Plug-in Electric Vehicles
History, Technology and Rates

Ben Echols
Southern Company (NYSE: SO), an investor-owned energy company in the Southeast, owns 290 generating units at 77 power plants with a combined capacity of more than 43,000 megawatts.
- 57% Coal
- 22% Oil & Natural Gas
- 16% Nuclear (two units under construction)
- 4% Hydroelectric
- 1% Biomass Plant

Southern Company is one of the largest producers of electricity in the United States and is the largest wholesale power provider in the Southeast.

Four main Operating Companies
- Georgia Power
- Alabama Power
- Gulf Power (Florida pan handle)
- MS Power

4.4 MM Retail customers
In July 1901, the first electric automobile came to Atlanta. It was owned by Henry M. Atkinson, founder of the power company. He said he was also buying one for use by the Georgia Electric Light Company.
A Little History

If Aladdin Could Have Seen the Electric Automobile

Yet It's Here—We Moderns Have Got Aladdin Beat a Mile

Flanders Colonial Electric

$2,500

Only electric car that ever made the trip from the Great Lakes to the Gulf under own power and without any assistance, an official pathfinder for 1912 Golden Tour, Detroit to New Orleans.

Atlanta Auto Sales Co.
225-27 Peachtree Street, Atlanta, Georgia

Also distributors for National, Flanders Sixes and Henderson Gas Cars
A Little History

Meter Department Vehicles

1910

1998
A Little History

- Georgia Power operated over 450 EV’s and logged over 7 million all electric miles 1996 – 2003.
A Little History

- Georgia Power installed over 1000 chargers in 300 locations from 1995 – 2002
- Of those 300 locations 50 were public installations with over 200 chargers installed
- Of the 50 public charger installations 15 were at malls or shopping centers
Why “Electric” Transportation?

- It’s clean
- It’s energy efficient
- It’s cost effective
- It’s made in the USA
- It holds future energy sales opportunities
Why “Electric” Transportation?

IT’S CLEAN AND GETTING CLEANER

- Electric vs gasoline and diesel
  - Lower emissions and more efficient
  - EVs have 40% - 65% lower GHG emissions

- SO investing billions of dollars to lower emissions
  - Environmental controls on existing coal units
  - Adding cleaner sources to our diverse supply of generation
    - New nuclear
    - Clean coal
    - Carbon capture and sequestration
    - Renewables
Why “Electric” Transportation?

**IT’S ENERGY EFFICIENT**

1 Gallon of Gasoline

- 36 kWh of Energy
- 6 lbs
- 19.7 lbs of CO$_2$
- 30 miles/range per gallon
- 90 miles total range (3 gallons)
  - 59.1 lbs of CO$_2$
  - 108 kWh total energy used
  - $10.50 for 3 gallons

1 Li-ion BEV Battery

- 36 kWh of Energy
- 600 lbs
- 1.5 lbs of CO$_2$ per kWh
- 400 Watt-hours per mile
- 90 miles total range per charge
  - 54 lbs of CO$_2$
  - 36 kWh total energy used
  - $3.60 for 36 kWh

Battery Electric Vehicle uses 1/3 Energy of comparable Gasoline vehicle.
Why “Electric” Transportation?

IT’S MADE IN THE USA

• $1 billion/day spent on foreign oil

Energy independence

SOUTHERN COMPANY
What’s different this time?

Battery Requirement for EV

Battery Pack Weight (kg) vs. Battery Energy (kWh)

- EVs Now
- EVs of 1990s
Battery Technology Advances

- 100,000-mile/8-year auto manufacturer warranty
- Lithium-ion technology
- 100-plus-mile range
- Second-life use
Variety of Vehicles to Consider

- Nissan Leaf
- Tesla Model S
- Coda
- Fisker Karma
- Chevy Volt
PEV Market Arrives!

- **Variety** – something for everyone
  - 20 models expected by end of 2012
- **Technology improvements**
  - Advanced battery technology
  - 120/240-volt capability
  - Fast charging options
  - Decreasing costs
Residential Charging

• We believe that most charging (80% or more) will occur at home
  – Two types of charging
    • Level 1: 120 Volt
      – Doesn’t typically require changes to wiring or upgrades
      – GPC does recommend that a dedicated circuit is used
      – Depending on type of vehicle / miles driven, can be a long charging time
    • Level 2: 240 Volt
      – Requires the purchase on Electric Vehicle Supply Equipment
      – Permit and inspection may be required
      – GPC recommends hiring a certified electrician

• Customers who live in condo associations should talk with their Home Owners Association about the feasibility of installing chargers.
Other Charging

• Workplace and retail
  – Up to these businesses to decide if they want to install charging and if they will provide this as an incentive or charge a fee

• Fast Charging (DC)
  – Anticipate that this will be installed at the rate of vehicle sales
  – GPC is working on developing a fast charging plug standard for the United States
What is GPC doing to support PEV’s?

