Revisiting Control, Storage & Backup for a solar cooling system with 1^{e} absorption chiller

Ali Shirazzi, Stephen White & Rob Taylor

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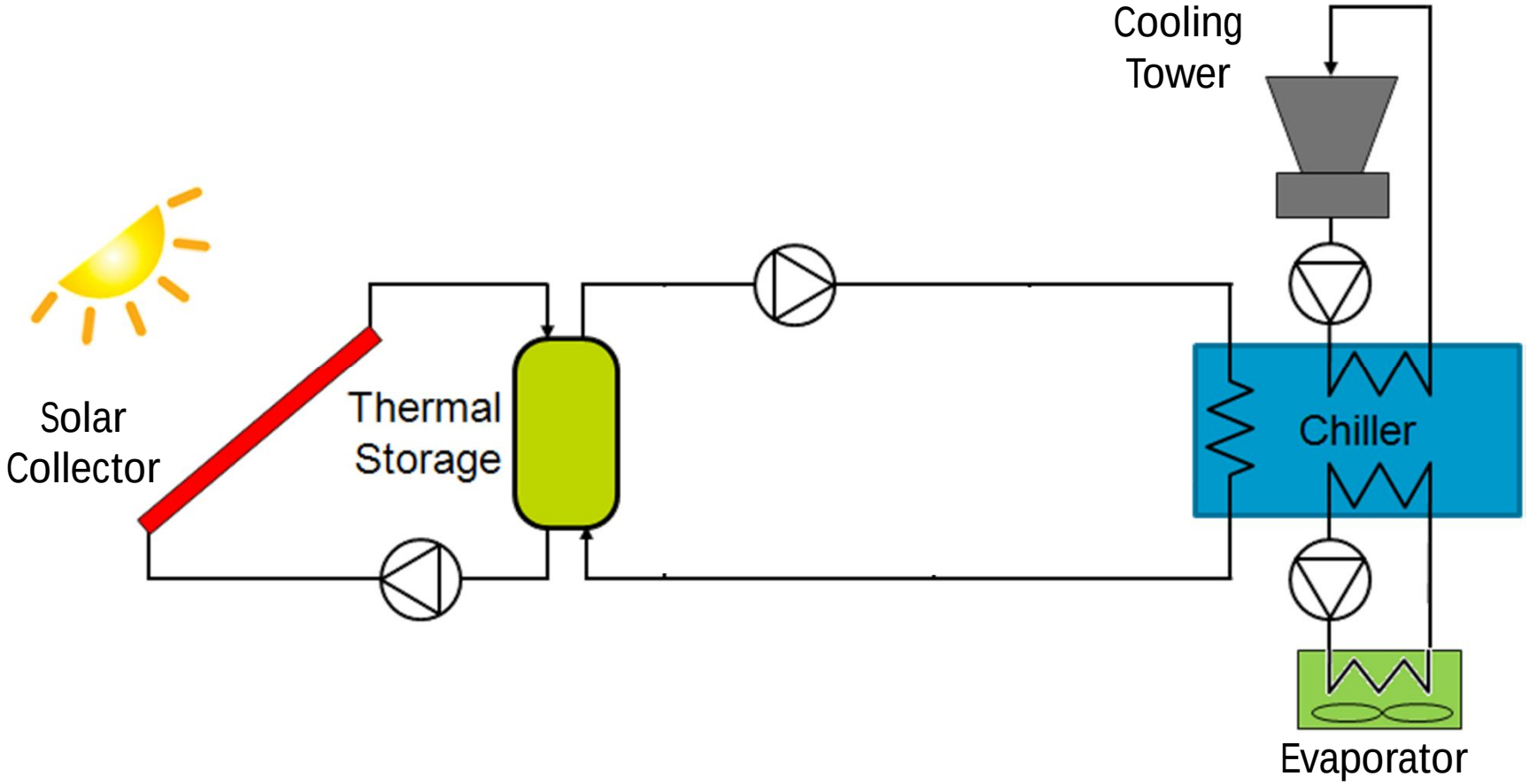
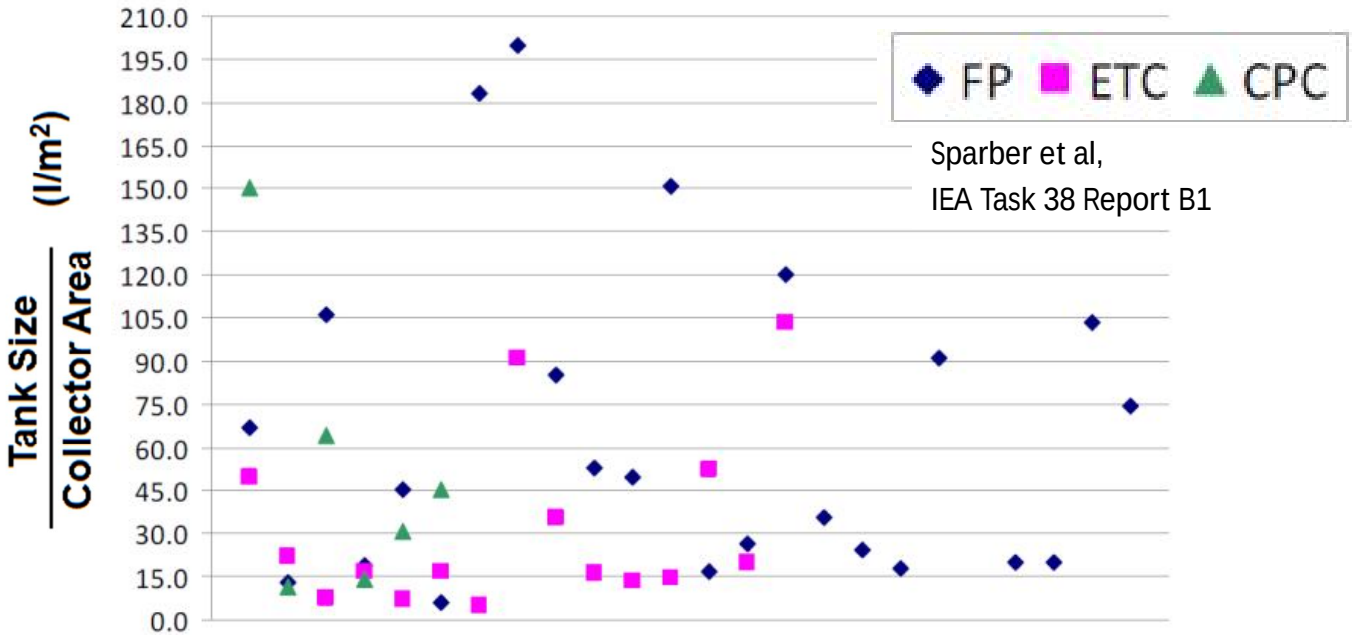
Generic flow-sheet for matching an intermittent heat source and a variable demand for cooling



