Energy Management & Utilization

Chapter 6

Demand-Side Management

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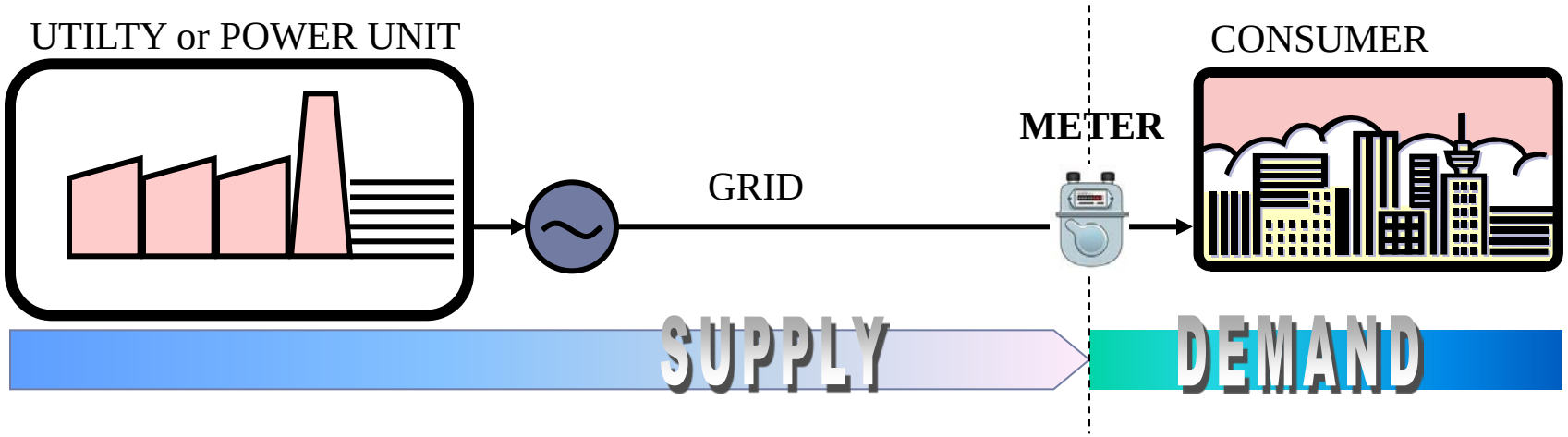
What is Understood from Demand-Side Management?



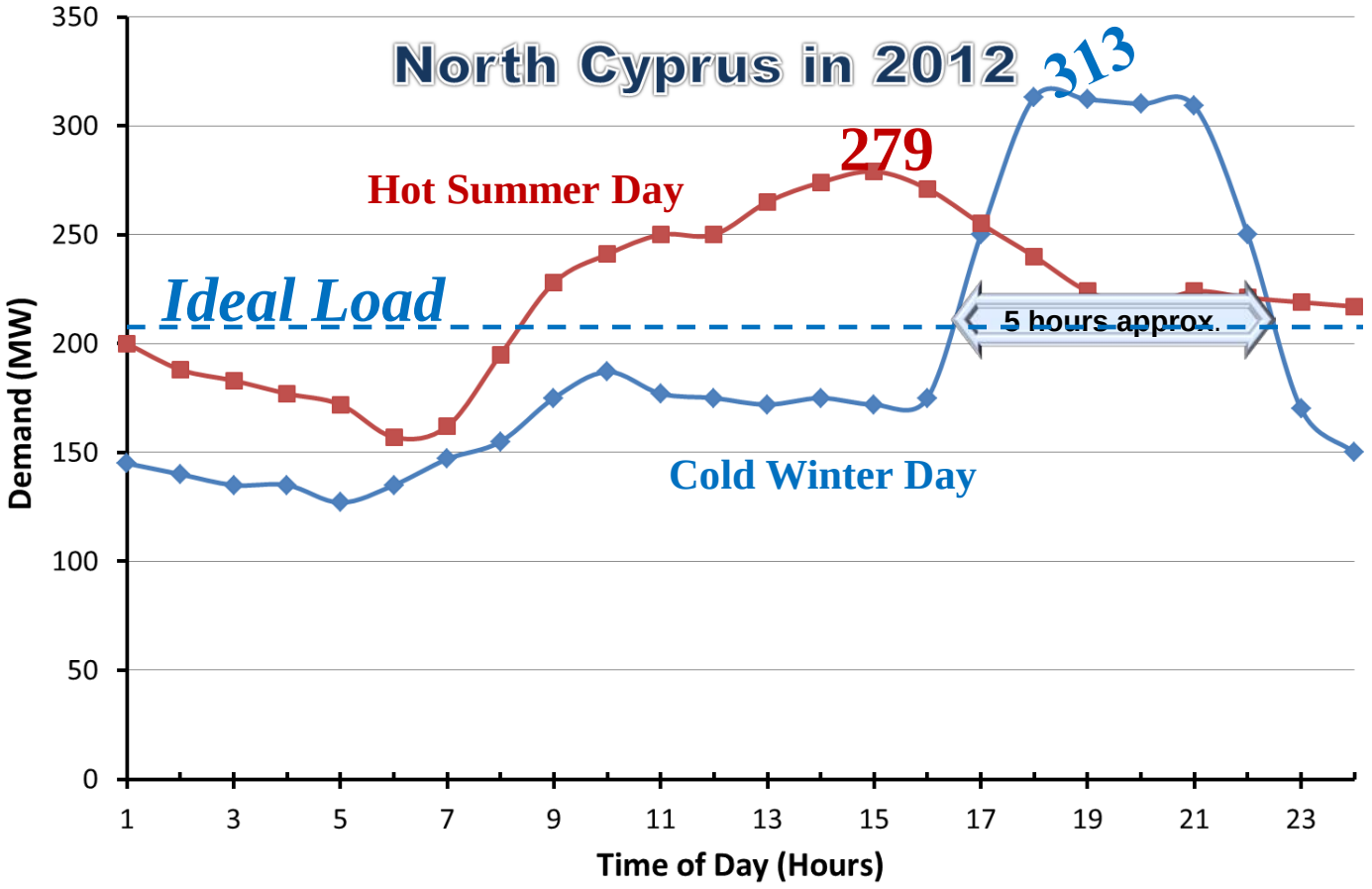
“Activities that involve actions on the demand or customer side of electric meter, either directly or indirectli stimulated by *the utility*.”

