

Planning Processes and Categories

1.0 Introduction

We will do the following in these notes.

- Define electric systems planning and identify fundamental planning steps
- Provide a taxonomy of planning categories

2.0 Definition and process

We can think of our subject in terms of actions taken, and in terms of the thing produced by those actions. Two definitions adapted from [1, ch. 2] are:

The *planning process* is the systematic assembly and analysis of information about electric energy supply, transport, and demand, and the presentation of this information to decision-makers who must choose an appropriate course of action.

The *plan* is a statement of the choices made by decision-makers at any one point in time in order to meet specific goals and objectives.

Planning approaches may be distinguished in a number of ways, but all of them must consist of some of the following steps

1. Define goals
2. Determine the planning category
3. Identify information required from the planning process
4. Choose the analysis process and associated tools
5. Conduct the analysis
6. Present results to decision-makers
7. Document the information, analysis results, decision, and decision rationale

I make a few brief comments about the first two of the above steps. Steps 5-7 need no further clarification. Steps 3-4 will be included in what we will do in the remainder of this course.

1.1 Definition of goals:

All planning exercises have as their ultimate aim to inform the capital investment decision-making associated with expanding the electric system. But these exercises may occur at a local, regional, or national level. For example,

- Local: A local utility must identify a plan to meet their load growth over the next 10 years.
- Regional: MISO maintains a guiding principle that [2] “Midwest ISO regional expansion plans should identify efficient investments in the transmission infrastructure system to:
 - Make the benefits of a competitive energy market available to customers by providing access to the lowest possible electric energy costs;
 - Provide a transmission infrastructure that safeguards local and regional reliability;

- Support state and federal renewable energy objectives by planning for access to all such resources (e.g. wind, biomass, demand side management);
- Create a mechanism to ensure investment implementation occurs in a timely manner;
- Develop a transmission system scenario model and make it available to state and federal energy policy makers to provide context and inform the choices they face.
- National: Goals at this level could be [1]:
 - To develop appropriate government policies influencing the development of the electric system, or
 - To provide signals to appropriate industries and institutions as to the directions that will be taken in the future.

It is quite typical to also specify what we will refer to as targets which are really more narrow, and typically more quantifiable, objectives. Some of the most common ones include:

- Costs:
 - Minimize investment costs
 - Minimize production costs
- Resiliency:
 - Maximize reliability (e.g., minimize LOLE)
 - Maximize supply diversification
 - Minimize external dependence
 - Maximize price stability
- Sustainability:

- Maximize renewables
- Minimize CO₂ emissions

The planning problem is, therefore, an inherently multiobjective optimization problem.

1.2 Planning category:

There are two different sets of attributes which can be used to identify the planning category. These are provided in what follows.

The first set is traditional and has always been of interest to electric system planners. They are

- a. Time-frame: short-term, mid-term, long-term**
- b. Subsystem: distribution, generation, transmission**
- c. Collaboration level: single-entity vs. collaborative**
- d. Geographic scale: local, regional, national**

Figure 1 illustrates the possibilities with respect to the first two attributes. Although all combinations of time frame and subsystem can occur, the types of planning studies of most interest to us in this course are colored in yellow.

		Time Frame		
		Increasing time →		
		0-4 years	4-10 years	>10 years
Subsystem	Load			
	Generation			
	Transmission			
	Distribution			

Fig. 1: Subsystem and time frame

Figure 2 illustrates the possibilities with respect to the third and fourth attributes. It has been the case that only the combinations that are in yellow have occurred in practice. Single company studies and joint studies at a local level have always occurred. Regional studies including multiple companies began occurring after the 1965 blackout, most of which were coordinated by the regional reliability councils or regional power pools. Independent system operators (ISOs), in their capacity as regional transmission organizations (RTOs), now perform the function of coordinating regional planning studies which involved multiple companies at first and now involve all stakeholders. Some RTOs are now considering studies at a level that extends beyond regional and may be properly considered to be national in scope.

