Pathways to Universal Access to Electricity by 2030

Lawrence Jones
Vice President
Monash University
Melbourne, Australia
February 28, 2020
Great days are ahead of this nation and the world. And electricity will have a great part to play, granted only that it can be unfettered, with full opportunity for the largest possible individual initiative and energy.

Thomas Alva Edison, 1928
About EEI
The mission of EEI International Programs is to provide members in the global electric power industry an agile and efficient platform for collaboration, dialogue, outreach, and leadership.

This mission is accomplished through the delivery of high-quality and relevant information and services that enhance the capacity of EEI members to realize their commitments to building affordable, reliable, resilient, and sustainable energy systems of the future.
EEI International Members by Region

NORTH AMERICA
- AES Corporation
- Electra
- Altalink
- APR Energy
- ATCO Electric
- Brookfield Power
- Capital Power Corp.
- Comisión Federal de Electricidad
- Emera, Inc.
- ENMAX
- Entegris Powerlines
- Fortis, Inc.
- FortisAlberta
- FortisBC
- FortisOntario
- Hydro One
- Hydro Ottowa
- Hydro-Québec
- Manitoba Hydro
- Maritime Electric
- Newfoundland Power
- Nova Scotia Power Inc.
- Ontario Power Generation
- SaskPower
- Toronto Hydro

AFRICA & MIDDLE EAST
- Compagnie Ivoirienne d'Electricité
- Gulf Cooperation Council Interconnection Authority

LATIN AMERICA & CARIBBEAN
- Bahamas Power and Light
- Barbados Light and Power
- Belize Electricity
- Bermuda Electric Light
- Caribbean Utilities
- CEMIG
- EDominica Electricity Services
- GE Haina
- Guyana Power and Light
- FortisTCI
- St. Lucia Electricity Services
- St. Vincent Electricity Services

EUROPE
- Electricité de France
- Energias de Portugal
- Electricity Supply Board
- ENGIE
- Iberdrola
- National Grid
- Polska Grupa Energetyczna
- UK Power Networks

ASIA
- CESCLtd.
- Chubu Electric Power
- China Southern Power Grid
- J-POWER
- Kansai Electric Power
- Korea Electric Power
- Power Assets Holdings
- State Grid Corporation of China
- Tohoku Electric Power
- Tokyo Electric Power

AUSTRALIA & NEW ZEALAND
- Energy Queensland
- Endeavour Energy
- Jemena
- Orion New Zealand Ltd.
- Powerco Ltd.
- SA Power Networks
- TasNetworks
- Transpower New Zealand
- Unison Networks Ltd.
- Vector Ltd.
- Wellington Electricity
New Thinking
To Rethink, Reimagine, and Reinvent, One Must Question

“The bigger the problem or opportunity in the world, the bigger the insight we need – and the bigger the questions we should be prepared to ask” - Hal Gregersen
Question Today’s Facts Before Reinventing the Present to Create the Future
Universal Access to Clean Energy by 2030

- With less than a decade remaining, is this goal still achievable?

- What questions should we be asking to catalyze actions that leapfrog us towards this goal?

- How must business and regulatory models evolve in the ever-changing energy sector?

- What technologies, existing or under development, will shape the pathways to an all-electric future?
Questions

• What if assumptions behind the projections about urbanization are wrong, and the current trend of urbanization is reversed by 2030 or 2050?

• What if the global south achieved the same level of prosperity, wealth, and standard of living as the global north?

• What will it mean for the planet when the resources demand in cities in the global south equals or exceeds that of the global north, and why should we assume it could not happen?

• What kinds of cities do we want to live in tomorrow?
Questions

• Will cities still be the engines of growth in a knowledge intensive and service dominated economy, where there is no locational requirement for creating and delivering value?

• What if the global south achieved the same level of prosperity, standard of living as the global north?

• What if we could reduce the hardships of rural living and be fully transparent about the stresses of urban living?
Questions

• What is the future of financing urbanization - economies of scale, economies of unscaled, or a hybrid?

• Do we get more insights from best or worst practices, and successes or failures?

