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Availability of Smart Technologies in India

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Domains and impact criteria - Recap

In the SRI service catalogue, services are structured along 9 domains: **Heating, Cooling, Domestic Hot Water, Controlled Ventilation, Lighting, Dynamic Building Envelope, Electricity, Electric Vehicle Charging, Monitoring and Control**



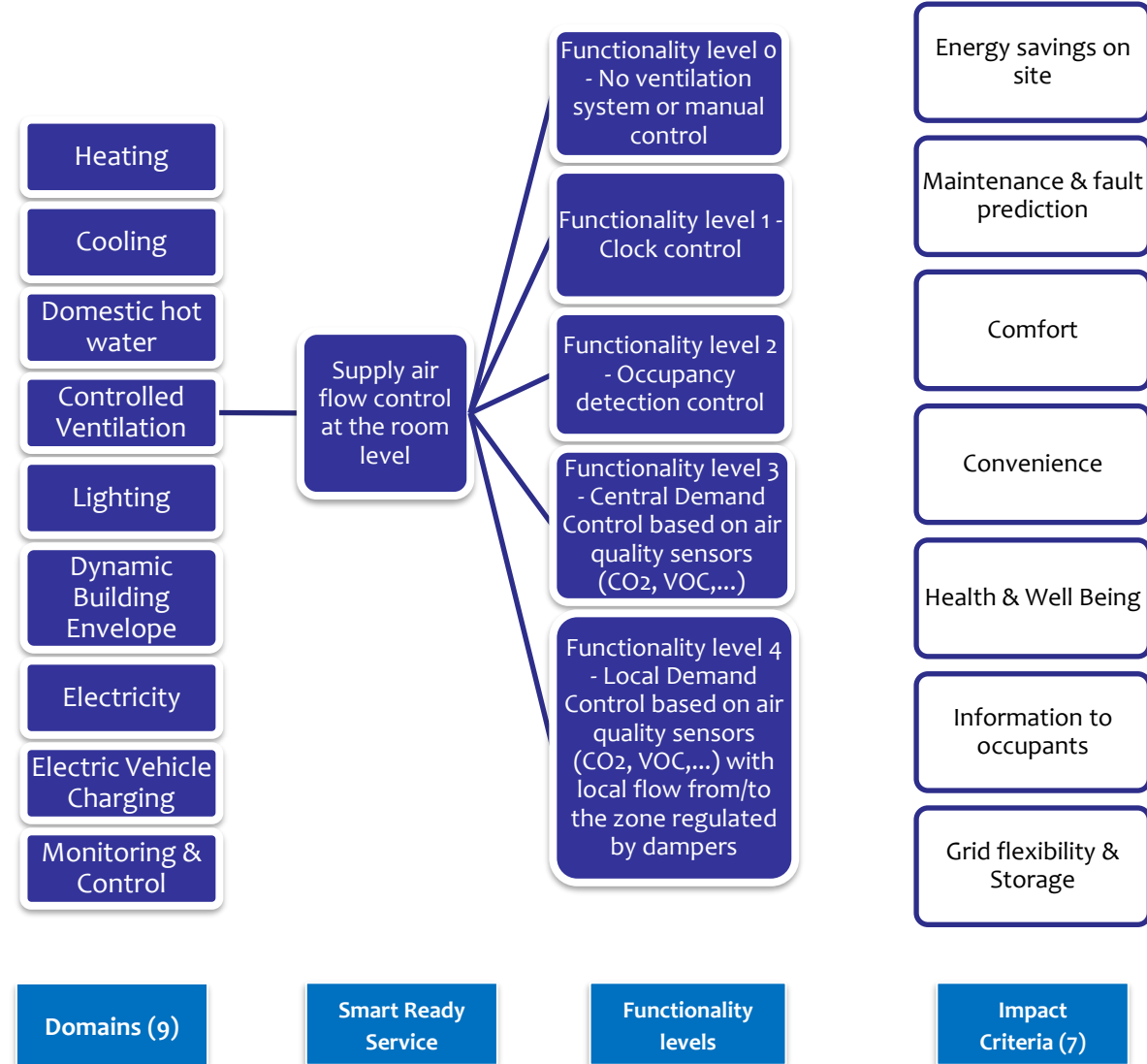
Impact criteria:



SRI Catalogue - Recap

A smart ready service can provide several impacts to the building, its users and the energy grid. An example of **‘Supply air flow control at room level’** as a Smart Ready Service is presented.

