An Electrifying Transition: Electrification Barriers and Opportunities Workshop
Today’s Session

- Welcome
- Presentations
  - Andrea Pratt
  - Rick Cameron
  - Q&A
- Table Breakouts
- Break from 11:00 – 11:15
- Presentations
  - Cedric
  - Jennifer
  - Q&A
- Table Breakouts
- Wrap-up
What is Electrification?

Electrification: the conversion of a machine or system to the use of electrical power.
Opportunities for Electrification

Electric Transport

Building Space & Water Heating

Non-road Transport
Benefits of Electrification

- Increased Energy Efficiency
- Domestic Energy Support
- Improved Local Air Quality
- Increased Safety
- Reduced Emissions
# Metrics for Valuing Electrification

<table>
<thead>
<tr>
<th>Metric Options</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Customer</td>
</tr>
<tr>
<td>Economic Efficiency</td>
<td>✔</td>
</tr>
<tr>
<td>-- <em>It costs less</em></td>
<td></td>
</tr>
<tr>
<td>Economic Development</td>
<td>✔</td>
</tr>
<tr>
<td>-- <em>Jobs creation</em></td>
<td></td>
</tr>
<tr>
<td>-- <em>Development of community assets</em></td>
<td></td>
</tr>
<tr>
<td>Energy Efficiency</td>
<td>✔</td>
</tr>
<tr>
<td>-- <em>Uses fewer BTUs overall</em></td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td>✔</td>
</tr>
<tr>
<td>-- <em>Emissions reduction, CO2 savings, water savings, etc.</em></td>
<td></td>
</tr>
<tr>
<td>Plant Productivity Improvements</td>
<td>✔</td>
</tr>
<tr>
<td>-- <em>Plant output increases</em></td>
<td></td>
</tr>
<tr>
<td>-- <em>Reduction in energy intensity</em></td>
<td></td>
</tr>
<tr>
<td>-- <em>Improved product quality</em></td>
<td></td>
</tr>
<tr>
<td>Worker Safety Improvements</td>
<td>✔</td>
</tr>
<tr>
<td>-- <em>Reduced loss time accidents and fatalities</em></td>
<td></td>
</tr>
</tbody>
</table>
Energy-related Emissions Come From Different Sources

- Transportation: 1870 MMT (34%)
- Residential Buildings: 1112 MMT (20%)
- Commercial Buildings: 968 MMT (17%)
- Industrial: 1615 MMT (29%)
The Transportation Sector

GLOBAL ANTHROPOGENIC EMISSIONS
≈ 38 Gt CO₂

TRANSPORT EMISSIONS
≈ 8.8 Gt CO₂

ROAD TRANSPORT EMISSIONS
≈ 6.5 Gt CO₂

LEGEND

- RAIL
- AVIATION
- ROAD
- MARINE
- HEAVY-DUTY VEHICLES
- LIGHT-DUTY VEHICLES

Sources:
Electric Transport
# Incentives to increase EV adoption

<table>
<thead>
<tr>
<th>Area</th>
<th>Action</th>
</tr>
</thead>
</table>
| Federal | • Vehicle efficiency standards  
• Vehicle purchase subsidy  
• Vehicle charging infrastructure |
| State   | • Zero Emission Vehicle program  
• Vehicle purchase subsidy  
• Fee reduction or testing exemption  
• Home charger incentive, support  
• Public charging  
• Parking benefit  
• Fleet purchasing incentive  
• Manufacturing incentive  
• Low carbon fuel policy |
| City    | • Vehicle purchase subsidy  
• Parking incentive  
• City fleet purchasing  
• Carpool lane access  
• Car sharing program link  
• Local electric vehicle strategy  
• Website, informational materials  
• Outreach, education events |
| Utility | • Preferential rates for charging  
• Home charger support  
• Cost comparison tool  
• Website, informational materials  
• Other outreach activities |
Electric Transportation Opportunities

In-road charging Hamburg

Electric Hybrid bus in Stockholm

Siemens Offboard High Power Charger

UPS E-Trike had US debut in Portland in 2016

Electric highway in Sweden
What's Coming?

