

**SOUTHWEST POWER POOL (SPP)
STRATEGIC & CREATIVE RE-ENGINEERING
OF INTEGRATED PLANNING TEAM (SCRIPT)**

Oct. 16, 2020, 2:00 P.M. to 4:00 P.M. | WebEx

MINUTES

AGENDA ITEM 1 – ADMINISTRATIVE ITEMS

Chair Mark Crisson called the meeting to order at 2:00 P.M. and began by reviewing the agenda (Attachment A – Agenda). Vice Chair Bronwen Bastone (SPP Board) moved to approve the minutes from the Oct. 9, 2020 meeting (Attachment B – Oct. 9 Meeting Minutes). Chris Jones (City Utilities of Springfield) seconded and the motion passed unanimously.

AGENDA ITEMS 2 & 3 – WELCOME AND INTRODUCTIONS AND STAKEHOLDER ENGAGEMENT EXPECTATIONS

Mark Crisson welcomed members and participants (Attachment C – Attendance List). Russell Carey (SPP) reviewed logistics for net conference participation. Lanny Nickell (SPP) explained how questions and input from members and participants would be addressed during the educational presentations to be made during this and upcoming meetings.

AGENDA ITEM 4 – PRESENTATION – INTEGRATED TRANSMISSION PLANNING (ITP)

Amber Greb (SPP) provided an overview of SPP's ITP process, how SPP calculates benefit-to-cost (B/C) ratios and adjusted production cost for project decisions, inputs for economic portfolio development, and the use of multiple sensitivities to predict likely ranges of actual costs and benefits. Amber also provided an overview of resource, generation and operational assumptions and requirements that impact the ITP. Additional information on APC was provided in presentation appendices (Attachment D – Integrated Transmission Planning (ITP) Deep Dive).

AGENDA ITEM 5 – QUESTIONS AND DISCUSSION

SPP staff fielded questions from SCRIPT members and other attendees throughout presentations and after presentation of overview materials. SCRIPT members requested additional education on how APC for designated resources is assigned by zones, especially for designated resources. Members also noted some topics for future policy discussion: combining sensitivities, improving accuracy of B/C extrapolation, aligning fixed costs with variable benefits

Antitrust: SPP strictly prohibits use of participation in SPP activities as a forum for engaging in practices or communications that violate the antitrust laws. Please avoid discussion of topics or behavior that would result in anti-competitive behavior, including but not limited to, agreements between or among competitors regarding prices, bid and offer practices, availability of service, product design, terms of sale, division of markets, allocation of customers or any other activity that might unreasonably restrain competition.

and improving how SPP calculates regional benefits of the ITP. Lanny Nickell noted these suggestions would be incorporated into future educational and ideation sessions.

AGENDA ITEM 6 – UPCOMING TOPICS AND MEETING SCHEDULE

- Oct. 23, 2020 – GI Deep Dive
- Oct. 30, 2020 – Transmission Services Deep Dive
- Nov. 6, 2020 – Cost-Allocation Deep Dive
- Nov. 13, 2020 – Decision Quality Deep Dive

ADJOURNMENT

Crisson adjourned the meeting at 4:01 P.M.

ACTION ITEMS:

- Staff will collect outstanding questions from the meeting or sent by email after the meeting to address in future sessions.

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SOUTHWEST POWER POOL, INC.
SCRIPT Meeting
Oct. 16, 2020 | 2:00 p.m. - 4:00 p.m.
Net conference

AGENDA

1. Call to Order and Administrative Items..... Mark Crisson
 - Approval of Oct. 9 Minutes
2. Welcome & Introductions..... Mark Crisson
3. Stakeholder Engagement Expectations..... Lanny Nickell
4. Presentation – Integrated Transmission Plan (ITP) Deep DiveAmber Greb
5. Questions and Discussion All
6. Upcoming Topics and Meeting ScheduleLanny Nickell
7. Adjournment Mark Crisson

**SOUTHWEST POWER POOL (SPP)
STRATEGIC & CREATIVE RE-ENGINEERING
OF INTEGRATED PLANNING TEAM (SCRIPT)**

Oct. 9, 2020, 1:00 P.M. to 3:00 P.M. | WebEx

MINUTES

AGENDA ITEM 1 – ADMINISTRATIVE ITEMS

Chair Mark Crisson called the meeting to order at 1:03 P.M. and began by reviewing the agenda (Attachment 1 – Agenda). Richard Ross (AEP) moved to approve the minutes from the Oct. 2, 2020 meeting (Attachment 2 – Oct. 2nd Meeting Minutes). Vice Chair Bronwen Bastone (SPP Board) seconded and the motion passed unanimously.

AGENDA ITEMS 2 & 3 – WELCOME AND INTRODUCTIONS AND STAKEHOLDER ENGAGEMENT EXPECTATIONS

Mark Crisson welcomed members and participants (Attachment 3 – Attendance List). Russell Carey (SPP) reviewed logistics for net conference participation. Lanny Nickell (SPP) explained how questions and input from members and participants would be addressed during the educational presentations to be made during this and upcoming meetings.

AGENDA ITEM 4 – PRESENTATIONS – OVERVIEW OF PLANNING PROCESSES AND COST ALLOCATION

Antoine Lucas (SPP) began the educational session by providing an overview of SPP's historical and current planning and tariff services processes. Casey Cathey (SPP) presented current projects and trends in SPP's stakeholder-driven, member-funded processes. David Kelly (SPP) reviewed interregional planning, Jason Davis (SPP) covered customer-driven and funded processes and Steve Purdy (SPP) presented on generation interconnection (GI). Sunny Raheem (SPP) discussed planning models. Casey Cathey concluded by presenting transmission investment processes and process interaction. (Attachment 4 – Overview of Planning Process and Cost Allocation)

AGENDA ITEM 5 – QUESTIONS AND DISCUSSION

SPP staff fielded questions from SCRIPT members and other attendees throughout presentations and after presentation of overview materials. SCRIPT members requested additional education on reliability modeling, safe-harbor limit, public policy goals used in the

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ITP, relationship between congestion hedging and SPP's transmission services and transmission investment trends and drivers produced by each planning process. Lanny Nickell noted that these suggestions would be incorporated into future educational sessions.

AGENDA ITEM 6 – UPCOMING TOPICS AND MEETING SCHEDULE

- Oct. 16, 2020 – ITP Deep Dive
- Oct. 23, 2020 – GI Deep Dive
- Oct. 30, 2020 – Transmission Services Deep Dive
- Nov. 6, 2020 – Cost-Allocation Deep Dive
- Nov. 13, 2020 – Decision Quality Deep Dive

ADJOURNMENT

Crisson adjourned the meeting at 3:03 P.M.

ACTION ITEMS:

- Staff will incorporate requested topics and requests for data into upcoming education sessions.

Attachments: Oct. 2nd Meeting Minutes, Agenda, Attendance List, Overview of Planning Process and Cost Allocation Presentation

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SCRIPT ATTENDANCE LIST, OCTOBER 16, 2020

Attendance list from WebEx registration.

* Denotes SCRIPT Member

#	NAME	COMPANY
1	*Andrew French	Kansas Corporation Commission
2	*Brett Leopold	ITC Great Plains
3	*Bronwen Bastone	SPP
4	*Chris Jones	City Utilities
5	*Dennis Florom	Lincoln Electric System
6	*Dennis Grennan	Nebraska Power Review Board
7	*Greg McAuley	Oklahoma Gas & Electric
8	*Mark Crisson	SPP
9	*Michael Wise	Golden Spread Electric Cooperative
10	*Richard Ross	AEPSC
11	*Steve Gaw	APA
12	*Tom Christensen	Basin Electric
13	*William Grant	SPS
14	Al Tamimi	SEPC
15	Alan Decker	GRDA
16	Alan Myers	
17	Alfred Busbee	East Texas Electric Coop
18	Amber Greb	APP
19	Ben Bright	SPP
20	Benny Achenkunju	AEP
21	Bernie Liu	Xcel Energy
22	Betsy Beck	Enel Green Power North America
23	Brenda Prokop	ITC Holdings Corp.
24	Brian Johnson (AEP)	AEP
25	Brian Rounds	AESL Consulting
26	Britt Runion	Southwest Power Pool
27	Calvin Daniels (WFEC)	WFEC
28	Carrie Bellamy	Geronimo Energy
29	Casey Cathey	Southwest Power Pool
30	Charles Locke	Southwest Power Pool
31	Christine Aarnes	Sunflower Electric Power Corporation
32	Cole Bailey	
33	Daniel Hall	AWEA

#	NAME	COMPANY
34	Dara Solomon	SPP
35	Daria Diaz	Stone Pigman
36	David Kelley	SPP
37	David Mindham	EDP Renewables
38	David Schmitt	IUB
39	Gayle Freier	SPP
40	Gayle Nansel	WAPA-UGPR
41	Harika Basaran (PUCT)	PUCT
42	Heather Starnes	MJMEUC
43	J.P. Maddock	Basin Electric
44	James Bailey	SPP
45	Jason Mazigian	Basin Electric
46	Jeremy Severson	Basin Electric Power Cooperative
47	Jill Rummel	Basin Electric
48	Jim Krajecki	Customized Energy Solutions
49	Jon Sunneberg	Nebraska Public Power District
50	Josh Jarriel	Enel
51	Josh Norton	SPP
52	Josie Daggett	WAPA
53	Julian Brix	SPP BOD
54	Kelsey Allen	SPP
55	Kirk Hall	SPP
56	Krista Kisch	AEP Renewables
57	Kristie Fiegen	SD PUC
58	Kristina Luke Fry	KCC
59	Lane Sisung	Louisiana Public Service Commission
60	Lanny Nickell	Southwest Power Pool
61	Lee Elliott	Southwest Power Pool
62	Liz Gephardt	SPP
63	Mary Ann Zehr	TSGT
64	Mike Kraft	Basin Electric Power Cooperative
65	Mugwe Kiragu	London Economics International
66	Natasha Henderson	Golden Spread Electric Cooperative
67	Nick Parker	SPP
68	Pat Hayes	LS Power
69	Phil Westby	
70	Pius Fischer	BEPC
71	Preston Blinsky	BEPC


