Centro interdipartimentale di ricerca
«CENTRO STUDI DI ECONOMIA E TECNICA
DELL'ENERGIA
GIORGIO LEVI CASES"

PROGETTO DOTTORATO DI RICERCA 2014:

Convertitori dc-dc ad elevata efficienza per l'interfacciamento di sorgenti di energia in sistemi di generazione distribuita

High Efficiency Interfacing DC-DC converters for distributed energy systems.

AGGIORNAMENTO DOPO IL PRIMO SEMESTRE

Giovedì 14 maggio 2015

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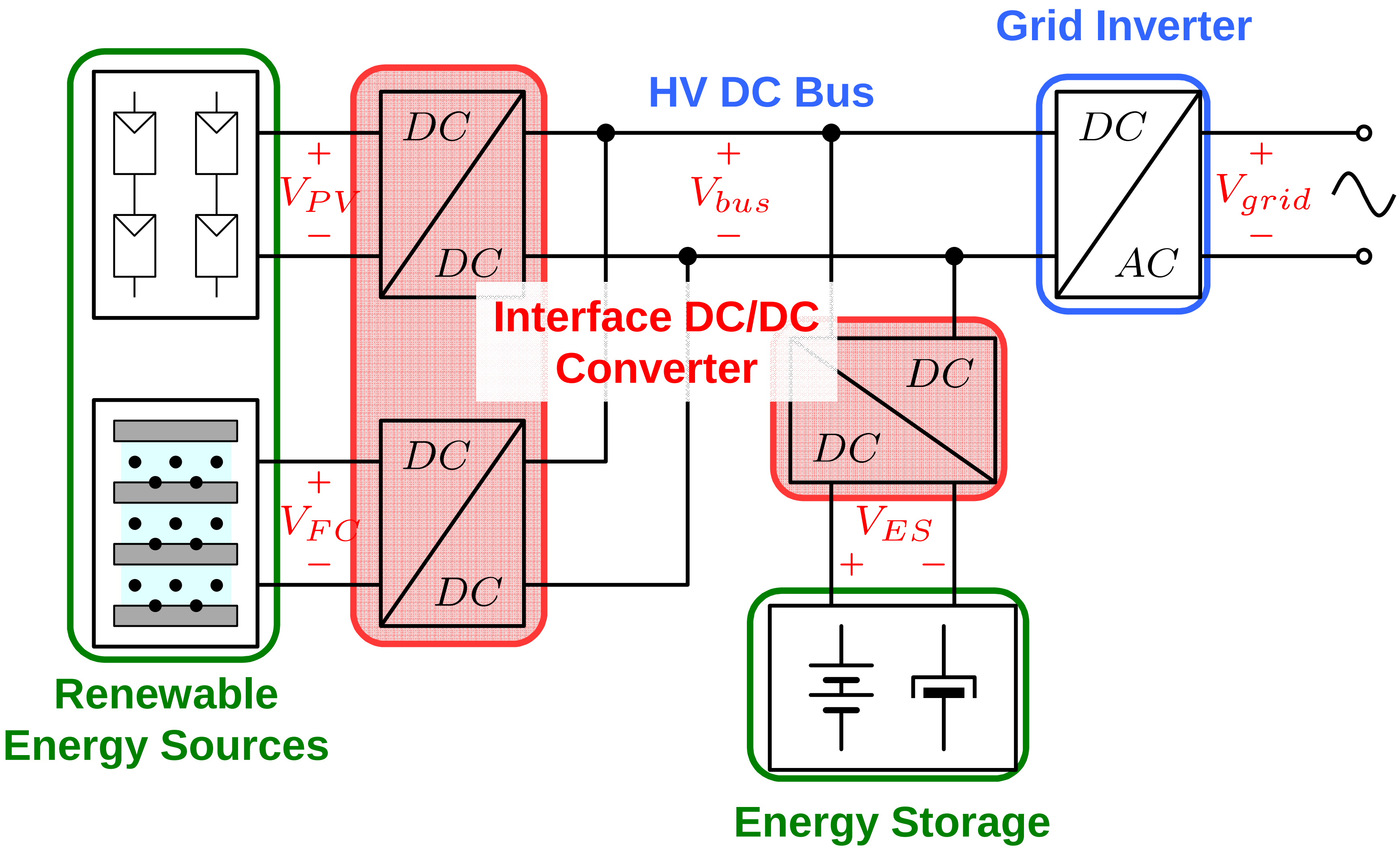
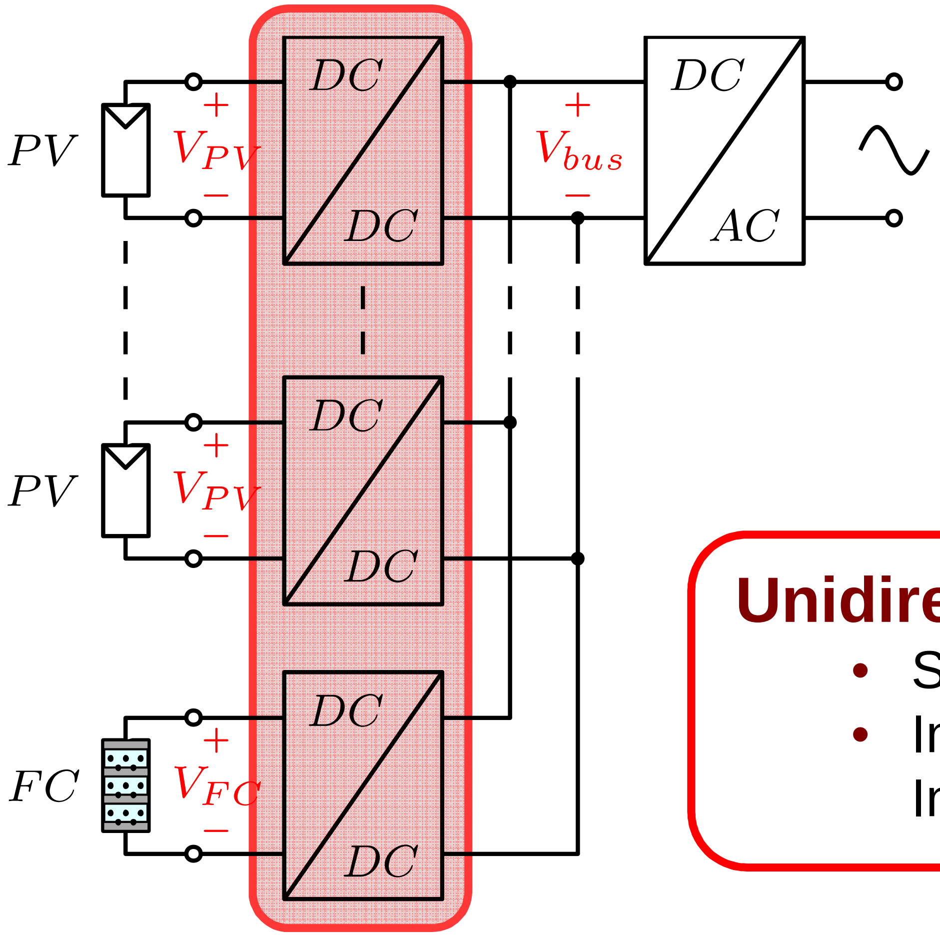
Dottorando: Davide Biadene