Clark Gellings
(Electric Power Institute, USA) 1984

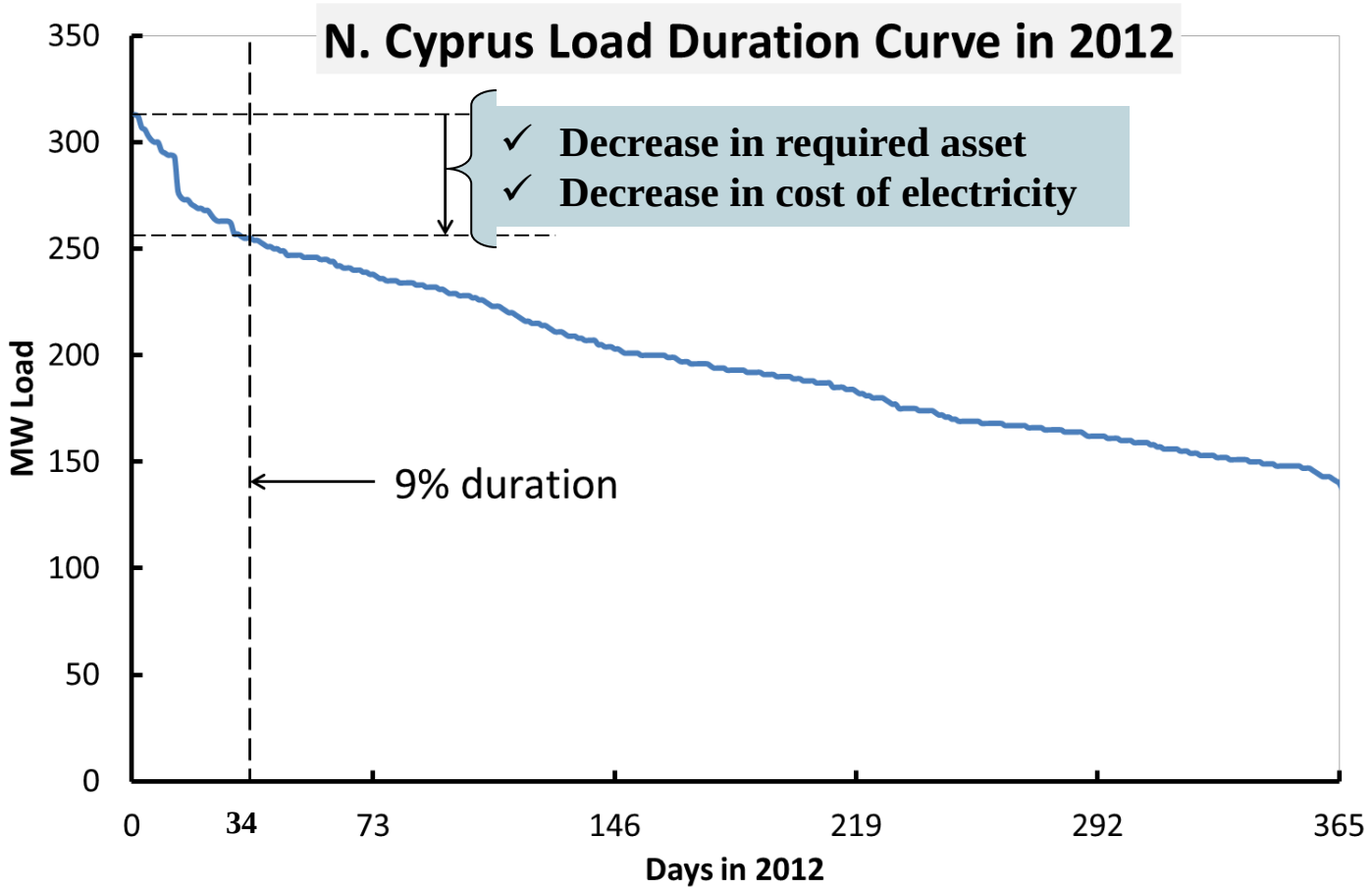
What is Understood from Demand-Side Management?

- The adjustment of consumer demand for electricity by means of financial incentives (such as rebates) or education is termed demand-side management (DSM)
- The main objective of DSM is to
  - encourage the consumer to use less energy during the peak hours
  - use different sources of energy replacing electricity during peak hours
  - move the time of energy use to off-peak times (such as after mid-night or weekend)
  - reduce the need for investments in the electricity networks

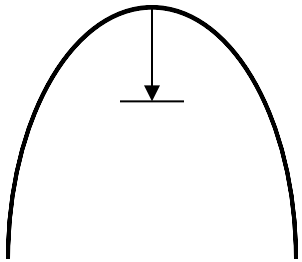
Typical Daily Demand Curves



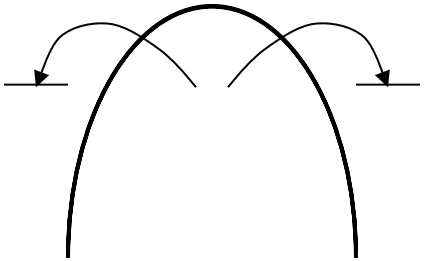
Typical Duration Hours for Maximum Peaks



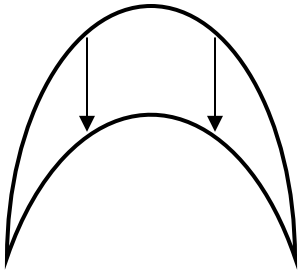
Load Leveling Strategies



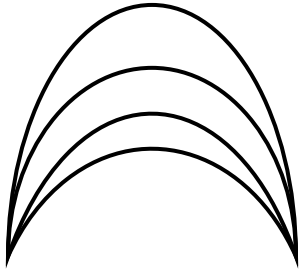
Peak clipping



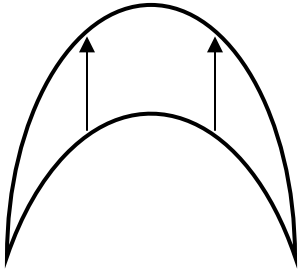
Load shifting



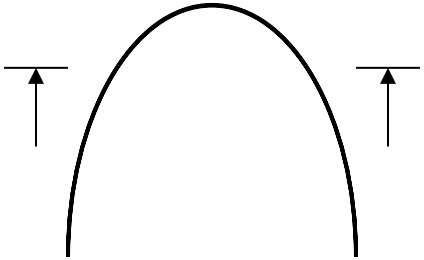
Strategic conservation



Flexible load shape



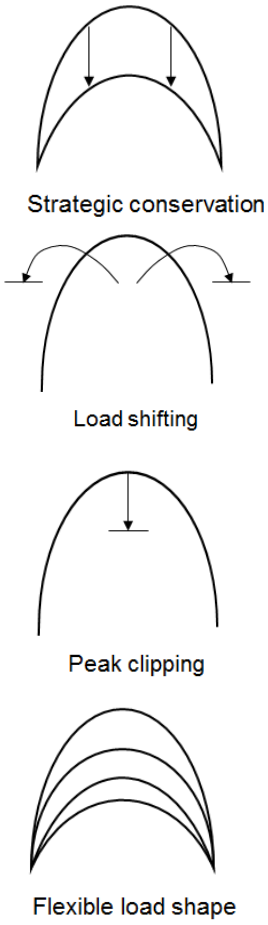
Strategic load growth



Valley filling

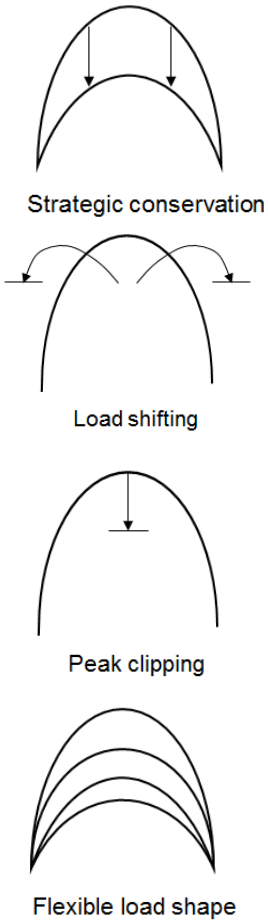
Examples of DSM Technologies: Residential Sector

	Residential measures	Impact on demand curve
Energy Efficiency	Thermal Insulation	Strategic conservation
	Double glazing windows	Strategic conservation
	Energy efficient motors	Strategic conservation
	Efficient appliances	Strategic conservation
Time of Use	Heat Storage	Valley filling/Load shifting
	Timers	Valley filling/Load shifting
	Instantaneous electric water heaters	Load shifting
Disconnect	DHW cyclic control	Peak clipping/strategic conservation/flexible load
	Gas heaters	Peak clipping
	Photovoltaic systems	Peak clipping/strategic conservation

