An Energy Internet Platform for Transactive Energy and Demand Response Applications

Keynote Speech
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PPT slides will be available at

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What is the Energy Internet?

The Internet allows information to flow to anyone from anywhere.

The Energy Internet is a vast network that will allow efficient distribution of electricity to anyone and from anywhere.

EI will utilize smart sensors, ICT technologies and algorithms to facilitate power supply in real-time, enhance storage applications, and integrate renewable energy into the grid.

Mission of the Energy Internet

Energy Internet is an online marketplace that transacts in energy (One-to-One, One-to-Many and Many-to-One)

O-to-O: Between individual users for bilateral transactions
O-to-M: One electric utility sells to Many customers
M-to-O: Many customers sell to One electric utility

But in the Energy Internet:

All transactions must be done in real-time
All network constraints must be met
Vision of the Future Grid

Electricity Transmission

Equipment: Versatile, Self-healing

Supply: Efficient, Reliable, Compatible and Resilient

Customer: Flexible, Intelligent, Interactive and Accountable

Electricity Production and Storage

Electricity Consumption

Mapping the Energy Internet into the Future Grid

Source: SGCC
Future power system integrated with modern information technology

Source: SGCC
Functions of the Energy Internet

Key Technologies of the Energy Internet

Source: SGCC
The ICT Framework

Field Implementation

Control Devices
- Load control switches
- Smart thermostats
- Other controls integrated into EMS/ES

Monitoring Systems
- EMS Software
  - Custom database
  - Sensors & controls
- EIS Software
  - Interval Meters
  - Data Gateways

Communication Systems
- Customer
- Utility

Source: P. Siano
Participants

Prosumers

Building Owners

DER Owners

Community battery storage  Distribution-scale solar PV  Energy stored in EVs

Transactive Energy in a Microgrid

Focus: Top develop & pilot an Energy Internet platform that provides higher efficiency, cost reduction, and energy insights for both utilities and end-customers by leveraging

1) Existing IoT/smart devices in homes
2) Blockchain/distributed ledger/related technology to execute smart contracts and maintain records of all transactions
Demand Response
An Element of the Energy Internet

Energy Transaction and Demand Response
Demand Response

The aim of Demand Response (DR) is to make the load an active participant in balancing electricity supply and demand around the clock via side-by-side competition with supply-side resources.

DR allows loads curtailment in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is at risk (using direct control by the utility or ancillary services markets).

Basic Transactive Energy Process

- **OpenBidding**: 09Nov19-13:00
  - Sent @12:01

- **CloseBidding**: 09Nov19-13:00
  - Sent @12:59

- **Sell**
  - I have 6 kWh to sell between 13:00-14:00 @ 3tokens/kWh

- **Buy**
  - I want to buy 5 kWh between 13:00-14:00 @ 4tokens/kWh

- **DSO**
  - The Reserve Price between 13:00-14:00 @ 8tokens/kWh

- **Buy**
  - I want to buy 5 kWh between 13:00-14:00 @ 4tokens/kWh
Home Energy Management System

These signals enter the house through a Home Gateway.

Source: P. Siano

Building Automation Platform

ISO

• Buy electricity from DERs
• Request for demand reduc.ion

P2P transactions +
• Sell kilowatts to the utility or
neighbors
• Sell megawatts to the utility or
neighbors

DER owners

HVAC loads
Lighting loads
Plug loads
Sensors/energy meters
DERs, e.g., PV and storage
Occupant comfort

Internet

Wireshield Cloud

Buildings

Virginia Tech
Innovate the Future
Small Scale Realization of EI

- Control/user interface
- Intelligent control mechanisms
- Energy insights
- Historical data
- Current status
- Locational data
- Immutable data

Source: www.bemcontrols.com

Energy Internet Value Proposition

- Building Energy Management
  - Commercial Open Architecture Software Platform
  - Monitor and Control energy systems (HVAC, lighting, plug loads)
  - Extendible to solar PV systems in micro-grid environments.
  - Help buildings participate in Demand Response programs through OpenADR

- Local Energy Market
  - Immutable, secure record of P2P and Negawatt trading transactions
  - Proprietary bidding algorithms to maximize participants’ utility from trading
  - Automated transactions governed by smart contracts executed in near real-time (1 hour ahead)

- Microgrid Energy Management
  - Monitor and Control energy resources in Microgrid (battery storage, PVs, other DERs)
  - Create programs and involve customers in the energy consumption, generation, and management process
  - Demand Response
  - Data analytics & energy insights applicable to local communities

Homeowners, utilities, microgrids and other distributed energy resource owners can:
- Transact on a trusted common platform
- Fully integrate building control into P2P and negawatt trading contexts
- Harness the value of demand response initiatives and microgrid-level PV production while maintaining comfort of individual buildings
Thank You

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