

Risks and Opportunities – Detailed Look at Option 3 DAM

October 29, 2007



- Includes both physical unit commitment and financial schedules
- Day-ahead physical unit commitment based on 24-hour optimized day-ahead resource multi-part offers/bids
- IESO forecasts default demand
- Two settlement system
- FTRs settled on DAM prices
- No day-ahead CMSC
- Production cost guarantee

- Two-settlement equation is the net of day ahead financial and real-time physical:
- $(DAUS \times DAP) + RTP (RTCS - DAUS)$

Where:

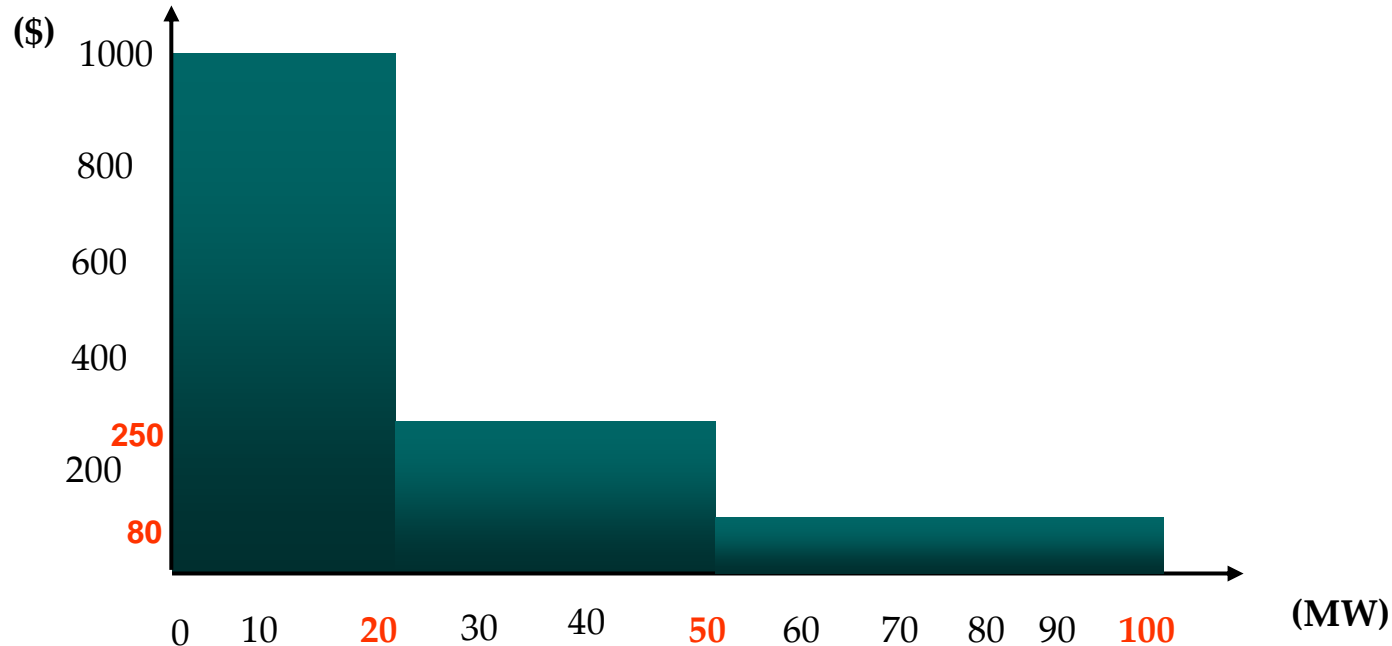
- DAP = DA Price
- DAUS = DA Unconstrained Schedule
- RTP = RT Price
- RTCS = RT Constrained Schedule

- Following examples illustrate that a two-settlement system with a real-time only CMSC regime does not pose any additional financial risks to dispatchable resources than what they would face under a two settlement DAM of one our neighbouring markets, assuming:
 - No change in bids, offers between DA and RT
- Other examples available in posted paper

- Illustrate the calculation of energy and CMSC settlement for dispatchable resources
- Based on the illustrations, compare consumer surplus for dispatchable load under:
 - Today's RT-only market
 - Option 3 for the DAM
 - Hypothetical DAM-only scenario

- Energy and CMSC settlements for Option 3 illustrated for a simple dispatchable load (i.e., no start-up costs or minimum load)
 - The day-ahead constrained schedule will not play a role in the examples, because energy settlements and CMSC do not depend on the day-ahead constrained schedule.
- For simplicity, illustrations will assume that resources' bid curves are the same for the DAM and the RTM and excludes any payments for Operating Reserve

- The following dispatchable load bid curve will be used in all of the examples:



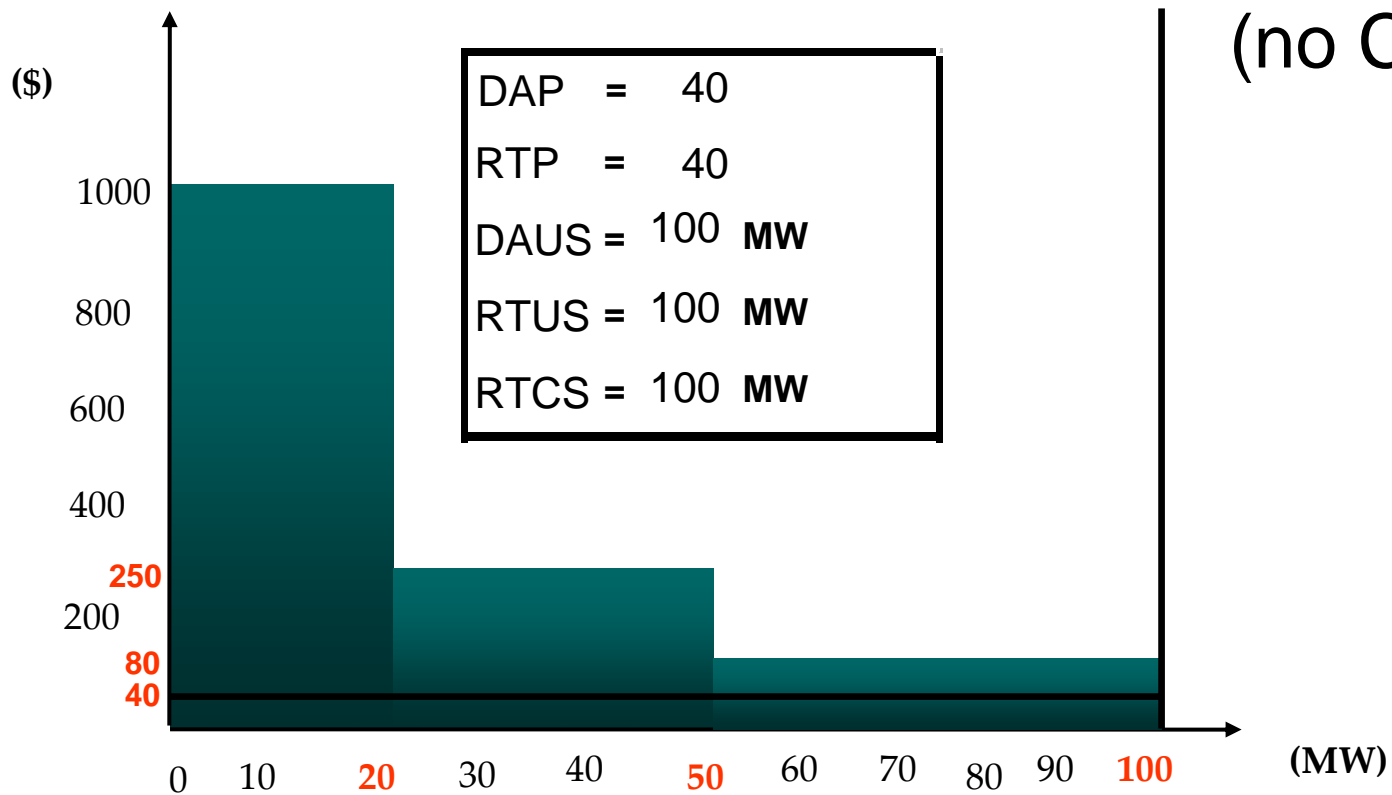
- All calculations of consumer surplus will be based on as-bid costs, which may or may not be equal to the load's actual costs.



Power to Ontario.
On Demand.

RTUS = RTCS

(no CMSC)



$$\text{DAUS} = \text{RTUS} = \text{RTCS}, \text{ RTP} = \text{DAP}$$

REAL-TIME SINGLE SETTLEMENT CONSUMER SURPLUS

$$\begin{aligned} \text{Consumer Surplus} &= \text{As-offered Cost of RTCS} + \text{CMSC} - \text{Energy Costs} \\ &= \$31,500 + \$0 - \$4,000 \\ &= \$27,500 \end{aligned}$$

$$\begin{aligned} \text{As-Offered Costs} &= \text{Sum of as-offered costs up to RTCS} \\ \text{For RTCS} &= \$1000 * 20\text{MW} + \$250 * 30 \text{ MW} + \$80 * 50\text{MW} \\ &= \$31,500 \end{aligned}$$

$$\begin{aligned} \text{CMSC} &= \text{Consumer Surplus for RTUS} - \text{Consumer Surplus for RTCS} \\ &= \$27,500 - \$27,500 \\ &= \$0 \end{aligned}$$

$$\begin{aligned} \text{Energy Costs} &= \text{RTP} * \text{RTCS} \\ &= \$40 * 100\text{MW} \\ &= \$4,000 \end{aligned}$$

$$\begin{aligned}\text{CMSC} &= \text{Consumer Surplus for RTUS} - \text{Consumer Surplus for RTCS} \\ &= \$27,500 - \$27,500 \\ &= \$0\end{aligned}$$

$$\begin{aligned}\text{Consumer Surplus RTUS} &= \text{RTP} * \text{RTUS} - (\text{Sum of as-offered costs up to RTUS}) \\ &= \$40 * 100\text{MW} - (\$1,000 * 20\text{MW} + \$250 * 30 \text{ MW} + \$80 * 50 \text{ MW}) \\ &= \$27,500\end{aligned}$$

$$\begin{aligned}\text{Consumer Surplus RTCS} &= \text{RTP} * \text{RTCS} - (\text{Sum of as-offered costs up to RTCS}) \\ &= \$40 * 100\text{MW} - (\$1,000 * 20\text{MW} + \$250 * 30 \text{ MW} + \$80 * 50 \text{ MW}) \\ &= \$27,500\end{aligned}$$

$$\text{DAUS} = \text{RTUS} = \text{RTCS}, \text{RTP} = \text{DAP}$$

TWO SETTLEMENT DAM Consumer Surplus

$$\begin{aligned} \text{Consumer Surplus} &= \text{As-offered Cost of RTCS} + \text{CMSC} - \text{Energy Costs} \\ &= \$31,500 + \$0 - \$4,000 \\ &= \$27,500 \end{aligned}$$