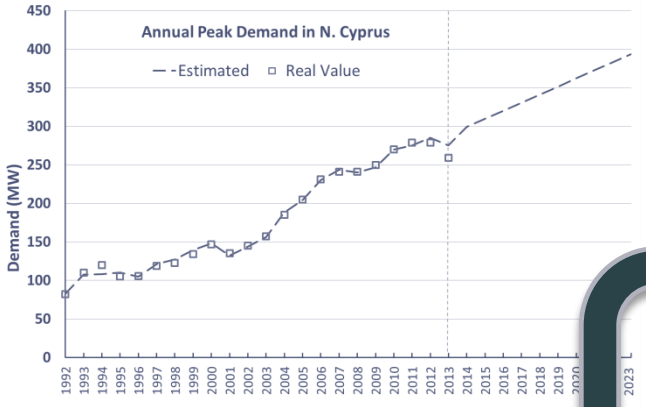


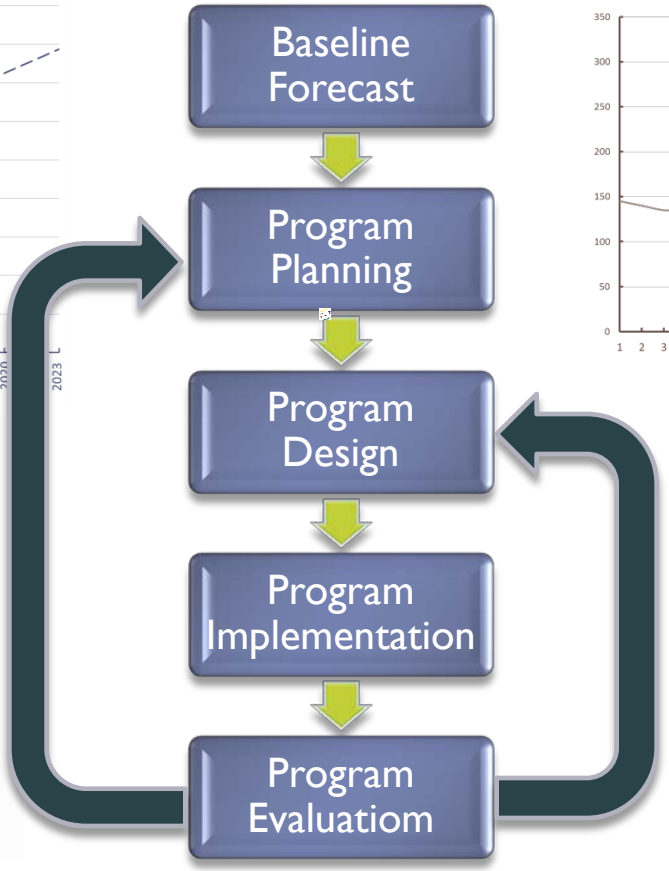
Examples of DSM Technologies: Commercial/Industrial Sectors

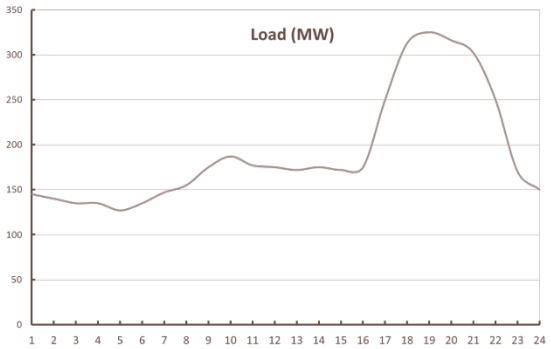
	Commercial and Industrial measures	Impact on demand curve
Energy Efficiency	Insulation/double glazing	Strategic conservation
	Efficient appliances	Strategic conservation
	CFL or LED lamps	Strategic conservation
	Energy efficient motors	Strategic conservation
	Heat pump water heaters	Strategic conversation
Time of Use	Time of use controllers	Load shifting
	Cool storage	Load shifting
Disconnect	Gas heaters	Peak clipping
	Industrial process heat exchangers	Peak clipping/strategic conservation
	Cogeneration	Peak clipping



A Simple DSM Planning Cycle





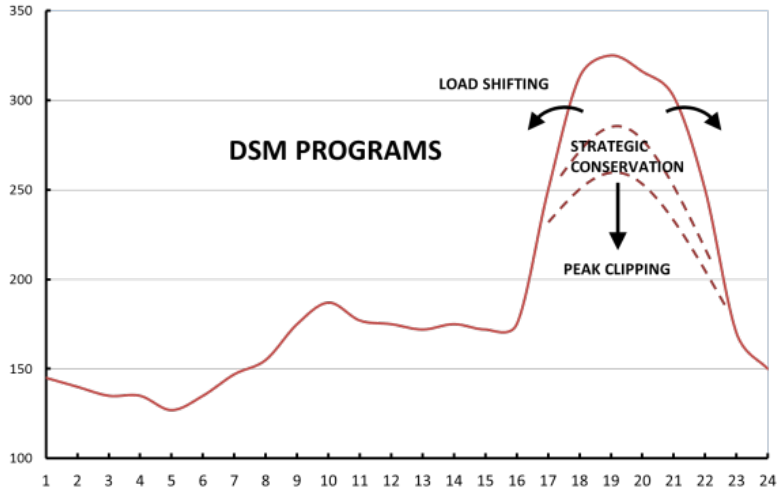


Cost Effectiveness Requirement in DSM – *The Traditional Approach*

- The costs associated with any DSM program must be less than any «equivalent» supply-side option. (i.e., $NPV = PV_{AS} - PV_I$)

