Innovation Overview and Advanced Technology Focus Areas
Ram Sastry, VP – Innovation and Technology
(rsastry@aep.com)
Nick Akins, Chairman, President and CEO recently said:

"I am confident in our ability to transform our industry for the benefit of the communities we serve. AEP is globally searching for, and validating innovative, advanced technologies, especially to integrate into the distribution grid of the future, for all of our customers and for our operations. Our electrification activities need to improve the lives of all members of society."
THE GRID OF THE FUTURE

Decentralized
Intelligent devices from substations to customers’ homes and premises – Industrial Internet of Things

Digitalized
Network services across multiple platforms providing customers with greater control over energy products and services

Decarbonized
Cleaner, greener more sustainable energy options
AEP AREAS OF INTEREST EXAMPLES: Platforms (P), E-Mobility (E) and Resiliency (R)

- P/R-Distributed Energy Resource Management Systems (DERMS)
- P/E-Mobility – EV Fleet Management and Optimization
- P/E-Mobility – Vehicle to Grid, etc. (V2x) applications (Grid and Home)
- P/E/R-Machine Learning (ML)/Artificial Intelligence (AI) Use Cases for Energy Management for Commercial Customers
- P/R-ML/AI Use Case for Asset Management (aka Predictive Analytics)
- P/R-ML/AI Use Case for sensor data (on grid and at customer premise)
- Resiliency as a service
- Reliability as a service
- P-UAS/Image Processing/Work Management Integration
- P-Blockchain Use Case – Customer Data Management and Digital ID
- P-Blockchain Use Case – Transactive Systems
- P/R-Micro and nano grids
- R-Residential distributed solar plus storage
- P/R-second life storage

Seeking deployable opportunities that are looking 2 – 5 years into the future
START-UP PITCH DECK QUESTIONS TO ANSWER ABOUT YOUR TECHNOLOGY

1. What is the challenge your technology can solve for AEP?
2. What is the solution that your technology provides?
3. Describe a pilot with the minimum, fastest to complete activities that would demonstrate its benefits to AEP and its customers.
4. What would you need from AEP to have a successful pilot?
5. What would be the approximate cost of your pilot?
6. What would be the milestones and duration of your pilot?
Recognised as national leaders in efficiency and innovation.

Owns, operates and controls energy delivery infrastructure for 6.5 million Victorians.

Energy and infrastructure services for businesses, government, and communities.

Development and deployment of world leading solutions, connecting you to the new energy future.

Mondo is a commercial, unregulated subsidiary of AusNet Services.
New ways of operating that improve performance and quality of service for our customers, employees, suppliers and partners.

WE ARE LOOKING FOR
Ideas, products and solutions that help drive digital transformation.

WE ARE INTERESTED IN

Improving Safety
For our people and our customers

Distributed Energy Resources
SME and Industrial DER, Microgrid, Grid integration of DER, Network Demand & DER Generation forecasting, DER marketplace

Demand Response & Demand Management
Energy Aggregation & Orchestration

Data Driven Intelligence / Insights
Using smart meter and asset data for Risk based and predictive maintenance, Predictive outage management, Network modeling, HV/LV modeling & Spatial analytics

Digital Asset Models
Using satellite remote sensing data, aerial/mobile LiDAR and image data for Automated defect identification, Predictive vegetation growth & Digital 3D design and modelling

Enhanced Customer & Employee experience
Improving our end to end service provision for our customers.

Cyber Security

Something Amazing
An application in an area of interest or a new or disruptive business model that we can’t go past - feel free to convince us
Who we are and what we do

1. ELECTRICITY TRANSMISSION
Moves electricity long distances from multiple generation sources at high voltages along transmission powerlines and lowers into the distribution network.

2. ELECTRICITY DISTRIBUTION
Converts and delivers electricity at lower voltages into homes and businesses.

3. GAS DISTRIBUTION
Converts gas from high to lower pressures for delivery into homes and businesses.

4. METERING
Collecting and analysing consumption data for billing and network operation purposes.

5. ASSET MANAGEMENT
The inspection and maintenance / enhancement of gas and electricity assets, including vegetation management.

