EE 458 Project Assignment
Due Friday December 13, 2019, 5pm

1. Groups

For this project, each person is assigned into a group, as follows. The person with the bolded email address is considered to be the group leader. If my suggested group leader does not want the job, then the group can decide to select another group leader.

GROUP 1	**GROUP 3**	**GROUP 5**
collinb@iastate.edu	**acarp95@iastate.edu**	**zheifner@iastate.edu**
ugerah@iastate.edu	kccierz@iastate.edu	mhuebsch@iastate.edu
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czh@iastate.edu	dldrees@iastate.edu	colemata@iastate.edu
GROUP 2	**GROUP 4**	**GROUP 6**
sergioj@iastate.edu	**emandle@iastate.edu**	**kdziska@iastate.edu**
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zcs1@iastate.edu	congyuz@iastate.edu	aimnz00@iastate.edu

2. Objective

Your objective in this project is to articulate the market architectures of each of several electricity markets, to see if they are consistent with the *FERC Standard Market Design*, to identify any significant differences between them, and to recommend any design differences that you think are necessary.

Here are the US ISO/RTO electricity markets from which your group may select a subset to study, but you must select at least one from a-d and at least one from e-g.

a. ISO-New England: http://www.iso-ne.com/
b. New York ISO: http://www.nyiso.com/
c. Midwest ISO: http://www.misoenergy.org/
d. PJM: http://www.pjm.com/
e. California ISO: http://www.caiso.com/
f. Southwest Power Pool: http://www.spp.org/
g. ERCOT: http://www.ercot.com/

3. General process

The first thing you should do is to send email to your group to determine if there is anyone in your group who is no longer active in the class or who, for some reason, chooses not to participate in this project. Please let me know if there is a group member who does not respond within two days of sending the email. Assuming there are N active participants in your group, all groups should review a number of markets equal to N-1, e.g., groups having 4 active members should review 3 electricity markets, and groups having 5 active members should review 4 electricity markets. You may make your selection of electricity markets as you like from the above list of seven (but, again, you must select at least one from a-d and at least one from e-g).

- Group member task: Each group member who is not a leader is responsible to review one electricity market in depth and prepare a report on that market. Each of these group members should provide the report to the group leader no later than Monday, December 2, 2019 (your group may decide to have an earlier date if that is preferred). Group members should then respond to any request for assistance from the group leader necessary for the group leader to complete the group leader task (see next bullet), including any revisions to group member reports.
- Group leader task: Between now and December 2, 2019, the group leader should review all N-1 of the group-selected electricity markets and identify significant differences and similarities between them. Clearly, the group leader will not be able to go into as much depth on any one market, but this effort will position the group leader to understand the reports that each of the group members provide and to tie the final report together in a cohesive fashion. After receiving the various reports from the group members, the group leader is then responsible to lead the compilation of the different reports into a single integrated report for the entire group, to be submitted to me no later than Friday, December 13, 2019, 5pm. This is a fixed, hard deadline; i.e., extensions will not be given, and so plan accordingly.

4. Report content

As indicated in Section 1 above, a part of your group's objective is to articulate the market architectures of each of the 3 or 4 electricity markets and to identify any significant differences between them. Your group is entirely free to capture "market architecture" in whatever way makes sense. But below is what I consider to be a minimal set of information that you should provide for each electricity market:

1. What is the service area of this market? Provide a map. Identify installed capacity, peak load, and the percentage split between fuel types used by generators (e.g., coal-fired, gas-fired, hydro, nuclear, and other).
2. Energy markets:
    a. What are the different energy markets operated by this ISO?
    b. Summarize basic attributes associated with how each energy market operates.
        i. Is it wholesale or retail?
        ii. Who can participate in the market?
        iii. What information is required in each interaction?
        iv. How are clearing prices determined?
        v. What is the gate closing?
        vi. How and when are the markets settled?
        vii. Is there a price cap?
        viii. Are there other significant market rules?
        ix. What percentage of energy trading takes place in the market that is closest to real time (normally called the real-time market or the balancing market)?
    c. How do the different energy markets interface?
    d. How does bilateral trading interface with the described energy markets?
3. Ancillary service markets:
    a. What are the different ancillary service markets operated by this ISO?

