CUTTING HEATING BILLS:

EFFICIENCY, SOLAR AND INSULATION

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Summary

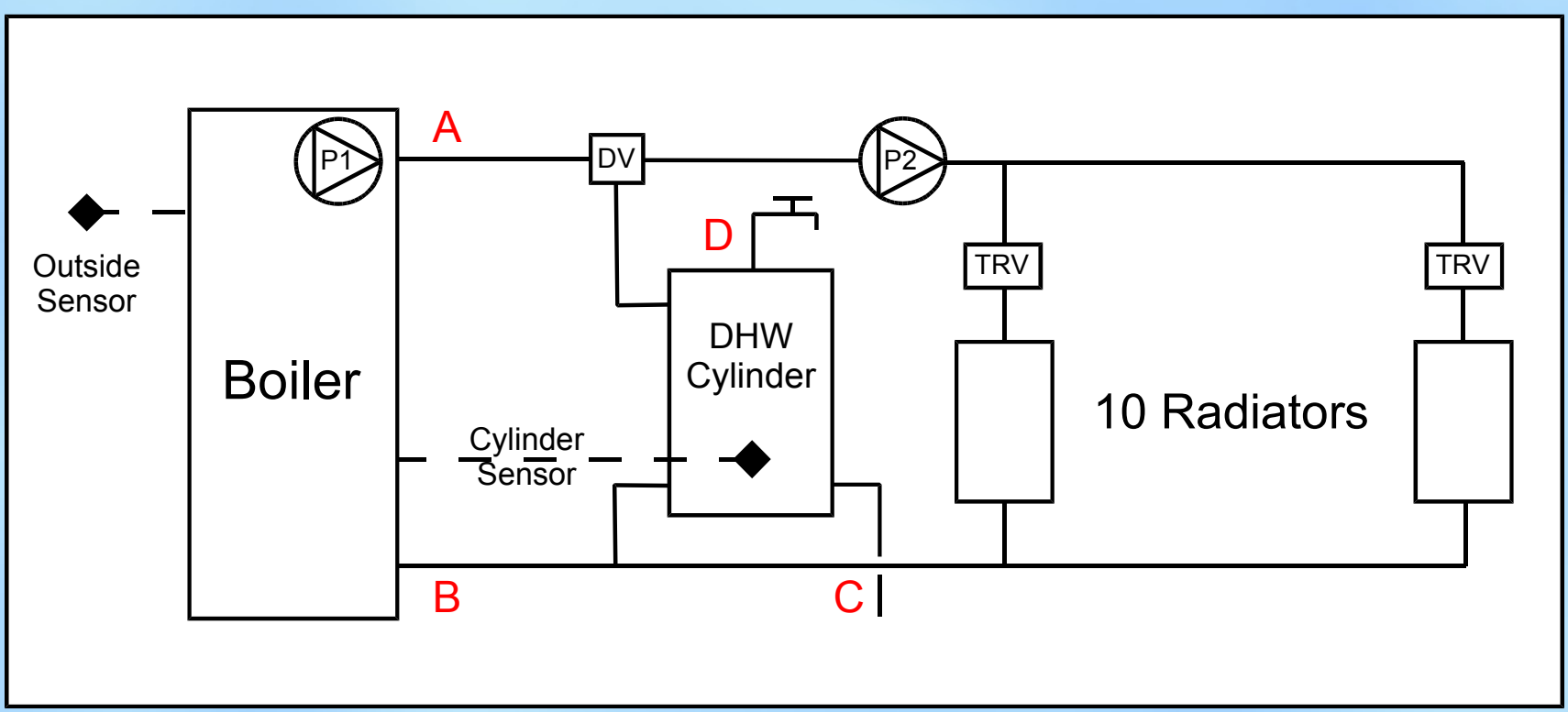
- Measurements and Data Logging
- Design for High Boiler **Efficiency**
- Boiler Performance and **Efficiency**
- House Heat Loss and **Solar Gains**
- Heat Loss Reduction with **Insulation**

The Test House

The Test House

- 2-storey, 4-bedroom, ~ 100 m^2 floor area
- Floor – concrete, no cellar, no insulation
- Walls – brick, cavity of ~ 50 mm, UF foam
- Windows, doors - uPVC frames, double-glazed
- Roof – tiled, ~75 mm mat, later + ~170 mm mat

