Develop Smart Power Inverters to Improve the Performance of Smart Power Grid

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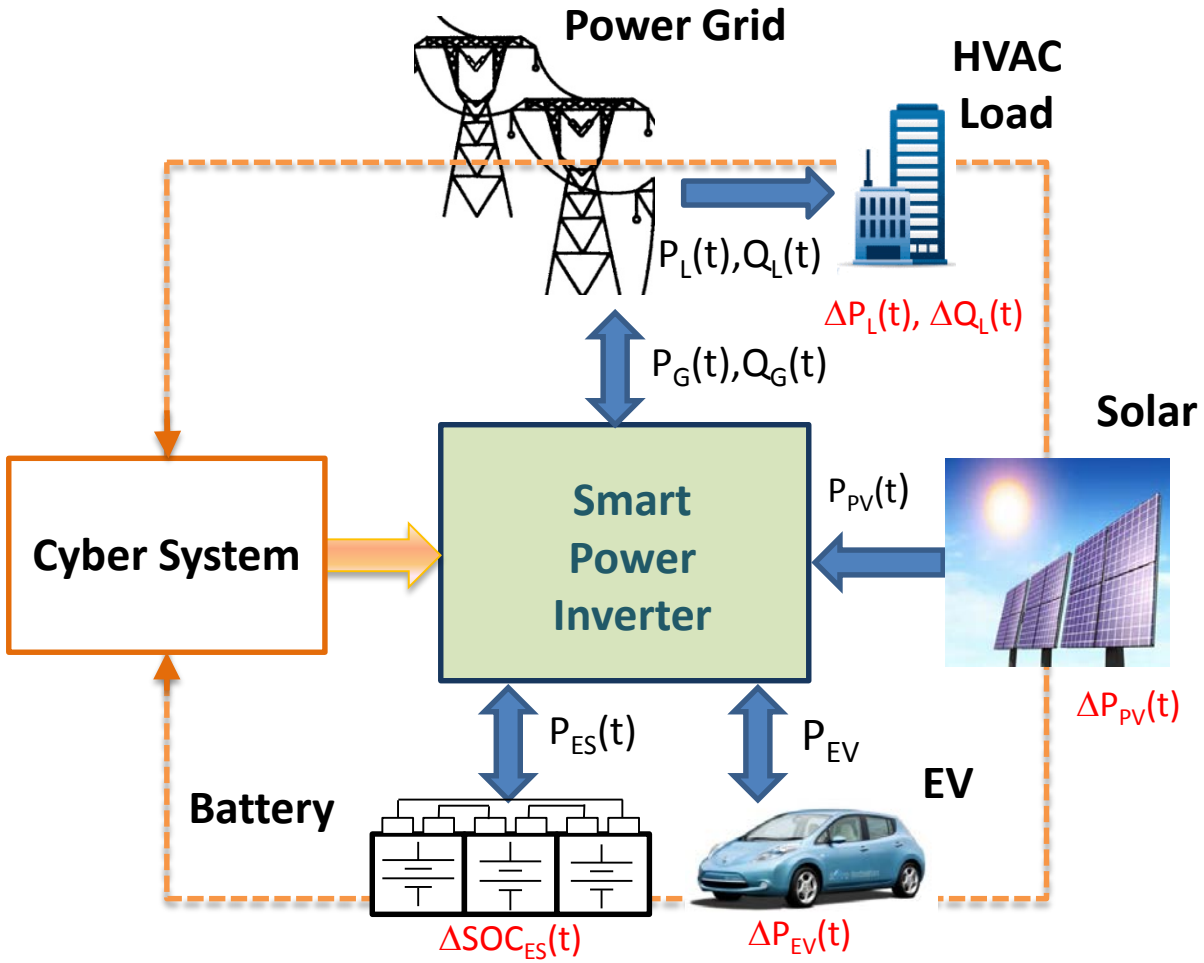
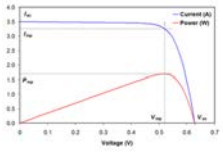


Smart Power Inverter:

1) **Integration of PV, Battery, EV, and power grid**
2) **Control power flow**
3) **Power generation, reactive power compensation (voltage regulation), harmonic compensation, load balancing, battery and EV charging**

Power flow; Data flow; $\Delta P(t)$, $\Delta Q(t)$, $\Delta SOC_{ES}(t)$, $\Delta P_{EV}(t)$: Forecasted P, Q, P_{EV} and SOC variation

Smart Power Inverter System Architecture



Solar

MPPT Control

DC Bus

HVAC Load

$P_L(t), Q_L(t)$

Smart Power Inverter Integrated with FACTS, STATCOM Functionality

D_1

Smart Power Grid

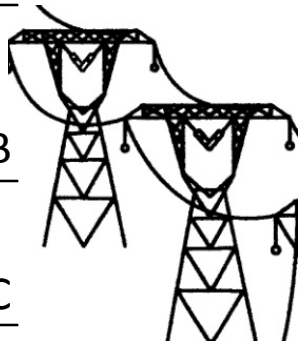
AC / DC

Other energy source: Wind

Multifunctional, Bidirectional Power Flow, DC/AC Inverter — A

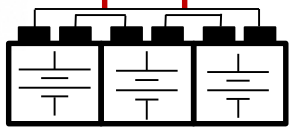
Multifunctional, Bidirectional Power Flow, DC/AC Inverter — B

