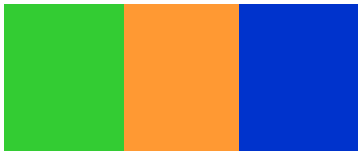
# NYISO 2005 Demand Response Program Evaluation Results



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**12/12/05**

# Overview

- Participation Statistics
- EDRP/SCR Reliability Benefits
- Changes in Methodology for 2005 Evaluation
  - Supply Curve functional form
- Supply Function Estimates
  - Supply flexibilities
- Market Benefits Estimates
  - Electricity Market Bill Savings
  - Bilateral Market Bill Savings
  - Social Welfare Improvements
  - System Reliability Improvements
- DADRP Bid Analysis
- Conclusions and Recommendations

# SCR Program Detail

| Resource Type | ICAP | | | ICAP UnSold | | |
|---|---|---|---|---|---|---|
| | # SCRs | # Participants | Sold MW | # SCRs | # Participants | Subscribed MW |
| Individual Resources | 144 | 144 | 495 | 5 | 5 | 11.8 |
| Aggregated Resources | 59 | 1638 | 588.3 | 0 | 0 | 0.0 |
| **Total** | **203** | **1782** | **1083.3** | **5** | **5** | **11.8** |

# Program Summary by Agent Type

| Agent Type | EDRP [1] | | | ICAP UnSold [2] | | | ICAP [3] | | | DADRP [4] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | # CSP | # Part. | MW | # RIP | # Part. | MW | # RIP | # Part. | MW | # DRP | # Part. | MW |
| Aggregator | 3 | 5 | 19.5 | 2 | 2 | 2.6 | 11 | 1591 | 523.8 | 0 | 0 | 0.0 |
| Curtailment Program End-Use Customer | 0 | 0 | 0.0 | 0 | 0 | 0.0 | 2 | 3 | 144.0 | 0 | 0 | 0.0 |
| Direct Customer | 0 | 0 | 0.0 | 0 | 0 | 0.0 | 1 | 2 | 2.6 | 0 | 0 | 0.0 |
| LSE | 1 | 1 | 0.3 | 2 | 2 | 8.7 | 6 | 146 | 255.9 | 4 | 4 | 32.5 |
| Transmission Owner | 7 | 951 | 557.9 | 1 | 1 | 0.5 | 3 | 40 | 157.5 | 4 | 14 | 353.4 |
| **Total** | **11** | **957** | **577.6** | **5** | **5** | **11.8** | **23** | **1782** | **1083.8** | **8** | **18** | **385.9** |

Note 1: The sum of EDRP and ICAP UnSold = Total EDRP.

Note 2: Participants in the ICAP program with UnSold capacity are considered as EDRP resources in the month(s) that capacity is unsold. MW represent reductions registered in the ICAP program, but not sold.

Note 3: MW represent reduction MW sold in the ICAP program.

Note 4: Total NYISO participation is not necessarily the sum of all programs due to the rules that state that participants are allowed to participate in a reliability program (EDRP or ICAP) and economic (DADRP).

# 2005 Program Participation by Zone

| Zone | EDRP [1] | | ICAP UnSold [2] | | ICAP [3] | | DADRP [4] | |
|---|---|---|---|---|---|---|---|---|
| | # | MW | # | MW | # | MW | # | MW |
| A | 25 | 34.8 | 0 | 0.0 | 133 | 333.1 | 4 | 138.0 |
| B | 11 | 6.4 | 1 | 0.3 | 31 | 67.0 | 0 | 0.0 |
| C | 85 | 29.3 | 0 | 0.0 | 46 | 86.7 | 2 | 37.4 |
| D | 13 | 105.0 | 0 | 0.0 | 5 | 85.1 | 1 | 100.0 |
| E | 49 | 50.8 | 0 | 0.0 | 21 | 16.9 | 1 | 10.0 |
| F | 43 | 43.8 | 1 | 8.4 | 21 | 61.9 | 7 | 84.0 |
| G | 24 | 34.4 | 1 | 2.0 | 3 | 2.4 | 0 | 0.0 |
| H | 9 | 6.8 | 0 | 0.0 | 1 | 0.7 | 0 | 0.0 |
| I | 19 | 7.5 | 0 | 0.0 | 18 | 12.2 | 1 | 2.0 |
| J | 116 | 132.1 | 2 | 1.1 | 1358 | 300.4 | 1 | 2.5 |
| K | 563 | 126.8 | 0 | 0.0 | 145 | 117.4 | 1 | 12.0 |
| **Total** | **957** | **577.6** | **5** | **11.8** | **1782** | **1083.8** | **18** | **385.9** |

Note 1: The sum of EDRP and ICAP UnSold = Total EDRP.

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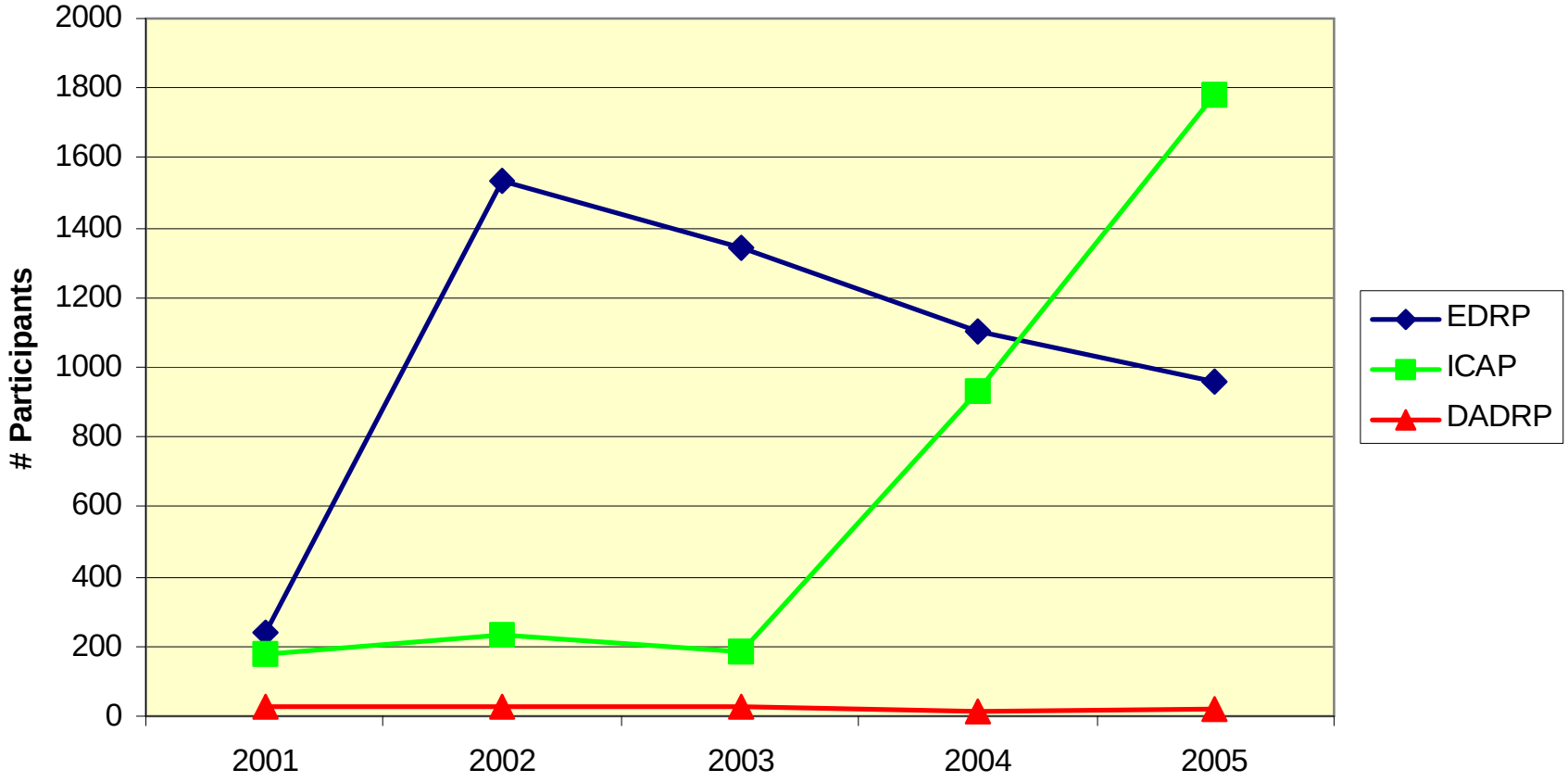
# Program Enrollment Changes 2004 to 2005 (Number of Participants)

