

CPET 581 Smart Grid & Energy Management

2013/9/3

Lecture 3

Keywords

- Electricity generating capacity, United States
- U.S. gas-fired power plants project
- AEP Generating Plants
- Gas-fired power plants
- Combined Cycle Gas Plant
- GreenHouse Emission
- Indiana electricity capacity charge

Planned Topics of Discussion

- Review of 2013/8/29 Topics of Discussion
- Terms:
 - Electricity Generation and Capacity
 - Electric Bills, Rates, Tariffs and Charges
 - GreenHouse Emission
- U.S. Electricity Generating Capacity
- Electric Load Types
- Natural Gas-Turbine Technologies
- Types of gas-fired power plants
- Efficiencies and Emissions
 - Household Carbon Footprint Calculator,
<http://www.epa.gov/climatechange/ghgemissions/ind-calculator.html>
- **EPA Emission Regulation/Taxes**
 - Greenhouse-Gas Fight Escalates, 2013/9/3, by Keith Johnson, WSJ,
http://online.wsj.com/article/SB10001424127887324324404579040950076712782.htm?mod=WSJ_WSJ_US_News_5
- Electric Power Cost Reduction & Management through Computer-Based Predictive Control, Dec. 2008, Senior Design Report, by Christopher A. Hayes, Advisor – Paul I. Lin
- A Case Study: Capacity Planning and Management
 - Construction of new plants
 - Improvement of existing plants
 - Delayed plant retirements
 - Energy efficiency program
 - Demand response

FAQs: Electricity generation capacity and electricity generation,

<http://www.eia.gov/tools/faqs/faq.cfm?id=101&t=3>

- Capacity – maximum electric output a generator can produce under specific condition
- Net Summer Capacity
- Net Winter Capacity

- Generation (Mega Watt Hour) – the amount of electricity a generator produced over a specific period of time.
- Net Generation – the amount of gross generation a generator produces less the electricity used to operate the plant; such uses include
 - Fuel handling
 - Feedwater pumps
 - Combustion air fans
 - Cooling water pumps
 - Pollution control equipment
 - Other electricity needs

Electric Bills, Rates, Tariffs and Charges

- Electricity Capacity Charge
- Demand Charge
- Energy Charges
- Delivery Charges
- System Access
- Distribution Charges
- Energy Efficiency Surcharges
- Renewable Energy Surcharge
- Securitization and Securitization Tax
- Regulatory Asset

References

- Understand your Electric Bill, Duke Energy, <http://www.duke-energy.com/pdfs/110452-Understand-Bill-Guide-IN-WEB.pdf>
- I&M Glossary of Terms, <https://www.indianamichiganpower.com/service/choice/glossary.aspx>
- RATE 834 – Rate for Electric Service – General Service, NIPSCO, http://www.nipsco.com/Libraries/Electric_Tariffs/rate-834.sflb.ashx
- Understanding your Bill, Lagrange County REMC, <http://www.lagrangeremc.com/products-services/paying-your-bill/understanding-your-bill/>
- Why long term electricity contracts in PJM service area make sense, <http://bettercostcontrol.com/why-long-term-electricity-contracts-in-pjm-service-area-make-sense/>
- MPSC Glossary of Terms on Electric Power Choice, Michigan Public Service Commission (MPSC), <http://www.dleg.state.mi.us/mpsc/electric/restruct/glossary.htm>
- Explanation of Unbundled Electricity Charges (Non-Residential Customers, Consumers Energy, Michigan, Aug. 2013, <http://www.consumersenergy.com/uploadedFiles/CEWEB/SHARED/ElecChargesNONRESIDENTIAL.pdf>
- Citizen Utility Board, Illinois, http://www.citizensutilityboard.org/ciElectric_CapacityCosts.html
 - Capacity cost => Electricity Supply Charge
- Energy Vortex
- Energy Dictionary, <http://www.energyvortex.com/pages/index.cfm?pageid=1>
 - Demand charge, http://www.energyvortex.com/energydictionary/demand_charge_capacity_charge.html