		Geographic scale		
		Local	Regional	National
Collaboration level	Single company			
	Joint studies			
	Multi-company			
	All stakeholders			

Fig. 2: Collaboration level and geographic scale

On Feb 16, 2007, FERC issued Order 890. Two requirements of this rule were [3]: (1) Transmission providers must participate in a coordinated, open and

transparent planning process on both a local and regional level, and (2) Each transmission provider's planning process meet FERC's nine planning principles: coordination, openness, transparency, information exchange, comparability, dispute resolution, regional coordination, economic planning studies, and cost allocation.

For example, the MISO Business Practice Manual for Transmission Planning [4] identifies "stakeholders" as transmission owners, generation owners, load serving entities, transmission customers, other regional transmission operators (RTOs), and state regulators. They make the following statement:

4.1 Stakeholder Interactions during Regional Planning Cycle

At each major step of the planning process, the staff will engage stakeholders through the following planning groups and through various working groups, task forces and workshops that may be organized by these planning groups.

4.1.1 Subregional Planning Meetings

Sub regional Planning Meetings (SPMs) are established under Attachment FF to the tariff for the purpose of providing an interface to stakeholders on a more localized basis than the centralized stakeholder meetings of the Planning Subcommittee and the Planning Advisory Committee. SPMs are open stakeholder meetings subject to the CEI provisions under the Tariff and as described in Section 2.7 of this BPM. At a minimum, one SPM will be established for each of the three planning regions established under Attachment FF (West, Central, East). The SPMs will occur at the times and for the purposes listed below associated primarily with the Short-term planning process described in Section 4.3.

Purpose	Date	Location (Subject to change)
1. Provide additional input to staff on stakeholder issues and needs 2. Discuss Pre-Planning information and develop MTEP cycle study scope 3. Review and provide input to planning models 4. Review and discuss known issues and proposed projects reported by TOs	January	West, Central, East (locations to be announced)
1. Review system performance issue identified in initial phase analysis. 2. Discuss possible alternative solutions to issues	March/April	West, Central, East (locations to be announced)
1. Review results of alternative analyses 2. Comment on proposed preferred solutions	June/July	West, Central, East (locations to be announced)

Another attribute characterizing the planning category has come about as electricity markets have developed. This is the so-called planning paradigm and is mainly oriented towards transmission planning studies.

e. Paradigm: reliability-motivated, market-motivated

Planning studies that are reliability-motivated must ensure that future plans must satisfy NERC’s reliability criteria for system planning. These criteria are extensive, but they are succinctly captured by the so-called disturbance-performance table, provided below [5].

Table I. Transmission System Standards – Normal and Emergency Conditions

Category	Contingencies	System Limits or Impacts		
	Initiating Event(s) and Contingency Element(s)	System Stable and both Thermal and Voltage Limits within Applicable Rating ^a	Loss of Demand or Curtailed Firm Transfers	Cascading Outages
A No Contingencies	All Facilities in Service	Yes	No	No
B Event resulting in the loss of a single element.	Single Line Ground (SLG) or 3-Phase (3Ø) Fault, with Normal Clearing: 1. Generator 2. Transmission Circuit 3. Transformer Loss of an Element without a Fault	Yes Yes Yes Yes	No ^b No ^b No ^b No ^b	No No No No
	Single Pole Block, Normal Clearing ^c : 4. Single Pole (dc) Line	Yes	No ^b	No
C Event(s) resulting in the loss of two or more (multiple) elements.	SLG Fault, with Normal Clearing ^e : 1. Bus Section 2. Breaker (failure or internal Fault)	Yes Yes	Planned/ Controlled ^d Planned/ Controlled ^d	No No
	SLG or 3Ø Fault, with Normal Clearing ^e , Manual System Adjustments, followed by another SLG or 3Ø Fault, with Normal Clearing ^e : 3. Category B (B1, B2, B3, or B4) contingency, manual system adjustments, followed by another Category B (B1, B2, B3, or B4) contingency	Yes	Planned/ Controlled ^d	No
	Bipolar Block, with Normal Clearing ^e : 4. Bipolar (dc) Line Fault (non 3Ø), with Normal Clearing ^e : 5. Any two circuits of a multiple circuit towerline ^f	Yes Yes	Planned/ Controlled ^d Planned/ Controlled ^d	No No
	SLG Fault, with Delayed Clearing ^g (stuck breaker or protection system failure): 6. Generator 7. Transformer 8. Transmission Circuit 9. Bus Section	Yes Yes Yes Yes	Planned/ Controlled ^d Planned/ Controlled ^d Planned/ Controlled ^d Planned/ Controlled ^d	No No No No

