NOVEMBER 8, 2017

INTRODUCTION TO ARGONNE SAGES

PROPOSED ENERGY OF THE FUTURE TRAINING EVENT

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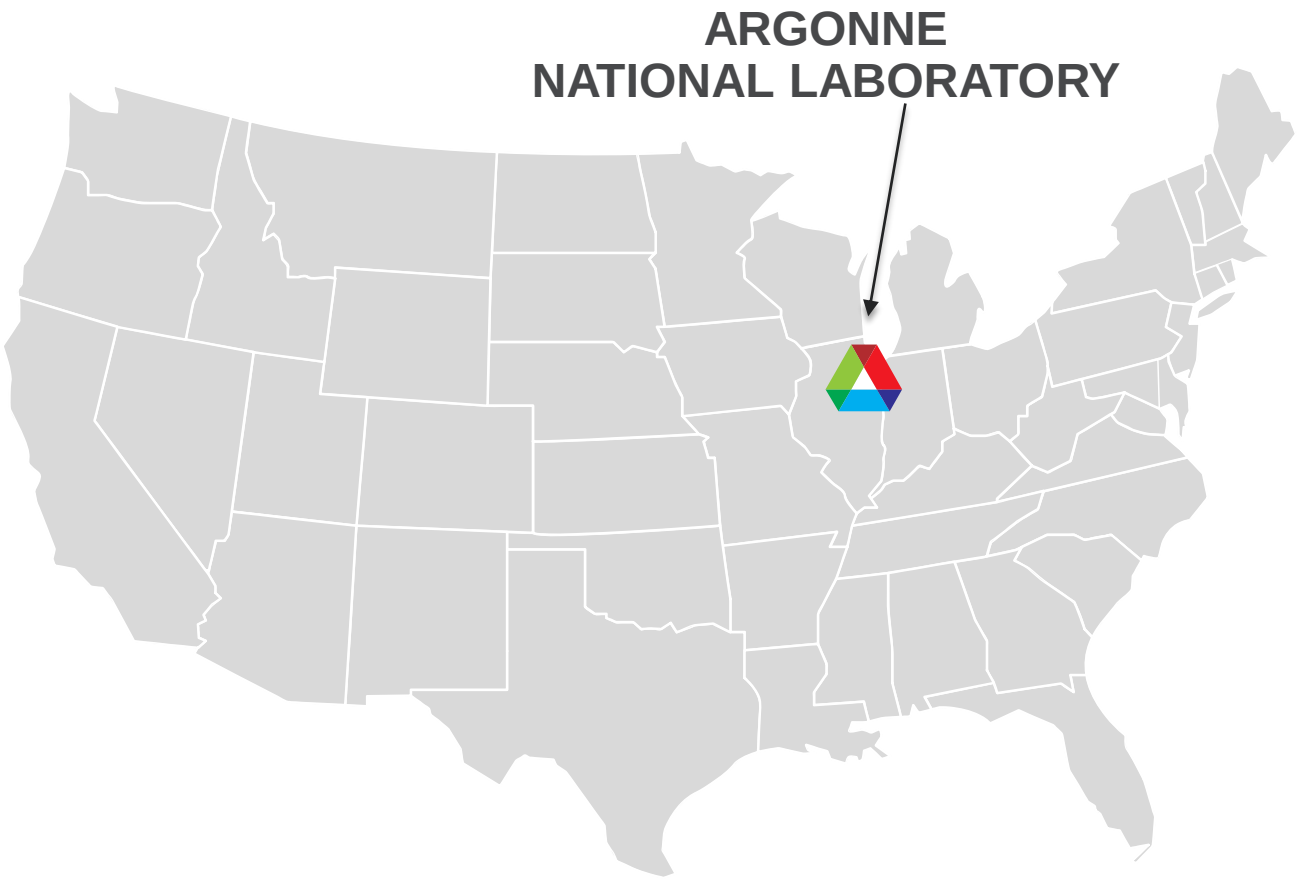
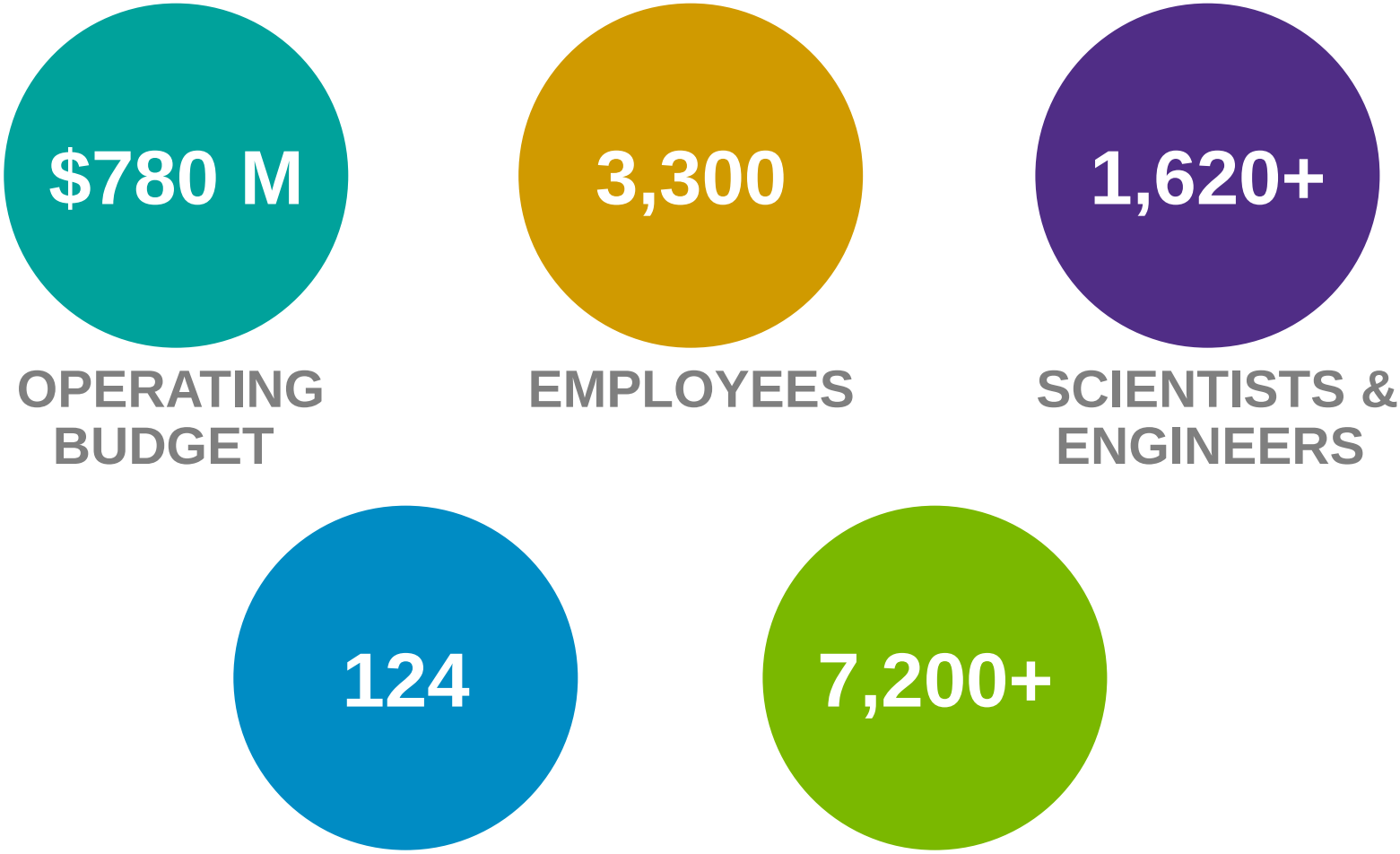
Argonne NATIONAL LABORATORY

