Engineering Research Center

Future Renewable Electric Energy Delivery and Management (FREEDM) Systems

Dr. Alex Huang, Director
Progress Energy Distinguished Professor
of Electrical and Computer Engineering

NC STATE UNIVERSITY

ASU Arizona State University

Florida State University

Florida A&M University

Missouri S&T

RWTH Aachen University

ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich

FREEDM Systems Center

- Core Partner Universities
  - NC State University
  - Missouri University of Science & Technology
  - Florida State University
  - Arizona State University
  - Florida A & M University
- International Universities
  - Aachen University (Germany)
  - Swiss Federal Institute of Technology (Switzerland)
- Affiliated Universities
  - Auburn University
  - Univ. of Buffalo
- National Laboratories
  - Sandia National Lab (SNL)
  - National Renewable Energy Lab (NREL)
  - National Electric Technology Lab (NETL)
- Industry Partners
  - (31 companies)
- Innovation Partners (17)
- Pre-College Partners
  - 9 middle schools
  - 5 high schools

FREEDM Systems Center

Industry Collaboration and Innovation

Full Member (6)

ABB

China Qianjiang Group

DRS TECHNOLOGIES

MegaWatt Solar

DELTA

consert
COMMUNICATE · CONTROL · CONSERVE

Associate Member (12)

AEP AMERICAN ELECTRIC POWER

Duke Energy

EATON

GE

International IOR Rectifier

M.C. DEAN
BUILDING INTELLIGENCE

Progress Energy

HRL LABORATORIES

SILICON POWER

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL Company

PSi

UL Underwriters Laboratories Inc.

Affiliate Member (13)

Maxwell TECHNOLOGIES

ACLARA

Advanced ENERGY

AVRC Advanced Vehicle Research Center

Beacon POWER

EnerNex CORPORATION

EPRI ELECTRIC POWER RESEARCH INSTITUTE

EVANS CAPACITOR COMPANY

KEMA

MICROCELL Delivering the Future...

RTI INTERNATIONAL

United Technologies Research Center

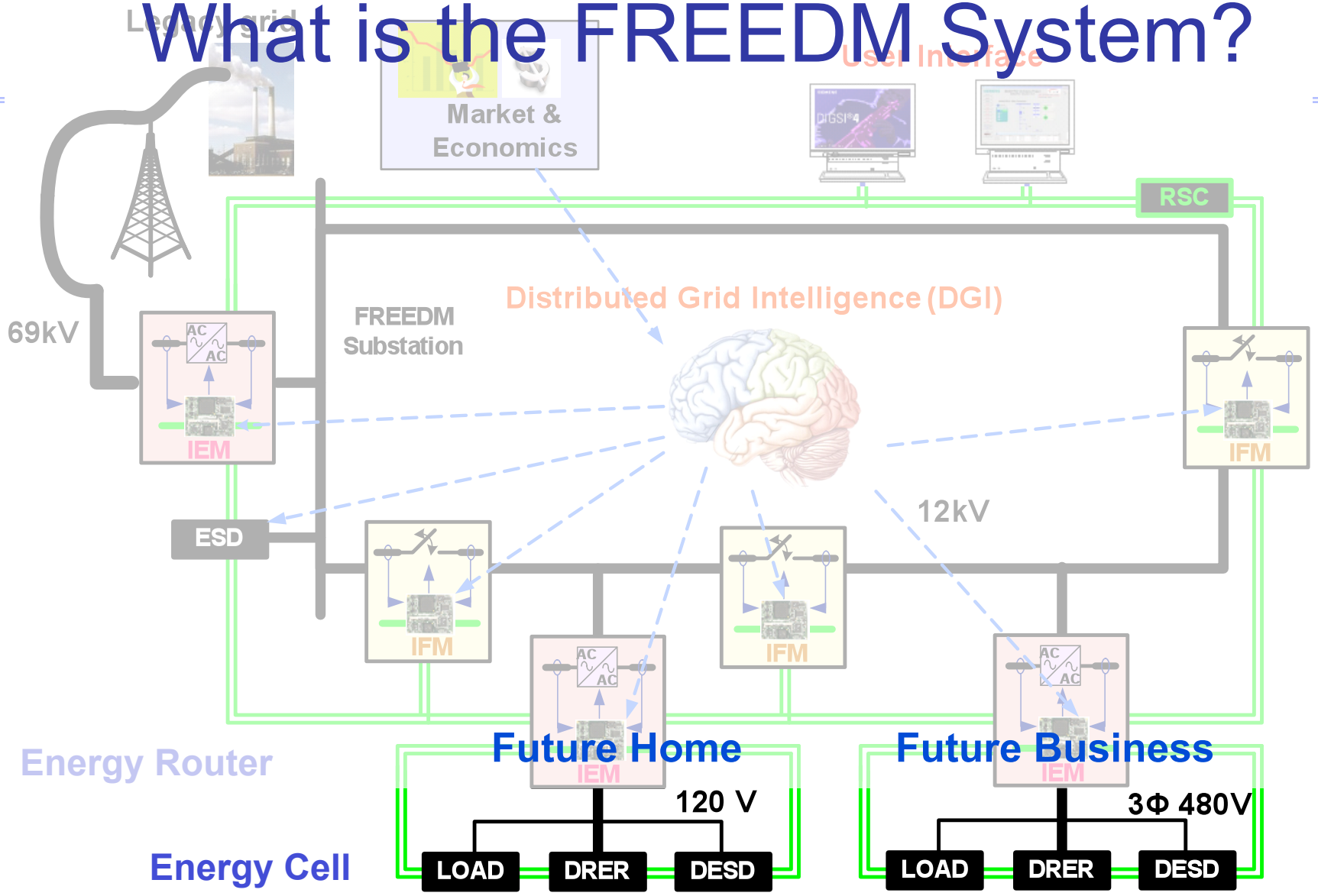
Venture 2 Reality, LLC

Center Vision

- To develop an efficient and revolutionary power grid
  - Utilizing revolutionary **power electronics** technology and **information technology**
  - Integrating distributed and scalable alternative energy sources and storage with existing power systems
  - Automate the management of **load**, **generation** and **storage**