| | 2004 | | 2005 | | Percent Change From 2004 to 2005 | | Subscribed MW per Participant | | |
|---|---|---|---|---|---|---|---|---|---|
| | Count | MW | Count | MW | Participant Count | Subscribed MW | 2004 | 2005 | Percent Change |
| **EDRP** | 1097 | 570.7 | 957 | 577.6 | -13% | 1% | 0.52 | 0.60 | 16% |
| **ICAP UnSold** | 29 | 5.3 | 5 | 11.8 | -83% | 123% | 0.18 | 2.36 | 1191% |
| **ICAP** | 933 | 980.8 | 1782 | 1083.3 | 91% | 10% | 1.05 | 0.61 | -42% |
| **DADRP** | 17 | 376.9 | 18 | 385.9 | 6% | 2% | 22.17 | 21.44 | -3% |

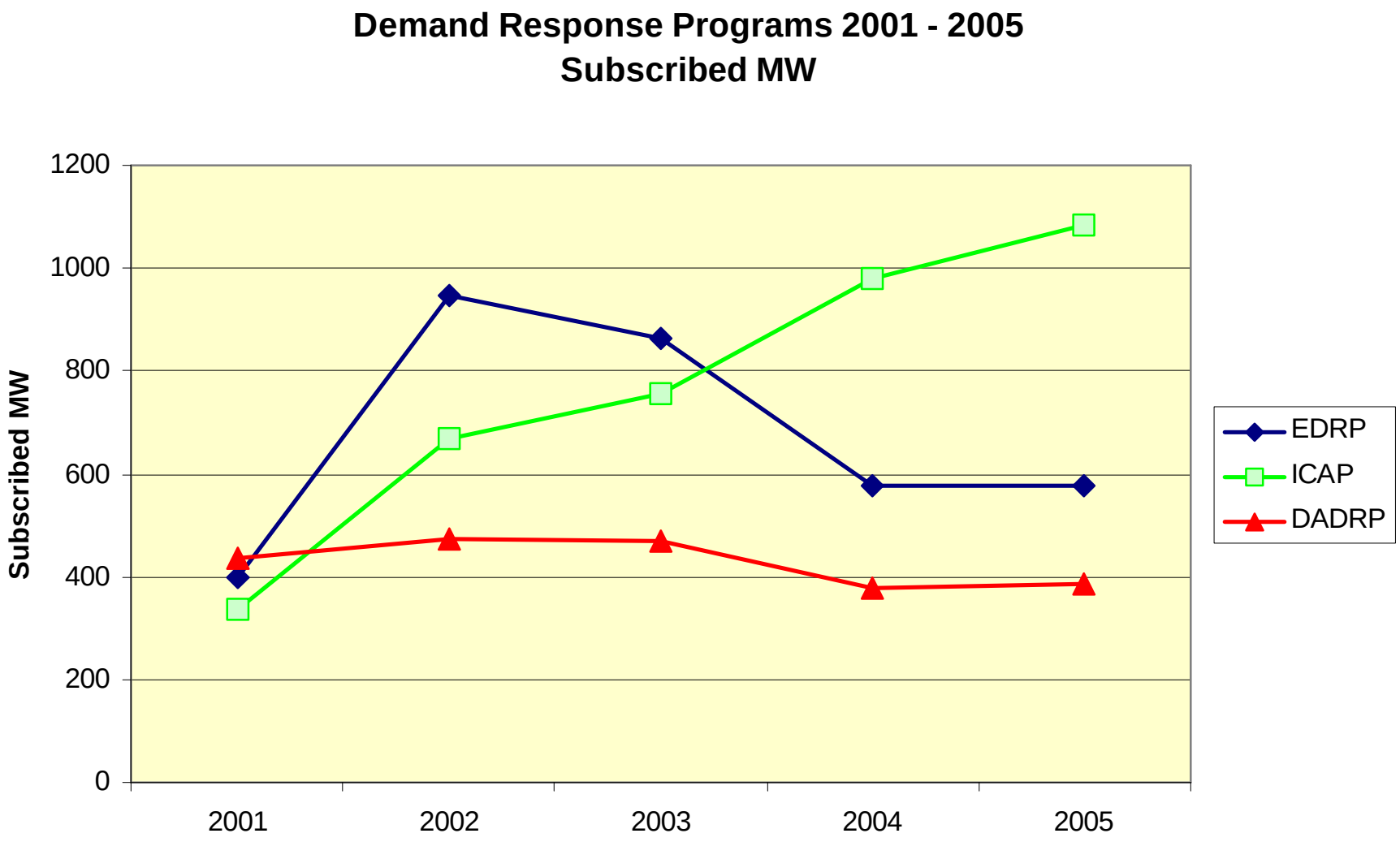
# Program Participation by Number of Participants 2001 - 2005

