



# Smart Grids Testing: Work Under ISGAN's Smart Grid International Research Facility Network



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**Joint TCP Workshop:**  
**Energy Efficiency in Future Electricity Systems: The Invisible Fuel**  
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**CLEAN ENERGY**  
MINISTERIAL

Accelerating the Transition to Clean Energy Technologies



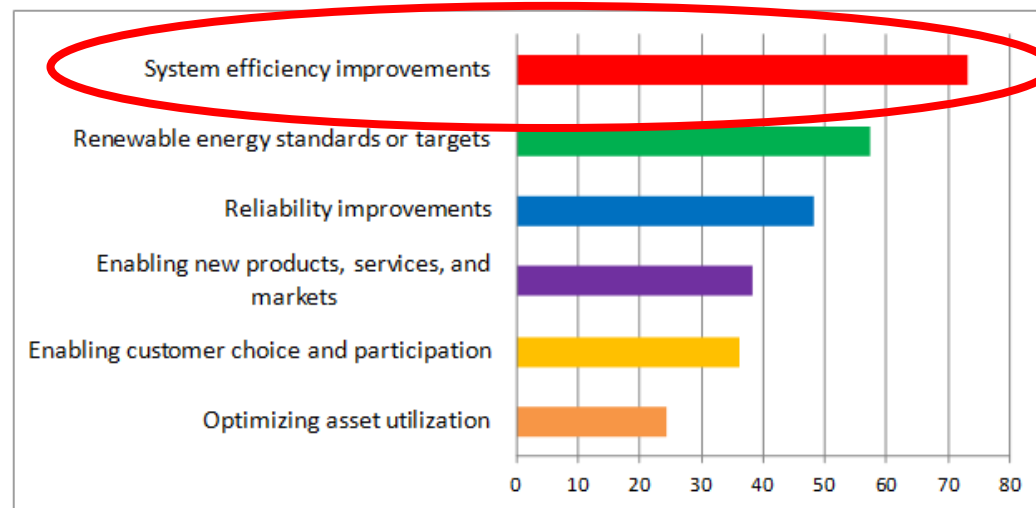
# Why Multilateral Cooperation on Smart Grids



## Diverse Systems, Common Drivers:

- Electricity **grids differ greatly** from country to country, market to market, in technical characteristics, market structures, and governance.
- Yet, countries are asking the **same questions** about grid modernization and drawing from similar pools of technologies, policies & standards.
- Multilateral cooperation increases the likelihood of **brokering meaningful connections** across the specific areas of synergy.

**Top 6**  
**Motivating Drivers**  
**for Smart Grids**  
from ISGAN analysis of  
22 national-level survey results



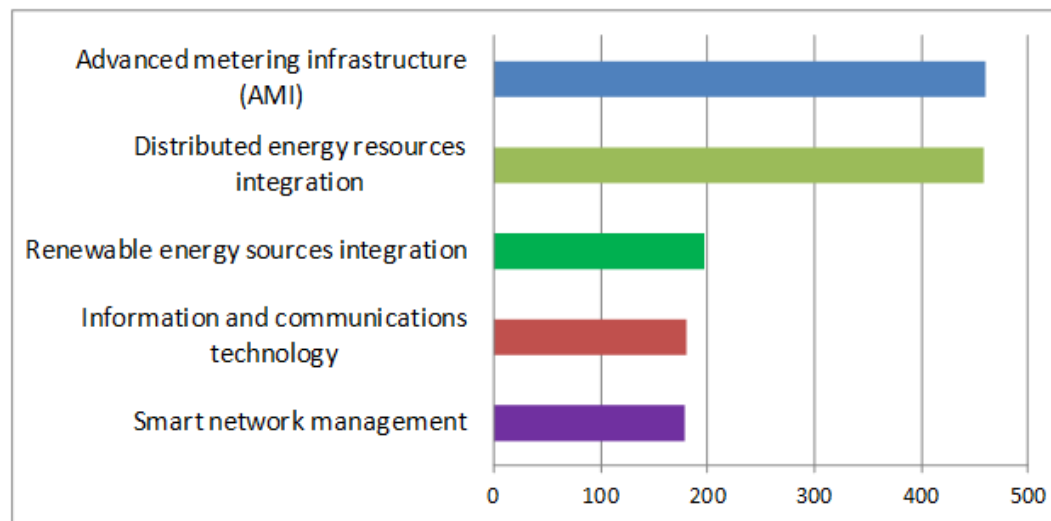
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**Top 5  
Technologies  
across All Drivers  
from ISGAN analysis of  
22 national-level survey  
results**