6. CUSTOMER SERVICES
Supporting our customers to enhance their electricity and gas network experience.

7. COMMERCIAL SERVICES
Providing infrastructure assets and services, and energy solutions to commercial customers.
Come and work with us down under

Working with us will give you access to

**Electricity distribution**
- 50,000km+ network
- 700,000+ Customers
- 100% Smart Meters homes and businesses

**Electricity transmission**
- 6,000km+ transmission lines
- 13,000+ transmission towers

**Gas distribution**
- 11,000km of network
- 600,000+ Customers
Collaborate to Innovate: Shaping the Energy Landscape of Tomorrow

CLP
We want to work with you!
CLP is a leading utility in APAC

APAC operations

Revenue in 2018
~US$ 12 billion

Generation and Transmission

Over 23,700 MW
Renewables over 3,000 MW

Coal 51%
Gas 21%
Nuclear 11%
Others e.g. oil 4%
Wind 8%
Solar 2%
Hydro 2%

Over 15,800 km transmission lines

Retailer and Services

Over 5.1 million Customers
EV charging network
Smart Energy Services
Smart CITY and GRID
## CLP Businesses in APAC

### CLP Power Hong Kong

- **Generation**
- **Transmission & Distribution**
- **Over 2.6 million customers**

### New Energy Services

#### CLPe Solutions

- Power engineering
- Infrastructure
- Facilities management
- Consulting
- Smart energy services
- DER

Platform that offers digital energy management solutions to save energy, money and time:
- Sustainability
- Energy cost saving
- Wellness
- Security
- Connectivity
- Productivity

EV charging infrastructure
CLP Businesses in APAC

Mainland China

**Generation:** One of the largest external independent power producers with a focus on clean and low-carbon energy, including nuclear and renewables.

Developer of Incremental Distribution Networks (IDN) and energy services.

India

**Generation:** Operate broad generation portfolio covering coal, gas and wind and solar energy. CLP is one of the largest foreign players in the Indian power industry.

Southeast Asia and Taiwan

**Generation:** Investments in a solar project in Thailand and a coal-based generation plant in Taiwan.

Australia

**Gentailer:** Provide gas and electricity to 2.50 customer accounts and owns & operates a portfolio of generation assets, including coal, gas, wind power and battery storage.

Energy Solutions: CLP is actively offering innovative energy solutions focused on C&I and industrial parks, including:

- Microgrid solutions
- PPA
- EV charging
- Battery
- DER
- Smart Energy Services
Why does CLP work with Start-ups?

To provide new *digital, connected, smart* and *low carbon* products and services to our customers and *prepare* our assets for the future.

*From producing electricity to offering customer centric energy related services.*

*Energy is one of the last industries to be disrupted*

*Digitalisation*
*Decarbonisation*
*Decentralisation*
*Democratisation*
*Electrification*

*Competition from disruptive players and convergence of industries*
Why Work With CLP?

**Revenues → Route to Market within CLP and to our Customers:**
Access to APAC Markets, 5 mln+ customers, World class brand

**Domain and Marketing Expertise:**
We have 118 years of experience and a Diverse Portfolio for you to test solutions

**We really make it easy to work with us:**
Simple agreement and a process to quickly pilot & deploy your solution

**We have outstanding People:**
Diverse range of skills, all committed to the future of energy
What are we looking for?

Customer Solutions
Our customers need solutions that increase **insights, efficiency, sustainability, connectivity, safety, wellbeing** and **productivity**. We are in the process of rolling out smart meters to all our Hong Kong customers.
- Smart Home and Solutions using Smart Meter data
- Smart Office – comfort, services offerings
- Smart Buildings – retro-commissioning, energy efficiency, BEMS
- Facility Management – productivity
- Green Energy - PPA

Distributed Generation and Demand
Flexible generation and demand are playing a large role in the future of the grid.
- Integration of customer solutions with grid solutions
- Demand management solutions

Smart City Solutions
Industries are converging and CLP as infrastructure provider has an important role in the city of the future. How can you help our citizens and public services.
- Data optimization and sharing tools
- Energy sharing platforms
- Data centre solutions
- Public lighting, safety, transport, healthcare, education