## Demand Response Programs 2001 - 2005
## Individual Participants

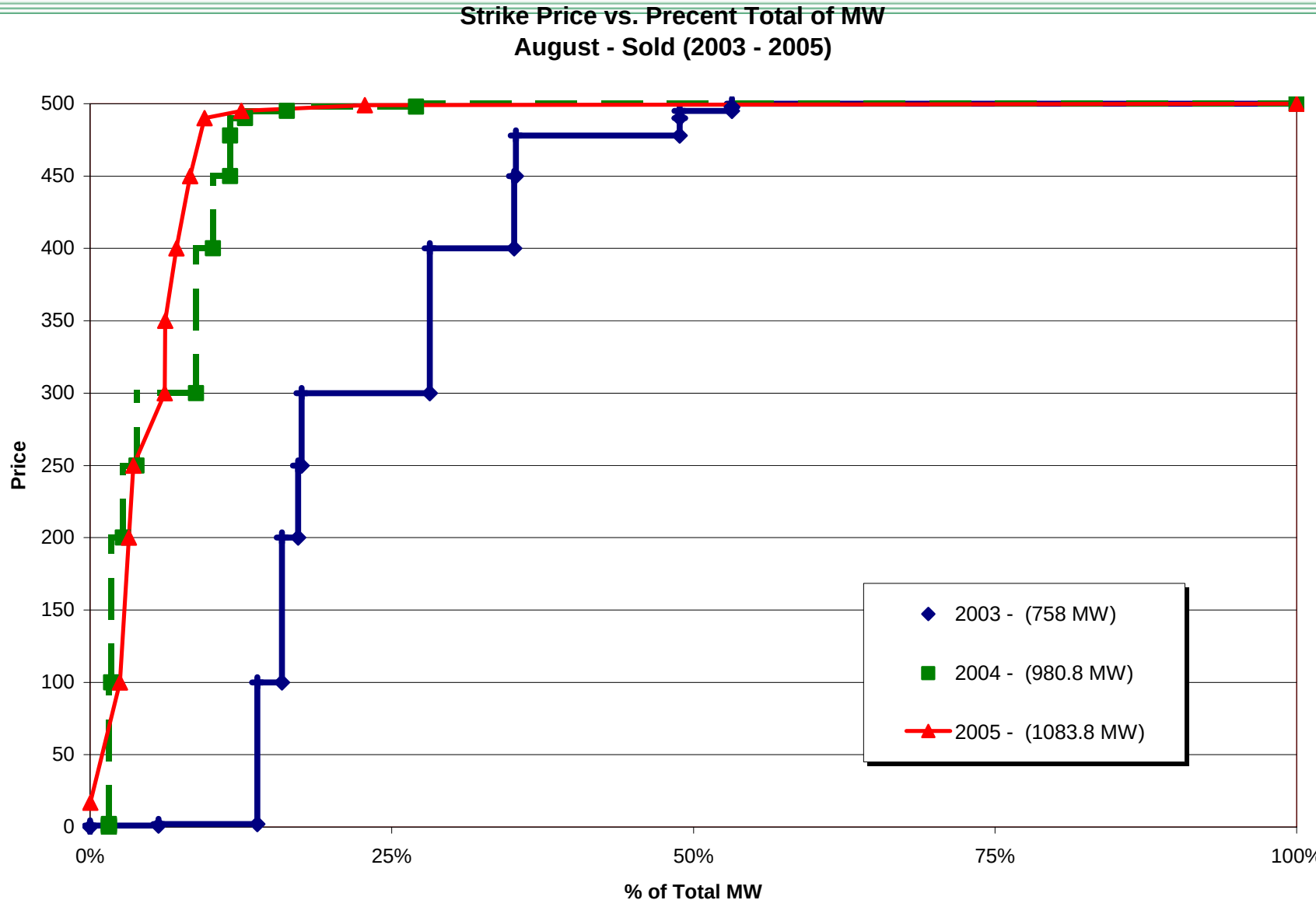
**ICAP participants aggregated 2001 - 2003. Disaggregation of ICAP resources began in 2004**