Aim

- How much storage is the right amount ?
- What is the best control strategy ?
- What is the best gas booster flowsheet ?



Sparber et al,
IEA Task 38 Report B1

TRNSYS Model Scenarios

- **Sydney hotel:** (maximum cooling demand = 1000 kW, no potable hot water)
  - 24 hr a day load **or**
  - 7am to 6pm load
- **1023 kW single effect chiller**
- **Evacuated tube or flat plate collectors**
- **Gas burner backup in series or parallel**
- **Tank insulation** (0 to 30 kJ/hr-m2-K)
- **Parametric sensitivity**
  - $1 < m^2/kW < 5$
  - $10 < l/m^2 < 180$

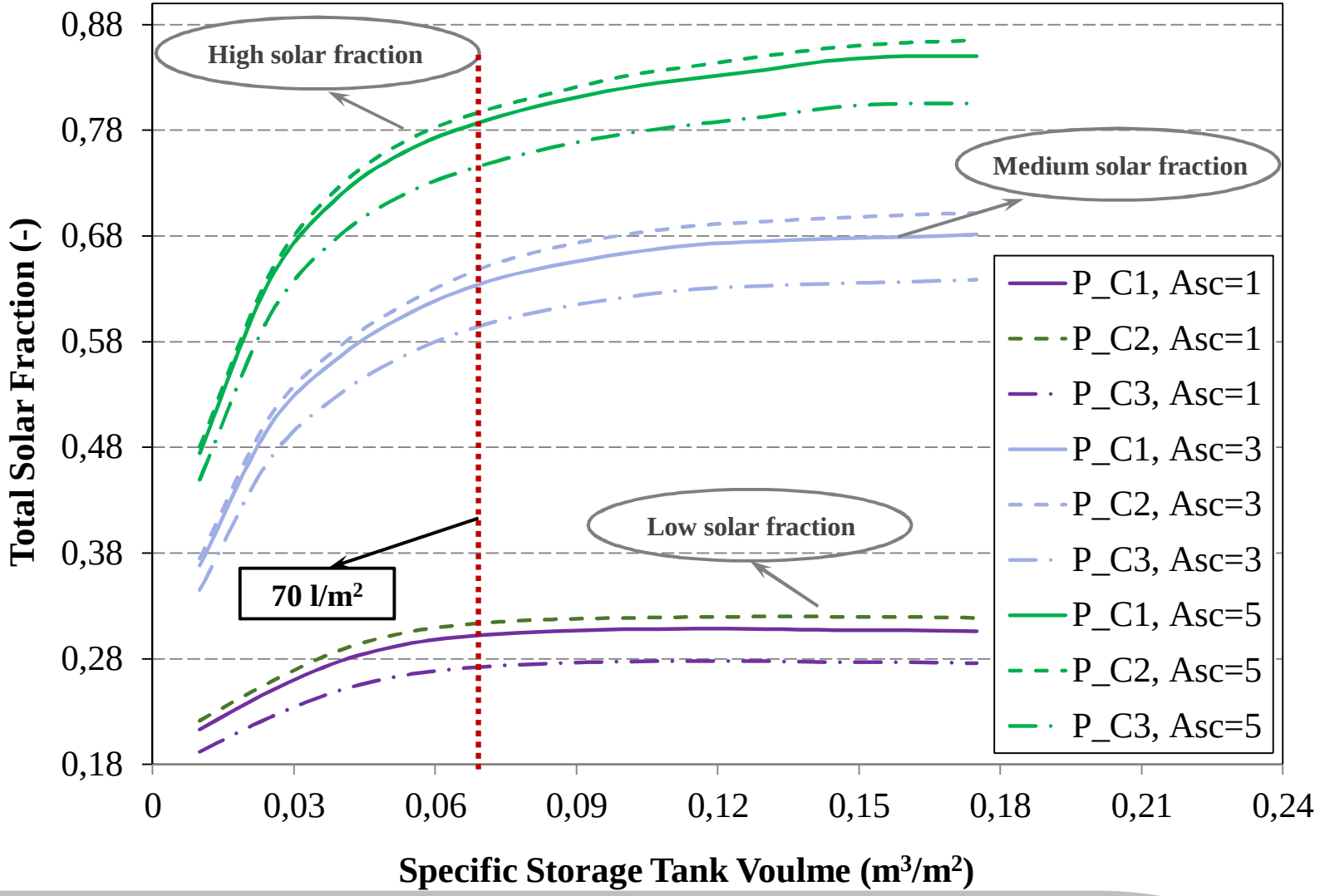
➢ Optimising solar fraction

(shifting to chiller capacity utilization)