Smart Grid and Distribution
The future of networks is connected and decentralized. We are preparing our grid and offering microgrid solutions to end customers
- Microgrid solutions for HK, China, Thailand and India
- Distributed Energy Resources
- Demand Management for Hong Kong
- Integration of renewables
- Future proofing of grid operations and business model

Transportation and Mobility
The number of EV’s is increasing and hence creating an impact on CLPs grid in Hong Kong. CLP also owns a charging network
- EV solutions for grid operator
- EV Charging platform
- Fleet management (busses, trucks, taxis etc)

Operational efficiency
Improving the resource allocation of our current operations.
- Wind farm analytics – fault predictions & (price) forecasting
- Predictive maintenance for critical assets in our infrastructure
- Increase insights in our customer base

Moonshot Ideas
Surprise and convince us! How can we not have thought about this and why should CLP do this! We are all ears!
DEWA
Dubai Electricity & Water Authority
SUPPORT FROM OUR LEADER

H.H Sheikh Mohammed bin Rashid Al Maktoum Directed the Nation to Focus on Innovation at a Global Level and Become One of the Most Innovative Nation

“The UAE is already the most innovative Arab nation. Our target is to be amongst the most innovative nations in the world”

His Highness Sheikh Mohammed bin Rashid Al Maktoum
Vice President and Prime Minister of the UAE and ruler of Dubai
SUPPORT FROM MD&CEO OF DEWA

H.E. opened the doors for all DEWA employees to use their innovative minds to lead DEWA toward it’s vision

“The stage is yours to prove your capabilities, improve your skills and enhance your knowledge to help DEWA consolidate its leadership at the global level. You can achieve this in the highly motivating environment that DEWA provides to encourage innovation and success, so that excellence becomes a lifestyle and a way of thinking”

His Excellency Saeed Al Tayer
MD&CEO of DEWA

DEWA’s Vision
A Globally Leading Sustainable Innovative Corporation
DEWA is aligned with many Agendas, Strategies, Government Plans and Visions of Our Great Leaders

To be a Digital Utility and Lead the Way of Digital Transformation
FREE ELECTRONS: THE GLOBAL ENERGY ACCELERATOR

“Accelerate digital transformation in the energy industry through disruptive technologies that are not limited to Quantum Computing, and can include Artificial Intelligence (AI), Blockchain, Automation, Robotic Process Automation (RPA), Internet of Things (IoT), Augmented Reality and others”

DEWA’s CORE BUSINESS

- Power & Water Planning
- Distribution Power
- Water & Civil
- Transmission Power
- Generation
- Customer Happiness
- Business Support & Human Resources
- Innovation & The Future
EDP Innovation
EDP GROUP OVERVIEW

CONSOLIDATED 2018
Clients: ~11Mn
EBITDA: € 3.3 Bn
Generation cap: 27.1GW

EDP PORTUGAL
32% of EBITDA*
#1 Producer, distributor and trader in Portugal

EDP BRAZIL
20% of EBITDA*
#4 private wholesale market player
#5 private power generation

EDP SPAIN
9% of EBITDA*
#2 in gas retail

EDP RENEWABLES
WIND & SOLAR POWER
39% of EBITDA*
#4 player in wind power worldwide

* Percentage of recurrent EBITDA
EDP INNOVATION PRIORITIES

SMARTER GRIDS
- Smart Grids Infrastructure
- Energy Distribution Management
- Demand Response
- Energy Aggregation
- Micro-Grids

ENERGY DISTRIBUTION MANAGEMENT

DEMAND RESPONSE

ENERGY AGGREGATION

MICRO-GRIDS

CLEANER ENERGY
- Centralized Renewable Energy
- Assets Monitoring and Sensing
- Preventive / Predictive analytics
- O&M

DATA LEAP / DIGITAL
- Big Data and Advanced Analytics
- IoT
- Cybersecurity
- Artificial Intelligence
- Augmented Reality
- Blockchain
- Quantum Computing

CLIENT-FOCUSED SOLUTIONS
- Energy Efficiency
- Mobility
- Connected/Smart Homes
- Distributed Solar
- New services / new offers