# Program Participation MW
# 2001 - 2005



# 2003, 2004 & 2005 ICAP-SCR Curtailment Bid Curves

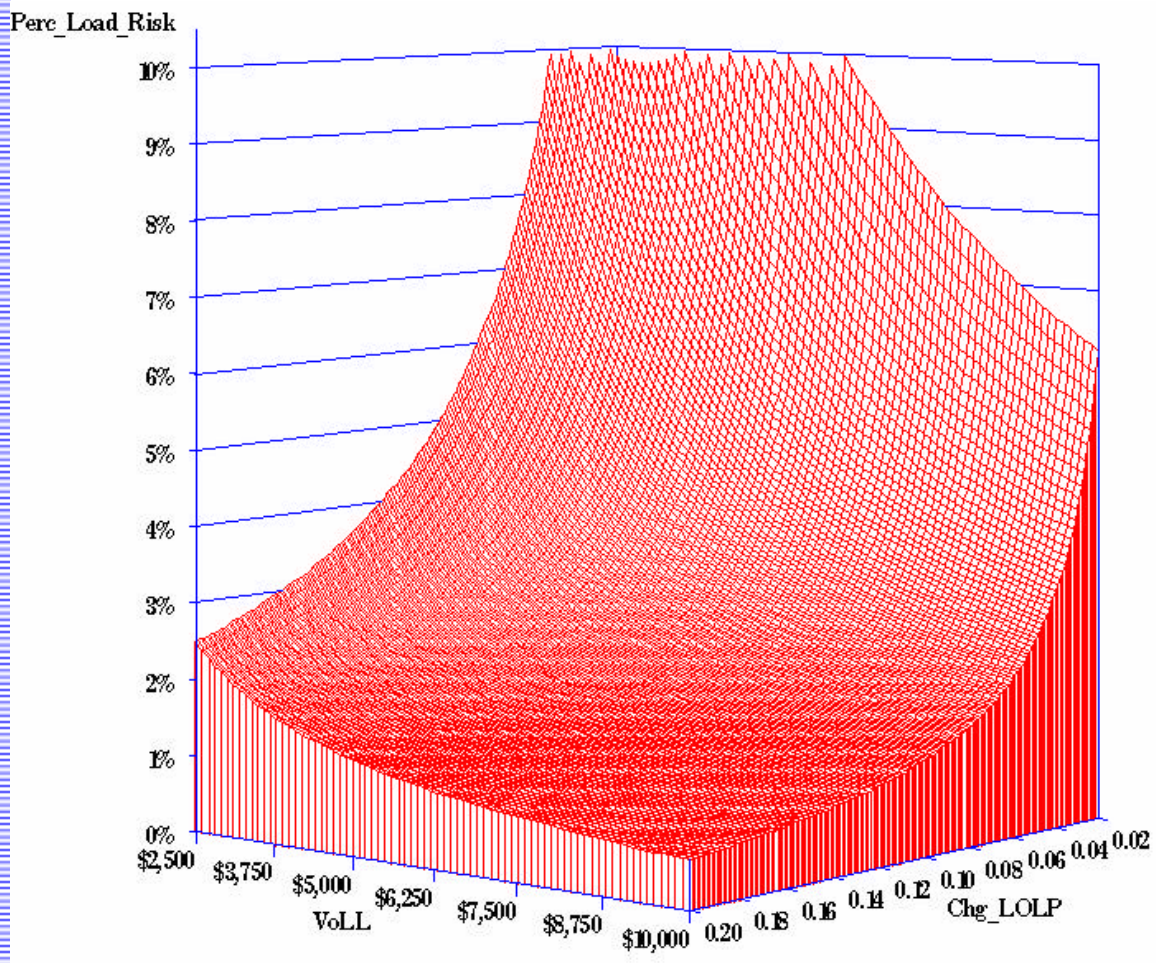


# EDRP/SCR Reliability Benefits
## Value of Expected Unserved Energy (VEUE)

**VEUE = VoLL * (? LOLP) * (Load @ Risk)**

- Places monetary value on the improvement in system reliability due to reductions in demand
- Estimates use a wide range of values for the inputs, since they are all unknown with certainty
  - Value of lost load (VoLL)
    - $2,500/MWh - $10,000/MWh
  - Change in loss of load probability (? LOLP)
    - 0.01 – 0.20
  - Load at risk of an outage (Load @ Risk)
    - 1% - 10% of zonal RTM load

# EDRP/SCR
## Estimated Reliability Benefits




- Total NYISO payments are roughly $815,000
- Surface represents reliability benefits equated to payments
- Any point above surface represents points where benefits exceed payments
- Can see trade-off between VoLL, ?LOLP, and % Load @ Risk

# EDRP/SCR
## Estimated Reliability Benefits (5% Load @ Risk)

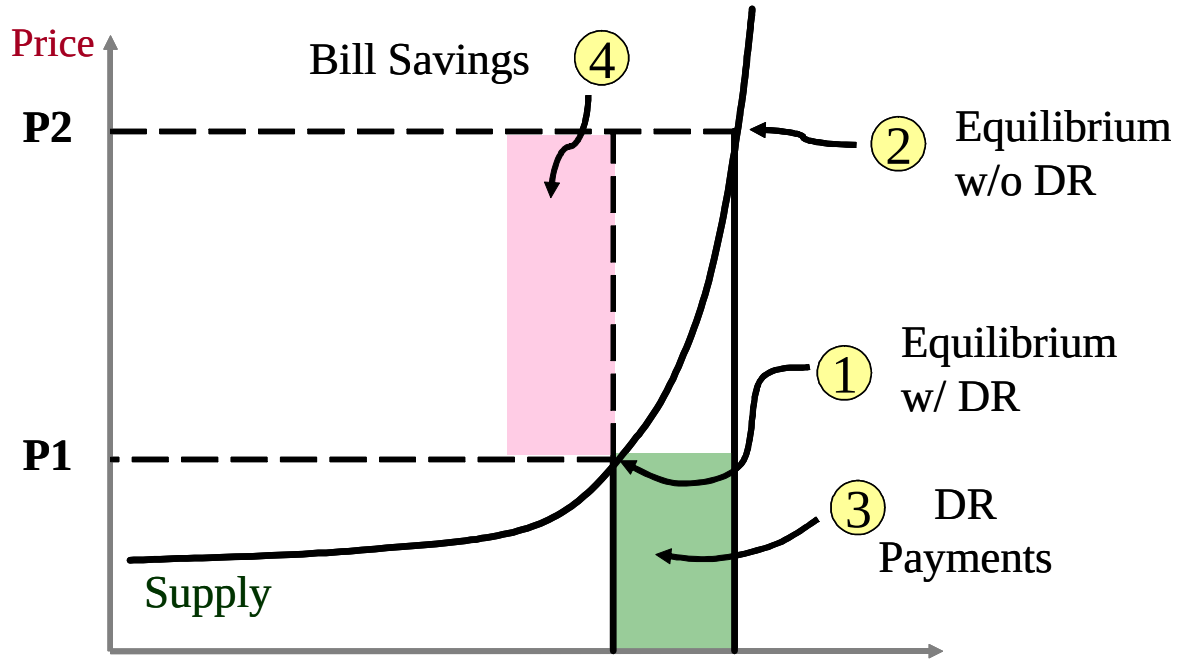
| Change in LOLP | Outage Cost | | | |
|---|---|---|---|---|
| | $2,500/MWh | $5,000/MWh | $7,500/MWh | $10,000/MWh |
| 0.05 | $405,779 | $811,558 | $1,217,336 | $1,623,115 |
| 0.10 | $811,558 | $1,623,115 | $2,434,673 | $3,246,230 |
| 0.15 | $1,217,336 | $2,434,673 | $3,652,009 | $4,869,345 |
| 0.20 | $1,623,115 | $3,246,230 | $4,869,345 | $6,492,460 |

- Assume 5% of load at risk of an outage during event
- For $2,500/MWh VoLL, Change in LOLP has to be greater than 10% to produce benefits that exceed payments
- For Change in LOLP of 0.05, VoLL must exceed $5,000/MWh to produce benefits that are larger than payments
- If VoLL > $5,000/MWh or Change in LOLP > 0.10 then benefits always exceed costs

# DADRP Program Benefits

- Market Transfer Savings
  - LBMP Spot Market
    - Savings from purchasing energy in NYISO LBMP markets at lower prices caused by DR
  - Forward Hedge Market
    - Savings from purchasing energy in bilateral markets at lower prices due to reduced LBMP caused by DR
- Social Welfare Improvements
  - Resources are more efficiently used when customers pay actual prices, not average prices

# LBMP Spot Market Savings




- Reduction in LBMP causes a short-term transfer from Generators to LSEs as the cost to purchase electricity in RTM is reduced

# Forward Hedge Market Savings

- Reduction in LBMP in NYISO markets due to DR has an effect on average commodity prices
- If those who demand hedge contracts assume these reductions in LBMP will be maintained in the long-run, they will demand hedge contracts that incorporate this lower price expectation
- This amounts to a “long-run” transfer from producers to consumers as the money that would have gone to producers (Gens) inures back to consumers (LSEs)