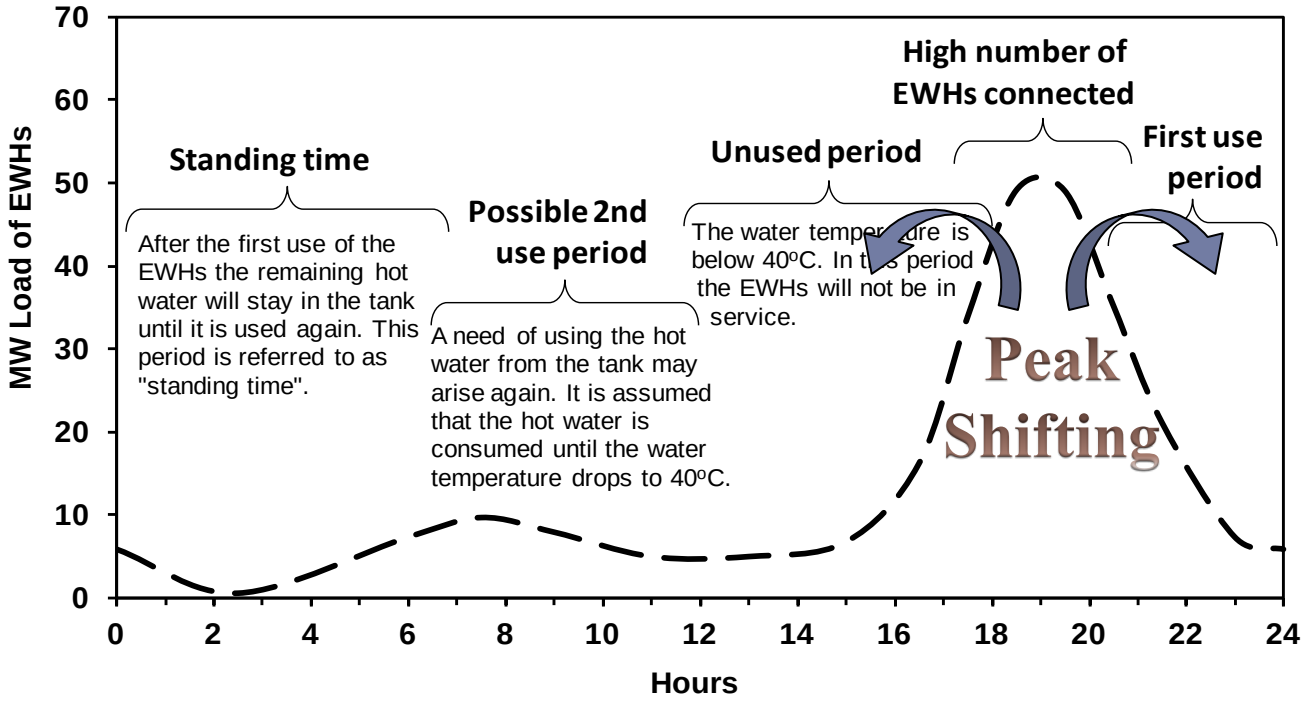
Equivalent Power Plant Cost

Rebate payments and other costs of DSM



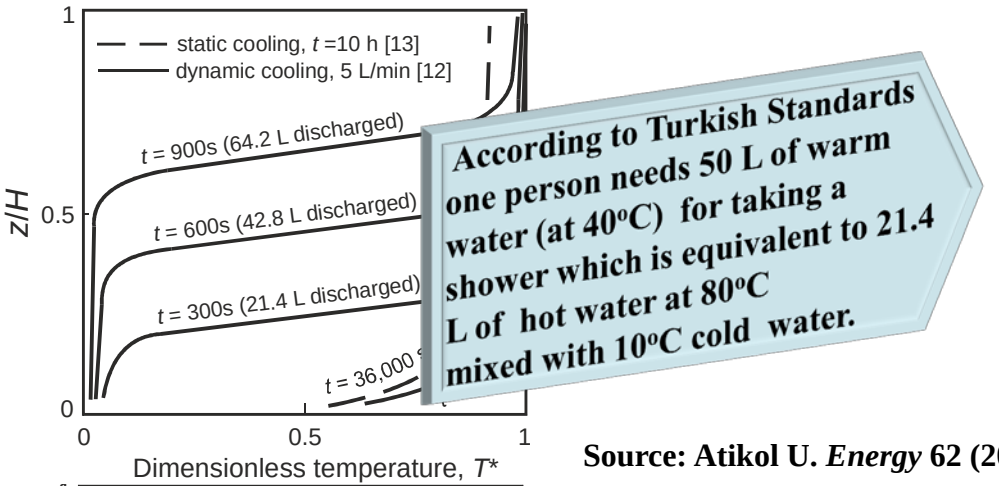
Example of a DSM Program for Electric Water Heaters

- Hot water consumption pattern explored
- Two-stage discharging is assumed

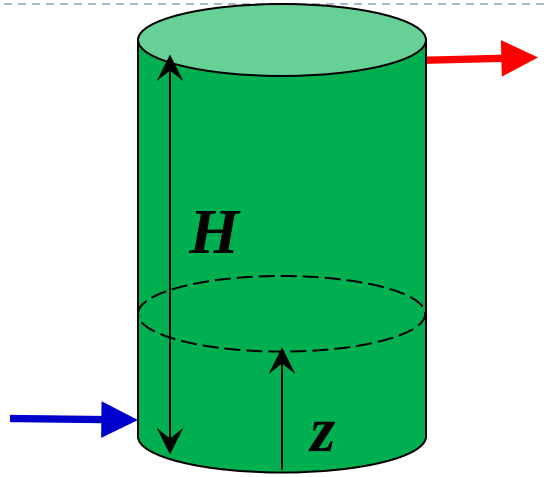


Source: Atikol U. *Energy* 62 (2013) 435-440.

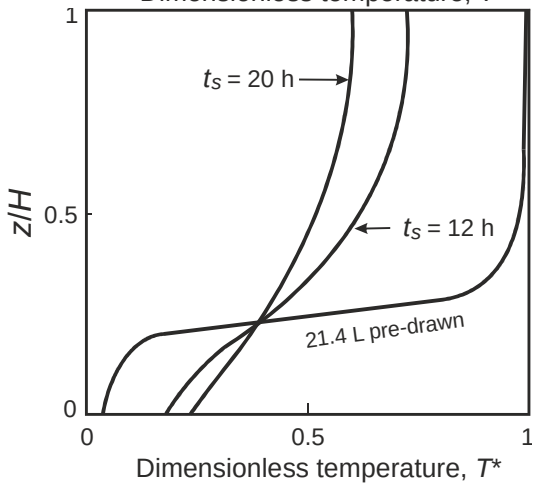
The Effect of Standing time on Temperature

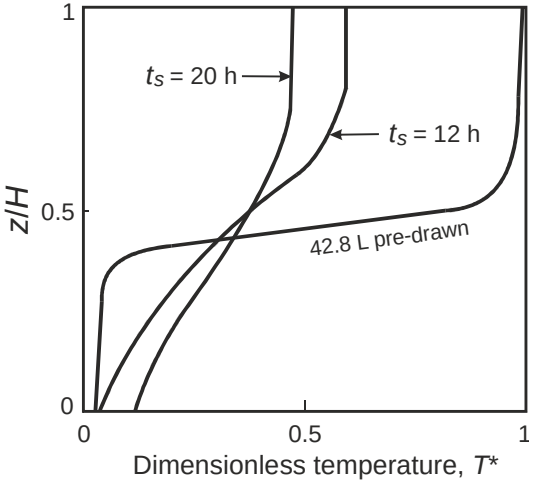


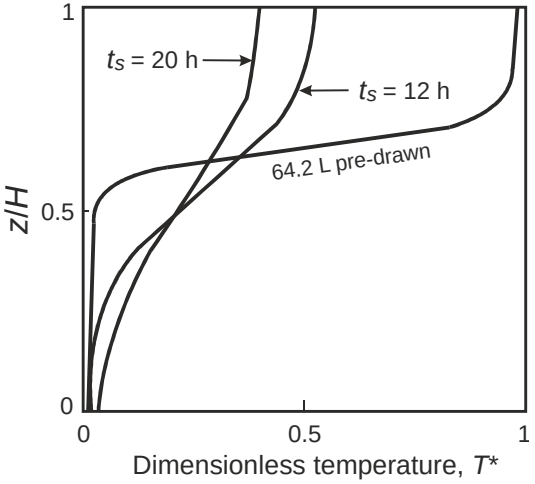
According to Turkish Standards one person needs 50 L of warm water (at 40°C) for taking a shower which is equivalent to 21.4 L of hot water at 80°C mixed with 10°C cold water.



Source: Atikol U. *Energy* 62 (2013) 435-440.



