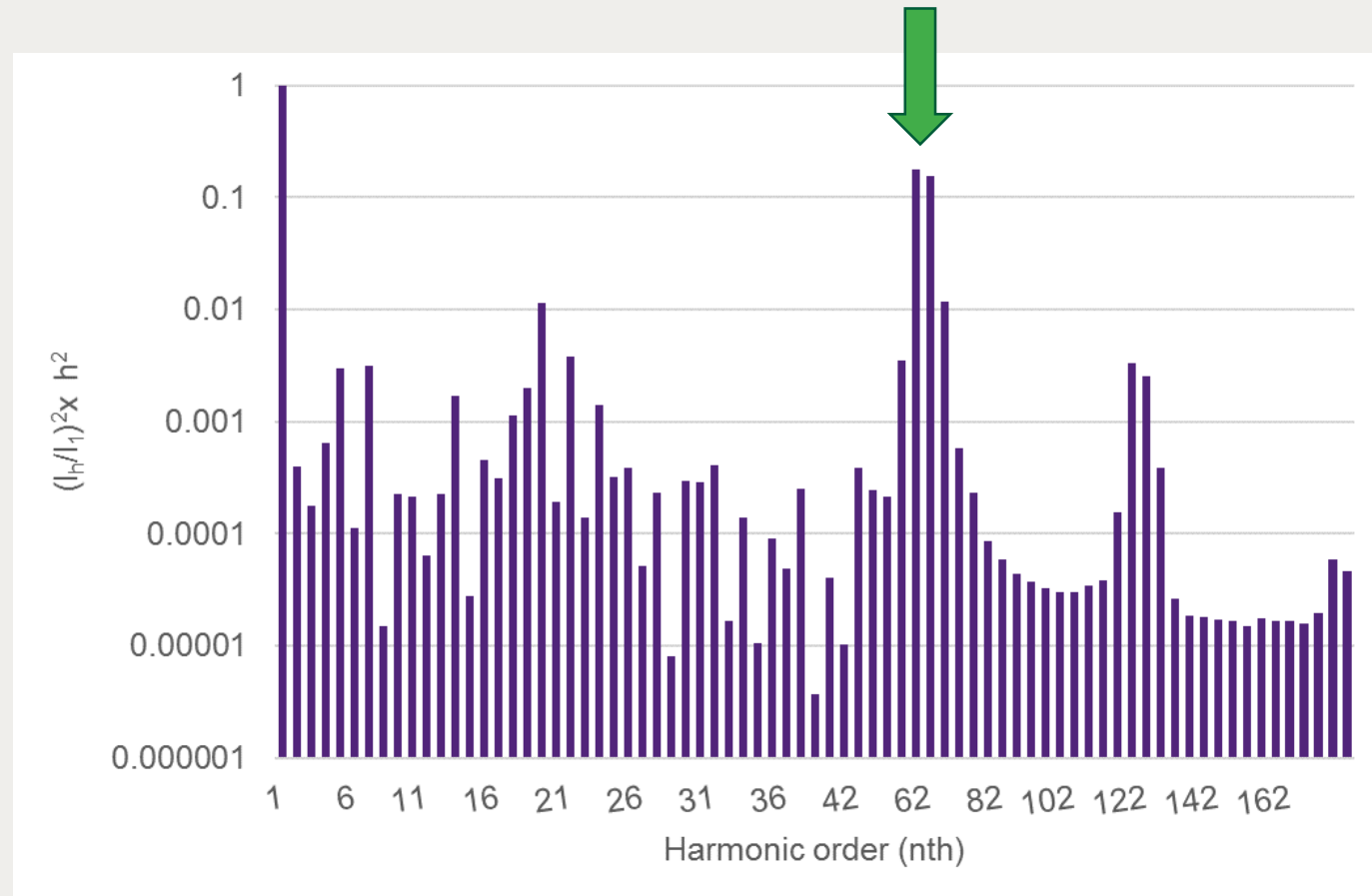


Experience with harmonics from PV

SCA2 PS1, Question 1.2 What design and operation considerations should be included to optimise the selection of transformers for photovoltaic plant applications?