• How do we measure a smart, livable, intelligent, sustainable city? Is a city smart and sustainable with all great technology but many poor and underserved residents?
Longevity of Infrastructure

• Should we build infrastructures to meet today’s needs or those that will serve future generations?
• Do we upgrade the existing or build completely new infrastructure?
• How do we pay for building and maintaining physical infrastructures that are public good?
• What happens when city population outpaces infrastructure capacities?
• Must the future of humanity depend on the proposed benefits of vertical densification in cities or is there another way?
Global Trends
GRAND CHALLENGES & OPPORTUNITIES

- CLIMATE CHANGE
- URBANIZATION
- POPULATION GROWTH
- POVERTY
- TRUST DEFICIT
- INERTIA AND THE PACE OF CHANGE
- INSECURITY
- LACK OF SHARED FUTURE VISION
Electrification of Urban and Rural Futures
Duality of *Scarcity and Abundance*
Waste-to-Energy-to-Poverty Reduction
### The Evolving Risk Landscape, 2015-2020

#### Top 5 Global Risks in Terms of Likelihood

<table>
<thead>
<tr>
<th>Year</th>
<th>1st Risk</th>
<th>2nd Risk</th>
<th>3rd Risk</th>
<th>4th Risk</th>
<th>5th Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>Interstate conflict</td>
<td>Extreme weather</td>
<td>Natural disasters</td>
<td>Terrorist attacks</td>
<td>Natural catastrophes</td>
</tr>
<tr>
<td>2016</td>
<td>Extreme weather</td>
<td>Involuntary migration</td>
<td>Climate action failure</td>
<td>Data fraud or theft</td>
<td>Data fraud or theft</td>
</tr>
<tr>
<td>2017</td>
<td>Extreme weather</td>
<td>Extreme weather</td>
<td>Natural disasters</td>
<td>Climate action failure</td>
<td>Climate action failure</td>
</tr>
<tr>
<td>2018</td>
<td>Extreme weather</td>
<td>Extreme weather</td>
<td>Natural disasters</td>
<td>Cyberattacks</td>
<td>Climate action failure</td>
</tr>
<tr>
<td>2019</td>
<td>Extreme weather</td>
<td>Extreme weather</td>
<td>Natural disasters</td>
<td>Human-made environments disasters</td>
<td>Cyberattacks</td>
</tr>
<tr>
<td>2020</td>
<td>Extreme weather</td>
<td>Extreme weather</td>
<td>Natural disasters</td>
<td>Water crises</td>
<td>Data fraud or theft</td>
</tr>
</tbody>
</table>

#### Top 5 Global Risks in Terms of Impact

<table>
<thead>
<tr>
<th>Year</th>
<th>1st Risk</th>
<th>2nd Risk</th>
<th>3rd Risk</th>
<th>4th Risk</th>
<th>5th Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>Water crises</td>
<td>Climate action failure</td>
<td>Weapons of mass destruction</td>
<td>Interstate conflict</td>
<td>Natural catastrophes</td>
</tr>
<tr>
<td>2016</td>
<td>Climate action failure</td>
<td>Involuntary migration</td>
<td>Weapons of mass destruction</td>
<td>Data fraud or theft</td>
<td>Data fraud or theft</td>
</tr>
<tr>
<td>2017</td>
<td>Weapons of mass destruction</td>
<td>Extreme weather</td>
<td>Extreme weather</td>
<td>Natural disasters</td>
<td>Cyberattacks</td>
</tr>
<tr>
<td>2018</td>
<td>Extreme weather</td>
<td>Climate action failure</td>
<td>Natural disasters</td>
<td>Water crises</td>
<td>Biodiversity loss</td>
</tr>
<tr>
<td>2019</td>
<td>Climate action failure</td>
<td>Weapons of mass destruction</td>
<td>Water crises</td>
<td>Climate action failure</td>
<td>Energy price shock</td>
</tr>
<tr>
<td>2020</td>
<td>Climate action failure</td>
<td>Climate action failure</td>
<td>Water crises</td>
<td>Natural disasters</td>
<td>Water crises</td>
</tr>
</tbody>
</table>

The Global Risks Interconnections Map 2020

Number and strength of connections ("weighted degree")