FIRST NATIONAL LABORATORY OF THE U.S. DEPARTMENT OF ENERGY



- **Mission areas: Energy, Environment, Security**

ARGONNE BY THE NUMBERS (FY 2016)



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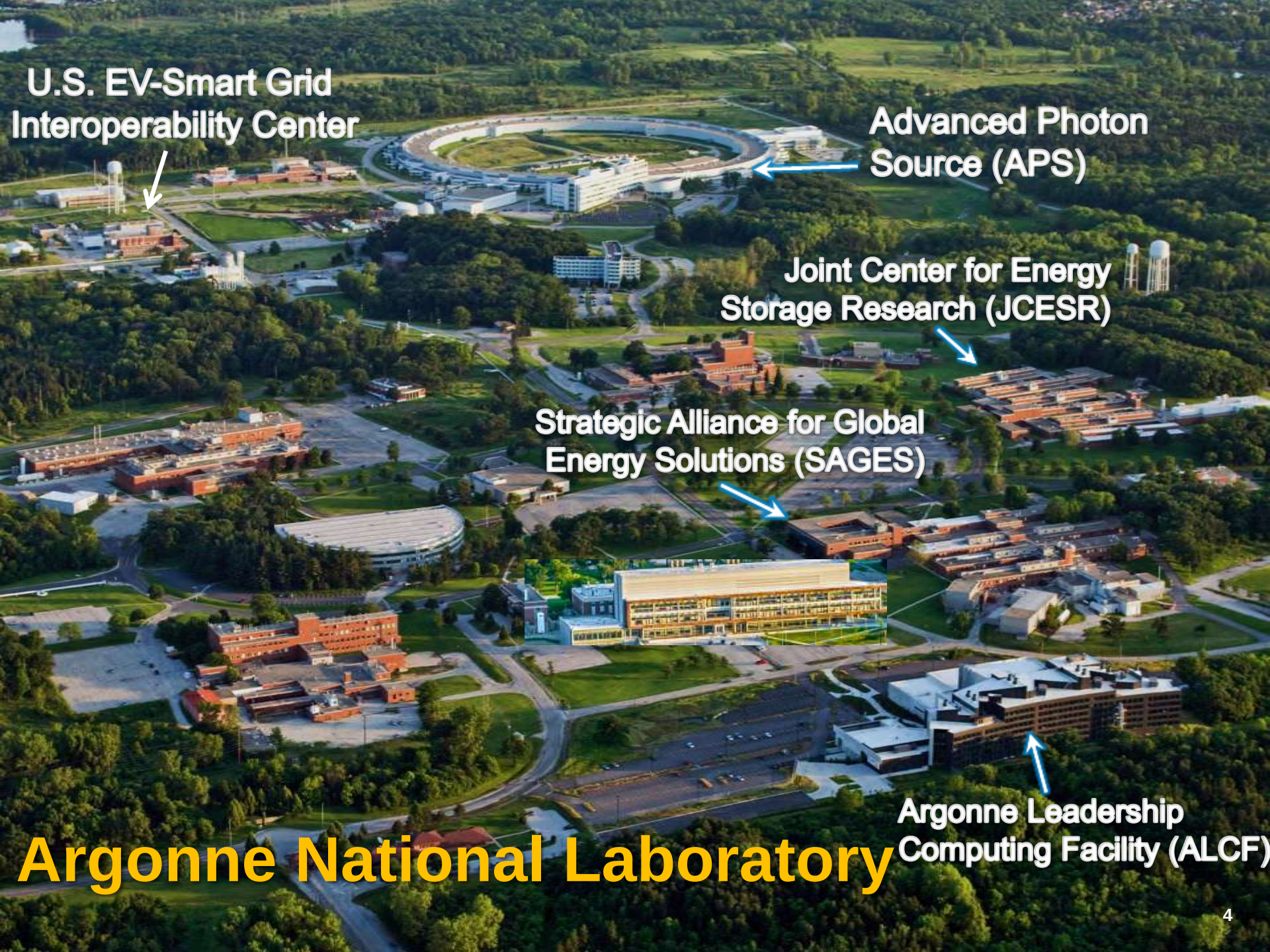

Argonne National Laboratory

What is JCESR?