# Current Focus



- To start its 2<sup>nd</sup> five-year term (in 2017), ISGAN is reviewing its programme, objectives and structure with an eye to generating more practical outcomes
  - Flexibility chosen as ISGAN's primary theme for the next year (or more)
  - Digitalization selected as a key sub-theme
  - ISGAN activities are expected to map how their activities address these themes
- ISGAN is also considering how its activities (and grid modernization more broadly) support attainment of countries' NDCs (as part of the "Road from Paris") and fit within the objectives of Mission Innovation

# Clean Energy Solutions For Today and Tomorrow



## Mission Innovation

## Clean Energy Ministerial

### Future Innovations

Science  
Research  
Development  
Analysis

Tech  
Demos

### Deployment Now

Policies  
Best Practices  
Capacity Building  
Prizes, Recognition

Create  
New Ideas

Improve Performance

Reduce  
Cost

Raise Awareness

Facilitate  
Market Uptake



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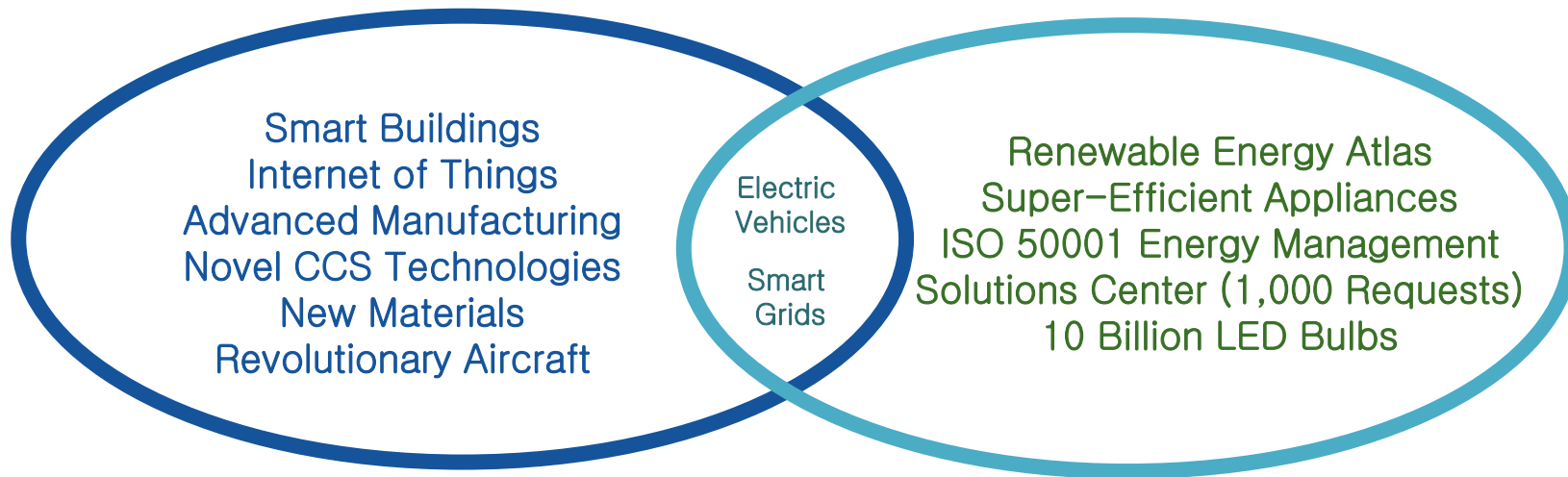


# Clean Energy Solutions: Examples



## Mission Innovation

## Clean Energy Ministerial



**MI Smart Grids Innovation Challenge:** To enable future grids that are powered by affordable, reliable, decentralised renewable energy systems



# ISGAN Annex 5: SIRFN



- **The Smart Grid International Research Facility Network (SIRFN)** is a collaboration among world-class smart grid research and testing facilities
- SIRFN's collaborative testing/evaluation capabilities are meant to be leveraged by the international community to enable improved testing / evaluation of smart grids.

## Participants (15)



## Major Active Subtasks

- RE & DER Integration
- Smart Grid Modelling
- Power System Testing
- Advanced Laboratory Testing Methods

## Website



*[sirfn.net](http://sirfn.net)*

## Operating Agent



[sirfn@der-lab.net](mailto:sirfn@der-lab.net)

# Current SIRFN Participants



Central Power  
Research Institute



UNIVERSITY OF  
TORONTO



Korean Agency for  
Technology & Standards





# Objectives



- **Share Capabilities:**  
Exchange knowledge on engaged facilities, including their infrastructure, equipment, programmes, etc.
- **Share Knowledge:**  
Exchange data, knowledge and experience among facilities:
  - *Non-proprietary results of current research*
  - *Best practices, novel & emerging methods, etc.*
- **Coordinate Joint Testing / Evaluation:**  
Implement joint efforts to address testing gaps, compare results across countries, advance testing state of the art