## 2018 Natural Disaster Events & Losses

### Top 10 Global Economic Loss Events

<table>
<thead>
<tr>
<th>Date(s)</th>
<th>Event</th>
<th>Location</th>
<th>Deaths</th>
<th>Economic Loss (Billion USD)</th>
<th>Insured Loss (Billion USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct 10-12</td>
<td>Hurricane Michael</td>
<td>United States</td>
<td>32</td>
<td>17.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Sept 13-18</td>
<td>Hurricane Florence</td>
<td>United States</td>
<td>53</td>
<td>15.0</td>
<td>5.3</td>
</tr>
<tr>
<td>November</td>
<td>Camp Fire</td>
<td>United States</td>
<td>88</td>
<td>15.0</td>
<td>12.0</td>
</tr>
<tr>
<td>Sept 4-5</td>
<td>Typhoon Jebi</td>
<td>Japan</td>
<td>17</td>
<td>13.0</td>
<td>8.5</td>
</tr>
<tr>
<td>July 2-8</td>
<td>Flooding</td>
<td>Japan</td>
<td>246</td>
<td>10.0</td>
<td>2.7</td>
</tr>
<tr>
<td>Spring &amp; Summer</td>
<td>Drought</td>
<td>Central &amp; Northern Europe</td>
<td>N/A</td>
<td>9.0</td>
<td>0.3</td>
</tr>
<tr>
<td>Sept 10-18</td>
<td>Typhoon Mangkhut</td>
<td>Oceania, East Asia</td>
<td>161</td>
<td>6.0</td>
<td>1.3</td>
</tr>
<tr>
<td>July-Sept</td>
<td>Flooding</td>
<td>China</td>
<td>89</td>
<td>5.8</td>
<td>0.4</td>
</tr>
<tr>
<td>November</td>
<td>Woolsey Fire</td>
<td>United States</td>
<td>3</td>
<td>5.8</td>
<td>4.5</td>
</tr>
<tr>
<td>Aug 16-19</td>
<td>Tropical Storm Rumbia</td>
<td>China</td>
<td>53</td>
<td>5.4</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>All Other Events</td>
<td></td>
<td></td>
<td>123</td>
<td>45</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>225</strong></td>
<td><strong>90</strong></td>
</tr>
</tbody>
</table>

Source: AON, Weather, Climate & Catastrophe Insight: 2018 Annual Report
2019 Natural Disaster Events

- UK Wildfires
- Cyclone Idai
- South Asia Floods
- Hurricane Dorian
- New South Wales Bushfire
- Typhoon Hagibi
## Resilience Investments – Florida P&L

### Restoration Comparison: Wilma vs. Irma

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Saffir-Simpson Scale</td>
<td>Category 3</td>
<td>Category 4</td>
</tr>
<tr>
<td>Cyclone Damage Potential Index</td>
<td>2.8</td>
<td>4.3</td>
</tr>
<tr>
<td>FPL Counties Affected</td>
<td>21</td>
<td>35</td>
</tr>
<tr>
<td>Substations De-energized / Time Restored</td>
<td>241 / 5 days</td>
<td>92 / 1 day</td>
</tr>
<tr>
<td><strong>Customers Impacted</strong></td>
<td><strong>3.2 million</strong></td>
<td><strong>4.4 million</strong></td>
</tr>
<tr>
<td>Customer Restoration (100%)</td>
<td>18 days</td>
<td>10 days</td>
</tr>
<tr>
<td>... 50%</td>
<td>5 days</td>
<td>1 day</td>
</tr>
<tr>
<td>... 75%</td>
<td>8 days</td>
<td>3 days</td>
</tr>
<tr>
<td>... 95%</td>
<td>15 days</td>
<td>7 days</td>
</tr>
<tr>
<td><strong>Average Customer Outage</strong></td>
<td><strong>5.4 days</strong></td>
<td><strong>2.3 days</strong></td>
</tr>
</tbody>
</table>

*Source: Florida Power & Light*
Managing the Uncertainty of the Energy Transition
Energy Innovation Through the Eyes of Customers
Attributes of Energy Innovation

- Incremental vs. Disruptive
- Customer-Centric vs. System-Centric
- Tangible vs. Intangible
- Visible vs. Invisible
New Science for Understanding Customers
Understanding Electricity Customer Varying Needs

