

Market Efficiency Process

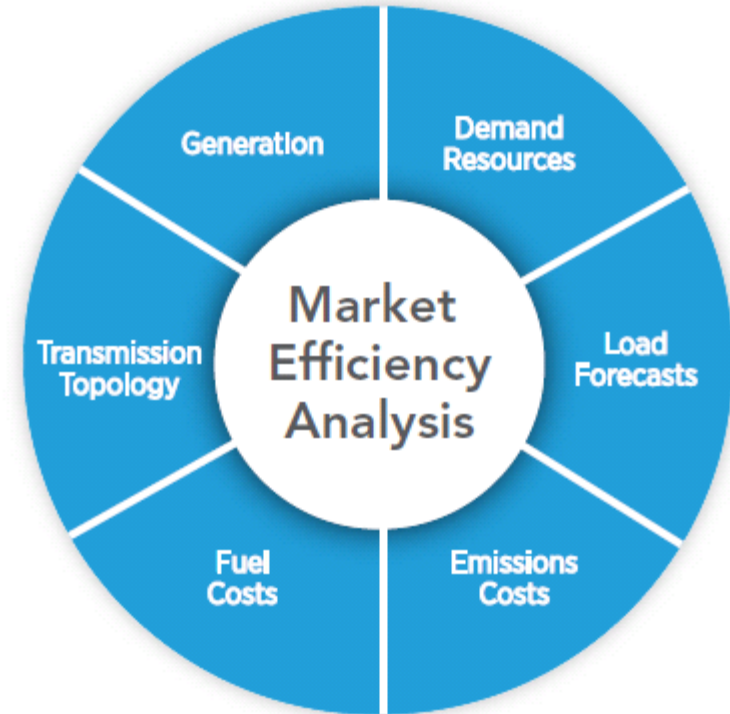
Nicolae Dumitriu
Sr. Lead Engineer, Market Simulation

Market Efficiency Process Enhancement
Task Force – Education Session
February xx, 2018

- Section 1: Market Efficiency Window Process
- Section 2: Critical Modeling Inputs
- Section 3: Project Selection Process

Section 1: Market Efficiency Window Process

- Goals
 - Asses future energy and capacity market congestion
 - Solicit and approve projects to relieve congestion
 - Strategic multi driver project development
 - Address both reliability and congestion
 - Accelerate beneficial reliability projects
- PJM Model
 - Sponsorship model



2006

Inception of ME in RTEP

RTEP Drivers:

- Reliability
- **Market Efficiency**
- Operational Performance
- Public Policy

2011

Order 1000

Reforms:

- Cost Allocation
- Non incumbent Development

2014

1st Window

Impacts:

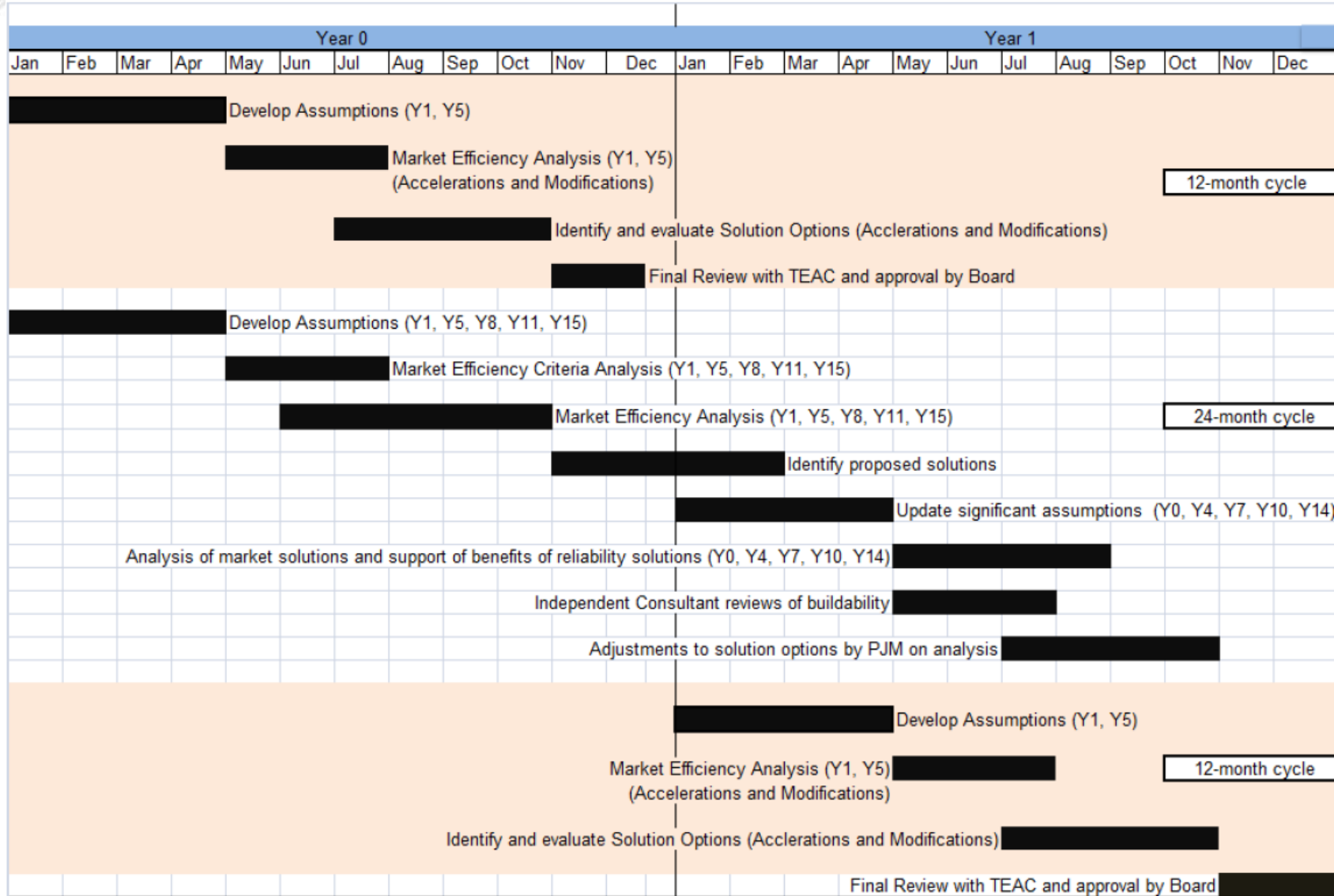
- Formal
- Competitive
- Long term

2016

2nd Window

Impacts:

- Fees

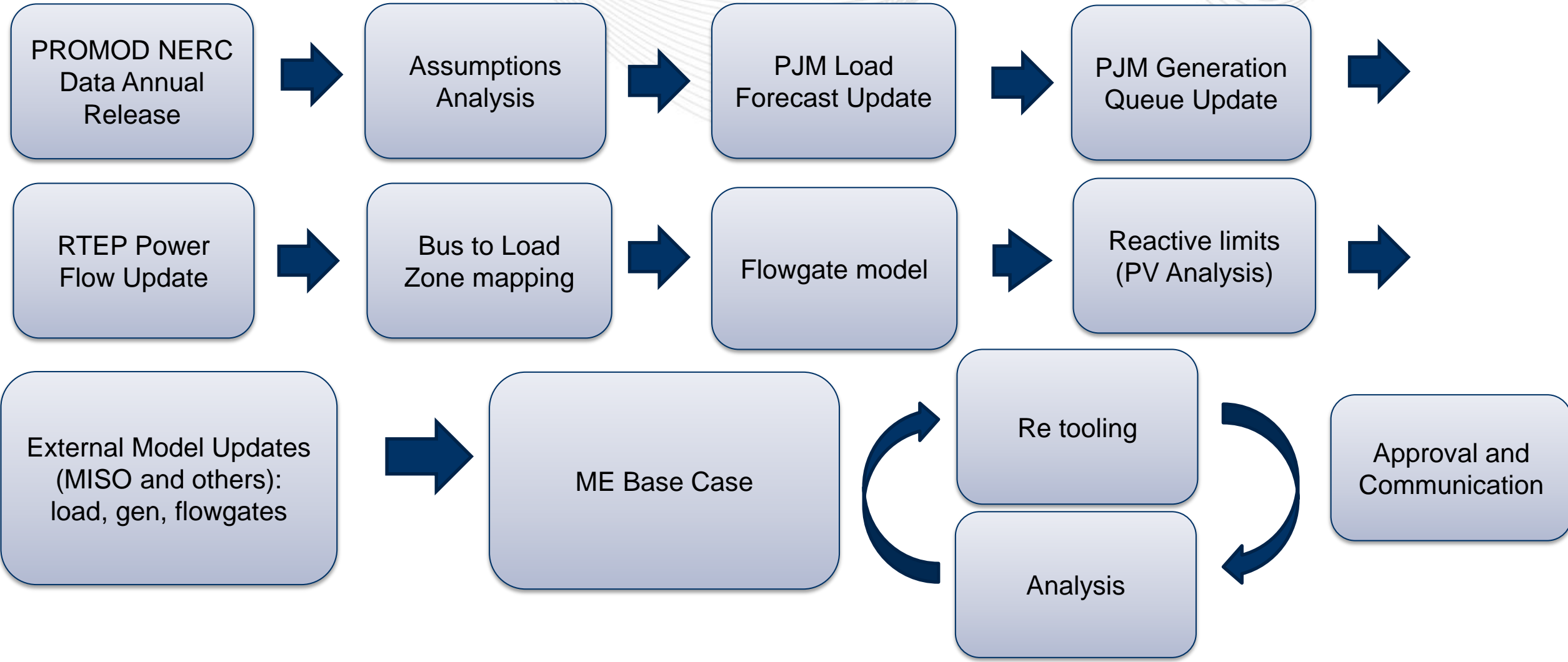


- 12 Month Cycle
 - Acceleration
- 24 Month Cycle
 - Input assumptions
 - Base case development
 - Develop target congestion
 - Proposal submission
 - Evaluation
 - Approval

