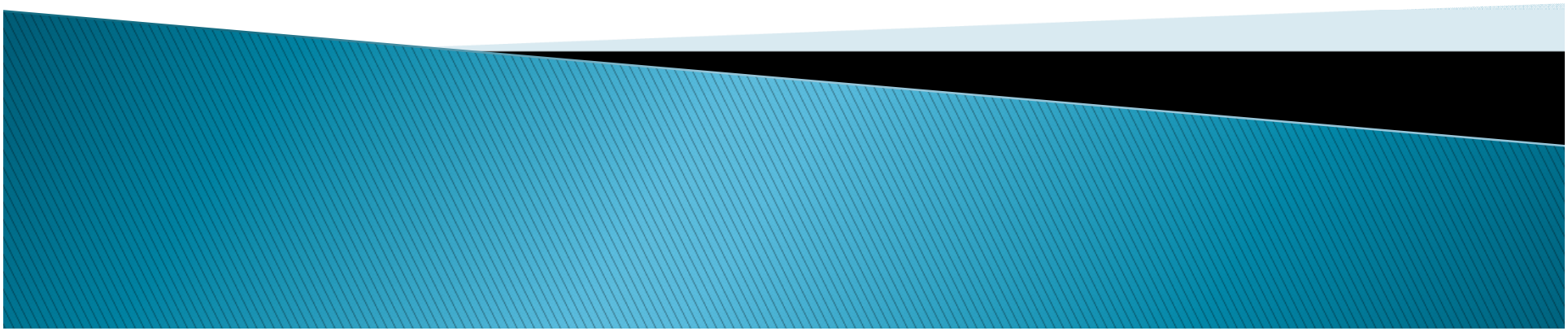
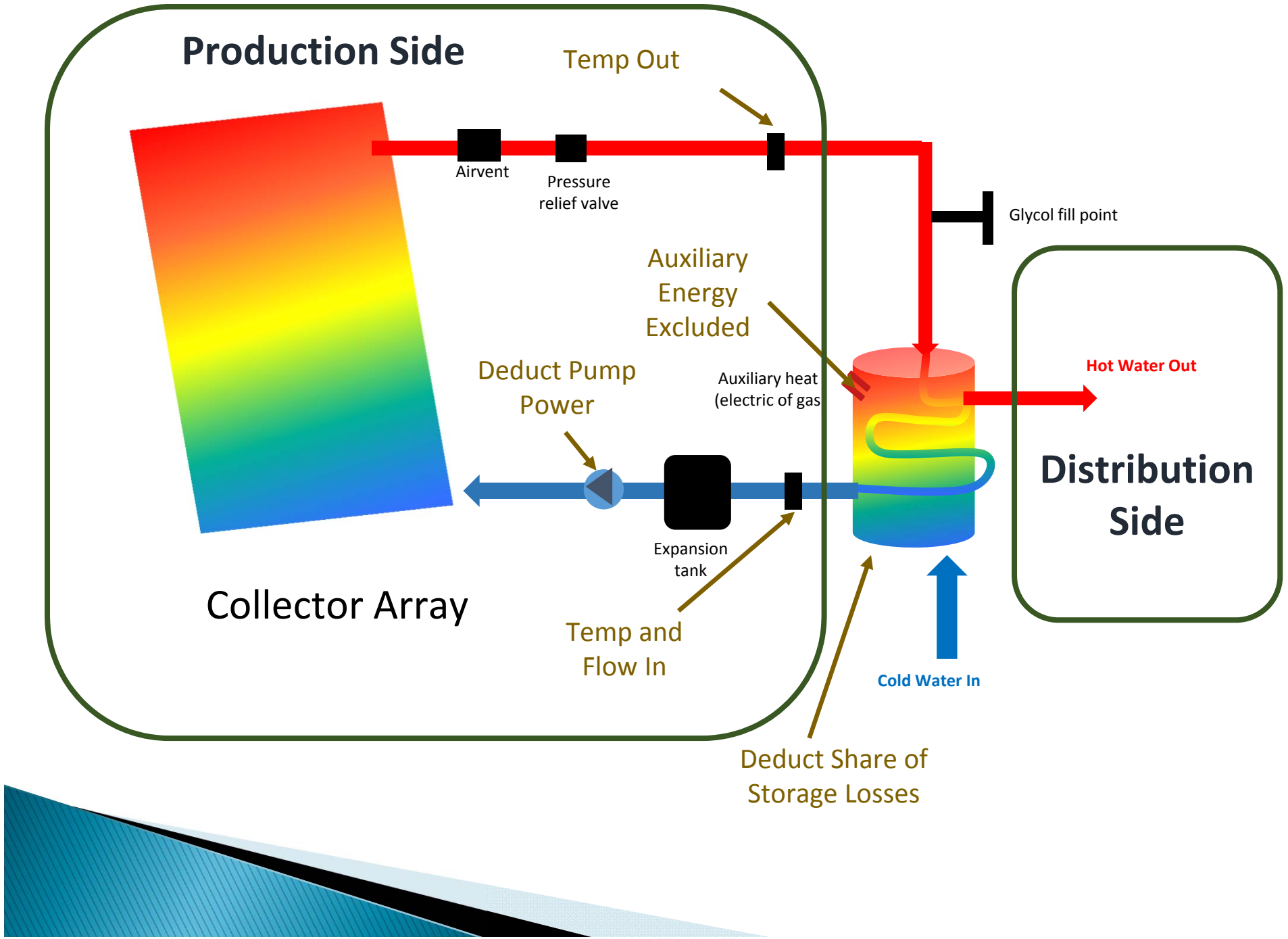
Solar Thermal Energy