For each of the services, 2 to 5 functionality levels are defined. A higher functionality level reflects a “smarter” implementation of the service, which generally provides more beneficial impacts to buildings, its users or to the grid compared to services implemented at a lower functionality level.



Penetration of smart technologies in India



Impact of smart services under ‘Cooling’ domain – EU perspective

Assessment done on “cooling emission control” smart service in Europe



Mapping of potential impact of all smart services against SRI impact criteria

Fn Lvl	Fn Lvl Name	Energy savings on site	Flexibility for the grid and storage	Comfort	Convenience	Wellbeing and health	Maintenance & fault prediction	Information to occupants
0	No automatic control	0	0	0	0	0	0	0
1	Central automatic control	+	0	+	+	+	0	0
2	Individual room control	+	0	+	++	++	0	0
3	Individual room control with communication between controllers and to BACS	++	0	++	+++	++	+	0
4	Individual room control with communication and occupancy detection	+++	0	++	+++	++	+	0

Each functionality level is given an ordinal ranking (---- to +++) based on SRI impact criteria

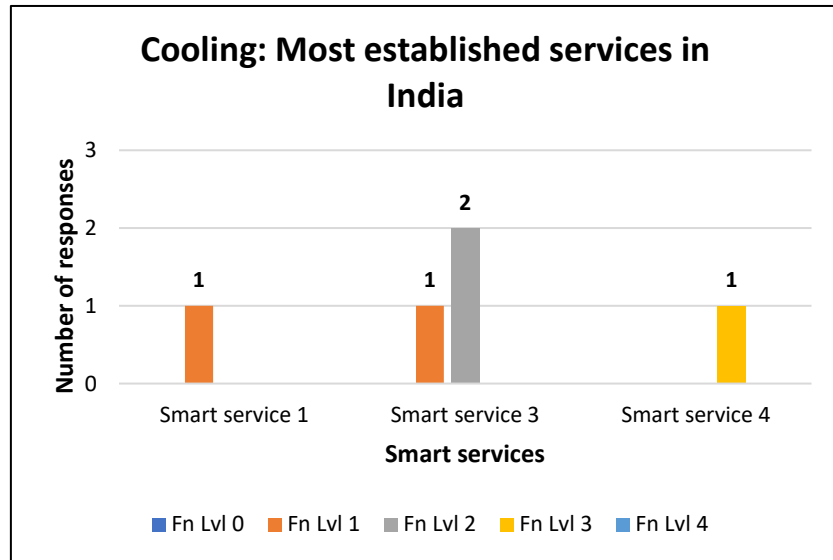
“----” indicates lowest impact

“++++” indicates highest impact

		Highest impact		Moderate impact		Low impact		No impact	
S.No.	Smart Service Name	Energy savings on site	Flexibility for the grid and storage	Comfort	Convenience	Wellbeing and health	Maintenance & fault prediction	Information to occupants	
1	Cooling emission control	Green	White	Orange	Green	Orange	Yellow	White	
2	Emission control for TABS (cooling mode)	Orange	White	Orange	Green	Orange	Yellow	Yellow	
3	Control of distribution network chilled water temperature (supply or return)	Orange	White	Yellow	Yellow	White	White	White	
4	Control of distribution pumps in networks	Orange	White	White	White	White	White	White	
5	Interlock: avoiding simultaneous heating and cooling in the same room	Green	White	White	White	White	White	White	
6	Control of Thermal Energy Storage (TES) operation	Orange	Orange	White	White	White	White	White	
7	Generator control for cooling	Orange	Green	Orange	White	White	White	White	
8	Sequencing of different cooling generators	Green	Green	White	White	White	White	White	
9	Report information regarding cooling system performance	Yellow	White	White	Yellow	White	Green	Green	
10	Flexibility and grid interaction	Orange	Green	Green	Green	Yellow	White	White	



