

Workshop on Grid-Integrated Vehicles in the Southeast

Project Co-Leads: Professors Marilyn Brown and Deepak Divan, Georgia Institute of Technology

Host: David Wade, CEO, Electric Power Board

Participants in Attendance

Marilyn Brown – Director, Climate and Energy Policy Lab, School of Public Policy, Georgia Institute of Technology

Bill Copeland – EPB Strategic – Director of Business Intelligence

Deepak Divan – Director, Center for Distributed Energy (CDE), Georgia Institute of Technology

Joe Ferguson – brought Electric buses to Chattanooga – running manufacturing plant in Chattanooga – Chairman of the EPB Board of Directors

Billy Gibson – President, Select Solar, LLC, Charging Station Installer

Rohit Jinsiwale - Graduate Student, Center for Distributed Energy, Georgia Institute of Technology

Karthik Kandasamy – Postdoctoral Fellow, Center for Distributed Energy (CDE), Georgia Institute of Technology

Ryan Keele – EPD Technical Operations Division, both electric and communications

Katie Southworth – President, EMV Energy Solutions, LLC.

Anmol Soni – Graduate Student, School of Public Policy, Georgia Institute of Technology

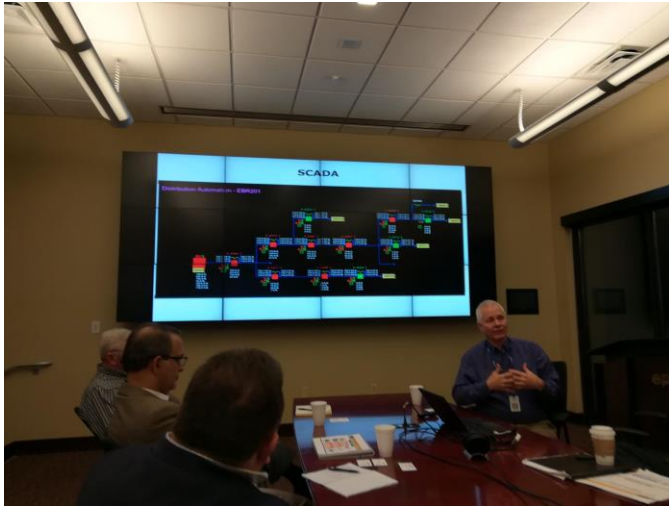
Jim Tripiano (Southern Co). – Product Development – Electric Transportation how to move it forward & Smart Cities and Connectivity

David Wade - CEO, Electric Power Board

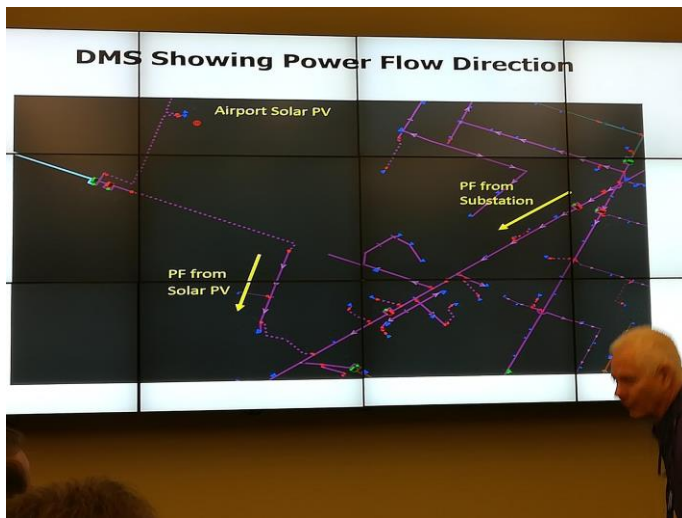
EPB Welcome

The meeting started with an introduction to EPB's activities. EPB concluded that to modernize their electric system, there is a need for communications with fiber optics, EPB could future proof for whatever they want to do in the future and also sell as a commercial product. Now have 96K communications customers; they were expecting 30K. Voice and data are available to anyone in a 600 sq. mile service area.