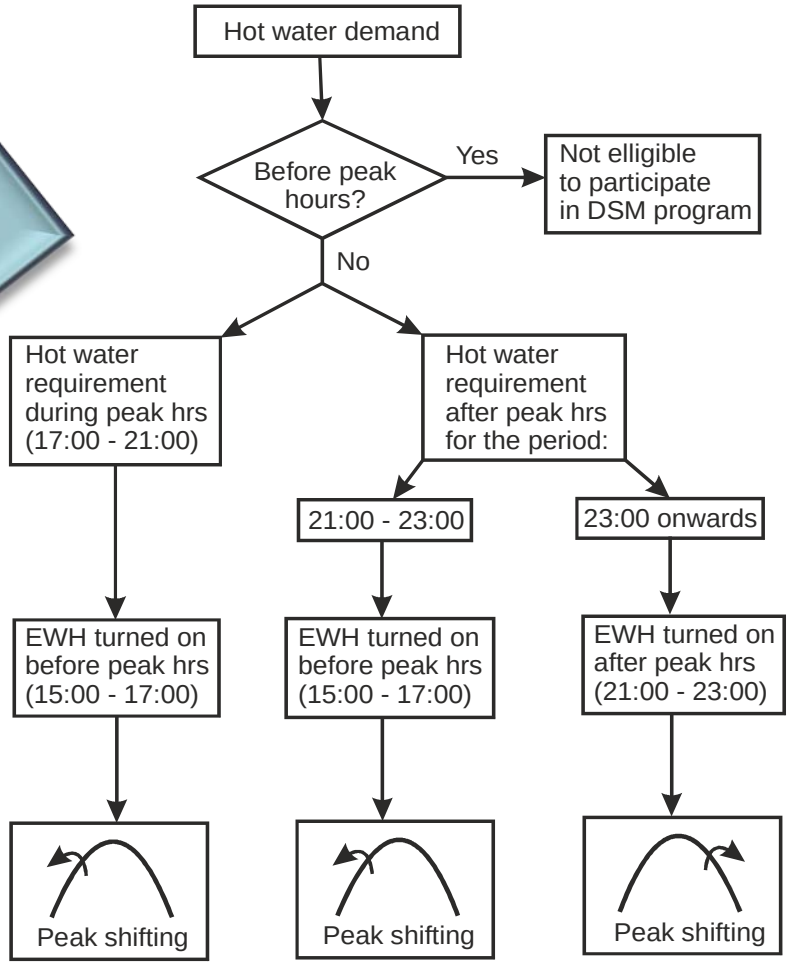




DSM Program Implimentation Options

Timer setting strategy that can be employed in N. Cyprus

By controlling the connection times of the EWHs instead of the disconnection times, the utilities can have more control over the hourly load curve



Source: Atikol U. *Energy* 62 (2013) 435-440.

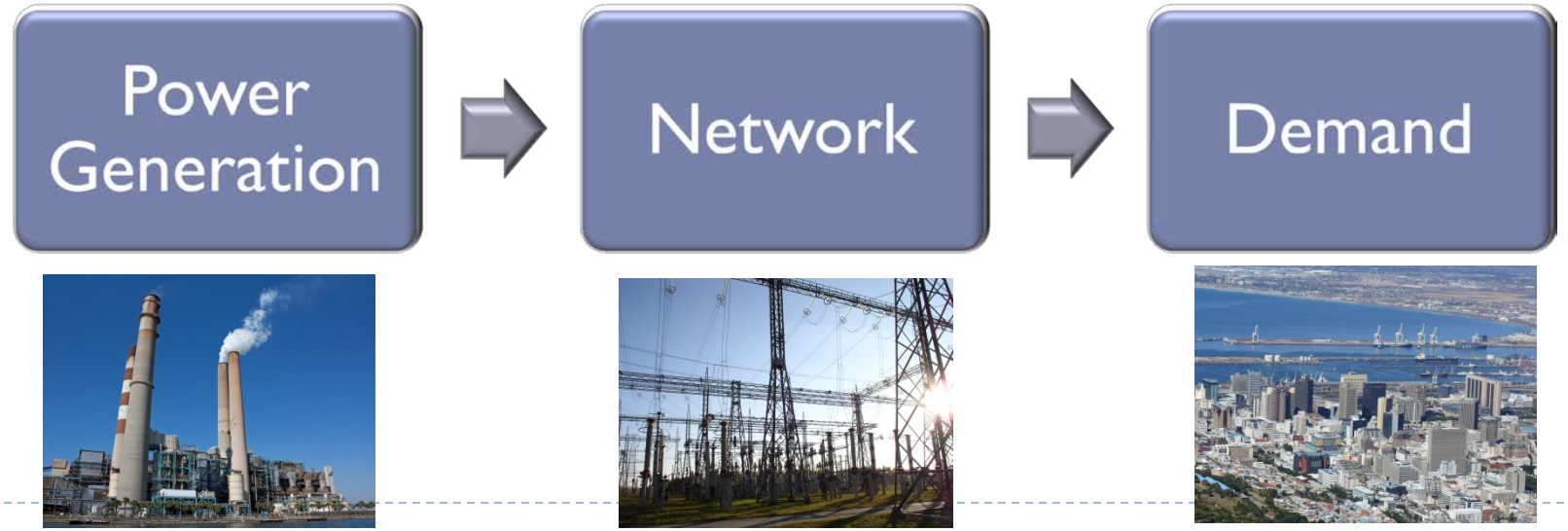
Cost-Effectiveness of the Peak-Shifting DSM Program

- Cost of each timer + installation **$42 USD**
- 5667 houses selected (5667 x 3kW→17 MW)
- Rebate **$200** → Total cost of program **$242**
- Total cost of timer installations = **$1,371,414**
- A 17-MW power plant costs **$12,000,000.-**
- Avoided cost is **$ 10,628,586 USD**
- Cost effectiveness is **12.4 W /$**

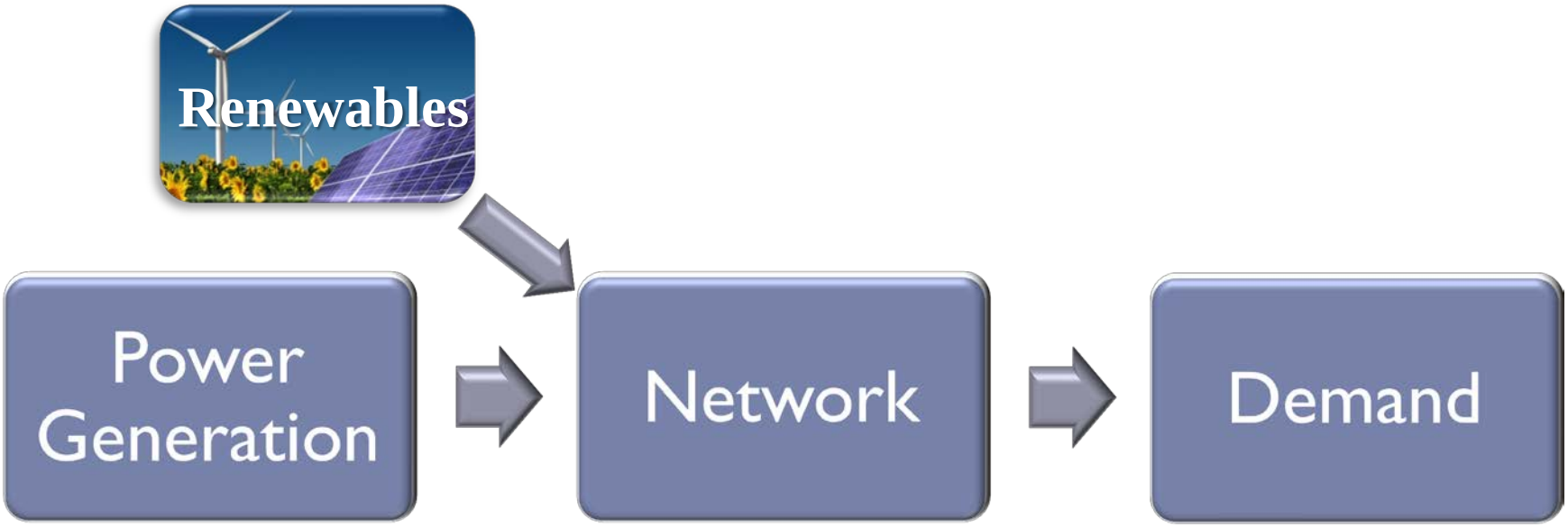
Source: Atikol U. *Energy* 62 (2013) 435-440.