# Overview: Value Proposition



- **Network of world-class facilities**
  - Brings together laboratories and test beds across 14 member countries (and EC)
  - At least one leading research organization in each participating country; some with multiple institutions
  - Potential for engagement with DERLab members not directly in SIRFN
- **Technical Excellence**
  - Participating facilities (and experts) are world leaders
  - Growing number of publications, partnerships and presentations
  - Flexible portfolio based on participants' capabilities, interests, and priorities
- **SIRFN/DERLab meetings, events, and facility information strive to maintain relevance to global smart grid community**



# Overview: Technical Projects



## Smart Grid International Research Facility Network

### Test Protocols for Advanced Inverter Functions

- *Goal:* Develop / demonstrate consensus-based interoperability test protocols for IEC 61850-90-7 advanced distributed energy resources (DERs) – *currently PV and ESS*
- “Round robin” evaluation of test protocols among facilities
- Meant to inform/accelerate adoption of the protocols by international standards organizations / grid code bodies

### Smart Grid Modeling

- Emphasis on **model-centric approach**, based on duplication of the physical grid in a computer model used for all analysis, containing all device details and geospatially referenced
- Using Graph Trace analysis, model solved within a SCADA scan using time-series data, such as AMI, while also integrating measurements and other important data sets
- Collaboration for joint algorithm development / analysis; training on use and programming of model

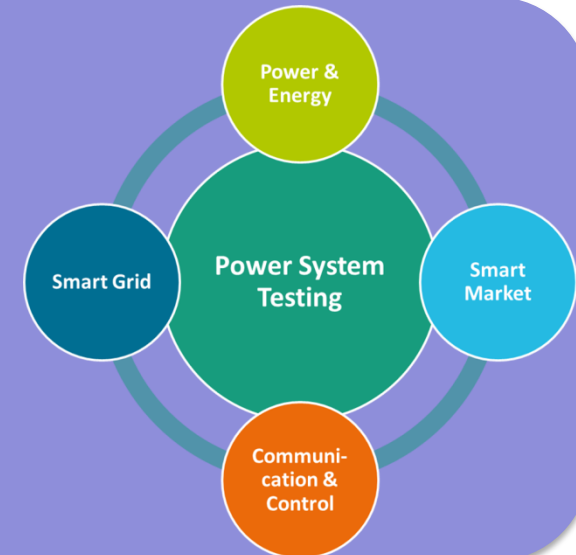
# Overview: Technical Projects



## Smart Grid International Research Facility Network

### Power Systems Testing

- Numerous interdependencies in power system control
- Testing components only may miss such interactions/interdependencies
- Seeks to **define requirements for true systems testing, applying state-of-the-art adv. lab testing methods**



### Advanced Laboratory Testing Methods

- Utilize novel ideas and novel methods (**PHIL, CHIL**, MD/Co-Sim)
- **Creation of a work basis for future contributions to**
  - Rapid prototyping and manufacturing
  - Standardized testing procedures (writing, testing)
  - Novel research areas in the electrical domain

# Example: Adv. Inverter Functions BESS Methodology



**BESS interoperability tested in test definition and test sequence:**

- 1. Communication verification**
- 2. EUT remote reconfiguration in terms of:**
  - a) *Timing parameters*
    - i. *ramp time*
    - ii. *recovery time*
    - iii. *time window (delay time)*
    - iv. *timeout*
  - b) *Functional parameters*
    - i. *operation curves in the 4 quadrants*
    - ii. *hysteresis*
    - iii. *power*
- 3. Interoperability verified according to:**
  1. *EUT acknowledgement messages*
  2. *EUT electrical behavior in different test conditions*

# Example: Adv. Inverter Functions Interoperability Function



**The first draft of BESS test protocol started with 5 functions that are considered most significant for storage systems**

- 1. Request Active Power from Storage (INV4)***
- 2. Request Reactive Power (VV13)***
- 3. Commanded Power Test (INV3)***
- 4. Frequency/Watt “P(f)” (FW)***
- 5. Var Priority Volt-Var “Q(V)” (VV12)***