JCESR is the U.S. Department of Energy Innovation Hub, where scientists (~120 FTEs) are tackling critical issues in storing energy for transportation and the grid applications.

energy.gov

A new paradigm for battery R&D that integrates discovery science, battery design, research prototyping and manufacturing collaboration in a single highly interactive organization

JCESR's goals energy storage 5-times more powerful at 1/5 the cost

- A bold approach to battery R&D
- Accelerate the pace of discovery and innovation
- Shorten the time from conception to commercialization

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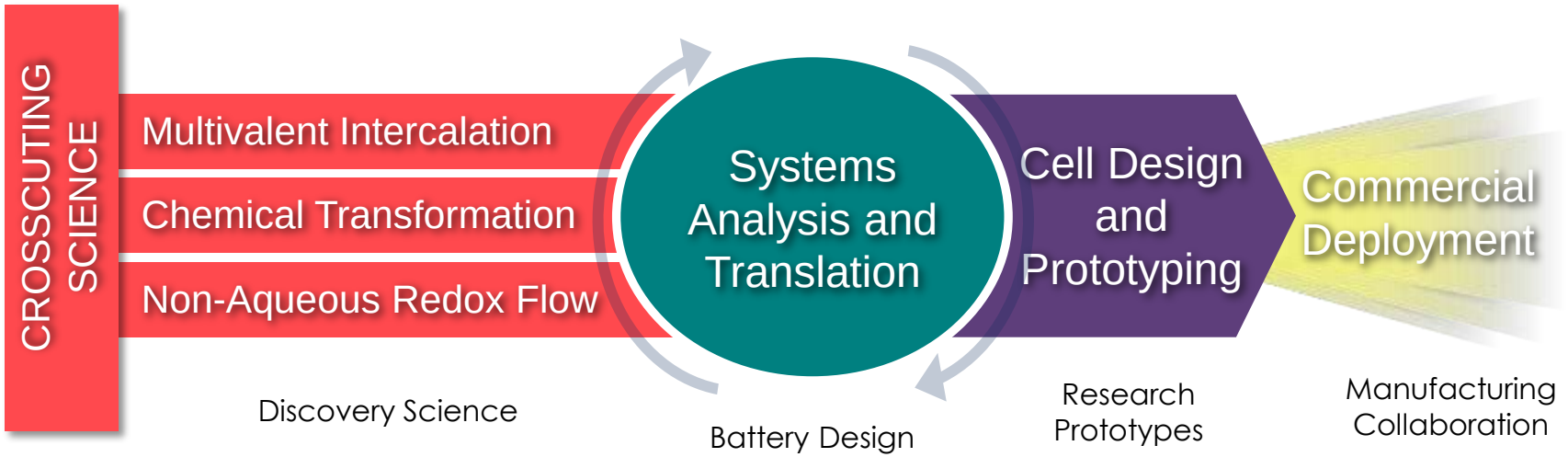
The JCESR Partner Team



National Laboratories

Argonne

Lawrence Berkeley

Sandia

SLAC

Pacific Northwest

Universities

University of Illinois at Chicago

University of Illinois at Urbana-Champaign

Northwestern University

University of Chicago

University of Michigan

Faculty from

MIT, University of Waterloo, Harvard, Notre Dame

Private Sector

Johnson Controls (JCI)

Dow

Applied Materials

Clean Energy Trust

Researchers from

United Technologies Research Center (UTRC)

U.S. EV-SMART GRID INTEROPERABILITY CENTER AT ARGONNE INITIAL FOCUS ON GLOBAL HARMONIZATION …

- Develop and verify enabling technologies and standards for grid connectivity and communication
- Support harmonization of interoperability standards
- Support interoperability/grid integration activities of the DOE Grid Modernization Initiative
- Test communication and control systems in a network of grid-connected devices