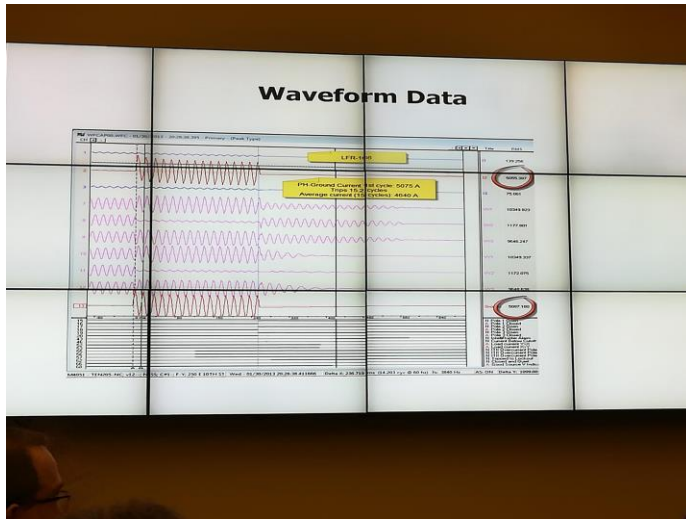
The electric system looks very different today, with 1200 automated switches, and a significant reduction in outage disruption.



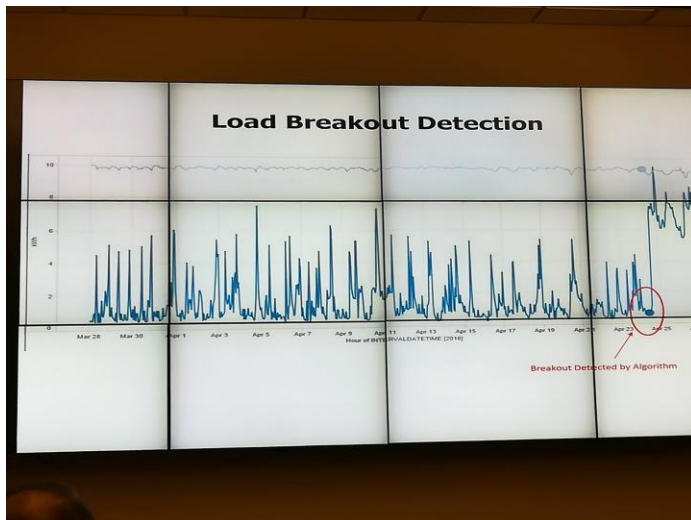
(Picture) of typical feeder – intelliRupter displays.



DMS Showing Power Flow Direction (picture). Arrows show where the power flow is in near real time - within a few milliseconds. EPB has public EV charging stations at the airport. EPB also has high levels of solar which has introduced significant variability. TVA buys the solar and turns it around and sells it back EPB.



Waveform Data (picture) – huge asset



Load Breakout Detection (picture) – EPB found that there are conditions (several times a year) where a distribution transformer will fail but not catastrophically – EPB is now able to schedule an outage and fix it before it happens! Turned what looked like a mainframe into what looked like a PC.

Other TVA local power co. are considering use of fiber EPB has been able to work with some and provide wholesale services to them.

Chattanooga set the EPB board up as autonomous/independent. Everybody deserves full internet service. Improved reliability has saved 50 – 60 million dollars. EPB has become an integrated energy and communications company.

Tour Image



Virtual Participants

Armond Cohen – Clean Air Task Force (Boston)

Matt Cox – Greenlink Group – Electricity – City of Atlanta office of sustainability

Brian Hanrahan - Florida Power and Light

Mladen Kezunovic– Texas A&M smart grid center – focusing on EV integration with transportation system