*Additional functions to be added in the future*

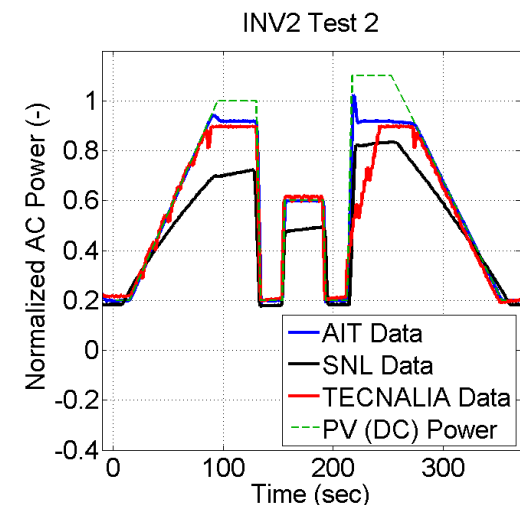
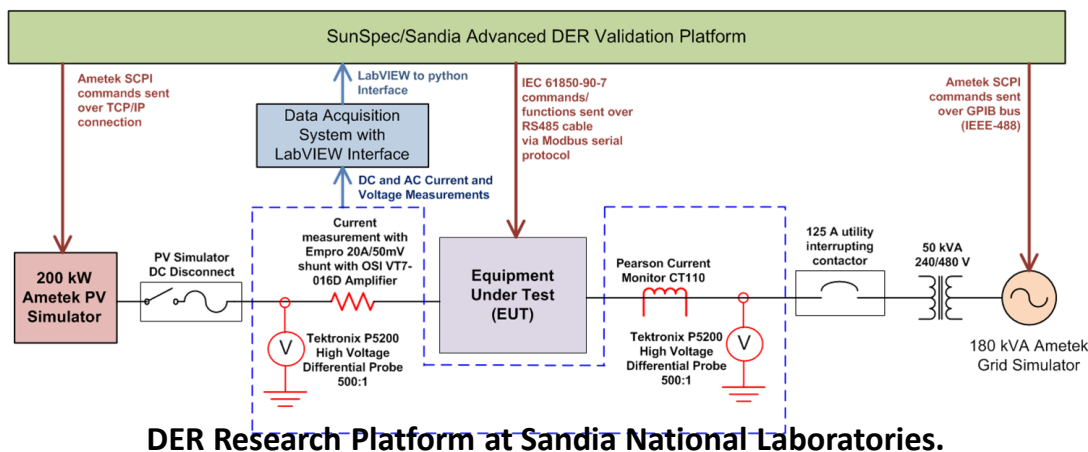
*Tests are being performed now.*



# Example Outcomes (and why they worked)



- **Success: Labs are rallying around the SIRFN-supported standardized method for verifying advanced distributed energy resources!**
- SIRFN is developing test procedures and a common testing environment by:
  - Coordinating the experimental testing of DER devices in the U.S., Europe, and Asia
  - Building test-beds for advanced interoperability DER testing (including electrical performance and communications certification tests)
  - Comparing results from advanced DER function experiments
  - Improving the draft test protocols for adoption by code-making bodies



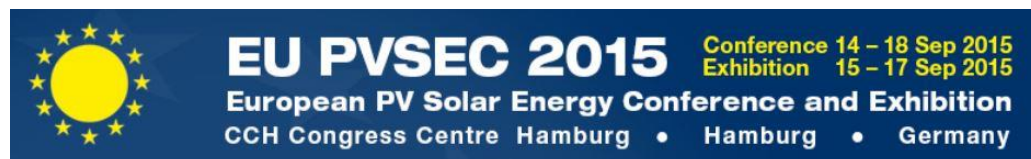
Real Power Curtailment Tests



# Example Outcomes (and why they worked)



- All involved partners participated actively in developing test procedures and testing them in their labs
- Draft protocol and test results presented in a common paper at EU-PVSEC 2015



## INTERNATIONAL DEVELOPMENT OF ENERGY STORAGE INTEROPERABILITY TEST PROTOCOLS FOR PHOTOVOLTAIC INTEGRATION

David Rosewater, Jay Johnson, Maurizio Verga, Riccardo Lazzari, Christian Messner, Roland Bründlinger, Kathan Johannes, Jun Hashimoto, Kenji Otani

- Common partner interests, regular meetings and specific deadlines helped to reach the goal

