# Participation of customers in Active Demand Side Participation programs under different pricing schemes

# **University of** Strathclyde **Engineering**

# Han Xu, Ivana Kockar

Department of Electrical and Electronic Engineering, University of Strathclyde, Glasgow Email: {han.xu; ivana.kockar}@strath.ac.uk

# Introductions

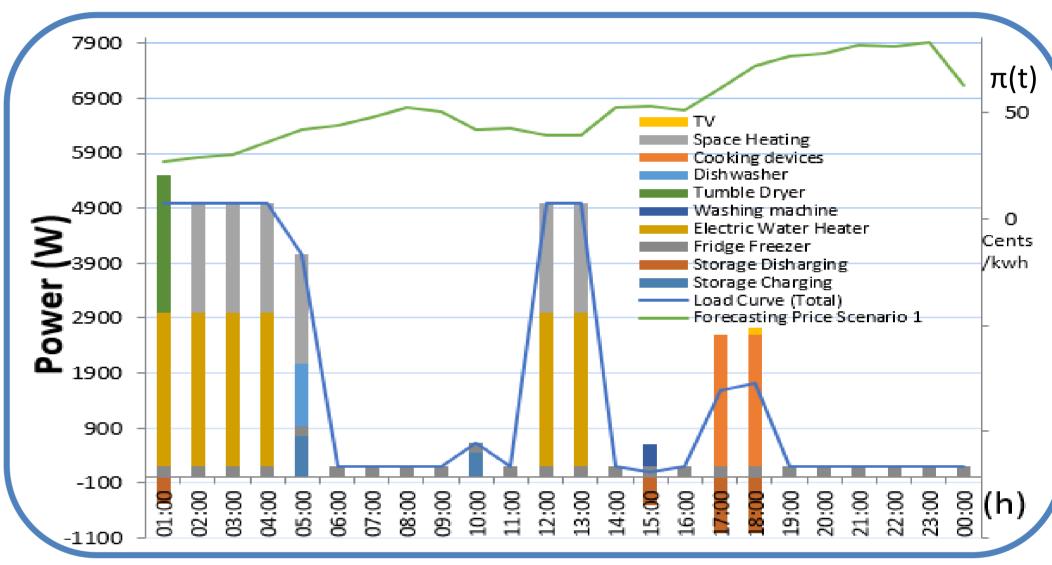
It is known that higher operational flexibility in the electricity markets is required with the implementation of new technologies and penetration of renewable resource. These changes are associated with a shift towards more flexible network operation. A particular emphasis is an expectation that this operational flexibility will be coming from the active demand side engagement. This research outlines an approach that enables consumers take part in Active Demand Participation program and help them decide how to schedule various appliances within the household. A scheduling tool that enables participating customers to automatically respond to the inflow price signals that may vary during a day is presented.

### Results Price Plan 1 Electric Water Heater $_{\pi(\pm)}$ Price Scheme 1 - Economy 7 3000 Fridge Freezer — Load Curve (Total) System 1 1000 Cooking devices System 2 Washing machine

### Consumer-based Scheduling Tool

- Different from the external direct load control method
- An intelligent tool which could help consumers rescheduling their home appliances in individual households automatically
- On the basis of consumers' preferences and predefined daily electricity consumption patterns





#### Research Methodology **Background Information Tool** Study Configurations (Consumer electricity consumption (Tool's objective, constraints, patterns, users preferences, price tariffs, inputs & outputs, system) social surveys, DSM methods) **Tool Testing Tool** (Electricity Price data\*; Implementation Results Home appliances data; Energy storage data; Test (Fico Xpress [1]) systems)

# Which Activity Do You Engage in 7-9PM Which Activity Are You Willing to Shift After 9PM Washing Machine Watching TV **Minimize** Cooking Washing machine Subject to: Household constraints Home appliances constraints Energy storage constraints Figure 1. EPRG survey on potential load shifting. [2]

Mathematical Formulation (End-user's energy payments)

\*The electricity price data include predetermined Time of Using price tariffs,

forecasted Real-Time Pricing tariffs by means of ARIMA time series model analysis.

#### TV Space Heating Cooking devices Dishwasher ■ Tumble Dryer Washing machine Electric Water Heater Fridge Freezer Storage Disharging Storage Charging $\pi(t)$ 6900 Load Curve (Total) Forecasting Price Scenario2 25 5900 **S** 4900 3900 2900 Cents 1900 900 -100 -1100

#### **Conclusions**

The consumer-based demand side management tool helps active participation consumers changing their electricity consumption patterns corresponding to different price notifications intelligently. Moreover, the tool succeeds in achieving its goal in energy bill savings and fulfills consumers' needs at the same time.

#### **Future Work**

- Expand the system of the tool, e.g. more home appliances, different types of energy storage devices (EVs), etc.
- Add more flexibility and stochasticity to achieve dynamic control

#### References

- [1] Fico Xpress [Online] Available: http://www.fico.com/en/products/ficoxpress-optimization-suite/
- [2] L. Platchkov, M. G. Pollitt, D. Reiner, I. Shaorshadze, "2010 EPRG Public opinion survey: policy preferences and energy saving measures," Cambridge, Electricity Policy Research Group, Faculty of Economics, University of Cambridge.