Confluence of Trends

Shared Mobility

Autonomous Vehicles

Electric Vehicles

Fast Level 2 Charging
Plugless is a 3.3kw charging system - just as fast as an L2 corded charger - but wireless.

Seamless Integration
No impact on your EV's native systems, software, or apps. Your vehicle will operate 100% as designed.

Works In All Weather
Rain, snow, sleet, mud. Jump on it. Drive over it. Rugged design, top quality materials.

Doesn't Affect Your Plug
Your EV charging plug is not affected, so you can continue to plug in wherever you want.

(Photo courtesy of Qualcomm)
Building Electrification Technologies
Currently available
– CO₂ and cost effective –
Technologies

<table>
<thead>
<tr>
<th>Residential</th>
<th>Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat pump technologies</td>
<td>Variable capacity heat pumps</td>
</tr>
<tr>
<td></td>
<td>Heat pump water heaters</td>
</tr>
<tr>
<td></td>
<td>Forklifts (comm &amp; ind applications)</td>
</tr>
<tr>
<td></td>
<td>Truck stop electrification</td>
</tr>
<tr>
<td></td>
<td>Commercial food service equipment</td>
</tr>
<tr>
<td></td>
<td>Water ozonation</td>
</tr>
<tr>
<td></td>
<td>Wastewater treatment</td>
</tr>
<tr>
<td></td>
<td>Industrial Processes</td>
</tr>
<tr>
<td></td>
<td>Pipeline compression</td>
</tr>
<tr>
<td></td>
<td>Electric furnaces</td>
</tr>
<tr>
<td></td>
<td>C&amp;I heat recovery chiller</td>
</tr>
</tbody>
</table>
Non-road Transport
Panelists

- Andrea Pratt, City of Seattle, WA
- Jennifer Wallace-Brodeur, Vermont Energy Investment Corporation
- Cedric Daniels, Alabama Power
- Rick Cameron, Port of Long Beach, CA
Andrea Pratt
Green Fleet Program Manager
City of Seattle, WA
FLEET ELECTRIFICATION

Andrea Pratt
Green Fleet Program Manager
2017 DOE Better Buildings Summit
CITY OF SEATTLE FLEET

FLEET OPERATIONS
- 4,000 vehicles maintained
- 11 garages & 5 warehouses
- All city departments: Police, Fire, Utilities, Parks, SDOT, etc.

ALT FUEL FLEET
- 99 Battery electric
- 47 Plug-in hybrids
- 500+ conventional hybrids

EVSE INFRASTRUCTURE
- 100 Fleet EVSE over 11 locations
- 1 DCFC for fleet use (480v)
- Large EVSE expansion project underway
DRIVE CLEAN SEATTLE

Powering a new generation of clean cars with carbon neutral electricity.

- Public EVs
- Equity
- City Fleet
- EV Car Share
- Electric Transit
- City Codes
- EVs & RD
## Action #1: Transform the City Fleet

| 50% GHG Reduction by 2025 | Install 400 EVSE to support electrification | Advance EVs & renewable diesel for med/hvy duty |

### DRIVE CLEAN SEATTLE

Powering a new generation of clean cars with carbon neutral electricity.
BENEFITS OF ELECTRIFICATION

- Reduced Emissions
- Reduced Operating Costs
- Economic Development
- Energy Independence
REDUCED GHG EMISSIONS

Replacing hybrids with BEVs = 98% GHG reduction/vehicle

GHG based on Carb LCFS CI values and Seattle City Light retail power emissions factor
# REDUCED OPERATING COSTS

TCO = Acquisition + Life Fuel + Life Maint. – Salvage

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Life</th>
<th>Acq.</th>
<th>Fuel</th>
<th>Maint.</th>
<th>Salvage</th>
<th>TCO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas</td>
<td>Ford Focus</td>
<td>10 yrs</td>
<td>$21,284</td>
<td>$8,000</td>
<td>$11,790</td>
<td>$2,128</td>
<td>$38,946</td>
</tr>
<tr>
<td>Hybrid</td>
<td>Ford CMAX</td>
<td>10 yrs</td>
<td>$25,028</td>
<td>$5,830</td>
<td>$6,481</td>
<td>$2,503</td>
<td>$34,836</td>
</tr>
<tr>
<td>BEV</td>
<td>Nissan Leaf</td>
<td>10 yrs</td>
<td>$22,638</td>
<td>$1,980</td>
<td>$5,553</td>
<td>$2,264</td>
<td>$27,907</td>
</tr>
</tbody>
</table>