$$\begin{aligned} \text{As-Offered Costs} &= \text{Sum of as-offered costs up to RTCS} \\ \text{For RTCS} &= \$1000 * 20\text{MW} + \$250 * 30 \text{ MW} + \$80 * 50 \text{ MW} \\ &= \$31,500 \end{aligned}$$

$$\begin{aligned} \text{CMSC} &= \text{Consumer Surplus for RTUS} - \text{Consumer Surplus for RTCS} \\ &= \$27,000 - \$27,500 \\ &= \$0 \end{aligned}$$

$$\begin{aligned} \text{Energy Costs} &= \text{DAP} * \text{DAUS} + \text{RTP} * (\text{RTCS} - \text{DAUS}) \\ &= \$40 * 100\text{MW} + \$40 * (100\text{MW} - 100\text{MW}) \\ &= \$4,000 \end{aligned}$$

DAM- ONLY Consumer Surplus

$$\begin{aligned}\text{Consumer Surplus} &= \text{As-offered Cost of DAUS} - \text{Energy Costs} \\ &= \$31,500 - \$4,000 \\ &= \$27,500\end{aligned}$$

$$\begin{aligned}\text{As-Offered Costs For DAUS} &= \text{Sum of as-offered costs up to DAUS} \\ &= \$1000 * 20\text{MW} + \$250 * 30 \text{MW} + \$80 * 50 \text{MW} \\ &= \$31,500\end{aligned}$$

$$\begin{aligned}\text{Energy Costs} &= \text{DAP} * \text{DAUS} \\ &= \$40 * 100\text{MW} \\ &= \$4,000\end{aligned}$$

$$\text{DAUS} = \text{RTUS} = \text{RTCS}, \text{ RTP} = \text{DAP}$$

REAL-TIME SINGLE SETTLEMENT Consumer Surplus

$$\begin{aligned} \text{Consumer Surplus} &= \text{As-offered Cost of RTCS} + \text{CMSC} - \text{Energy Costs} \\ &= \$31,500 + \$0 - \$4,000 \\ &= \$27,500 \end{aligned}$$

TWO SETTLEMENT DAM Consumer Surplus

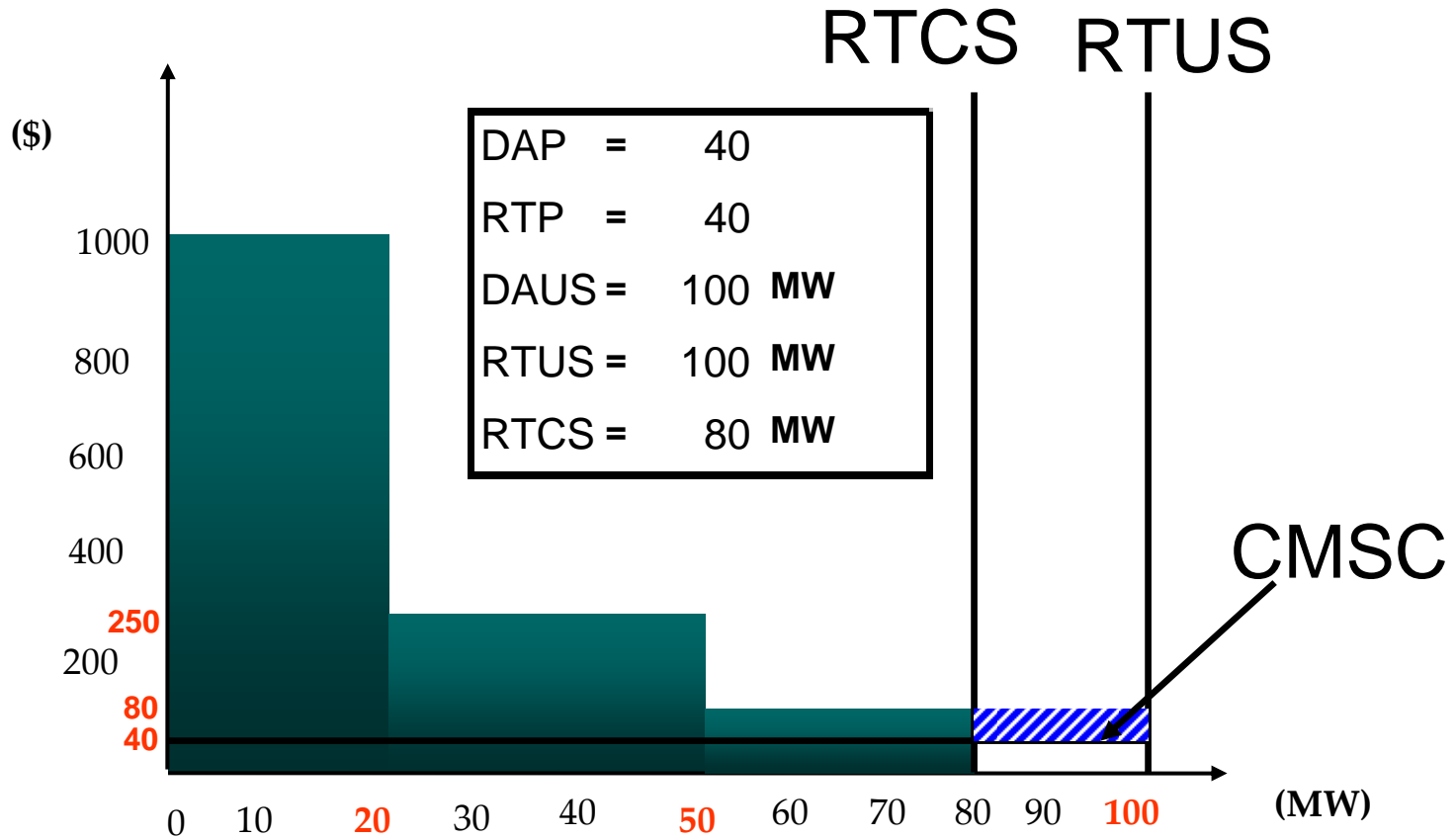
$$\begin{aligned} \text{Consumer Surplus} &= \text{As-offered Cost of RTCS} + \text{CMSC} - \text{Energy Costs} \\ &= \$31,500 + \$0 - \$4,000 \\ &= \$27,500 \end{aligned}$$