- Electricity a vital critical infrastructure for modern and sustainable society – *The future is electric*

- Electricity must be reliable and increasing clean, but it must also be affordable

- The perceived value peaks when the lights go off

- The physical infrastructure should be invisible

- Simple messages about a complex process
# What Customers Want

Q: Which is most important? That your energy company is...? (TOP 2)

<table>
<thead>
<tr>
<th></th>
<th>Opinion Influencers</th>
<th>Millennials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuously improving how we operate</td>
<td>50%</td>
<td>49% 33%</td>
</tr>
<tr>
<td>Investing in smarter energy infrastructure</td>
<td>48%</td>
<td>57% 32%</td>
</tr>
<tr>
<td>Serving customers in ways that make their experience easier</td>
<td>34%</td>
<td>21% 40%</td>
</tr>
<tr>
<td>Leading the way on clean energy and carbon reduction</td>
<td>33%</td>
<td>47% 38%</td>
</tr>
<tr>
<td>Working with customers to create customized solutions</td>
<td>15%</td>
<td>11% 26%</td>
</tr>
<tr>
<td>Investing in digital tools to help customers manage their energy</td>
<td>12%</td>
<td>9% 19%</td>
</tr>
<tr>
<td>Making a positive contribution to the community</td>
<td>8%</td>
<td>7% 14%</td>
</tr>
</tbody>
</table>