    b. Summarize attributes associated with how each ancillary service market operates.
4. FTR market:
    a. Is there an FTR market?
    b. What is its function?
    c. How does it operate?
5. Capacity market:
    a. Is there a capacity market?
    b. What is its function?
    c. How does it operate?
6. Does the market allow for bilateral contracts?
7. What kind of energy, ancillary service, FTR, and capacity market historical data are available?
8. Does the ISO/RTO operate automatic generation control (AGC)? How does this function relate to its markets?
9. Does the ISO/RTO coordinate a transmission planning process? If so, what is it called? Who participates?
10. Are there any requirements of FERC's standard market design which do not appear to you to be satisfied by this market architecture?
11. How transparent is the market? One measure of this is the extent to which it was easy for you to access the answers to the above questions, i.e., were you able to find answers to all questions on the ISO's website?
12. Compare and contrast the different market architectures that you have reviewed based on the answers provided to each of the above questions for each ISO. What are the significant similarities? What are the significant differences? Consider developing a table to facilitate answering this question.

Finally, I want your group to consider the following question: Considering all of the markets that you have reviewed, what do you see as the most significant weakness of electricity markets in the US? If you were a FERC commissioner (and thus in some sense the architect of all markets in the US) what would you change?

5. References

Your report should provide references. I would strongly suggest that you use an auto-cite function; otherwise, you will spend a lot of time rearranging references as you add new ones. Both LaTex and WORD have this capability. In WORD, for example, one way to auto-cite is to use "References" and then select the button at the lower right-hand-corner of the "footnotes" menu; doing this will pop up a dialogue box. In the dialogue box, you can select whether you want "footnotes" or "endnotes" (choose the latter for technical papers), and also the number format (choose "1, 2, 3" for technical papers). Then hit the "Insert" button and it will insert a number into the text and the corresponding number at the end of the document. These numbers get automatically updated whenever you insert another one. You can also provide a reference to a number you have already inserted by using the "cross-reference" command under the "Reference" menu.

And in providing references, you should give enough information in the reference you cite so that the reader sees (a) who developed it; (b) what it is (i.e., a journal paper, or a FERC report, or a book); (c) when it was published; and (d) how to find it (e.g., give journal name, vol. no, issue no, date, pages, or give URL and your date of access to it). If it is not possible for someone else to readily find it, then you should reconsider citing it as a reference. You should use high-quality references. Most journal articles are peer-reviewed and so have some level of quality-assurance. Some journals are better than others; the impact factor of a journal gives a first-order indication of its quality. IEEE Transactions are journal articles that are usually very high quality. Conference articles are usually (though not always) peer-reviewed, but with less rigor than journal articles. Reports developed by National Laboratories (e.g., NREL, PNNL, ORNL, Sandia, Argonne, Ames Lab, etc.) usually have a lot of internal review and so are generally high-quality. Reports from other organizations (e.g., ISOs, government agencies, university research centers) are also usually of reasonable quality, though one should be a little careful. Wikipedia pages are typically *not* good references to use. For this particular assignment, you will probably need to use ISO webpages for much of your material. This is OK in this case, as you are mainly reporting on "what they do" rather than trying to establish that what they do is right.

References are an important tool for avoiding plagiarism. Your should never plagiarize[1]. If you quote a document, then it should be clear in your report that you are doing so by using quotations and giving the reference. If you paraphrase, you can write, "According to Ref [7], …." A general rule to avoid plagiarizing is that it should not be possible for the reader to mistake someone else's original thinking for your original thinking.

[1] To plagiarize means to take the work or idea of someone else and indicate it is your work or idea.

APPENDIX A
SUMMARY OF FERC'S STANDARD MARKET DESIGN

This summary is taken verbatim from the following reference:

S. Zhou, T. Grasso, and G. Niu, "Comparison of Market Designs," developed for the Public Utility Commission of Texas, Jan., 7, 2003, available at http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.297.836&rep=rep1&type=pdf, accessed Nov. 8, 2019.

I. FERC Standard Market Design

The Federal Energy Regulatory Commission (FERC), in its Working Paper[2] on Standardized Transmission Service and Wholesale Electric Market Design, states that:

1. The objective of standard market design for wholesale electric markets is to establish a common market framework that promotes economic efficiency and lower delivered energy costs, maintains power system reliability, mitigates significant market power and increases the choices offered to wholesale market participants. All customers should benefit from an efficient competitive wholesale energy market, whether or not they are in states that have elected to adopt retail access.