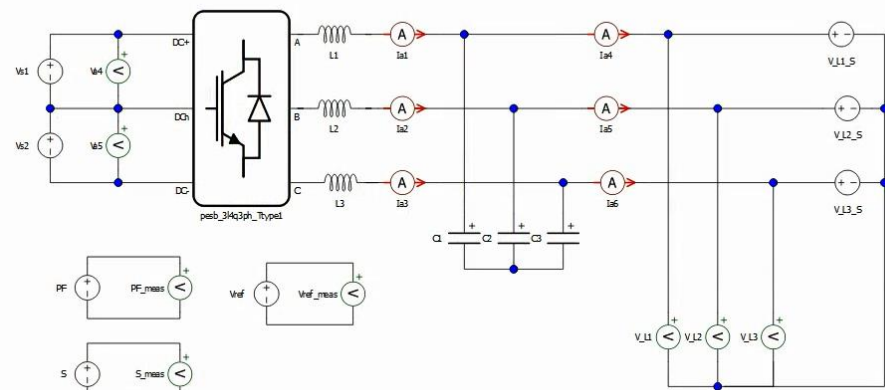
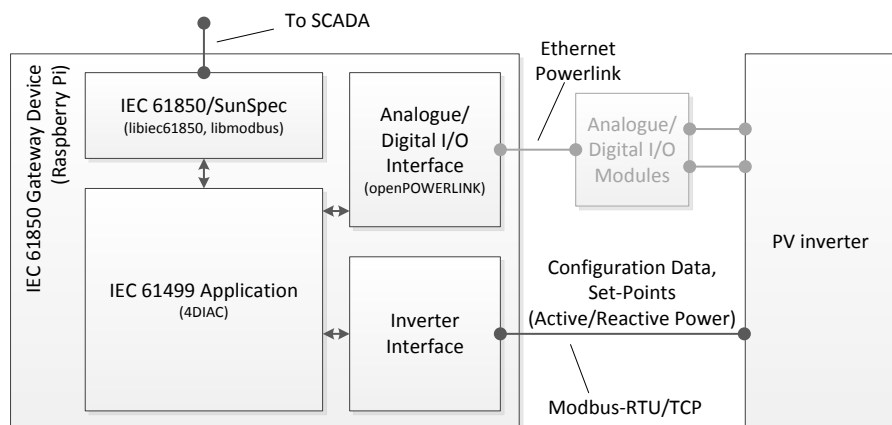
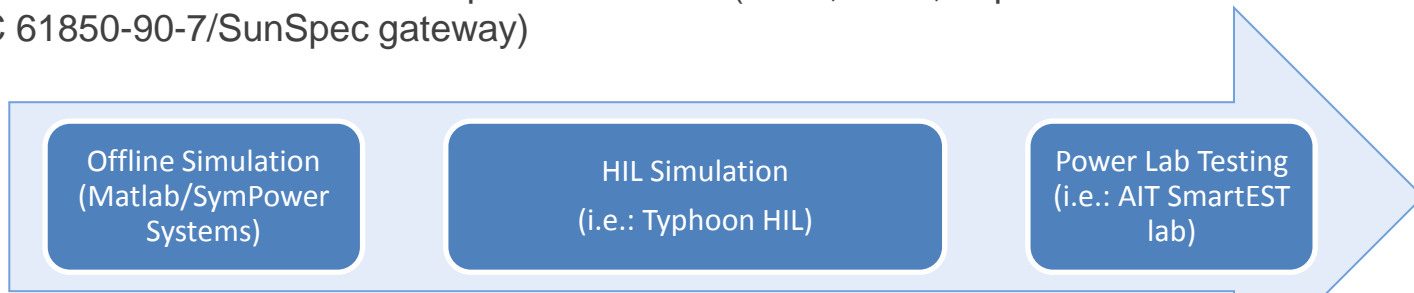


# Example Outcomes (and why they worked)

- **Success: Two-day workshop on ‘Adv. Lab Testing Methods’ provided researchers “hands-on” joint testing / live demo**

Vienna, AIT SmartEST Laboratory, 9-10 Sept., 2015

- Presentation of Use Cases and Live Demonstration of CHIL method
- Reference case studies for comparison in 2016 (CHIL, PHIL, Implementation of an IEC 61850-90-7/SunSpec gateway)



# Example Outcomes (and why they worked)



## Success: Smart Grid Modelling training with CPRI

- BNL and EDD worked with India's Central Power Research Institute (CPRI) to train staff and students in the Model-Centric Approach and Academic Distributed Energy Workstation (ADEW) software in 2014-15 via webinars.
  - About 9 students and staff were trained over the period.
  - After training, students were able to develop their own algorithms
  - Good feedback about the learning experience and expressed interest to continue the training