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GLOBAL HARMONIZATION …

Targeting universal interoperability and compliance methods

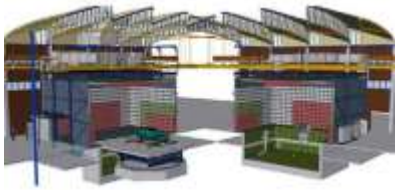
2014 — 2015 — 2016

The European Interoperability Centre for Electric Vehicles and Smart Grids

Low Temperature Testing

DC Interop testing

AC Interop testing and equipment evaluation



VELA-9 construction

L2 instrumentation and testing at ANL

Comparative testing at JRC

BMW i3 REx reference vehicle

Global InterOP

Audi · BMW · DAIMLER · FCA · Ford · GM · Opel · Porsche · VW · Argonne

requirements

Version control

scienlab

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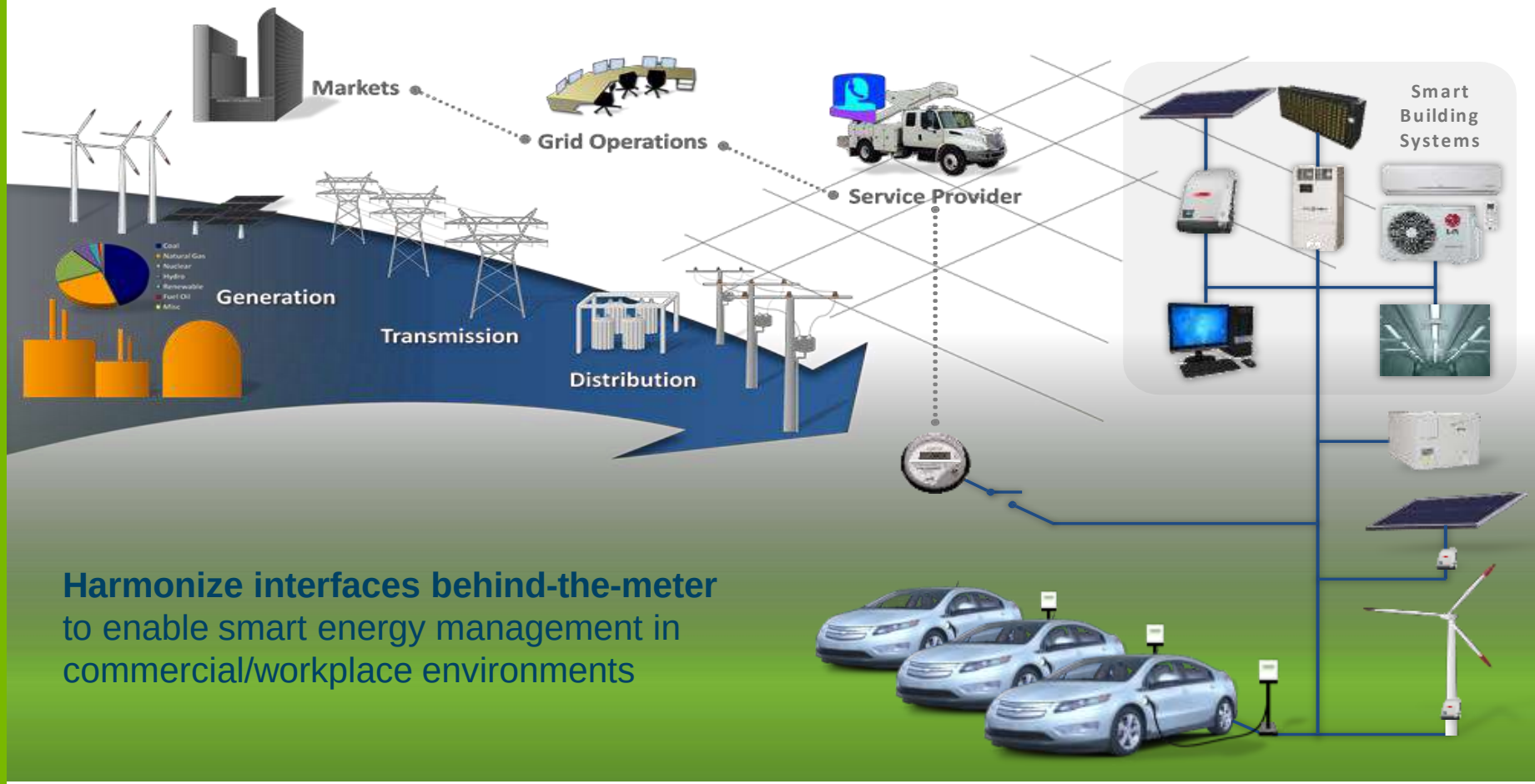
NOW FOCUSED ON GRID INTEGRATION