Jeff Lehman – American Electric Power

John Mann – GNT co-op Rocky Mtn. Region

Jackie Piero – Nuvve

Rich Simmons - Energy Policy and Innovation Center, Georgia Tech

Tom Weaver – American Electric Power – Smart Grid Planning

Cornelius Willingham - Nissan

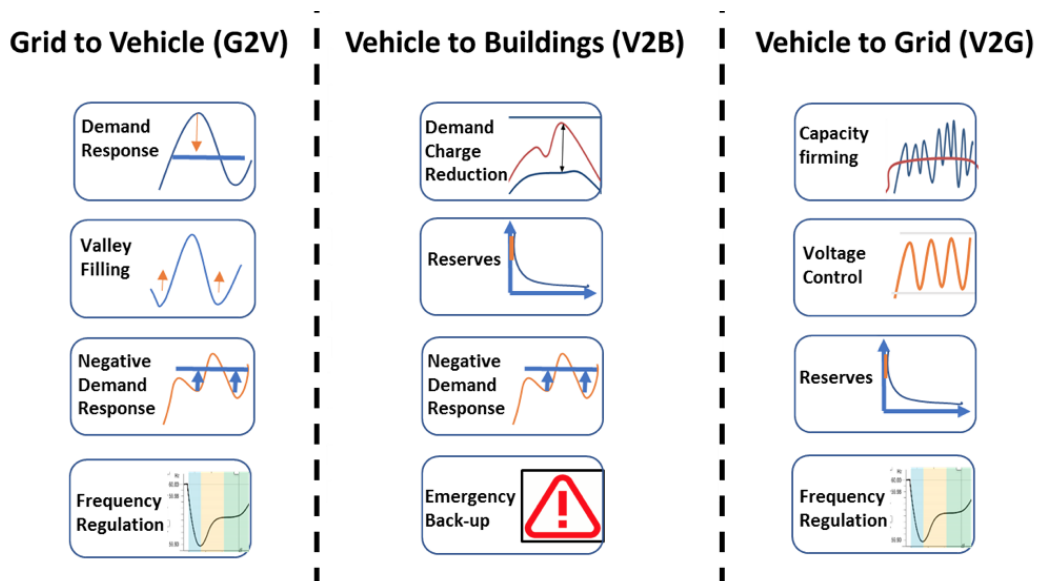
Project Briefing

Dr. Brown opened the meeting with an overview of the scope and goals of the Georgia Tech project, and she gave a brief overview of the Climate and Energy Policy Lab.

Deepak Divan introduced the Center for Distributed Energy (CDE) and provided an overview of ongoing activities.

Modes and Services

Marilyn Brown described three modes of EV integration and some of the grid services they can provide to enhance the grid. These range from load management and demand response to frequency regulation and voltage control, as well as back-up generation and reserves. Each EV mode of integration with the grid offers a unique set of services.



Technological Considerations

EV Adoption

EVs cannot be examined in isolation – 1 EV connected to transformer on pole is not problematic, but with 2 – 3 EVs connected, transformer problems can expand. You need to think of the whole system. Range of batteries is the most discussed EV topic, but in the next 3 years, range will be increased.

Charging is still a huge topic – you don’t want to have to charge your car for 12 hours. No one wants to wait for 3 hours, so we need DC fast charging.

Unless people can get comfort that they won’t be stranded, they won’t invest in EVs. It has been estimated that 15,000 charging stations are needed in rural areas!

David Wade – perhaps one of the opportunities, would be to have mobile charging that can reach different places rather than having fixed mechanisms of charging in one spot. It’s an asset that gains value, and that the Grid can use all the time.

Deepak Divan mentioned a similar idea called an “energy hub”. For most EV operators, or charging infrastructure providers - the “Demand Charge” is a key issue. Therefore, this dialogue between the power providers and car companies is important; ultimately, an integrated approach is necessary. Based

on Terry Boston from PJM – “if I had 1 million EVs that I could work with, everything would be done!”
We need forward thinking utilities to take these steps and invest in new technologies.

Mladen Kezunovic listed a number of issues; integration of vehicles and faced some of these issues

- The cost of oil/gas. The barrel was \$120 but is now \$61-62. Interest in EVs has gone down.
- Utilities are facing flat loads.
- The built environment – individual chargers or concentrated like gas stations, parking garages or optimizing locations?
- Non-attainment zones (polluted areas based on local industry) are pushing out cars with tailpipes.