# Social Welfare Improvements
## Reduction in Deadweight Loss

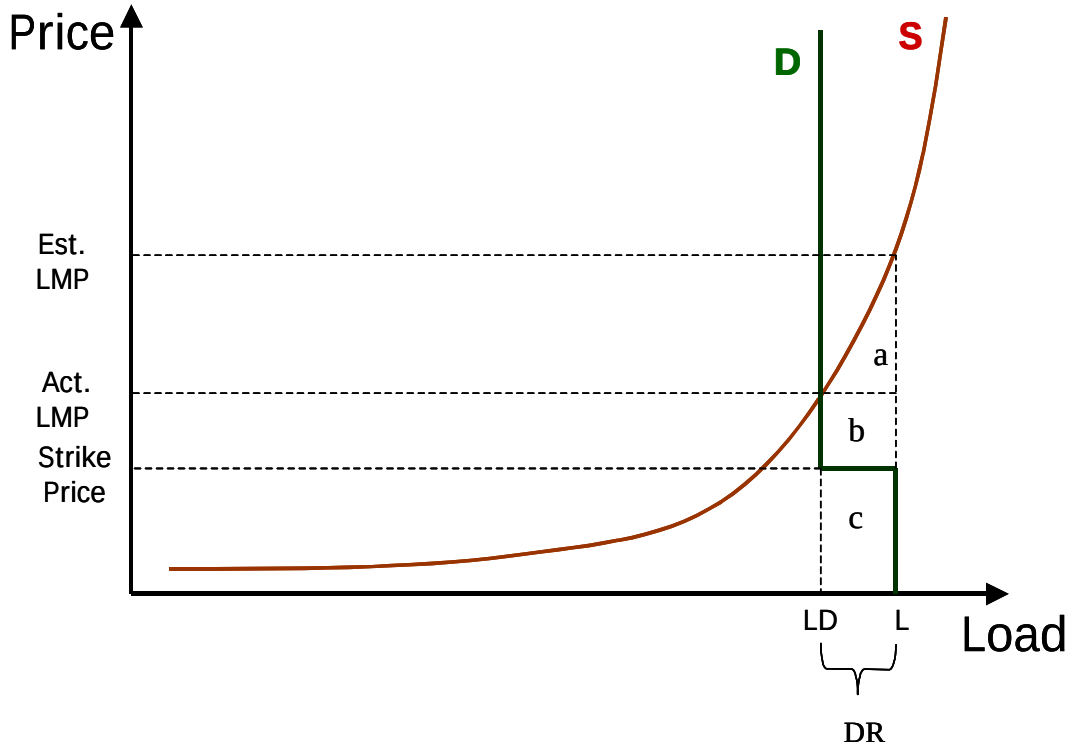
- Measures how efficiently resources are being allocated
- Not a transfer benefit, represents gain to society as a whole
- Calculated as difference between the areas under the supply and demand curves

  DWL = (a + b)
- To arrive at Net Social Welfare, any program payments have to be subtracted from the reduction in deadweight loss

  NSW = DWL – Pay

  = (a + b) – (b + c)

  = a – c
- If a > c, then NSW > 0



# Estimated Supply Models

| Season | Market | Zone | R-Sq | Supply Price Flexibility Min. | Avg | Max. |
|---|---|---|---|---|---|---|
| Fall | DA | NYC | 85% | 0.3 | 1.1 | 2.4 |
| | | LI | 85% | 0.1 | 0.7 | 1.7 |
| | | West | 89% | 0.2 | 0.7 | 1.3 |
| | | Capital | 91% | 0.3 | 1.2 | 2.5 |
| | RT | NYC | 54% | 0.2 | 1.0 | 6.0 |
| | | LI | 42% | 0.1 | 0.7 | 4.5 |
| | | West | 50% | 0.3 | 1.7 | 5.6 |
| | | Capital | 46% | 0.2 | 1.1 | 11.1 |
| Winter | DA | NYC | 87% | 0.4 | 1.7 | 5.0 |
| | | LI | 92% | 0.3 | 1.2 | 4.5 |
| | | West | 91% | 0.2 | 0.5 | 1.4 |
| | | Capital | 92% | 0.3 | 1.3 | 4.7 |
| | RT | NYC | 60% | 0.4 | 1.7 | 9.9 |
| | | LI | 73% | 0.3 | 2.0 | 40.0 |
| | | West | 46% | 0.5 | 1.9 | 7.6 |
| | | Capital | 52% | 0.3 | 1.4 | 7.0 |
| Spring | DA | NYC | 91% | 0.3 | 1.1 | 2.8 |
| | | LI | 85% | 0.2 | 0.8 | 2.1 |
| | | West | 88% | 0.2 | 1.0 | 2.0 |
| | | Capital | 92% | 0.3 | 1.2 | 2.6 |
| | RT | NYC | 56% | 0.3 | 1.4 | 16.9 |
| | | LI | 47% | 0.1 | 0.6 | 4.5 |
| | | West | 52% | 0.1 | 0.5 | 5.4 |
| | | Capital | 50% | 0.4 | 1.9 | 11.2 |
| Summer | DA | NYC | 95% | 0.2 | 1.1 | 4.0 |
| | | LI | 93% | 0.2 | 0.9 | 5.5 |
| | | West | 92% | 0.1 | 0.4 | 0.8 |
| | | Capital | 94% | 0.1 | 0.8 | 2.8 |
| | RT | NYC | 74% | 0.1 | 1.1 | 16.7 |
| | | LI | 74% | 0.1 | 1.4 | 37.9 |
| | | West | 60% | 0.1 | 0.7 | 7.8 |
| | | Capital | 61% | 0.1 | 0.6 | 11.5 |

- Split analysis into four periods
  - Fall: Sep. – Nov.
  - Winter: Dec. – Jan.
  - Spring: Feb. – May
  - Summer: Jun. – Aug.
- $R^2$ for Day-Ahead around 90%; Real-Time around 50%
- NYC and LI generally have highest flexibilities with a few exceptions

# Day-Ahead Demand Response Program
## Estimated Benefits

| | | | | Transfer Benefits | | | | Social Welfare Benefits | |
|---|---|---|---|---|---|---|---|---|---|
| Zone | Performance (MWh) | Program Payments ($) | Average DAM LBMP ($/MWh) | Average Price Reduction ($/MWh) | Market Bill Savings ($) | Hedge Contract Savings ($) | Benefits to Payment Ratio | Reduction in Deadweight Loss ($)* | Benefits to Payment Ratio |
| NYC | 0 | $0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| LI | 0 | $0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Western NY | 714 | $62,632 | $86.20 | $0.12 | $17,982 | $33,088 | 0.82 | $47,193 | 0.75 |
| Hudson River | 1,356 | $109,745 | $83.08 | $0.21 | $91,807 | $122,278 | 1.95 | $34,883 | 0.32 |
| **Total** | **2,070** | **$172,376** | **$83.72** | **$0.19** | **$109,789** | **$155,366** | **1.54** | **$82,076** | **0.48** |

* This represents gross benefits. Net Social Welfare can be calculated by subtracting program payments

- DADRP offers accepted only in Western NY and Hudson River areas
- Average LBMP when bids are scheduled is less than $90/MWh, subsequently reducing prices minimally
- Transfer benefits exceed payments
- Social Welfare benefits are roughly half as large as the payments