Results of the survey - Cooling



Smart service 3 - Control of distribution network chilled water temperature (supply or return)

Fn Lvl 2 - Demand based control

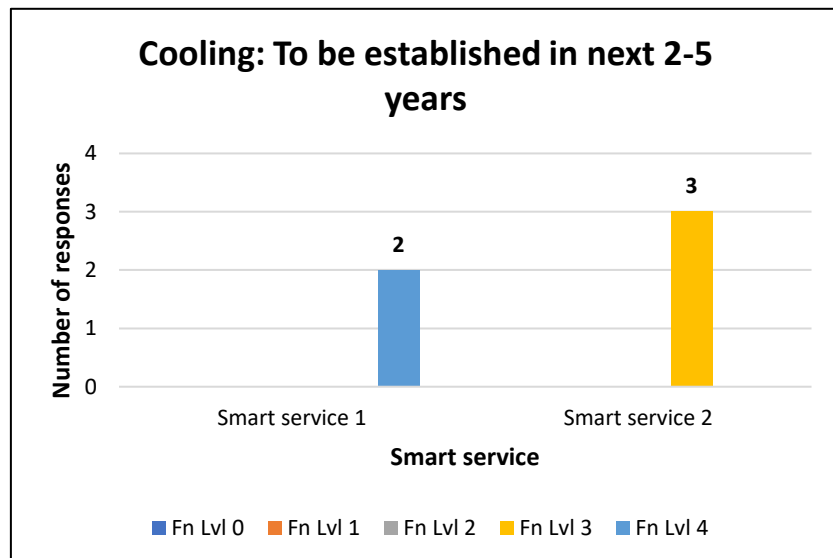
Fn Lvl 1 - Outside temperature compensated control

Smart service 4 - Control of distribution pumps in networks

Fn Lvl 3 - Variable speed pump control (pump unit (internal) estimations)

Smart service 1 - Cooling emission control

Fn Lvl 1 - Central Automatic Control



Smart service 2- Emission control for TABS (cooling mode)

Fn Lvl 3 - Advanced central automatic control with intermittent operation and/or room temperature feedback control

Smart service 1 - Cooling emission control

Fn Lvl 4 - Individual room control with communication and occupancy detection

Factors for successful establishment of smart services

1. Consumer awareness about energy efficiency
2. Less maintenance of system
3. Less capital cost

Drivers for successful establishment in next 2-5 years

1. Consumer awareness about energy efficiency
2. Convenience
3. Less maintenance of system



Summary - Cooling

Market scenario of smart services in India

Smart service	Service name	Availability of the smart service	Market scenario of smart services			
			Most established along with EE impact		Potential to be established in the next 2-5 years along with EE impact	
1	Cooling emission control	Fn Lvl 1	Fn Lvl 1	+	Fn Lvl 4	+++
2	Emission control for TABS (cooling mode)				Fn Lvl 3	++
3	Control of distribution network chilled water temperature (supply or return)	Fn Lvl 2	Fn Lvl 2	++		
		Fn Lvl 1	Fn Lvl 1	+		
4	Control of distribution pumps in networks	Fn Lvl 3	Fn Lvl 3	++		
		Fn Lvl 1				
5	Interlock: avoiding simultaneous heating and cooling in the same room					
6	Control of Thermal Energy Storage (TES) operation	Fn Lvl 1				
7	Generator control for cooling					
8	Sequencing of different cooling generators					
9	Report information regarding cooling system performance	Fn Lvl 1				
		Fn Lvl 2				
10	Flexibility and grid interaction					
Services available and established in India						

Smart services with most energy savings potential as per EU analysis

- Smart service 1
- Smart service 5
- Smart service 8

Smart services with potential to be established in future in India

- Smart service 1
- Smart service 2

Most promising smart services

1. **Smart Service 1**- Cooling emission control
2. **Smart Service 2**- Emission control for TABS (cooling mode)
3. **Smart Service 5**- Interlock: avoiding simultaneous heating and cooling in the same room
4. **Smart Service 8**- Sequencing of different cooling generators

Most of the available smart services in India have functionality levels which are still in the nascent stage and there are very few smart services with intermediate or advanced functionality levels.