Texas A&M is interested in future collaborations on this theme

Challenges in Enabling V2G

What is the long-term opportunity for V2G to work? What’s the staying power?. Using V2G what is the life impact and warranty impact on the battery. Nuvve contests the effect on battery performance, but the issue is not resolved.

Key Considerations

Bill Copeland – The fundamental benefit is going to be to the consumers and environment. Change is also going to create for-profit opportunities.

Jeff Lehman – Putting a DC fast charger every 20 miles will not be possible, especially on the highway. Charging infrastructure won’t accommodate existing EVs and we have to be okay with that. Anything with less than 200-mile ranges is not for the highway, it is a city car. The ratio of driving time to charge time is key. Currently the charging station business model is not financially viable. Even if we gave away electricity for free, it’s expensive. There is no business model for these projects yet and this provides an opportunity for utilities to get involved to create a business model that is revenue positive.

Marilyn Brown - With regard to urban vs rural, it is a matter of staging. Metro America is currently the most viable market in Georgia.

Deepak Divan. There is no business model at this moment; everyone is losing money.

Mladen Kezunovic - It is useful to engage government and car rental fleets.

Marilyn Brown – We need to consider the likely evolution of opportunities over time! EVs eventually will be a more democratized base, evolving from the current ownership by the more affluent.

Jackie Piero - How are we perceiving EV infrastructure? What role for utilities...what if they rate-base this model. Then it would be public service or are we assuming it as a private industry? Then you would have utilities not able to own generation owning the gateway to generation. The regulatory perspective is important.

Business Models for GIVs

Marilyn Brown – What does the business model look like if utilities were to participate directly – especially in the vertically integrated utilities (VIUs) like those in the Southeast?

Katie Southworth – If it is utility owned, all the benefits can be rolled up into system planning and management. With the PJM model, this planning and purchasing is looked at but can be more complicated. With VIUs, it could be much more straightforward

Mladen Kezunovic – The discussion with PUCs with the resilience model is very different than any other format as a business developing on its own

Marilyn Brown – We have been reflecting on the priorities of the new Assistant Secretary at the DOE, Bruce Walker who has 5 pillars representing his priorities. One pillar is reliability (the reliable delivery of services) and resilience (meaning the recovery from threats and disasters). Another pillar is storage (although DOE OE is focusing primarily on stationary storage).

Jackie Piero mentioned the following points when considering the integration of EVs:

- Would the infrastructure be a part of the utilities or private only
- Vehicles can also play a role in the resilience provision aspect of the business
- This could be a source of distributed information and as node of control - whether directly or via an aggregator - the ability to isolate outages

Deepak Divan – Microgrids can restart on their own, a black start from the bottom up.

Marilyn Brown – This is what Puerto Rico needed. The Cybersecurity issue needs to be overlaid on this as well. The purpose of EAC Smart Grid Sub-Committee project is to look at EVs as a source of resilience.

Group discussion – less than 2% of cars nationwide are EV. About 15% EV penetration would have a significant impact. Those rough #s are what we need to calculate (Jackie offered to help).

Marilyn Brown then briefly presented the EAC survey designed to get comments from EAC members.

The screenshot shows a Blue Jeans meeting window. The main content area displays a survey question: "6. c) How much of a challenge do you think the following policy/regulatory factors present to a full deployment of all modes - G2V, V2B, and V2G?". Below the question is a table with five columns representing challenge levels from 1 (Least challenging) to 5 (Most challenging). The factors listed are: Tariff or rate design policies, Valuing ancillary services in a vertically integrated market, Open source architecture platform, Creating resilience service products in wholesale markets, Cybersecurity, Certification of charging infrastructure, and Other (please identify in the comment section below). Each factor has a radio button in each of the five columns. Below the table is a section for "Additional comments:" with a text input field and a "Your answer" label. The right sidebar shows a list of 7 participants: Elizabeth Hyman, 14236483200, Cornelius Willingh..., EPB, Jacqueline Piero, Mladen Kezunovic, and Shaun. At the bottom, there are controls for "UNMUTE ALL" and "MUTE ALL". The bottom of the window shows the Georgia Tech logo, navigation links (ABOUT, TERMS, POLICY, THIRD PARTY COPYRIGHT), and the Blue Jeans Network, Inc. © 2018 copyright notice. The Windows taskbar at the very bottom shows the time as 12:09 PM on 3/1/2018.

