



AARHUS
UNIVERSITY
DEPARTMENT OF ENGINEERING

Combined Price- and Event based Demand Response using Two-Stage Model Predictive Control

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Model Predictive Control

$$\min_u J = \sum_{k=1}^N s_k u_k$$

Cost function

Subject to

$$\left. \begin{aligned} \bar{x}_{k+1} &= \mathbf{A}\bar{x}_k + \mathbf{B}u_k + \mathbf{E}\bar{d}_k \\ y_k &= \mathbf{C}\bar{x}_k \end{aligned} \right\}$$

System dynamics

$$\bar{x}_0 = \hat{x}_{ini}$$

Initial condition

$$0 \leq u_k \leq 500$$

Control input

$$y_k \geq y_{k,min}$$

Output

Model Predictive Control

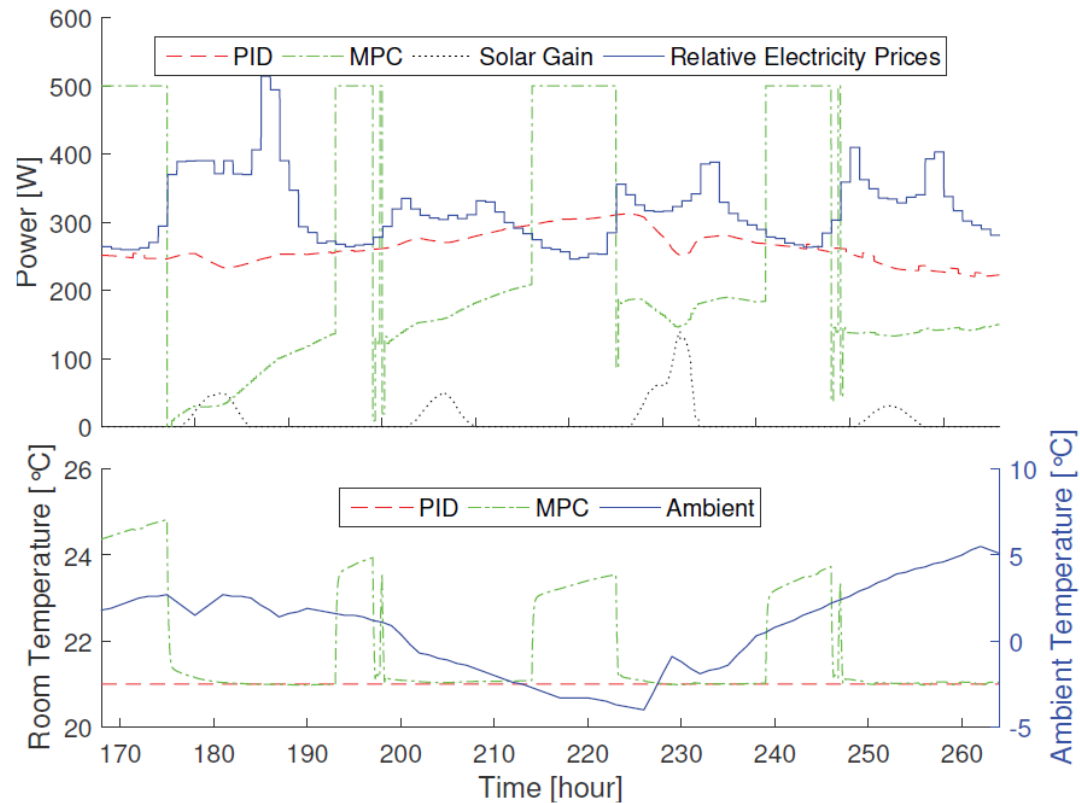
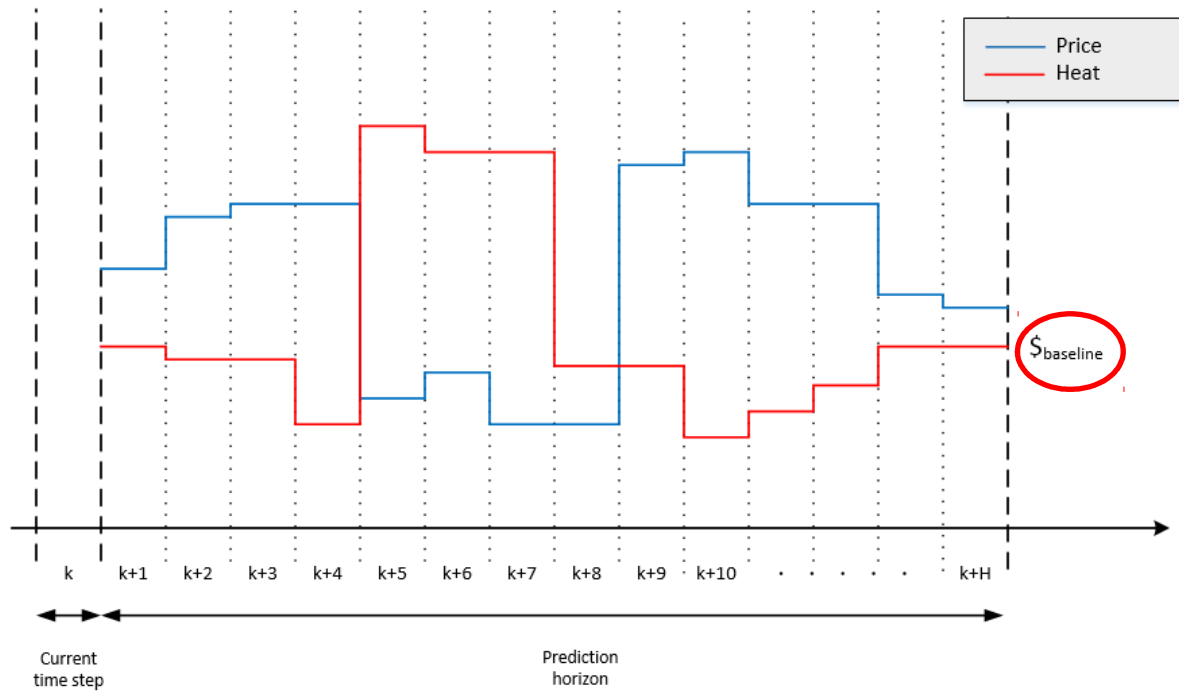