On the other hand, the advent of locational marginal price (LMP) electricity markets has created the need to identify investments that enhance market efficiency. This simple fact raises a very important question:

➔ To what extent is this objective different from that of a reliability-motivated plan?

We will attempt to address this question in this course. For

now, consider some discussion from the 2007 MISO expansion plan report (MTEP-2007) [6]:

1.3 The Planning Context for MTEP 07

MTEP 07 is a transitional MTEP report. It isolates on those upgrades that are driven almost exclusively by peak load period transmission capacity needs to reliably serve load during those relatively few peak demand hours of the year. These are the traditional “must-do” projects needed to “keep the lights on”. While this infrastructure is essential for reliability, and will also provide for some level of improved efficiency of market operations, it is not designed using tools that comprehensively address maximizing total value of transmission investment, generation investment, and energy costs. As a consequence, the sum total of these expansions, while impressive in total investment terms, is likely not sufficient to provide for near optimal levels of investment. However, the Midwest ISO approach to transmission planning is undergoing fundamental and significant changes. These changes are a response to not only the Midwest ISO energy market, but to evolving energy policy related decisions at both the federal and state levels, FERC initiatives to promote improved regionally coordinated planning, and developing structures for more equitable transmission pricing policies.

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There is a natural and inseparable intertwining of planning for long-term load growth, and for interconnection of new generation. This is true despite the fact that as a consequence of the Open Access Order 888 in 1996, these two processes have been forced apart to accommodate the need to fairly interconnect independent suppliers. The separation of these processes was necessitated by the separate competitive supply positions, business objectives, and plans of the independent supplier and the integrated Transmission Provider at the outset of implementation of Order 888 and its follow-on Order 2000 addressing generator interconnections. Melding together the independent decisions of a multitude of independent suppliers and load serving entities into a cohesive and efficient transmission infrastructure remains a puzzle that the industry continues trying to solve.

The Midwest ISO believes that the RTOs are uniquely positioned to reintroduce the cohesion in generation and transmission planning that has been stretched since the open access rule. We and our stakeholders have lived through the effects of this separation and experienced first hand the difficulty and frustration of trying to at once achieve fast, effective, and fair generator interconnections, while developing an efficient forward looking long-range transmission plan. These difficulties have been the result of some growing pains surely, but at the core we believe are the result of essentially adopting the pro-forma procedures enacted in Order 2000 to ensure fair and comparable interconnection service, and applying them to the high volume of interconnects the RTO must deal with. The advantage of the broader regional focus of the RTO is frustrated by the pro forma procedures, the sequential nature of which does not lend itself to any kind of efficiency of scope.

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The trick is to solve the open access sixty-four thousand dollar question: “where should I locate transmission and of what design, when I don’t know where, when or how much generation suppliers will bring on to the grid”. The answer comes by linking together the planning analyses that we have been pursuing, until recently, on somewhat separate tracks.

We have recognized that in order to develop efficient transmission expansions, a long term view is needed. There are efficiencies in developing facilities that can move higher volumes of electricity; with respect to right-of-way utilization and in facility costs per unit of power. These facilities take longer to permit and develop, and so require the longer view. A longer term view cannot be planned for without some assumptions about load and generation. Neither of these is particularly easy to predict, but of the two, load forecasting can be done with less error using traditional methods. Forecasting where the generation may be, its size, operating characteristics and location is difficult and has a significant element of risk. However, this is a risk that must be accepted, unless we are willing to live with the costs that result from repeated increments of small upgrades to the transmission grid and the limitations that that process places on the ability to introduce new generation effectively.