Deepak Divan mentioned that there is no market for resilience today.

Katie Southworth mentioned that the NYISO developed the New York REV project on the basis of a settlement that addressed energy shortages that occurred several years ago during a polar vortex.

Mladen Kezunovic suggested that resilience should address everyday outages as well as catastrophic events.

Working Lunch

Jackie Piero - Utilities are realizing the potential of EVs as a distributed system of controllable nodes, as an opportunity rather than a problem.

Aggregating 13,000 vehicles unidirectionally to participate in the frequency regulation market in TenneT in the Netherlands. Nuvve is operating in 3 different TSO market - PJM, Energinet, TenneT. Now they are setting up in the UK, California and NY.

Interconnections in the U.S. are taking 4-6 months for each EV. Helping utilities streamline the interconnection process is key to success. There is also an interconnection fee that can be prohibitive

UL 1741 is the testing standard that complies with IEEE 1547 for DC Chargers. Where the inverter is in the charging station - it complies. But with an onboard inverters on the car charger, it is impossible for the acr to meet 1547. SAE has developed a "standard" that is compliant with 1547. But that is something the utilities need to be comfortable with. CA - Smart inverter working group - looking at these.

Deepak Divan - but these standards keep changing. So which one do you apply? It depends on who is making the evaluation.

Billy Gibson - We have to design with flexibility so that we don't have to redo it.

Nuvve had 1741 compliant chargers that weren't compliant in CA because changes to the standard were activated before they got the chargers installed.

Deepak Divan - Larger companies can afford to send engineers on the standards committees. Smaller business ventures are the ones rolling projects out but a small company can't afford to have engineers spend months at a time working on the standardization systems.

Jackie Piero – As charging stations are developed, by the time they roll out, they are obsolete. Also, they are expensive. They will have to be replaced because they are not good. 80% of lifetime cost of a charging station is maintenance – they are "buggy" and not reliable.

Jim Trupiano: The Southern Company innovation center focus is the business cases: where do you start? What role does utility play – install? Hardware? Software? Maintenance? Financing? Sale/Lease of Vehicle? Installing the infrastructure? Piece it all together – that whole value chain. When does this market really make a splash. Look at projections – where is it going? Look at China?

Next, look at how long it takes to switch? In 2017, Ford spent \$70 Million just educating people on the differences of two ICE cars. The cost of educating people on EVs will probably be over \$2 Billion. Who will pay for it? Who will pay for the infrastructure/ the education piece? It will happen – sooner rather than later.

There are investments utilities can make. Fleets are the way to go. It is a Hub and Spoke approach. There seems to be a universal agreement on that. Bluebird rolled out its first electric bus. 80 MPH, silent (not always good), it's almost doubled the cost already, so price will need to come down. When GA had the tax credit, there was a huge increase in EVs. How do you try to get more cars out on the market? What are barriers? Phase 1 – cars talking to charging unit. Protocol for talkback to charging units - working with EPRI on this.

Southern Company (Bruce Edelston is working on a project to place EVs in low-income areas of Atlanta. It's still early, but can EV be a value in low income areas. Many believe it's a "Rich person's" game. Rich people took advantage of the GA tax rebate by getting a second or third car. The cars coming off the leases are low cost and for them, maintenance is almost nothing – windshield wipers, tires, etc... Have been working with Uber and Lyft! They make more money the more EV drivers there are (but they can only drive a few 100 miles a day).

Marilyn Brown: What would be the business models?