The Heating System



P1, P2 Pumps, DV Diverter Valve, TRV Thermostatic Radiator Valves

A & B - Boiler Heat Meter, C & D - Domestic Hot Water Heat Meter

Boiler and Instruments

1 Boiler, 2 Rain Gauge, 3 Electricity sub-meter, 4 Heat Meter-Boiler, 5 Heat Meter-DHW, 6 Screen of Data Logger PC.

PCs and Data Logger

Efficiency via Boiler Sizing

- Combi boiler must be ~ 30 kW, sized for DHW
- System boiler needs storage cylinder for DHW
- System boiler can be 10 to 15 kW, sized for CH
- Lower output boiler is smaller, quieter and cheaper
- And can be more efficient at given load

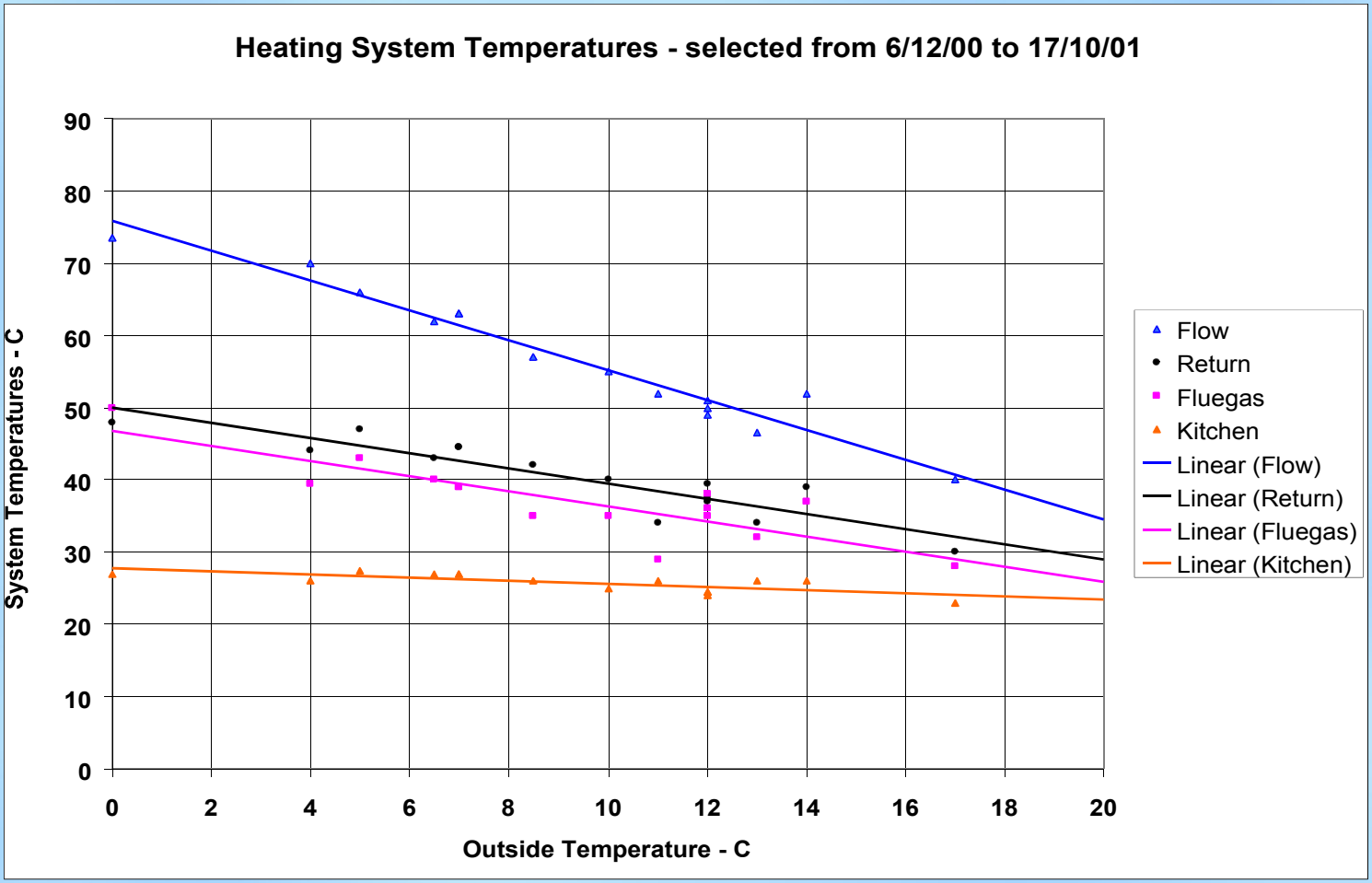
Efficiency via Radiator Sizing

Added 2, upsized 3, now 10. Connected TBOE

Efficiency and Solar etc. via Controls

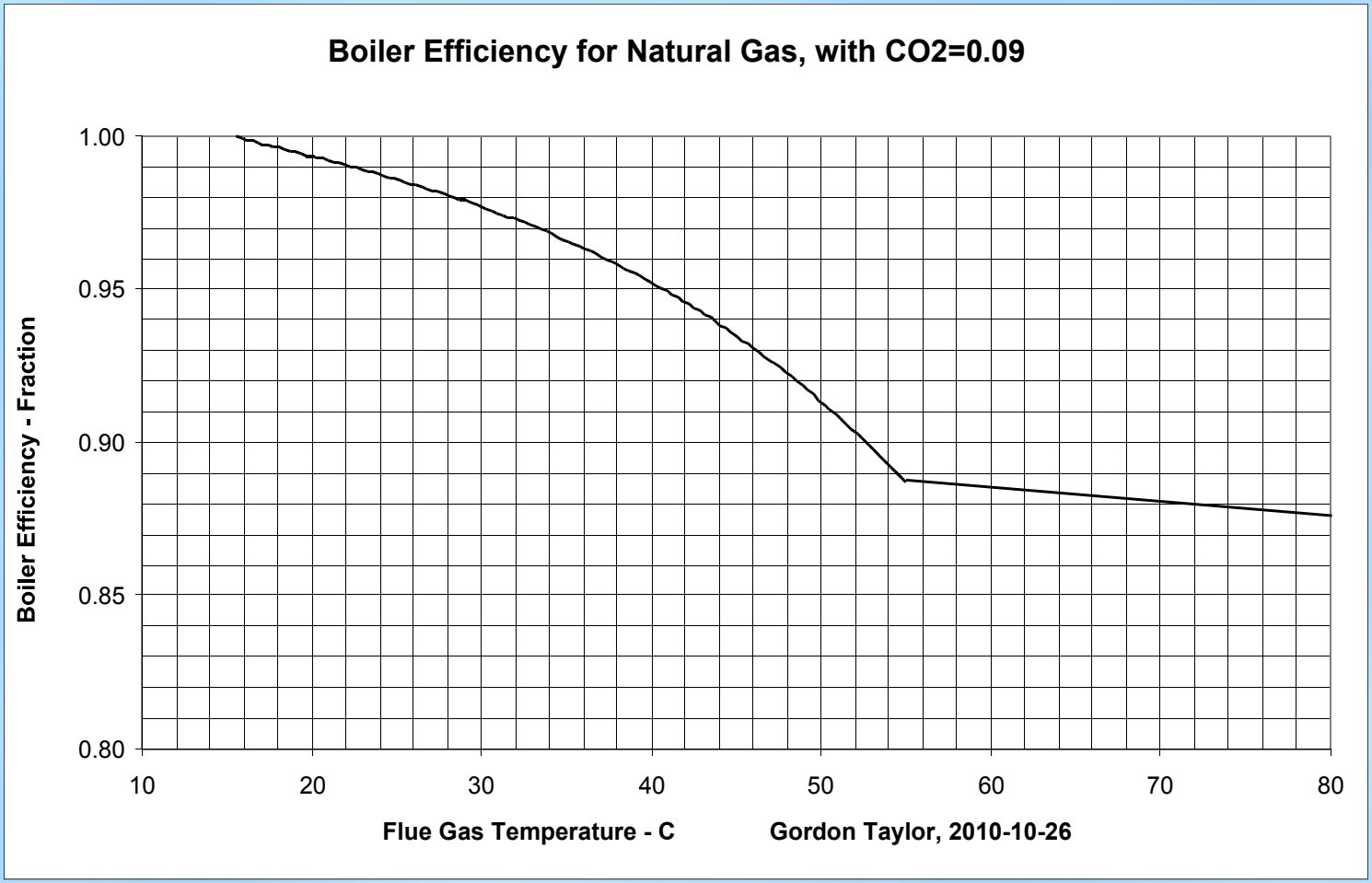
- The Time Constant of most homes is > 24 h
- So Time Control lowers boiler output and efficiency
- A Single Thermostat cannot give comfort in each room while harnessing Solar and Internal gains
- An Outside Compensator raises boiler efficiency
- TRVs in each room can give required comfort while harnessing Solar and Internal gains

