Optimal Production Investment and Economic Dispatch, DTU-42002 Assignment 2

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1, without Storage

Symbol	Definition	Example
T	Time Units	$(12:15, 12:45), (12:45, 13:15)$
J	Controllable generation technologies	$\{\text{Gas Turbine}, \text{Biomass Power Generation}\}$

Table 1, summary of sets

Symbol	Definition	Unit	Set
y_j	Capacity of different generation technologies	MW	J
$x_{j,t}$	Average power output during time interval	MW	J, T
z	Percent of new wind turbine compared with installed	MW	wind

Table 2, summary of decision variables

Symbol	Definition	Unit	Set
w_t	Historical wind power output of installed turbines	MW	T
d_t	Historical electricity demand	MW	T
a	Length of the time interval	hour	–
c_j^{fix}	Fixed cost per capacity of conventional generation technologies	DKK / MW	J
$c^{fix,wind}$	Fixed cost per percent capacity of wind turbines	DKK / %	wind
c_j^{var}	Production cost per unit output of different generation technologies	DKK / MW	J
s_j^{max}	Max percent of controllable increment power output	%	J
β_j^{min}	Minimum percent of load percent of full load	%	J

Table 3, summary of constants

$$
\begin{aligned}
\min \quad & \sum_j c_i^{fix} y_j + c^{fix,wind} z + a \sum_j \sum_t c_j^{var} x_{j,t} \quad \text{(DKK)} \\
\text{s.t.} \quad & y_j \beta_j^{min} \le x_{j,t}/a \le y_j \quad \text{for } j \in J, t \in T \quad \text{(MWh)} \\
& \sum_j x_{j,t} \ge d_t - w_t * z \quad \text{for } j \in J, t \in T \quad \text{(MWh)} \\
& -s_j^{max} y_j \le x_{j,t+1} - x_{j,t} \le s_j^{max} y_j \quad \text{for } j \in J, t \in T \quad \text{(MWh)}
\end{aligned}
$$

2, with Storage (Electric Vehicle)

Symbol	Definition	Example
T	Time units	$(12:15, 12:45), (12:45, 13:15)$
J	Controllable generation technologies	$\{\text{Gas Turbine}, \text{Biomass Power Generation}\}$
G	Groups of electric vehicles	$EV1, EV2$

Table 4, summary of sets

Symbol	Definition	Unit	Set
y_j	Capacity of different generation technologies	MW	J
$x_{j,t}$	Average power output during time interval	MW	J, T
z	Percent of new wind turbine compared with installed	MW	wind
$u^-_{g,t}$	Discharge speed of every EV in group g at t	MW	T, G
$u^+_{g,t}$	Charging speed of every EV in group g at t	MW	T, G
$l_{g,t}$	State of every EV in group g at t	MWh	T, G

Table 5, summary of decision variables

Symbol	Definition	Unit	Set
w_t	Historical wind power output of installed turbines	MW	T
d_t	Historical electricity demand	MW	T
$d^{EV}_{g,t}$	Historical driving demand	MW	T, G
a	Length of the time interval	hour	–
b_g	Number of EVs in group g	–	G
c^{fix}_j	Fixed cost per capacity of conventional generation technologies	DKK / MW	J
$c^{fix,wind}$	Fixed cost per percent capacity of wind turbines	DKK / \%	wind
c^{var}_j	Production cost per unit output of different generation technologies	DKK / MW	J
s^{max}_j	Max percent of controllable increment power output	%	J
β^{min}_j	Minimum percent of load percent of full load	%	J
$u_g^{-,\max}$	Max discharging speed of EVs in group g	MW	G
$u_g^{+,\max}$	Max charging speed of EVs in group g	MW	G
η^-_g	Discharging efficiency of EVs in group g	%	G
η^+_g	Charging efficiency of EVs in group g	%	G

Table 6, summary of constants

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\begin{aligned}
\min \quad & \sum_j c^{fix}_i y_j + c^{fix,wind} z + a \sum_j \sum_t c^{var}_j x_{j,t} \quad \text{(DKK)} \\
\text{s.t.} \quad & y_j \beta^{min}_j \le x_{j,t}/a \le y_j \quad \text{for } j \in J, t \in T \quad \text{(MWh)} \\
& \sum_j x_{j,t} + \sum_{g \in G} b_g \eta^-_g u^-_{g,t} \ge d_t - w_t * z + \sum_{g \in G} b_g u^+_{g,t} \quad \text{for } j \in J, t \in T \quad \text{(MWh)} \\
& -s^{max}_j y_j \le x_{j,t+1} - x_{j,t} \le s^{max}_j y_j \quad \text{for } j \in J, t \in T \quad \text{(MWh)} \\
& l_{g,t+1} = l_{g,t} + a u^+_{g,t} \eta^+_g - a u^-_{g,t} - a d^{EV}_{g,t} \quad \text{for } g \in G, t \in T/t_{max} \quad \text{(MWh)} \\
& l^{min}_{g,t} \le l_{g,t} \le l^{max}_{g,t} \quad \text{for } g \in G, t \in T \quad \text{(MWh)} \\
& u^+_{g,t} \le u_g^{+,\max} \quad \text{for } g \in G, t \in T \quad \text{(MW)} \\
& u^-_{g,t} \eta^-_g \le u_g^{-,\max} \quad \text{for } g \in G, t \in T \quad \text{(MW)} \\
& u^+_{g,t} d^{EV}_{g,t} = 0 \quad \text{for } g \in G, t \in T \quad \text{(-)} \\
& u^-_{g,t} d^{EV}_{g,t} = 0 \quad \text{for } g \in G, t \in T \quad \text{(-)}
\end{aligned}
$$