#	NAME	COMPANY
72	Rob Janssen	Dogwood Energy
73	Robert Pick	NPPD
74	Robert Tallman	OG&E
75	Ruth Sakya	SPS
76	Ryan Houk	Transource
77	Ryan Kirk	AEP
78	Ryan Koch	BEPC
79	Shawn Carlson	Basin Electric
80	Sherri Maxey	Southwest Power Pool
81	Steve Purdy (SPP)	SPP
82	Sunny Raheem (SPP)	Southwest Power Pool
83	Susan Certoma	SPP
84	Tammy Bright	Spp
85	Terri Pemberton	Kansas Corporation Commission
86	Tessie Kentner	SPP
87	Tim Owens	NPPD
88	Tony Green	Southwest Power Pool
89	Traci Bender	NPPD
90	Yohan Sutjandra	The Energy Authority



INTEGRATED TRANSMISSION PLAN (ITP) DEEP DIVE

SPP SCRIPT
OCTOBER 16, 2020

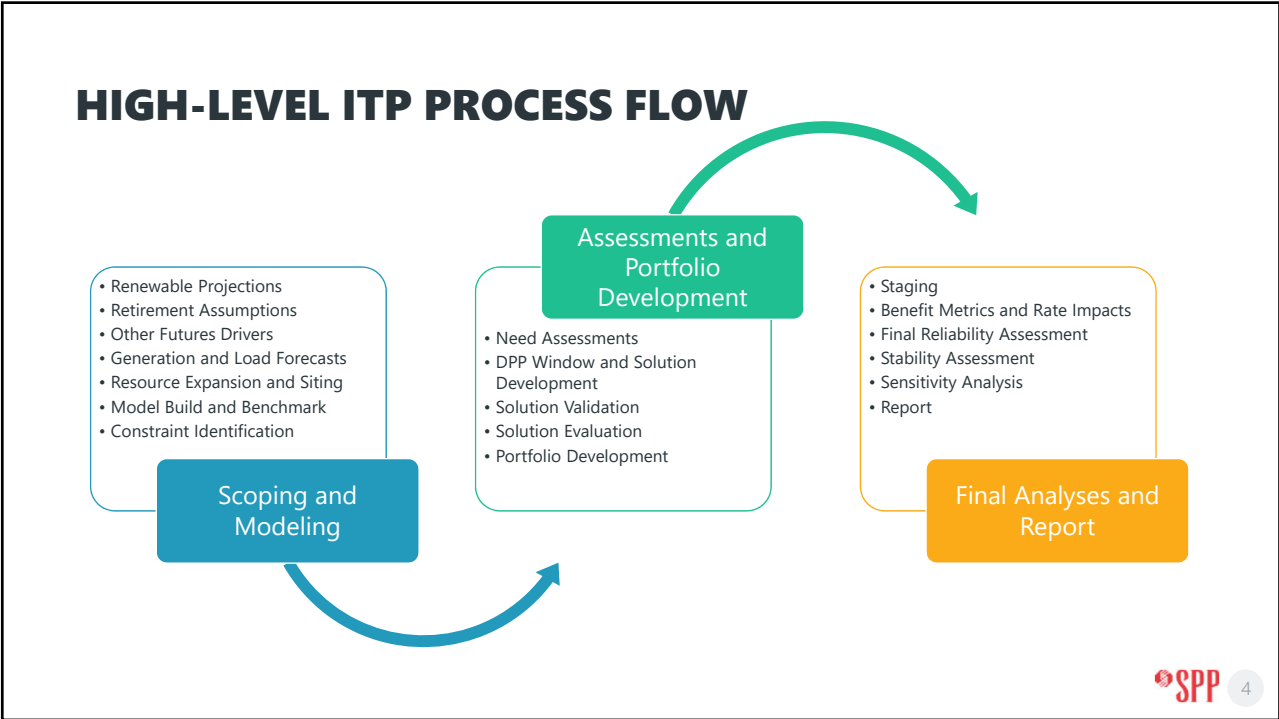
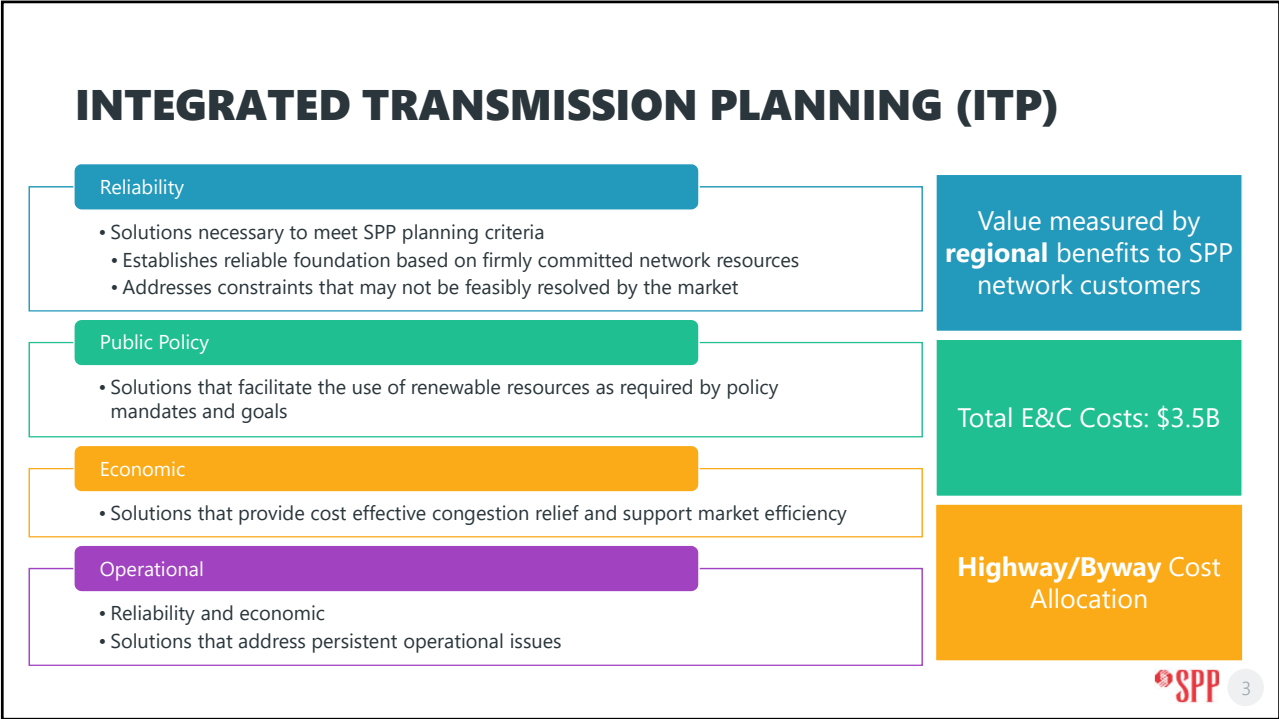
Helping our members work together to keep the lights on... today and in the future.

 SouthwestPowerPool  SPPorg  southwest-power-pool

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OBJECTIVE

- ITP Overview
- Deep dive into
 - How do we calculate and use B/C ratios?
 - How do future generation assumptions impact benefits?
 - How do we track with operations?