- RPM 101: How the Electricity Capacity Auction Works .., <http://www.pseg.com/info/media/rpm-auction.jsp>
 - Reliability Pricing Model (RPM), established by PJM
- Business Electricity Consumers Face Higher Power Charges, www.PAElectricity.org , <http://www.paelectricity.org/transmission-and-capacity-charges-expected-to-increase-for-pa-and-nj-business-electricity-consumers/>
 - Transmission and capacity changes

Types Gas-Fired Power Plants

- Steam generation gas-fired turbine
- Simple cycle gas-fired turbine
- Combined cycle gas-fired turbine
- Distributed generation
- Industrial natural gas-fired turbine (Combined Heat and Power System (CHP), http://www.naturalgas.org/overview/combinedheat_powersystems.asp)
 - Takes the wasted heat from the burning of fossil fuels and applies it to power another process
 - CHP generate electricity through a large gas-fired turbine
 - Produced a great amount of wasted heat => use it to heating an industrial boiler
 - Up to 45% efficiency in the electricity generation process
 - With the addition of a wasted heat recovery unit, it can achieve energy efficiencies in excess of 80 percent
- Microturbine
 - 25 to 500 kW, for residential or small scale commercial unit
 - Advantages
 - Compact size
 - A small number of moving parts, light-weight, low-cost, increased efficiencies
 - Can achieve efficiencies of up to 80 percent

Power Generation and Load Types

- Base Load
- Intermediate Load
- Peak Load

Electric Generation Using Natural Gas, http://www.naturalgas.org/overview/uses_electrical.asp

Natural Gas Technology for Power Generation

- Electricity from Natural Gas (Clean Energy, Nonrenewable), <http://www.epa.gov/cleanenergy/energy-and-you/affect/natural-gas.html>
- Environmental Impacts
 - Air Emission
 - Water resource used
 - Water discharge
 - Solid waste generation
 - Land resource use
 - Reserves

Types of Natural Gas Plant	Load Type	Start-up Time	Efficiency (convert thermal energy /heat into electricity)	Installation Time
Steam Generation Gas Plant (basic)	Base Load		Very low (33 to 35%)	
Simple Cycle Gas Plant	Peak Load	Very short	Inefficient (34-42%)	Short
Combined Cycle Gas Plant	Intermediate or Base Load	Longer	A combination of gas turbine and water/steam cycle optimized for high efficiency (52-60%)	

Up to 46% for supercritical coal plants, 50% for ultra supercritical coal plants

EPA Emission Data: Coal vs. Natural Gas Electric Power

	Natural Gas	Coal
Nitrogen Oxides (lbs/MWh)	1.7	6
Carbon Dioxide (lbs/MWh)	1,135	2,249
Sulfur Dioxide (lbs/MWh)	0.1	13
Ash Content	0%	10%

AEP Power Generation, <https://www.aep.com/about/MajorBusinesses/powergeneration/>

- Owns and operates more than 60 generating stations, with a capacity of nearly 38,000 megawatts (38 Giga Watts)
 - 60% coal-fired
 - 23% natural gas
 - 5% nuclear
 - Others: wind, hydro, pumped storages
- Natural Gas Technology, <http://www.aep.com/about/IssuesAndPositions/Generation/Technologies/NaturalGas.aspx>
- Three types of natural gas plants to heat water and create steam that spins a turbine.
 - Steam generation gas plant
 - Similar to conventional solid fuel plant such as a coal plant
 - Simple cycle gas plant,
 - Used during the periods of peak demand since they have short start-up times compared to other generating facilities
 - Very inefficient in their ability to convert heat into electricity
 - Combined cycle gas plant
 - Incorporate simple cycle turbines and a heat recover steam generator
 - As gas is burned to create high pressure gas, the waste heat from that process is captured and used to generate steam to spin a steam turbine
 - Most efficient form of natural gas plant but have longer start-up time

- Primarily used for Intermediate-Load and Base-Load Generation

Simple Cycle Power Plants

- <http://www.energy.siemens.com/hq/en/fossil-power-generation/power-plants/gas-fired-power-plants/simple-cycle-power-plant-concept/>

Combined Cycle Gas-Fired Power Plants

- Siemens, <http://www.energy.siemens.com/hq/en/fossil-power-generation/power-plants/gas-fired-power-plants/combined-cycle-power-plant-concept/>
 - SGT5-8000H Combined Cycled

