Savastat Principles of Operation

If this system will save me 20% in energy costs, where is the wasted energy going now?

Answer:
This is an excellent question, and it raises many issues - the least of which is the whole concept of 'load compensation'.

Let’s begin by approaching the general question of 'compensation'.

The accepted form of compensation - weather compensation, is mandatory in the UK under our building regulations - it concerns the adjustment of system temperature (secondary loop - the water circulating the building and heat emitters).
For the purposes of this explanation let’s assume you have little knowledge of this.
The boiler flow temperature is fixed - typically 175°F. This flow will circulate a fairly short primary loop and be 'bled' into the secondary loop via a motorized valve. The 'intelligence' for this action is gathered via an outside sensor and the result is a variable secondary system loop temp.

I assume you agree with the 'concept' of weather compensation - how would this 'improve' a typical system - or to use your query - how would a system 'waste' energy if it didn't employ weather compensation?
Designers developed weather compensation to reduce space temperature overshoot which for the most part is caused by the differential of temperature between the space and the radiator/heat emitter.
When the load is high the heat emitter will pass heat more efficiently to the space - the differential is high. As the space temperature rises the differential decreases - but not by that much. So, once the space temperature has been achieved there is still too much heat within the system. To reduce this overshoot it would be wise to reduce the system temperature as the space temperature nears its set point. Flow sensors in weather compensation systems attempt to do this and in turn regulate the motorized mixing valve to regulate the primary loop contribution to the secondary loop.

Without this apparatus the building space temperature would vary about its set point - **wasting fuel**. The boiler would be producing unnecessarily high water temperature with regular firing - with the associated high level of waste - during ignition the majority of heat is lost via the flue due to **heat transfer inertia**. It is widely accepted that these losses can account for very **high levels of waste**.

You might argue that the boiler temperature could be reduced to overcome some of these problems - an important point!
The problem with this approach is that you need as much heat as you can get when the system is under heavy load - when the system starts at the beginning of each day - or when there is high demand on the domestic hot water side of the system (assuming the boiler is providing heat and hot water). So for it to a viable method you'd need to be able to 'regulate' the boiler thermostat.

Assuming we now accept the concept of 'weather compensation' there is an extension to the argument - that it is wise to make the boiler output 'adjustable'. If we accept the benefit of 'regulating' the flow temperature around the system, why not extend this concept to the primary loop. What 'extra' benefits might there be? Where would the 'savings' come from?

If we consider the 'modern' approach to new building design, a new build has the opportunity to leave old technology behind. The current design looks to 'drive' the boilers at varying temperatures. There would be no motorized valve as the boiler flow temperature would be directly regulated to suit the 'load'. This load is assessed by measuring the rate of temperature loss at the boiler return and the rate of flow temperature build up at the common flow header - in the case of multiple boilers.

The regulation of this type of system will make savings via the reduction in boiler firings and the reduction in overshoot. There would be a system over-ride to deal with the generation of domestic hot water - via dedicated pump and valve. In addition to the accepted efficiency measures described earlier - ignition losses, etc., there is another important benefit of this approach - **a boiler's efficiency is related to the differential between its output and the temperature of the water passing through it.** So it can be seen that if the primary loop temperature is allowed to drop (only by relatively small amounts 5 - 10 °F) there will be efficiencies in heat generation back into the system. We are NOT claiming to make the 'boiler' more efficient but we are claiming that when the boiler fires - due to the drop in primary loop temperatures, **the heat transfer will be more efficient.** This is one of the basic laws of thermal dynamics - heat flows to cold, and the speed/efficiency of this transfer is related to the temperature differential between the two objects.

If we look at existing systems and consider how we might be able to provide the benefits of the latter design and 'mix it ' with an existing system, - without dramatic changes to the 'plumbing' i.e. removing motorized valve etc., the easiest way would be to monitor the 'load' via return rate of loss and combine this 'intelligence' with the adjustment of mean temperature output from the boiler/primary loop. This can be achieved by holding the boiler off for periods of time, which are related to load/demand. By dropping the primary loop temperature related to load service to the space and hot water storage will be maintained (the existing controls continue to function as before Savastat LC is introduced) and the losses associated with unnecessary firings and transfer inertia reduced. That is how Savastat makes savings - by reducing flow temperature as, and when, it can. The rate of loss is computed twice per second to relate system output to load.

Savastat provides the benefits of direct acting load compensation without the need for extensive plant changes. Hence the results obtained when Savastat LC is applied even where 'weather compensation' already exists, as it applies another level of economy to the boiler output by reducing the average temperature of the primary loop, using the same argument as the primary function of weather compensation. There is no need to maintain such high primary temperatures when load is light. However, it is important that higher flow rates are available when the demand exists during start-up, etc.

All systems are oversized for 95% of their operating life. They have to be to deal with the extreme weather situations. The rest of the time this excess capacity provides the opportunity for 'fine tuning'. Load compensation is widely accepted as the best approach as it encompasses not only outside weather effect but also 'looks' at the internal load which constantly varies due to building use and hot water demands.
A recent 'scientific' paper on the subject is available from the UK Building Research Establishment (BRE) http://www.brebookshop.com/search.jsp?anywhere=b+crozier&publisher=&type= search under the following - Enhancing the performance of oversized plant <details.jsp?id=30948> Crozier B (2000) This an excellent work that describes the value of providing load related controls to oversized plant.

There is no 'one point' where Savastat makes economies, it is a combination of opportunities, and these will vary in each situation.