DAM-ONLY Consumer Surplus

$$\begin{aligned} \text{Consumer Surplus} &= \text{As-offered Cost of RTCS} - \text{Energy Costs} \\ &= \$31,500 - \$4,000 \\ &= \$27,500 \end{aligned}$$

DAUS = RTUS=RTCS, RTP=DAP

- Since all schedules and prices are the same, consumer surplus' are all equal.



REAL-TIME SINGLE SETTLEMENT Consumer Surplus

$$\begin{aligned}\text{Consumer Surplus} &= \text{As-offered Cost of RTCS} + \text{CMSC} - \text{Energy Costs} \\ &= \$29,900 + \$800 - \$3,200 \\ &= \$27,500\end{aligned}$$

$$\begin{aligned}\text{As-Offered Costs} &= \text{Sum of as-offered costs up to RTCS} \\ \text{For RTCS} &= \$1000 * 20\text{MW} + \$250 * 30 \text{MW} + \$80 * 30\text{MW} \\ &= \$29,900\end{aligned}$$

$$\begin{aligned}\text{CMSC} &= \text{Consumer Surplus for RTUS} - \text{Consumer Surplus for RTCS} \\ &= \$27,500 - \$26,700 \\ &= \$800\end{aligned}$$

$$\begin{aligned}\text{Energy Costs} &= \text{RTP} * \text{RTCS} \\ &= \$40 * 80\text{MW} \\ &= \$3,200\end{aligned}$$

$$\begin{aligned}\text{CMSC} &= \text{Consumer Surplus for RTUS} - \text{Consumer Surplus for RTCS} \\ &= \$27,500 - 26,700 \\ &= \$800\end{aligned}$$

Consumer Surplus

$$\begin{aligned}\text{RTUS} &= \text{RTP} * \text{RTUS} - (\text{Sum of as-offered costs up to RTUS}) \\ &= \$40 * 100\text{MW} - (\$1000 * 20\text{MW} + \$250 * 30 \text{MW} + \$80 * 50 \text{MW}) \\ &= \$27,500\end{aligned}$$

Consumer Surplus

$$\begin{aligned}\text{RTCS} &= \text{RTP} * \text{RTCS} - (\text{Sum of as-offered costs up to RTCS}) \\ &= \$40 * 80\text{MW} - (\$1000 * 20\text{MW} + \$250 * 30 \text{MW} + \$80 * 30 \text{MW}) \\ &= \$26,700\end{aligned}$$

TWO SETTLEMENT DAM Consumer Surplus

$$\begin{aligned}
 \text{Consumer Surplus} &= \text{As-offered Cost of RTCS} + \text{CMSC} - \text{Energy Costs} \\
 &= \$29,900 + \$800 - \$3,200 \\
 &= \$27,500
 \end{aligned}$$

$$\begin{aligned}
 \text{As-Offered Costs} &= \text{Sum of as-offered costs up to RTCS} \\
 \text{For RTCS} &= \$1000 * 20\text{MW} + \$250 * 30 \text{ MW} + \$80 * 30 \text{ MW} \\
 &= \$29,900
 \end{aligned}$$

$$\begin{aligned}
 \text{CMSC} &= \text{Consumer Surplus for RTUS} - \text{Consumer Surplus for RTCS} \\
 &= \$27,500 - \$26,700 \\
 &= \$800
 \end{aligned}$$

$$\begin{aligned}
 \text{Energy Costs} &= \text{DAP} * \text{DAUS} + \text{RTP} * (\text{RTCS} - \text{DAUS}) \\
 &= \$40 * 100\text{MW} + \$40 * (80\text{MW} - 100\text{MW}) \\
 &= \$3,200
 \end{aligned}$$

DAM- ONLY Consumer Surplus

$$\begin{aligned}\text{Consumer Surplus} &= \text{As-offered Cost of DAUS} - \text{Energy Costs} \\ &= \$31,500 - \$4,000 \\ &= \$27,500\end{aligned}$$

$$\begin{aligned}\text{As-Offered Costs For DAUS} &= \text{Sum of as-offered costs up to DAUS} \\ &= \$1000 * 20\text{MW} + \$250 * 30 \text{MW} + \$80 * 50 \text{MW} \\ &= \$31,500\end{aligned}$$

$$\begin{aligned}\text{Energy Costs} &= \text{DAP} * \text{DAUS} \\ &= \$40 * 100\text{MW} \\ &= \$4,000\end{aligned}$$

REAL-TIME SINGLE SETTLEMENT Consumer Surplus

$$\begin{aligned}\text{Consumer Surplus} &= \text{As-offered Cost of RTCS} + \text{CMSC} - \text{Energy Costs} \\ &= \$29,900 + \$0 - \$3,200 \\ &= \$27,500\end{aligned}$$