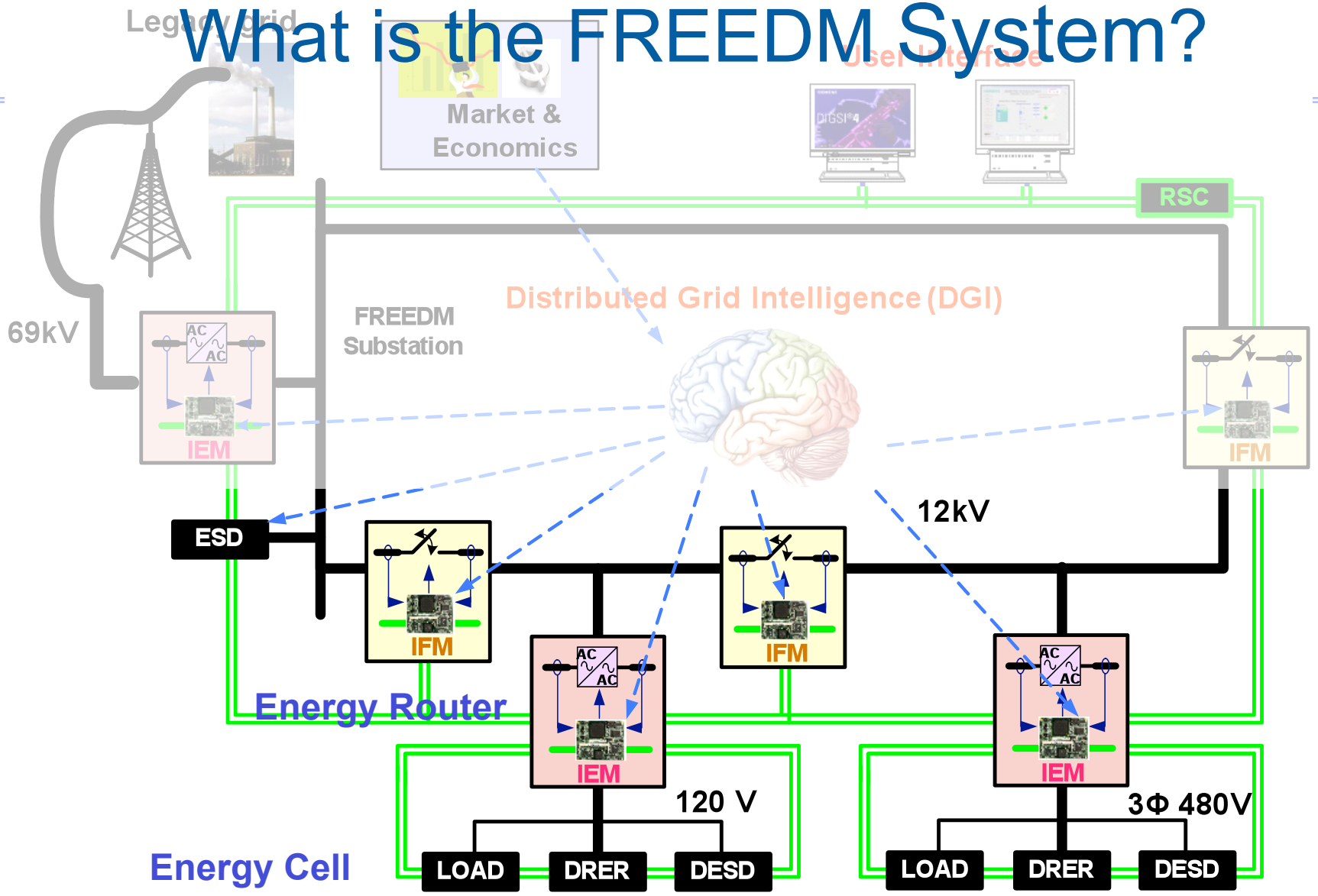



What is the FREEDM System?



DRER: Distributed Renewable Energy Resource **DESD**: Distributed Energy Storage Device