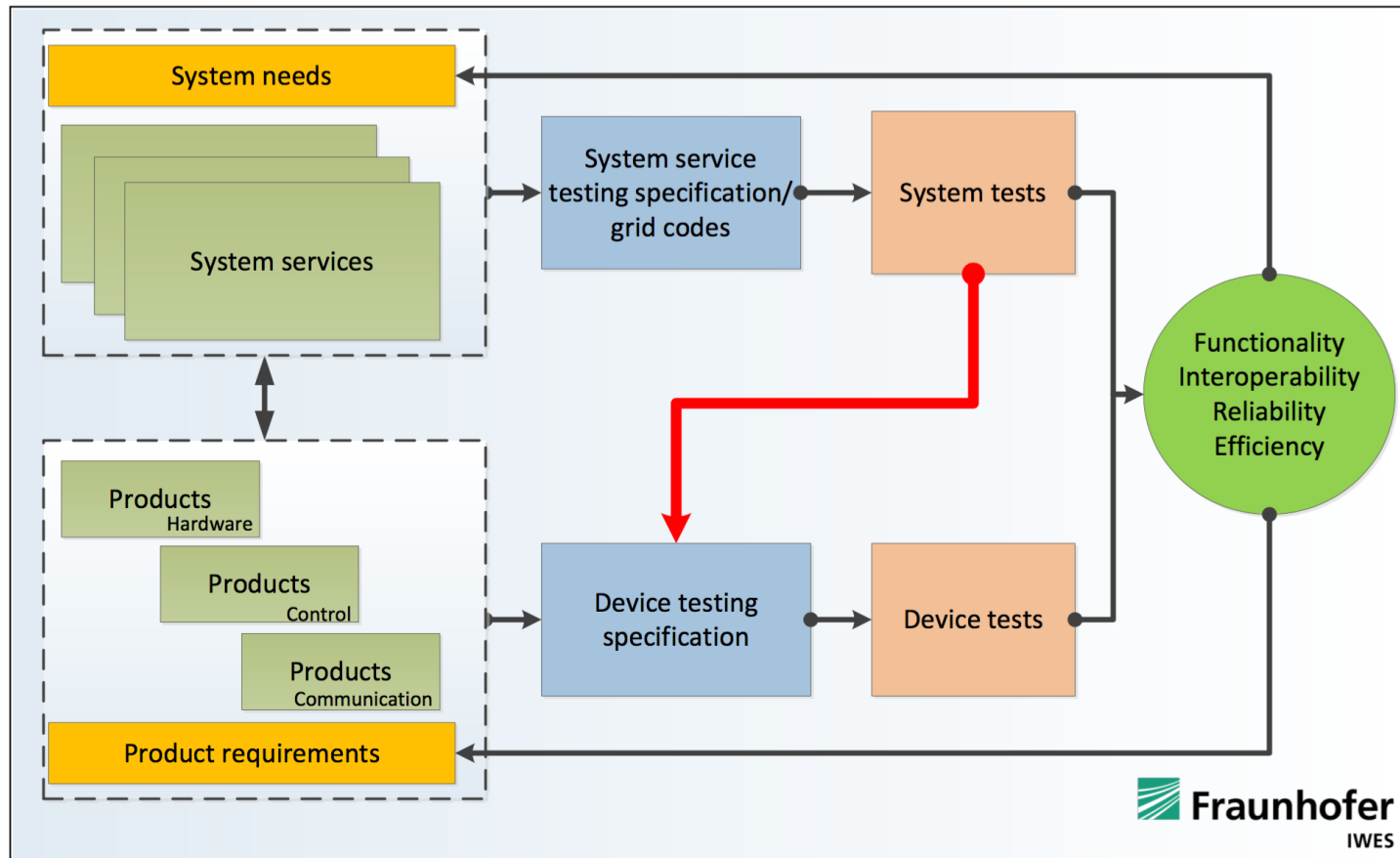
## Success: First ISGAN/SIRFN Grid Modelling Workshop

- Held at BNL in April 2016.  
40+ grid modelers and practitioners on "Tools for a Smarter Grid," included representatives from South Africa, Korea, The Netherlands, Austria, and Romania plus several U.S. national labs



