NOVEL SWITCHED CAPACITOR-FILTER COMPENSATOR FOR SMART GRID-ELECTRIC VEHICLE CHARGING SCHEME

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Why EV/Hybrid EV

- Rising Cost /depleting Resources of fossil fuels
- Unreliable /Unproven reserves
- Climate change/Global warming and CO2 Emissions
- Need to incorporate green Energy/Energy Efficiency and Renewable Energy in the Energy Mix Scenario
- Hybrid Fast Charging Regimes
- Low impact on the Host Electrical Grid
- Improved Utilization

What is the Solution?

- EV and Hybrid Plug-in EV and Ultimately Electric Vehicle (EV)

Why?

- Low Pollution /Smog and GHG& Clean Environment
- Charged by Sustainable/Green/Renewable Sources(FC,PV, Wind,….)
- Carbon Foot Print/Less Global Warming
- Cheaper Running Cost/KWh Charges

What Challenges?

- Low Impact/Improved Decoupling/Fast Battery Charging Scheme
- Minimal Impact in terms of Power quality and Improved Power Factor
- Efficient Energy Utilization and effective Interface of Smart Grid with Renewable hybrid Green Energy Sources
- Improved Less transient and Inrush Current Conditions
- Hybrid Secure and Diverse Utilization of RE/Green Sustainable Sources including Hydrogen

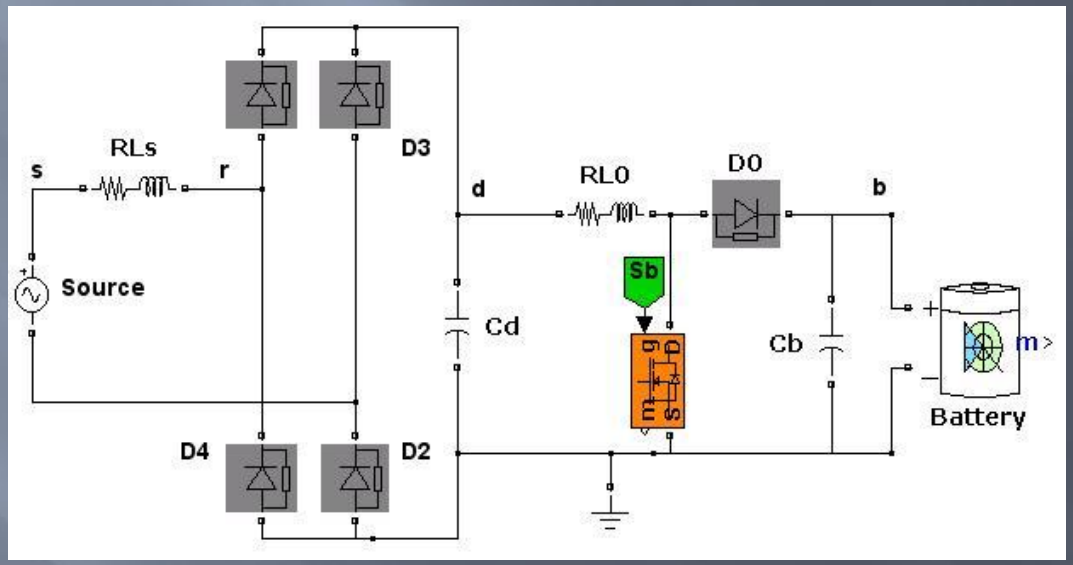
Novel FACTS Schemes

- On AC Side:
  - Switched Capacitor-Filter Compensator (HSCFC)
  - New Switching Controller for Improved AC-DC Coupling and Enhanced PQ/PF Operation

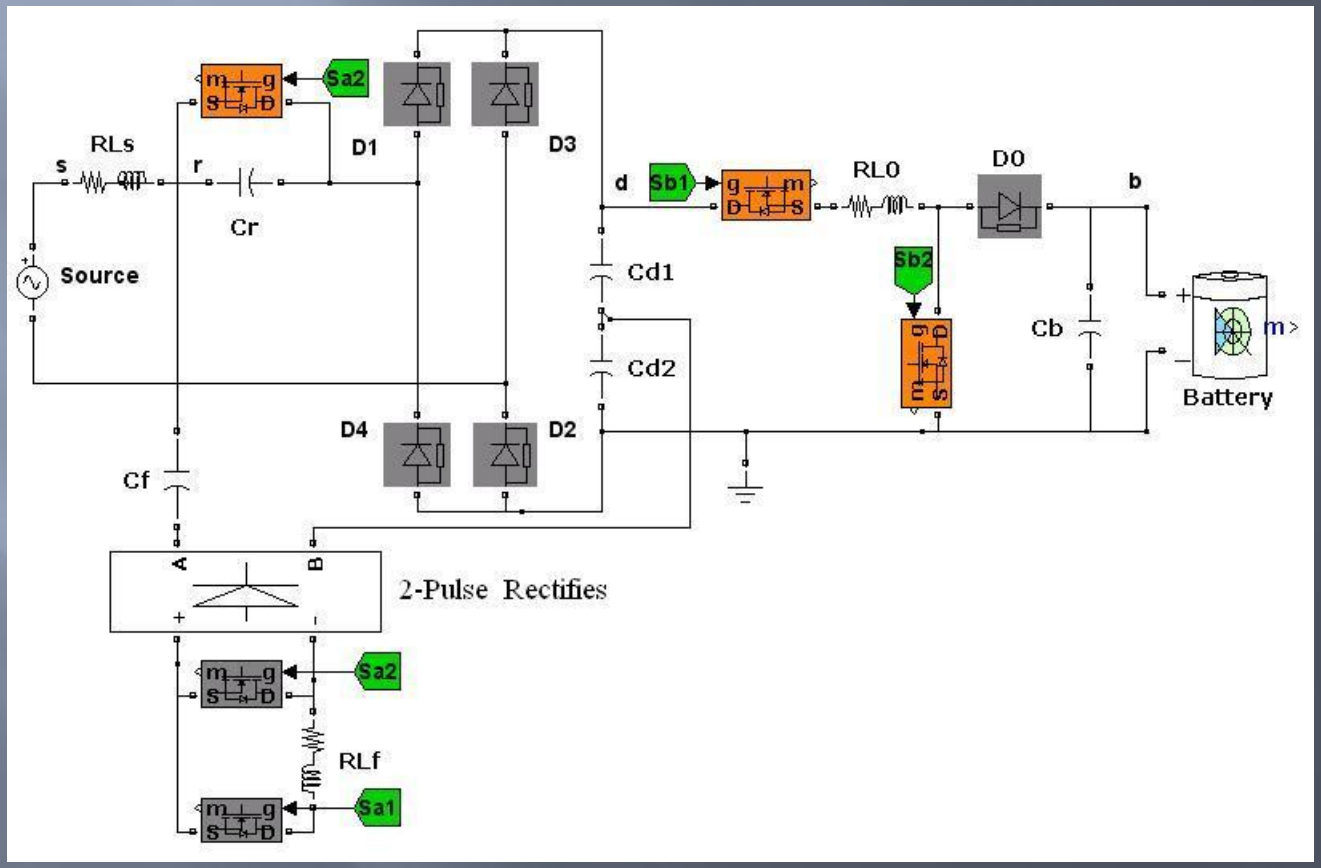
- DC Side:

- New Multi Model V_I_P Charging Regime with Weighted Switching Controller for DC-DC Chopper

Basic Smart Grid-Battery Charging Scheme

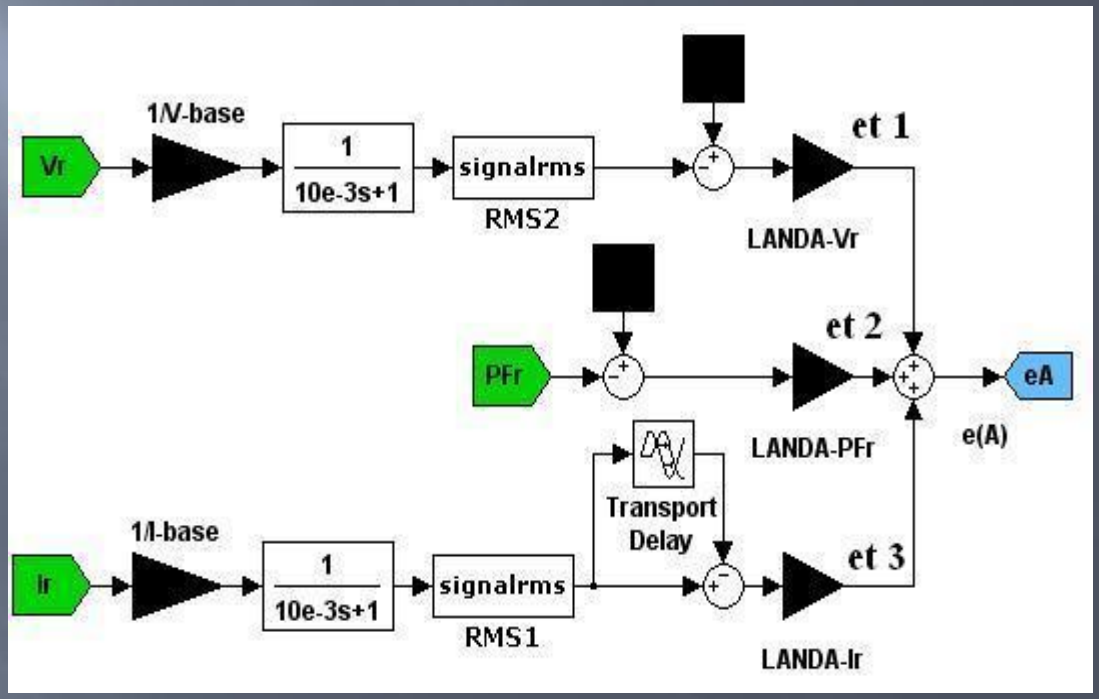


Proposed Battery Charger Grid



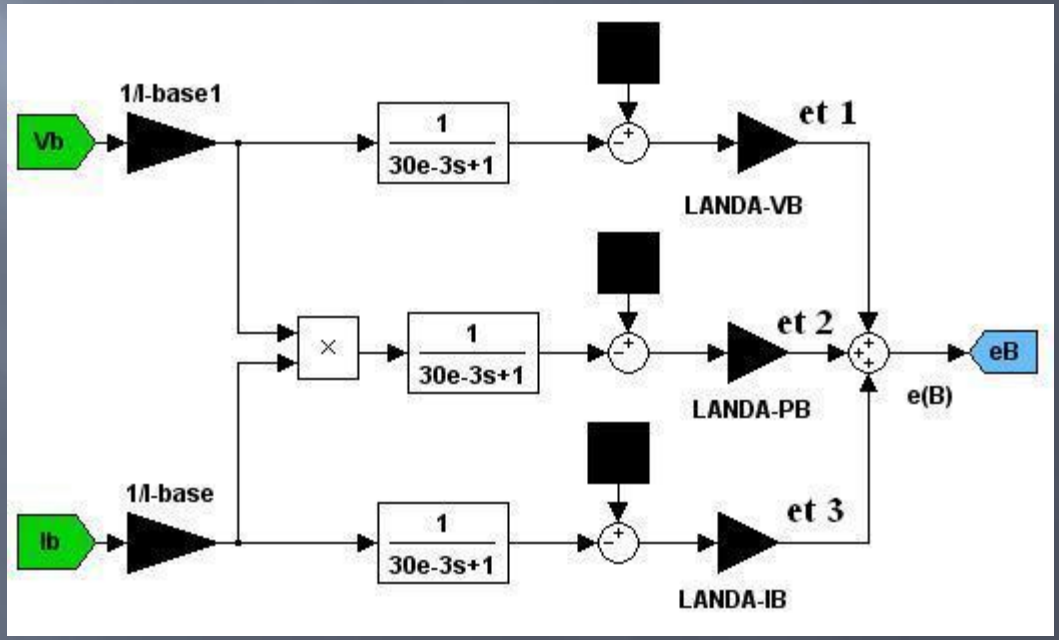
Dynamic Error-Driven Controller for HSCFC

- Triple-Loop Controller:
  - **et1**: Dynamic Voltage Error
  - **et2:** Dynamic Power Factor Error
  - **et3**: Dynamic Current Ripple

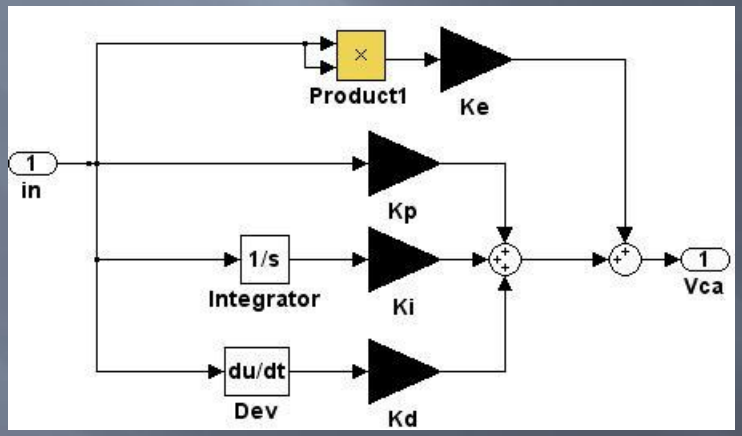


Dynamic Error-Driven Controller for Buck-Boost DC/DC Chopper

- Triple-Loop Controller:
  - **et1:** Voltage Deviation from Desired Value
  - **et2**:Power Deviation from Desired Value
  - **et3**:Current Deviation from Desired Value