TWO SETTLEMENT DAM Consumer Surplus

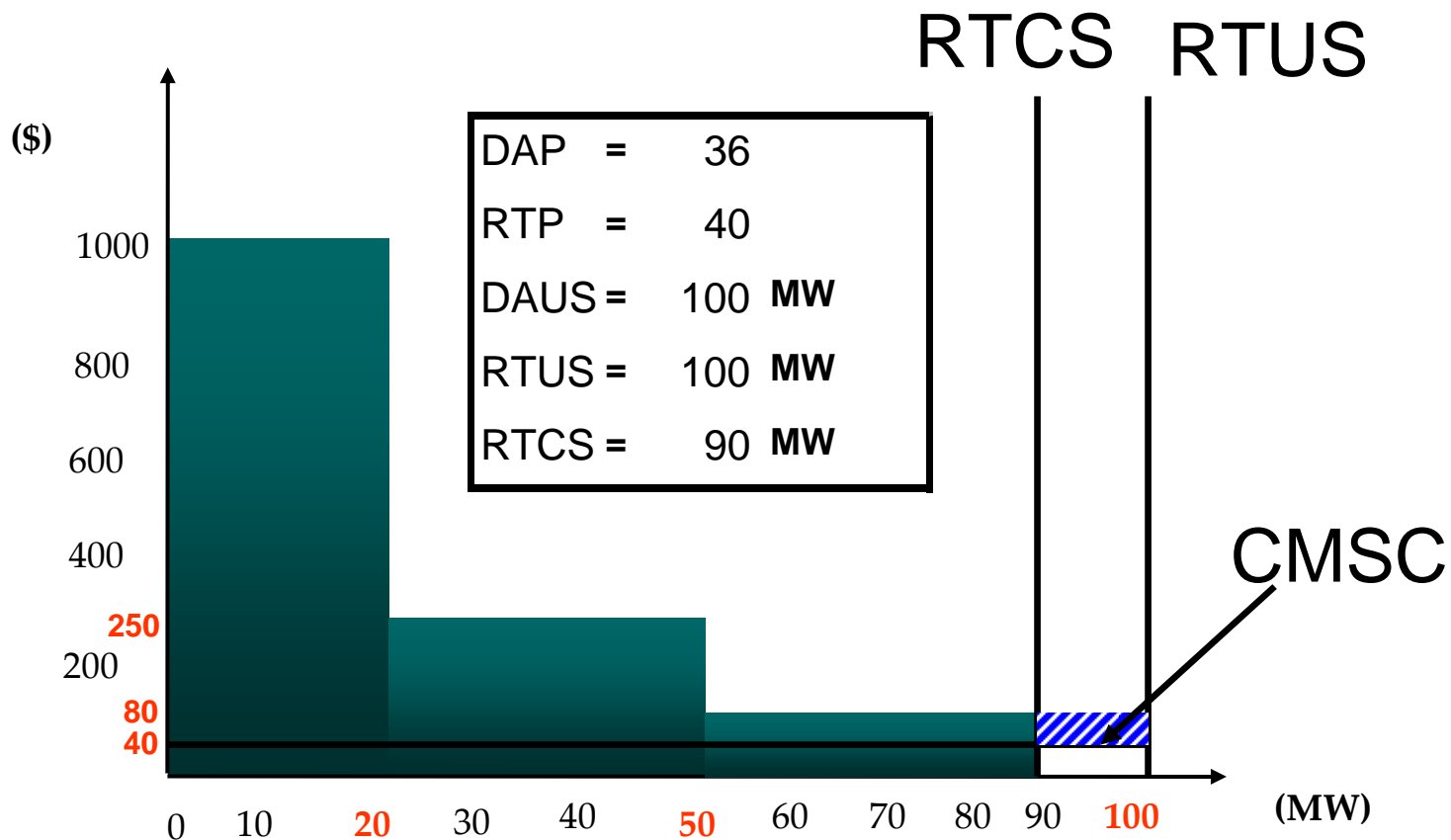
$$\begin{aligned}\text{Consumer Surplus} &= \text{As-offered Cost of RTCS} + \text{CMSC} - \text{Energy Costs} \\ &= \$29,900 + \$800 - \$3,200 \\ &= \$27,500\end{aligned}$$

DAM-ONLY Consumer Surplus

$$\begin{aligned}\text{Consumer Surplus} &= \text{As-offered Cost of RTCS} - \text{Energy Costs} \\ &= \$31,500 - \$4,000 \\ &= \$27,500\end{aligned}$$

$$\text{DAUS} = \text{RTUS} > \text{RTCS}, \text{ RTP} = \text{DAP}$$

- One and two-settlement consumer surplus are the same since the DA and RT prices are equal.
- The cost of buying out the 20 MW of unconsumed DA position is offset by the CMSC.
- DAM-only consumer surplus equals two-settlement consumer surplus as long as $\text{RTUS} = \text{DAUS}$.