CALCULATING AND USING B/C RATIOS



B/C RATIO BACKGROUND

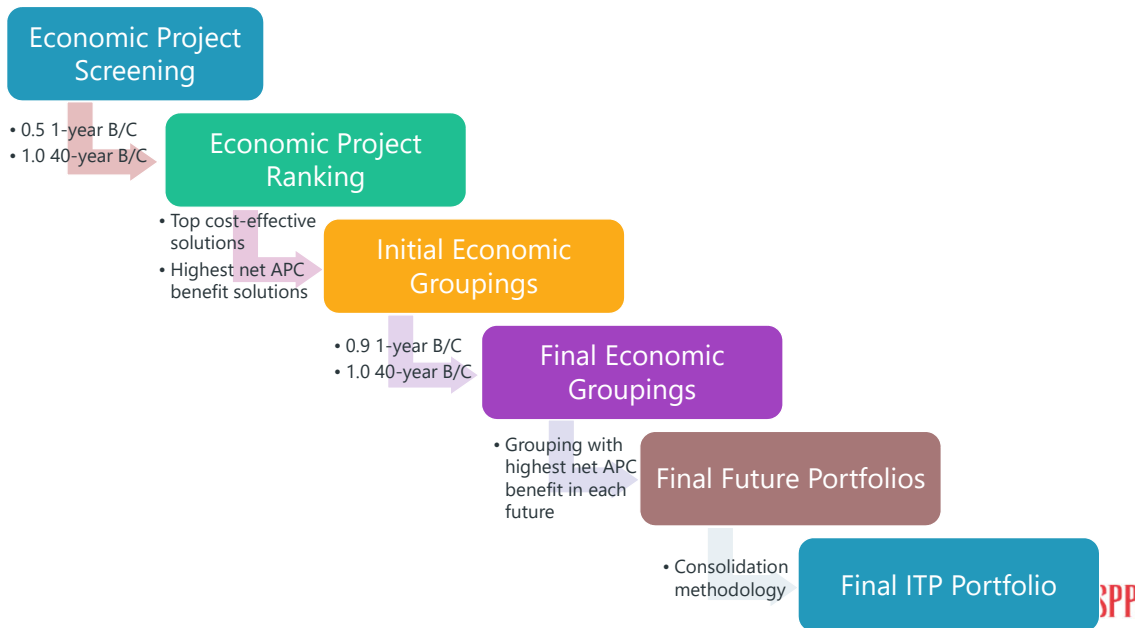
- Benefit-to-cost (B/C) ratios are one of many tools used to make economic project decisions
- B/C ratios are used to filter projects out on a screening (stand-alone) basis and within a portfolio
- Conceptual cost estimates used for screening and study cost estimates used for portfolio development



APC IN B/C RATIOS


- Generally, B/C includes adjusted production cost (APC) benefit only
 - Additional metrics considered during Benefit Metrics milestone
 - In recent portfolios, APC has made up 65%-80% of total benefit

ECONOMIC PORTFOLIO DEVELOPMENT




ECONOMIC PORTFOLIO DEVELOPMENT

Cost-Effective Grouping	Highest Net APC Grouping	Multi-Variable Grouping
<ul style="list-style-type: none"> Cost per congestion relief Specific to each economic need Generally results in smaller-scale solutions fixing 1-2 needs at a time 	<ul style="list-style-type: none"> Difference in project benefit & cost With respect to net SPP APC benefit Generally results in small-scale solutions and comprehensive solutions benefitting region 	<ul style="list-style-type: none"> SPP-developed portfolio generally based on results from other groupings & qualitative information Discretionary


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APC BENEFIT



APC benefit is the reduction in APC when a solution is added to the model

- 1-year APC benefit based on performance in individual study years within each future
- Years 5 and 10 APC benefit used to calculate 40-year APC benefit by future

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APC CALCULATION

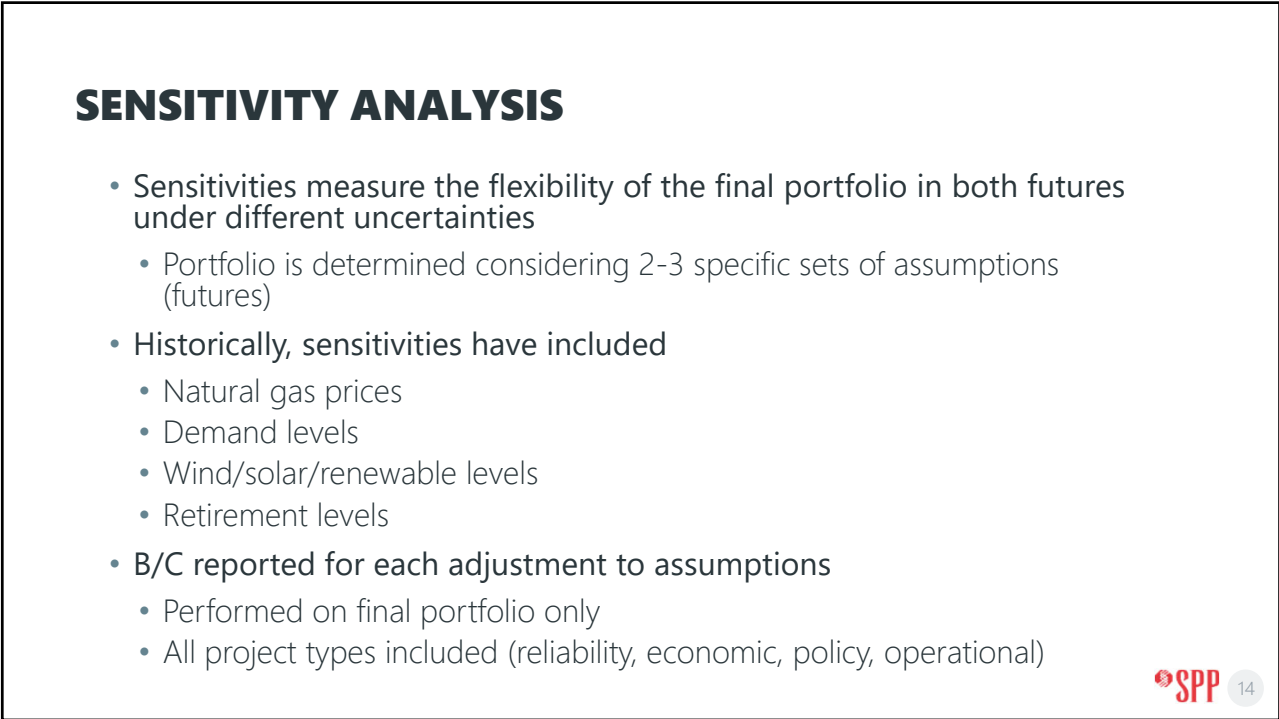
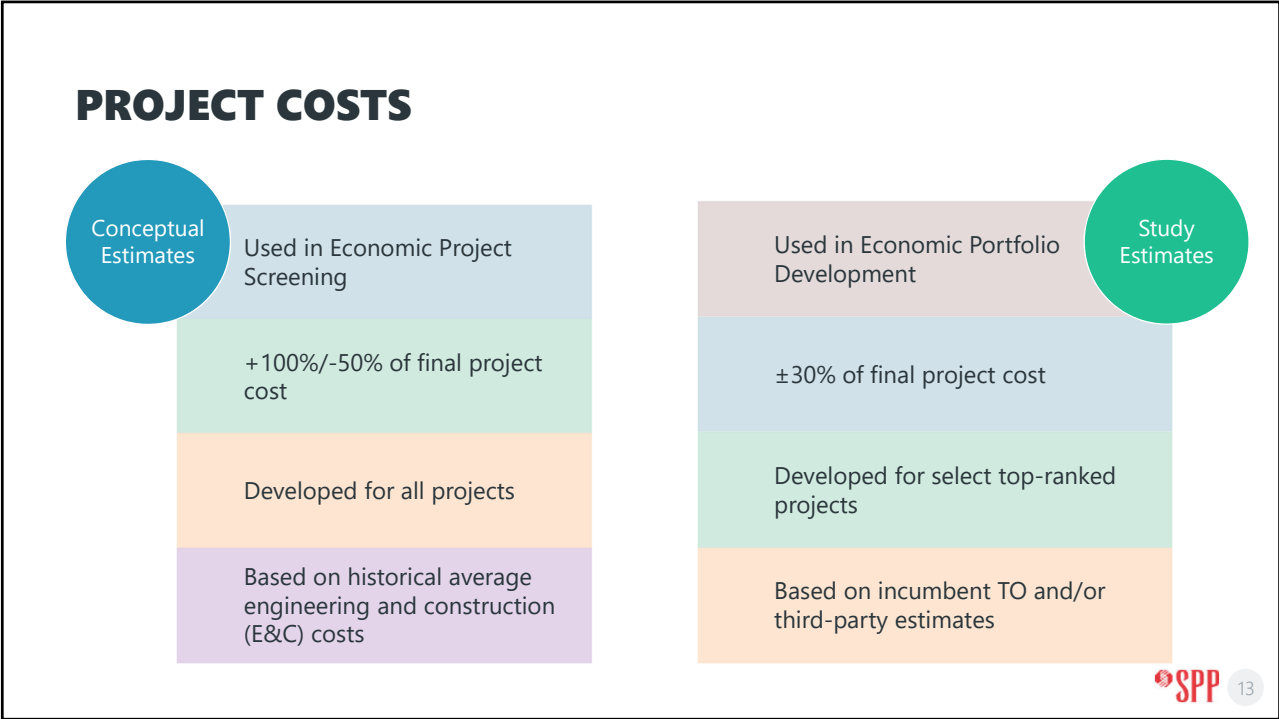
- Calculated hourly for each pricing zone
 - SPP pricing zones are defined in SPP OATT Attachment H
 - Regional APC values made up of individual pricing zone APC values
 - Unassigned generation in SPP market is not directly considered in SPP regional APC (SPP Other)