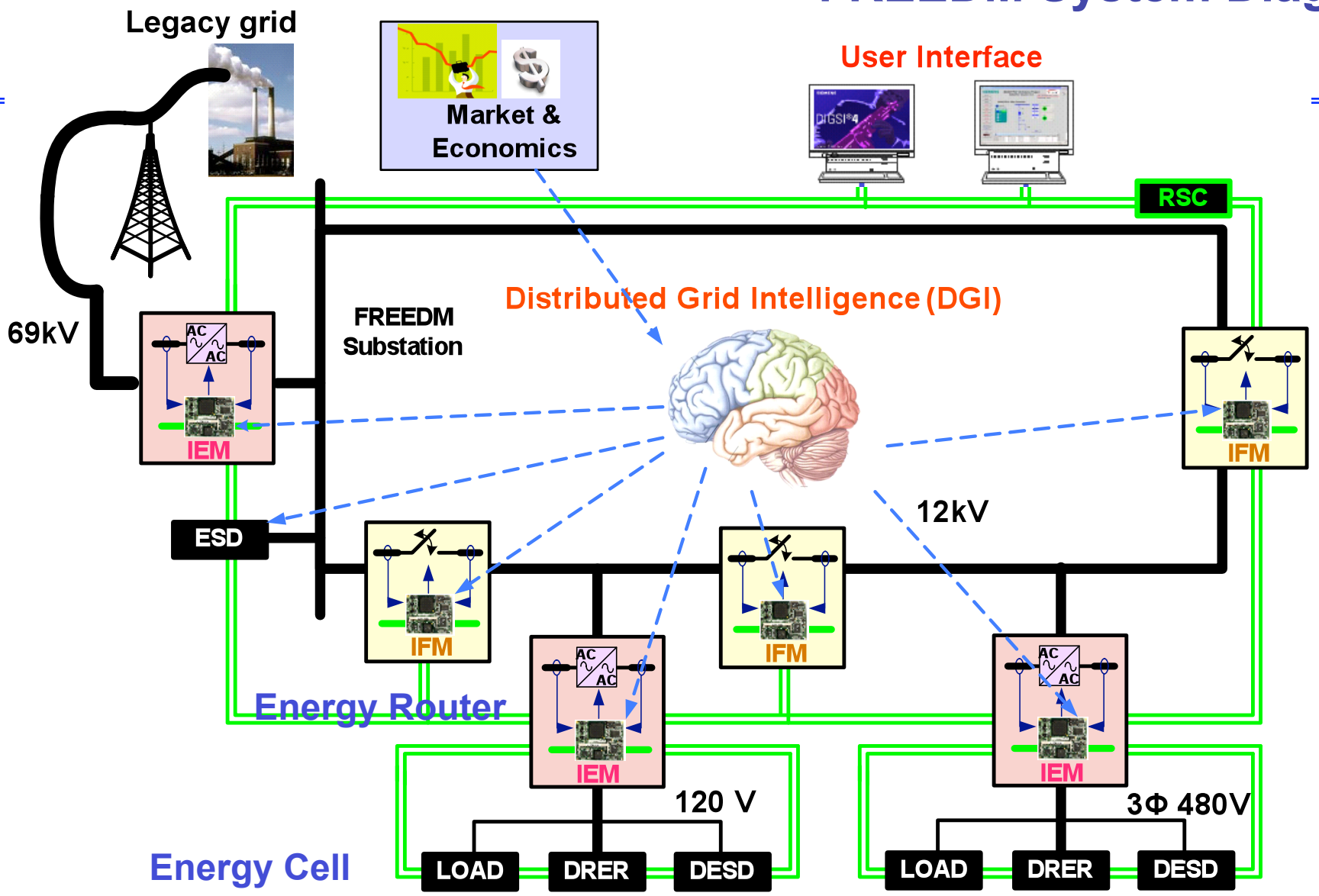
What is the FREEDM System?



IEM: Intelligent Energy Management **IFM**: Intelligent Fault Management

DRER: Distributed Renewable Energy Resource **DESD**: Distributed Energy Storage Device