Considered Scenario



Interface Topologies for RES

- **Proposed Solution**

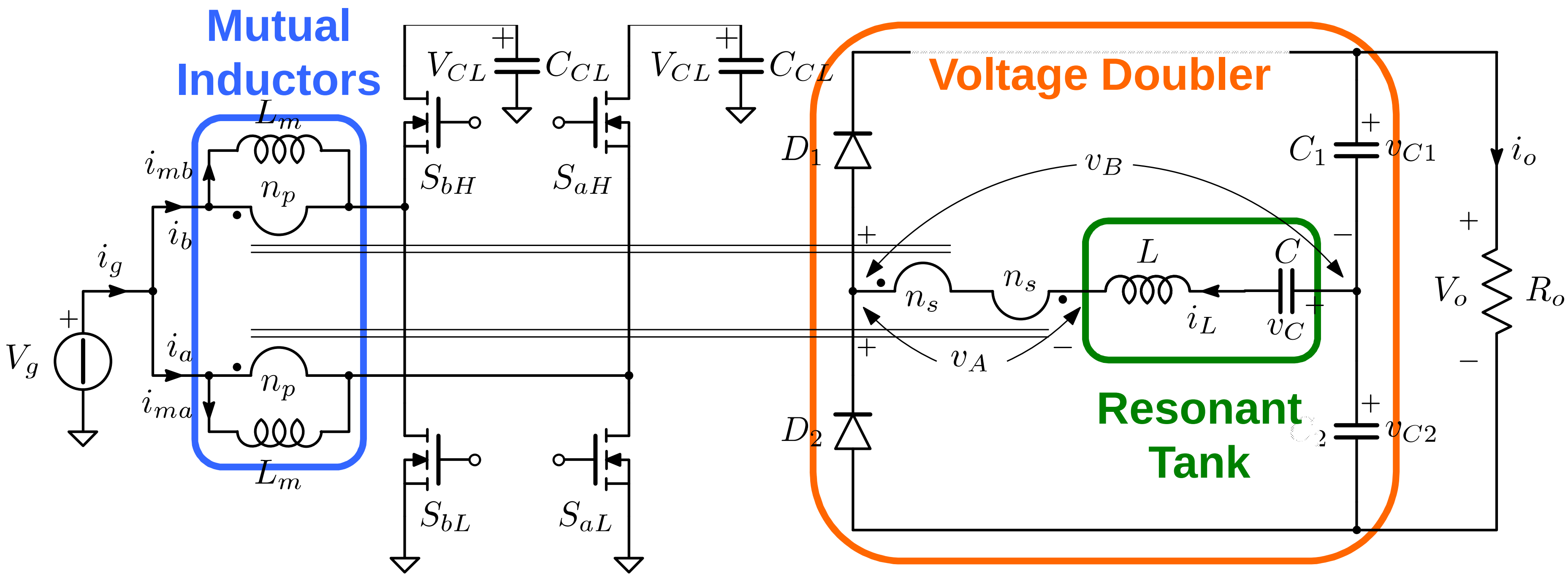


- **Characteristics**
  - No Multiple Maximum Power Points;
  - Maximum Available Power from each RES;
  - High Voltage Gain DC/DC Converter;
  - Possible Galvanic Isolation.

Unidirectional DC-DC Converters

- Single Active Bridge (SAB)
- Interleaved Boost with Coupled Inductors (IBCI)