Harmonize interfaces behind-the-meter
to enable smart energy management in commercial/workplace environments

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ARGONNE SUPPORT FOR DEMAND FORECASTING AND ENERGY SYSTEM PLANNING

CAREC Power Sector Regional Master Plan

- Supported ADB project to develop integrated transmission and generation expansion plan

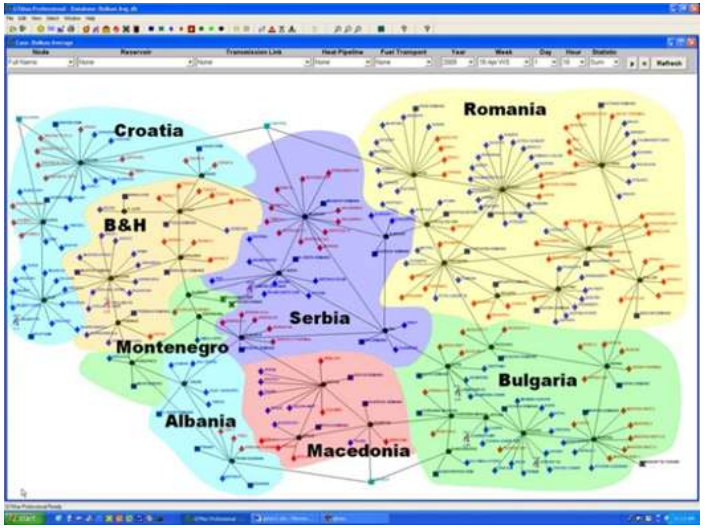
ADB Consultant to Greater Mekong Subregion Regional Power Trade Coordination Committee

- Defined performance standards for harmonizing GMS power systems to facilitate regional power trade
- Conducted demonstration analysis to identify timing, amount and price of mutually beneficial energy trade between China, Lao PDR, Myanmar and Thailand

Southeast Europe Regional Electricity Market

- Argonne models applied with 16 utilities (USAID study)
- Optimize utilization of hydro and thermal power
- Identify volume of power transactions between systems
- Compute financial benefits to buyers and sellers

- Supported PwC for World Bank study to identify timing and location of generation and transmission investments that most benefit regional market



Proven Approach for Facilitating Regional Power Trade

MAED
Model for the Analysis of Energy Demand

INPUT

- Energy sector data (energy balance)
- Scenario assumptions
  - Socio-economic
  - Technological
- Substitutable energy uses
- Process efficiencies
- Hourly load characteristics

OUTPUT

- Useful and final energy demand by sector/fuel
- Electricity demand
- Hourly electric load
- Load duration curves

