Course notes for EE394V Restructured Electricity Markets: Locational Marginal Pricing

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Transmission pricing and hedging

(i) Volatility of energy prices,
(ii) Transmission prices,
(iii) Congestion revenue rights.

6.1 Volatility of energy prices

- LMPs vary over time as supply and demand conditions vary.
- Consider a generator and demand that are co-located at the same bus.
- They are exposed to the same LMPs.
- Each might prefer to be exposed to a more uniform price over time, despite the variation of LMPs over time.
- That is, they may want to **hedge** their exposure to **price volatility**.
- To do this, they can sign a financial contract, called a **contract for differences**, that removes the exposure of each to variation in the LMP for a given contract quantity over a given contract period.

6.2 Transmission prices

- If the generator and demand are not co-located, they are effectively exposed to the *difference* in LMPs between their buses.
- Although they could hedge exposure to either the generator LMP or the demand LMP, they will be exposed to variation in the price difference between the two LMPs.
- A **financial transmission right** or **congestion revenue right** (**CRR**) is the right to receive the product of:

  a contract quantity
  times
  the difference in LMPs between a notional point of withdrawal and a point of injection,

- over the contract period.
- The CRR hedges the exposure to volatile LMP differences.

6.3 Issuing CRRs

- Since prices are typically higher at demand than generation, CRRs will typically pay out positive amounts of money in expectation.
- That is, the expected payout over a contract duration will be positive.
- It can therefore be expected that a typical CRR will cost money to acquire!
- A speculator might offer to sell a CRR based on the expected payout over the contract duration (plus a risk premium).
- Is there any other source of money to fund CRRs not involving speculation?

6.4 CRRs funded out of congestion rent

- Congestion rent accrues to the ISO.
- It can be used to fund (non-speculative) CRRs.
- The ISO can sell CRRs.
- How "much" CRRs can be sold?
- Consider a collection of CRRs that have been sold.

  Model each injection as a generation and each withdrawal as a demand. Let the total vectors of **implied dispatch** be P' and D', respectively.
- By (5.2), if P' and D' are feasible for the transmission system (so that the implied dispatch due to all CRRs is **simultaneously feasible**) then we have:

$$[\lambda^\star]^\dagger (D' - P') \leq [\lambda^\star]^\dagger (D - P^\star),$$

- where $\lambda^\star$ are the LMPs corresponding to the actual dispatch $P^\star$ and D.
- Note that the term on the left is payout from the CRRs.
- The term on the right is the congestion rent.
- That is, the revenue to the ISO from the congestion rent is **revenue adequate** to fund the CRRs.

6.5 Test system

- CRRs are typically issued for extended periods such as a month.
- A **test system** is used for issuing the CRRs.
- If the system used in the actual market has smaller line limits (or there is a constraint represented in the market that was not in the test system) then the revenue adequacy result no longer applies.
- A **derating policy** is needed for the case of revenue shortfall.

6.6 Summary

- In this chapter we have considered transmission pricing and hedging.
- We defined CRRs and considered conditions for revenue adequacy.

References

- William W. Hogan "Contract Networks for Electric Power Transmission," *Journal of Regulatory Economics,* 4(3):211–242, 1992.
- Felix Wu, Pravin Varaiya, Pablo Spiller, and Shmuel Oren, "Folk Theorems on Transmission Access: Proofs and Counterexamples," *Journal of Regulatory Economics,* 10(1):5–23, 1996.