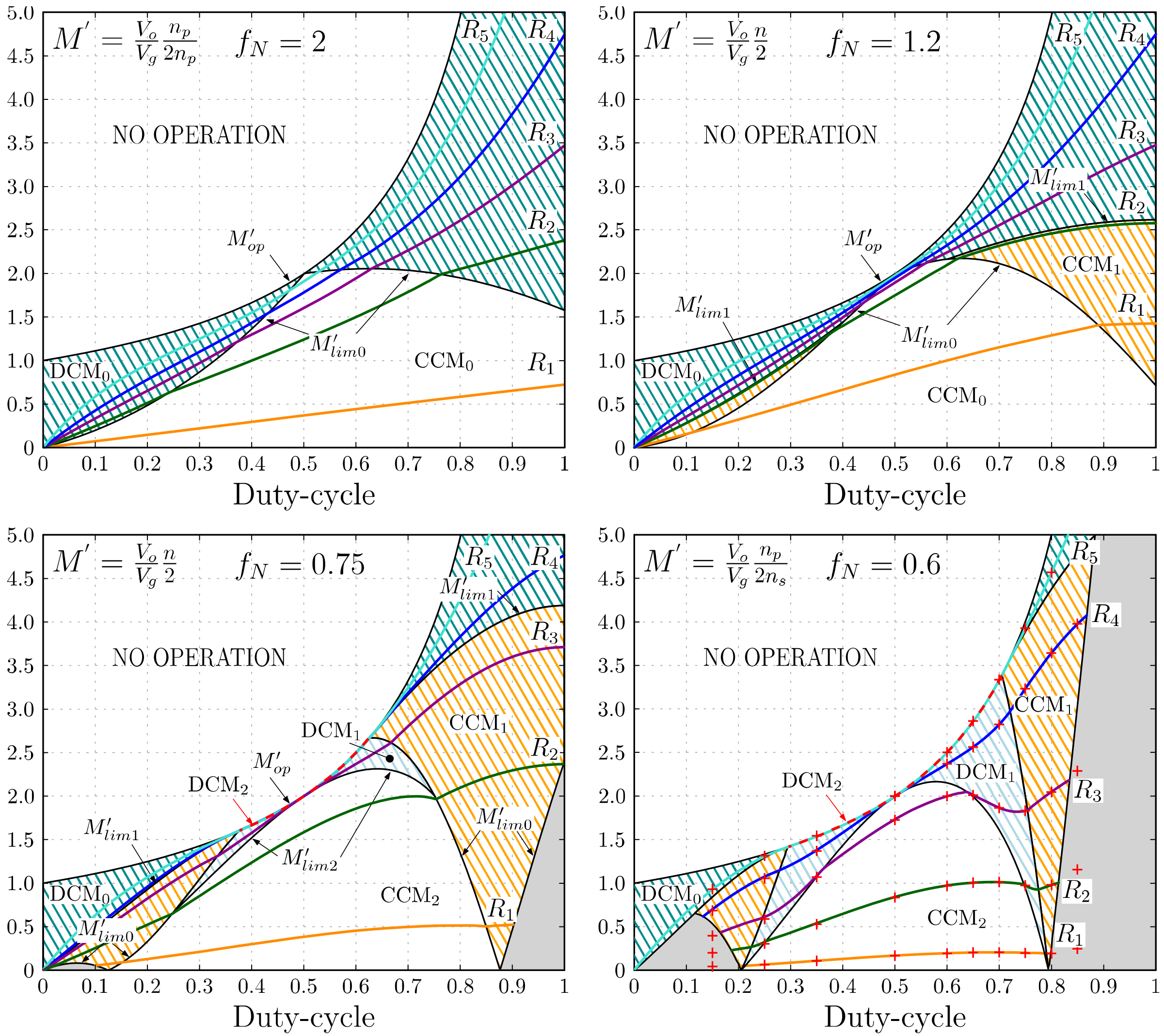
IBCI Converter



- **Characteristics**
  - Mutual Inductors;
  - Output Voltage Multiplier;
  - Resonant Tank;
  - Galvanic Isolation.
- **Advantages**
  - Small Input Current Ripple;
  - Less Switch Voltage Stress;
  - Improved Voltage Gain;
  - Controlled Switching Losses.