Impact of smart services under ‘Controlled ventilation’ domain – EU perspective

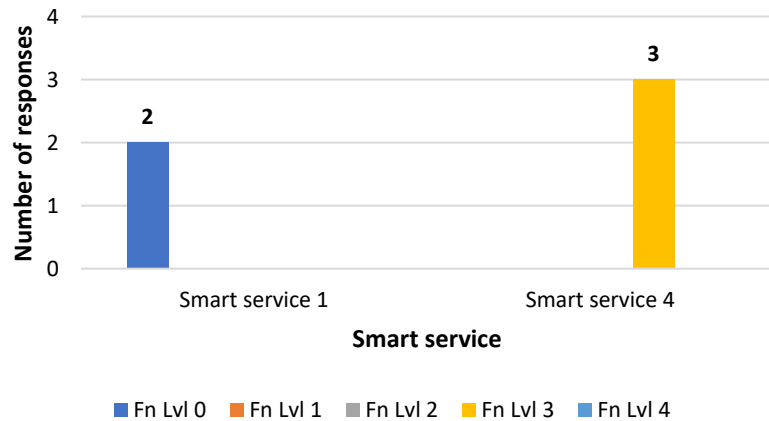
Mapping of potential impact of all smart services against SRI impact criteria

Highest impact		Moderate impact		Low impact			No Impact	
S.No.	Smart service name	Energy savings on site	Flexibility for the grid and storage	Comfort	Convenience	Wellbeing and health	Maintenance & fault prediction	Information to occupants
1	Supply air flow control at the room level	Green						
2	Air flow or pressure control at the air handler level	Orange		Orange	Orange	Orange		
3	Heat recovery control: prevention of overheating	Green		Orange	Yellow			
4	Supply air temperature control at the air handling unit level	Green		Orange	Yellow			
5	Free cooling with mechanical ventilation system	Green		Green	Orange	Yellow		
6	Reporting information regarding IAQ					Green	Orange	Green



Results of the survey – Controlled Ventilation

Controlled ventilation: Most established services in India



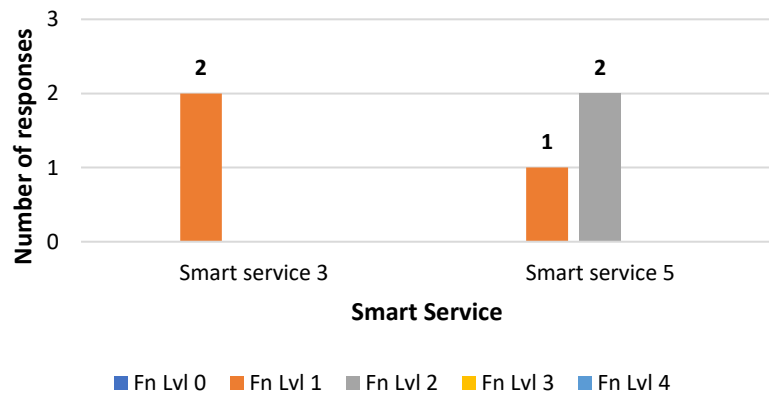
Smart service 4 - Supply air temperature control at the air handling unit level

Fn Lvl 3 - Variable set point with load dependent compensation. A control loop enables to control the supply air temperature. The setpoint is defined as a function of the loads in the room

Smart service 1 - Supply air flow control at the room level

Fn Lvl 0 - No ventilation system or manual control

Controlled ventilation: To be established in next 2-5 years



Smart service 3- Heat recovery control: prevention of overheating

Fn Lvl 1 – Modulate or bypass heat recovery based on sensors in air exhaust

Smart service 5- Free cooling with mechanical ventilation system

Fn Lvl 1 – Night cooling

Fn Lvl 2 – Free cooling: air flows modulated during all periods of time to minimize the amount of mechanical cooling

