 450mc™ and the F900™, consider using print settings that replace support material with model material. This reduces the number of swaps required between model and support tips, decreasing print time. With F123 Series™ printers, this effect is negligible. Review your model when using this setting, as it may increase the difficulty of removing support material for certain geometries.

In GrabCAD Print™, this option is found under ***Support Settings.***

With Insight™ software, this option is found under ***Support -> Support Setup -> Support Parameters.*** Figure 6 shows what this looks like in Insight and the sequence of how to bring up and choose the option to use model material.

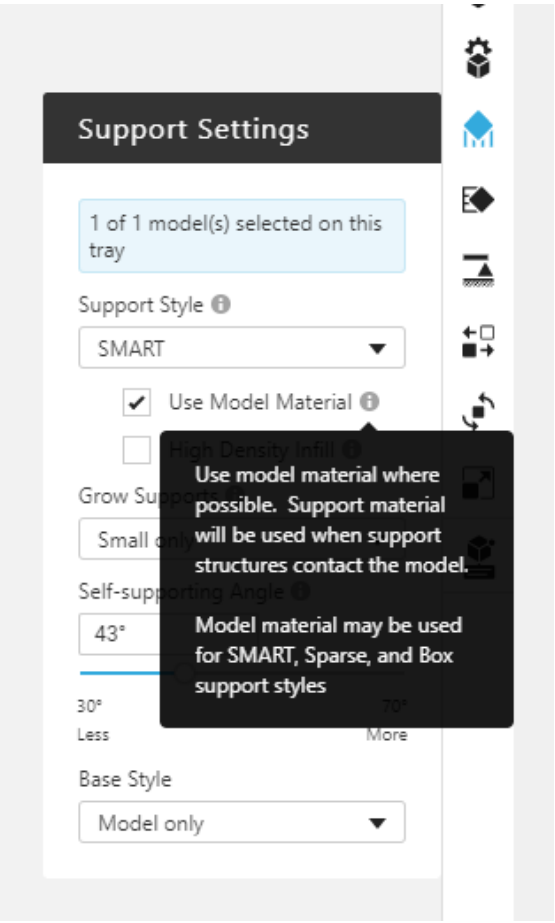


Figure 5. The ***Support Settings*** function within GrabCAD Print software.

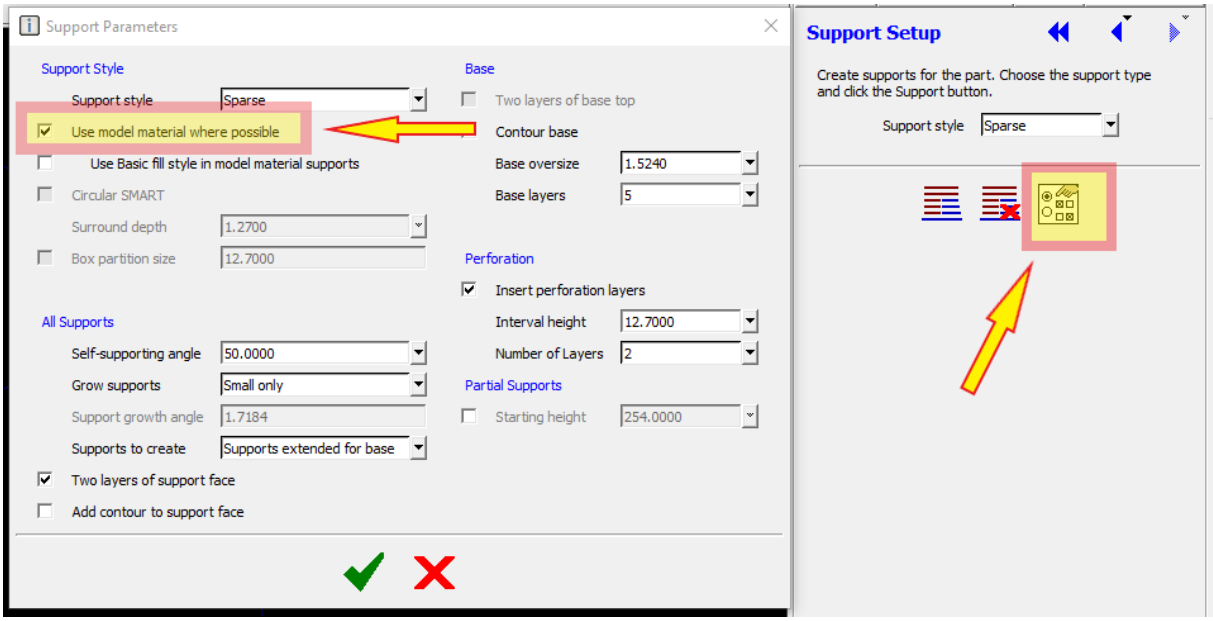


Figure 6. Choosing the ***model material*** option in Insight software.