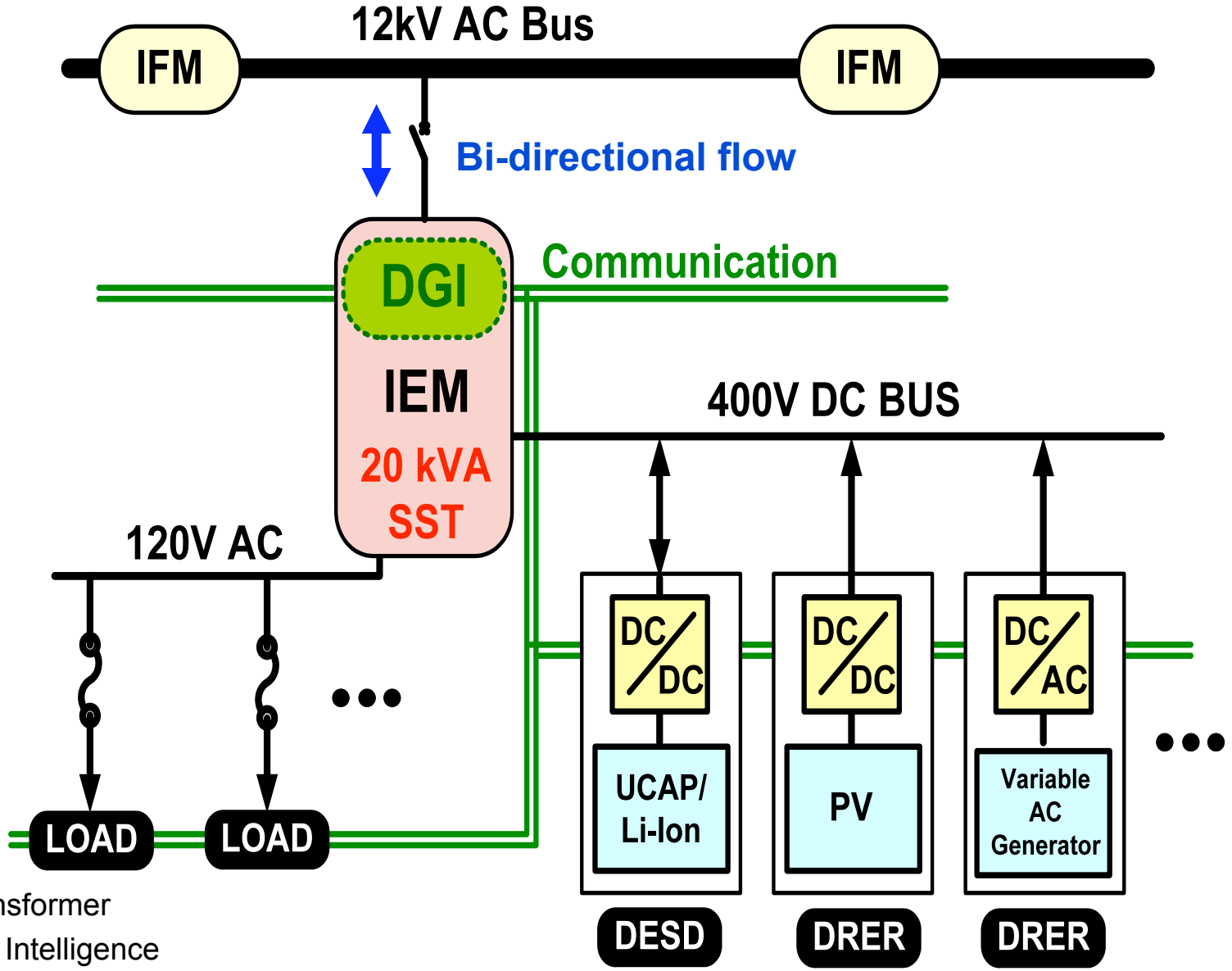
FREEDM System Diagram



IEM: Intelligent Energy Management **IFM**: Intelligent Fault Management

DRER: Distributed Renewable Energy Resource **DESD**: Distributed Energy Storage Device

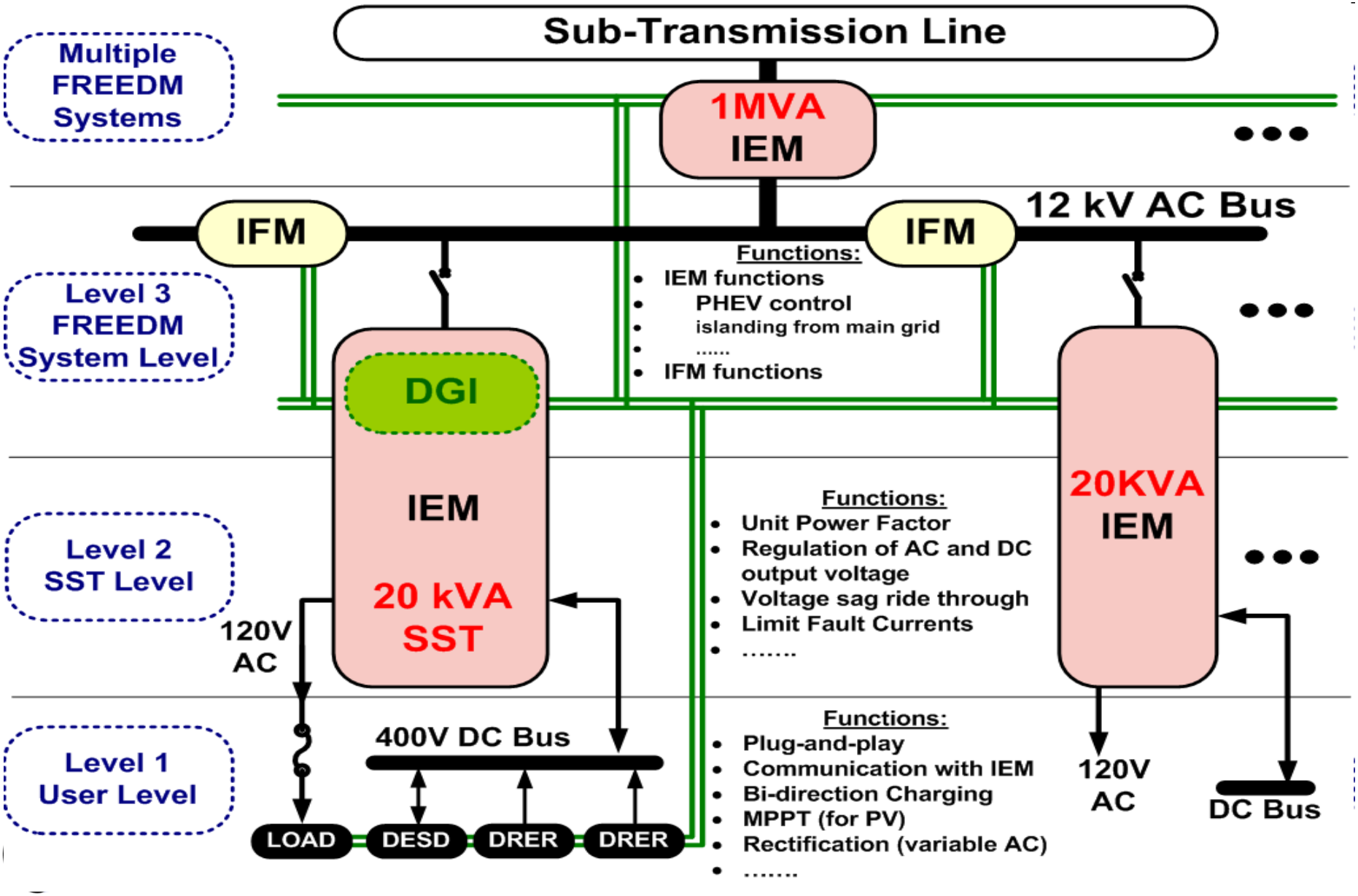
A closer look of the IEM and future home