DATA LEAP / DIGITAL

FLEXIBILITY AND AGGREGATION
- Flexibility and aggregation for demand response
- Preventive / Predictive analytics for energy storage technologies
- Storage behind-the-meter
- Utility-scale storage
OUR 2030 VISION

Leading the energy transition to create superior value

- Decarbonization
  - >90% renewables generation
  - Reduce 90% specific emissions (vs 2005 levels)
  - Become coal-free

- Digitalization

- Decentralization
  - >4 Mn decentralized solar PV panels installed
  - >1 Mn clients with e-mobility solutions
  - 100% smart grids (in Iberia)
EDP’s STARTUP ROUTE

How we work with startups

Scouting

Screening

Business Acceleration
• Starter Acceleration Program
• Free Electrons

Pilot Projects

Startup Community

Investment
• EDP Ventures

Commercial Rollout
LEADING THE WAY TO A BRIGHTER FUTURE
ESB is a leading Irish vertically integrated utility operating across the electricity market, from generation through transmission and distribution, to supply of customers, with an expanding presence in Great Britain’s generation and supply markets. In addition, we extract further value at certain points along this chain by supplying gas and using our networks to carry fibre for telecommunications.

**Strategy, Innovation and Transformation**

Strategy, Innovation and Transformation’s purpose is to set and manage the strategic direction of ESB, to influence energy policy and regulation and drive business transformation across ESB group to lead the transition to a low carbon future.

We will continue to work collaboratively across ESB to develop and implement our Strategy, drive cross-company transformation projects and incubate new cross value chain innovations from concept to business case before releasing to the business to scale.

**Generation Trading**

"ESB develops, operates and trades the output of ESB’s electricity generation assets. The portfolio consists of 5,564 MW of thermal and renewable generation assets across ROI, NI and GB, with a further 158 MW under construction.

**Networks**

ESB builds, manages and maintains the transmission and distribution network in ROI and NI. Over 229,000 KM of Network.

**Customer Solutions**

Supplying electricity, gas and energy services to customers in ROI, NI and GB.

**Engineering and Major Projects**

To deliver the major projects and engineering required for ESB to lead the transition to reliable, affordable, low carbon energy both at home and internationally.”

**Enterprise Services**

Enterprise Services is responsible for providing business critical processes and services to the rest of ESB Group through its two delivery arms, Business Operations and IT Delivery; and responsible for leading the digital transformation of ESB Group, and ensuring excellent IT system availability including management of cyber security risks.
Our Purpose
Is to 'Create a Brighter Future for the customers and communities we serve, by leading the transition to reliable, affordable, low-carbon energy.'

Our Objectives

- Put customers’ current and future needs at the centre of all our activities
- Produce, connect and deliver clean, secure and affordable energy
- Develop energy services to meet evolving market needs
- Grow the business while maintaining ESB’s financial strength
- Deliver a high-performance culture that supports innovation and collaboration

Through our diverse businesses across the Republic of Ireland, Northern Ireland and Great Britain we aim to meet customer energy needs by bringing the best of our capabilities together to deliver innovative and value driven solutions for a low-carbon world.
Business Environment Factors

Business environment factors that significantly impact on the ESB Strategy

**Climate and Energy Policy**
The Republic of Ireland (ROI) and the UK have set targets for the proportion of electricity to be produced from renewable sources of 40% and 30%, respectively by 2020. Progressive decarbonisation of its energy system, targeting 80% reduction by 2050.

**Advances in Technology**
Technological advances will enable a greater level of electricity production, storage and control, either directly by customers, or by service providers controlling and managing energy demand on their behalf.

**Changing Customer Preferences**
Customer's ongoing expectations regarding secure, affordable and increasingly low-carbon energy.

**Emergence of New Business Models**
ESB sees advances in technology, energy and regulatory policy combined with changing customer preferences giving rise to a range of new business models.