REAL-TIME SINGLE SETTLEMENT Consumer Surplus

$$\begin{aligned}\text{Consumer Surplus} &= \text{As-offered Cost of RTCS} + \text{CMSC} - \text{Energy Costs} \\ &= \$30,700 + \$400 - \$3,600 \\ &= \$27,500\end{aligned}$$

TWO SETTLEMENT DAM Consumer Surplus

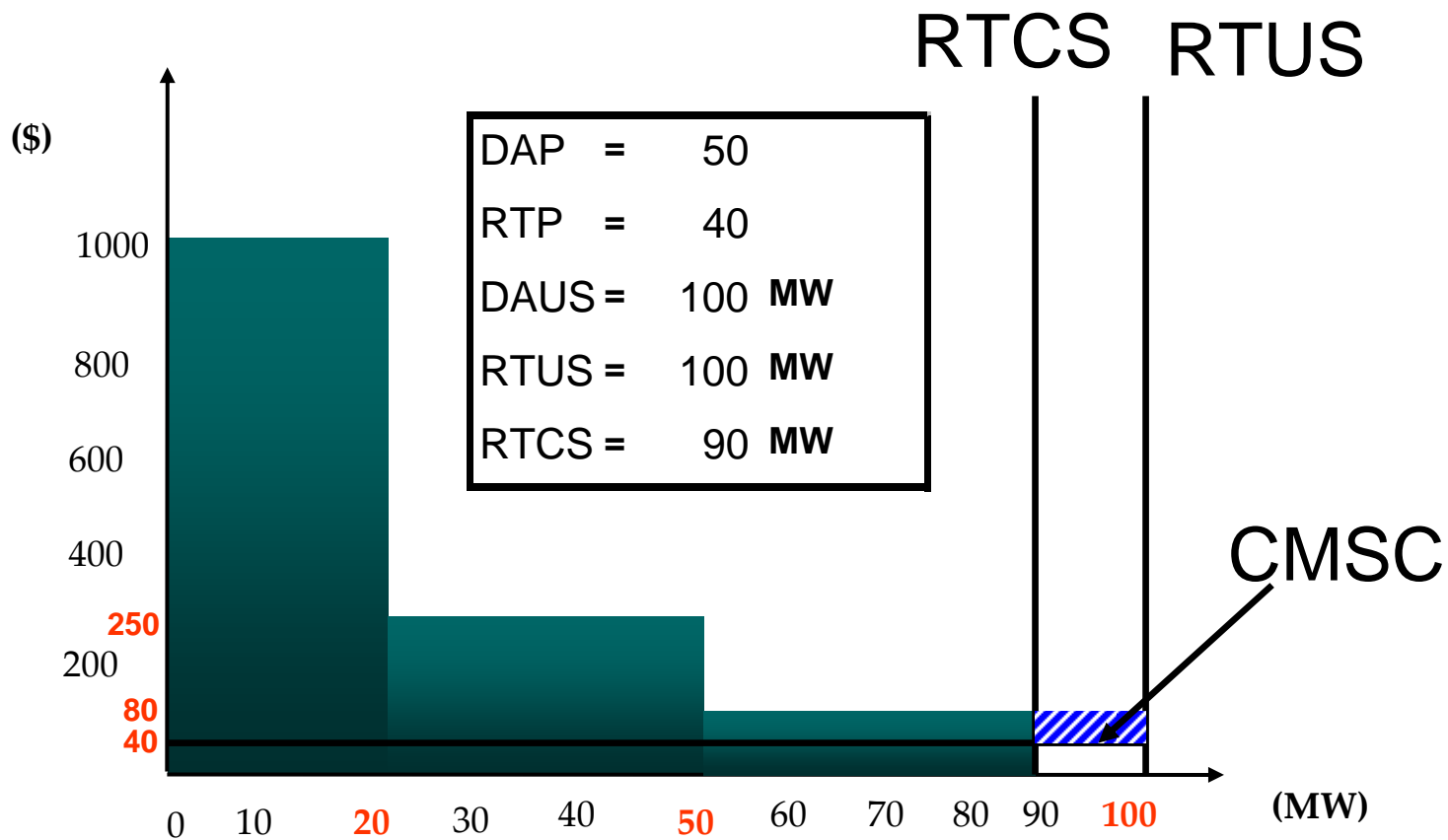
$$\begin{aligned}\text{Consumer Surplus} &= \text{As-offered Cost of RTCS} + \text{CMSC} - \text{Energy Costs} \\ &= \$30,700 + \$400 - \$3,200 \\ &= \$27,900\end{aligned}$$

DAM-ONLY Consumer Surplus

$$\begin{aligned}\text{Consumer Surplus} &= \text{As-offered Cost of RTCS} - \text{Energy Costs} \\ &= \$31,500 - \$3,600 \\ &= \$27,900\end{aligned}$$

$$\text{DAUS} = \text{RTUS} > \text{RTCS}, \text{RTP} > \text{DAP}$$

- Again, the cost of buying out the unconsumed 10 MW of DA position in RT is offset by the CMSC payment.
- Single-settlement only model results in \$400 less surplus than the two-settlement model because the RT price is \$4 higher than the DA price.
- DAM-only Consumer Surplus equals two-settlement Consumer Surplus as long as $\text{RTUS} = \text{DAUS}$.



$$\text{DAUS} = \text{RTUS} > \text{RTCS}, \text{ RTP} < \text{DAP}$$

REAL-TIME SINGLE SETTLEMENT Consumer Surplus

$$\begin{aligned} \text{Consumer Surplus} &= \text{As-offered Cost of RTCS} + \text{CMSC} - \text{Energy Costs} \\ &= \$30,700 + \$400 - \$3,600 \\ &= \$27,500 \end{aligned}$$

TWO SETTLEMENT DAM Consumer Surplus

$$\begin{aligned} \text{Consumer Surplus} &= \text{As-offered Cost of RTCS} + \text{CMSC} - \text{Energy Costs} \\ &= \$30,700 + \$400 - \$4,600 \\ &= \$26,500 \end{aligned}$$