Jim Trupiano: The choice is one model or a couple of models in different areas. In low income areas – Zip cars? or Uber/lyft type models? – driving and servicing that area. But the question in this context with the Uber/Lyft model would be how do you draw a fence to keep them in that area. With zipcars - credit cards and insurance are needed, which people in low income neighborhoods might not have.

Jackie Piero – another point about education - the people selling the cars need to be taught how to sell EVs.

Jim Trupiano– In an average month, \$600K is made on maintenance by dealerships. There is no incentive for dealerships to sell EVs.

Jackie Piero – The lower service requirements are driving automakers into energy services. The second factor is the battery element of an EV which changes the residual value of a car. This affects the balance sheet for the automakers.

Marilyn Brown – there is no secondary market for those batteries today – but there will be. TVA is working on stationary storage from used EV batteries.

David Wade – EPB has an EV car share program downtown. Employees can pay a small amount a month to rent a vehicle between 530-7am. It's a multi-use vehicle. Both as a daily use: car share and nightly use – to drive to and from work. It opens up the door to do it in an economical way. They charge it using a Level 1 charger at home!

Bill Copeland - No one has had to get towed yet. EPB has started with employees first – to understand and to play with our brand! Look at fiber optics, energy service, etc... it's a way to combine all of those.

Joe Ferguson – cited the example of Porsche - 300 mile range - developing a 800 volt charging system. 15 min. of charging at 240-volt. 5X faster than CHAdeMO charging. They are planning to be in the market in 5 years

Billy Gibson – Infrastructure work with EVGo using Nissan Leaf. Plug out kits – hook up to the car battery – alligator clamps ... to run a fridge and other core appliances.

Katie Southworth - Compared to utilities working in competitive wholesale markets, vertically integrated utilities can take a long term view of the opportunity and can invest in building out the infrastructure.

Rich Simmons – What about the demand and load side? The current generating capacity might be capable of addressing the current and future demand.

Rich Simmons – mentioned and shared NREL papers that look at monetizing these effects and also look at social effects.

Next Steps

Marilyn Brown – Regional effects be analyzed using the National Energy Modeling System, which models 22 NERC regions and can distinguish the supply/demand on a regional basis. If oil prices go up, NG prices also go up, they are all integrated and electricity prices rise in the integrated NEMS framework. NEMS models advances in technologies, both on the demand side (i.e., energy efficiency) and supply.

Deepak Divan – Some technologies have moved at rates that we haven't expected (ex: LED light bulbs)

Marilyn Brown – In our past NEMS modeling exercises, we thought solar cost assumptions were high and energy efficiency uptake was low so we developed alternative scenarios. What happens with wind and solar increases variability which needs either storage or demand management. EVs can help with dynamic load balancing.

Deepak Divan – Denmark/Norway are doing dynamic balancing with Hydro energy - throttling back and forward.

Katie Southworth – Western Power Administration is using load following with Hydro.

Marilyn Brown – TVA water mgmt. system has multiple goals that impact lake levels and hydro power generation: – 1) flood control 2) commerce 3) recreation 4) power, etc.

Bill Copeland – TVA looks at the average load every day, they are at the ceiling value of that shaping.

Jackie Piero – Denmark has DC links to Germany which helps with wind integration. Denmark is split into 2 regions. Frequency response price is set based on the weather on a yearly basis by Sweden.

Marilyn Brown – Germany is managing Energiewende by having a huge battery backup provided by hydro in Scandinavia.

Marilyn Brown – Going forward we would like to look at impact on US energy market (with a large penetration of EVs) using NEMS.

Input-Output for Modeling Jobs

Anmol Soni – We are using the IMPLAN software – std. input/output. What would happen if there was a push to EVs since some of the alternative energy industries are not included as separate industries. So we work outside the model to generate a distribution of costs - a “bill of goods” and then estimate the employment effects in three ways – direct, indirect, and induced.

Marilyn Brown - The effect of the Advanced Energy Economy may be job growth, not losses.

Katie Southworth— At the moment it seems as though there is interest in examining jobs once again.