**Brexit**
Notwithstanding the uncertainty related to Brexit the UK energy sector continues to provide a pipeline of growth opportunities in proximate markets.
Innovation Priorities

**Generation Trading**
- New Low Carbon Assets
- Asset Optimisation
- Autonomous Trading
- Data Analytics
- System Services

**Networks**
- Electrification of Heat & Transport
- Flexibility on our Networks
- Operational Excellence
- Connecting Renewables
- Asset Optimisation
- Network Resilience

**Customer Solutions**
- Home Care
- Mobility
- Connected/Smart Homes
- Distributed Solar
- Energy Efficiency

**Engineering and Major Projects**
- Battery Storage
- Flexible Power Generation
- Biomass
- Preventive and Predictive Analytics

**Technologies**
- Blockchain
- Machine Learning
- Artificial Intelligence
- Hydrogen
- IoT
- Advanced Analytics
- Cyber Security
innogy is a stable business with a platform for growth

innogy is active along the energy value chain in three divisions:

- **Renewables**
  - Wind
  - Hydro
  - Solar
  - 3.6GW installed capacity\(^1\)

- **Grid & Infrastructure**
  - Grid Assets
  - Grid+
  - Broadband
  - €11.7bn regulated asset base\(^2\)

- **Retail**
  - Commodity
  - Energy+
  - 21.5m customers

2019 targeted net investments of ~€2.5bn\(^3\)

Targeted payout ratio of 70-80% of adjusted net income

Market cap of around €23.7bn (as of 7 Aug 2019)

40,522 employees (as of 30 Jun 2019)

Note: Rounding differences may occur.

1 Accounting view. 2 Czech gas grid business removed from RAB following sale to RWE in February 2019. 3 Excluding disposal proceeds from sale of CZ gas grid. Capital expenditure on property, plant and equipment and on intangible assets, financial assets \(/\) proceeds from disposal of assets/divestitures and net changes in equity.

Innogy SE - August 2019
1. CHANGE DRIVERS OF THE ENERGY BUSINESS

We face significant emission reduction targets....
1. CHANGE DRIVERS OF THE ENERGY BUSINESS

...which can only be realised through renewable energy in all sectors (Electricity/Mobility/Heat)...

THE „INTEGRATED ENERGY TRANSITION“ DEPENDS ON RENEWABLE ENERGY IN ALL SECTORS!

DigiKoo

Source: Umweltbundesamt (07/2018)
1. CHANGE DRIVERS OF THE ENERGY BUSINESS

...via a massive transformation until 2030/2050
1. CHANGE DRIVERS OF THE ENERGY BUSINESS

This will lead to additional cost/investment of 100 trillion EUR globally and 2 trillion EUR for Germany...
1. CHANGE DRIVERS OF THE ENERGY BUSINESS

...and requires a smart connection of Electricity, Mobility and Heat (sector coupling)

- To enable the future picture and reach our emission goals, data-driven energy and smart networks will play a crucial role
- We need to make our grid infrastructure more data-driven and also leverage our very strong position in grids to develop new data-driven energy business models
- For our customer base in Europe, we need to provide connectivity to the energy system and products/services that enable them to participate and benefit from the energy transition
Origin is one of Australia’s leading energy companies

**Australia’s Leading Energy Retailer**
4.2 million gas, electricity and LPG customer accounts

**Large and flexible gas supply**
Contract length, cost and transportation flexibility

**Growing Renewable Supply**
From ~19% of Origin’s owned and contracted generation capacity today to more than 25% by 2020

**Growth Opportunities**
- Increase generation flexibility and capacity - brownfield growth and integrate storage
- New revenue streams – centralised energy services, adjacencies

Origin also has a presence in California’s Silicon Valley to better connect us to the global epicentre of digital innovation, and an LPG business throughout the Pacific islands.
Strategy to deliver value in the future energy world

Connecting customers to the energy and technologies of the future

• Accelerate towards clean energy
• Low cost operator developing & growing gas resources
• Embrace a decentralised and digital future
• Leading customer experience and solutions
Based on our strategic priorities we are looking for innovative ideas in the following areas

<table>
<thead>
<tr>
<th>Area</th>
<th>Ideas</th>
</tr>
</thead>
</table>
| **Accelerate towards clean energy**           | - Innovations that improve the integration of renewables into the existing transmission / distribution network and market structures  
- Integrated inverter / battery solutions for business customers  
- Solutions for the integration of behind the meter assets, compatibility with BMS systems and major asset brands |
| **Embrace a decentralised and digital future** | - Data and algorithms to analyse competitor behaviour and optimise our energy trading portfolio accordingly  
- Propensity modelling of customer take up of batteries and electric vehicles  
- Low cost hardware for customer homes that send sensor data |
| **Leading customer experience and solutions**  | - How might non-tech-savvy consumers make their home smart and connected  
- How can energy companies build deep engagement and trust with customers?  
- Data Driven Business Models |
| **Open Innovation**                           | - New ideas that we haven’t though of! |
Origin is open for innovation business

Energy markets around the world are transforming and Australia is no exception.