Factors for successful establishment of smart services

1. Less Capital Cost
2. Availability
3. Convenience

Drivers for successful establishment in next 2-5 years

1. Consumer awareness about energy efficiency
2. Convenience
3. Less maintenance of system



Summary – Controlled Ventilation

Market scenario of smart services in India

Smart Service	Service Name	Availability of the smart service	Market Scenario of Smart Services			
			Most Established along with EE impact		Potential to be established in the next 2-5 years along with EE impact	
1	Supply air flow control at the room level	Fn Lvl 0	Fn Lvl 0	+		
		Fn Lvl 2				
		Fn Lvl 3				
		Fn Lvl 4				
2	Air flow or pressure control at the air handler level	Fn Lvl 1				
		Fn Lvl 2				
		Fn Lvl 4				
3	Heat recovery control: prevention of overheating	Fn Lvl 1			Fn Lvl 2	++
4	Supply air temperature control at the air handling unit level	Fn Lvl 1	Fn Lvl 3	++		
		Fn Lvl 2				
		Fn Lvl 3				
5	Free cooling with mechanical ventilation system				Fn Lvl 1	+
					Fn Lvl 2	++
6	Reporting information regarding IAQ	Fn Lvl 1				
Services available and established in India						

Smart services with most energy savings potential as per EU analysis

- Smart service 1
- Smart service 3
- Smart service 4
- Smart service 5

Smart services with potential to be established in future in India

- Smart service 3
- Smart service 5

Most promising smart services

1. **Smart Service 1**- Supply air flow control at the room level
2. **Smart Service 3**- Heat recovery control: prevention of overheating
3. **Smart Service 4**- Supply air temperature control at the air handling unit level
4. **Smart Service 5**- Free cooling with mechanical ventilation system

Most of the available smart services in India have functionality levels which are still in the nascent stage and there are very few smart services with intermediate or advanced functionality levels.



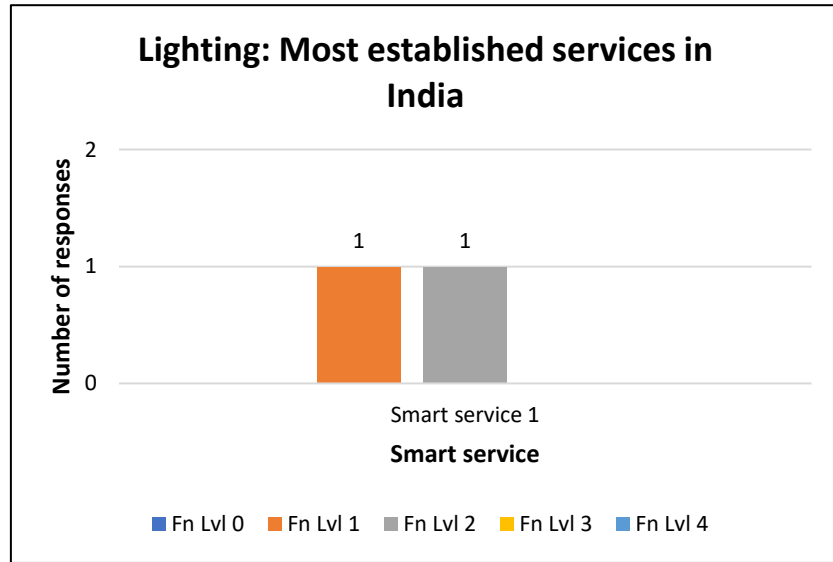
Impact of smart services under ‘Lighting’ domain – EU perspective

Mapping of potential impact of all smart services against SRI impact criteria

Highest impact		Moderate impact			Low impact			No Impact	
S.No.	Smart service name	Energy savings on site	Flexibility for the grid and storage	Comfort	Convenience	Wellbeing and health	Maintenance & fault prediction	Information to occupants	
1	Occupancy control for indoor lighting								
2	Control artificial lighting power based on daylight levels								