Jim Trupiano – Role in economic development - impacts not just on automakers but the entire supply chain.

Marilyn Brown- Jobs won't be in EV repair. Comparing ICEs and EVs

Katie Southworth- what about software? That will be an ongoing need.

Anmol Soni – We see a lot of employment moving away from industry and manufacturing to connectivity and software sector. There will be a shift and we will need to identify who are the winners and who are the losers.

Jim Trupiano – Brattle Group looked at who would win and who would lose? Making predictions by who has the most money – Utilities, Big Oil, then TECH! Technology will win because they have the most energy to invest! EVs are basically laptops on wheels.

Guy by me - You get in a Tesla and there are no knobs! It's a great time to be in this field!

Jackie Piero – Tech companies are getting into Vehicle technology. Building a car is harder than it looks; they either need to partner with, or buy auto manufacturing companies. This is one of the places that Tech can make a huge footprint!

Anmol Soni – Uber has said they are a tech company not a taxi. This is just one of the services that they provide so that is set to alter the way we perceive these industries and how much output, employment they can generate.

Rohit Jinsiwale– Resilience – most of the stuff the group does is about optimizing the system

Karthik Kandasamy– Working on power conductor solutions for EV modeling and market research for EV charging.

Jim Trupiano– look at the challenges of cars and OEMs were saying they don't have the money for the infrastructure and they were turning to Utilities, and Utilities look at regulation and rate based designs. The resilience angle might provide an interesting way forward

Marilyn Brown– Some portion of these costs should be rate based if they support reliability and resilience.

Deepak Divan – Is there a way to divide the costs? A sliding balance of system cost.

Billy Gibson - A back-loaded incentive system is needed for infrastructure.

Marilyn Brown – States have recognized that government resources will be needed to help with this.

Katie Southworth – is it transportation/transmission or distribution? Deferring traditional assets - at the transmission level or at the distribution level?

Jackie Piero – There is a blurring between distribution and transmission. Communication and control infrastructure running a certain amount of resources, increasing amount of control nodes by 5 orders of magnitude, not just integration devices, but also software to control this resource.

Deepak Divan – It is best if we have intermediaries that handle some these problems as they bear the role of communicating with the utilities.

Jackie Piero - Different actors with different incentives and there are going to be competing issues among the players.

Marilyn Brown – How would this model translate for the TVA or Southern Company models? Contract with third parties for services with utilities? Utilities may have a motivation to directly own the whole resource themselves.

Deepak Divan – Prices are dropping so you don't want to sign a contract now based on today's prices. Market will move you in a direction, you want to give a price signal to everyone; if it's free use as much as possible. It just went up, limit what you use. Smart controllers (Rohit's dissertation).

Wrap Up

Cornelius Willingham – referred to a broader change in attitudes. We have been trained over the years to drive gas powered vehicles. We need to refill every week, and have a full tank etc... that's not true with EVs. There is a myth that we drive further than we think. It's cheaper to rent a car to drive 250 miles than to drive your own. EVs do not have to be a replica of gas-powered vehicles. A lot of advantages, lower-cost, higher reliability, etc in EVs. With larger batteries, there is a trade-off between range and cost. But people are unwilling to pay the extra cost associated with that. The cost is 95¢/mile. When they go to the public with that, customers are unwilling to pay. Range, isn't as important as we thought it would be.

David Wade – He owned an EV for 4 years, and it is a different experience – you never have to stop at a gas station. From a grid services standpoint, they have to be creative in their role, because the environment that they are in. TVA charges them a demand on and off peak energy charge. There is no value stream from TVA – they are shifting to a fixed charge.

Area between Chattanooga and Nashville is rural – you would need to find spots along the way to build a series of micro-grids. That has some significant potential to create a more dynamic market.

Joe Ferguson – There will be a revenue stream. Marketing will be the answer. The cost will have to come down, and he thinks it will happen but it takes some smart people to move it forward.

Link to Files on Georgia Tech's Website

<https://cepl.gatech.edu/projects/sgp/GIV>