Weighted Modified PID with Error Squared Acceleration Loop



Simulation Results
using MATLAB/SIMULINK

C_f=150micro Farad, R_f=0.05 Ω, Lf=3 mH
C_r=30 micro Farad
C_{d1}=C_{d2}= 2000 micro Farad
C_B=4500 micro Farad

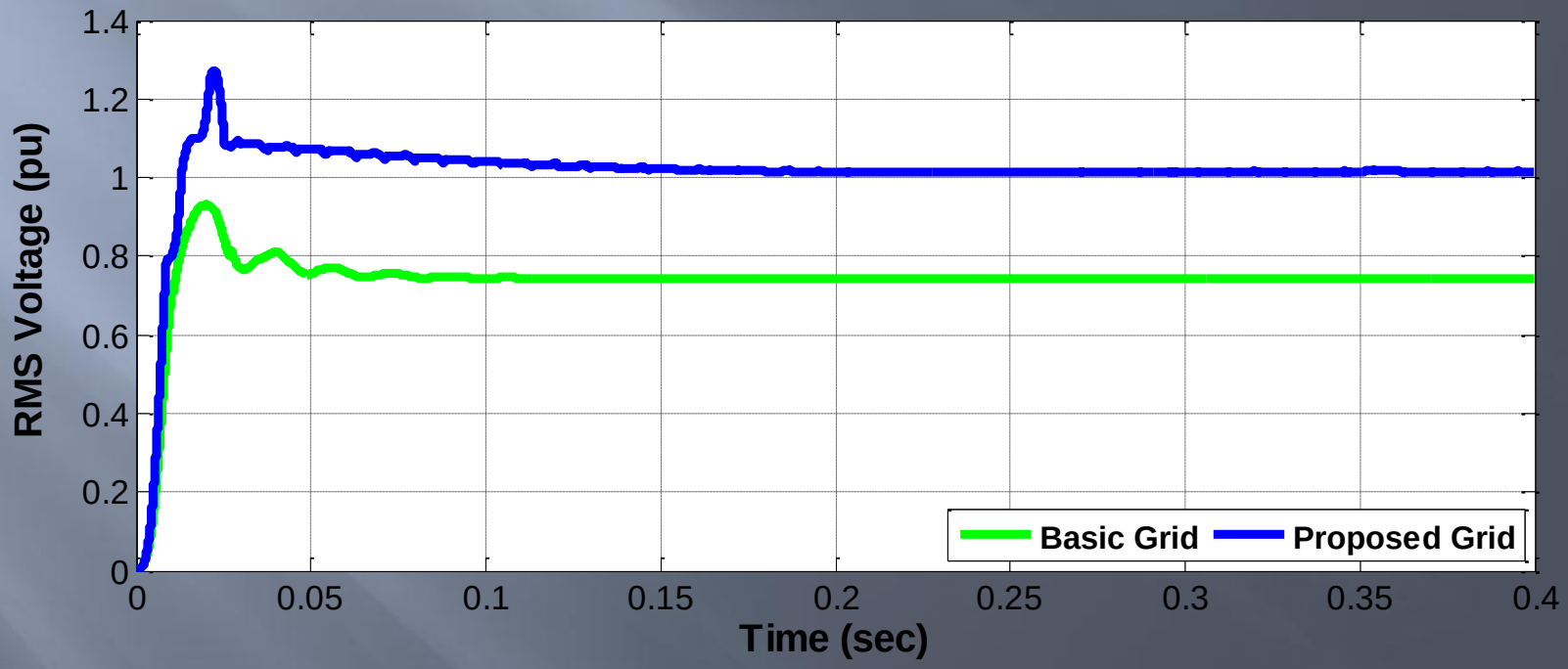
Battery Type: Lithium-Ion,
Nominal Voltage: 300V, Rated Capacity: 650 Ah

Multi-Loop Error Driven Controller:
γ_{Vr}=0.75, γ_{Ipf}=0.5, γ_{Ir}=0.5
γ_{Vb}=0.75, γ_{Pb}=0.25, γ_{Ib}=0.5