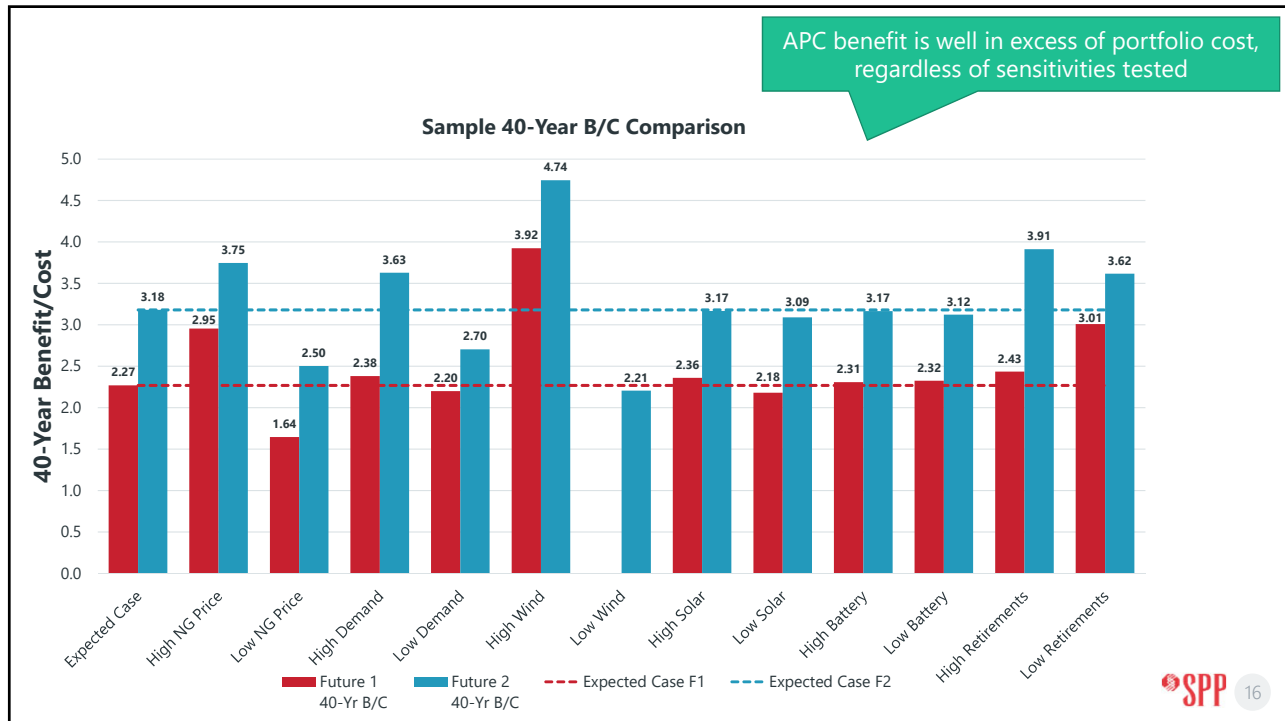
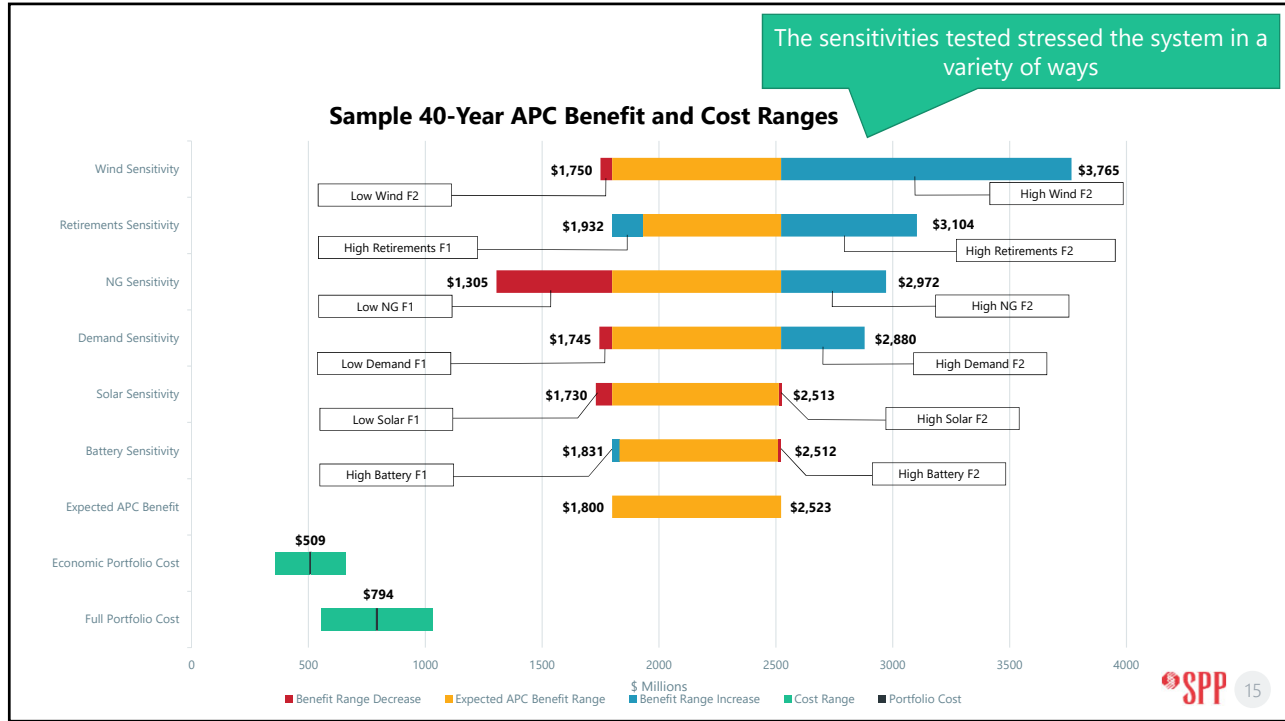
APC CALCULATION

APC is representative of generation production cost adjusted for purchases and sales



- **Production Cost** is the cost to run generation
 - Fixed and variable operating & maintenance (O&M) costs
 - Start-up costs
 - Fuel costs
 - Emissions costs
- **Purchases** are the product of MW imports and the load-weighted locational marginal price (LMP)
- **Sales** are the product of MW exports and the generation-weighted LMP





GENERATION ASSUMPTIONS

RESOURCE EXPANSION

- Resources are added to the model to meet
 - Approved future renewable projections
 - Renewable portfolio standards
 - 12% reserve margin requirements

RESOURCE SITING

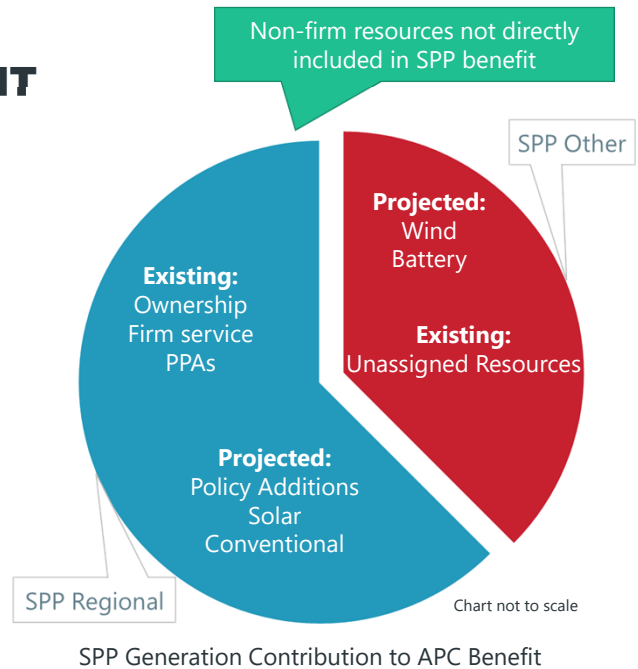
- The resource siting process determines the location of this generation
 - Wind and solar sites are sourced from GI queue
 - Battery co-located with wind and solar
 - Conventional sites are sourced from member input
 - Ranking of sites
 - Low interconnection and network upgrade costs (when available)
 - Site availability (considering transfer capability and existing generation at the site)
 - Some stakeholder input

GENERATOR OUTLET FACILITIES

- Generator outlet facilities may be added to the market models if GI upgrades are assigned or sited amount exceeds site availability
 - Allows projected resources to be delivered to load without causing or masking system issues
 - Leverage existing GI results
 - Proxy GI process

GENERATION ASSIGNMENT

- **SPP Other** = all resources that are not assigned ownership to SPP but are in SPP footprint
- Project decisions **only** based on **SPP Regional** benefits
 - **SPP Other** benefit **not** included in **SPP Regional** benefit
 - Reflects benefits to ratepayers
- APC impacts for SPP region when renewable generation assigned to **SPP Other**
 - Reduced production costs and sales
 - Increased purchases (from **SPP Other**)
 - Generally, reduced APC overall



POLICY REQUIREMENT DIFFERENCES

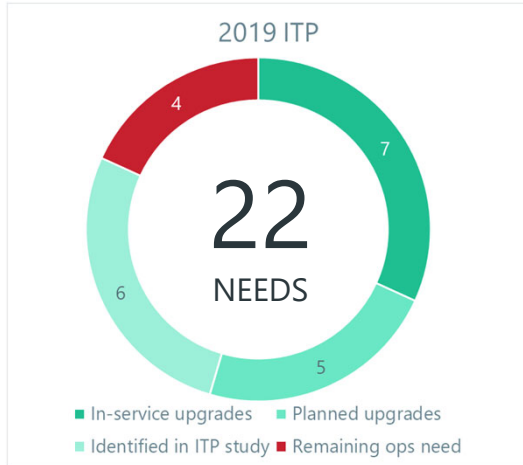
- October 9 SCRIPT: “How do vastly different RPS of one state having a larger requirement than the remaining states potentially drive transmission (e.g. New Mexico)?”
 - Disproportionate assignment of projected wind to utilities in driving state
 - Projected wind resources otherwise assigned to SPP Other
 - More potential for APC benefit from less purchases and/or more sales
 - New Mexico (Energy Mandate)
 - Energy RPS more impactful than capacity (delivered vs. installed)
 - Potentially more resources outside of the immediate area being assigned to driving utility/state