SST: Solid State Transformer

DGI: Distributed Grid Intelligence

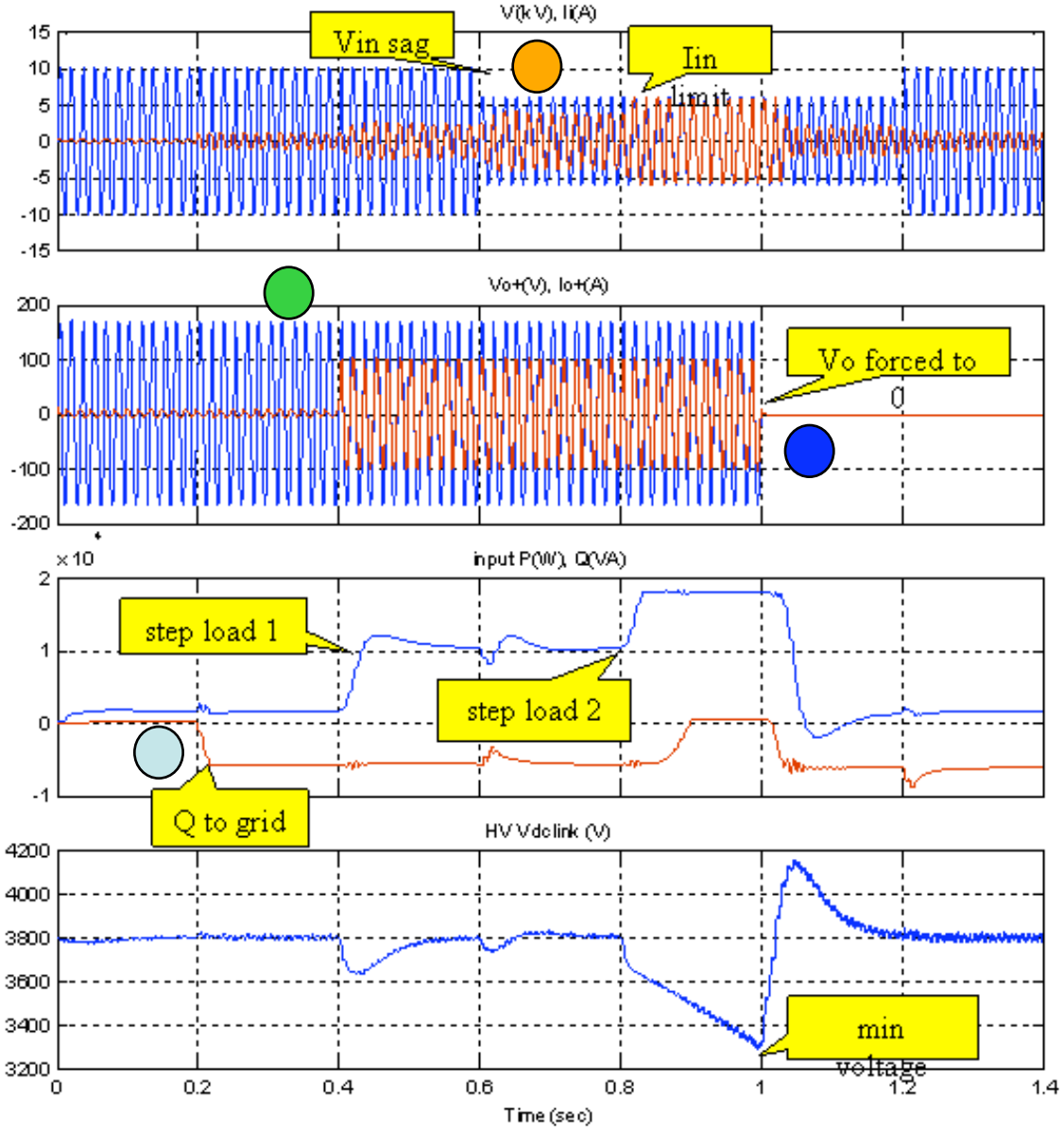
SMC Subthrust Control Roadmap



Simulated SST Capabilities (Level 2 Control)

Project Y1.E.C5
Prof. Raja Ayyanar (ASU)

- A SST model is developed and used by center teams
- Unity power factor or arbitrary VAR support
- Voltage regulation (120V And 400VDC)
- Voltage Sag Rid Through
- Short circuit current limiting



