Power Electronics in Utility Application in Korea

忠北大学
Jaeho Choi

(Choi 先生には、平成 20 年 8 月 2 日、第 174 回定例研究会においてご講演頂きました)
Energy Management System (EMS) and Test Site for Microgrid

Prof. Jaeho Choi
Chungbuk National University

Outline of Presentation

1. Introduction of Chungbuk National University (CBNU)
2. Introduction of Power IT National Projects in Korea
3. Development of Energy Management System and Test Site for Microgrid
4. Conclusion

Chungbuk National University

- 1951: Started originally from Cheongju Junior Agricultural College
- 1977: Upgraded to Chungbuk National University
  - 18,000 students
  - 644 faculty members
- 1997: School of Electrical and Computer Eng.
- 2009: College of Electrical and Computer Eng.
**School of Electrical & Computer Engineering (ECE)**

<table>
<thead>
<tr>
<th>Division</th>
<th>No. of Students (Under.)</th>
<th>No. of Graduate Students</th>
<th>No. of Ph.D.</th>
<th>Contact Faculty</th>
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</thead>
<tbody>
<tr>
<td>Electrical Eng.</td>
<td>71</td>
<td>28</td>
<td>10</td>
<td>3</td>
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<tr>
<td>Electronics Eng.</td>
<td>105</td>
<td>63</td>
<td>19</td>
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<td>Information &amp;</td>
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<tr>
<td>Communication Eng.</td>
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<td>88</td>
<td>17</td>
<td>16</td>
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<tr>
<td>Computer Eng.</td>
<td>109</td>
<td>68</td>
<td>17</td>
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</tbody>
</table>

*Registered Students*

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**Division of Power Engineering**

- 10 Faculties
  1. Electrical Material Lab.
  2. Power Electronics Lab.
  4. Semiconductor Lab.
  5. Electrical Machine Lab.
  7. Plasma Lab.
  8. Communication Lab.
  10. Control Lab.

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**Lab. of Energy and Power Electronics Application in CBNU**

- Faculty: Prof. Jaeho Choi
  Chungbuk National University
  School of Electrical and Computer Engineering
  410 Sungbong-Ro, Heungduk-Gu, Cheongju, Chungbuk 361-763
  Republic of Korea
  choi@chungbuk.ac.kr
  Tel: +82-43-261-2425

- Students
  - Ph. D: 2+1(FT), 6(PT)
  - Master: 4(FT)

- Graduate Students
  - Ph. D: 15
  - Master: 46

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**Current Research Activities of EPE Lab. in CBNU**

1. CRA Based Design Controller for Power Converter
   - PWM Converter for Traction Drives
   - Inverter System for Renewable Energy Sources
2. Overmodulated PWM Technique for Three Level Inverter
   - Traction Drives Application
3. Energy Storage System for Supercapacitors
   - SM Flywheel System
4. Management and Control of Micro-Grid System
5. Power Quality Monitoring and Classification

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Center for Power IT National Program (CPIT)

Power IT?
Implementation and integration of information and communication technology for power technology, power systems, and power business.

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History of Korean Power IT Program

- Dec. 2004: Power IT Steering Committee was created by the Ministry of Knowledge Economy (MKE)
- Sept. 2005: Nine Power IT projects were initiated
- Sept. 2006: Power IT Education project and Standardization project were initiated
- April 2007: Center for Power IT National Program (CPIT) was established
- Sept. 2007: The tenth Power IT project (Development of integrated EMS for the Microgrid and application technology to real site) was launched

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Organization of CPIT

- Ministry of Knowledge and Economy
- Board of Directors
  - Director
  - Advisory Committee
  - Program and Evaluation Committee
  - CPIT Central Office
  - Technology Management
  - Administrative Management

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Vision, Goal, and Strategy

- Driving force of national development and enabling sustained growth in electricity industry
- Innovation of electricity services and creation of new business in electricity industry
- Implementation of intelligent, environmentally friendly, and high quality electricity supply system
- High value-added and ubiquitous electricity services
- Creation and expansion of Power IT related business
- Education and training of Power IT specialists
- Development of world-class Power IT technologies
- Encouraging convergences among technologies
- Timely commercialization and application of research products
- Seeking for international trend and developing new projects
Composition of Power IT Program

CPIT

- Major large-scale R&D projects
- Small-scale R&D projects
- Supporting infrastructure projects

- Government driven projects based on Power IT technology roadmap
- Currently 10 projects
- Project period: 4-6 years
- Research-oriented projects supporting major Power IT projects
- Currently 8 projects
- Project period: 2-3 years
- Power IT Specialist Education and Training project
-Currently 5 projects
- Project period: 4-5 years

Introduction of Major Power IT R&D Projects (1)