Metering Methods and Options




Production Side
Temp Out
Airvent
Pressure relief valve
Glycol fill point
Auxiliary Energy Excluded
Deduct Pump Power
Auxiliary heat (electric of gas
Hot Water Out
Distribution Side
Expansion tank
Collector Array
Temp and Flow In
Cold Water In
Deduct Share of Storage Losses

Thermal Metering Production

- Continuous Metering – Solar Collector Loop
  - Temperature sensors installed close to thermal storage (loop inflow and outflow)
  - Flow meter near storage outlet to array
  - Accuracy to **match** EN1434 (ASTM Standard in progress)
- Thermal Generation formula

$Q_g = m*cp\ (To - Ti)$

Q_g = heat generated in the collector loop (BTU)

m = mass flow of the collector working fluid measured near the inlet to the solar storage tank (lbs/hour)

cp = specific heat of the working fluid (Btu/lb-F)

Ti = collector loop inlet temperature measured near the outlet from the the solar storage tank (F)

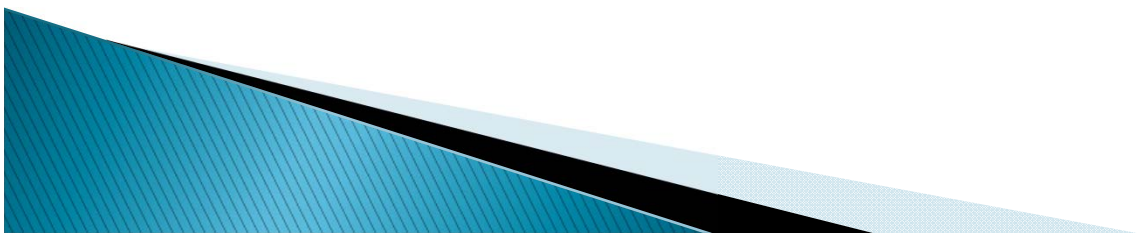
To = collector loop outlet temperature measured near the inlet to the solar storage tank (F)

Thermal Metering Adjustments

- Coefficient for solar storage losses
  - Coefficient determines solar share of tank losses
  - Primary method relies on tank certification data
  - Secondary method allows for onsite performance test
- Thermal Loss Coefficient formula (Certification Data)

Thermal storage standby loss factor (SLF) can be easily and reasonably accurately estimated from the storage tank manufacturers AHRI certification data for the Energy Factor (EF) and Recovery Efficiency (RE):

SLF = 1- EF/RE (Fraction of heat delivered to storage that is lost to environment)



Thermal Metering Adjustments

- Coefficient for Solar Loop Pumping Power
  - Coefficient determines pump energy consumed to produce solar thermal energy
  - Method relies on onsite performance test
- Pump Energy Coefficient formula

$dE/dQ = Vm*Am * t / Qg$

dE/dQ = Rate of electrical energy consumed by the pump per unit of heat generated (Wh/BTU)

Vm = measured voltage at the pump terminals (Volts)

Am = measured current flow to the pump averaged for the test period (Amps)

Q_g = heat generated/extracted in the collector loop for the test period (BTU)

t = total time in the test period (hours)

Thermal Metering – Net Useful Energy

- Net Useful Solar thermal energy delivered to distribution
  - Gross production continuously metered
  - Pump and Storage corrections to determine energy to distribution interface
- General Equation for Net Useful Thermal Energy

Q_u (net) = Q_g – Q_g*SLF(tank) – Q_g*dE/dQ(pumps)*k

Where:

Q_u (net) = Net useful thermal energy delivered (BTU)

Q_g = useful energy generated in the collector loop (BTU)

SLF(tank) = Standby Loss Factor for the thermal storage tank

dE/dQ(pumps) = Rate of Energy consumed by collector loop pump per unit of heat generated (Wh/BTU)

k = 3.412 BTU/Wh direct conversion factor

Exceptions/Additions

- Multiple Storage tanks require multiple thermal loss factors
- Custom storage tank installations may need to use secondary method (on site test procedure for loss coefficient)
- Small DHW system option – metered system operation time correlated with calculated energy production