From [7]

Corresponding with Midwest ISO’s efforts was the increasing interest of FERC in transmission planning and expansion to not only protect reliability but also to enhance competition by building transmission to alleviate chronic transmission congestion and to access remote generating resources. Such economic transmission planning, called that because it refers to transmission not needed for reliability, typically looks at scenarios such as the 10,000-MW Midwest ISO wind scenario and incorporates load flow and dispatch models to measure the reliability impacts and the costs and benefits of the proposed generation and transmission additions. In addition to Midwest ISO, the Southwest Power Pool, PJM, NYISO, and the RMA’s process in the West are all carrying out various forms of economic transmission planning. Such economic transmission planning represents an opportunity to access remote wind resources, and for this reason, the wind industry is keenly interested in it. Yet economic transmission planning faces at least three challenges.

- 1) Economic transmission planning is viewed separately from transmission planning for reliability, yet the two may be intertwined, i.e., certain reliability fixes may be necessary in order for an economic transmission addition to move forward.
- 2) These economic transmission studies may not result in any action; market participants are asked, rather than required, as is the case with reliability studies, to contribute financially to support any identified transmission upgrades or expansion.
- 3) Related to the previous point, economic transmission planning studies are time, labor, and cost intensive, and efforts to keep them going may fail without some sign of success.

Another interesting comment comes from [8]:

However, it is worthwhile to note that not all potential transmission expansions can be conducted through a competitive process. Potential transmission expansions may be characterized as economic or reliability expansions. An exact delineation between economic and reliability expansion is hard to be drawn. In general, when a transmission expansion will potentially impact large number of participants in an excessive geographical region, it may better be classified as reliability expansion. It is considered appropriate that reliability expansions be handled as a coordinated planning process subject to due regulatory procedures, as this type of investments may be considered for public good. However, for economic transmission expansions, beneficiaries can be identified explicitly due to its impacts on limited number of participants within a well defined geographic area. Economic transmission expansions should be conducted using a market based mechanism.

A last planning attribute, again most generally applicable to transmission planning studies, is the design scale.

f. Design scale: incremental, bulk

Most planning studies that have ever been done anywhere are incremental, that is, load growth is represented in the planning model together with any generation capacity additions, and then studies are performed to identify the transmission upgrades necessary to just satisfy the reliability criteria (as identified in the disturbance-performance table).

The incremental planning study is in stark contrast to those needed to implement high-voltage transmission overlay from the Midwest US to the East or West coasts. These kind of studies may require a significantly revised tool set to perform properly.

References:

- [1] International Atomic Energy Agency, “Expansion planning for electrical generation systems,” Technical Reports Series No 241, 1984.
- [2] Midwest ISO Board of Directors Statement of Guiding Principles For the Midwest ISO Transmission Expansion Plans, available at www.midwestmarket.org/publish/Document/469a41_10a26fa6c1e_-6ebf0a48324a.
- [3] FERC “Fact Sheet” for Order 8890, available at www.ferc.gov/industries/electric/indus-act/oatt-reform/order-890/fact-sheet.pdf.
- [4] Midwest ISO Transmission Planning Business Practices Manual, Dec. 7, 2007, available at <http://www.midwestiso.org/page/Planning>.
- [5] North American Electric Reliability Corporation, at end of Standard TPL-001-0, available at www.nerc.com/files/TPL-001-0.pdf.
- [6] The MISO 2007 Expansion Plan Report, called “MTEP 2007: Growing the Grid,” http://www.midwestiso.org/publish/Document/5d42c1_1165e2e15f2_-7ba40a48324a?rev=1
- [7] R. Piwko, D. Osborn, R. Gramlich, G. Jordan, D. Hawkins, and K. Porter, “*Wind Energy Delivery Issues*,” IEEE Power and Energy Magazine, Nov/Dec. 2005.
- [8] X. Ma, “Reliability Compliant Market: Incentives for Long-Term Transmission and Generation Capacity Adequacy,” IEEE Power Engineering Society General Meeting, 2007, June 24-28, 2007 pp. 1-6.