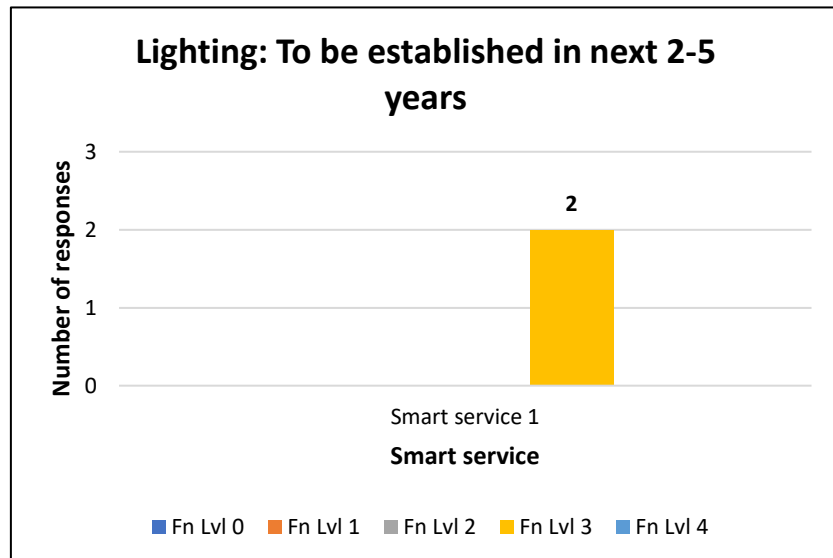


Results of the survey – Lighting



Smart service 1 - Occupancy control for indoor lighting

Fn Lvl 1 - Manual on/off switch + additional sweeping extinction signal
Fn Lvl 2 - Automatic (auto on/auto off)



Smart service 1- Occupancy control for indoor lighting

Fn Lvl 3 - Automatic (manual on / dimmed or auto off)

Factors for successful establishment of smart services

1. Consumer awareness about energy efficiency
2. Less capital cost
3. Convenience

Drivers for successful establishment in next 2-5 years

1. Consumer awareness about energy efficiency
2. Less capital cost
3. Convenience



Summary – Lighting

Market scenario of smart services in India

Smart service	Service name	Availability of the smart service	Market scenario of smart services			
			Most established along with EE impact		Potential to be established in the next 2-5 years along with EE impact	
1	Occupancy control for indoor lighting	Fn Lvl 1	Fn Lvl 1	+	Fn Lvl 3	+++
		Fn Lvl 2	Fn Lvl 2	++		
2	Control artificial lighting power based on daylight levels					

Services available and established in India

Smart services with most energy savings potential as per EU analysis

- Smart service 1
- Smart service 2

Smart services with potential to be established in future in India

- Smart service 1

Most promising smart services

1. **Smart Service 1**- Occupancy control for indoor lighting
2. **Smart Service 2**- Control artificial lighting power based on daylight levels

Only smart service 1 with intermediate functionality levels is available in India



Impact of smart services under 'Electricity' domain – EU perspective

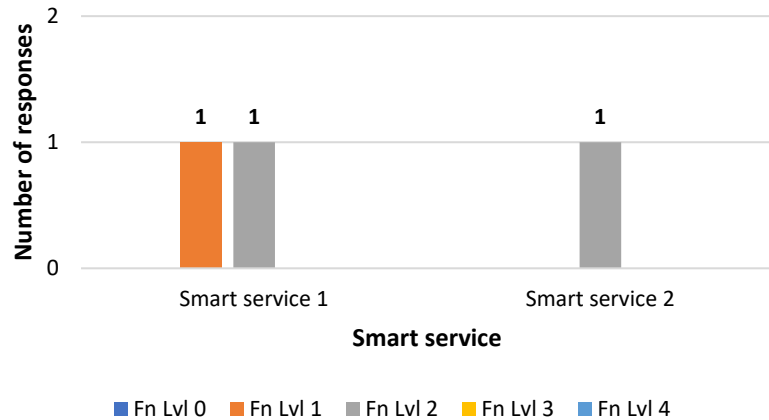
Mapping of potential impact of all smart services against SRI impact criteria

Highest impact		Moderate impact		Low impact			No Impact	
S.No.	Smart service name	Energy savings on site	Flexibility for the grid and storage	Comfort	Convenience	Wellbeing and health	Maintenance & fault prediction	Information to occupants
1	Reporting information regarding local electricity generation	Low impact			Low impact		Moderate impact	Highest impact
2	Storage of (locally generated) electricity		Highest impact		Moderate impact			
3	Optimizing self-consumption of locally generated electricity		Highest impact		Moderate impact			
4	Control of combined heat and power plant (CHP)	Moderate impact	Moderate impact		Low impact			
5	Support of (micro)grid operation modes		Highest impact		Highest impact			
6	Reporting information regarding energy storage	Low impact			Low impact		Moderate impact	Highest impact
7	Reporting information regarding electricity consumption	Highest impact			Low impact		Moderate impact	Highest impact