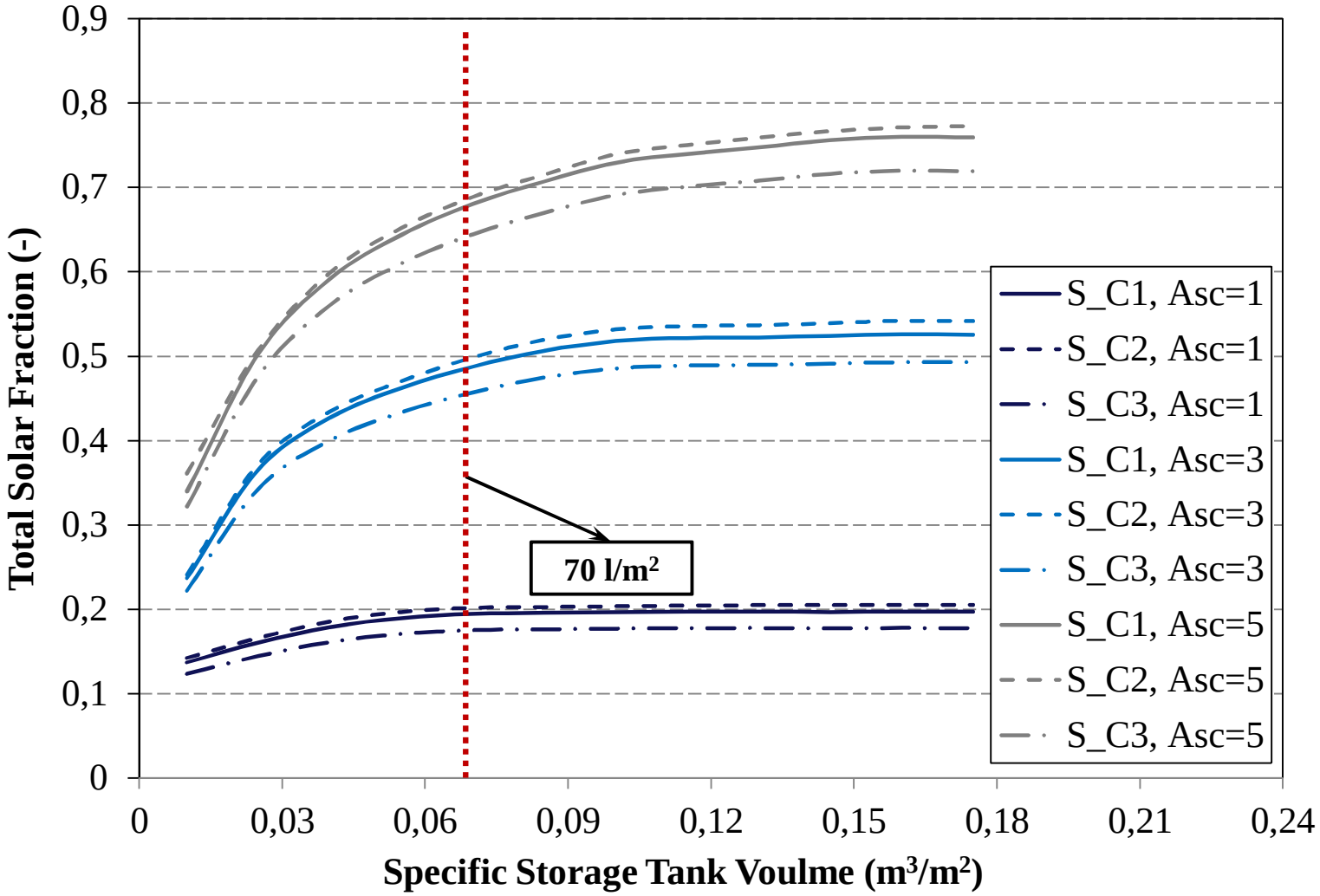
Collector Control Loop Options

- **C1**: Fixed collector outlet temperature *with a VSD pump*:
  - collector set point temperature:100 °C (summer), 70 °C (winter)
  - Pump is off if G < 150 kW/m^2 or $\Delta T < 3K$
- **C2:** Variable collector outlet temperature *with a VSD pump*:
  - Pump is off if radiation < 150 kW/m^2 or $\Delta T < 3K$
  - Set point temperature $= T_{gen} + 5°C$
- **C3:** Single speed pump *with an on/off controller*
  - Pump is on if $\Delta T < 5K$ and off if $\Delta T < 2K$

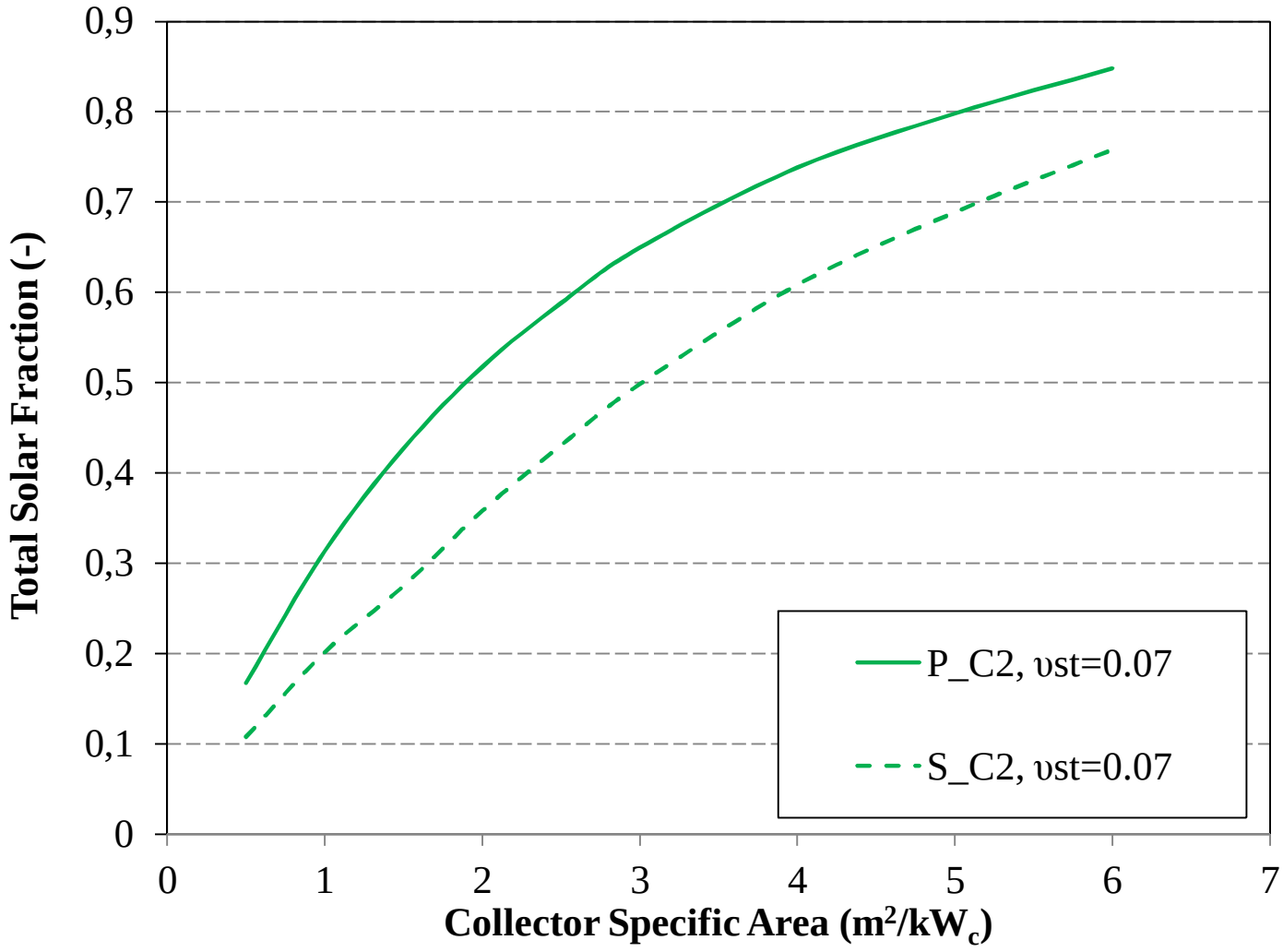
Parallel burner/ Evacuated tube/ 24 hr a day load



