

## Reducing Green House Gas Emissions via Efficient Coal Combustion

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### EXECUTIVE SUMMARY

The US consumes 1,100,000,000 tons of coal/year.

US coal consumption is estimated to increase by 33% by the year 2030, even with the growth of renewable energy sources.

We can burn coal more efficiently. Investing in efficiency enablers, such as Zolo's combustion sensor, provides dramatic return on capital on a \$/ton CO<sub>2</sub> reduced basis when compared to investing in wind or solar power.

A 1.25% increase in coal-fired efficiency across the US will do more to reduce green house gas, GHG, emissions than all of the currently installed wind and solar capacity combined.

Investing in Zolo's sensor, on a \$/ton CO<sub>2</sub> reduced basis is:

- 45 times more cost effective wind power
- 440 times more cost effective than household PV solar, without incentives
- 150 times more cost effective than household PV solar, with incentives

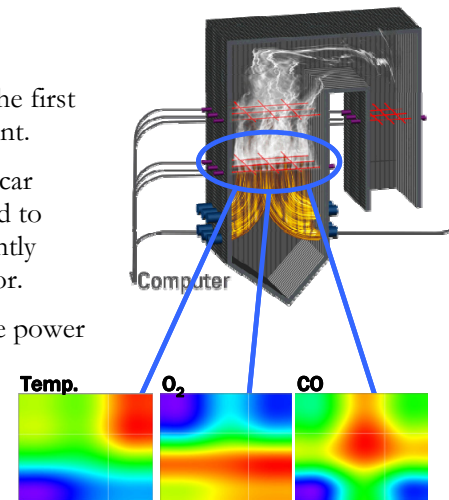
### BACKGROUND

Zolo Technologies has developed a unique laser-based sensor that, for the first time, directly measures the combustion process in a coal-fired power plant.

Fuel-injectors, which rely on sensors for oxygen, timing, etc., to control car engines, have dramatically increased engine performance when compared to carburetors. In an analogous sense, coal-fired power plants can significantly improve the performance of their boilers given Zolo's combustion sensor.

The combustion zone measurement images on the right demonstrate the power of Zolo's sensor: even a non-expert can immediately see that the distributions are asymmetrical; and non-symmetry equates to sub-optimum performance.

In addition to improving efficiency, and thereby concomitantly reducing GHG emissions, the ability to measure the combustion process *in situ* also enables the drastic reduction of other pollutants such as NO<sub>x</sub>, where a 25% decrease has been documented.



### WHY IS THIS IMPORTANT?

The public perception in America of the impact of GHG emissions has undergone a dramatic change, and America is now gearing up to address a tremendous challenge: reducing our carbon footprint. In parallel, America is also placing additional emphasis on reducing our strategic dependence on foreign supplies of natural gas and oil; fuels that will have to be replaced by less GHG efficient coal.

While we at Zolo Technologies fully support all efforts to transition to a carbon-free economy, current reality dictates that, in the short term, America's carbon footprint will increase, and that a large part of this increase will come from burning coal. The US Energy Information Administration's latest estimate <sup>i</sup> shows that coal consumption in the US will **increase** by 33% between the years 2006 and 2030, even with the predicted growth in renewable energy sources. And, to put this number in perspective, the US already consumes a staggering 1,100,000,000 <sup>ii</sup> tons of coal/year.

At Zolo, we believe that until such time as America can replace coal with cleaner energy sources, we must:

**Burn coal as efficiently as possible, with as few emissions as possible, starting today.**

### **COAL CONSUMPTION VS. RENEWABLE ENERGY**

The attention being paid to the newer renewable energy sources, wind and solar, is very encouraging. However on a macro-economic scale, wind and solar provides for just 0.28% of US energy consumption. Coal accounts for 23% <sup>iii</sup>. A different way of stating this is that a 1.25% increase in coal-fired efficiency will do more to reduce GHG emissions in the US than all of the installed wind and solar capacity combined. We believe, based on our experience, that a 1.25% increase is, if anything, conservative.

### **COST OF CLEANER COAL COMBUSTION VS. WIND POWER**

In order for the US to significantly reduce its carbon footprint, many different avenues and technologies will have to be pursued in parallel; there is no silver bullet. Wind and solar power are, justifiably, receiving a great deal of attention, and are favored by current tax and incentive structures. We at Zolo fully support these efforts; however, we wish to highlight the benefits that can be achieved by incentivizing coal-fired power plants to operate more efficiently. We believe that Zolo's sensor can enable efficiency improvements of up to 3% at coal-fired power plants, and are in the process of documenting actual results. However, assuming the ZoloBOSS can enable a 1% efficiency increase at an average sized coal-fired boiler <sup>iv</sup>, investing in Zolo's sensor, on a \$/ton CO<sub>2</sub> reduced basis is

**45 times more cost effective than investing in wind power**

### **COST OF CLEANER COAL COMBUSTION VS. SOLAR POWER**

Zolo Technologies is located in Boulder, CO, one of the more ideal locations in the world for PV solar technology. In Boulder, a 3 kW household PV system, prior to utility rebates and tax rebates, costs \$7,600/kW <sup>v</sup>. Even after rebates and tax credits, the cost is \$2,560/kW. Using the same assumptions as in the paragraph above, investing in Zolo's sensor, on a \$/ton CO<sub>2</sub> reduced basis is

**440 times more cost effective than investing in PV solar without incentives**

**150 times more cost effective than investing in PV solar with incentives**

Reducing the carbon footprint in the US will be a tremendous challenge and requires pursuing many different alternatives. While we are absolutely in favor of the attention that is being given to renewables, we believe that insufficient attention is being paid to improvements that can be made **today** to the existing coal-fired energy infrastructure.

On behalf of the Zolo team,

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<sup>i</sup> Energy Information Administration (EIA). <http://www.eia.doe.gov/oiaf/aeo/pdf/appa.pdf>

<sup>ii</sup> Energy Information Administration (EIA). <http://www.eia.doe.gov/oiaf/forecasting.html>

<sup>iii</sup> Energy Information Administration (EIA), <http://www.eia.doe.gov/neic/infosheets/renewableenergy.html>

<sup>iv</sup> 600 MWe boiler, 85% capacity factor. 1,500 \$/kW capital cost for wind power, 30% capacity factor

<sup>v</sup> SimpleSolar, Boulder, CO, quote dated September 1<sup>st</sup>, 2007. 4,300 kWh per year produced.