CONSIDERING OPERATIONS

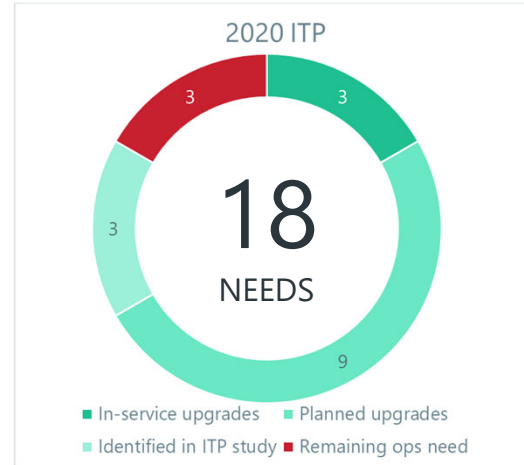
OPERATIONAL CONSIDERATIONS IN THE ITP

- ITP flowgates and contingencies start from SPP permanent and recent temporary flowgates during constraint assessment
- Operational need criteria defined in ITP Manual
 - Economic need identification
 - Congested at least 20% of time or \$10M in congestion cost over 24 months
 - Manual commitments 25% of year or \$1M in costs over 24 months
 - Reliability need identification
 - System reconfiguration for 10% of year for voltage issues or 25% of year for thermal issues

ITP OPERATIONAL NEEDS



2019 ITP operational needs included one voltage issue with planned upgrade, remaining were flowgates over congestion cost threshold



2020 ITP operational needs were flowgates over congestion cost threshold

OPERATIONAL ISSUES NOT IN ITP

- New ITP process aimed to address and consider persistent operational issues
- Original project evaluation method for operational needs not feasible
- New ITP Manual language will allow SPP flexibility to develop ITP planning models to replicate and analyze congested economic operational needs

CONCLUSION

KEY TAKEAWAYS

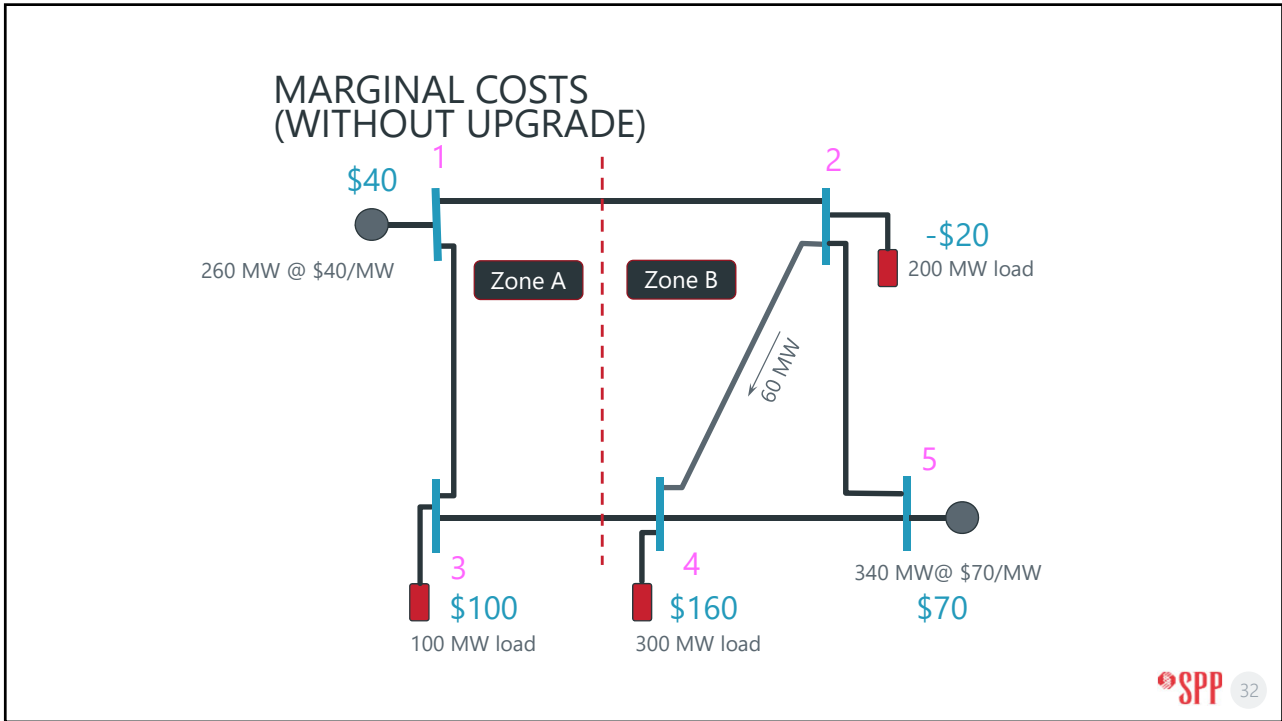
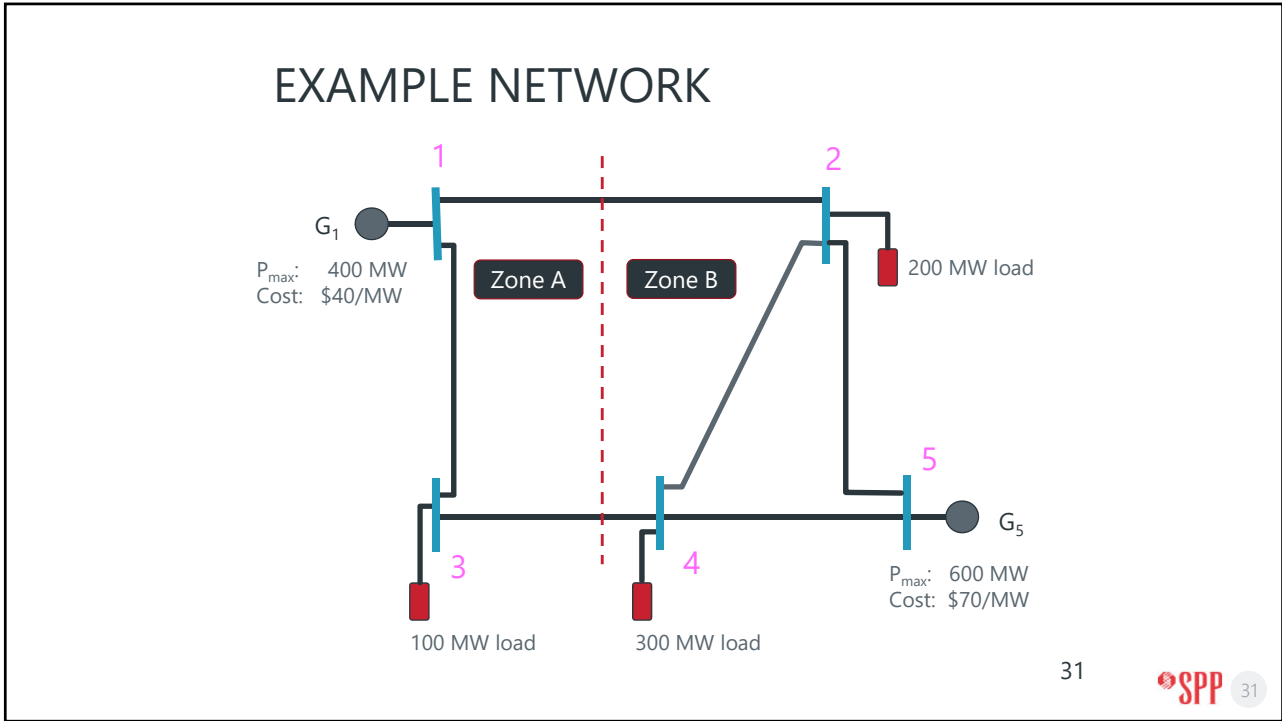
- APC benefit is the only benefit metric used to make economic project decisions
 - Historically, the accuracy added with additional metrics have not justified the time and cost
 - Some metrics may not be able to be calculated prior to final portfolio
- Costs and revenues from non-firm resources are not directly included in the SPP Regional APC
- ITP tracking well with real-time operations
 - Recent improvements to ITP operational solution evaluation will make process more flexible to track even better with operations

APPENDIX A

TRANSMISSION UPGRADE APC BENEFIT CALCULATION

EXAMPLE: ZONAL APC

- Start with 5 bus LMP solution from previous session
- Assign generators and loads to two zones
- Calculate APC for each zone for a single hour
- Calculate APC benefit of an upgrade for a single hour



APC CALCULATION: ZONE A (WITHOUT UPGRADE)