Fleet operating cost for 300 passenger sedans:

- Hybrids: $10,450,860
- BEVs: $8,372,160

**Savings** $2,078,700
OPPORTUNITIES

• Fleet fuel consumption =
  ○ 2.3 million gal/year
• ~26,000 tCO$_2$e
• ~300 Terajoules energy
• ~83 million kWh
• 956 tCO$_2$e
  ○ (Seattle City Light EF)
• Transverse Electric (TE) provides new load & significant GHG reduction potential
BARRIERS

- Infrastructure costs can be prohibitive
- Capital vs. operating budget – can savings transcend?
  - Managed/funded separately
- Capital project coordination and vehicle replacement timelines
- Utility paradigm shift – new load can be a good thing
- Local distribution network – handle fleet scale TE?
- Who should bear these costs?
Budget $10K/ea
(no svc upgrades)

Service upgrades?

$3-7K/ea
PROJECT MAP – SATELLITES & HUBS
LARGE PROJECTS

- SeaPark parking garage
- 100+ EVSE
- R&D project with industry partners to test new and existing technology and look for opportunities to reduce costs
- Stay tuned!
SMALL PROJECTS

- Less than 10 EVSE
- Use existing panel space
- Staff electricians can easily do this work
- Low cost installs
- Pick “low hanging fruit” while performing a larger electrical assessment for future needs
LESSONS LEARNED – EVSE RIGHTSIZING

- Battery size
- Vehicle dwell time
- Amperage needed

- May not need a full 32amp L2 for small vehicles with long dwell times

- **Nissan Leaf** - Battery size = 24kWh = 90 miles of range
  - L2 charge time: 4 – 6 hrs
  - Charge time assumes 32amp continuous load

- **Chevy Bolt** – Battery size = 60 kWh = 240 miles of range
  - L2 charge time: 9 hrs

- **Tesla Model X** – Battery size = 100 kWh = 290 miles of range
  - L2 charge time: 14.5 hrs

Average Fleet Dwell Time = 14 hours (assumes one shift, no overtime)
BENEFITS OF ELECTRIFICATION

Direct

- GHG Reduction
- Lower Operating Costs
- Zero Tail Pipe Emissions

Indirect

- Energy Independence
- Green Jobs
- Fuel Dollars Kept Locally
DISRUPTIVE INNOVATION

- Electrifying the movement of people, goods and services is the *evolution* of transportation.

- Using electricity for transportation fuel decouples the economy from volatile global commodity fuel prices which are embedded in everything we buy.

- Redirecting fuel dollars to your local utility creates economic development opportunities for *local* green jobs and offers energy independence.
REFERENCES

• 2014 Green Fleet Action Plan
• Drive Clean Seattle
• Residential & MUD EVSE installation tip sheet
• Commercial installation tip sheet
• Western Washington Clean Cities
• West Coast Cities – EV RFI
• City of Seattle Climate Action Plan
THANK YOU!

Andrea Pratt
Green Fleet Program Manager
City of Seattle, FAS Fleet Management Division
andrea.pratt@seattle.gov
206.684.0137
Rick Cameron
Managing Director, Planning & Environmental Affairs
Port of Long Beach, CA
Port of Long Beach
Zero Emissions and the Need for Electrification

Rick Cameron
Managing Director of Planning and Environmental Affairs
More than just cranes and ships, the iconic Port of Long Beach is a key economic engine for Southern California and critical to the world trade ecosystem.