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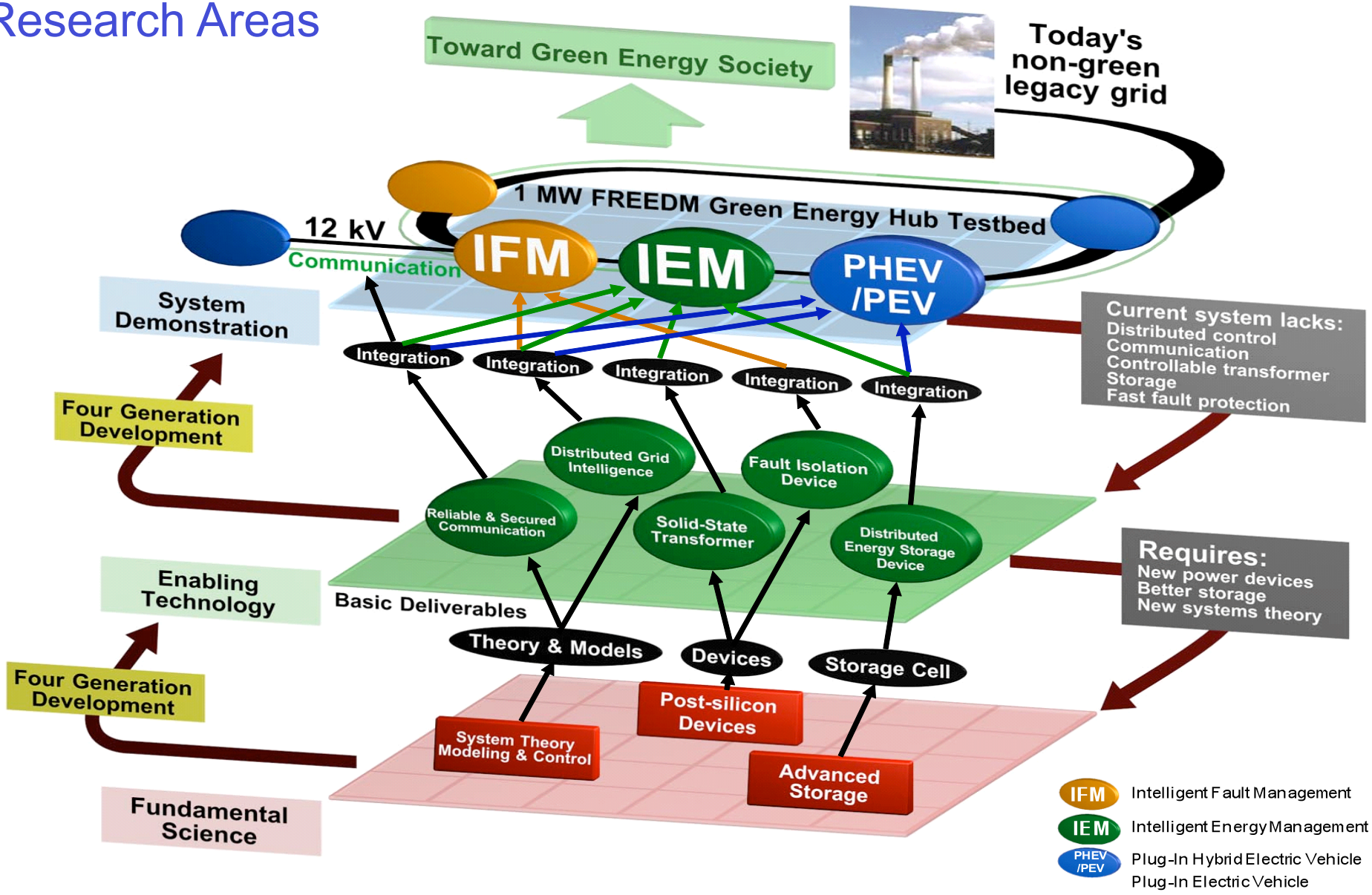
FREEDM Research Areas



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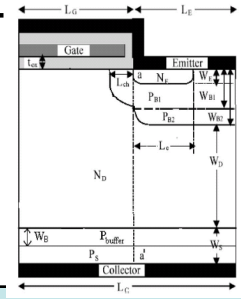
PSD Subthrust Roadmap