# DR Program Benefits Comparison

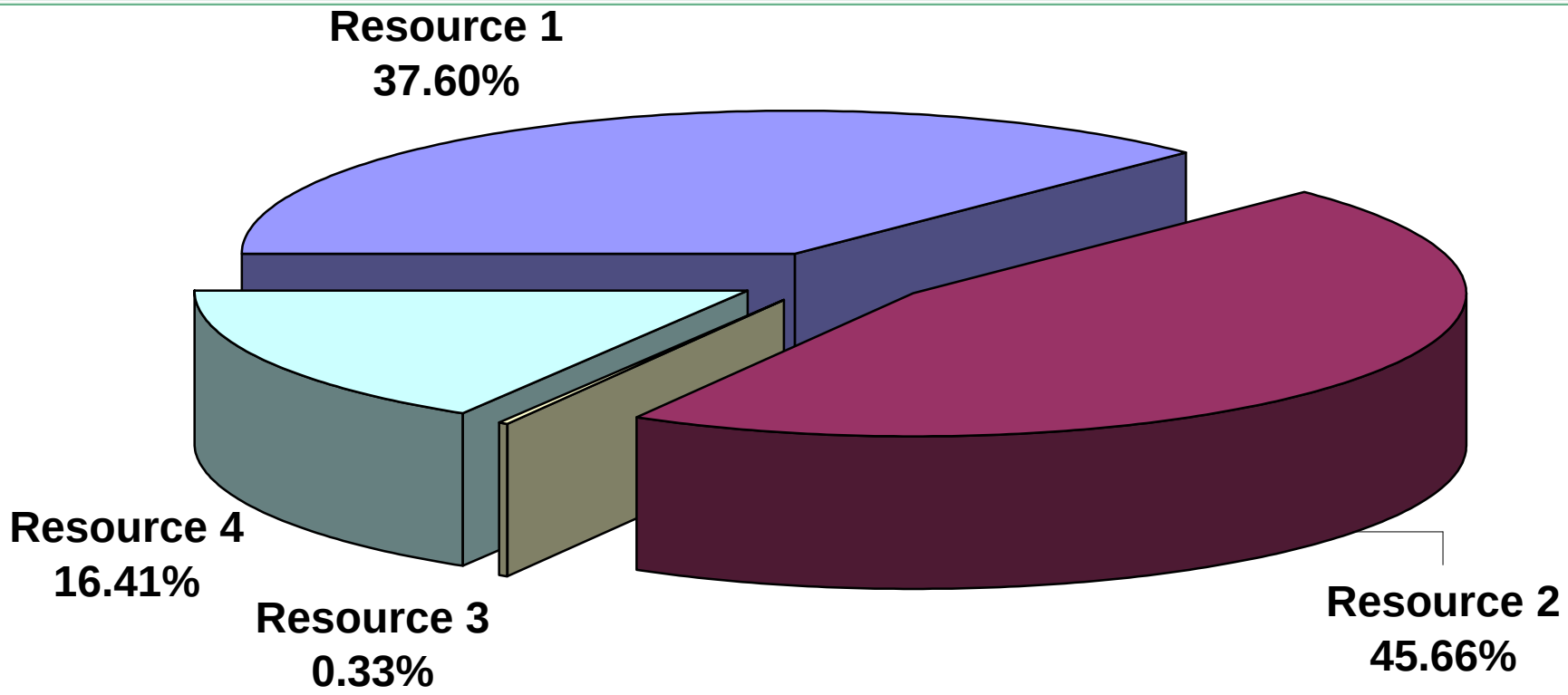
| | | DADRP | EDRP | SCR |
|---|---|---|---|---|
| Event Statistics | Performance (MWh) | 2,070 | 442 | 377 |
| | Payments ($) | $172,376 | $428,079 | $385,359 |
| | Average LBMP ($/MWh) | $83.72 | $503.36 | $742.59 |
| Transfer Benefits | Average Price Reduction ($/MWh)* | $0.19 | N/A | N/A |
| | Market Bill Savings ($) | $109,789 | N/A | N/A |
| | Hedge Contract Savings ($) | $155,366 | N/A | N/A |
| | Benefits to Payment Ratio | 1.42 | N/A | N/A |
| Societal Benefits | Reduction in Deadweight Loss ($) | $82,076 | N/A | N/A |
| | Benefits to Payment Ratio | 0.48 | N/A | N/A |
| | Reliability Benefits ($) | N/A | $876,547 | $746,568 |
| | Benefits to Payment Ratio | N/A | 2.05 | 1.94 |

- Transfer benefits exist for DADRP, but not EDRP/SCR due to Scarcity Pricing
- Reliability benefits of EDRP and SCR assume VoLL=$5,000/MWh and Change in LOLP=0.10
- All three programs met goals and produced benefits that exceeded payments in Program Year 2005

# DADRP Offer Analysis

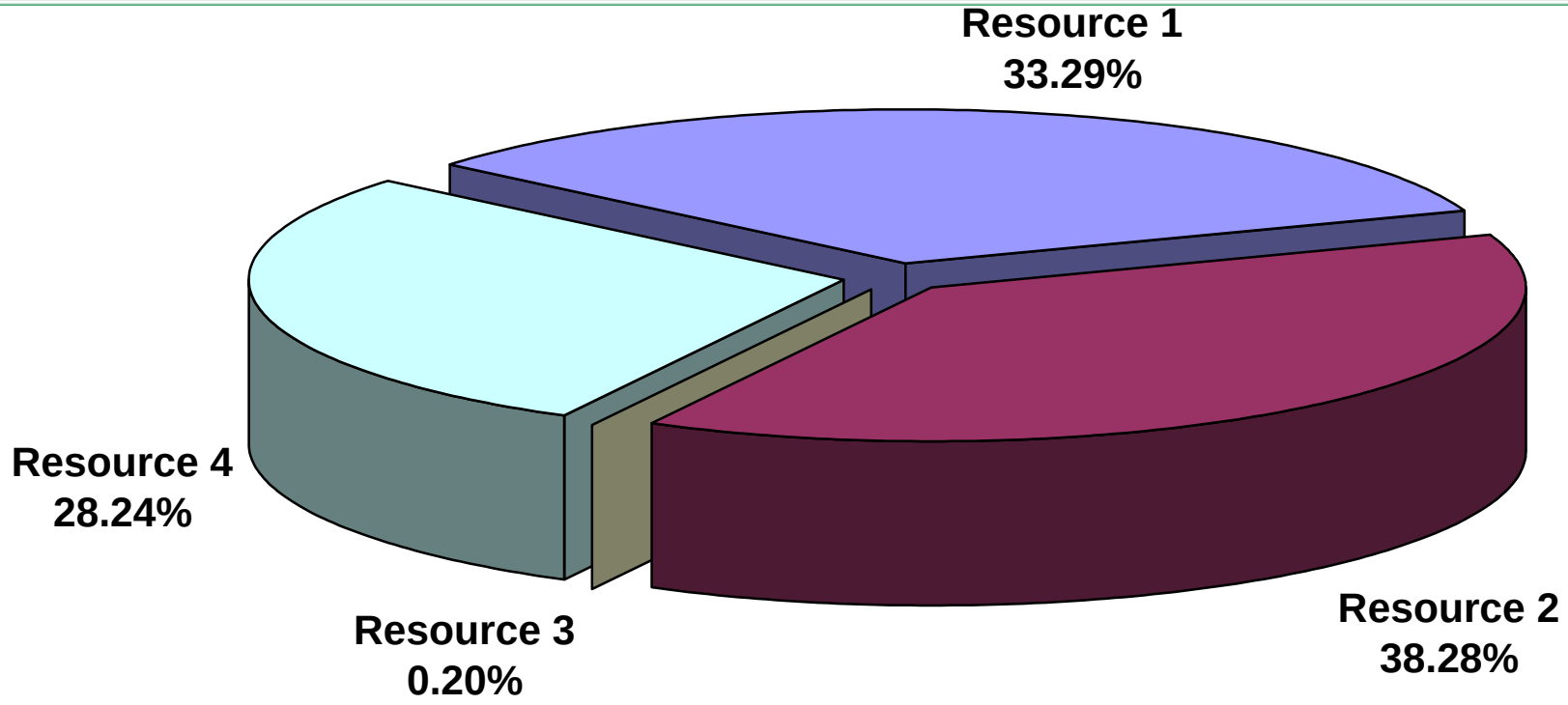
- Examined all DADRP offers from January 1, 2004 through September 30, 2005
  - Both accepted and rejected offers
  - All offer components used in analysis, including:
    - Bid block
    - Min Gen MW
    - Upper Operating Limit
- Analyzed offer behavior over time
  - Trends by participant
  - Trends by month
  - Trends by day
  - Trends by time of day