Gas Fired Power Plants

- Idaho Power:- Natural Gas- Fired Plants, <https://www.idahopower.com/aboutus/energysources/gas/gas.cfm>
 - Bennett Mountain Power Plant
 - 164 MW, Simple Cycle Combustion turbine power plant, completed in 2005, produced its first electricity for the grid in the late Feb. 2005
 - “Peaking” generating resources, for use primarily in meeting short-duration demands for electricity during hot summer afternoon when air conditioning and irrigation loads reach their highest point
 - Danskin Power Plant
 - 261 MW, three natural gas-fired simple cycle combustion turbines:
 - One 171 MW unit
 - Two 45 MW units
 - Langley Gulch Power Plant
 - Combined-cycle combustion turbine (CCCT), added in July 2012
 - It uses two turbines to generate electricity
 - One with natural gas
 - The other steam
 - 300 MW in the summer, and 330 MW ins the winter

New Gas-Fired Power Plant Projects

- **Five** Duke Energy natural gas-fired power plant projects in North Carolina (retired less efficient gas-fired and coal-fired units), <http://www.duke-energy.com/about-us/natural-gas-overview.asp>
 - Generation capacity diminish by 771 MW
 - Its modernization project, would add 2,760 MW – more than tripling its original capacity while significantly reducing emissions
 - Buck Combined Cycle plant: capacity 620 MW, commercial operation 20122
 - Dan River Combined Cycle Plant: Capacity 620 MW, commercial operation, Dec. 2012
 - H.F. Lee Combined Cycle Plant: Capacity 920 MW, commercial operation Dec. 2012
 - Smith Plant
 - Sutton Plant
- Panda Power Funds to build 859 MW gas-fired power plant, Brandywine, Maryland, 2013/8/19, <http://www.pennenergy.com/articles/pennenergy/2013/08/panda-power-funds-to-build-859-mw-gas-fired-power-plant.html>

- Siemens delivers 415 MW Dangjin 3 gas power plant in South Korea, <http://www.pennenergy.com/articles/pennenergy/2013/08/siemens-delivers-415-mw-dangjin-3-gas-power-plant-in-south-korea.html>
- Company proposed \$500M natural gas-fired power plant in Jessup, 2013.8/6

EIA Electricity Data

- Electricity Generating Capacity, Total net summary by fuel type, 2003-2011, <http://www.eia.gov/electricity/capacity/>
 - Existing Units by Energy Source
 - Units Additions
 - Unit Retirements
 - Form EIA-860 Source Data, <http://www.eia.gov/electricity/data/eia860/index.html>

EIA Electricity Analysis & Projections

Electric Power Monthly (EPM), <http://www.eia.gov/electricity/monthly/>

The Electric Power Monthly (EPM) presents monthly electricity statistics for a wide audience including Congress, Federal and State agencies, the electric power industry, and the general public. The purpose of this publication is to provide energy decision makers with accurate and timely information that may be used in forming various perspectives on electric issues that lie ahead. In order to provide an integrated view of the electric power industry, data in this report have been separated into two major categories: electric power sector and combined heat and power producers. The U.S. Energy Information Administration (EIA) collected the information in this report to fulfill its data collection and dissemination responsibilities as specified in the Federal Energy Administration Act of 1974 (Public Law 93 275) as amended.

- Aug. 22, 2013, Report, 188 pages, <http://www.eia.gov/electricity/monthly/pdf/epm.pdf>
- Summary Statistics, Aug. 22, 2013, 188 pages,
 - ES1.A Total Electric Power Industry
 - ES1.B Total Electric Power Industry, Year-to-Date
 - ES2.A Receipts and Cost of Fossil Fuels for the Electric Power Industry by Sector, Physical Units
 - ES2.B Receipts and Cost of Fossil Field for the Electric Power Industry by Sector, BTUs
 - ES3 New U.S. Electric Generating Units by Operating Company, Plant and Month
 - ES4 Retired U.S. Electric Generating Units by Operating Company, Plant and Month
- Electric Power Annual