DAM-ONLY Consumer Surplus

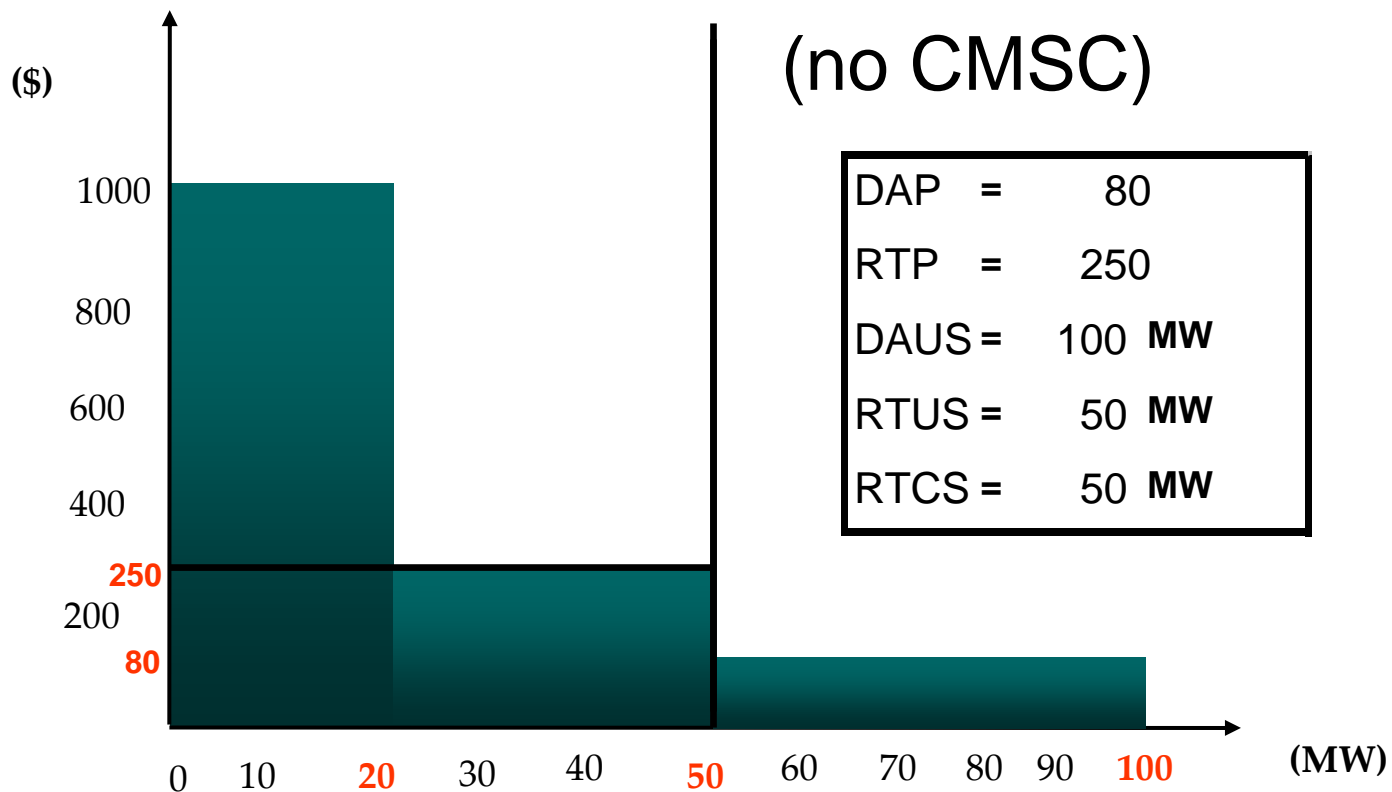
$$\begin{aligned} \text{Consumer Surplus} &= \text{As-offered Cost of RTCS} - \text{Energy Costs} \\ &= \$31,500 - \$5,000 \\ &= \$26,500 \end{aligned}$$

$$\text{DAUS} = \text{RTUS} > \text{RTCS}, \text{ RTP} < \text{DAP}$$

- Again, the cost of buying out the unconsumed 20 MW of DA position in RT is offset by the CMSC payment.
- The single-settlement results in \$1,000 more surplus than the two-settlement model because the RT price is \$10 lower than the DA price.
- DAM-only consumer surplus equals two-settlement consumer surplus as long as $\text{RTUS} = \text{DAUS}$.

RTUS = RTCS

(no CMSC)



REAL-TIME SINGLE SETTLEMENT Consumer Surplus

$$\begin{aligned}\text{Consumer Surplus} &= \text{As-offered Cost of RTCS} + \text{CMSC} - \text{Energy Costs} \\ &= \$27,500 + \$0 - \$12,500 \\ &= \$15,000\end{aligned}$$

TWO SETTLEMENT DAM Consumer Surplus

$$\begin{aligned}\text{Consumer Surplus} &= \text{As-offered Cost of RTCS} + \text{CMSC} - \text{Energy Costs} \\ &= \$27,500 + \$0 - (-\$4,500) \\ &= \$32,000\end{aligned}$$