Quick Wins

Shut it, don't slam it!

One of the reasons Stratasys FDM technology is best-in-class is the fully heated build chamber. Having such tight control over the build envelope improves accuracy and part strength. Leaving the printer door open for prolonged periods wastes heat to the atmosphere. Slamming the door can also introduce an influx of cold air, wasting more heat. So just like your parents always said, shut the door, don't slam it.

Enable Automatic Energy Saving Mode

You may not be aware your printer already has an automatic energy-saving mode built in. Once enabled, the system will automatically disable the heaters after two hours of idle status when printing has finished. This lets parts cool down slowly and save energy if you're not planning to restart the printer immediately.

For F123 Series printers, this setting is under ***Settings, Standby Mode*** in the printer's user interface, shown in Figure 7.

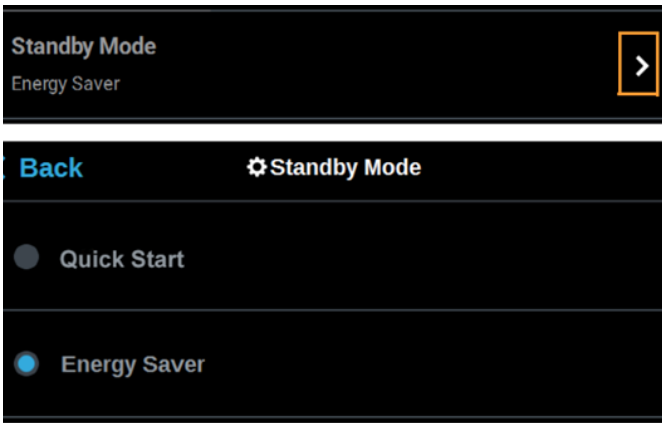


Figure 7. The Standby Mode in F123 Series printers.

For Fortus printers, system defaults can be changed from the System Default menu (Fortus 900mc and F900), and the Settings Page (Fortus 450mc), located through the respective printers' touchscreen. See Figure 8.

Fortus 900mc and F900 ***Sytem Default*** menu

Fortus 450mc ***Settings*** page

Figure 8 – Printer settings on Fortus printers enables the auto cooldown behaviour to be changed.

Don’t Waste Compressed Air

Fortus systems use compressed air to generate the vacuum that keeps your build sheets held firmly to the build bed. However, once printing is complete and the system is idle, turn the bed vacuum off by selecting the vacuum control icon on the machine’s touch screen to save compressed air consumption.

Figure 9. The Platen Vacuum Icon displays the current state of the system. Tapping the icon until the “Vacuum Off” symbol is displayed will reduce energy consumption during idle.

