A NOVEL SOLUTION FOR SHAPING ELECTRICITY DEMAND VIA CONTROLLING WATER CONSUMPTION OF AGRICULTURAL CUSTOMERS

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ABSTRACT

This paper introduces a novel solution for shaping electricity demand and decreasing it in peak hours via controlling electro-pumps which are used for irrigation purposes. It will be shown that in the regions where pilot projects are implemented, electricity demand is decreased dramatically. However a number of electro-pumps and whole electricity consumptions have is increased normally. Furthermore water usage efficiency is increased, simultaneously.

INTRODUCTION

Water resource status in Iran

Iran is located in an arid region, which 55% of its water needs is achieved from ground water and at least 90% of its water is used for irrigation.

Iranian government has a plan for installing water meters on all water wells from 2006, using a patented invention for measuring amount of pumped water by electro-pumps, bases on electrical parameters of electro-pumps, called Intelligent Electricity and Water Meter. [1]

While aquifers are overpumped, irrigation efficiency is less than 30% and many of farmers exceed their regular credit for using groundwater and according to law, authorities should stop them by some means, including cutting their electricity supply. [2][3]

Electricity consumption in agriculture

In 2011, there were 189,895 agricultural customers, who were 1% of whole Tavanir customers and consumer of 16.3% of the country's total electricity consumption.
According to law, electricity price for irrigation is less than 0.01$ per kWh.

Electricity consumption has increased 4.3% per year (from 2009 till 2011) while electricity consumption in agriculture has increased with an average of 14.9% per year.

According to a parliament regulation, Tavanir is obliged to replace all 400K gas operating pumps of the country with electricity based ones. So it is estimated that electricity consumption will be doubled at least and will be more than 25% of the whole country electricity consumption.

Nowadays in some grid operator sections, for example Southern Kerman, farmers have been consuming more than 50% of whole section electricity, using their well's electro-pumps; clearly, it is very critical to control irrigation electricity usage, especially its effect in high demand hours which unfortunately occurs at the same time whit residential peak hours, in hot hours of summers.

A NOVEL SOLUTION

It was suggested that if IEWM has an extra capability to cut irrigation electricity usage in predefined periods, grid operators could decline yearly peak electricity demand in summer hot hours, while water utilities could manage aquifers overpumping, in lowest efficient hours for irrigation.

Electricity utility could encourage farmers to participate in this program in two ways. First, new agricultural customers, i.e. those who want to change their gas operating pumps with electro-pumps, have to sign a 20 hours per day electricity contract; Actually they would have 24 hours electricity, except in summer dates. Second, current agricultural customers are invited to sign a new contract, in which they have 20 hours per day electricity consumption, for whole summer with zero bills.

PILOTS

This idea has implemented in some regional pilots, including Mashhad and Farashband (in Shiraz Grid operator) and some outspread pilots in Fars, Shiraz and Mashhad grid operators, between 2010 and 2011.

In 2011, there were 1000 operating meters in Farashband and another 1500 operating meters in other regions of Shiraz grid operator. There were 3000 operating meters outspread in Fars grid operator and 600 meters in Mashhad grid operator.

Pilot results

In this paper we compare electricity consumption and peak demand, in Shiraz pilot area with whole country and some other grid operators. We use Tavanir published official reports. There is no official data for agricultural electricity peak demand; so we use whole grid operator peak demand, instead. Fortunately, effect of pilot is so great that we can illustrate it in whole grid operator consumption.

Subsidies have been decreased in 2010 significantly. It has had a major impact in consuming patterns; so we decided to compare our pilot in two years to compensate its effect as much as possible. Furthermore, we compare our results with other provinces with similar conditions which do not participate in pilot projects.

Although we believe Mashhad pilot might be successful, irrigation is less than 10% of Mashhad electricity consumption, so we could not illustrates effect of our pilot in Mashhad, clearly.
Shiraz grid operator has installed IEWM and used its peak management capability as an intensive pilot project (Full pilot zone). Fars (pilot zone 2) and Isfahan (pilot zone 3) are provinces which have installed IEWM, but have not used its peak management capability, while Southern Kerman (zone 4) and Isfahan City (zone 5) are examples of provinces which have not implemented this project, yet. All of them have main irrigation electricity usage more than 20% of whole electricity consumption.