Fig. 3. Comparison of Performance of Economic MPC Against PID for the Days 7th, 8th, 9th and 10th of January 2015 in Denmark.

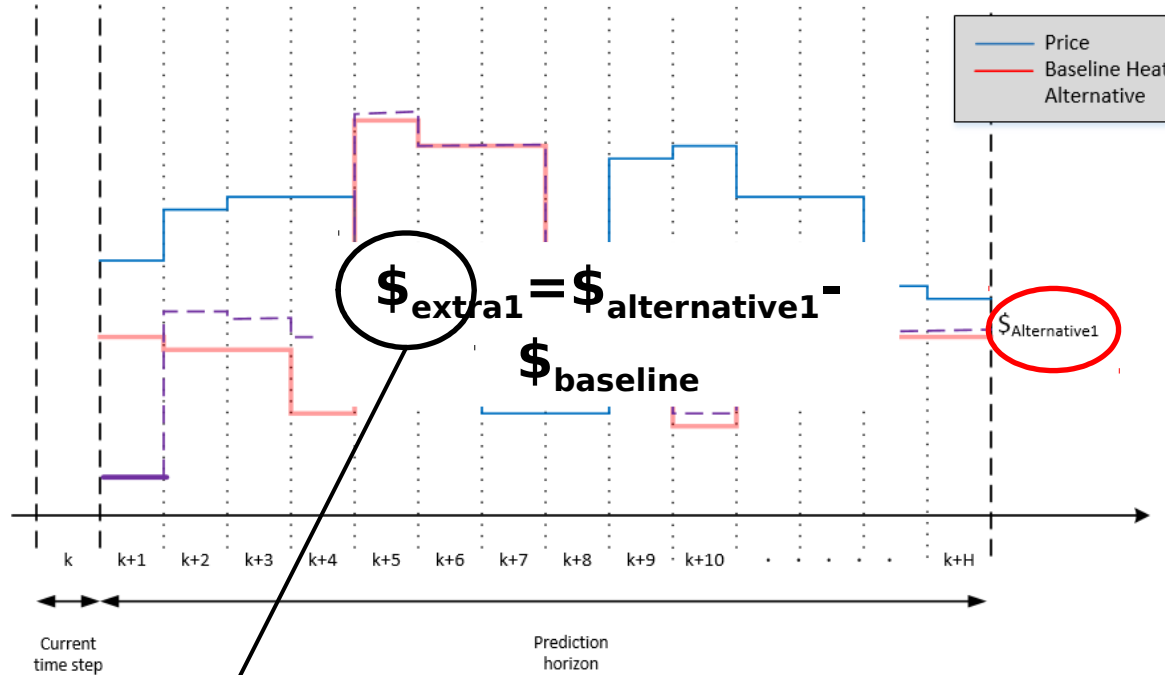
- Stage 1

Price-based demand response



- Stage 2

Event-based demand response



Current Time Step

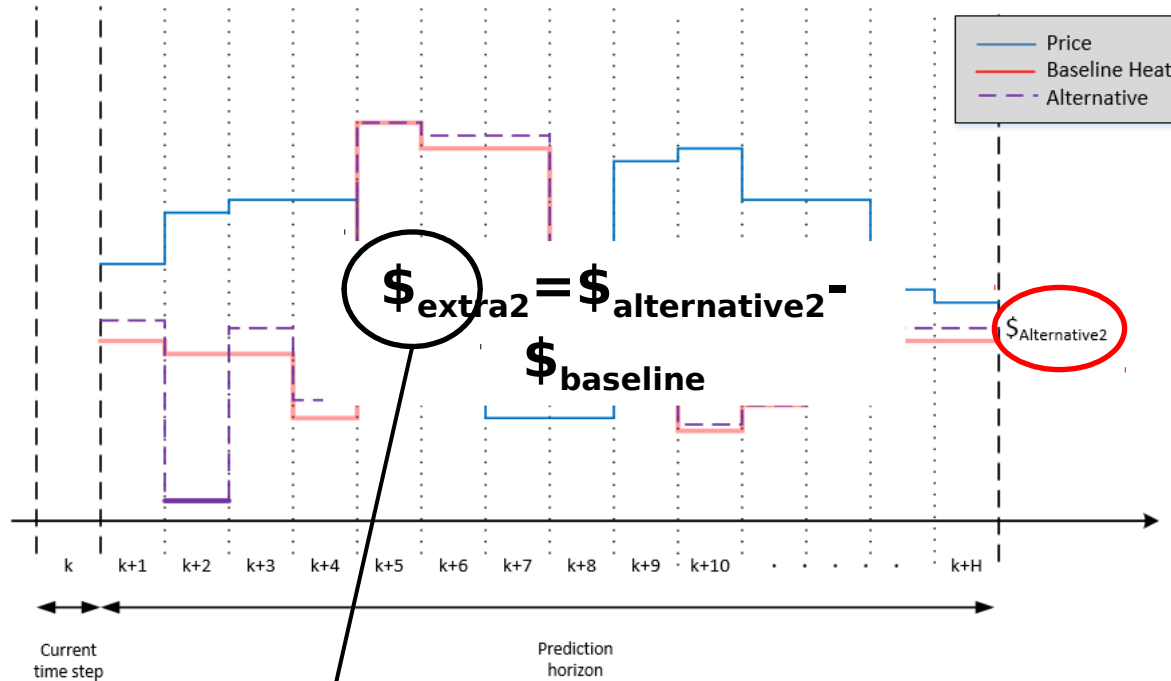
Predicted Time Steps

k+1 k+2 k+3 k+4 k+5 k+6 ... k+24

k $\$_{extra1}$

- Stage 2

Event-based demand response



Current Time Step

Predicted Time Step

k+1

k+2

k+3

k+4

k+5

k+6

...