PORT OF LONG BEACH 101

- #2 Busiest port in the U.S.
- $180 Billion Worth of cargo is imported through the port annually
- 300 Thousand Jobs created regionwide

Although a public agency, the Port’s operations are not supported by tax dollars. Instead, its revenues come from leasing marine terminals.
GREEN PORT POLICY
Leading the way in reducing environmental impacts
CLEAN AIR ACTION PLAN
Driving the need for zero emissions, including electrification
Groundbreaking plan to significantly reduce air pollution and health risk

Strategies targeting reductions from all port sources

Developed jointly with POLA, in cooperation with EPA, CARB and AQMD

SOURCES OF PORT-RELATED EMISSIONS

• Ocean-going Vessels
• Harbor Craft
• Heavy-Duty Trucks
• Cargo-handling Equipment
• Rail Locomotives
Clean Air Progress and Goals

<table>
<thead>
<tr>
<th>Category</th>
<th>2023 Goal</th>
<th>2005 Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel Particulate Matter</td>
<td>84%</td>
<td></td>
</tr>
<tr>
<td>Nitrogen Oxides</td>
<td>48%</td>
<td></td>
</tr>
<tr>
<td>Sulfur Oxides</td>
<td>97%</td>
<td></td>
</tr>
<tr>
<td>Greenhouse Gases</td>
<td>14%</td>
<td></td>
</tr>
</tbody>
</table>

From 2005 Baseline

77%

2023

59%

93%

7% TEUs
MIDDLE HARBOR
Electrified, zero emissions operations

Port of LONG BEACH
BATTERY EXCHANGE
Robots will replace batteries for driverless vehicles.
EMERGING TECHNOLOGIES
Investing to Accelerate Commercial Availability of Clean Technology
ENERGY PROGRAM
Advancing green power, clean fuels, energy efficiency
Solar Power
Thank you
Resources

• Middle Harbor Overview:
  http://www.polb.com/about/projects/middleharbor.asp
• Middle Harbor Development Project:
  http://www.polb.com/environment/leed/middleharbor/default.asp
• Green Port Policy:
  http://www.polb.com/environment/green_port_policy.asp
• Energy Island:
  http://www.polb.com/environment/energyisland.asp

For more information, please visit us at www.polb.com
Table Breakouts

1. Electric Transport
2. Heat Pumps
3. Port/Partnerships
4. Grid Integration
5. Green Fleets
6. Rural Electrification

15 minute break
Cedric Daniels
Electric Transportation Manager
Alabama Power
Electrification is a **Win Win Win**

- Customers
- Society
- Utilities
Electrifying Building Heating and Cooling

Benefits of an Electric Heat Pump

- Most advanced and efficient heating and cooling system
- Comfort – stay warm in the winter and cool in the summer
- Saves $ on monthly energy bills
- Lasts an average of 20 years
- More flexibility when building a home (no flues or vent pipes)

Benefits of Electric Water Heating

- Avoids using a combustion process to heat water
- Good indoor air quality
- Simple and convenient operation and maintenance
- Adheres to building codes and standards
- Low standby loss
- Easy installation
Awareness and Incentives
Electric Transportation Strategy

**Growth**
- Commercial & industrial
  - Forklifts
  - Seaports
  - Mining
  - Airports
  - Overland conveying
  - Railways
  - Med/heavy trucks
  - Refrigerated trucks
  - Delivery trucks
  - Mass transit
- Residential
  - Plug in electric vehicles

**Readiness & Education**
- PEV rates & rider options
- Programs & incentives
- Market & customer analytics
- Infrastructure
  - Residential
  - Workplace
  - Community
- Education and outreach
  - Internal
  - External

**Leadership**
- Partnerships & Collaborations
  - EEI
  - EPRI
  - EDTA/GED
  - Clean Cities
  - NGOs
  - OEMs
  - EVSPs
  - SO Fleet

**Research & Development**
- Charging Technology
  - Network operators
  - Vehicle smart charging
  - Wireless
  - DC fast charging
- Vehicles Technology
  - Driveline efficiency
  - VIA truck demonstration
  - Autonomous/AGV
- Alternative Technologies
  - Fuel Cell
  - CNG
Utility charging infrastructure & market support
Current activities