# Proportion of Total Offers by Participant



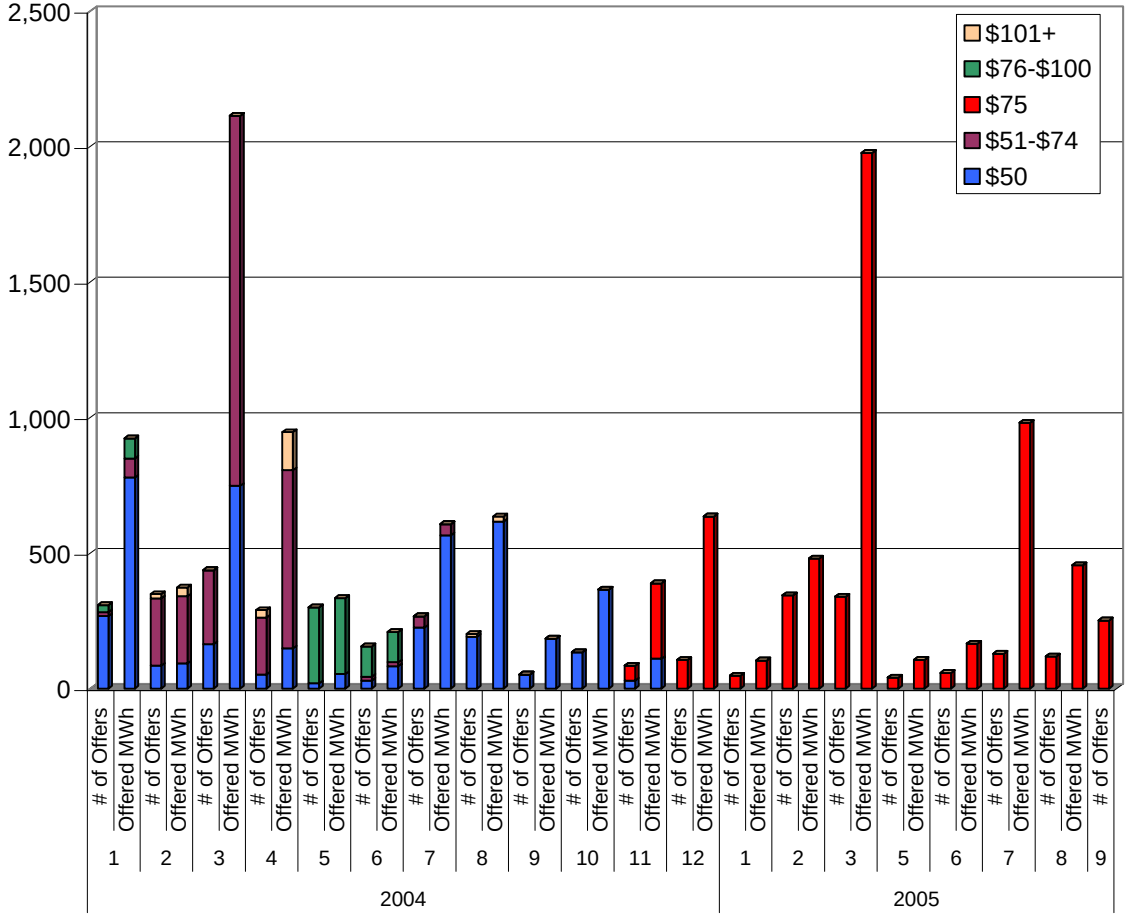

- Only four resources submitted offers during analysis period; only three submitted substantial number of offers
- One resource accounts for almost 50% of total number of submitted offers