Outside Compensator Control



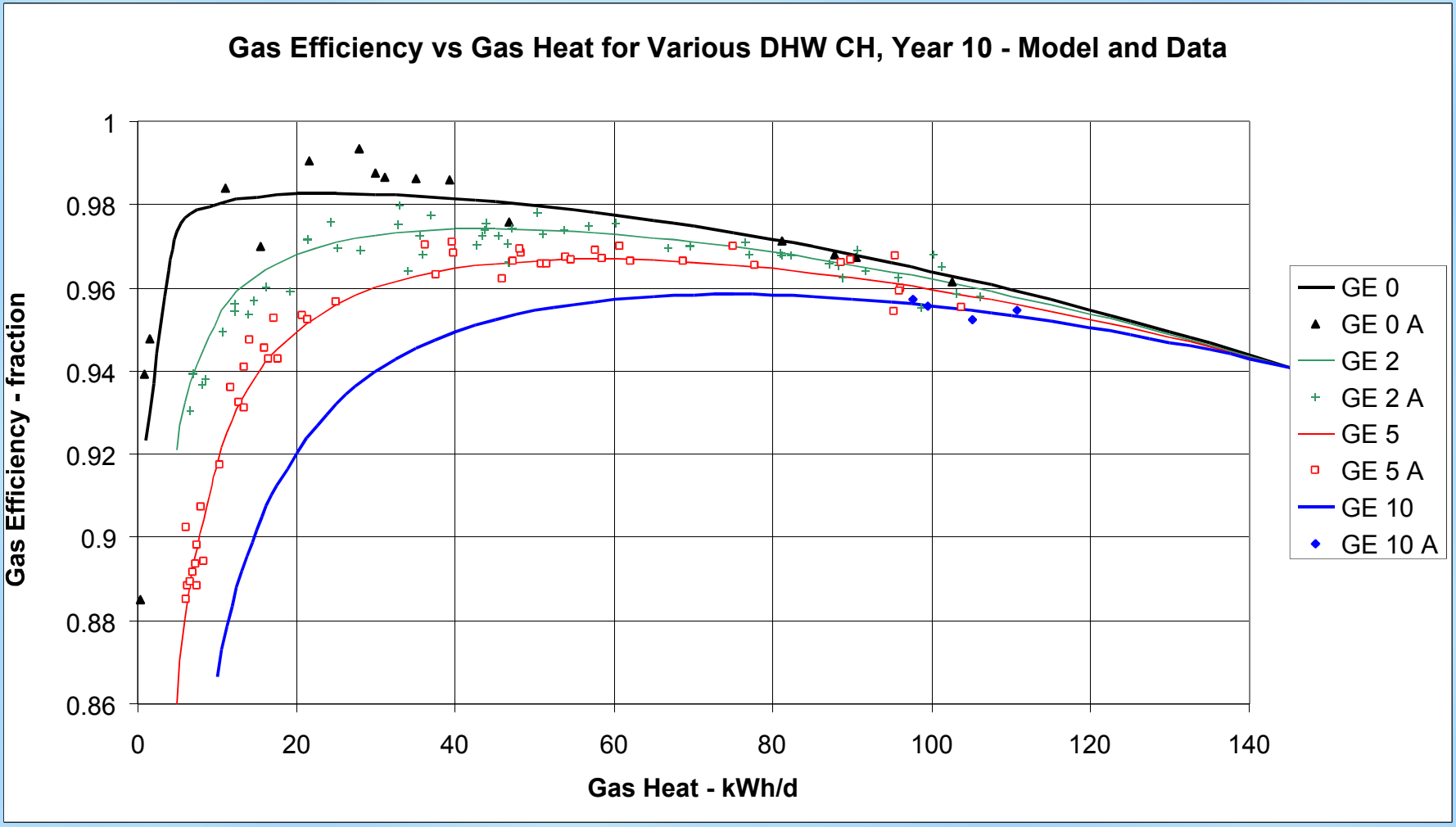
Low Boiler Return to give Low Fluegas Temperature