<table>
<thead>
<tr>
<th>Utility</th>
<th>Investment size / structure</th>
<th>Charging Infrastructure Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avista (WA)</td>
<td>3.1M Rate-based</td>
<td>Ownership and operation of Level 2 chargers at 120 homes, ~50 workplace (2 connections per station) and 23 public, plus 7 DC fast chargers. Provide market education.</td>
</tr>
<tr>
<td>PG&amp;E (CA)</td>
<td>103M phase 1 Rate base</td>
<td>7,500 stations + necessary infrastructure (“make-readies”) in multi-unit dwellings, workplaces and in disadvantaged communities.</td>
</tr>
<tr>
<td>SDG&amp;E (CA)</td>
<td>$45M Rate base</td>
<td>3,500 stations at 350 multi-unit dwellings and workplaces. Provide market education.</td>
</tr>
<tr>
<td>HECO (HI)</td>
<td>25 DCFC Drivers pay directly</td>
<td>25 DC fast chargers authorized. HECO owns and operates</td>
</tr>
<tr>
<td>Consumers (MI)</td>
<td>$15M</td>
<td>810 chargers: 60 DCFC and 750 Level 2 stations; $1000 incentive for home level 2 station</td>
</tr>
<tr>
<td>Ameren (MS)</td>
<td>$0.6M Drivers pay directly</td>
<td>Installing 6 DC fast chargers along I-70, 25 to 45 miles apart.</td>
</tr>
<tr>
<td>KCP&amp;L (KS)</td>
<td>$20M shareholder funds</td>
<td>Own, operate, and maintain 1000 charging stations. No cost to host for installation or drivers for electricity for two years. Asking for cost recovery in parallel</td>
</tr>
<tr>
<td>IPL (IN)</td>
<td>$3M (filed for $12M)</td>
<td>Distribution upgrades “in public interest”</td>
</tr>
<tr>
<td>LG&amp;E and KU (KY)</td>
<td>10 stations per utility</td>
<td>Station hosts pay full cost of charging stations, including maintenance, installation, and energy usage. Drivers pay an hourly fee.</td>
</tr>
<tr>
<td>Georgia Power (GA)</td>
<td>$12M</td>
<td>Community DC Fast Chargers and Level 2 charging for residential, business, multi-family &amp; fleet. Provides $250 home / $500 commercial rebate and marketing education campaign</td>
</tr>
</tbody>
</table>
## What Have We Done?

<table>
<thead>
<tr>
<th>Registration through February 2017</th>
<th>Georgia</th>
<th>Alabama</th>
<th>Florida</th>
<th>Mississippi</th>
<th>SO TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEVs registered in states</td>
<td>26,114</td>
<td>1,328</td>
<td>21,157</td>
<td>342</td>
<td>48,941</td>
</tr>
<tr>
<td>PEVs registered in SO territory</td>
<td>13,832</td>
<td>689</td>
<td>362</td>
<td>48</td>
<td>14,981</td>
</tr>
</tbody>
</table>

### Georgia Power Information
- 300+ Employee Owners
- 2984 PEV Rate Customers
- 38 Public Charging Station Islands (DCFC + Level2)
- Incentives – Workplace & Residential Stations

### Alabama Power Information
- 49 PEVs in Fleet
- 115 Chargers @ 40 Facilities
- 30 PEV Employee Owners
- Incentives
  - $500/Business EVSE

### Florida Power Information
- 275 Employees in Green Pool Program
- 35 Chargers @ 11 Locations
- Incentives
  - $500/Business
  - $750/EV
  - $250/Dealer
  - $100/New Home Builder

### Mississippi Power Information
- Focus on major customer events (universities fairs, celebrations) and installing destination charging stations (casinos, malls, etc.)

APC and GPC both have customer PEV Time of Use rates available for residential customers.
US customers have bought ~604,000 PEVs (3/17)
Year-over-Year Growth in the EV Market: “InsideEVs.com”

2016 showed 37% year-over-year sales growth of EVs (yellow)
- Tesla Model S
- Chevrolet Volt
- Tesla Model X
- Ford Fusion Energi
- Nissan Leaf

2017 showing 62% year-over-year EV sales growth (green)
- Chevrolet Volt
- Toyota Prius Prime
- Tesla Model S
- Chevrolet Bolt EV
- Nissan Leaf

What’s coming?