Year 1

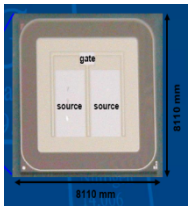
6.5 kV, 125°C, 3 kHz
Silicon IGBT

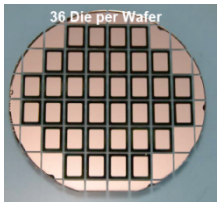


10 X improvement in speed*voltage

Year 3

15 kV, 125°C, 10 kHz
Silicon Carbide IGBT Technology



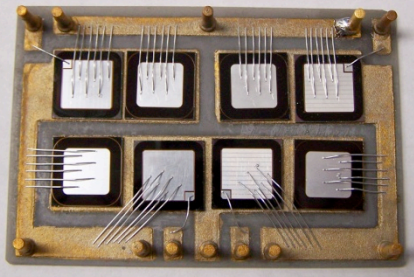


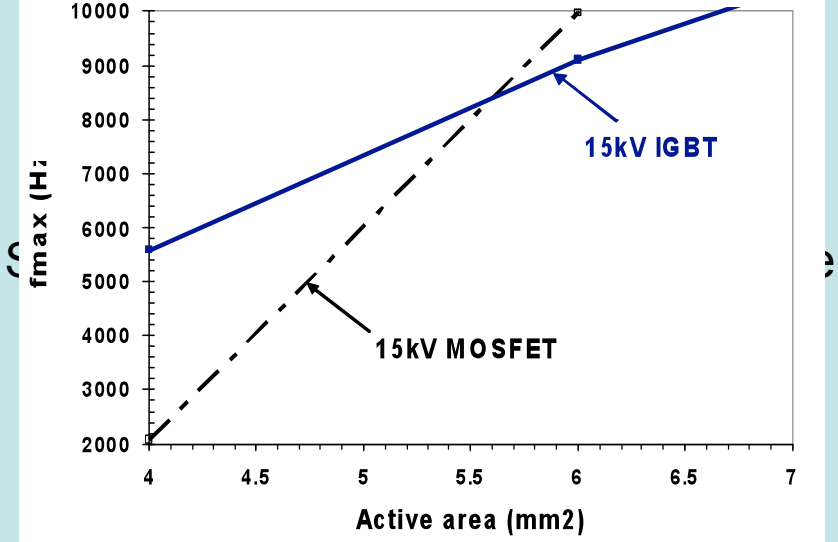
CREE®

ABB

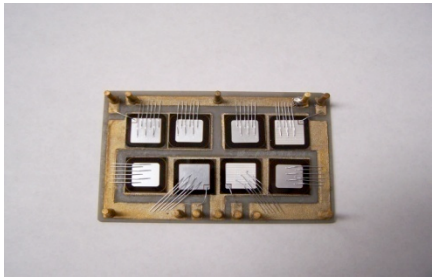
AEgis TECHNOLOGIES

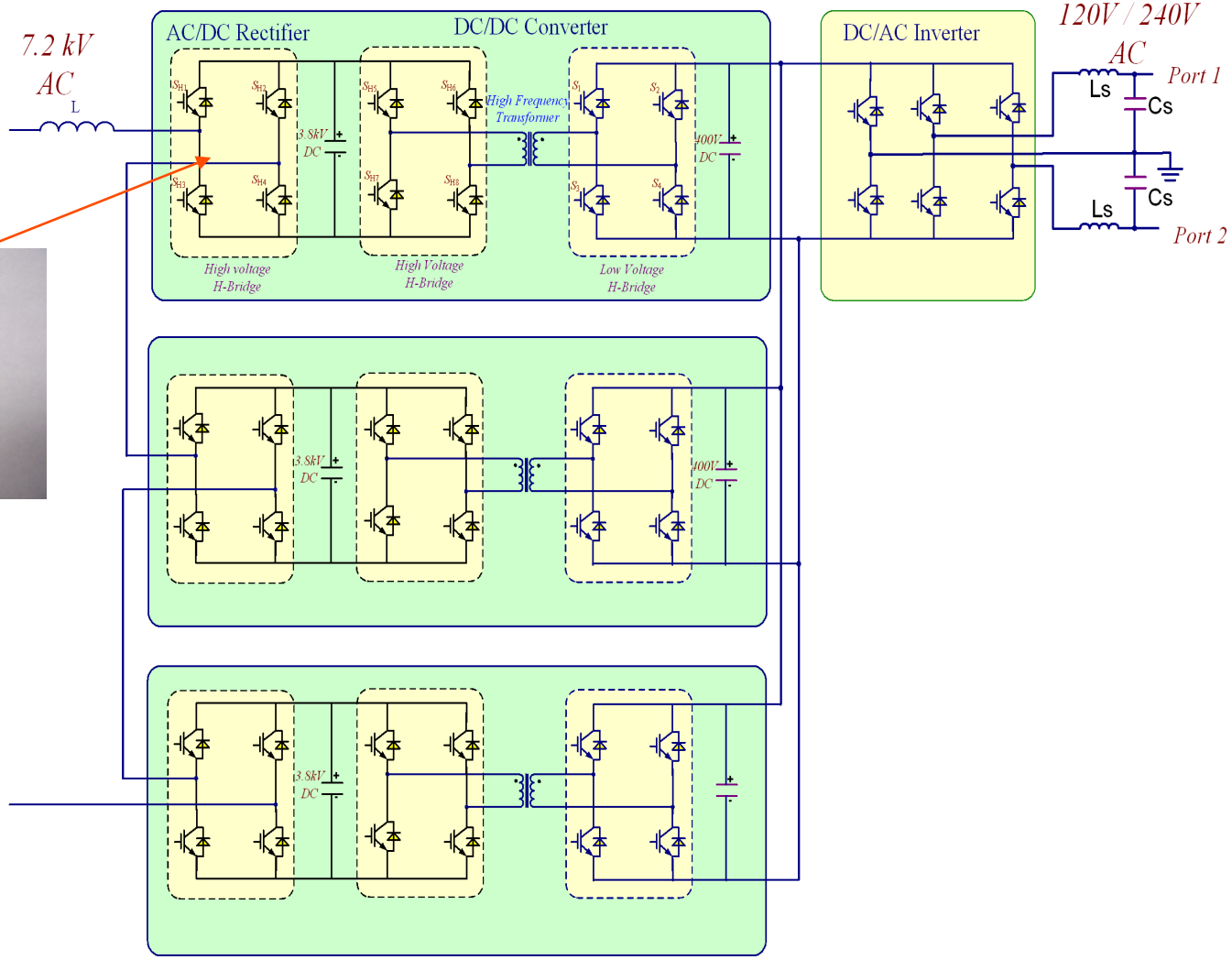
6.5 kV/25A Module





Year 1-2 Gen-I SST Target
Based on 6.5 kV, 3 kHz IGBT





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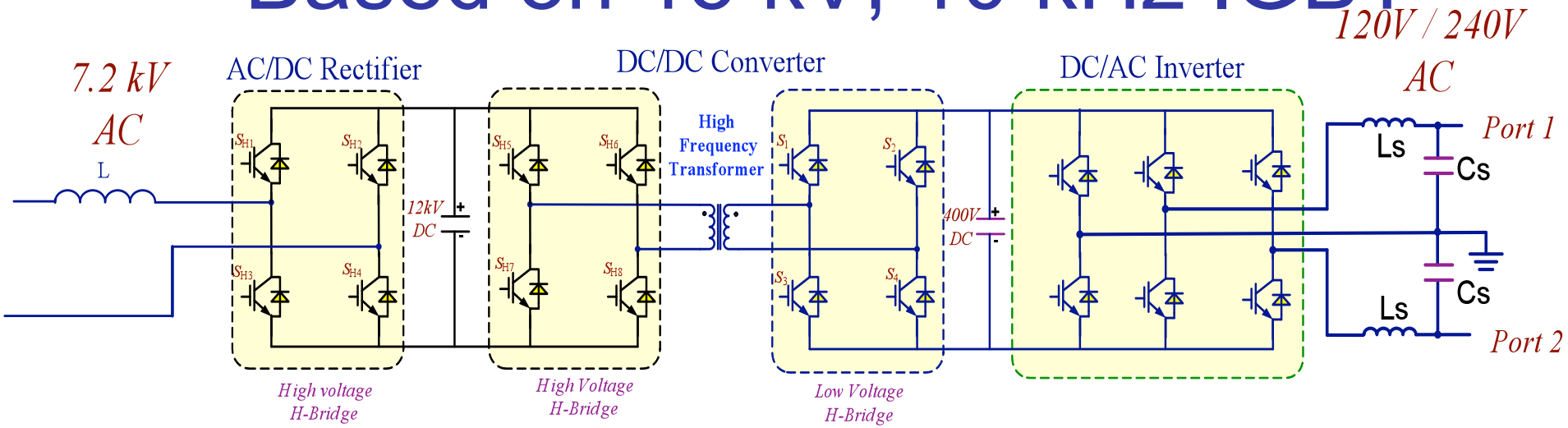
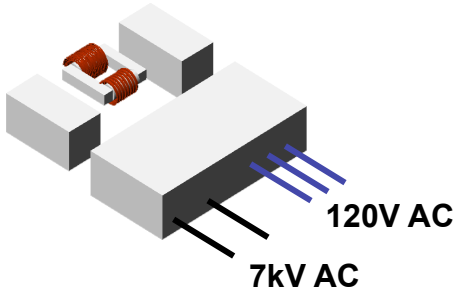
Year 3-5 Gen-II SST Target
Based on 15 kV, 10 kHz IGBT