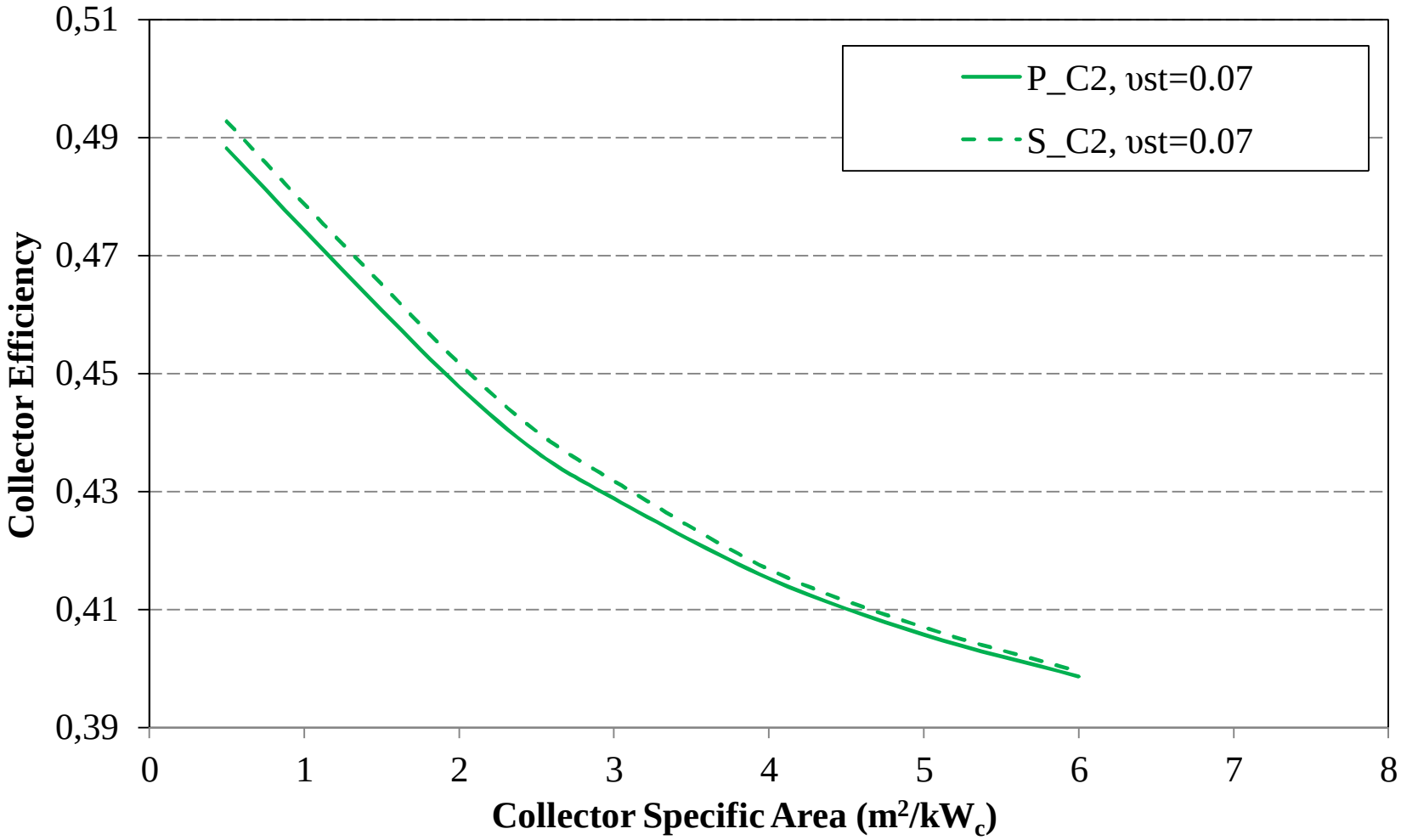
Series burner/ Evacuated tube/ 24 hr a day load