Boiler Efficiency via Return Temperature



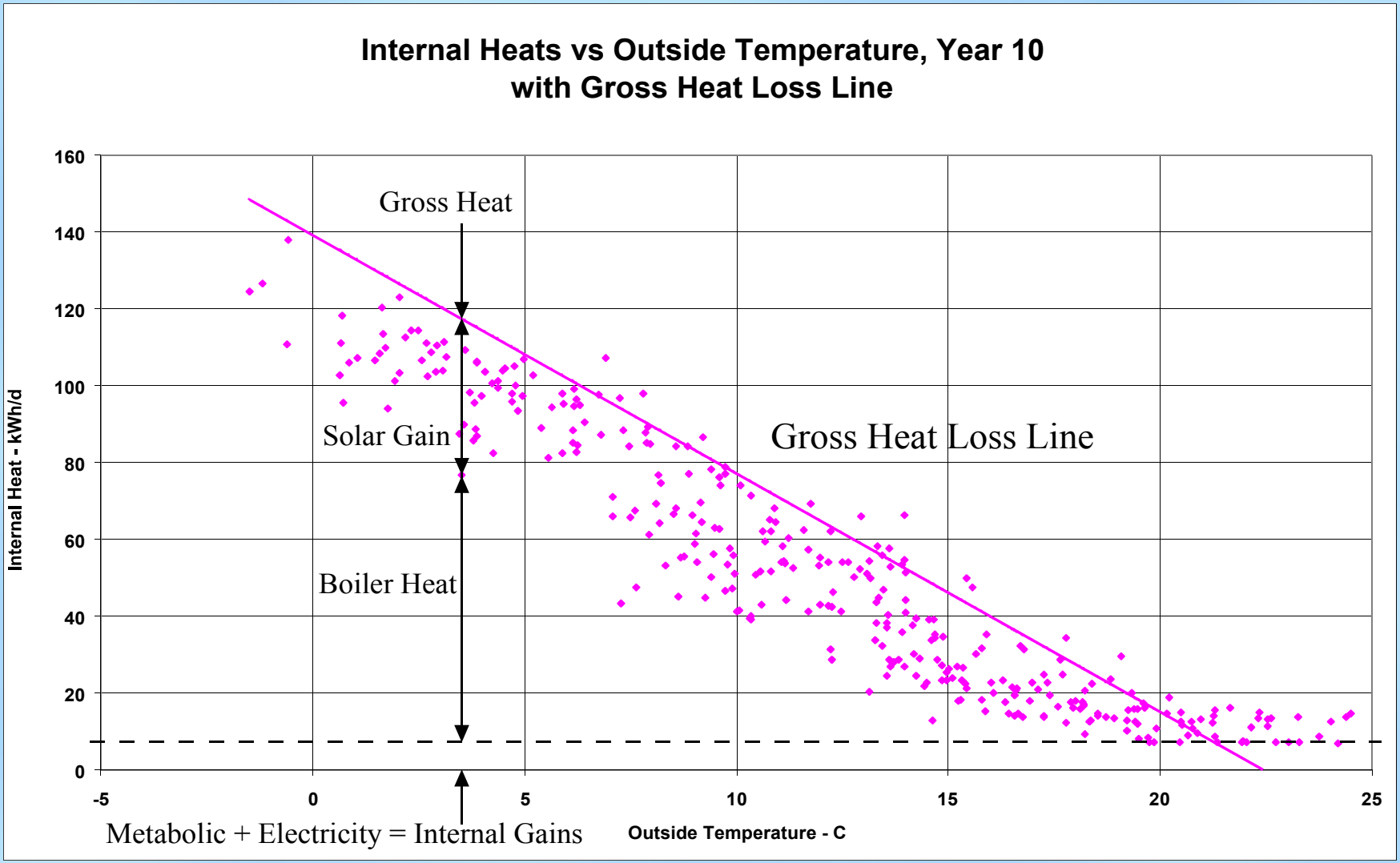
Low Fluegas Temperature to give High Boiler Efficiency