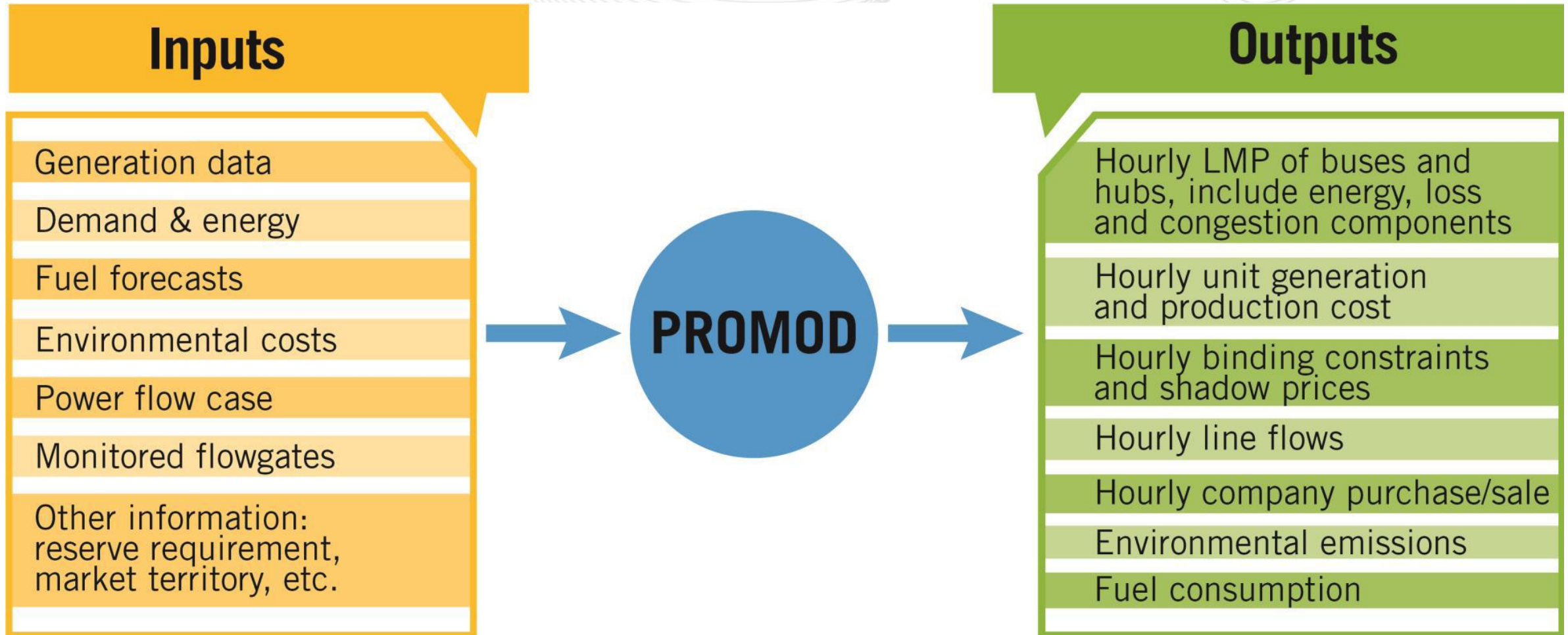


Market Efficiency Statistics

Cycle	Proposed Projects	Analyzed Projects	Approved Projects
Prior to 14/15	25 projects (2010, 2011) 17 projects (2012) 17 projects (2013)	25+ projects (with combinations) 17 projects(2012) 17 projects (2013)	2010, 2011 – 1 project approved 2012 - No project approved 2013 – 1 project approved
2014/15 Window	93 projects	110+ projects (with combinations) 2400+ PROMOD runs, 50,000+ runtime hrs.	14 projects
2016/17 Window	96 projects	120+ projects (with combinations and reevaluations) 3500+ PROMOD Runs, 90,000+ runtime hrs.	In-progress



Section 2: Critical Modeling Inputs



PROMOD SCED Simulation

Generation Expansion Plan (ISA/FSA)

Demand Response Forecast

Intermittent resource hourly shapes

Transmission Topology (As-Is, RTEP)

Fuel Price Forecast: Natural Gas, Coal, Oil-H, Oil-L

Topology Mapping: Bus-Area, BusLoad-Demand, Gen-Bus (As-Is, RTEP)

Emissions Price Forecast: CO2 (National, RGGI), SO2, Nox (seasonal, annual)

Reactive Interface PV Analysis

Demand Forecast: Annual Peak Load and Energy, Hourly shapes

Monitored lines and contingencies, interfaces and nomograms, PARs

Interregional Inputs

MISO and NY Updates: GenExp, load forecast, wind profiles, major upgrades, flowgates, transactions with SPP/MRO, imports Canada

Pool Interaction Modeling: M2M flowgates, pseudo-ties, DC schedules, hurdle rates, import/export limits, inactive pools