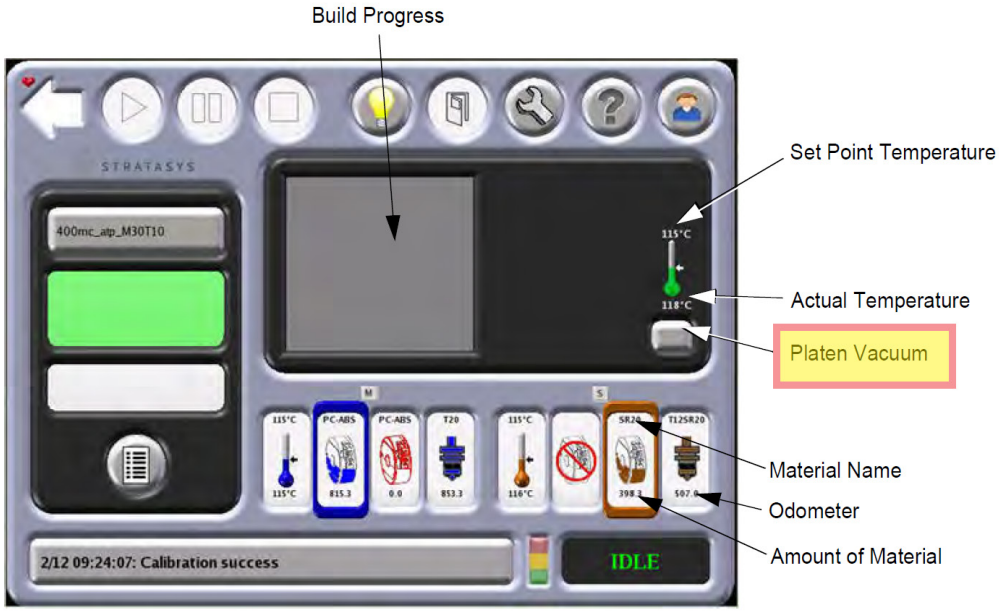


Figure 10. Picture showing the location of the vacuum status and control icon on the touchscreen for Fortus printers.

Support Removal Tanks

For the fastest results, support removal tanks need to be heated. But the quickest way to remove supports is not to print them in the first place, as we explained earlier.

When you do have to use support, it is often possible to manually remove it from your part. The best way to do this is to use heat-resistant gloves and pliers to pull the support away from your part while it is still warm from the printer. Don’t worry if you can’t get it all; you can still use the tank, but by removing big bulky areas of support, you’ll reduce your tank times.

Finally, depending on your manufacturing schedule, you could also consider turning off the heat on your support removal tanks or reducing the temperature at night or over the weekend. Support material will still dissolve at lower temperatures, just more slowly.

Nesting and Scheduling High-Temperature Builds Efficiently

If operating a system that regularly swaps between high and low-temperature materials, consider grouping parts together to avoid unnecessary material changes and temperature stabilization periods.

Next-Level Tips

System Location and Heating vs. Cooling

Like a lot of industrial equipment, Fortus printers need to exhaust waste heat into the atmosphere. Careful consideration of how you locate your system could save you energy in more ways than one. The following bullets outline ways to do this.

- **Is your facility in need of heat?**

  Co-locating equipment in areas that need heating repurposes this waste heat from your system. Consider which methods of ventilation would enable this. For example, if you need to duct large amounts of exhaust out of the building, can this waste heat be recaptured by a heat pump or heat recovery unit?

- **Is your facility in need of cooling?**

  Clearly, it's not ideal to heat up an area that you wish to keep cool. However, if you're unable to relocate your systems to a more efficient location, many customers have had success by strategically placing extraction ducting or hoods to capture the waste heat and remove it from the building before it can spread to other areas.

  We have also seen basic partition walls used to great effect to subdivide manufacturing spaces to keep hot machines together and away from machines that prefer to run cooler.

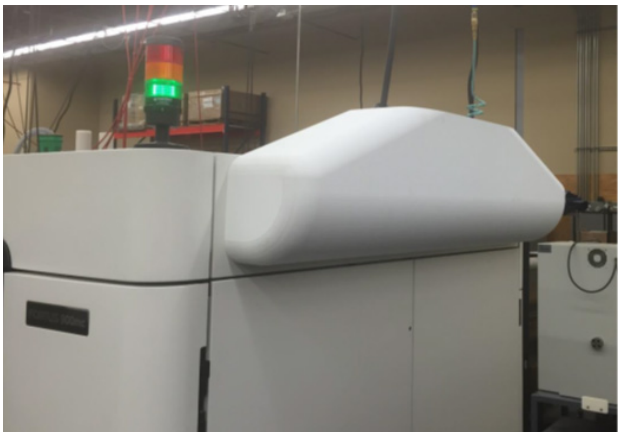


Figure 11. An F900 fitted with a custom printed duct to redirect hot exhaust gases towards external ducting.

Figure 12. A large industrial vent hood.

Figure 12 shows an example of an industrial exhaust hood that can be placed over a printer or the printer's exhaust ports in a non-contact manner to capture hot gasses and remove them from the building without adding any additional backpressure to the system's cooling system.

Customers should take care to match any external air extraction flow rates with the flow rate of the built-in ventilation system on the printer. Over- or under-extraction could alter the behavior and print quality of the system. To help prevent this, vents can be added to the coupler which sits between the machine and external ducting to provide a separation point in the system. Figure 13 shows an example of this type of coupler made with FDM additive manufacturing.