Multifunctional, Bidirectional Power Flow, DC/AC Inverter — C



EV

Charging Station G2V, V2G

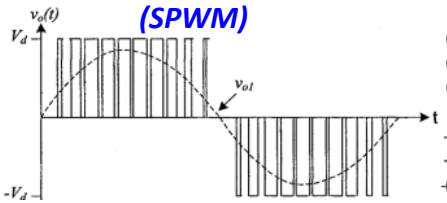


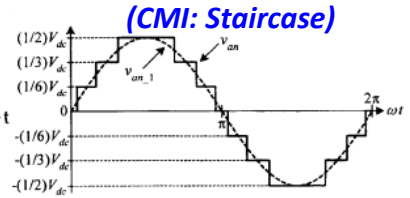
Energy Storage

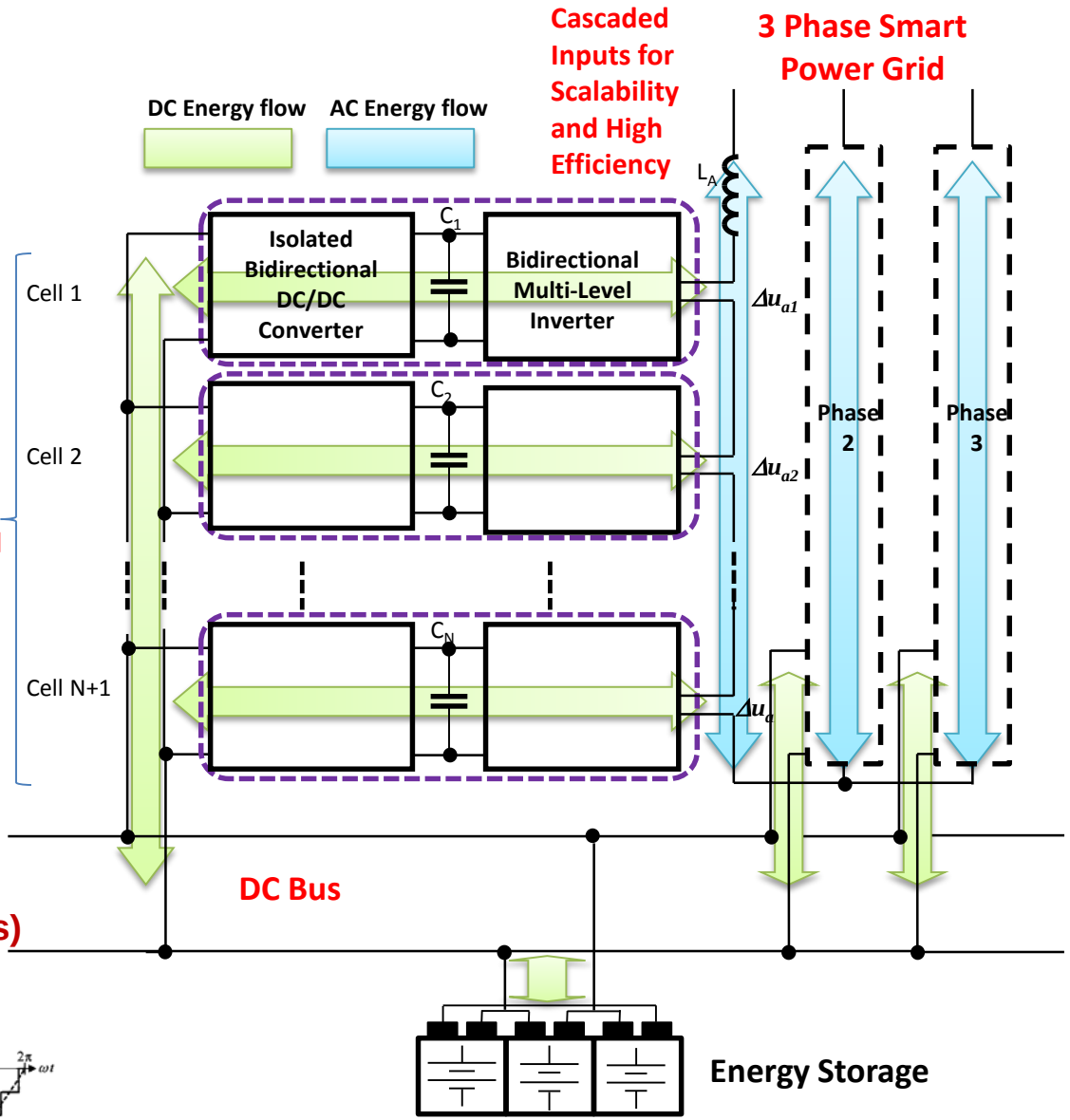
Smart Power Inverter Circuit Structure

1. **Modular Cell approach, low cost and scalability**
2. **Redundant N+1cells, high reliability**
3. **Cascaded inputs for input scalability**
4. **Parallel outputs for high current and output scalability**
5. **Cascaded multilevel Inverter (CMI), much lower energy loss than SPWM, high energy efficiency.**

(CMI: Lower switching f, Lower Energy Loss)



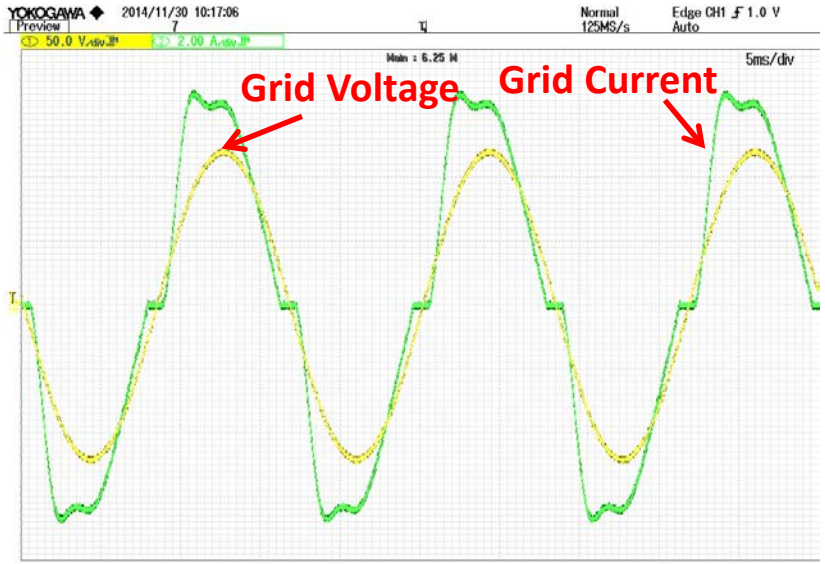




Smart Power Inverter Experimental Results

(Q and harmonic compensation, battery charging)

W/O Smart Inverter



W/ Smart Inverter