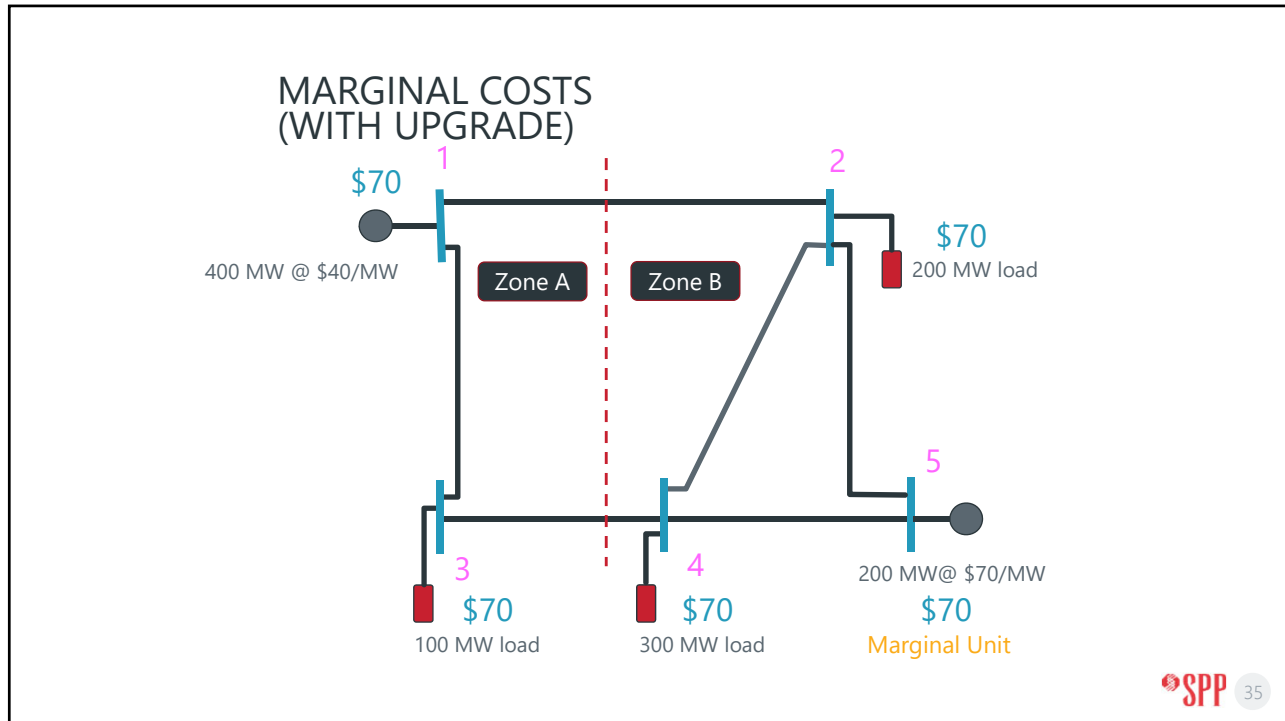
- $APC = \text{Production Cost} + \text{Purchases} - \text{Sales}$
- $\text{Production Cost} = 260 \text{ MWh} * \$40/\text{MWh} = \$10,400$
- $\text{Purchases} = \$0$
- $\text{Sales (MWh)} = \text{Unit Generation} - \text{Area Native Load}$
 - $160 \text{ MWh} = 260 \text{ MWh} - 100 \text{ MWh}$
- $GLMP = \frac{\$40/\text{MWh} * 260 \text{ MWh}}{260 \text{ MWh}} = \$40/\text{MWh}$
- $\text{Sales (\$)} = \text{Sales (MWh)} * GLMP (\$/\text{MWh})$
 - $\$6,400 = 160 \text{ MWh} * \$40/\text{MWh}$
- $APC = \$10,400 + \$0 - \$6,400 = \$4,000$



APC CALCULATION: ZONE B (WITHOUT UPGRADE)

- $APC = \text{Production Cost} + \text{Purchases} - \text{Sales}$
- $\text{Production Cost} = 340 \text{ MWh} * \$70/\text{MWh} = \$23,800$
- $\text{Purchases (MWh)} = \text{Area Native Load} - \text{Unit Generation}$
 - $160 \text{ MWh} = (200 \text{ MWh} + 300 \text{ MWh}) - 340 \text{ MWh}$
- $LLMP = \frac{(-\$20/\text{MWh} * 200 \text{ MWh}) + (\$160/\text{MWh} * 300 \text{ MWh})}{200 \text{ MWh} + 300 \text{ MWh}} = \$88/\text{MWh}$
- $\text{Purchases (\$)} = \text{Purchases (MWh)} * LLMP (\$/\text{MWh})$
 - $\$14,080 = 160 \text{ MWh} * \$88/\text{MWh}$
- $\text{Sales} = \$0$
- $APC = \$23,800 + \$14,080 - \$0 = \$37,880$





APC CALCULATION: ZONE A (WITH UPGRADE)

- $APC = \text{Production Cost} + \text{Purchases} - \text{Sales}$
- $\text{Production Cost} = 400 \text{ MWh} * \$40/\text{MWh} = \$16,000$
- $\text{Purchases} = \$0$
- $\text{Sales (MWh)} = \text{Unit Generation} - \text{Area Native Load}$
 - $300 \text{ MWh} = 400 \text{ MWh} - 100 \text{ MWh}$
- $GLMP = \frac{\$70/\text{MWh} * 400 \text{ MWh}}{400 \text{ MWh}} = \$70/\text{MWh}$
- $\text{Sales (\$)} = \text{Sales (MWh)} * GLMP (\$/\text{MWh})$
 - $\$21,000 = 300 \text{ MWh} * \$70/\text{MWh}$
- $APC = \$16,000 + \$0 - \$21,000 = -\$5,000$

APC CALCULATION: ZONE B (WITH UPGRADE)

- $APC = \text{Production Cost} + \text{Purchases} - \text{Sales}$
- $\text{Production Cost} = 200 \text{ MWh} * \$70/\text{MWh} = \$14,000$
- $\text{Purchases (MWh)} = \text{Area Native Load} - \text{Unit Generation}$
 - $300 \text{ MWh} = (200 \text{ MWh} + 300 \text{ MWh}) - 200 \text{ MWh}$
- $LLMP = \frac{(\$70/\text{MWh} * 200 \text{ MWh}) + (\$70/\text{MWh} * 300 \text{ MWh})}{200 \text{ MWh} + 300 \text{ MWh}} = \$70/\text{MWh}$
- $\text{Purchases (\$)} = \text{Purchases (MWh)} * LLMP (\$/\text{MWh})$
 - $\$21,000 = 300 \text{ MWh} * \$70/\text{MWh}$
- $\text{Sales} = \$0$
- $APC = \$14,000 + \$21,000 - \$0 = \$35,000$



APC BENEFIT (ZONE A)

- Measure of change in APC from base case (constraint binding) to change case (constraint relieved by upgrade)
- Zone A benefits from increased sales at a higher value than its production costs

Scenario	Production Cost	Purchases	Sales	APC
Base	\$10,400	\$0	\$6,400	\$4,000
Change	\$16,000	\$0	\$21,000	-\$5,000
			Benefit	\$9,000



APC BENEFIT (ZONE B)

- Measure of change in APC from base case (constraint binding) to change case (constraint relieved by upgrade)
- Zone B benefits from increased purchases at a lower cost than its production costs

Scenario	Production Cost	Purchases	Sales	APC
Base	\$23,800	\$14,080	\$0	\$37,880
Change	\$14,000	\$21,000	\$0	\$35,000
			Benefit	\$2,880

APC BENEFIT (REGIONAL)

- Measure of change in APC from base case (constraint binding) to change case (constraint relieved by upgrade)
- Region benefits from production costs being offset by lower cost purchases and increased sales revenues