Series vs. parallel gas burner

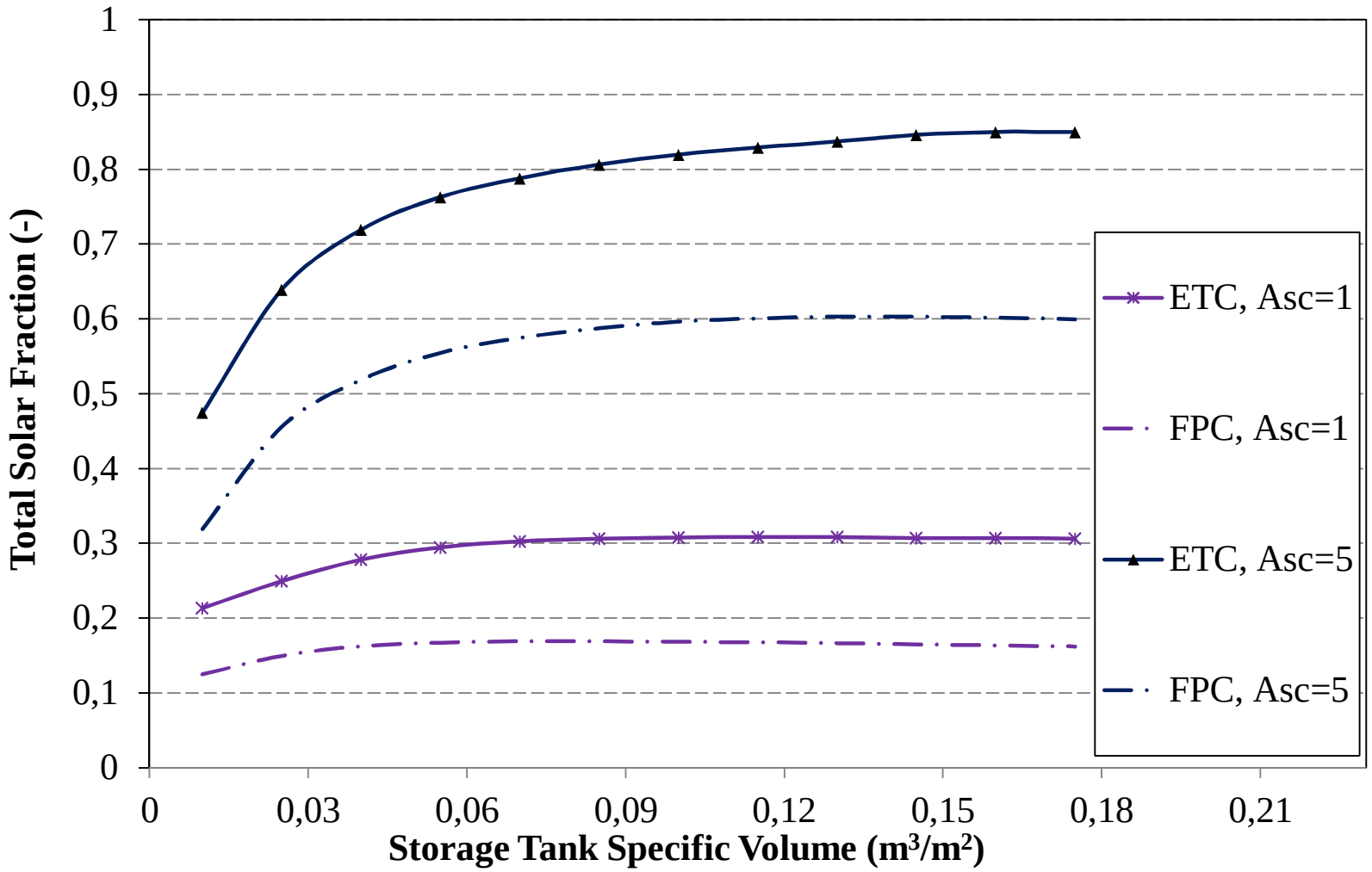


Series vs. Parallel collector efficiency

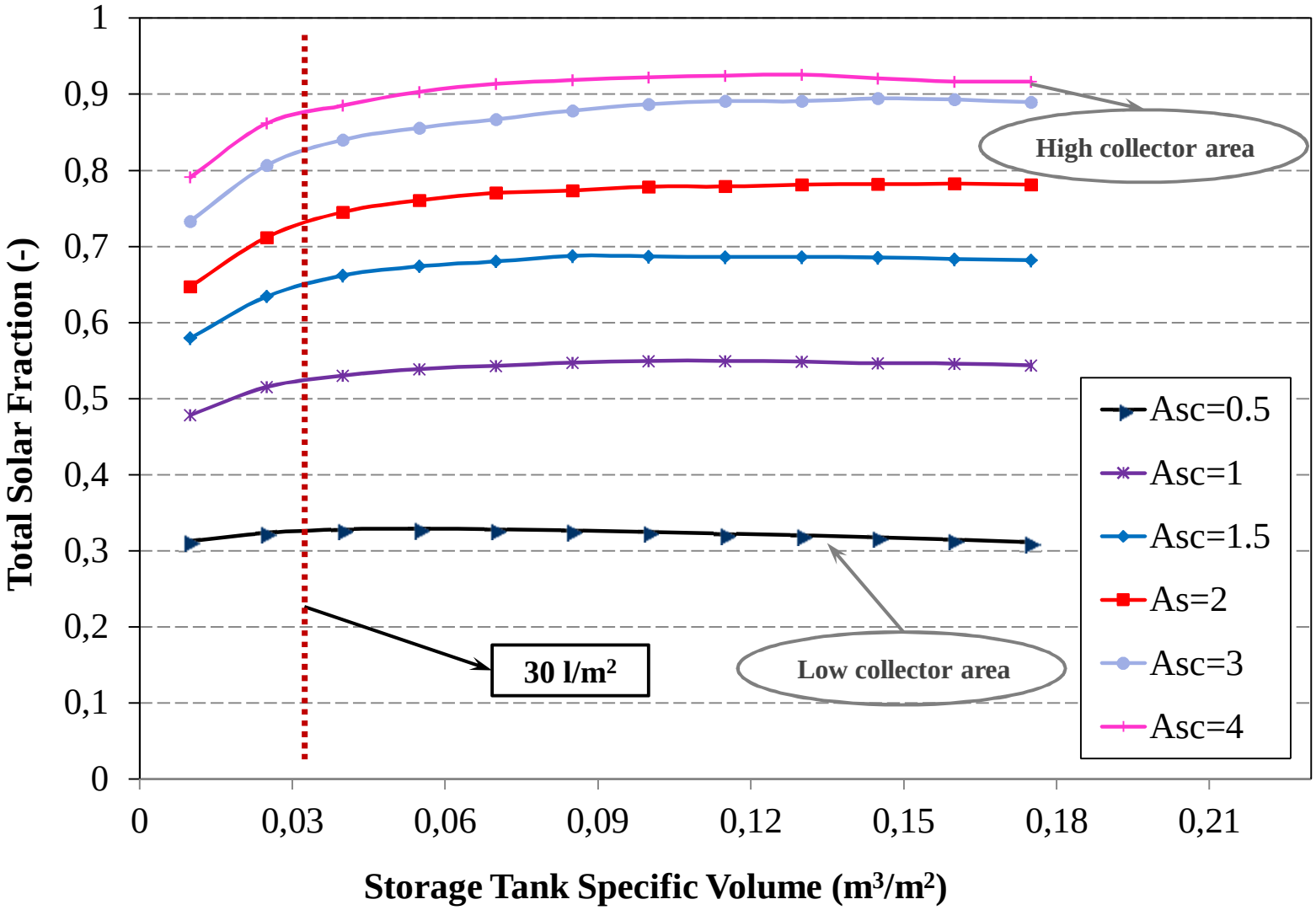


