Questions Often Asked about the Benefits and Savings using the Paladin Wireless AC DRED Control

1. Please provide the data to support comparison of overall site draw from grid between active and inactive precooling operation of the device.

When the building cooling requirement exceeds the cooling capacity of the AC unit then : the DRED / AUTO operation will absorb all excess PV up to the limit electrical draw of the AC unit bar a nominal 250W of buffer over and above compressor draw+ house load.
If the AC is at full power then obviously, any excess PV will be exported as normal.

Since the building cooling requirement is (usually) directly related to the amount of solar heating then sunny days produce more excess solar and allow the compressors to work harder.
Putting specific numbers on this is almost impossible and only generic rules can be applied due to the almost infinite variability of the modelling.

However, extensive testing in my Auckland home with one and two controlled compressors of different sizes provides results that are exactly as desired.

It might be helpful at this point to explain the background design logic of the system in reasonably general terms.

With an understanding of the DRED system as implemented in an AC compressor it is obvious that it can be used in conjunction with suitable grid measurement to run the AC exclusively on excess PV.

Prima facie the DRED granularity (off/50%/75%/100%) does not lend itself to anything like an accurate system. However, like EV charging, which I solved many years ago, a suitable averaging, blending and timing algorithm will largely overcome the granularity, particularly given the chaotic nature of both the PV excess - given the PV and house load variability and the rapidly changing and largely unpredictable compressor draw.

What is employed alongside a smoothing averaging mechanism is a simple but surprisingly elegant digital adaptation of the twin balance wheels employed in a Tourbillon watch movement. Where essentially one 'wheel' monitors real time excess solar and the other drives the UP and DOWN progress of a sequential movement through the DRED states. Add this to a dynamically changing number of 'wheel' teeth depending upon the DRED state and the priority (user selectable) of a 2nd compressor (if in use) and a relatively simple AI (Ant Intelligence?) in each compressor controller can manage its own load without knowledge or reference to anything else except real time excess PV.

Control is via a separate monitor unit that passes only a switch position (AUTO/OFF/MAX) and receives back a continuous feedback from the compressor unit of 'wheel' position, DRED state and grid data. If the monitor fails or is powered off, the compressor AI with continue with the last received switch position until reset - when it defaults of DRED inactive / MAX / NORMAL ops.

All units are linked via 915Mhz LoRa radio on a 5 second synchronised broadcast. Data is uncompressed comma delimited ASCII for simplicity and ease of error correction. LoRa is well suited to this task as it has remarkable range in a domestic situation (unlike WiFi) or RF433 and copes well with the unusual and often remote positioning of some compressors without resorting to boosters or meshing. Multiple channels are selectable if adjacent systems have conflict issues.

The grid data can be broadcast from either a Paladin unit or a stand alone transmitter module, both of which read the real time grid status through a CT on the main grid input cable.

2. What is the expected reduction in export to the grid (middle of the day) per site? (typical)

The principle effect is that with our DRED Control active there will be a reduction in Grid Export up to a maximum of the AC compressor size (electrical load size - not cooling).
If the building reaches a stabilised temperature (as set on the internal controller) then, even if the DRED CONTROL is signalling MAXimum, the actual draw will be less than the AC compressor maximum.

3. What is the expected customer savings per year? Considering various tariff scenarios such as flat, ToU, demand tariff scenarios?

This is a largely unknowable value without any specific values for the principal variables. However if we assume :

[PVAS] PV array size = 6kW.
[HUS] Hours of usable sunlight (giving over 2kW of PV) = 8.
[TPV] Total PV output in HUS = 40kWh.
[ACCS] AC Compressor Size = 4kW.
[P100] Fraction of time AC at 100% = 0.8.
[ACPV] kWh used by AC during HUS = HUS * ACCS * P100 = 25.6kWh
[FIT] Feed In Tariff = 8c/kWh .
[EEC] Evening Electricity Tariff = 35c/kWh
[RECR] Reduction in evening cooling requirement = 50% (of cooling input during sunlight hours).

[FFIT] Forgone FIT = ACPV * FIT = 204c / day precooling cost.

And this is where it gets problematic in terms of modelling without some more quality real world / Australia data points. My experience in Auckland is that I reduce my AC electricity consumption (measured) by around 50% once the house is cooled and temperature stable. However this is just one data point, and the starting and stable temperatures may not be typical. And our house is very active during the heat of the day when these measurements were taken. However I feel this is a pretty good approximation for this relatively temperate climate here. In higher humidities and temperatures I believe the advantages of reducing the dwelling's RH over the day will accrue significantly higher fiscal benefits.

Worst case of 50% cooling requirement post precooling :

Hours of full AC required without precooling = 4.
So 4 * ACCS * EEC = 560c.
Assuming RECR at 50% gives 560c * 0.5 = 280c.
Add in the FFIT = 280 + 204 = 484c / day.
Daily saving = 76c
Assume 240 days per year = $182 / year.

Probable better case RECR of 30%

Hours of full AC required without precooling = 4.
So 4 * ACCS * EEC = 560c.
Assuming RECR at 50% gives 560c * 0.3 = 168c.
Add in the FFIT = 168 + 204 = 372c / day.
Daily saving = 188c
Assume 240 days per year = $451 / year.

4. Does it come with a customer app and any web dashboard? If not how is customer informed of how much they saved in a particular period?

Absolutely NOT - not having WiFi or having to use a phone is a feature !! Customer saving can be assessed via the power vendor's data.