2. Market rules and market operation must be fair, well defined and understandable to all market participants.

3. Imbalance markets and transmission systems must be operated by entities that are independent of the market participants they serve.

4. Energy and transmission markets must accommodate and expand customer choices. Buyers and sellers should have options which include self-supply, long-term and short-term energy and transmission acquisitions, financial hedging opportunities, and supply or demand options.

5. Market rules must be technology- and fuel-neutral. They must not unduly bias the choice between demand or supply sources nor provide competitive advantages or disadvantages to large or small demand or supply sources. Demand resources and intermittent supply resources should be able to participate fully in energy, ancillary services and capacity markets.

6. Standard market design should create price signals that reflect the time and locational value of electricity. The price signal – here, created by LMP – should encourage short-term efficiency in the provision of wholesale energy and long-term efficiency by locating generation, demand response and/or transmission at the proper locations and times. But while price signals should support efficient decisions about consumption and new investment, they are not full substitutes for a transmission planning and expansion process that identifies and causes the construction of needed transmission and generation facilities or demand response.

[2] Federal Energy Regulatory Commission, Working Paper on Standardized Transmission Service and Wholesale Electric Market Design, May 2002, pp 6-7.

7. Demand response is essential in competitive markets to assure the efficient interaction of supply and demand, as a check on supplier and locational market power, and as an opportunity for choice by wholesale and end-use customers.
8. Transmission owners will continue to have the opportunity to recover the embedded and new costs of their transmission systems. Consistent with current policy, merchant transmission capacity would be built without regulatory assurance of cost recovery.
9. Customers under existing contracts (real or implicit) should continue to receive the same level and quality of service under standard market design. However, transmission capacity not currently used and paid for by these customers must be made available to others.
10. Standard market design must not be static. It must not inhibit adaptation of the market design to regional requirements nor hinder innovation.

Detailed Requirements in FERC's SMD

Under the stated goal of Standardized Market Design (SMD), "To enhance competition in wholesale electric markets and broaden the benefits and cost savings to all wholesale and retail customers,"[2] the electricity wholesale market should meet the following requirements:

- Each Regional Transmission Operator (RTO) should develop a day-ahead energy market, a real-time spot energy market, a financial transmission rights market, and simultaneously allow for bilateral contracts.
- Market-clearing prices should be derived through bid-based, security-constrained dispatch and be linked to the physical dispatch of the system through locational marginal pricing.
- Each RTO should seek to implement an energy market that, to the extent feasible, imposes the least amount of additional cost to the public.
- Each RTO should develop transparent rules and procedures that integrate and coordinate system operation with market administration functions for energy, ancillary services, and congestion management.
- RTOs should acknowledge the role of state utility commissions and the regional reliability authority in ensuring long-term supply adequacy and should coordinate with these entities in implementing a market approach.
- Load-serving entities should ensure that sufficient operating reserves and capacity are committed to meet the adequacy obligation established by the regional reliability authority or state commissions.
- Each RTO, in coordination with transmission owners or Independent Transmission Coordinators (ITCs) within the RTO, should manage or coordinate the operation of the transmission system.
- Limits may be necessary on bidding flexibility to mitigate market power. For example, suppliers may be required to submit a start-up bid which would remain in place for a period of several months (rather than re-bid every day). As more demand response becomes available in a regional market, limits on supplier bidding flexibility can be relaxed.

- The demand side must be able to participate in the energy market. The demand side can participate as buyers or sellers (e.g., offering to sell operating reserves). As a buyer, an entity must be able to submit bids that indicate it is willing to vary the quantities it purchases based on the prices that it may be charged.

The proposed SMD demonstrated in Figure 1 consists of:

1. Bilateral contract
2. Day-ahead and real time market
3. The day-ahead regulation and operating reserve markets (jointly optimize energy, regulation, operating reserves, and transmission service.)
4. Locational marginal pricing (LMP)
5. Congestion Revenue Rights (CRR)
6. Long-term resource adequacy requirement such as Installed Capacity Market (ICAP)
7. Demand-side responsiveness
8. Market power mitigation (Optional Automated Mitigation Procedure (AMP))

The transmission provider may identify generating units that must run for reliability. Because these units are required by reliability and security of grid operation and have locational market power, the bids submitted by these units should be subject to mitigation. Similarly, market power in load pockets must be mitigated with on-going behavioral mitigation, such as call options or bid caps, unless structural solutions are possible.

Figure 1: FERC SMD