Parallel burner/ C1/ 24 hr a day load

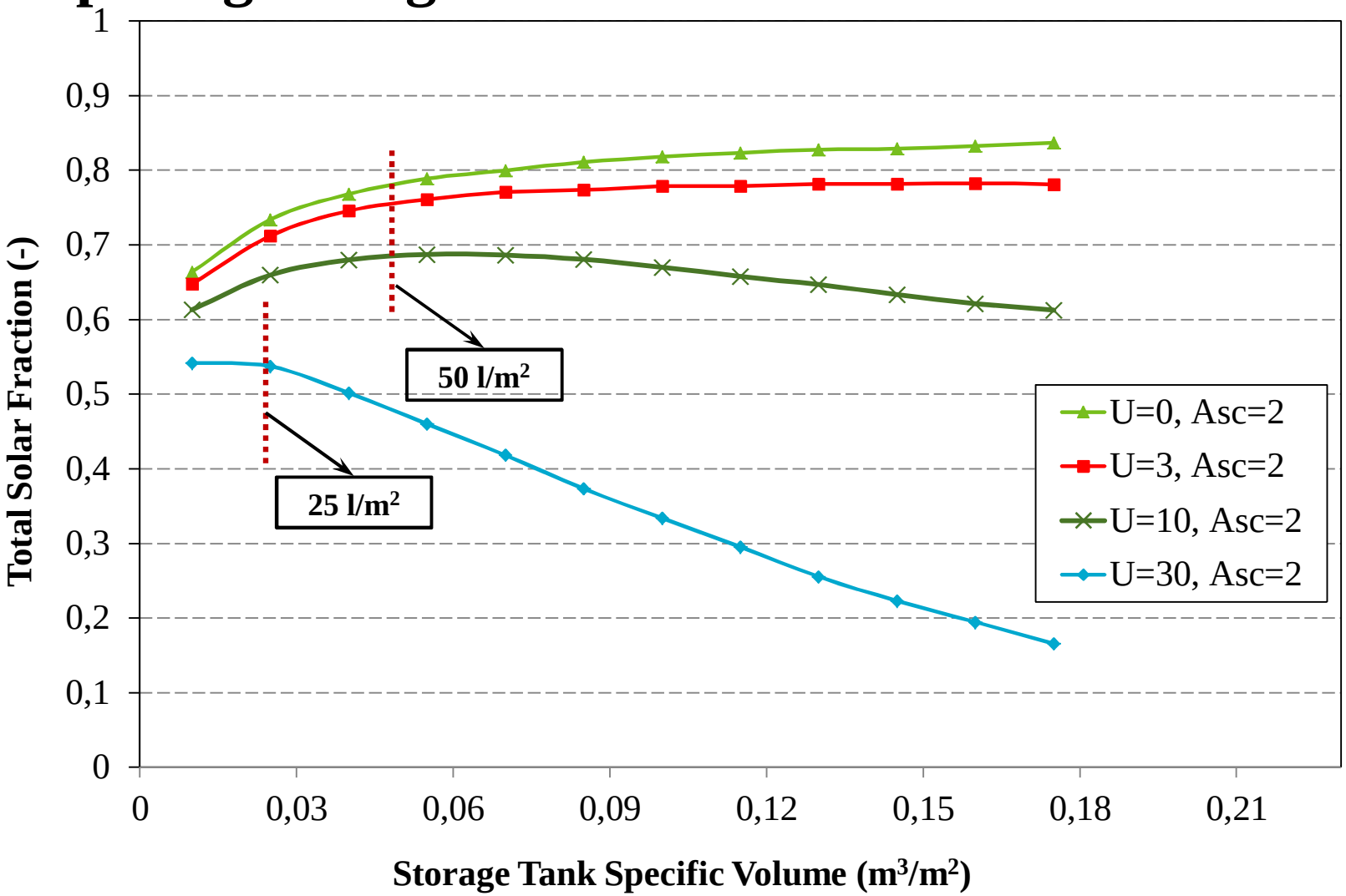
Comparing evacuated tube and flat plate collectors