Importance of DSM for Networks

- The capacity of network needs to be taken into account →Helps regulating the power in the network.
- Even though the installed power is sufficient for meeting the demand if the network capacity is not good, then demand may not be met.
- DSM needs to be applied



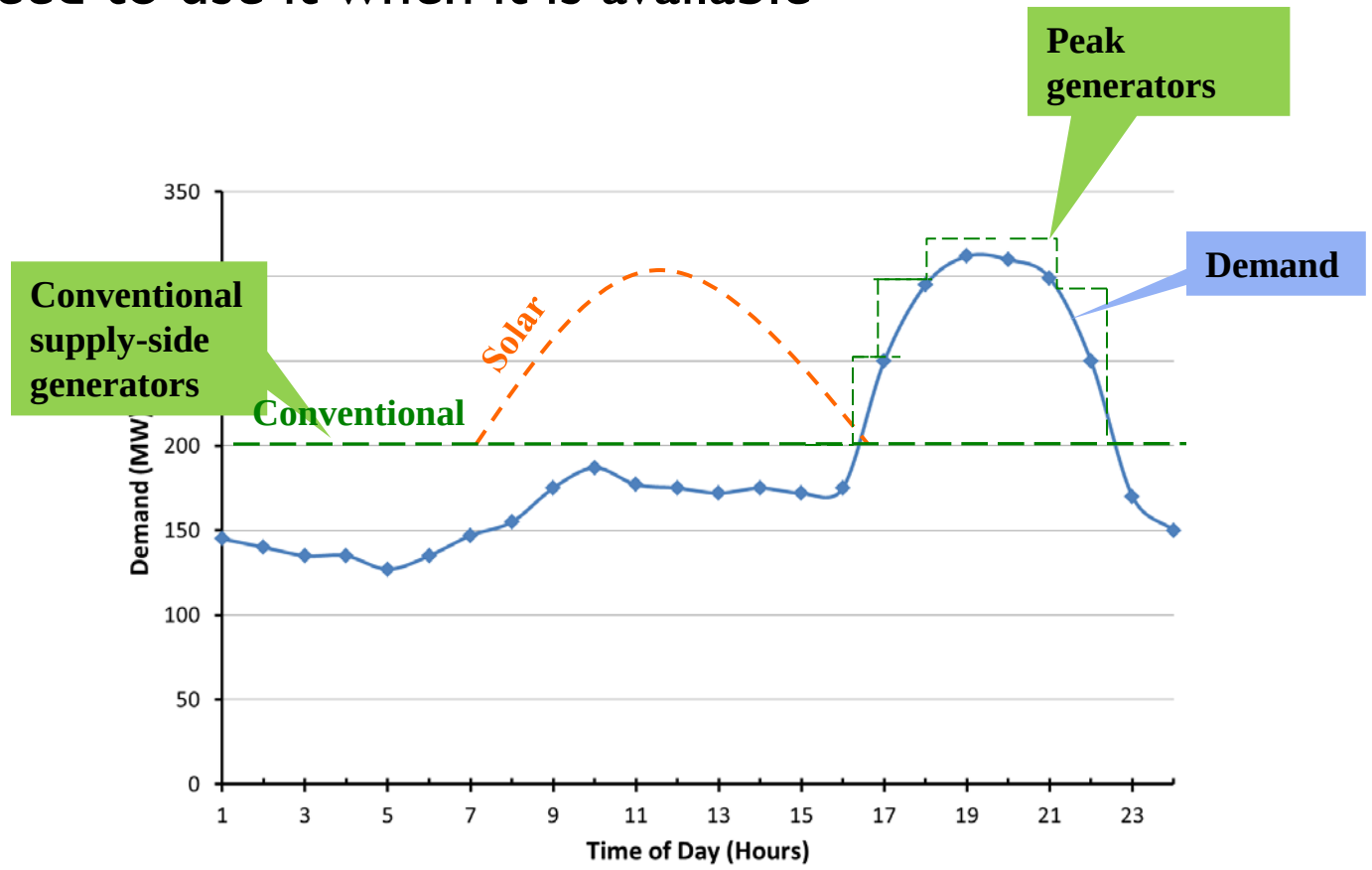
Renewables Complicate the Problem Further



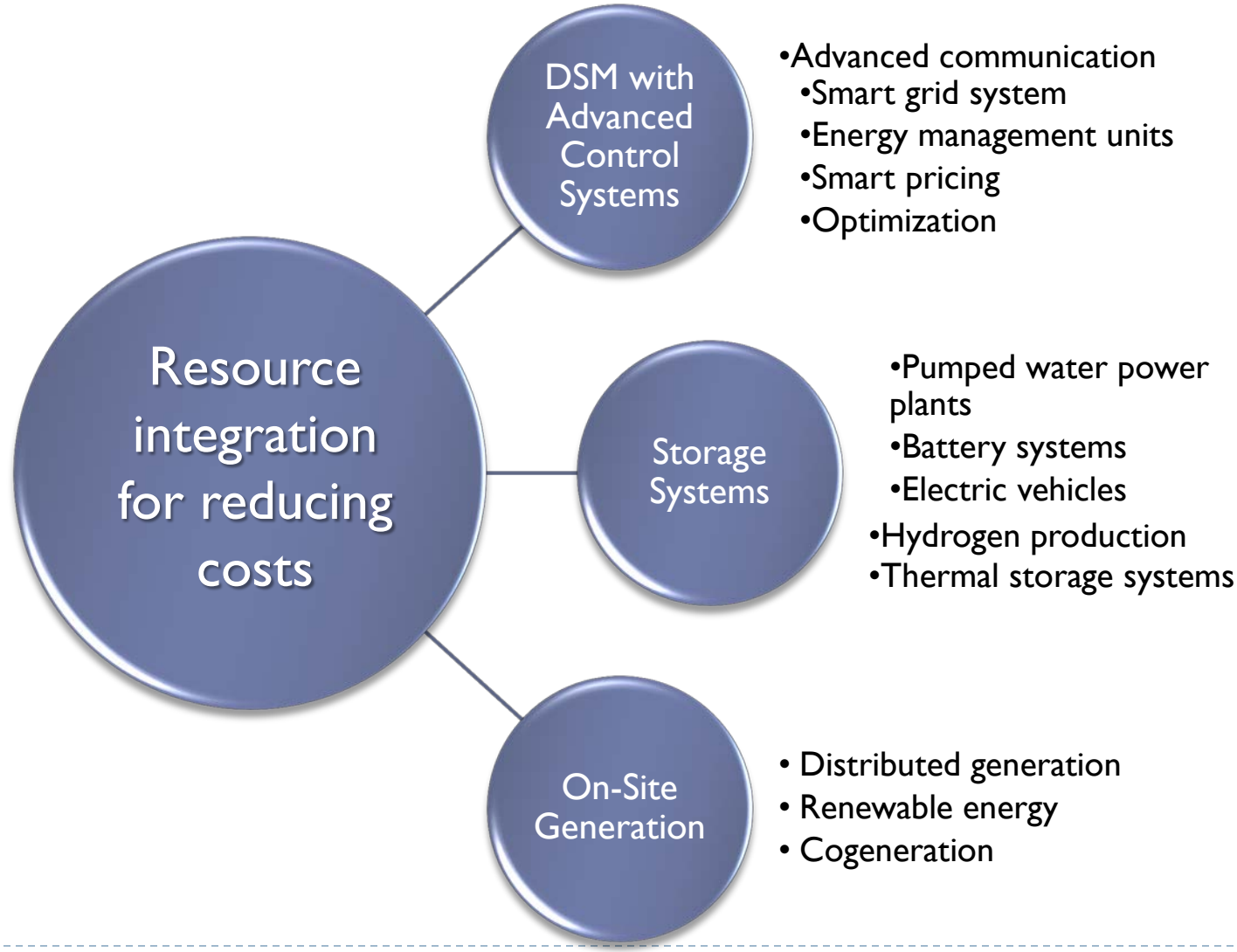
- ✓ Renewable energy may be available when there is no demand
- ✓ Demand needs to be modified to use the renewable power when it is available – **DSM needs to be applied !**