# Current PST Use Case: Aggregated Services

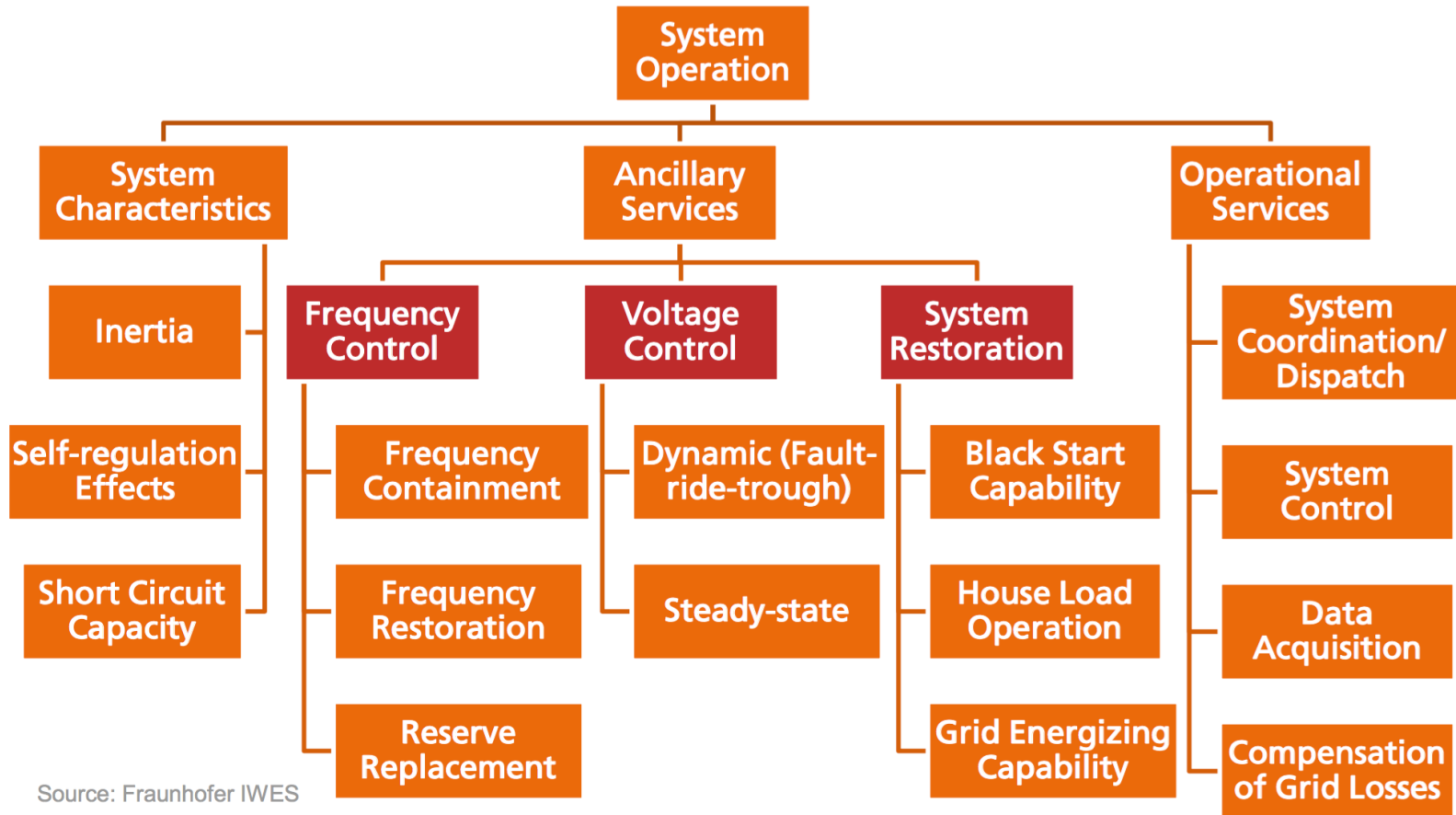
System testing defines component testing





# Current PST Use Case: Aggregated Services

## System Operation: Characteristics and Services

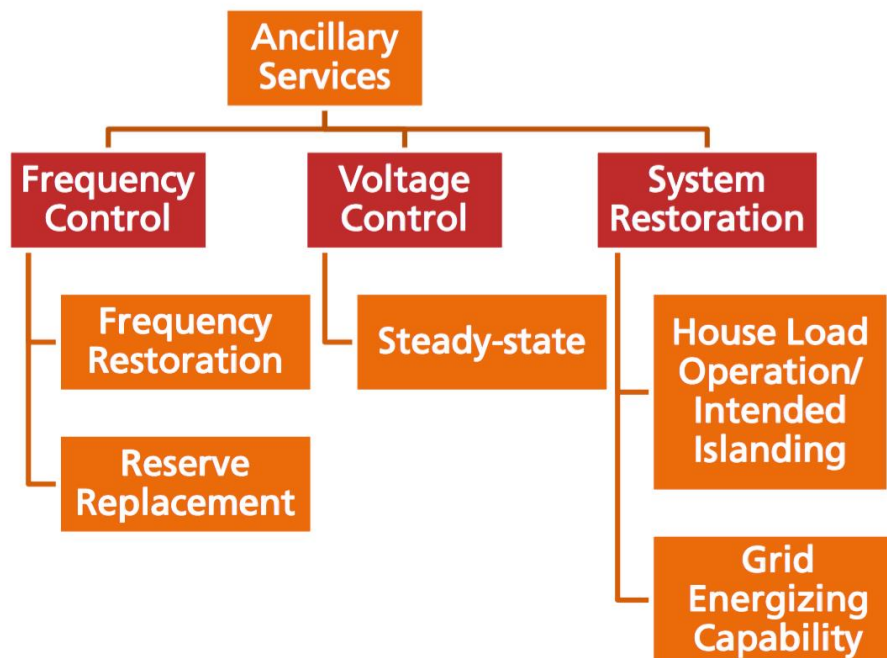


Source: Fraunhofer IWES



# Current PST Use Case: Aggregated Services

## Aggregated Services: Options from DER and Microgrids



- Frequency control
  - Global service
  - Market can be created
  - Provided by freely distributed units
- Voltage control & system restoration
  - Nodal service
  - Bilateral agreements or grid code requirements
  - Provided by single units or units concentrated in grid areas (e.g. microgrids)