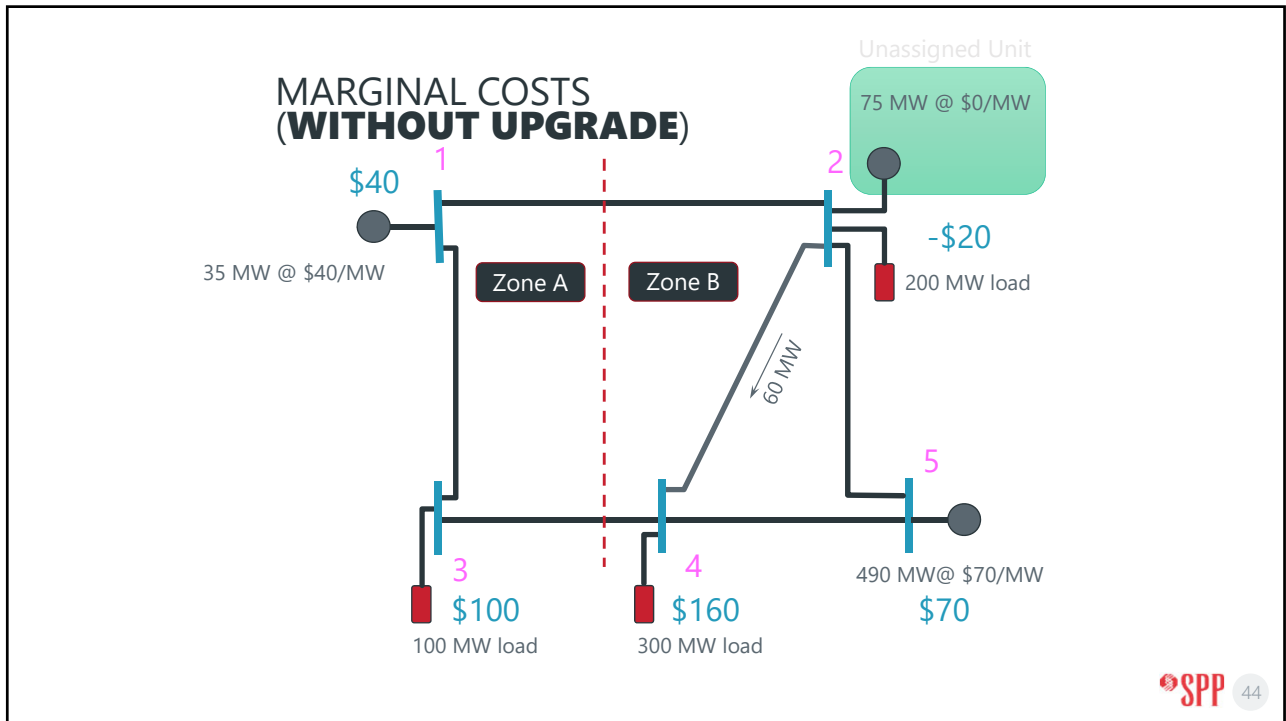
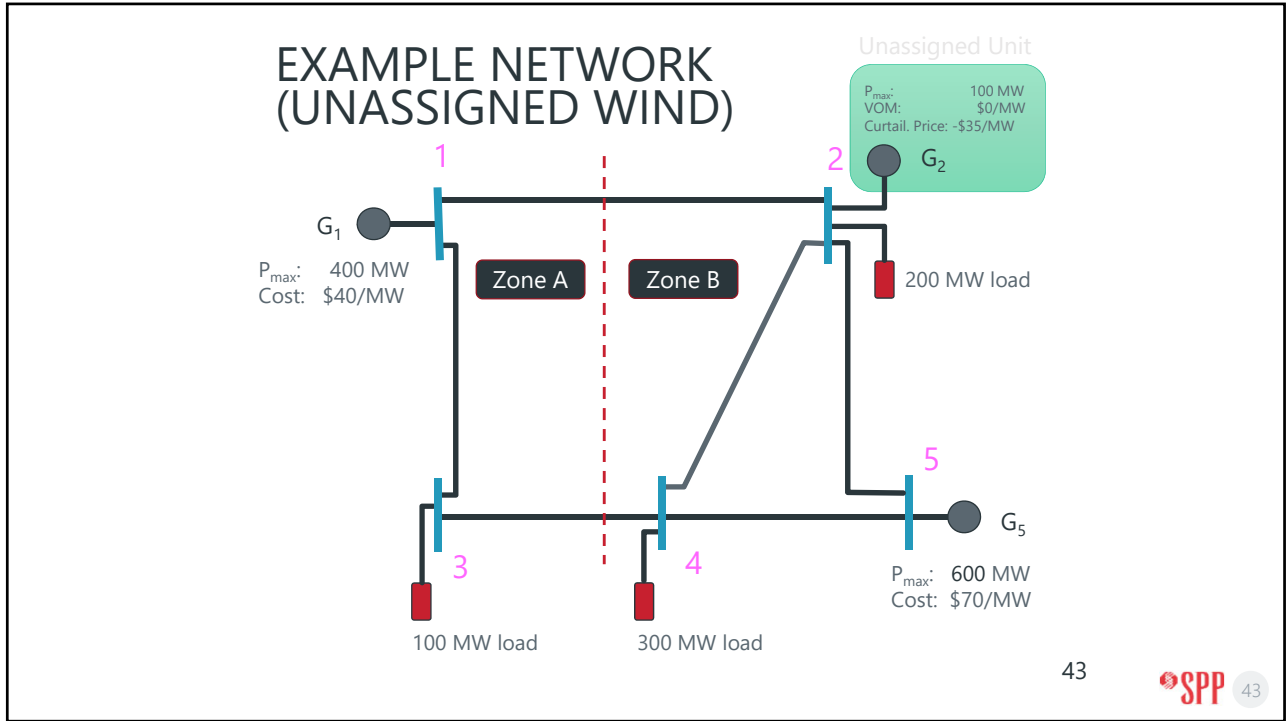
Scenario	Production Cost	Purchases	Sales	APC
Base	\$34,200	\$14,080	\$6,400	\$41,880
Change	\$30,000	\$21,000	\$21,000	\$30,000
			Benefit	\$11,880

APPENDIX B

UNASSIGNED VS. ASSIGNED WIND AND APC BENEFIT

EXAMPLE: UNASSIGNED WIND

- Start with previous example
- Add wind unit to Bus 2
- **Do not assign** wind unit to either zone
- Calculate APC for each zone for a single hour
- Calculate APC benefit of an upgrade for a single hour



APC CALCULATION: ZONE A (WITHOUT UPGRADE)

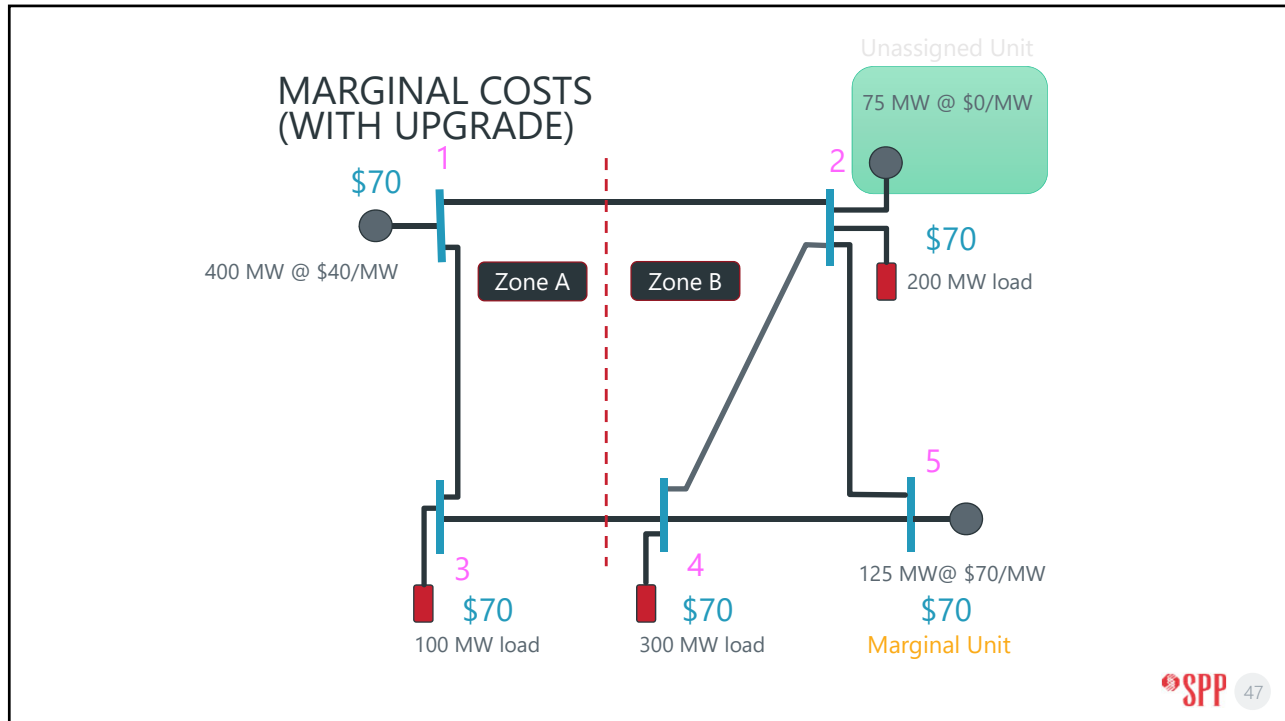
- $APC = \text{Production Cost} + \text{Purchases} - \text{Sales}$
- $\text{Production Cost} = 35 \text{ MWh} * \$40/\text{MWh} = \$1,400$
- $\text{Purchases (MWh)} = \text{Area Native Load} - \text{Unit Generation}$
 - $65 \text{ MWh} = 100 \text{ MWh} - 35 \text{ MWh}$
- $LLMP = \frac{\$100/\text{MWh} * 100 \text{ MWh}}{100 \text{ MWh}} = \$100/\text{MWh}$
- $\text{Purchases (\$)} = \text{Purchases (MWh)} * LLMP (\$/\text{MWh})$
 - $\$6,500 = 65 \text{ MWh} * \$100/\text{MWh}$
- $\text{Sales} = \$0$
- $APC = \$1,400 + \$6,500 - \$0 = \$7,900$



APC CALCULATION: ZONE B (WITHOUT UPGRADE)

- $APC = \text{Production Cost} + \text{Purchases} - \text{Sales}$
- $\text{Production Cost} = 490 \text{ MWh} * \$70/\text{MWh} = \$34,300$
- $\text{Purchases (MWh)} = \text{Area Native Load} - \text{Unit Generation}$
 - $10 \text{ MWh} = (200 \text{ MWh} + 300 \text{ MWh}) - 490 \text{ MWh}$
- $LLMP = \frac{(-\$20/\text{MWh} * 200 \text{ MWh}) + (\$160/\text{MWh} * 300 \text{ MWh})}{200 \text{ MWh} + 300 \text{ MWh}} = \$88/\text{MWh}$
- $\text{Purchases (\$)} = \text{Purchases (MWh)} * LLMP (\$/\text{MWh})$
 - $\$880 = 10 \text{ MWh} * \$88/\text{MWh}$
- $\text{Sales} = \$0$
- $APC = \$34,300 + \$880 - \$0 = \$35,180$





APC CALCULATION: ZONE A (WITH UPGRADE)