# Proportion of Offered MWh by Participant



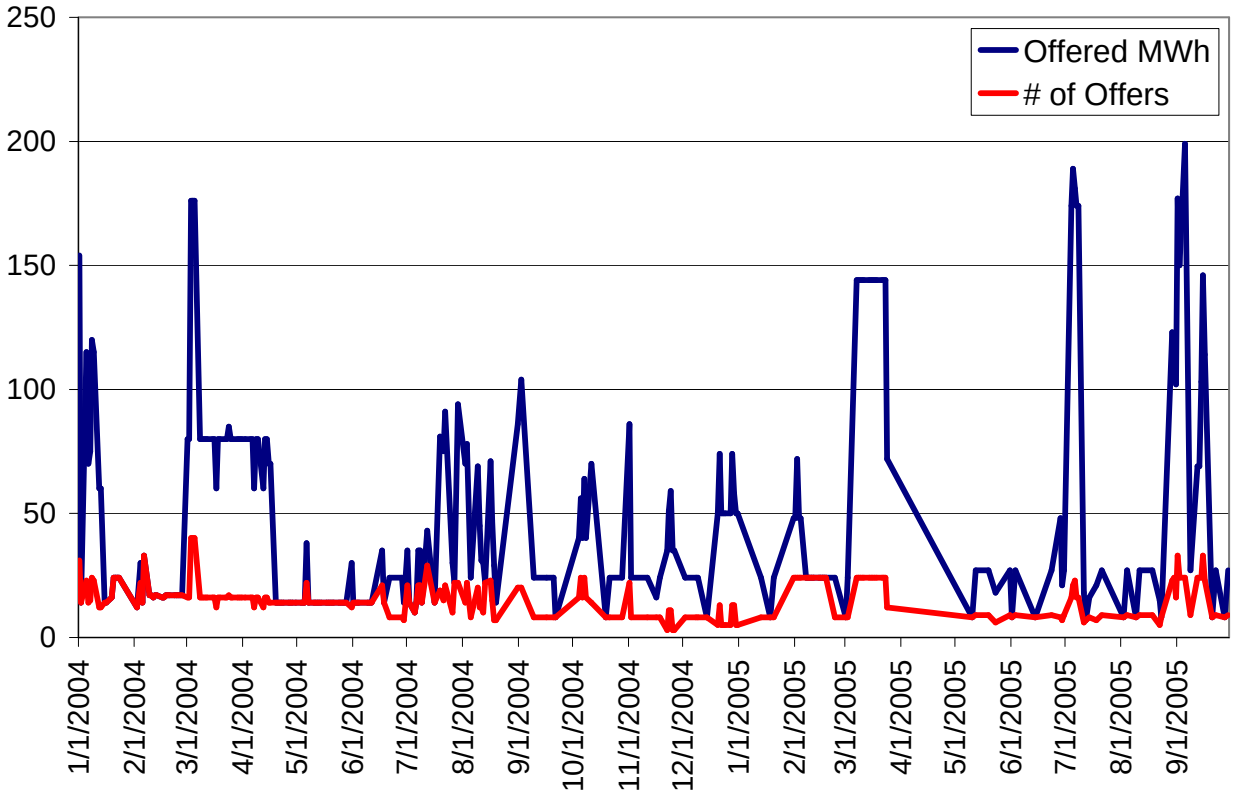

- Distribution of Offered MWh a bit more equally distributed than the submitted offers
- Resource 2 accounts for 45% of submitted offers but only 38% of offered MWh
- Resource 2 accounts for only 16% of submitted offers but 28% of offered MWh

# DADRP Offers and Offered MWh by Offer Price and Month



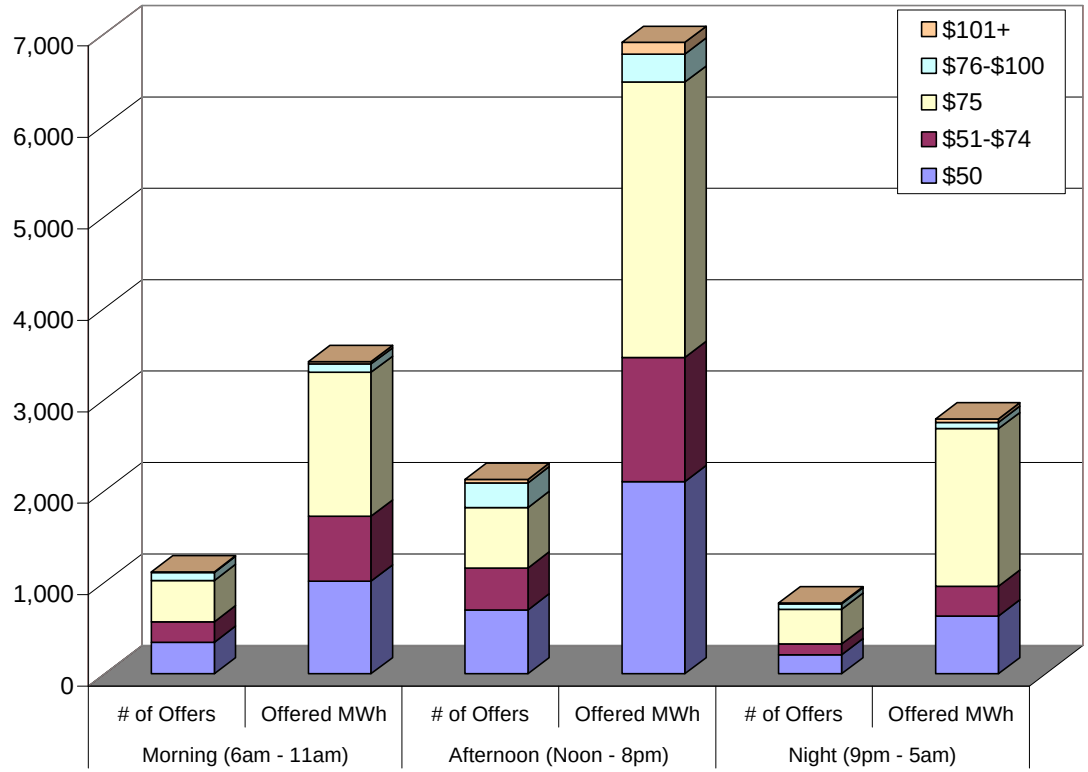

- When bid floor was $50/MWh, most offers were at the floor price, but offers were submitted at higher levels
- After the floor was increased to $75/MWh, all offers were submitted at the floor price

# Total Offers and Offered MWh by Day




- Offered MWh increase dramatically during all of March 2004 and 2005.
- Number of offers also rise around Labor Day and July 4th of 2005, but not in previous year

# DADRP Offers and Offered MWh by Bid Price and Time of Day




- Twice as many Offers and more than twice as many Offered MWh during the afternoon hours (12 Noon – 8 p.m.) than in the morning hours (6 a.m. – 11 a.m.)
- More than twice as many Offers and almost three times as many Offered MWh submitted in the afternoon than the overnight hours (9 p.m. – 5 a.m.)

# Conclusions

- EDRP/SCR programs
  - Under even conservative reliability improvement assumptions, emergency programs produce benefits that exceed payments by over 80%
- DADRP
  - Bids accepted at relatively low prices, resulting in Reduction of DWL < Payment
  - Very limited number of active bidders (only three)
  - Bids are overwhelmingly submitted at the floor price
  - Bidding behavior increased in March and around major holidays in 2005

# Recommendations

- DADRP
  - Raise bid floor price ($100/MWh) to increase likelihood of program generating NSW improvements
  - Possibly include days surrounding holidays in Weekend/Holiday CBL definition
  - Increase marketing efforts for DADRP
- ICAP SCR
  - Alter program to provide NYISO with more value
    - Dispatch as if SCRs are true 30-minute reserve providers (i.e. reduce notice of event to half-hour and reduce event length to 1 hour)
      - Currently counted toward 30-Minute Reserve requirement during event, so why not make them true 30-Min reserves?
    - Adjust APMD calculations to better reflect coincident peak demand per NYISO companion presentation