# Current PST Use Case: Aggregated Services



## Example Activities

- Presentation of project results related to aggregated services
  - Web conferences organized by DERlab
  
- DTU, Denmark
  - Global aggregated ancillary services
  - Frequency support by aggregation of huge numbers of small units
  - Performance assessment of aggregation control services for demand response
  
- RSE, Italy
  - Nodal aggregated ancillary services
  - Grid parallel microgrid operation
  - Intended islanding and resynchronization

# What's Missing



- **SIRFN subtasks are bottom-up, based on the interests and capabilities of the participants**
- **Thus far, there hasn't been a SIRFN work stream dedicated specifically to efficiency considerations.**
- **To date, technical and policy drivers for RE and DER integration have driven SIRFN activities.**

# Up Next

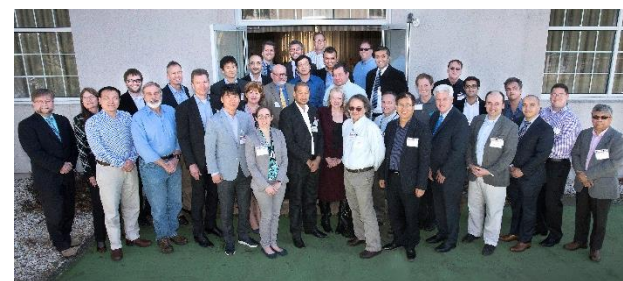
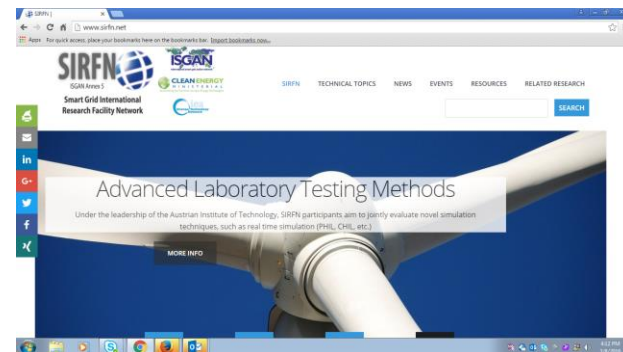


- **ISGAN ExCo13 Meeting:**
  - March 6-10, New Delhi, India
  - Part of India Smart Grid Week 2017
- **Looking ahead (way ahead)**
  - ISGAN ExCo14 – September 2017 – Belgium
  - ISGAN ExCo15 – March 2018 -- TBD
  - ISGAN ExCo16 – October 2018 – Austria  
*on sidelines of IRED 2018*
- **Plus CEM8/MI2 (June 2017), Annex workshops, etc.**

For more information, please visit  
the SIRFN website: [www.sirfn.net](http://www.sirfn.net)

## Contacts:

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# Be Recognized! ISGAN Award of Excellence



*International competition to showcase  
**global excellence, leadership and innovation**  
in smart grid projects*

**2017 Awards Theme:**

**Flexibility**



*Supported by*



- Competition expected to open around **February 3**
- Winner(s) to be publicly announced at CEM8 in China in Q2 CY2017
- Honorees for 2016 competition were announced at an awards ceremony at CEM7 in San Francisco on June 2, 2016—Theme: Excellence in Smart Grids for Reliable Electricity Service

✓ *Winner: CenterPoint Energy Smart Grid (Texas)*



# Thank you!



## For more information, please visit:

- ISGAN: [www.iea-iscan.org](http://www.iea-iscan.org)
- 21<sup>st</sup> Century Power Partnership: [www.21stcenturypower.org](http://www.21stcenturypower.org)
- Power System Challenge: [www.powersystemchallenge.org](http://www.powersystemchallenge.org)
- Clean Energy Ministerial: [www.cleanenergyministerial.org](http://www.cleanenergyministerial.org)
- IEA Energy Technology Network: <https://www.iea.org/tcp/>
- Clean Energy Solutions Center  
*including "Ask-an-Expert" service:*  
[www.cleanenergysolutions.org](http://www.cleanenergysolutions.org)
- Global Smart Grid Federation:  
[www.globalsmartgridfederation.org](http://www.globalsmartgridfederation.org)

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