WM-PID Controller:
K_e=0.05, K_p=2, K_i=0.1, K_d=0.05

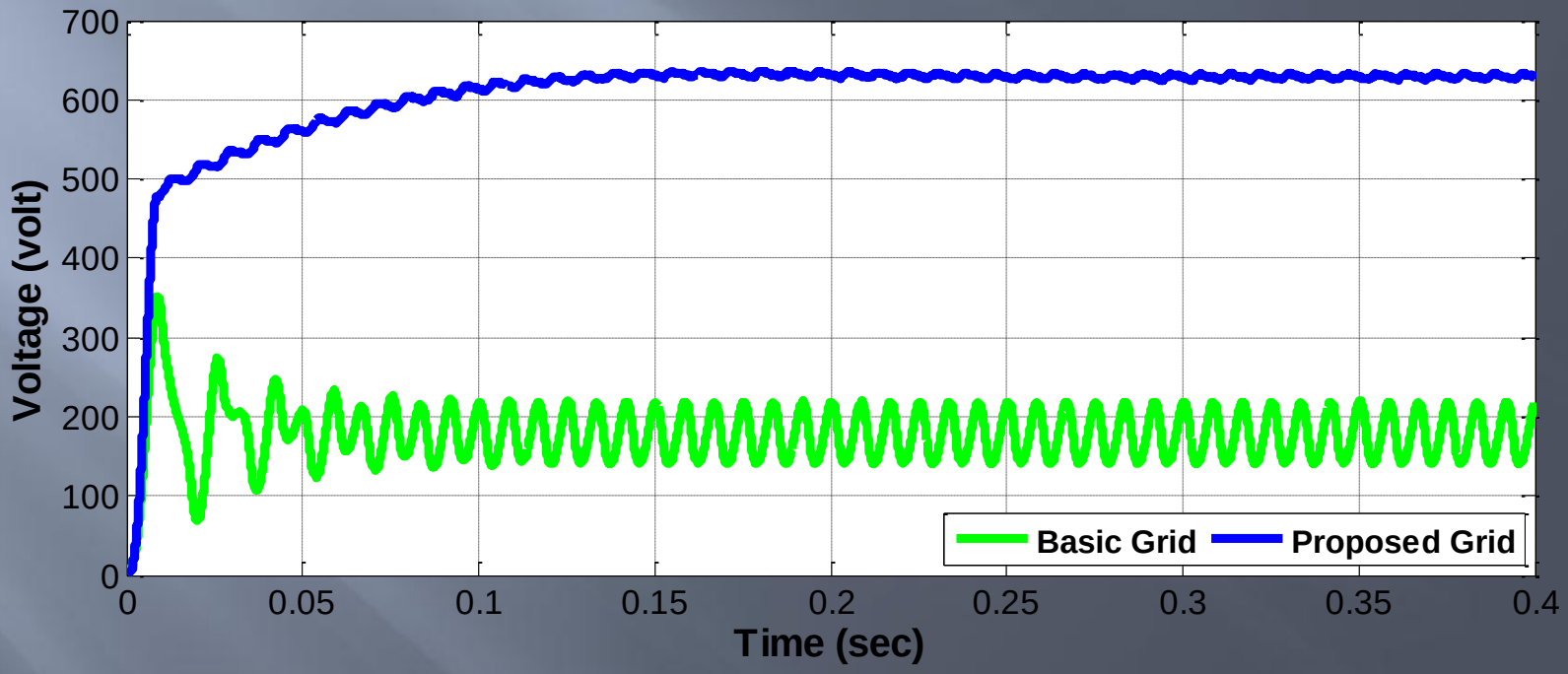
Voltages

Node r



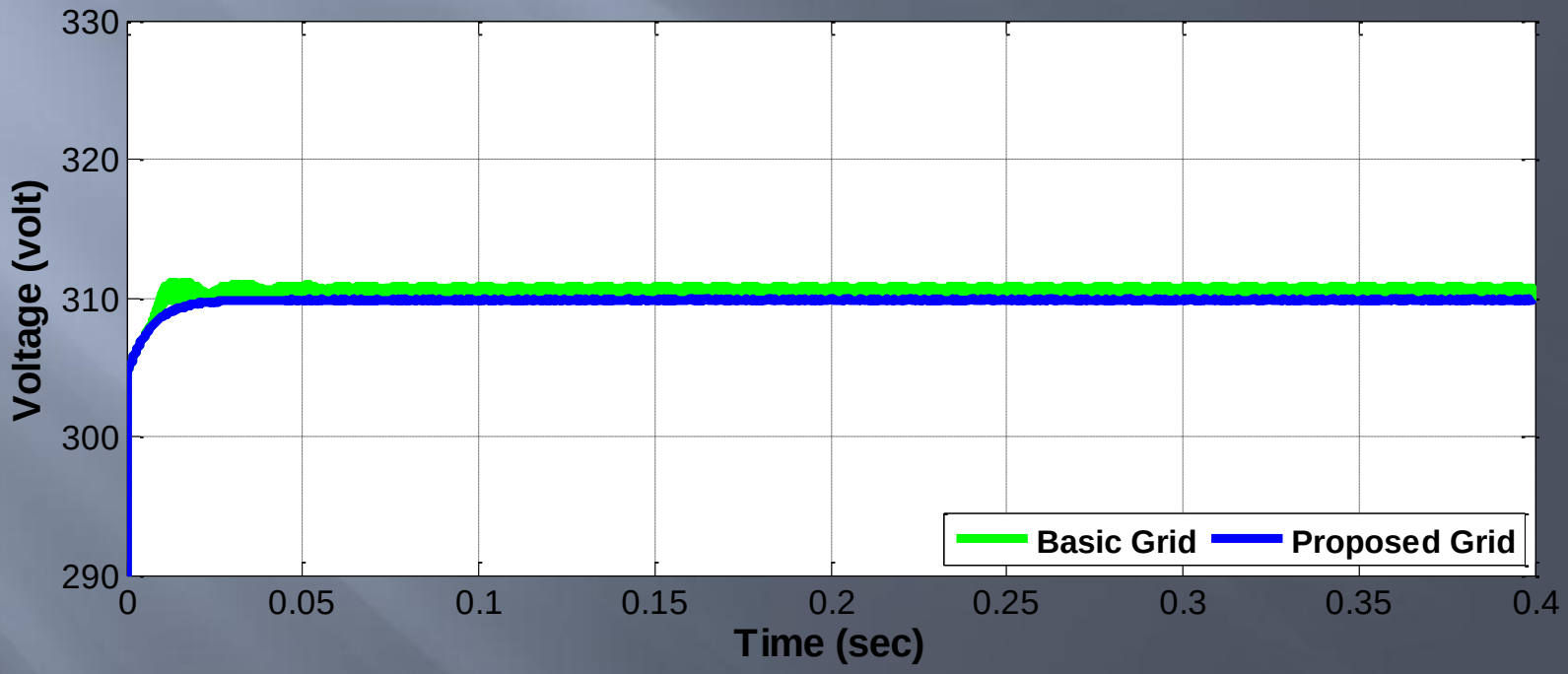
Voltages

Node d



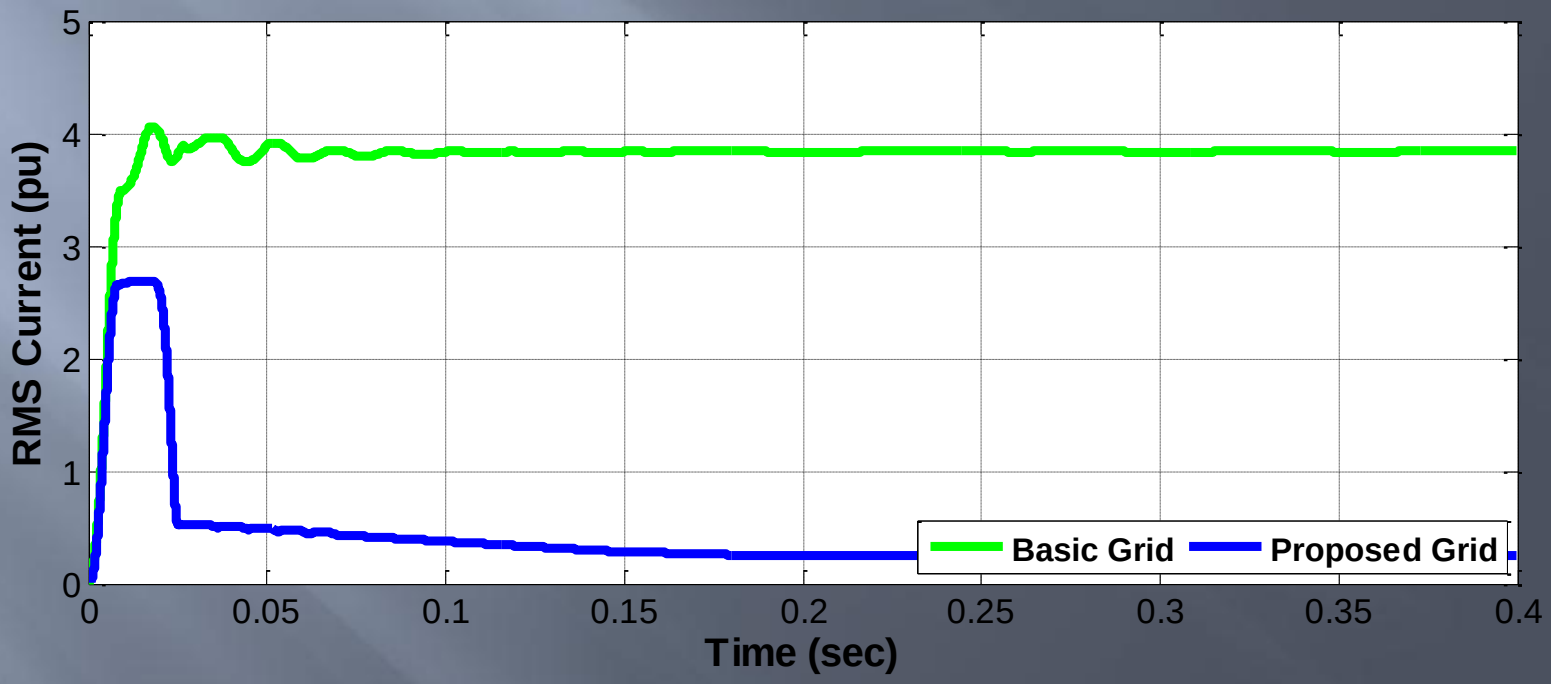
Voltage

Node b