A Whole-System Management for Lower Prices

- Electric energy is volatile
- Need to use it when it is available



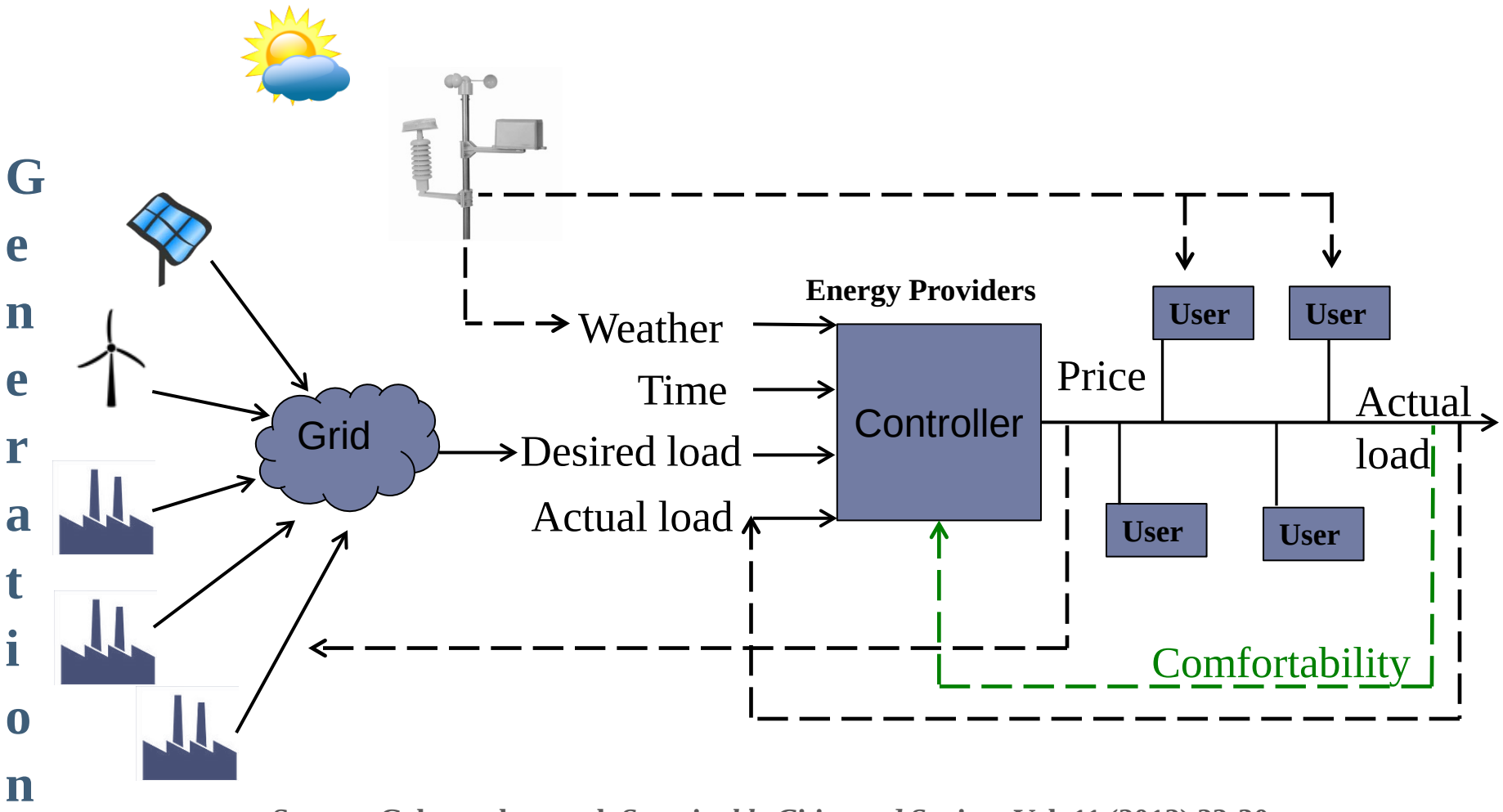
A Whole-System Management for Lower Prices



Future Directions

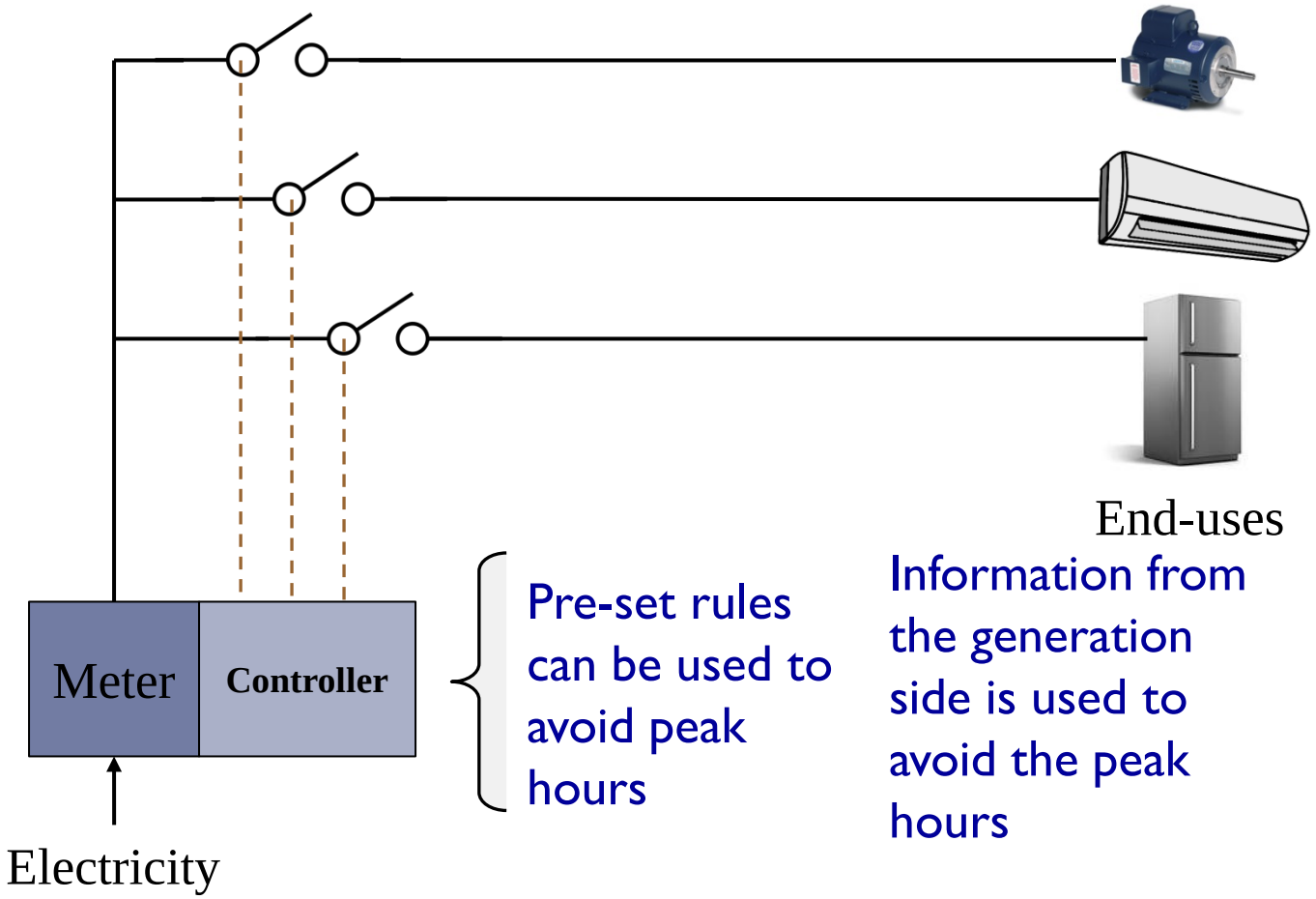
- Advanced control systems for the network to exchange communication with the end-users
- Smart grid is helpful
- Smart pricing
- Demand response
- Energy storage strategies
- On-site generation of electricity

