



Inverter & Interconnection Standards Overview

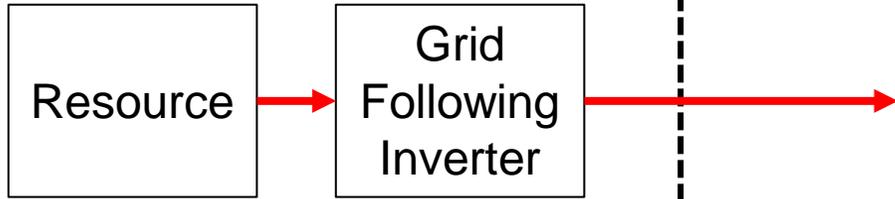
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Proprietary & Confidential – Creation Energy, LLC

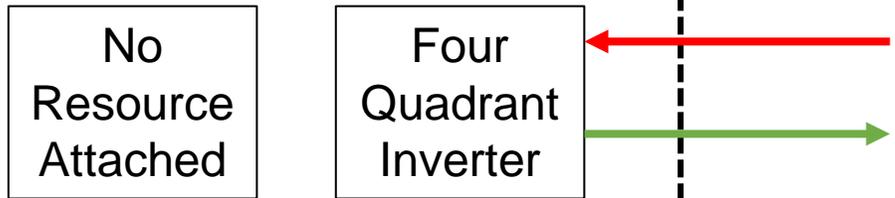
Why Four Quadrant Inverters Matter



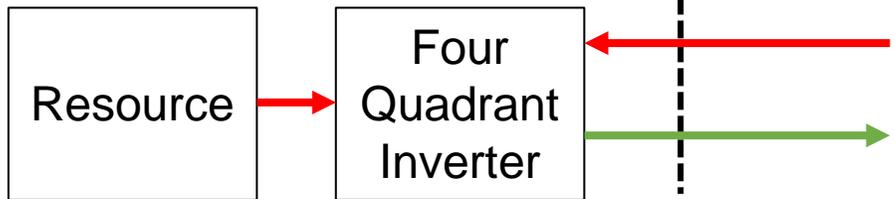
Today's "Dumb Energy Brick"



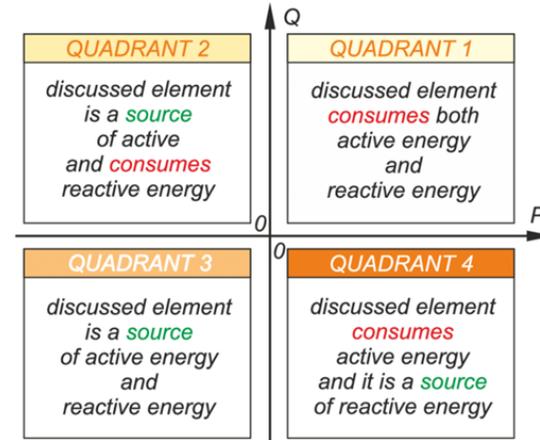
One-way flow delivering only kWh to the grid whenever it might be available with limited control.



Two-way flow that allows 24-hour use of grid power to produce VARs at the point of delivery with NO resource required.



Two-way flow that allows resource to produce Watts or VARs for grid while also allowing grid power to be used for VAR production simultaneously.



We do not have to know all the ways this can be monetized right now. We will figure that out over time. But we must recognize now that we are giving away our future if we continue to allow 'dumb energy bricks' to be deployed on the system.

UL 1741 Evolution

- Original 1741 – “Dumb Energy Brick” – Don’t burn down a house.
- 1741 SA – Significant improvement in ‘hardening’ to increase ride-through capability for voltage and frequency. First use of four-quadrant functionality and exposure of registries for use, but only in grid following mode. Sets dead band for voltage and if it sees grid excursions outside of dead band, it will automatically produce or consume VARs accordingly.
- 1741 SB – Additional hardening, better exposure/control of four quadrant functions, all still grid following but more flexibility on set points and, most importantly, adds industry standard communication required protocols of IEEE/PES 2030.5 and SunSpec.
- FYI – Pecan Street Project is taking the next step beyond 1741 SA and SB by testing ‘normal grid operation’ of dialing Watts and VARs to support Power Factor Correction, Volt/VAR management, Phase Balancing and market services support instead of just ‘grid following’ static actions defined in UL 1741 SA and SB.

IEEE 1547

- 1547-2013 what most are requiring
- 1547-2018 what is needed now as a requirement
- State of Maryland has mandated 1547-2018
- Future additions coming to 1547

Standard	Topic	Expires (10 yrs)	2018	2019	2020	2021	2022	2023	2024	2025	2026
P1547	Base Std	2028	Revised		Amended	PAR: Std		Revision?			
P1547.1	Test Std	2030			Revised		PAR: Std		Revision?		
P1547.2	Application Guide	2018	PAR: G			Expected Revision		PAR: RP		Revision?	
P1547.3	Cyber Security	2018 – parts in 1547-2018		PAR: G			Expected Revision		PAR: RP		Revision?
P1547.4	Intentional Islands	2021				Expires					
P1547.5	DER > 10 MVA	Withdrawn – now partly in P2800									
P1547.6	Secondary Networks	2021 – now in 1547-2018				Expires					
P1547.7	Impact Studies	2023						Expires			
P1547.8	Recommended Practice	Inactive (Included in Revised 1547)									
P1547.9	Storage + V2G	New Std		PAR: G		Expected Completion		PAR: RP		Revision?	

Legend:

Active Working Group

PAR Development

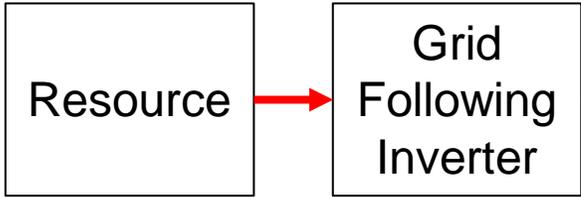
Future Working Group

Project types: Std – Standard; RP – Recommended Practice; G – Guide

Standards Progression Requirements

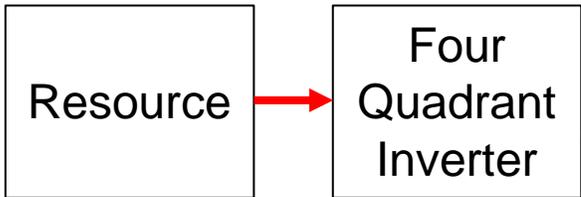


Today's "Dumb Energy Brick"



UL 1741 and IEEE/PES 1547-2013

What we need NOW/ASAP



UL1741 SA (Rule 21 in California forced this new standard; over 200 utilities in US have adopted already) and IEEE 1547-2018.

Both need to be required ASAP so all new resources can be better utilized in the future. Must draw this line in the sand ASAP. This is lesson learned from Australia.

State NOW, require in 12 months

UL1741 SB – Being ratified this month and most inverter manufacturers are working on compliance already. This will include requirement of IEEE/PES 2030.5 and/or SunSpec communication protocols so there are no proprietary communication issues going forward.

State this when making changes above.