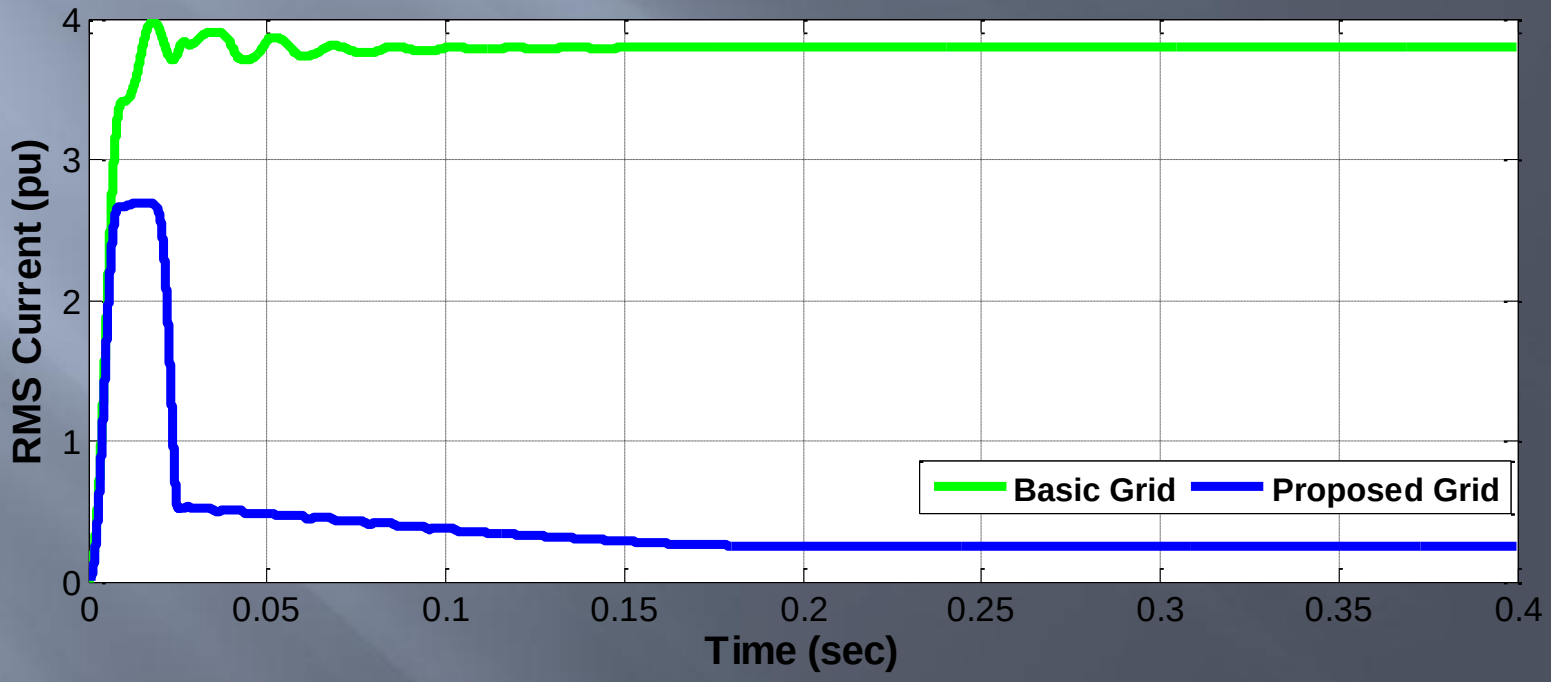
Currents

Node S



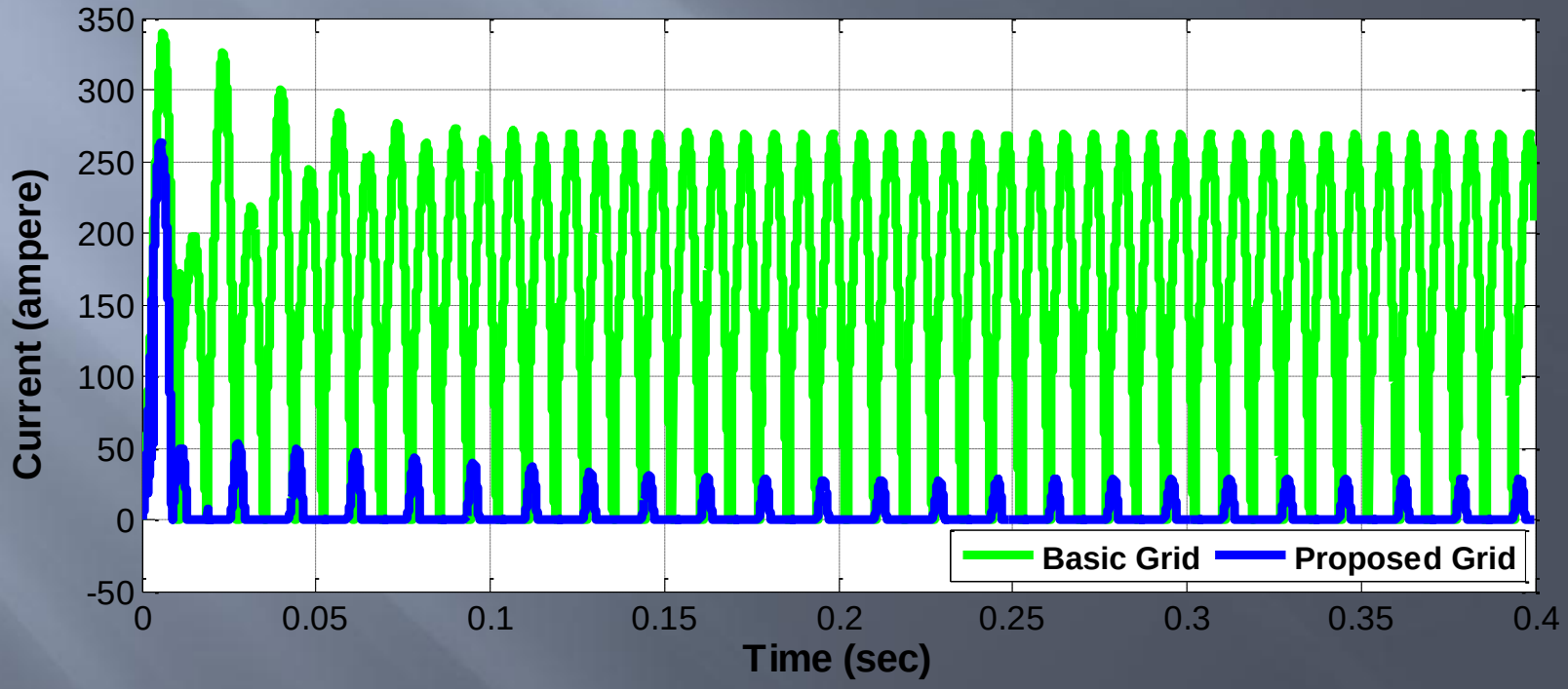
Currents

Node R



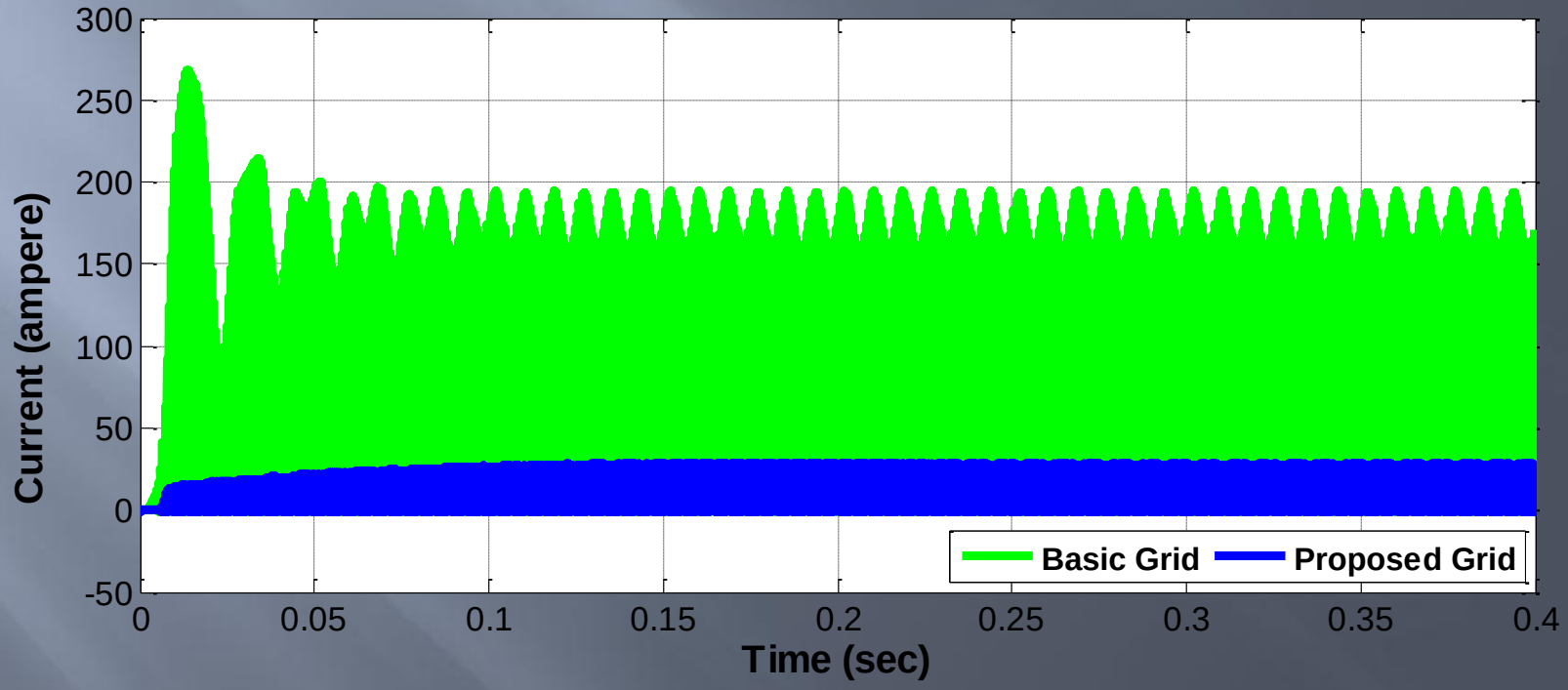
Currents

Node d



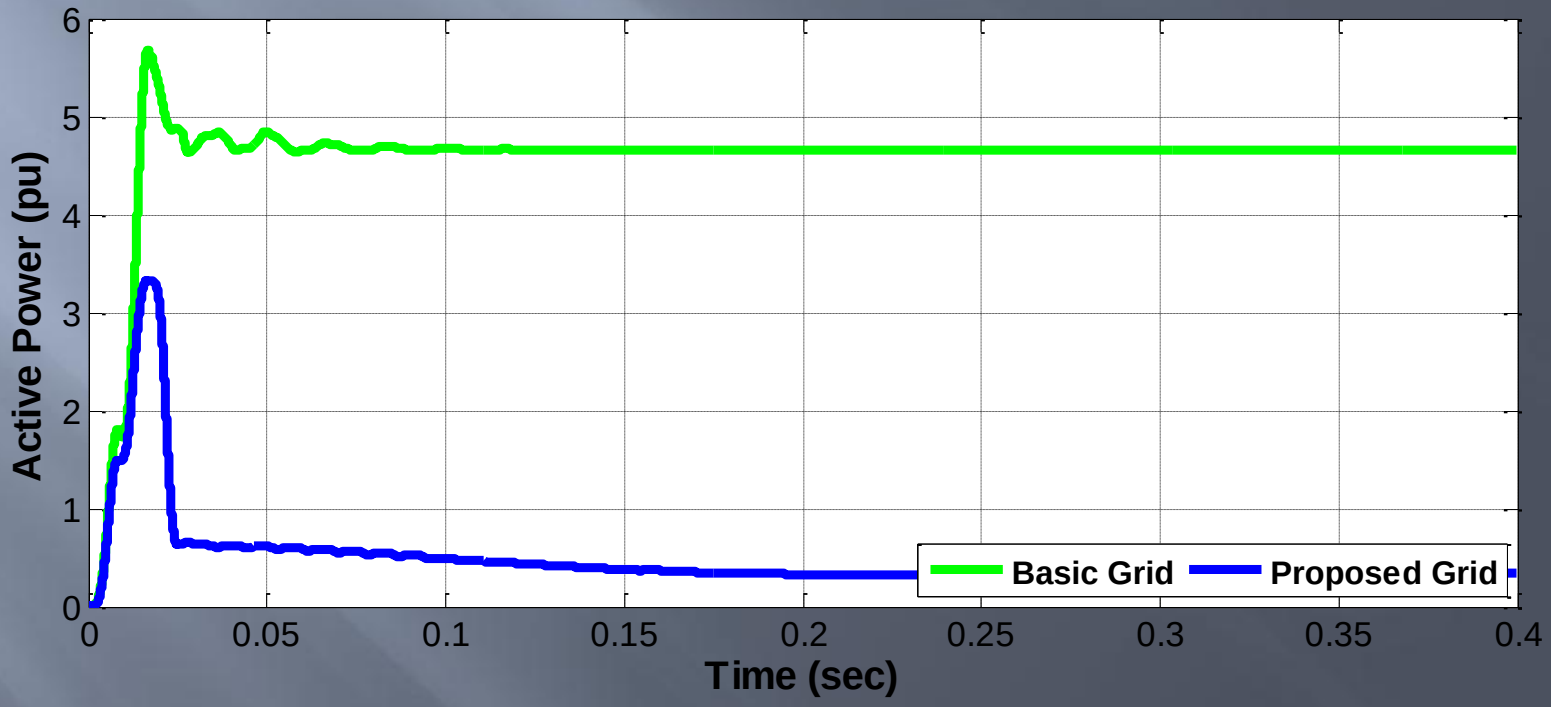
Currents

Node B