DAM-ONLY Consumer Surplus

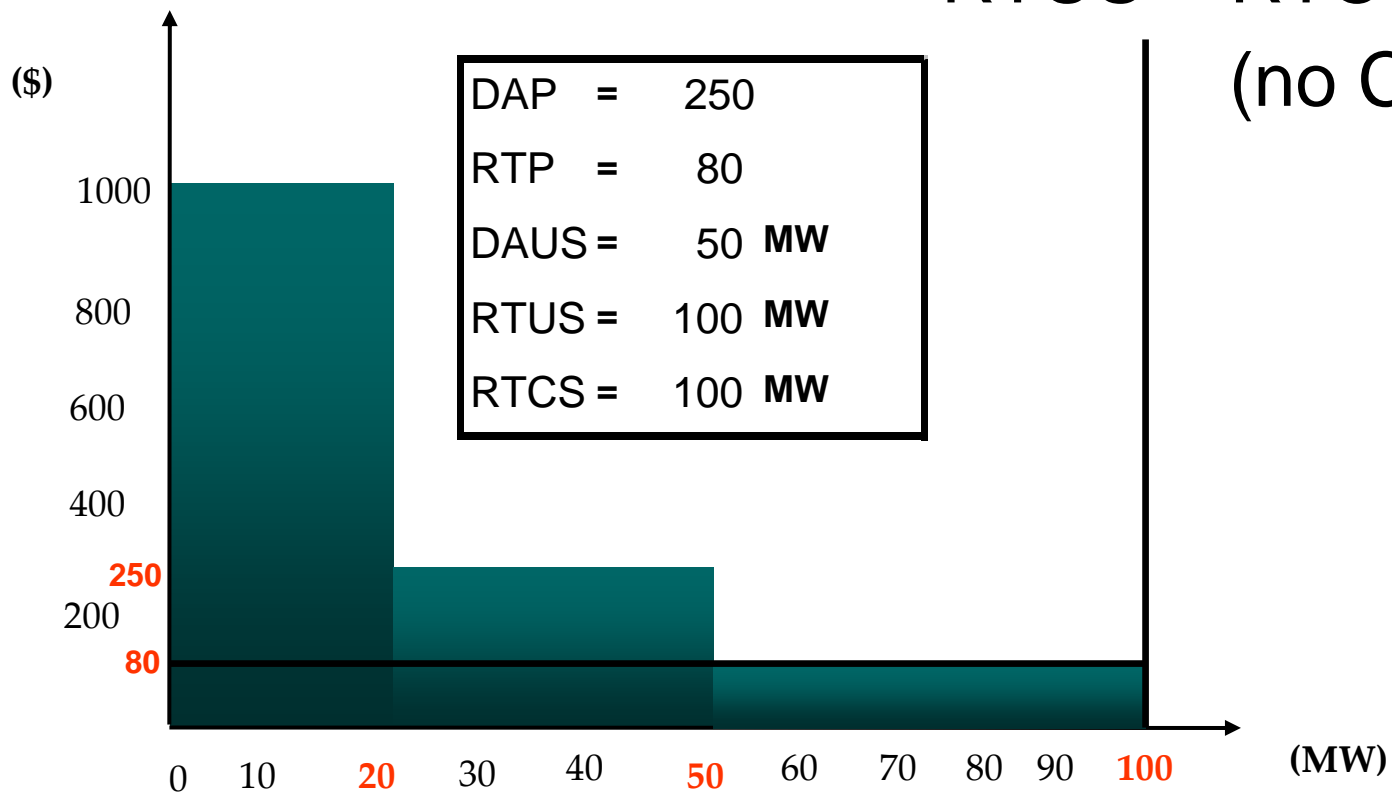
$$\begin{aligned}\text{Consumer Surplus} &= \text{As-offered Cost of RTCS} - \text{Energy Costs} \\ &= \$31,500 - \$8,000 \\ &= \$23,500\end{aligned}$$

DAUS > RTUS=RTCS, RTP > DAP

- The cost of buying out the unconsumed 50 MW of DA position in RT is offset by the savings from only consuming 50 MW rather than the DAUS of 100 MW.
- The surplus under the two-settlement model is higher than the single-settlement only model because RT price is higher than DA price.
- DAM-only consumer surplus is \$8,500 less than the two-settlement surplus because this hypothetical situation would have the dispatchable load consume 100 MW at its as-offered cost of \$80, rather than buying out of their position, earning \$170/MW by not consuming the extra 50 MW that are less desirable with the higher RT price.

RTUS = RTCS

(no CMSC)



REAL-TIME SINGLE SETTLEMENT Consumer Surplus

$$\begin{aligned}\text{Consumer Surplus} &= \text{As-offered Cost of RTCS} + \text{CMSC} - \text{Energy Costs} \\ &= \$31,500 + \$0 - \$8,000 \\ &= \$23,500\end{aligned}$$

TWO SETTLEMENT DAM Consumer Surplus

$$\begin{aligned}\text{Consumer Surplus} &= \text{As-offered Cost of RTCS} + \text{CMSC} - \text{Energy Costs} \\ &= \$31,500 + \$0 - \$16,500 \\ &= \$15,000\end{aligned}$$

DAM-ONLY Consumer Surplus

$$\begin{aligned}\text{Consumer Surplus} &= \text{As-offered Cost of RTCS} - \text{Energy Costs} \\ &= \$27,500 - \$12,500 \\ &= \$15,000\end{aligned}$$

$$\text{DAUS} < \text{RTUS} = \text{RTCS}, \text{ RTP} < \text{DAP}$$

- The surplus under the single-settlement only model is higher than the two-settlement model because the RT price is lower than DA price.
- DAM-only consumer surplus is \$8,500 less than the single-settlement surplus because under this hypothetical case the load consumes only 50 MW, foregoing a opportunity to consume an extra 50 MW with the lower RT price.

What These Examples Illustrate

- Two-settlement system with a real-time only CMSC regime does not pose any additional financial risks to dispatchable resources than what they would face under a two settlement DAM of one our neighbouring markets
- Participants are made financially better off by maintaining operating flexibility in the real-time market
- Profits from being available for real-time dispatch in a two-settlement system are exactly the same as the profits from being available for dispatch in the current real-time only system.

Questions