Demand Response Based on Advanced Control Theory



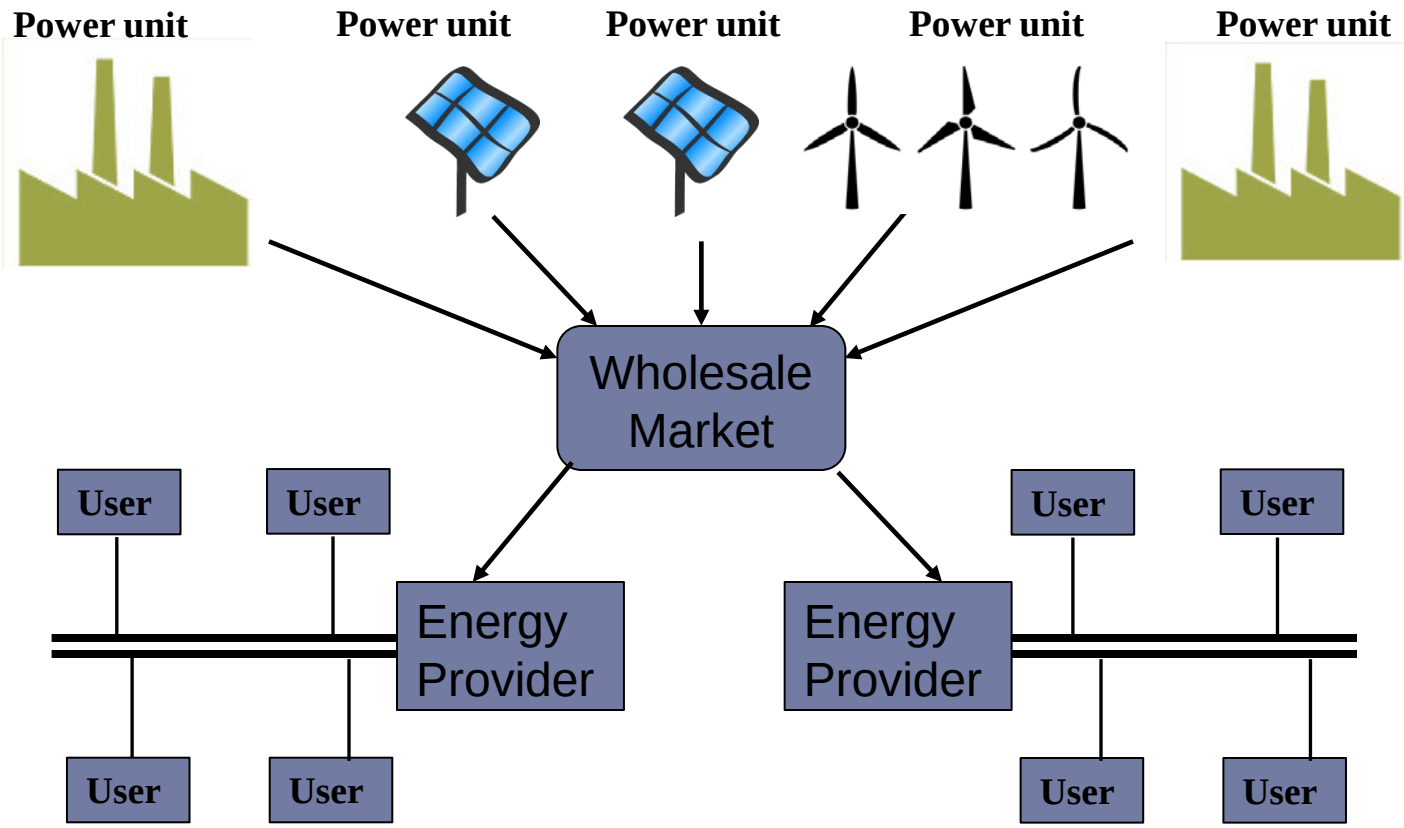
Source: Gelazanskas et al. *Sustainable Cities and Society.* Vol. 11 (2012) 22-30.

Energy Controllers on the Demand-Side



Source: Palensky et al. *IEEE Transactions on Industrial nformatics.* Vol. 7 (2011) 381-388.

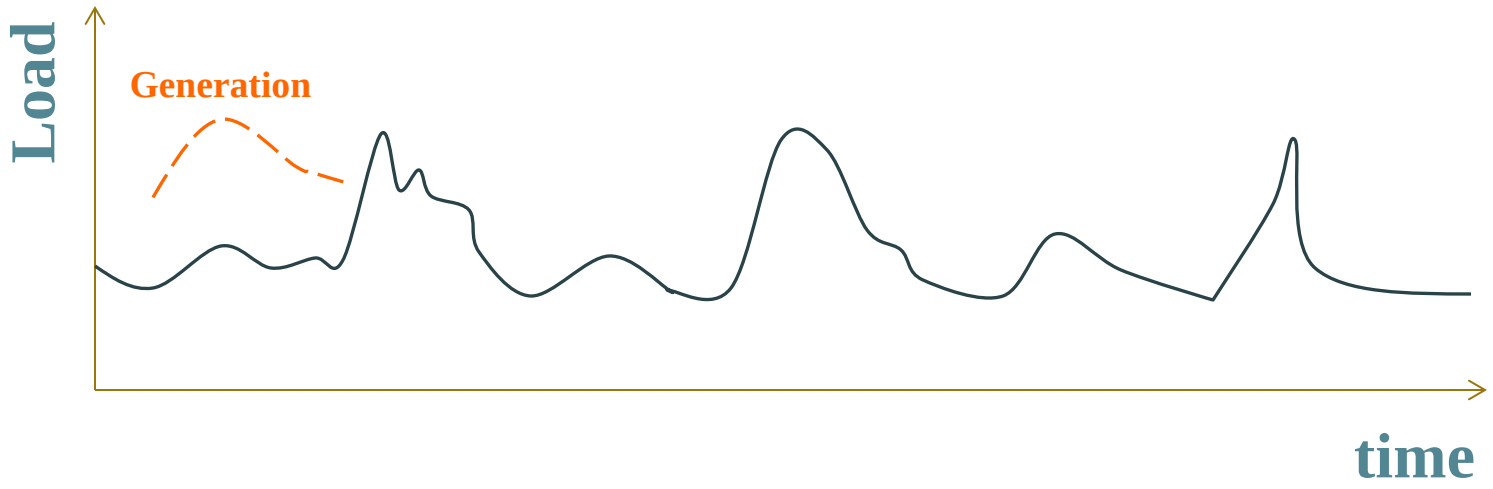
Wholesale Electricity Market and Pricing of Electricity



Source: Samadi et al. *IEEE Transactions on Smart Grid.* Vol. 3 (2012) 1170-1180.

Approaches in Pricing of Electricity

- Average pricing
- Peak load pricing
- Adaptive (real-time) pricing



Common Barriers for DSM in Developing Countries

- Lack of finance
- Inadequate incentives
- Inappropriate institutional structure
- Lack of policy framework
- Habits, traditions and cultural issues
- Poor public awareness
- Lack of technical expertise and know-how