Reporting Inputs

RTO Weighted Average Cost of Capital

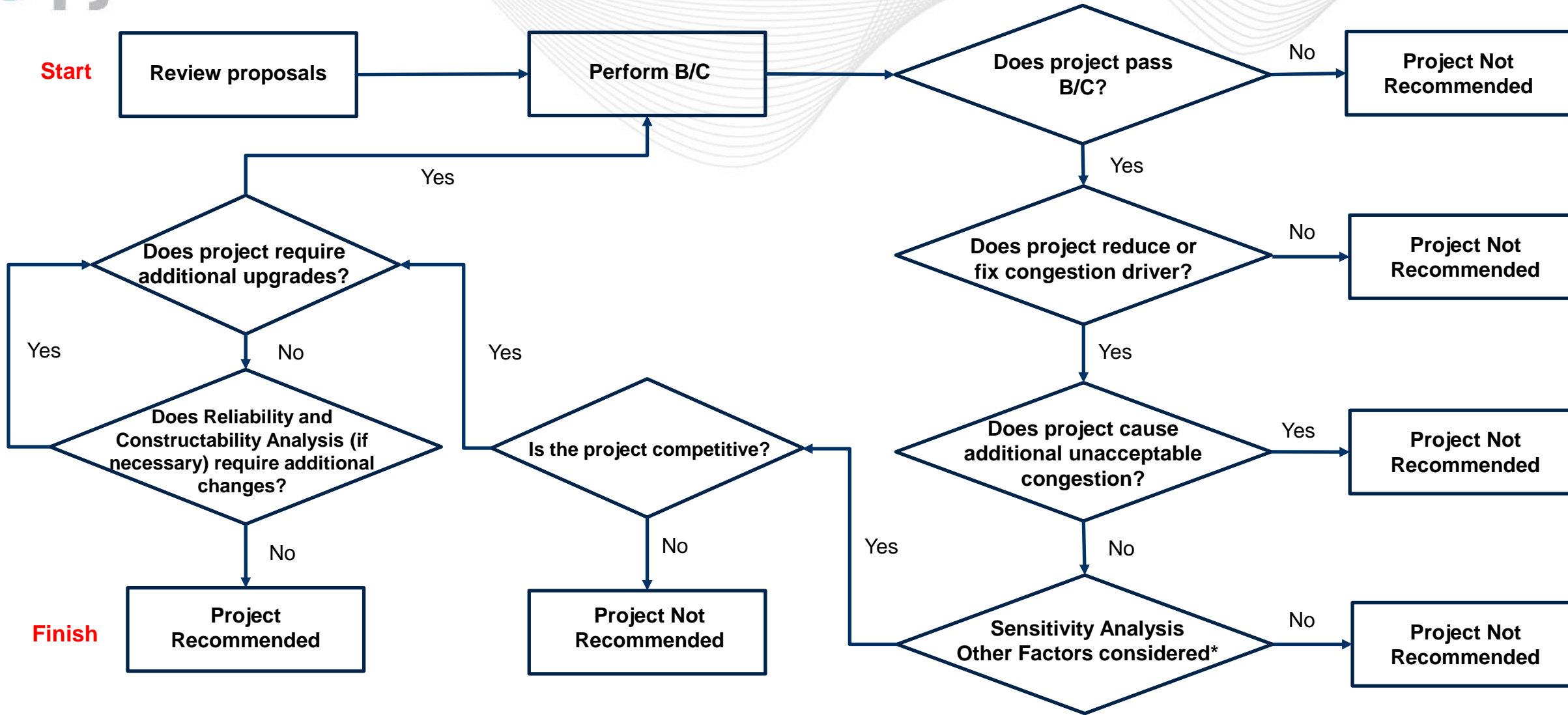
RTO Fixed Carrying Charge Rate

ARR Source Sink Paths and Cleared MW

Project Cost and ISD

Section 3: Project Selection Process

Market Efficiency Project Selection Flowchart



Other factors considered such as PJM Overall Production Cost, load Payments, and congestion

Market Efficiency Process – Congestion Drivers

- PROMOD simulations are used for determining future congestion drivers
- PJM solicits projects for posted congestion drivers

- Each valid proposal is tested for Benefits/Cost >1.25
 - Total Benefits = Energy Benefits + RPM Benefits
(for more details, see *PJM Market Efficiency Benefits Calculation* education session)
- Candidates passing B/C tests:
 - Congestion driver reductions
 - Other factors: overall PJM congestion changes, PJM Load Payments, PJM Production Costs
 - Perform Sensitivities
 - Gas Sensitivity
 - Load Sensitivity
 - Other sensitivities as needed (Examples: gen exp, renewable penetration, carbon tax, imports/exports, etc.)