Table 1: Electricity consumption statistics in 2009 (before pilot implementation)

	Overall Electricity Consumption (GWh)	Irrigation Electricity Consumption (GWh)	Highest Electricity Demand (MW)
Iran	167,526	21,410	33,229
Full pilot zone	3,883	800	994
Pilot zone 2	5,098	2,237	1,072
Pilot zone 3	7,347	1,766	1,398
Zone 4	3,259	1,242	824
Zone 5	4,266	507	796

Table 1 illustrates consumption information, including overall and irrigation electricity consumption and highest electricity demand, before pilot project implementation in the country, full pilot zone (Shiraz grid operator), semi pilot zones (Fars & Isfahan) and two out of pilot zones with similar conditions (Southern Kerman & Isfahan City), based on official Tavanir reports.

Table 2: Electricity consumption statistics in 2011 (after pilot implementation)

	Overall Electricity Consumption (GWh)	Irrigation Electricity Consumption (GWh)	Highest Electricity Demand (MW)
Iran	183,905	30,020	37,701
Full pilot zone	4,265	920	868
Pilot zone 2	5,288	2,575	1,124
Pilot zone 3	7,965	2,179	1,472
Zone 4	3,898	1,911	901
Zone 5	4,362	594	989

Table 2 illustrates mentioned information after pilot project implementation in above areas, based on official Tavanir reports.

Table 3 illustrates annual rate of increasing parameters in two years of study.

Table 3: Electricity consumption statistics Annual changes before and after pilot

	Overall Electricity Consumption	Irrigation Electricity Consumption	Highest Electricity Demand
Iran	4.77%	18.41%	6.52%
Full pilot zone	4.80%	7.23%	**-6.55%**
Pilot zone 2	1.84%	7.29%	2.40%
Pilot zone 3	4.12%	11.08%	2.61%
Zone 4	9.37%	24.04%	4.57%
Zone 5	1.12%	8.24%	11.47%

Figure 1 illustrates curves of highest electricity demand from 2009 to 2012.

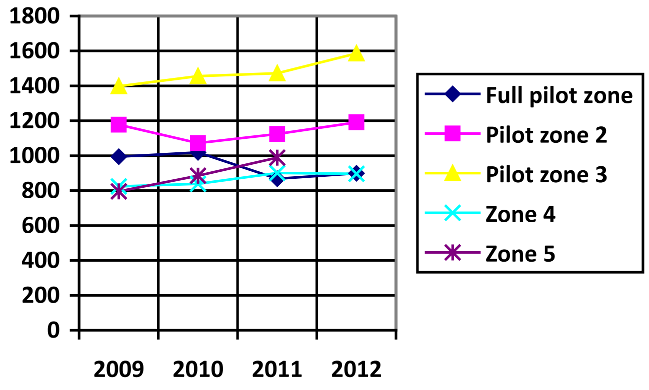

Figure 1: Changes in highest electricity demand for studied regions

For pilot customers, electricity supply of electro-pumps has been cut between 13:00 and 17:00 of June, July and August in which we experience highest electricity demand and least irrigation efficiency, since 2010.
Farmers participated in the program have benefitted zero electricity bill.

As illustrated in Table 3, the country have had a 6.52% increase in highest annual electricity demand; but full pilot zone recorded a 6.55% decrease in highest annual demand, while its electricity consumption have increased as much as the country's.

These pilot studies suggest that water consumption is decreased in different ways, too.

First, when end customers are informed that their water consumption is monitored, they decrease their water usage. Second, when a customer participates in high electricity demand cut program, he uses his electro-pumps in other hours of the day which results in higher irrigation efficiencies. An official report from Fars Water Utility estimates this value is at least 60,000 m^3 per day. Third, when a water utility uses credit capabilities of IEWM and cuts power supply of electro-pumps once water volume or time credit is over.

CHALLENGES

First, installed meters for irrigation electricity customers are mixed in the same network with other meters which are used for measuring domestic electricity consumption and there was no automated meter reading system to enable us to separately monitor each metering point on the network. Therefore we were not able to measure agriculture electricity demand. As a result we had to compare whole electricity demand, instead of electricity demand for irrigation usage. Although we could illustrate its high effect on overall demand, it could be mixed with other operations and programs of grid operator.

Second, in a case by case study, it is understood that farmers who were obliged to participate in program, i.e. new electricity customers, have tried to tamper the disconnection device, significantly. We think it is the major reason for better result in Shiraz in compare with Fars and Isfahan.

CONCLUSION

Controlling electricity consumption of irrigation usage was a win-win program which has benefited all stakeholders. Farmers have benefitted by participating in this program, through decreasing their electricity bills significantly, even to zero.

Grid operators have benefitted by shaping their electricity demand, saving production investment and preventing cut-outs in residential, commercial and industrials sectors, while increasing their income, through lower billing rates for agricultural usage, according to parliament act.

Whole national economy and environment have benefited from saving water resources, increasing irrigation efficiency, controlling groundwater usage, while decreasing electricity demand, during peak hours.

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