Customer choices will continue to increase

Vehicles Arriving 2016 – 2021
Public Installation Considerations

- Establishing an EV charging infrastructure has unique challenges in that the public may be unfamiliar with its purpose and use

- Without specific signage, ICE vehicles may park in EVSE equipped spaces because they are convenient and vacant

- When an PEV arrives, the driver finds the space occupied and is unable to recharge…
Municipalities can adopt specific ordinances to:

- Prohibit non-EVs from parking in spaces marked for “EV Charging Only”
- Require that EVs parked in spaces marked for “EV Charging Only” must be connected to the EVSE while parked
Resources

Helpful Resources:

- Electric Power Research Institute (EPRI)
- Plug-In America
- Electric Drive Transportation Association (EDTA)
- Department of Energy Alternative Fuel Center
- Edison Electric Institute (EEI)
- Local Utility
Jennifer Wallace-Brodeur
Director, Transportation Efficiency
Vermont Energy Investment Corporation
Clean Air for All: Electrification of School and Public Transportation

Better Buildings Summit
May, 2017
To act with urgency to enhance the economic, environmental and societal benefits of clean and efficient energy for all people.
Presentation Overview

• Transportation, Climate Change, and Health
• Operational Benefits & Challenges
• State of the Practice & Deployment
• Lessons from the Field- MA Electric School Bus Pilot
• Future Opportunities
Transportation, Climate Change, and Health

Benefits of Cleaner Buses
Transportation, Climate Change, and Health Impacts
Heavy Duty Electrification: Why Transit and School Buses?
Operational Benefits & Challenges
Operational Benefits & Challenges

- Compared to diesel, electric vehicles have a higher purchase price but lower operational costs
  - Fuel cost stability & savings
  - Reliability & lower maintenance costs
- New fueling practices & infrastructure
- Mechanical training
Emergency Preparedness
State of the Practice

Electric School Buses & Transit Buses
State of the Practice

• 400,000 school buses nationally
  – 90% – 95% of the fleet is diesel
  – ~10 electric school buses in service in the U.S

• 51,000 transit buses on the road in the U.S
  • .2% of the public transit bus fleet is electric
    (2016 APTA Yearbook)
Electric Transit Bus Deployment in US

As of August, 2016

Source: VEIC
Electric Transit Vehicles
Electric School Buses

eLion – Type C School Bus

TransTech/Motiv
Lessons from the Field

MA Electric School Bus Pilot
Project Overview

• Goals
  • Deploy electric school buses
  • Demonstrate V2G/V2B capabilities
  • Financial value of battery as energy storage resource
  • Outreach and Education

• Key Players
  • MA Department of Energy Resources
  • Vermont Energy Investment Corporation
  • Demonstration Sites / Participating Schools
What we Have Learned so Far....

<table>
<thead>
<tr>
<th>Easier Than we Thought</th>
<th>Harder Than we Thought</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Opinion</td>
<td>Charging Siting and Installation</td>
</tr>
<tr>
<td>Driver Training and Adoption</td>
<td>Manufacture Communication</td>
</tr>
<tr>
<td>Vehicle Delivery Time</td>
<td>Resolving Minor Mechanical Issues</td>
</tr>
<tr>
<td>Utility Interaction</td>
<td></td>
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</tbody>
</table>
Future Opportunities

V2G/V2B
Grid Integration - Renewables - Storage
Resources

Jwallace-brodeur@veic.org
Electric School Bus Resources

Announcement of MA DOER Electric School Bus Demonstration
http://www.mass.gov/eea/pr-2016/electric-school-bus-grants-to-four-schools.html

Feasibility of Electric School Buses in Vermont (VEIC)

Sacramento Deployment of Electric School Buses
https://cleantechnica.com/2016/05/17/elion-shows-off-new-electric-school-bus/
https://ngtnews.com/first-priority-greenfleet-provide-largest-electric-school-bus-fleet-u-s

VW Settlement State Mitigation Funds
http://www.naseo.org/volkswagen-settlement

How Utilities Can Help Realize Benefits of Electric Vehicles in the Northeast
Panel Discussion

Q&A
Table Breakouts

1. Electric Transport
2. Heat Pumps
3. Port/Partnerships
4. Grid Integration
5. Green Fleets
6. Rural Electrification

15 minute break
Thank You

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Download the app to your mobile device or go to bbsummit.pathable.com