- APC = Production Cost + Purchases – Sales
- Production Cost = 400 MWh * \$40/MWh = \$16,000
- Purchases = \$0
- Sales (MWh) = Unit Generation – Area Native Load
 - 300 MWh = 400 MWh – 100 MWh
- $GLMP = \frac{\$70/MWh * 400 MWh}{400 MWh} = \$70/MWh$
- Sales (\$) = Sales (MWh) * GLMP (\$/MWh)
 - \$21,000 = 300 MWh * \$70/MWh
- APC = \$16,000 + \$0 - \$21,000 = **-\$5,000**

APC CALCULATION: ZONE B (WITH UPGRADE)

- $APC = \text{Production Cost} + \text{Purchases} - \text{Sales}$
- $\text{Production Cost} = 125 \text{ MWh} * \$70/\text{MWh} = \$8,750$
- $\text{Purchases (MWh)} = \text{Area Native Load} - \text{Unit Generation}$
 - $375 \text{ MWh} = (200 \text{ MWh} + 300 \text{ MWh}) - 125 \text{ MWh}$
- $LLMP = \frac{(\$70/\text{MWh} * 200 \text{ MWh}) + (\$70/\text{MWh} * 300 \text{ MWh})}{200 \text{ MWh} + 300 \text{ MWh}} = \$70/\text{MWh}$
- $\text{Purchases (\$)} = \text{Purchases (MWh)} * LLMP (\$/\text{MWh})$
 - $\$26,250 = 375 \text{ MWh} * \$70/\text{MWh}$
- $\text{Sales} = \$0$
- $APC = \$8,750 + \$26,250 - \$0 = \$35,000$



APC BENEFIT (ZONE A)

- Measure of change in APC from base case (constraint binding) to change case (constraint relieved by upgrade)
- Zone A benefits from increased sales at a higher value than its production costs

Scenario	Production Cost	Purchases	Sales	APC
Base	\$1,400	\$6,500	\$0	\$7,900
Change	\$16,000	\$0	\$21,000	-\$5,000
			Benefit	\$12,900



APC BENEFIT (ZONE B)

- Measure of change in APC from base case (constraint binding) to change case (constraint relieved by upgrade)
- Zone B benefits from increased purchases at a lower cost than its production costs

Scenario	Production Cost	Purchases	Sales	APC
Base	\$34,300	\$880	\$0	\$35,180
Change	\$8,750	\$26,250	\$0	\$35,000
			Benefit	\$180

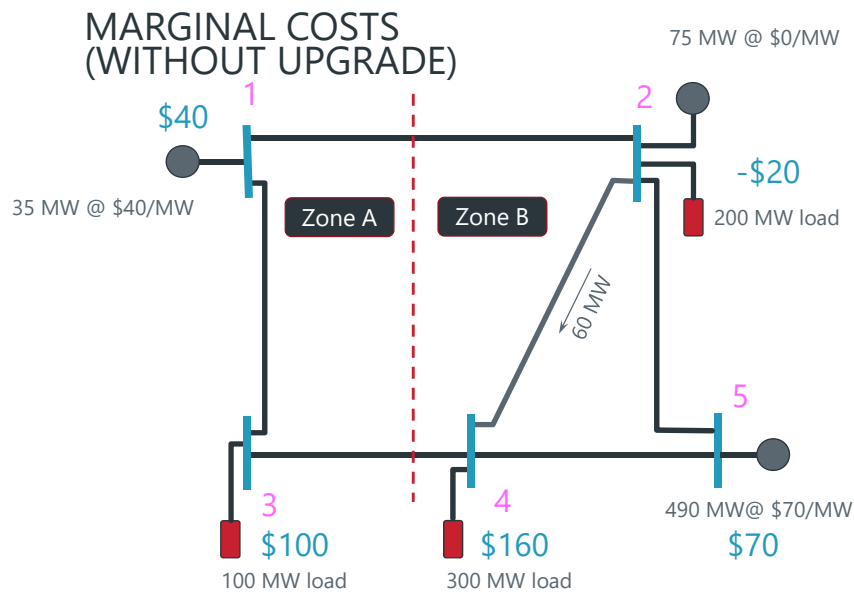
APC BENEFIT (REGIONAL)

- Measure of change in APC from base case (constraint binding) to change case (constraint relieved by upgrade)
- Region benefits from production costs being offset by lower cost purchases and increased sales revenues

Scenario	Production Cost	Purchases	Sales	APC
Base	\$35,700	\$7,380	\$0	\$43,080
Change	\$24,750	\$26,250	\$21,000	\$30,000
			Benefit	\$13,080

EXAMPLE: ASSIGNED WIND

- Start with previous example
- Add wind unit to Bus 2
- **Assign** wind unit to Zone B (e.g. PPA)
- Calculate APC for each zone for a single hour
- Calculate APC benefit of an upgrade for a single hour

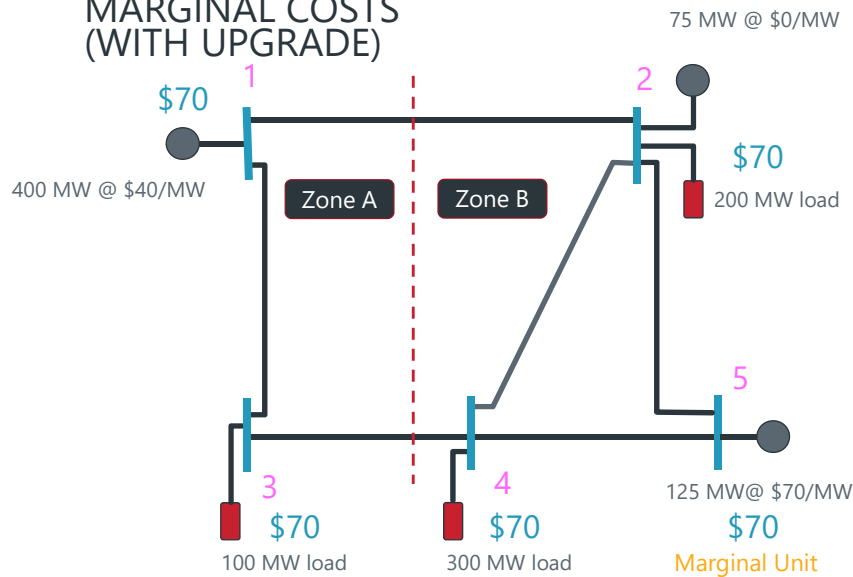


APC CALCULATION: ZONE B (WITHOUT UPGRADE)

- $APC = \text{Production Cost} + \text{Purchases} - \text{Sales}$
- $\text{Production Cost} = 490 \text{ MWh} * \$70/\text{MWh} + 75 \text{ MWh} * \$0/\text{MWh} = \$34,300$
- $\text{Purchases} = \$0$
- $\text{Sales (MWh)} = \text{Unit Generation} - \text{Area Native Load}$
- $65 \text{ MWh} = (490 \text{ MWh} + 75 \text{ MWh}) - (200 \text{ MWh} + 300 \text{ MWh})$
- $GLMP = \frac{(\$70/\text{MWh} * 490 \text{ MWh}) + (-\$20/\text{MWh} * 75 \text{ MWh})}{490 \text{ MWh} + 75 \text{ MWh}} = \$58/\text{MWh}$
- $\text{Sales (\$)} = \text{Sales (MWh)} * GLMP (\$/\text{MWh})$
- $\$3,770 = 65 \text{ MWh} * \$58/\text{MWh}$
- $APC = \$34,300 + \$0 - \$3,770 = \$30,530$



MARGINAL COSTS (WITH UPGRADE)



APC CALCULATION: ZONE B (WITH UPGRADE)

- $APC = \text{Production Cost} + \text{Purchases} - \text{Sales}$
- $\text{Production Cost} = 125 \text{ MWh} * \$70/\text{MWh} + 75 \text{ MWh} * \$0/\text{MWh} = \$8,750$
- $\text{Purchases (MWh)} = \text{Area Native Load} - \text{Unit Generation}$
 - $300 \text{ MWh} = (200 \text{ MWh} + 300 \text{ MWh}) - (125 \text{ MWh} + 75 \text{ MWh})$
- $LLMP = \frac{(\$70/\text{MWh} * 200 \text{ MWh}) + (\$70/\text{MWh} * 300 \text{ MWh})}{200 \text{ MWh} + 300 \text{ MWh}} = \$70/\text{MWh}$
- $\text{Purchases (\$)} = \text{Purchases (MWh)} * LLMP (\$/\text{MWh})$
 - $\$21,000 = 300 \text{ MWh} * \$70/\text{MWh}$
- $\text{Sales} = \$0$
- $APC = \$8,750 + \$21,000 - \$0 = \$29,750$



APC BENEFIT (ZONE B – ASSIGNED WIND)

- Measure of change in APC from base case (constraint binding) to change case (constraint relieved by upgrade)
- Zone B benefits from increased purchases at a lower cost than its production costs

Scenario	Production Cost	Purchases	Sales	APC
Base	\$34,300	\$0	\$3,770	\$30,530
Change	\$8,750	\$21,000	\$0	\$29,750
			Benefit	\$780



APC BENEFIT (REGIONAL)

- Measure of change in APC from base case (constraint binding) to change case (constraint relieved by upgrade)
- Region benefits from production costs being offset by lower cost purchases and increased sales revenues

Scenario	Production Cost	Purchases	Sales	APC
Base	\$35,700	\$6,500	\$3,770	\$38,430
Change	\$24,750	\$21,000	\$21,000	\$24,750
			Benefit	\$13,680