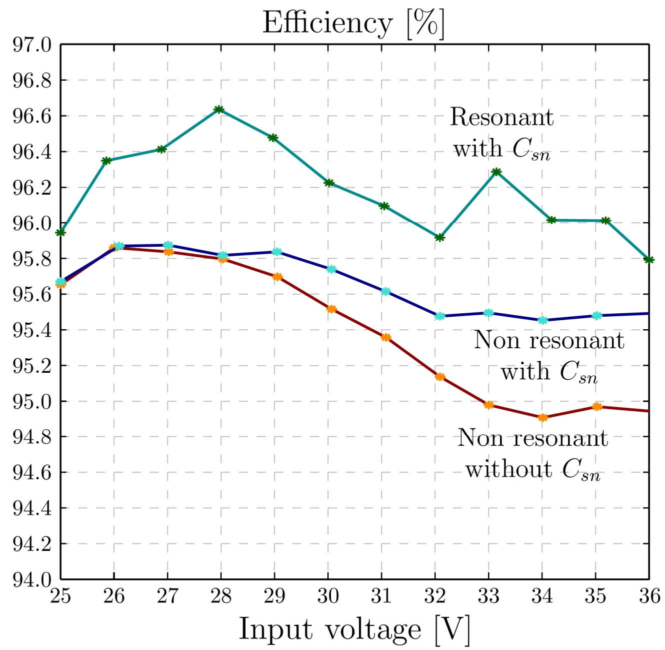
IBCI Converter

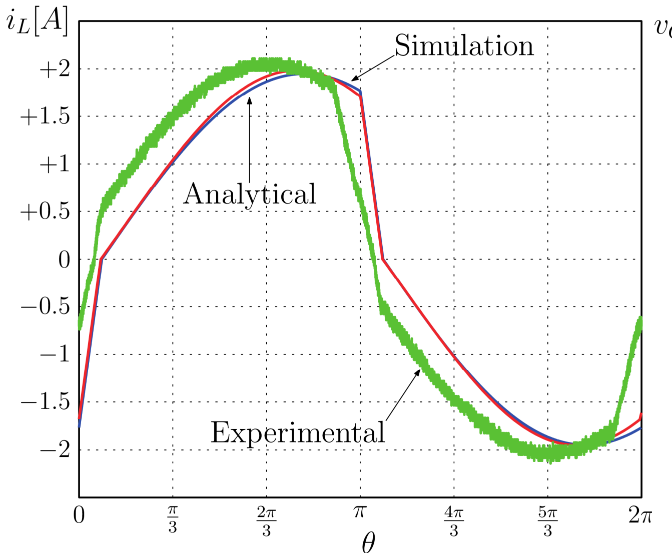
- **IBCI Converter Characterization**
  - Steady State Analysis (for almost all interested operating modes):
    - State Trajectories
    - Switch Voltage and Current Stress
    - Mode Boundaries
  - Voltage Gain:
    - Function of duty-cycle, frequency.
  - Output Power.

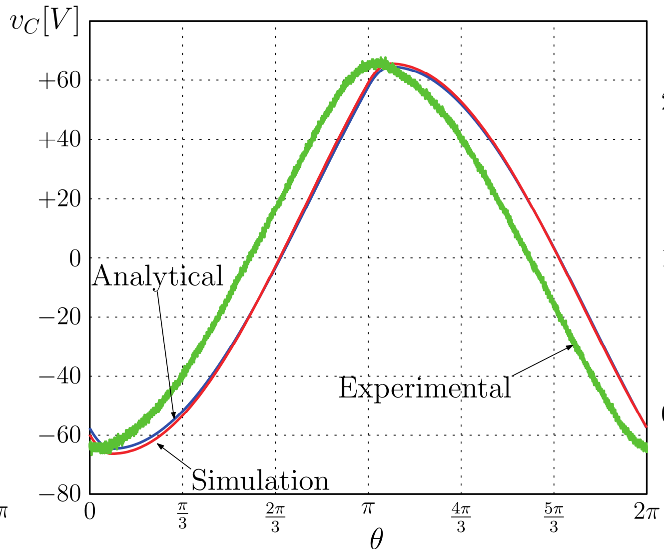


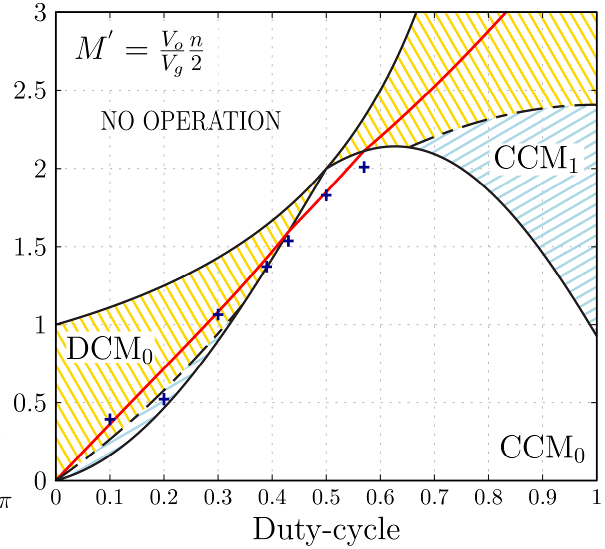
IBCI Converter

- **Validation of the theoretical analysis**
  - Simulation via Simulink-Matlab
  - Prototyping
  - State Trajectories Comparison
  - Voltage Gain Comparison
  - Efficiency Comparison