- Reliability Analysis
 - Additional reliability upgrades
- Independent Cost Analysis
 - Projects exceeding \$50M Independent cost analysis
- Constructability Analysis
 - Verification of proposed schedule duration
 - Other risks to both cost and schedule
- Project Combinations
 - Combination of components of multiple projects
 - Incremental or multiple projects



Market Efficiency Process – Approval & Communication

- Selected projects require PJM board approval
- Approved projects are communicated at TEAC meetings
- Letter from PJM notifying construction responsibility

Appendix A – Market Efficiency Inputs Modeling

- Forecasted generation includes:
 - In-service generation
 - Active queue generation with Interconnection Service (ISA) and Facility Service (FSA) agreements
 - Expected future deactivations
- Modeled inputs:
 - Operational: summer/winter capacity, heat rate, min runtime/downtime, must run status, emission rates
 - Cost: startup cost, variable O&M, curtailment price

- PJM Load Forecast Report
 - Peak Load and Annual Energy adjusted by Energy Efficiency cleared in RPM Auction
 - Load forecast mapped to PROMOD Areas
- ABB synthetic demand shapes
 - Based on the average of several years of load shapes
 - Hourly load shapes merged to match PJM load zones
- Demand Response
 - Modeled as discrete units
 - Amount based on the level cleared in the RPM BRA auction

- Level of Demand Response (DR) is based on the level cleared in the RPM BRA auction by delivery year, zone and product type.
- Demand Response is modeled as discrete units.
- Locations (zip codes) of Demand Response are based on registration data submitted through PJM DR Hub system.
- MW by Product Type are mapped to nearest BES facility.
- Strike price is modeled to ensure that DR is called at a level consistent with history and contractual requirements for the product type.

- Forecast prices developed by the ABB fuels group
 - Gas and Oil Price Forecasts
 - Prices derived from NYMEX (short term) and the EIA Annual Energy Forecast (long term)
 - ABB's Coal Forecast model
 - Mining costs, emission price forecasts, transportation routes and pricing, coal quality
- Additional input from IHS Energy
 - Alternative view on Gas Price forecast
 - Used to create high/low gas sensitivity scenarios

- Emissions prices developed by ABB
 - Three major effluents modeled: SO₂, NO_x, and CO₂
 - Effluents (by trading program) assigned to generators based on location and release rates
 - Sources:
 - EPA CEMS data
 - ABB's proprietary Emission Forecast Model (EFM)
- PJM checks
 - Consistency with expected emissions legislation affecting PJM Generators
 - Mapping of generating units to emissions price
 - Validate installation of emissions reduction equipment and removal rates for generating units (if necessary)

- Same topology used for all study years
 - To evaluate a project expected to be in service in 2019, the same topology is used in the pre-2019 study years simulated in PROMOD IV.
 - The generation (i.e. in-service or retired), fuel and emissions pricings will change by study year, but the topology is held constant.
- RTEP system topology
 - All approved baseline upgrades
 - All FSA network and direct interconnection upgrades
- External world topology
 - Derived from Eastern Interconnection Reliability Assessment Group (ERAG) Multi-Regional Modeling Working Group (MMWG) Series

- Thermal Flowgates
 - Historical market constraints
 - NERC Book of Flow-gates
 - Removed constraints with very low likelihood of binding in any future year simulation
 - Added constraints with increasing likelihood of binding
- Transmission Ratings Modeling
 - Summer 95 degree day-time rating for Normal and Long-term Emergency
 - Winter 32 degree day-time rating for Normal and Long-term Emergency
- Reactive Limits
 - PV Analysis to develop summer and winter MW transfer limits for commercially significant interfaces in PJM
 - Modeled interfaces: AEP-DOM, AP South, BCPEP, Black Oak Bedington, 5004/5005, Central Interface, Cleveland, COMED, Eastern Interface, Western Interface

Appendix B – Operating Agreement & Manual References

- Scope, PJM requirements & Member requirements
- <http://www.pjm.com/about-pjm/member-services.aspx>
- PJM Manual 14B, Section 2.6:
<http://www.pjm.com/~media/documents/manuals/m14b.ashx>
- PJM Operating Agreement, Schedule 6, Section 1.5.7:
<http://www.pjm.com/media/documents/merged-tariffs/oa.pdf>
- PJM Market Efficiency Practices
- <http://www.pjm.com/~media/planning/rtep-dev/market-efficiency/pjm-market-efficiency-modeling-practices.ashx>