- The continued penetration of distributed assets, combined with the rise of IoT devices, are changing the way our customers use energy.
- Origin believes significant opportunity exists in the transformative impact of decarbonisation, decentralisation and digitisation on the energy sector.

Innovation is at the heart of seizing this opportunity.

- We have been scouting and evaluating hundreds of start-ups across a wide range of areas.
- We have been trialling a number of technologies and solutions across a range of areas - smart home, IoT devices, storage, demand response, virtual power plants, energy management, AI/machine learning.
- We have partnered with and invested in a number of start-ups in the areas of energy management, renewables, storage, digital rights management, distributed transactions.
- We have a mandate to continue these activities in order to find the right technologies and solutions for our customers.
A leading energy utility company in Singapore & Asia Pacific
Core Businesses

Electricity & gas transmission and distribution

Metering & billing service

Singapore District Cooling

Highest reliability
Average Outage Duration
(SAIDI 0.19 min)

Convenience to customers
One click, one stop service

World’s largest underground district cooling network

Poweringthenation.sg
Innovation & Sustainability

Customer App
Helping customers save energy and money

EV Charging
Deploying Singapore’s largest public EV charging network

REC Marketplace
One of the world’s first blockchain-powered renewable energy certificate marketplace

Poweringthenation.sg
Innovation & Sustainability

PV + ESS
Largest solar rooftop in Singapore with AI-powered digital system

Urban Microgrid
Singapore's first urban micro-grid targets zero-emission

Smart Town
Developing Singapore’s first smart energy town in Tengah

Poweringthenation.sg
Areas of Interest

Energy Efficiency

Electric Vehicles

Distributed Energy Resources

Cooling Technologies

Digital Technologies

Poweringthenation.sg
1. The largest utility in Japan

Generates 1/3 Power in Japan

- **Generation**
- **T&D**
- **Retail**

- CHUBU Electric Power
- TEPCO Fuel & Power
- JERA
- TEPCO Power Grid
- TEPCO Energy Partner

- Transmission: Approx. 40,000 km
- Substation: Total: 1,614 locations, underground: 199 locations
- Distribution: About 360,000 km

- ¥5 Trillion In Sales
- 29 Million Customers

© Tokyo Electric Power Company Holdings, Inc. All Rights Reserved.
TEPCO believes that the “5-D’s” (the decreasing population, decarbonization, decentralization, deregulation and digitalization) driving social change in Japan present us with an opportunity to evolve so as to be prepared for the age of Utility 3.0* where not only existing energy operators, but also new operators that have digital technology, such as IoT, etc., will cooperate to provide comprehensive social infrastructure.

*Utility 3.0 is the predicted future state of the energy industry as seen based on various social changes and technological innovation.

2. “5-D’s”

Decreasing population
2050  50% decrease in populations in over 60% of regions (depopulation)
2065  Population in Japan: 88 million people

Decarbonization
Paris Accord (25% CO2 reduction by 2030)
Cabinet Decision (80% CO2 reduction by 2050) *2013 levels

Decentralization
Decentralized power sources, such as solar and wind power, and the spread of energy-storage technology, such as electric vehicles and heat pump water heaters

Deregulation
Electricity system reforms, gas system reforms

Digitalization
Business of providing “things” → Business of providing “services” through things
3. KEY GOALS

- Performance improvement
- Cost reduction
- New revenues / solutions

TEPCO is an extremely large utility that is involved in a wide range of operations, and that has a great number of customers and assets. So even if the impact for each customer or asset is limited, by working with us the overall impact will become much greater. We have high expectations of adopting your technologies and ideas to help us obtain new revenue streams over the next several years.