Distribution Transformer

size reduction
weight reduction

Solid State Transformer (SST)



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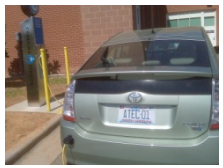
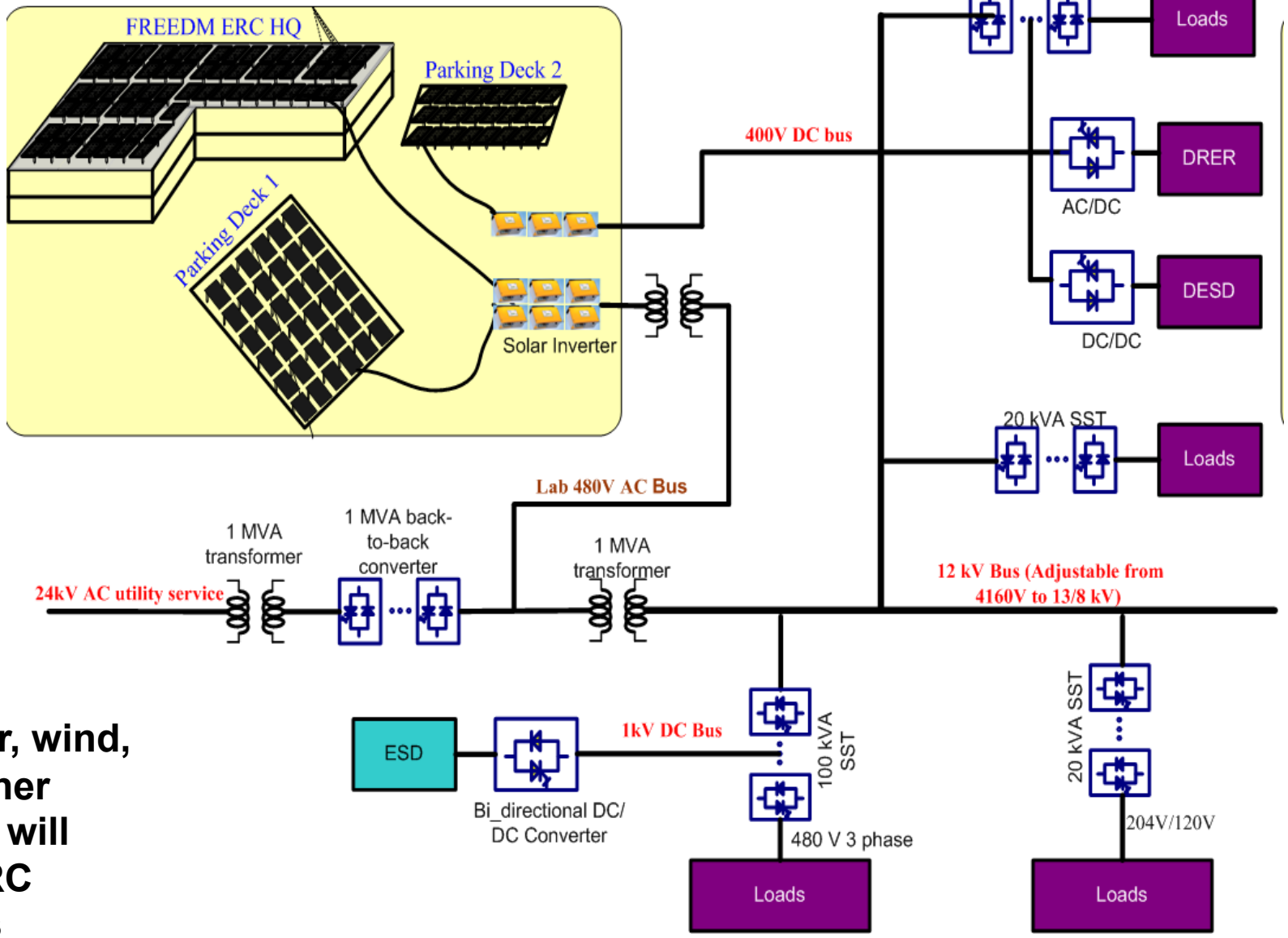
1 MW FREEDM System Green Energy Hub





A mix of solar, wind, PHEV and other technologies will power the ERC headquarters