5. Does the system handle coexistence of other DRED operation (e.g. PeakSmart DRED with hardware interface as per AS/NZS 4755.1)? If yes, how a DRED operational instruction prioritised?

For parallel operation my Panasonics take the most restrictive DRED signal for operation when 2 signals are presented simultaneously.

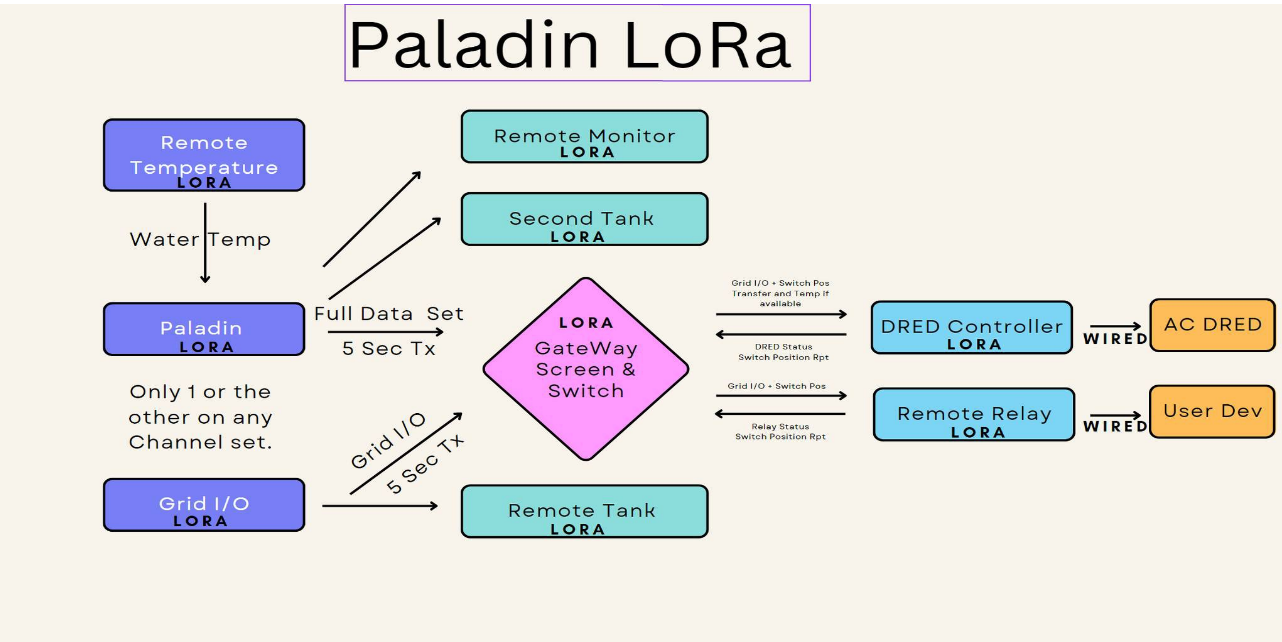
Regardless of that easy answer, connecting the DRED controller and your (J45) pass through cable - METER -> DRED interface - as I understand it, seems like a viable method. In that :

If you send a DRED OFF during the solar day then that will be honoured and all excess PV will be exported. However this I assume would be a code red situation since your daytime problem is normally too much solar on the grid and a depressed base load.

If you send a DRED 50% or 75% post solar then that would be ignored, since the AUTO command would have a DRED OFF anyway. Ditto if the controller was set to OFF If the controller was set to MAX your command would be honoured as it is more restrictive.

If you are leaving the DRED inactive / MAX then your wires are effectively inert and our controller would take control as normal.

6. It would be helpful if a system schematic drawing can be provided.



Using these numbers above in #3 we could revisit question #2

Regardless of costings. A single 4kW AC will nominally reduce grid export during the solar day by ~25kWh and reduce grid loading in the post solar 4 hour period by 12.5 kWh @ 50% RECR and at 16kWh@ 30%.

These savings seem quite insignificant until you realise that this is just a single AC compressor in a single dwelling with a modest PV array. Multiply this up somewhat and it starts to make a significant difference, both to fiscal and grid effects.

As a matter of interest, but relevant to your grid sustainability project. Attached is a DropBox link to a mathematically sound simulation of the effect of using 10,000 Paladins and associated 3kW hot water elements autonomously and very rapidly maintaining a stable grid frequency using hard grid data for the North island of NZ.
Dropbox link to Paladin Simulator files :
https://www.dropbox.com/scl/fo/h95vh1mz3xu1fp4elhy1p/h?rlkey=3c5qn69e6pwml4vkan21bgpoh&dl=0

Or check out the Paladin FB page for tech blogs etc :
https://www.facebook.com/groups/1108024512629017

Although the controlling premise for this was frequency, it could just as easily be voltage as well (for your case). However the math is based on purely autonomous operation at the local level to achieve speed and reliability. Any form of command level is just too slow and requires massive infrastructure and reliability to be effective.
The golden rule in my opinion is that in a moment by moment operation : Houses take care of houses. Streets take care of streets. Streets take care of towns ... It is a self regulating bottom up process rather than top down. Not that attractive a method for corporate control, but it is what it is.

Anyway, read the PDF and run the program on a PC. I have also included the source (in the dreaded BASIC - but this is old code!!). Use Liberty Basic (https://www.libertybasic.com/) to modify and recompile if required. Use notepad or whatever to read. It is simple enough code and reasonably commented.