The Potential and Economic Case for Deploying Smart Appliances in Europe

Smart-A Workshop
Berlin, Germany
15 June 2009

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System Attributes Calling for Smart Appliances

- Low flexibility of generation system
- High share of intermittent generation (but not too high!)
- High cost and emissions of marginal generation capacity
- Congested grid (but not too low tie line capacity)

→ Focus on specific regions is reasonable, particularly for development phase and early market engagement

Appliance/User Specific Attributes Calling for Smart Appliances

Major aspects

- High specific controllable load per appliance
- High total controllable load (sufficient appliances penetration)
- High temporal availability of controllable load (24/7)
- At least medium flexibility / duration of load rescheduling
- High consumer acceptance for smart use of the respective appliance
  - Due to low impact (e.g. all storage technologies) or
  - High incentives (high difference between value and cost)

Appliances Fulfilling Required Criteria

	WM	TD	WD	DW	RF	FR	AC	CP	WH
High specific load	(+)	+	+	(+)			+	+	+
High maximum load		+	+				+	+	+
High availability					+	+	(+)	+	(+)
Shifting flexibility	(+)		(+)	+					
Low impact for cons.				+	+	+	+	+	+

excluded: OS (no flexibility); EH (out of scale, to be substituted anyway)

System Value of Smart-A

Modelling results indicate that only limited value is to be distributed

- cycle based operation

	usage [cycles/year]	value [EUR/year]	value [EUR/cycle]
WD	120	13,75	0,11
WM	169	3,13	0,02
DW	203	6,25	0,03

- (quasi) constant operation

	avg. energy load [W]	max. value [EUR/year/kW]	max value [EUR/app/year]
RF	87	60	5,22
FR	89	60	5,34
AC	71	60	4,26
CP	75	60	4,50
WH	113	60	6,78

Source: calculations based on Final Reports of Smart-A WP2 and WP4

Note: assumptions for value calculations are not consistent; no investment/transaction cost included

Distribution of Cost and Benefit amongst Actors

- Actor will only decide to participate in a programme if his individual benefit is greater than his cost
- Individual consideration of benefits and costs also includes effects which are partly compensating each other with regard to overall benefit
  - E.g. stranded cost for existing conventional capacities vs. new incomes for smart appliance manufacturers
- Smart-A modelling does not differentiate between
  - Direct benefits for active market participants *and*
  - „Diffuse“ market-wide benefits

Relevant Actors in the Smart-A System

- Smart Consumer (SC, operator of the Smart Appliance (SA))
- Other energy consumers
- The supplier of the SC
- All other suppliers
- The distribution system operator of the SC
- Transmission system operators
- Balance market clients
- Power plant operators
  - Generators operating in the kWh market
  - Wind generators
  - Other providers of Balancing Power
- The manufacturers of SA
- Aggregators and service providers for SA
- (Society)

Note: Actors can play various roles within the overall system.

Costs and Benefits of Balancing with Smart Appliances

Effect of SA	Benefit/Cost	Beneficiary/ Disadvantaged	Possible secondary effect / transfer
Replacing/ complementing conventional balancing technology	Cheaper balancing power	Balancing market client	Pass on benefits to aggregators/smart consumers
	Operational cost for SA services	Service provider for SA	
	Operational cost and inconveniences	Smart consumer	
	Stranded cost of conventional balancing	Conventional balancing power provider	---
	Reduced wind spill	Wind power producers	Pass on benefits to aggregator / smart consumer
	Reduced CO2 emissions by reduced wind spill	Society	Subsidies to smart-a actors or regulatory measures
	Reduced market price by reduced wind spill	Suppliers	Pass on benefits to suppliers/ aggregators / consumers

Conclusions for Smart Appliances

- Market development:
  - Investment cost and control technology have to be minimised (bidirectional communication necessary?)
  - Inconvenience for users (implicit requirement for high incentives) has to be minimised
    - Minimisation of „active“ participation
    - Ideally no sensible impact on users

  → Storage appliances are probably most promising
- Longer term:
  - Realize potentials of further appliances

Implications for incentive strategies?

General Classification of Incentive Strategies for DSM

- Getting paid for smart operation
  - Fix upfront incentive
  - Market based upfront incentive
    - e.g. capacity market
    - Ancillary services (payment for availability / use)
- Having to pay less for smart operation
  - Time of Use-Tariff
  - Real Time Pricing
  - Critical Peak Pricing
  - …

Indicative List of Value Allocation Measures

- Lump sum subsidy from “the electricity system” to the manufacturer, retailer or buyer of the Smart-A
- Incentive for user readiness for automatic Smart-A operation based on external signal
- Long-term approach:
  - Cycle-based incentive for the actual use of Smart-A
  - Real Time Pricing (appliance-specific?)
- Increase in general electricity tax; revenues to be used for public incentives for Smart-A
- …

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