- Making sure the grid is ready to support new vehicle market
- Developing new rates
- Helping develop new industry standards for vehicle charging
- Researching what’s ahead
Grid Impact Study

2% PHEV penetration
# of PHEVs = 126

8% PHEV penetration
# of PHEVs = 504
Grid Impact Conclusion

• No impacts expected in the near term (2-5 year) planning timeframe due to 30% of nameplate base transformer loading.

• Impacts may eventually occur for forecasting periods with higher levels of expected PEV penetration.

• Future Impacts will mostly likely first appear on assets:
  – Closet to the customer
  – Low nameplate ratings
  – Serving relatively high number of customers
  – Most likely as overloads or low customer voltages
PEV Rate Options

- Residential customers only
- Single rate for the entire household
  - The car will not be metered separately
    - Easy, no additional metering costs
    - Simple for the customer
    - Encourages beneficial loadshapes
Rate Structure

Summer

(June 1st – September 30th)

<table>
<thead>
<tr>
<th>Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
<th>Sunday</th>
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<td></td>
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<td>2:00 PM</td>
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<tr>
<td>7:00 PM</td>
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<td></td>
</tr>
<tr>
<td>11:00 PM</td>
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</tr>
<tr>
<td>12:00 Midnight</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Off Peak:
- 7:00 AM - 2:00 PM
  - 5.8295¢ per kWh

On Peak:
- 2:00 PM - 7:00 PM
  - 19.2948¢ per kWh

Super Off Peak:
- 11:00 PM - 7:00 AM
  - 1.2500¢ per kWh
## Rate Structure

### Winter

(October 1st – May 31st)

<table>
<thead>
<tr>
<th>Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:00 Midnight - 7:00 AM</td>
<td>Super Off Peak</td>
<td>11:00 PM- 7:00 AM</td>
<td>1.2500¢ per kWh</td>
<td>11:00 PM- 7:00 AM</td>
<td>1.2500¢ per kWh</td>
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<td>2:00 PM</td>
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<td>7:00 PM</td>
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<td>11:00 PM</td>
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<tr>
<td>12:00 Midnight</td>
<td>Off Peak</td>
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</tr>
<tr>
<td>7:00 AM – 11:00 PM</td>
<td>5.8295¢ per kWh</td>
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</tr>
</tbody>
</table>

Off Peak: 7:00 AM – 11:00 PM

Super Off Peak: 11:00 PM- 7:00 AM

*Price .03
Plug-in Electric Vehicle Time Periods

**Summer Weekdays**

- "On-Peak" 25¢ per kWh
- "Off-Peak" 10¢ per kWh

- "Super Off-Peak" 6¢ per kWh
Expected Annual Electric Vehicle Usage

- 1 mile = 3 kWh
- Driver commutes 40 miles on weekdays & 20 miles on weekends / holidays
  - 12,380 Miles Annually

EREV requires more kWh at Level 1 due to decreased Efficiencies
Rate Summary

- Customers have the ability to save money over R and TOU-REO if the charging of the vehicle is moved to 11 PM.
- Customers can charge through the peak time periods, but will pay more for doing so.
## DC Fast Charging Standard Development

### Preliminary Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
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<tr>
<td>Voltage</td>
<td>600 VDC</td>
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<tr>
<td>Current</td>
<td>200 A</td>
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<td>Contacts</td>
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<tr>
<td>DC Power</td>
<td>8.5 mm diameter</td>
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<tr>
<td>Ground</td>
<td>2.8 mm diameter</td>
</tr>
<tr>
<td>Signal</td>
<td>1.5 mm diameter</td>
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<tr>
<td>Cable Sizes</td>
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<tr>
<td>DC Power</td>
<td>AWG 1/0 (50 mm²)</td>
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<tr>
<td>Ground</td>
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<td>Weight Estimate</td>
<td>0.75 Kg (1.65 Lbs.)</td>
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<tr>
<td>Insertion / Extraction Force</td>
<td>Est. 100 – 120 N</td>
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<tr>
<td>Incremental cost</td>
<td>tbd</td>
</tr>
</tbody>
</table>

*JARI Proposal*
What’s ahead?

FUTURE ENERGY OPPORTUNITIES

• Long-term promise of energy storage
What’s ahead?

**FUTURE ENERGY OPPORTUNITIES**

- Long-term promise of energy storage
PEV Market is here!

- Consumer desires transportation
  - Efficient
  - Economical
  - State and federal incentives
  - Environmental
  - Energy independence

- Auto manufacturer support
  - Heightened consumer interest
  - Environmental mandates for autos
  - Federal funding and tax incentives
  - Sales commitments
Questions?

- Georgia Power Website:
  http://www.georgiapower.com/electricvehicles

- National Plug-in Vehicle Initiative Website:
  http://www.goelectricdrive.com/