User Interface and E-learning Tools available in multiple languages

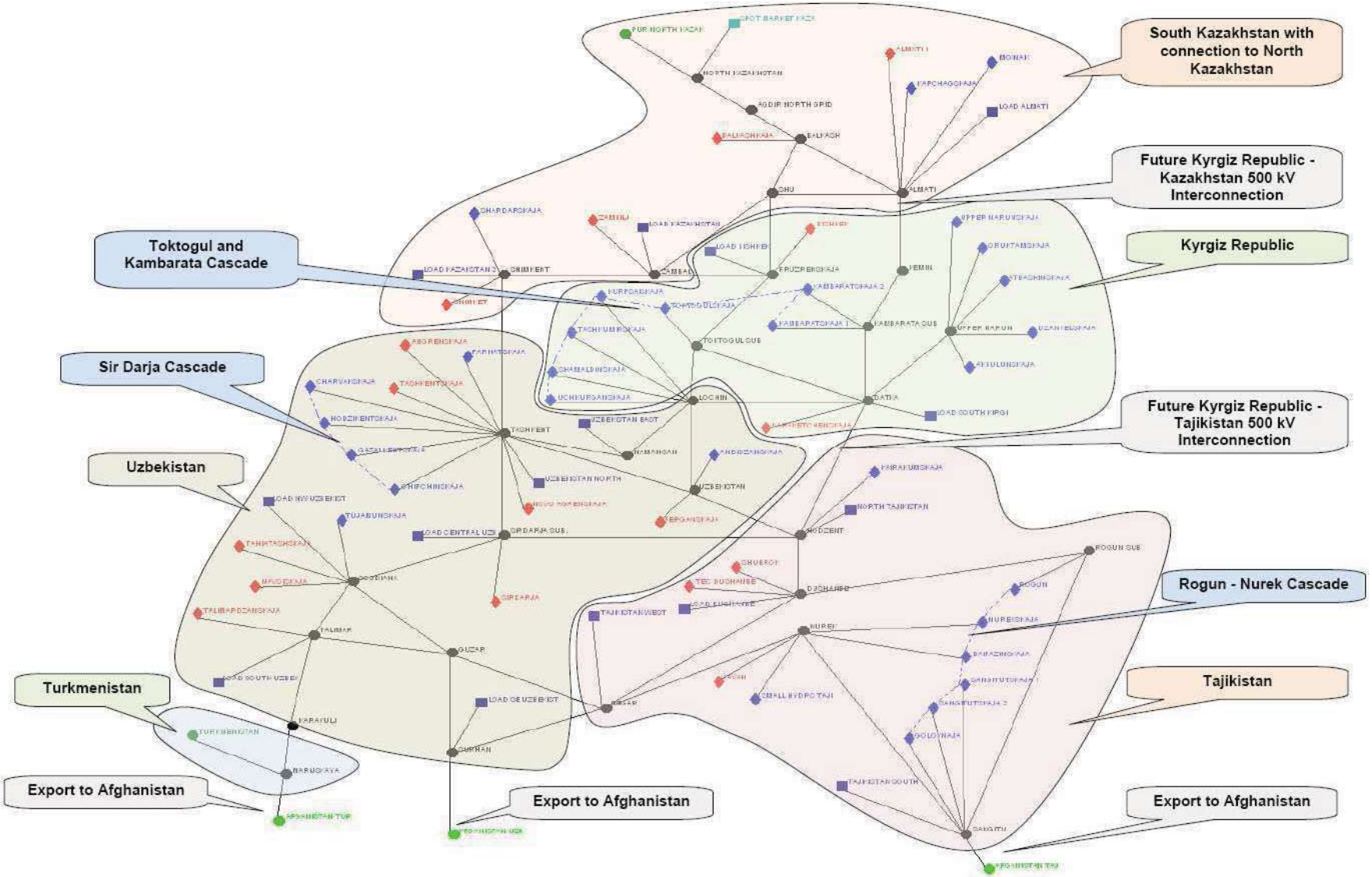
IAEA

Regional Trade Benefits from Use of A Common Analytical Framework

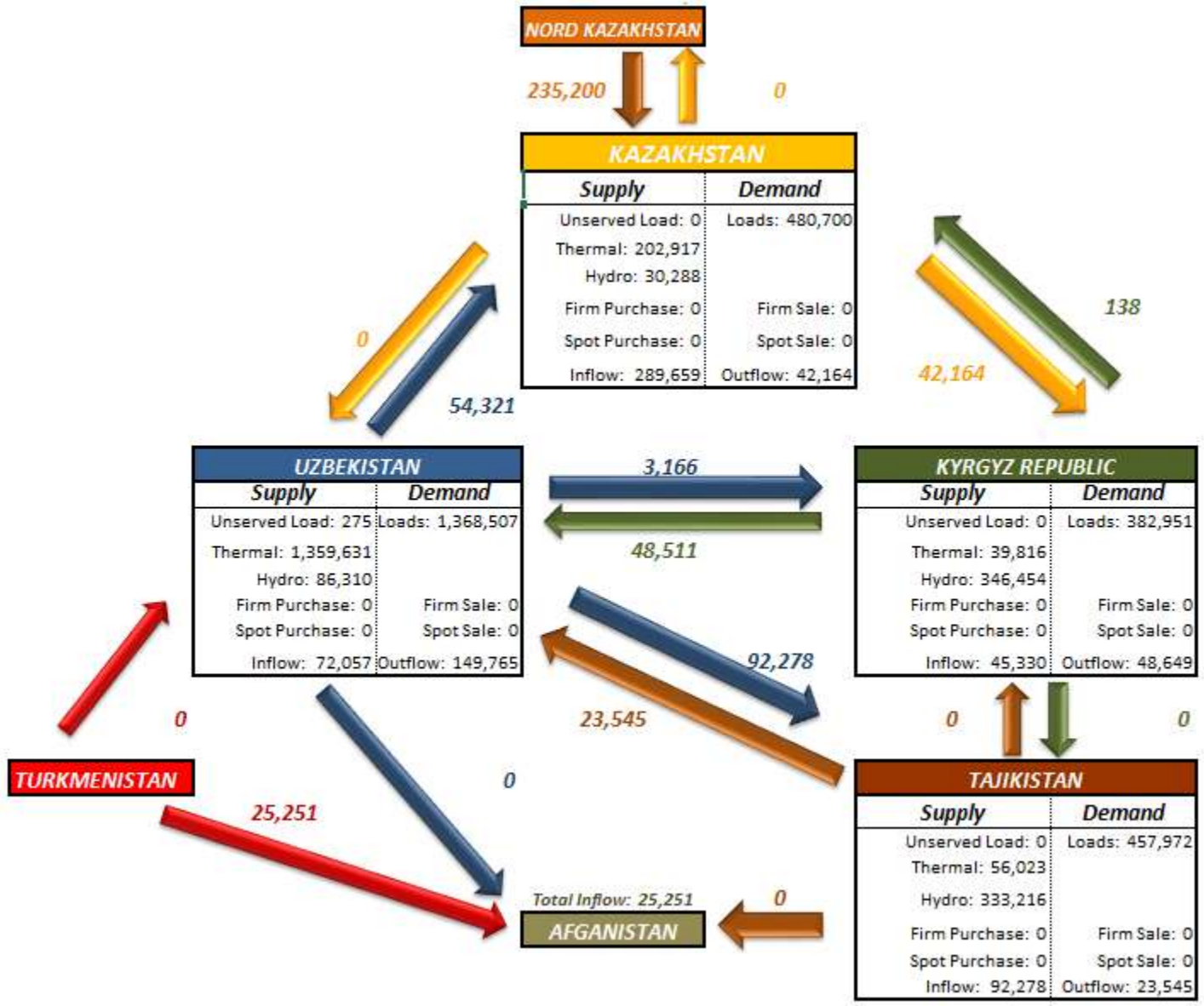
- Generation Expansion Planning
  - Prepare optimal generation expansion plans
- Generation & Transmission Planning
  - Optimize system operations taking into account power plants, hydro cascades, IPP agreements, power trading opportunities, and limitations of transmission resources
- Detailed Transmission Planning
  - Power Flow and Stability Analysis
  - Available Transmission Capacity

Use of a common analytical framework for evaluating regional energy trade builds consensus on mutually beneficial paths forward

GTMAX MODEL TOPOLOGY OF SYSTEM IN 2020



GTMAX SIMULATED POWER FLOWS



Potential Energy of the Future Training Event:

- **Prior to Event**
  - Collect, review, and harmonize power system data
- **Training Event**
  - Review and discussion of data collected on regional power trade
  - Presentation on tools and approaches applied to support demand forecasting, energy system planning, cross-border power trade
  - Briefings on current research into energy storage, EV infrastructure, grid resiliency, and renewable energy technology
- **Post Event**
  - Analyze and report on range of energy futures/scenarios

Thank You!