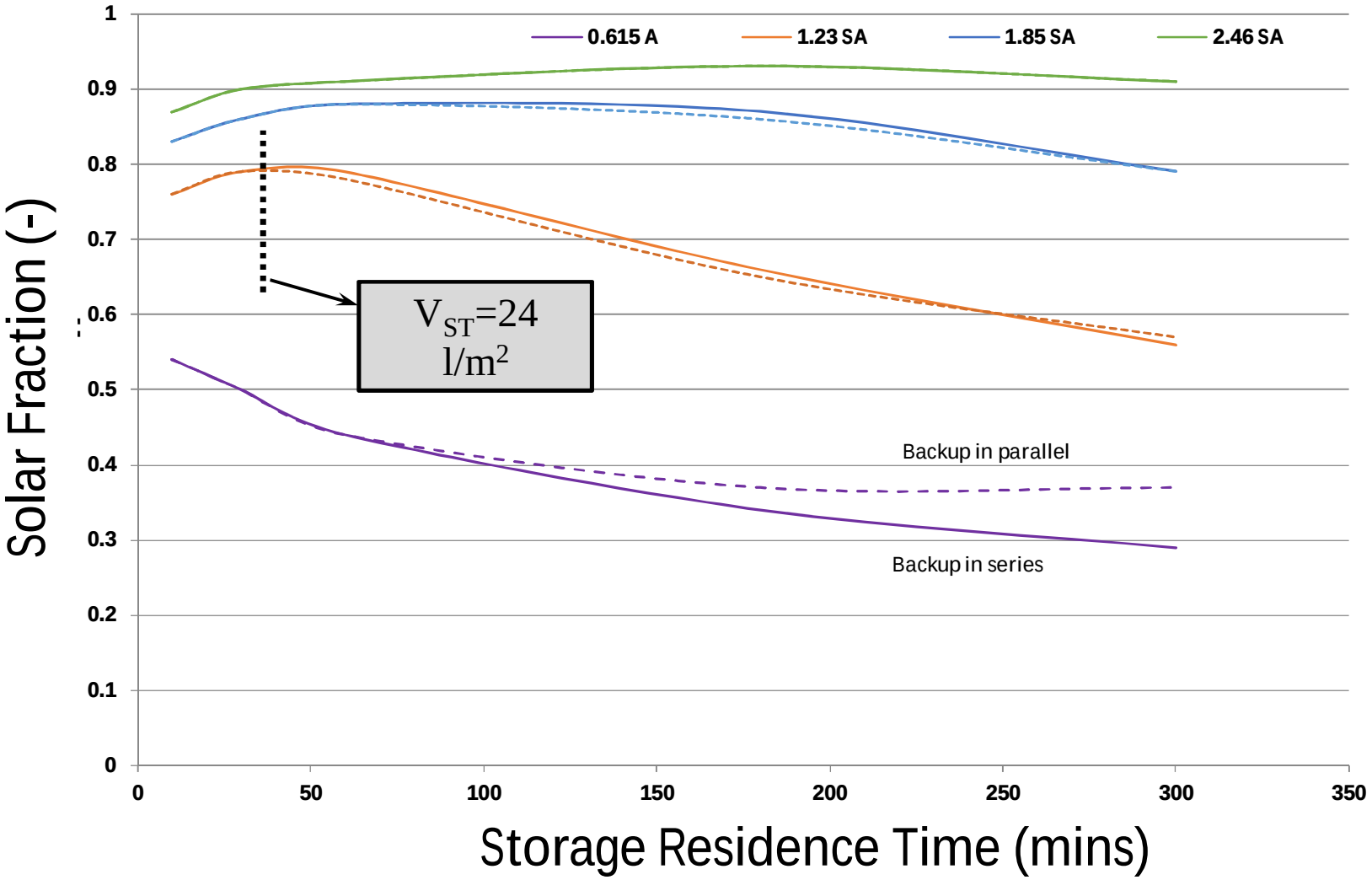
Parallel burner/Evacuated tube/C1/ 7am-6pm load



Parallel burner/ Evacuated tubes/C1 / 7am-6pm load
Comparing storage tank insulation



Triple effect chiller/ C1/ PT Collectors/ 7am-6pm load



Conclusion

- Parallel gas burner is preferred
- A variable speed drive will ideally be used to control the outlet temperature of the solar collector
- A storage volume of around 70 l/m^2 looks about right but may be too high if
  - The building is not occupied in the evening
  - Heat losses are expected (eg long pipe runs and/or multi-effect absorption chillers)
- *Next step*: More simulations with vapour compression backup and absorption chiller part load (no gas back up)

Thank you

CSIRO Energy Flagship
Prof Stephen White
Energy for Buildings Manager

t +61 2 4960 6070
e stephen.d.white@csiro.au
w www.csiro.au