Boiler Efficiency vs Space and Water Heat Loads

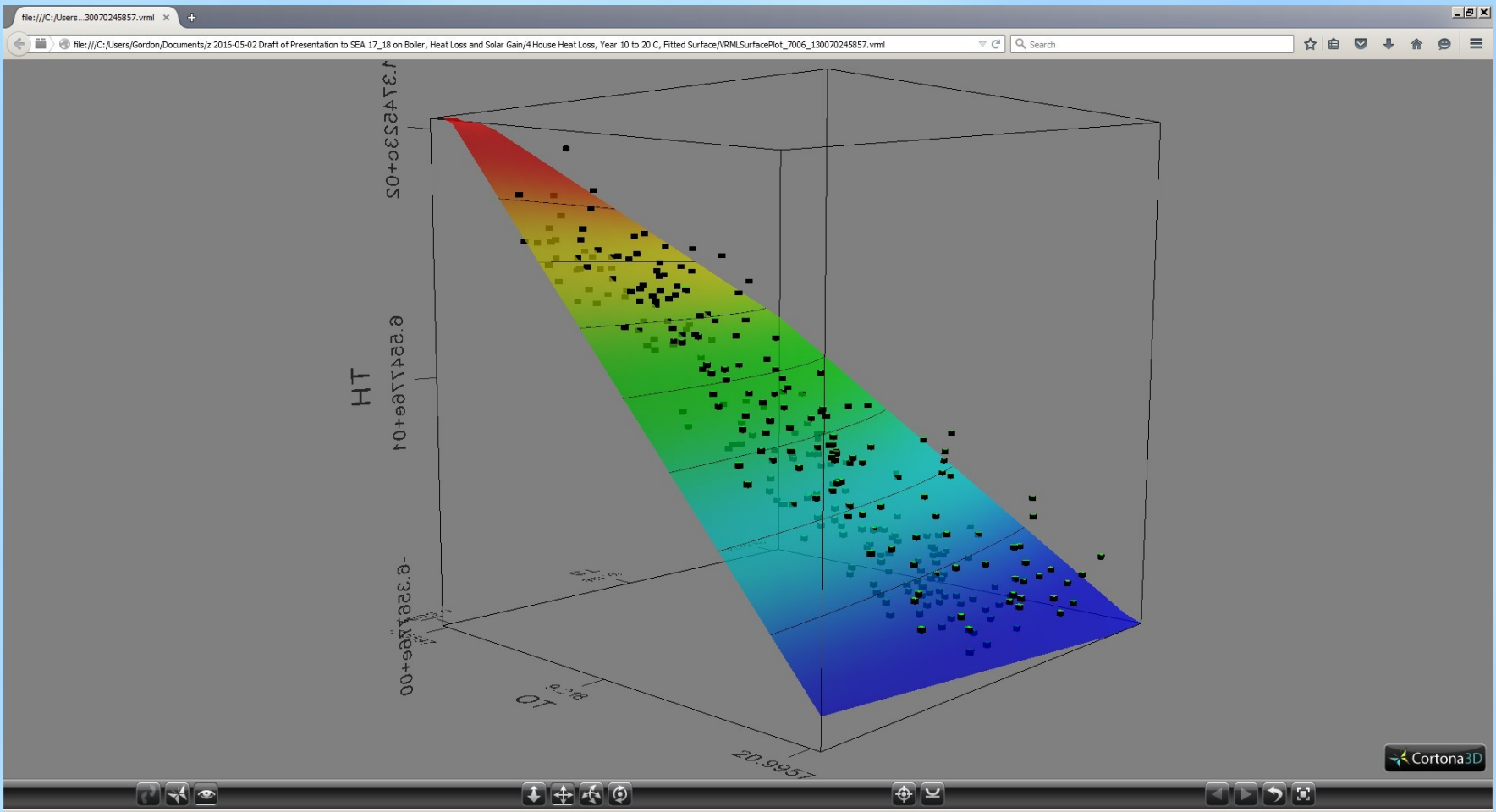


Effy can > 98% at DHW=0 & can = 96% at DHW=10 kWh/d

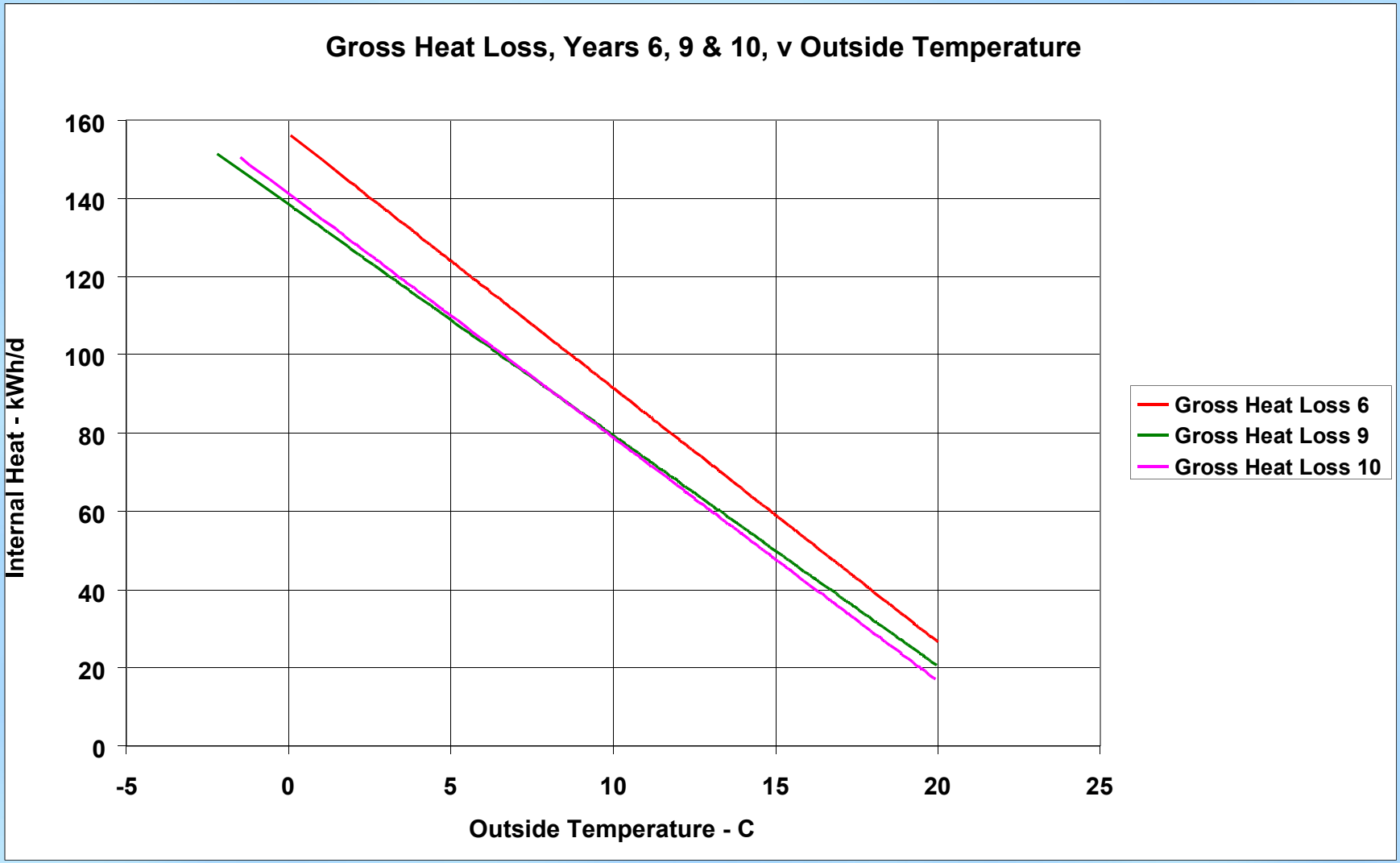
Daily Heat Flows vs Outside Temperature



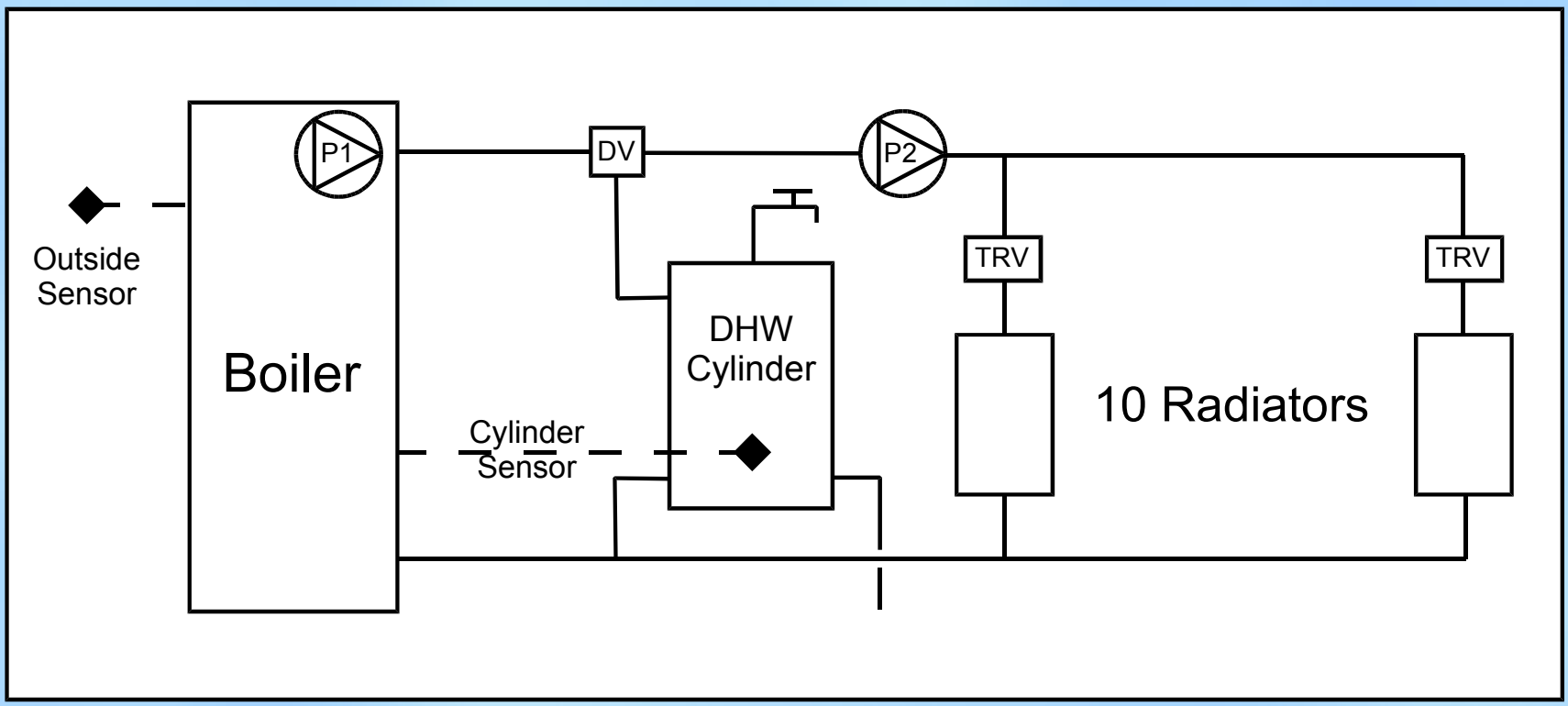
TH, OT, TS for year, with Fitted Surface



Years 6 (Before), 9 and 10 (After)



Heating System Hydraulic Diagram



P1, P2 Pumps, DV Diverter Valve, TRV Thermostatic Radiator Valves

Heating System Pumping

- Heating power – CH ~ 5 kW, DHW ~ 20 kW
- Assume Temperature Differences CH, DHW are equal
- Then Flowrate ratio – CH:DHW = 1:4
- Assume System Resistances CH, DHW are equal