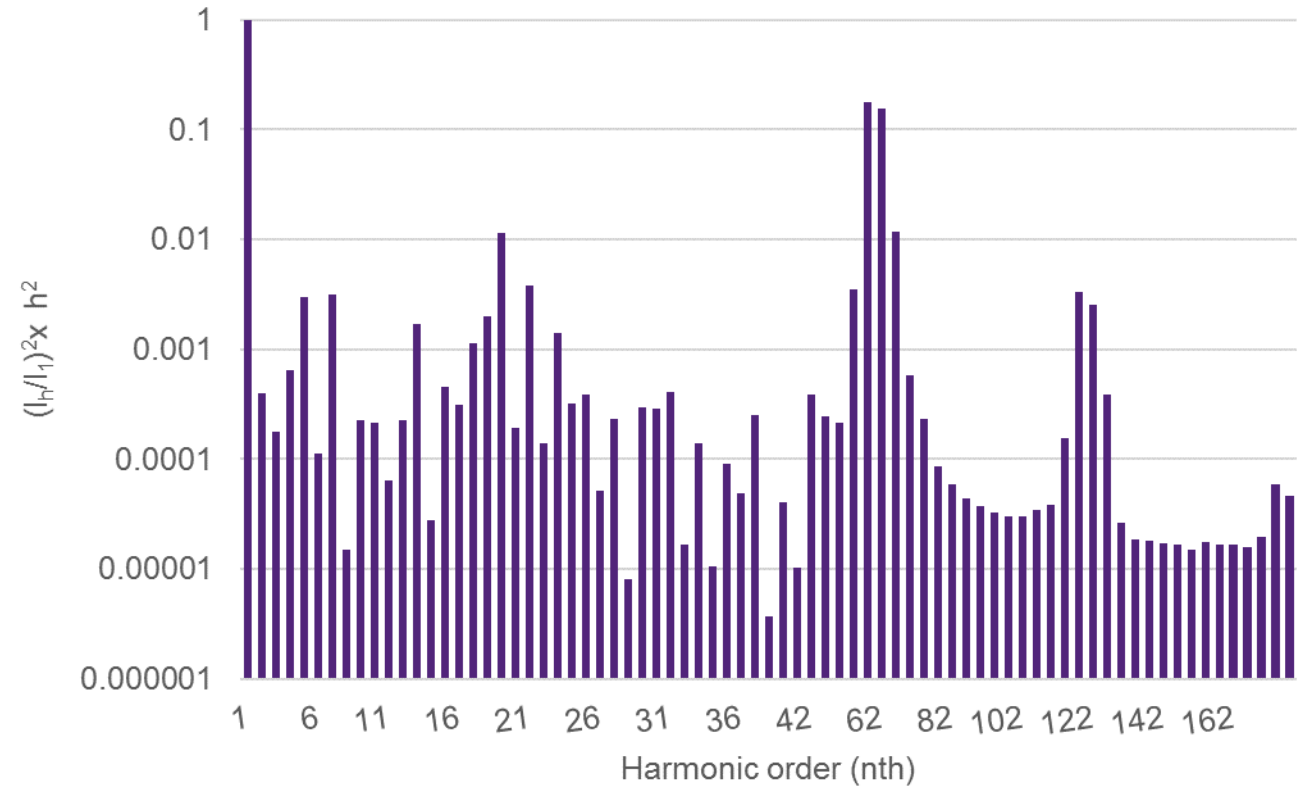
Jon Brown, Transpower (Speaker) and Dan Martin, ETEL (NZ); Firuz Zare, QUT and Matt Gibson, Ausgrid (Australia)

- The harmonics around a 1.4 MVA power transformer were investigated. The y-axis shows the heating effect of each harmonic normalised to the fundamental.
- The contribution of each individual harmonic on the loading factor is a function of the current² and frequency².
- An unexpected surprise was the peaks at the 58th and 62nd harmonic, together they had a combined effect of 33%.
- Most utilities only measure harmonics up to the 50th order, yet this figure shows higher frequency harmonics being significant.



Data provided by Prof. Zare & Dr. J. Yaghoobi

- In total, the harmonics increased losses in transformer by 2% at this load.
- This caused a maximum calculated 2 °C increase in hotspot temperature at this load.
- Our current recommendation is to measure high frequency harmonics and have analysed their impact on the insulation. At present, these high frequency harmonics are not well understood.



Design considerations

- The harmonic content needs to be known (quite often the purchaser can't provide an accurate spectrum). A manufacturer can recommend derating a transformer, but this can result in higher no-load loss.
- Consider using a normal cyclic rating matched to the generator, rather than peak load. This will require transformer components to be rated properly.
- If the insulation is to be run hotter then consider a natural ester rather than mineral oil.