<table>
<thead>
<tr>
<th>Project</th>
<th>Contractor</th>
<th>Participants</th>
<th>Period</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Korea Energy Management System (K-EMS)</td>
<td>Korea Power Exchange (KPEX)</td>
<td>Univ/Inst: 7 Ind/8</td>
<td>'05-'10 5yrs</td>
<td>Development of Korea energy management system (KEMS) Development of IT solutions for power system operations Development of power system operations training simulator Future application to Korean electric power system</td>
</tr>
<tr>
<td>IT*-based Flexible AC Transmission System</td>
<td>KEPR</td>
<td>Univ/Inst: 1 Ind/1</td>
<td>'05-'10 5yrs</td>
<td>Development of 1000kVA STATCOM Development of IT-based operations technology of STATCOM Development of 200kVA BTB STATCOM</td>
</tr>
</tbody>
</table>

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Introduction of Major Power IT R&D Projects (2)

<table>
<thead>
<tr>
<th>Project</th>
<th>Contractor</th>
<th>Participants</th>
<th>Period</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intelligent Transmission Network Monitoring &amp; Operation System</td>
<td>KEPR</td>
<td>Univ/Inst: 3 Ind/8</td>
<td>'05-'10 5yrs</td>
<td>Development of real-time transmission network monitoring system management system Development of Reactive power management system Development of transmission risk management system based on GIS Information</td>
</tr>
<tr>
<td>Advanced Substation Automation System Based on the Digital Control Technology</td>
<td>KEPR</td>
<td>Univ/Inst: 4 Ind/16</td>
<td>'05-'11 6yrs</td>
<td>IED development based on the IEC 61850 protocol Total operations management system development for digitalized substations Test and demonstration of the substation automation system</td>
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</table>

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Introduction of Major Power IT R&D Projects (3)

<table>
<thead>
<tr>
<th>Project</th>
<th>Contractor</th>
<th>Participants</th>
<th>Period</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intelligent Distribution Management System</td>
<td>KEPR</td>
<td>Univ/Inst: 6 Ind/16</td>
<td>'05-'10 5yrs</td>
<td>Development of distribution automation central control system Development of intelligent distribution facilities and devices Development of distributed generation interconnection technology</td>
</tr>
<tr>
<td>Active Telematics System for Power Facility Monitoring</td>
<td>KDN</td>
<td>Univ/Inst: 8 Ind/16</td>
<td>'05-'9 4yrs</td>
<td>Development of sensors and sensor network for transmission network monitoring Development of data management system and user platform for transmission network monitoring</td>
</tr>
</tbody>
</table>

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Introduction of Major Power IT R&D Projects (4)

<table>
<thead>
<tr>
<th>Project</th>
<th>Contractor</th>
<th>Participants</th>
<th>Period</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer Portal System for IT-based Energy Service Business</td>
<td>KEPRI</td>
<td>Univ/Inst: 6 Ind: 18</td>
<td>'05-'10</td>
<td>Development of distribution automation central control system, Development of intelligent distribution facilities and devices, Development of distributed generation interconnection technology</td>
</tr>
<tr>
<td>Broadband Power Line Communication</td>
<td>KEPI</td>
<td>Univ/Inst: 7 Ind: 11</td>
<td>'05-'11</td>
<td>Development of broadband PLC modem and network system, Development of open architecture PLC platform technology, Development of performance test system and advanced metering system of BPLC, Development of multi-business services using BPLC technology</td>
</tr>
</tbody>
</table>

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Definition of Microgrid

- Electrical network system for special districts
e.g. industrial plant, power park, etc.
- Power supply system with controlling and operating functions for various types of distributed generations, storage devices, and loads

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Concept of Microgrid

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Energy management system and test site for microgrid

Project Title
Development of Management System and Test Site for Microgrid

Period

Total Fund
US$ 14.65 M

Research Objective
- Technology development for highly reliable/efficient power grid
- Key device development, pilot plant for urban and rural system

Research subject and project Schedule

Technology Development for Key Device Commercialization

<table>
<thead>
<tr>
<th>1st Subject</th>
<th>2nd Subject</th>
<th>3rd Subject</th>
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<tbody>
<tr>
<td>1st Phase</td>
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<tr>
<td>Std. Network Gateway</td>
<td>Design Package</td>
<td>100kW Class</td>
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<tr>
<td>Std. PCS Specification</td>
<td>Engineering Tech.</td>
<td>Performance Evaluation</td>
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<tr>
<td>2nd Phase</td>
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<tr>
<td>Modular/Std. PCS</td>
<td>Integrated Op. System</td>
<td>MW Class</td>
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<tr>
<td>BTS</td>
<td>Management System</td>
<td>Prototype MG</td>
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<tr>
<td>Control IED</td>
<td>Facility Monitoring System</td>
<td>Performance Evaluation</td>
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<tr>
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<td>Standardization</td>
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</table>

Pilot plant system
Current Research Activities of EPE Lab. in CBNU

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Thank you for your attention!
chol@chungbuk.ac.kr