- Then Pumping power ratio – CH:DHW = 1:64
- Hence scope for low energy pump for CH

Added Low Energy Pump for CH

CH ~ 99% of time, Hydraulic Power ~1 W, Electric Power 5 W

Results of Measurement and Analysis

- Average Gas Thermal **Efficiency** ~ 96% (HHV basis)
- Average **Solar** Gains ~ 20% of Gross Heat energy
- Average Internal Gains ~ 12% of Gross Heat energy
- Gross Heat Saving from Increased **Insulation** ~ 13%
- Average ratio DHW-CH: (CH + DHW-CH) ~ 7.4%
- Boiler Electricity Saving from New Pump ~ 75%

Overall Results

- House Gross Heat Loss at 0 C ~ 5.8 kW
- Target Temperature in Lounge, Kitchen ~ 23 C
- Annual Gas Consumption ~ 19,000 kWh
- Annual Electricity Consumption ~ 1700 kWh
- Annual Gas + Electricity Bill ~ £ 876

Options for Zero-Carbon Buildings

- Biogas, but UK potential is only 14% to 50% of homes and...
- **Insulation**, but for existing buildings saves only ~ 30%
- **Efficiency** (CHP, ~ 330%) & **Solar** (renewable heat):

  Saves ~ 80% with networks – District Heating (DH)
- **Solar** (etc), **Insulation** & MVHR for new buildings:

  Saves ~ 80% – Passivhaus (PH)

Thank you!

Any comments and questions?

Measuring the Heat Losses and Solar Gains of Buildings
http://cms.energypolicy.co.uk/heat/268