k+24

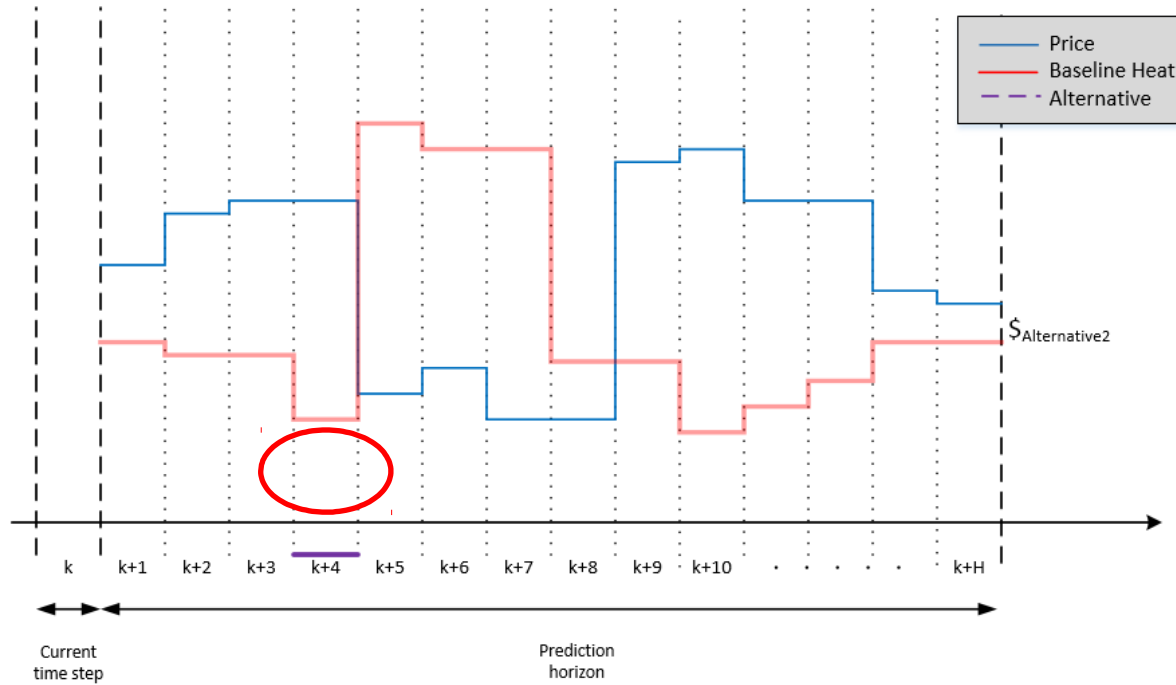
k

$\$_{extra1}$

$\$_{extra2}$

- Stage 2

Event-based demand response

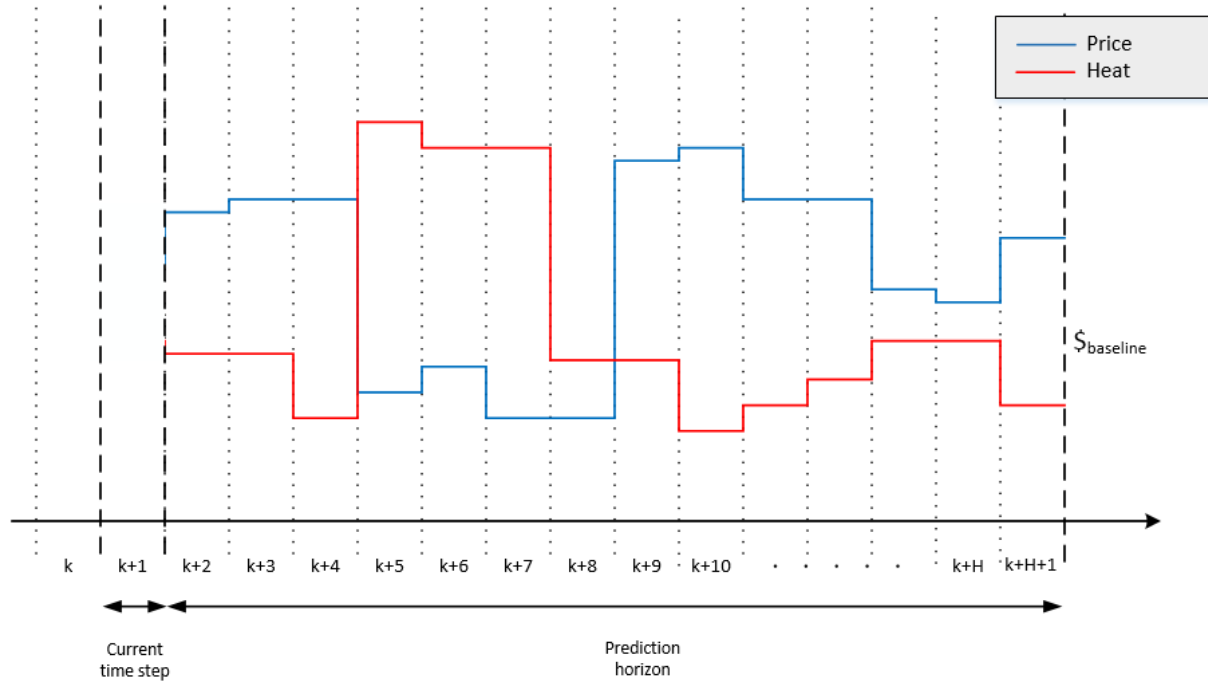


Current Time Step

Predicted Time Step

Current Time Step	$k+1$	$k+2$	$k+3$	$k+4$	$k+5$	$k+6$	...	$k+24$
k	$\$_{extra1}$	$\$_{extra2}$	$\$_{extra3}$	NA	$\$_{extra5}$	$\$_{extra6}$	...	$\\$_{extra24}$

Next Time Step....



Current Time Step

Predicted Time Step

	k+1	k+2	k+3	k+4	k+5	k+6	...	k+24	k+25
k	$\$_{k|k+1}$	$\$_{k|k+2}$	$\$_{k|k+3}$	NA	$\$_{k|k+5}$	$\$_{k|k+6}$	...	$\\$_{k|k+24}$	
k+1		$\$_{k+1|k+2}$	$\$_{k+1|k+3}$	NA	$\$_{k+1|k+5}$	$\$_{k+1|k+6}$	...	$\\$_{k+1|k+24}$	$\$_{k+1|k+25}$

And the Next....

Current t Time Step	Predicted Time Step											
	k+1	k+2	k+3	k+4	k+5	k+6	...	k+24	k+25	k+26	K+27	
k	$\$_{k|k+1}$	$\$_{k|k+2}$	$\$_{k|k+3}$	NA	$\$_{k|k+5}$	$\$_{k|k+6}$	...	$\\$_{k|k+24}$				
k+1		$\$_{k+1|k+2}$	$\$_{k+1|k+3}$	NA	$\$_{k+1|k+5}$	$\$_{k+1|k+6}$	...	$\\$_{k+1|k+24}$	$\$_{k+1|k+25}$			
k+2			$\$_{k+2 k+3}$	NA	$\$_{k+2 k+5}$	$\$_{k+2 k+6}$...	$\$_{k+2 k+24}$	$\$_{k+2 k+25}$	$\$_{k+2 k+26}$		
k+3				NA	$\$_{k+3 k+5}$	$\$_{k+3 k+6}$...	$\$_{k+3 k+24}$	$\$_{k+3 k+25}$	$\$_{k+3 k+26}$	$\$_{k+3 k+27}$	



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Thank You!

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