HYDRONIC SYSTEM BOILER TURNDOWN CONDENSING BOILER.

"By understanding condensing boiler operation and the basics of thermodynamics, one will realize that an extremely high-turndown burner on a hydronic condensing boiler does not promote the highest system efficiency, but actually can make the system less efficient."

Constant Speed pump scenario						
Boiler Input	**Firing Rate**	**Litre/Sec**	**Delta T**	**Supply**	**Return**	**Efficiency**
150kW	100%	2.4	15C	60C	45	96%
30kW	20%	2.4	3C	60C	57	93%
9kW	6%	2.4	1C	60C	59	84%

The scenario in the table above demonstrates the dynamics of constant speed pump on the return water and the efficiency of the boiler. As the Boiler modulates down additional excess air is required for satisfactory combustion; Natural gas condensing boilers is around 5% O_2. This correlates to flue gas dew point 54C. As the boiler modulates down (5:1) thus requiring more air, 10% O_2 so too the dew point drops requiring lower return water temperature to achieve the high levels of condensing performance.
In the table above the ultra high turndown is (16:1) note how significantly *the efficiency falls off*.

The common thought here would be to provide a variable speed pump, this would ignore the fact that the vast majority of ***condensing boilers are low water content***, and therefore have a minimum flow requirement which equates to 30% of maximum.
In the ultra high turndown scenario the pump would therefore be required to have a range varying from 0.36L/s (5C dT) to 2.4L/s (15C dT). In this instance we modelled a Multistage pump, the efficiencies went from 71% to 24% at a flow of .53l/s after that it fell of the curve. What is going on in the system at this point?
What heating application is going to require such a high turndown? As you can see what is evident in our endeavours to be more energy efficient we are becoming less efficient.

It is worth noting that the Modern Condensing boiler is designed for a modular system, this allows to "right size" the hydronic boiler for peak and low load conditions.
In your design consider adding boilers for several reasons, including redundancy & load matching to provide the correct system turndown.
Designing for system turndown select the smallest boiler first; this should be sized to handle the low load conditions at low fire. *A considered reasonable turndown is 5:1.*

ReF: Effects of Ulta-High Turndown S.Lobdell & B.Huibregtse 2014 Cleaver Brooks Article
Boiler Turndown Enough is enough b.Dawson 2012 Ashrea Article