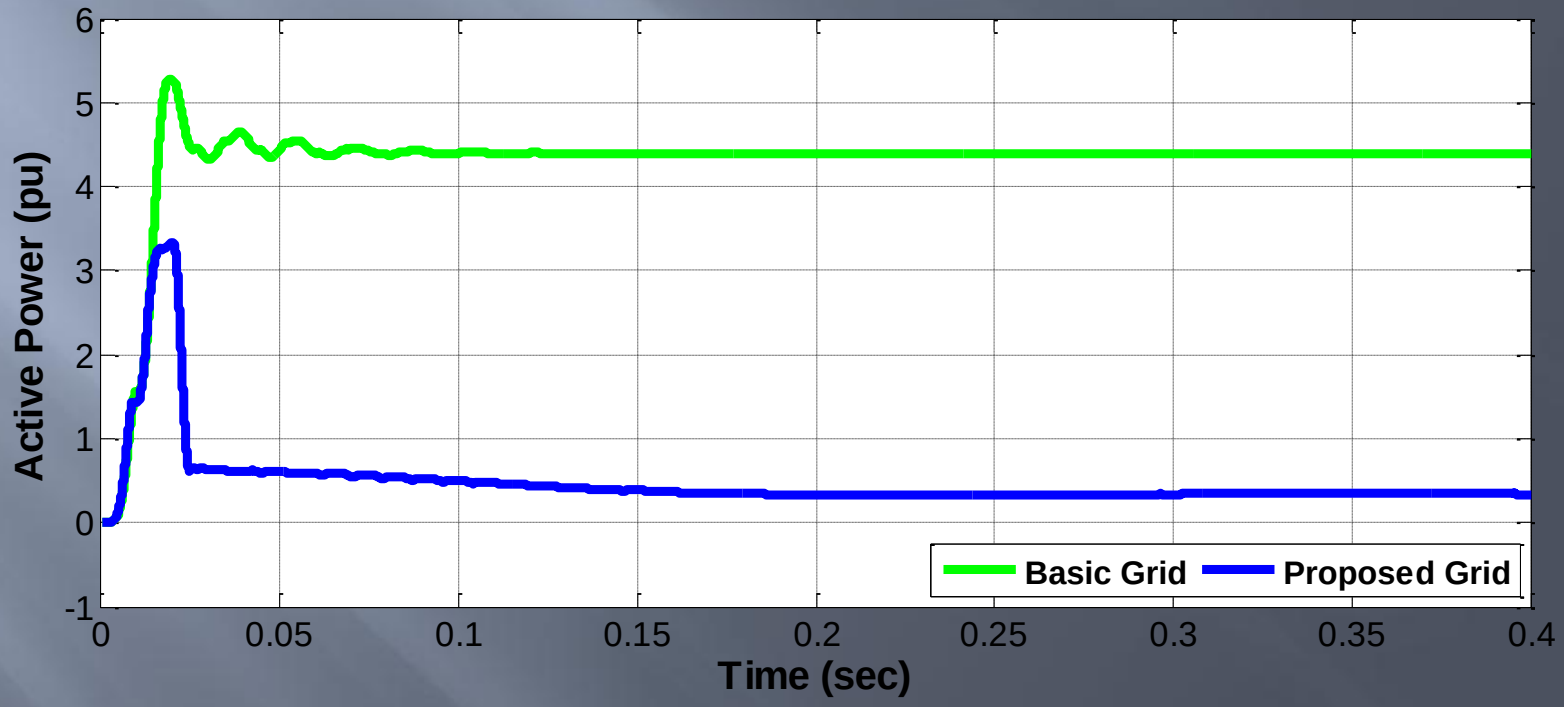
Active Power

Node S



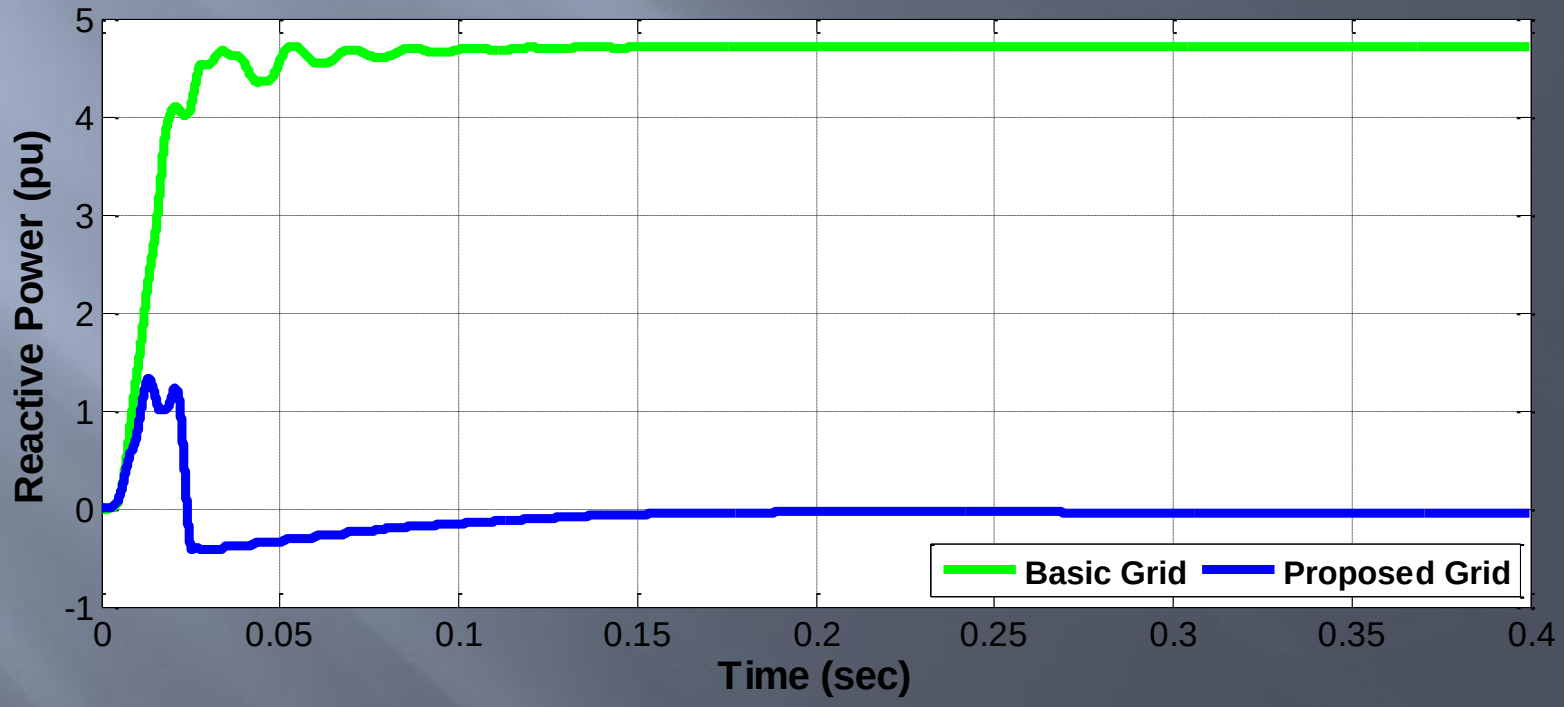
Active Power

Node R



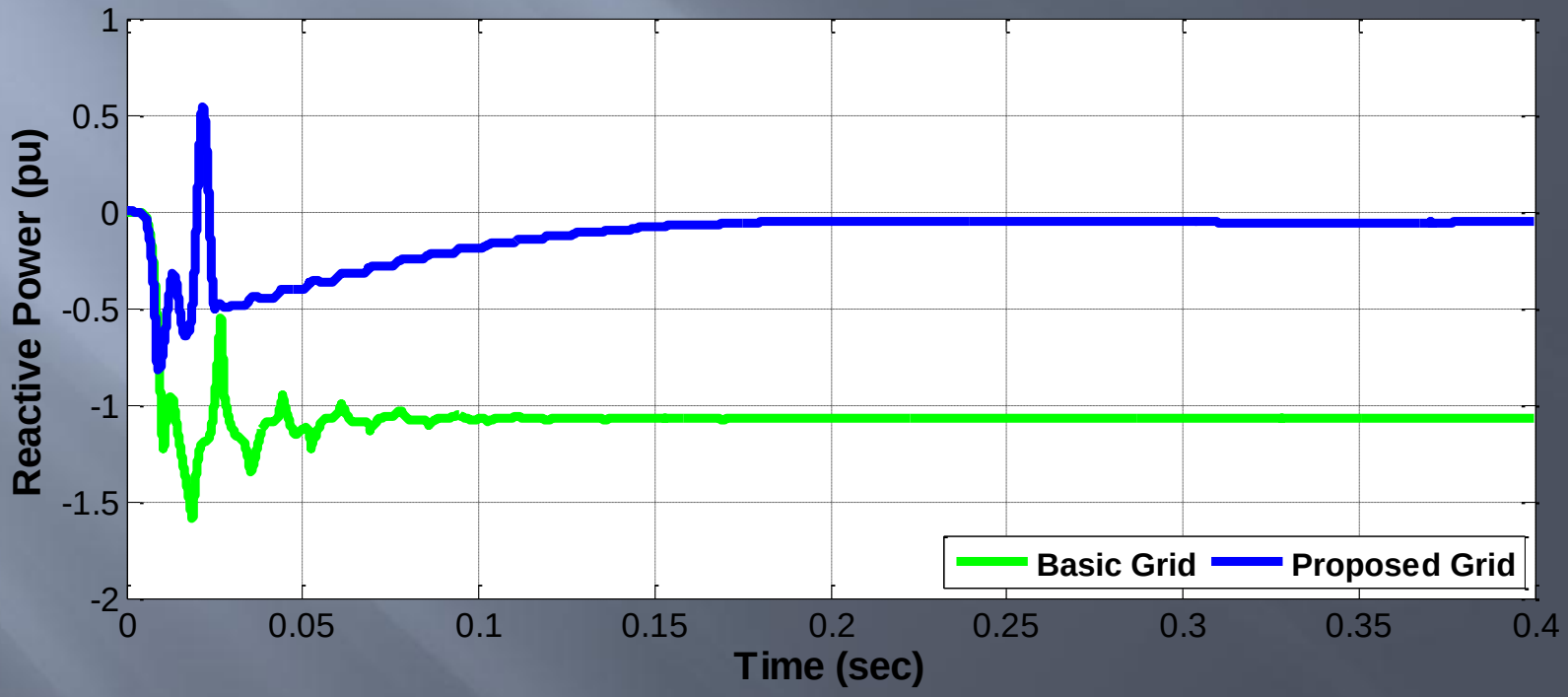
Reactive Power

Node S



Reactive Power

Node R



Conclusions

FACTS Hybrid SCFC **+ Buck-Boost DC/DC Chopper+ Novel Dynamic Control Strategies**

For…

- Improved Voltage Regulation/Minimal inrush/transients in addition
- Improved Power Quality/Power Factor at AC-DC Bus interface
- Reduced reactive Power demand on the Limited Short Circuit and Minimum Impact on Smart Grid Interface
- Flexible Hybrid V_I_P Charging Regimes for Fast Charging
- Can be extended for Flexible AC and DC side interface of PV, Wind and FUEL CELL/Hydrogen PEM Green Renewable Energy Sources

Thank You