Customer Expectations – Survey Results

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Total</th>
<th>Opinion Influencers</th>
<th>Low Income</th>
<th>NPS Detractors</th>
<th>Ages 18-34</th>
<th>Extreme Weather</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alerts me when power is out, how long it will take to restore, and when it is restored</td>
<td>81.7%</td>
<td>83.7%</td>
<td>80.1%</td>
<td>81.2%</td>
<td>68.0%</td>
<td>81.4%</td>
</tr>
<tr>
<td>Completes scheduled work when they say they will</td>
<td>80.8%</td>
<td>84.3%</td>
<td>78.3%</td>
<td>80.4%</td>
<td>67.8%</td>
<td>80.8%</td>
</tr>
<tr>
<td>Invests in a stronger energy grid that can withstand extreme weather and cyberattacks</td>
<td>80.5%</td>
<td>86.2%</td>
<td>75.3%</td>
<td>79.1%</td>
<td>66.7%</td>
<td>80.3%</td>
</tr>
<tr>
<td>Has workers who can efficiently resolve my issues when they come to my home</td>
<td>77.7%</td>
<td>80.0%</td>
<td>76.5%</td>
<td>77.0%</td>
<td>66.6%</td>
<td>77.3%</td>
</tr>
<tr>
<td>Has knowledgeable customer service representatives</td>
<td>76.3%</td>
<td>77.5%</td>
<td>75.1%</td>
<td>75.7%</td>
<td>66.2%</td>
<td>76.0%</td>
</tr>
<tr>
<td>Shares an accurate estimate of outage time and lets me know if it changes</td>
<td>73.7%</td>
<td>76.0%</td>
<td>71.8%</td>
<td>72.9%</td>
<td>62.4%</td>
<td>74.5%</td>
</tr>
<tr>
<td>Uses innovative technologies and data to predict and prevent outages before they happen</td>
<td>72.5%</td>
<td>76.9%</td>
<td>67.3%</td>
<td>71.0%</td>
<td>60.0%</td>
<td>73.3%</td>
</tr>
<tr>
<td>Takes the time to listen to my issues and actually help me</td>
<td>69.4%</td>
<td>68.8%</td>
<td>71.6%</td>
<td>68.9%</td>
<td>64.2%</td>
<td>69.4%</td>
</tr>
<tr>
<td>Completes work without needing follow up</td>
<td>69.2%</td>
<td>71.7%</td>
<td>65.0%</td>
<td>68.4%</td>
<td>58.1%</td>
<td>69.4%</td>
</tr>
<tr>
<td>Has easy to understand bills that explain charges clearly</td>
<td>69.0%</td>
<td>67.5%</td>
<td>68.4%</td>
<td>69.0%</td>
<td>63.5%</td>
<td>68.3%</td>
</tr>
<tr>
<td>Proactively communicates about storms and potential outages</td>
<td>66.0%</td>
<td>67.5%</td>
<td>64.4%</td>
<td>63.9%</td>
<td>57.0%</td>
<td>66.9%</td>
</tr>
<tr>
<td>Treats me with respect</td>
<td>64.5%</td>
<td>62.4%</td>
<td>67.5%</td>
<td>64.1%</td>
<td>61.4%</td>
<td>64.4%</td>
</tr>
<tr>
<td>Considers the impact that actions like tree trimming and working on power lines will have on my area and takes steps to ensure customers are happy with the result</td>
<td>63.5%</td>
<td>67.1%</td>
<td>58.5%</td>
<td>62.1%</td>
<td>54.4%</td>
<td>64.9%</td>
</tr>
<tr>
<td>Has workers who are friendly and considerate when they come to my home</td>
<td>62.6%</td>
<td>62.1%</td>
<td>62.5%</td>
<td>61.3%</td>
<td>57.0%</td>
<td>62.6%</td>
</tr>
<tr>
<td>Rewards my loyalty with benefits and savings</td>
<td>59.6%</td>
<td>51.8%</td>
<td>63.4%</td>
<td>61.5%</td>
<td>63.0%</td>
<td>58.7%</td>
</tr>
<tr>
<td>Offers programs to help low income or elderly community members</td>
<td>59.4%</td>
<td>63.5%</td>
<td>65.0%</td>
<td>59.6%</td>
<td>55.1%</td>
<td>58.9%</td>
</tr>
<tr>
<td>Is adding more clean energy sources to its energy mix</td>
<td>59.0%</td>
<td>71.3%</td>
<td>55.9%</td>
<td>59.0%</td>
<td>55.5%</td>
<td>58.7%</td>
</tr>
<tr>
<td>Is taking steps to reduce carbon emissions and protect the environment</td>
<td>57.9%</td>
<td>70.4%</td>
<td>55.0%</td>
<td>58.3%</td>
<td>56.0%</td>
<td>57.8%</td>
</tr>
<tr>
<td>Considers my needs and impact on my day-to-day activities when scheduling work</td>
<td>56.4%</td>
<td>56.0%</td>
<td>55.1%</td>
<td>55.6%</td>
<td>52.2%</td>
<td>56.9%</td>
</tr>
<tr>
<td>Has a user-friendly website that makes it easy to find the information I need and pay my bill</td>
<td>55.2%</td>
<td>54.2%</td>
<td>52.6%</td>
<td>55.2%</td>
<td>56.8%</td>
<td>54.8%</td>
</tr>
<tr>
<td>Sets up support centers during disasters where people do laundry or refrigerate food</td>
<td>54.4%</td>
<td>59.2%</td>
<td>54.7%</td>
<td>53.4%</td>
<td>50.4%</td>
<td>54.8%</td>
</tr>
<tr>
<td>Offers tools and programs to help me save money by managing my energy use</td>
<td>54.0%</td>
<td>59.0%</td>
<td>52.9%</td>
<td>54.2%</td>
<td>49.6%</td>
<td>54.0%</td>
</tr>
</tbody>
</table>
The Evolving Electricity Customer

- Time is limited
- Attention is scarce
- Money is consumable

*Deliver Product, Service, or Experience*
Disruptive Business Models & Electricity

- Free Model (Google, Facebook)
- Freemium Model (LinkedIn)
- Subscription Model (Netflix)
- Marketplace Model (itunes, Amazon)
- Shared Resources Model (Uber, Airbnb)
- Mega-Market Model (Amazon)
- Branded Experience Model (Tesla, Apple)
- Ecosystem Model (Apple, Google, Amazon, Facebook, Alibaba)

Source: Business of Change, Mike Pollock
Disruptive Technologies & Electricity

- Fail Fast vs. Fail Safe
- Automation
- Big Data
- Artificial Intelligence
- Image Recognition
- Internet of Things
- Blockchain
- Cross Reality

- 3D Printing
- Robotics
- Drones
- Quantum Computing
- Voice Recognition & Control
- Autonomous & Connected Vehicles

Source: Business of Change, Mike Pollock
TRUST AND THE FUTURE OF ENERGY
Questions?