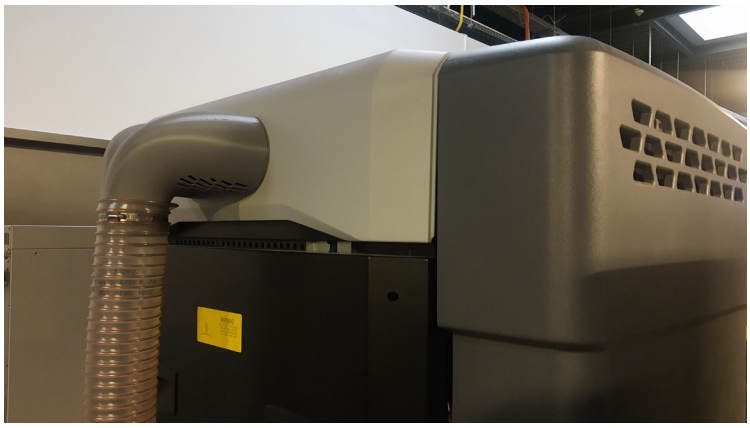


Figure 13. A 3D printed FDM coupler used to join the existing exhaust vents on a Fortus 450mc to an external air ducting system

Expert User Options

Removing Fortus Cameras and Cooling Air (Fortus Printers Only)

The internal camera that enables customers to remotely monitor their systems from anywhere in the world must be kept cool with a constant flow of compressed air. However, some customers may not require this function, and by removing the equipment from the system, it is possible to save six CFM of compressed air. Please contact your local Stratasys representative should you wish to implement this modification.

System Mode - Thin Wall Mode for High-Temperature Materials

When printing with high-temperature materials, thin-wall mode lowers the system oven temperature slightly. If you are carrying out serial production of a particular component, you may want to investigate if you can maintain your desired part quality at a slightly lower oven temperature. However, this may not be suitable for all geometries, resulting in a loss of part accuracy.

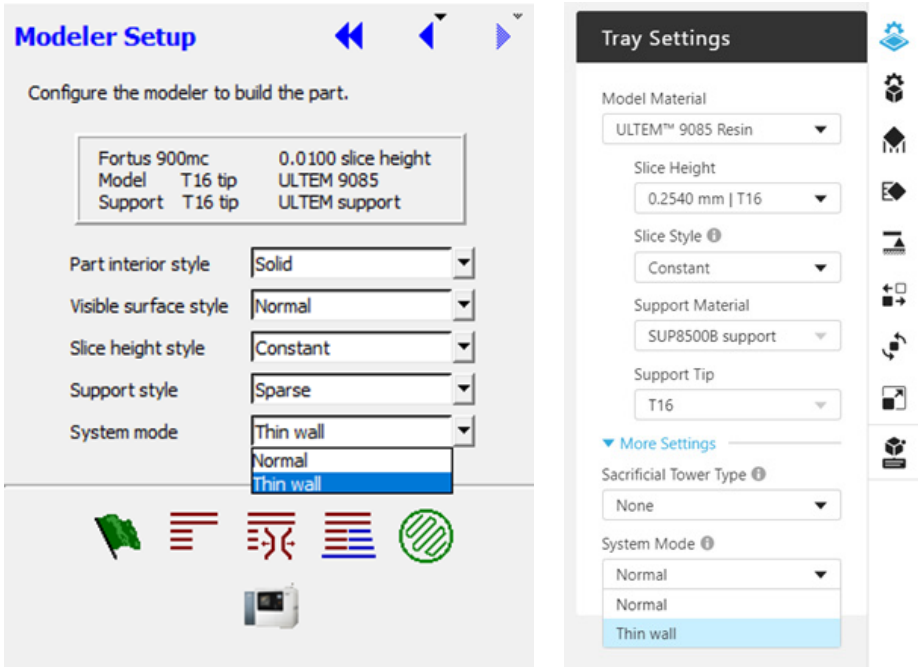


Figure 14. The ***Thin Wall Mode*** setting in (Left) Insight™ and (Right) GrabCAD Print™.

OpenAM™

OpenAM is software you can purchase for the Fortus 450mc that allows you to adjust print parameters to optimize material and print results. If you purchase this upgrade and plan on serial production of similar parts, you may want to evaluate if changing some advanced print tuning and oven settings can reduce energy consumption while maintaining part quality.

Conclusion

This solution brief offers several strategies to decrease energy consumption when printing with FDM technology. Stratasys recommends reviewing your system settings and build parameters to see how you can improve energy efficiency and increase or maintain productivity. For more information, contact your local Stratasys representative or application engineer.

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