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ELECTRICITY CONSUMPTION SHAPING AND AIR POLLUTION EMISSIONS REDUCTION (LONG RUN PLANNING PHASE OF THE ISRAELI ELECTRICITY SECTOR)

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ABSTRACT

While traditional power generation expansion planning had been focusing mainly on supply-side options, here both supply-side as well as demand-side options are simultaneously considered.

We present methodology for finding the cost effective way of emissions reduction in the electricity sector. Two most important demand side options for emissions reduction are considered: an increase in the energy efficiency and taxes imposed on 3 pollutants from the electricity sector - CO_2, NO_x and PM.

One purposes of this paper is to estimate the impact of smoothing the electricity consumption on the amount of air pollution emissions and their environmental effect for the economy, fuels consumption and the cost of capacity expansion program for the Israeli electricity sector over long-run period (2011 – 2025).

A modified version of WASP-IV package was used to find out the least-cost power generation expansion plans and to undertake an assessment of the cost and benefits to the electricity sector of a future emissions reduction programs.

We examine the following scenarios of demand reshaping for all the planning period (2011 – 2025):

- A uniform demand reduction of 5% (24 hr. per day every day)
- A demand reduction only for peak hours. In this scenario we consider reducing the demand during peak demand hours by 3, 5, 7 and 9 percent.

KEYWORDS: demand-side management, emissions reduction, capacity expansion planning, decision making

We use historical hourly electricity loads for each day of the year. The hourly load is consistent with the load duration curve over the corresponding period of the year (4 periods in each year are examined).

We consider 216 different scenarios of pollution reduction. One is business-as-usual (BAU) while the others were generated by our software.

The outcome of the analysis determines a cost–effective impact of emissions reduction on the long run planning phase of the Israeli electricity sector. To this end we use a methodology that can inform Decision Makers (DM) about potential trade-off between abatement costs and pollution as well as the impact on electricity consumers. The output of the modeling included the impact on electricity prices, social cost of electricity, fuels usage, etc.

A key finding in the case of Israel is that a uniform demand reduction by 5% would lead to reduction of 4% in CO_2, 3.2% in NO_x and 2.2% in PM pollutants over the period 2011-2025. In this case the amount of coal and gas for the electricity production will be also reduced by

1.3% and 8.1% respectively. For the fuel oil the reduction is more than 57% (!). The case of peak hours demand reduction by 9% causes a reduction of the generation cost by 0.24%. In this case fuel oil is found to reduced by 88.3% (!).

Another finding is the secondary benefit from CO2 reduction. E.g., average reduction of 1 millions ton of CO_2 connected with average reduction of 4841 tons of NO_x and 223 tons of PM in 2011 – 2015.

The fuel usage has substantial impact on emissions reduction. Reducing of each ton of CO_2 pollutants is connected with increase in using natural gas for electricity generation. Average reduction of 1 millions ton of CO_2 follows to average yearly increase of more than four hundred thousands tons of natural gas as compared with BAU scenario level. Towards the end of the period, the average yearly increase is more than 327 hundred thousands tons of natural gas.

In this study we also employed advanced statistical methods and reasonable goal method interactive decision maps (RGM/IDM) technique in order to help the DM selecting a small number of preferable alternatives from the large number of alternatives of pollution reduction to the given level.

We undertake an assessment of the cost and benefits to the electricity sector and all economy of future emissions reductions programs.