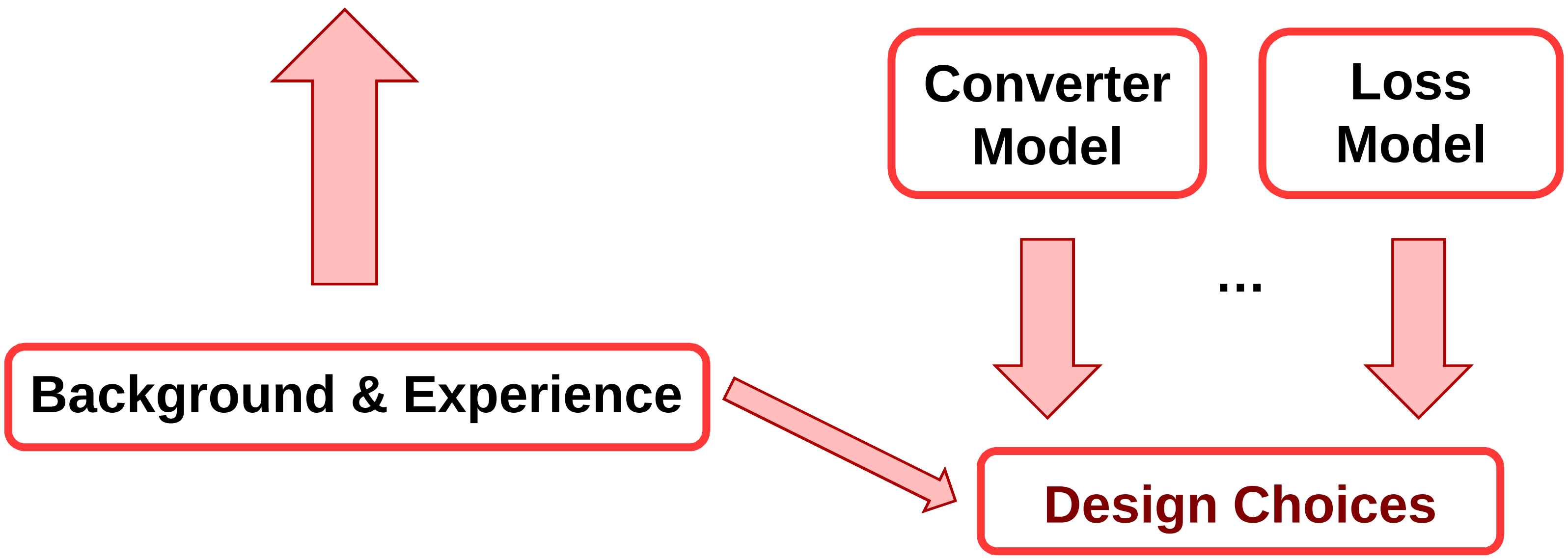




Optimum Design

- **Design Choices**
  - Switching Frequency;
  - Magnetic Core and Windings:
    - Winding Layout,
    - Core Type and Material.

- **Design Objectives**
  - Efficiency;
  - Volume;
  - Power Density;
  - …



Efficiency Optimization

- **Switching Losses**
  - Due to the stored energy in the switch parasitic capacitance;
  - $\propto$ Switching Frequency;
  - V-I superposition.

Feasible Loss Model

- **Magnetic Component and Winding Layout**
- **Switching Frequency**
- **Operating Mode**

- **Magnetic Losses**
  - Magnetic cores and windings;
  - Different contributions:
    - Hysteresis Loss,
    - Classical Eddy Current Loss,
    - Excess Eddy Current Loss,
    - Relaxation Process.
  - Strongly Non Linear Behaviour;
  - Different detailed model approaches:
    - Steinmetz Equation (SE),
    - Generalized SE (GSE),
    - Improved GSE (iGSE),
    - Preisach Model.

Conclusion

- **Addressed Issues**
  - Magnetic Materials:
    - comparison between different Loss Models proposed in literature,
    - Loss Measurement Methods.
  - IBCI Converter:
    - detailed steady-state analysis,
    - improved efficiency.
- **Future Issues**
  - Propose a Complete Design Procedure for DC/DC Converters,
  - Propose a feasible Magnetic Loss Model.