Results of the survey – Electricity

Electricity: Most established services in India



Smart service 1 - Reporting information regarding local electricity generation

Fn Lvl 1 - Current generation data available

Fn Lvl 2 - Actual values and historical data

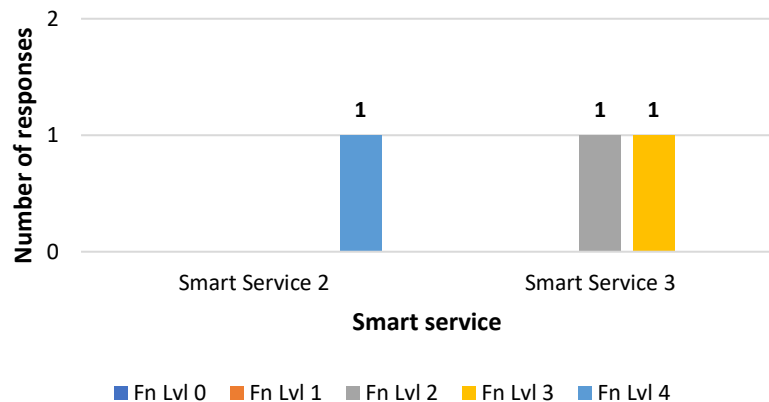
Smart service 2 - Storage of (locally generated) electricity

Fn Lvl 2 - On site storage of energy (e.g., electric battery or thermal storage) with controller based on grid signals

Factors for successful establishment of smart services

1. Convenience
2. Less capital cost
3. Less maintenance

Electricity: To be established in next 2-5 years



Smart Service 3 - Optimizing self-consumption of locally generated electricity

Fn Lvl 2 - Automated management of local electricity consumption based on current renewable energy availability

Fn Lvl 3 - Automated management of local electricity consumption based on current and predicted energy needs and renewable energy availability

Smart Service 2 - Storage of (locally generated) electricity

Fn Lvl 4 - On site storage of energy (e.g. electric battery or thermal storage) with controller optimising the use of locally generated electricity and possibility to feed back into the grid

Drivers for successful establishment in next 2-5 years

1. Less capital cost
2. Consumer awareness about energy efficiency
3. Convenience



Summary – Electricity

Market scenario of smart services in India

Smart service	Service name	Availability of the smart service	Market scenario of Smart Services			
			Most established along with EE impact		Potential to be established in the next 2-5 years along with EE impact	
1	Reporting information regarding local electricity generation	Fn Lvl 1	Fn Lvl 1			
		Fn Lvl 2	Fn Lvl 2			
2	Storage of (locally generated) electricity	Fn Lvl 2	Fn Lvl 2		Fn Lvl 4	0
		Fn Lvl 3				
		Fn Lvl 4				
3	Optimizing self-consumption of locally generated electricity				Fn Lvl 2	0
					Fn Lvl 3	0
4	Control of combined heat and power plant (CHP)					
5	Support of (micro)grid operation modes	Fn Lvl 2				
		Fn Lvl 3				
6	Reporting information regarding energy storage	Fn Lvl 3				
7	Reporting information regarding electricity consumption	Fn Lvl 1				
		Fn Lvl 2				
		Fn Lvl 4				
Services available and established in India						

Smart services with most energy savings potential as per EU analysis

- Smart service 7

Smart services with potential to be established in future in India

- Smart service 2
- Smart service 3

Most promising smart services

1. **Smart Service 2**- Storage of (locally generated) electricity
2. **Smart Service 3**- Optimizing self-consumption of locally generated electricity
3. **Smart Service 7**- Reporting information regarding electricity consumption

Most of the available smart services in India have functionality levels which are still in the nascent stage and there are very few smart services with intermediate or advanced functionality levels.



Impact of smart services under ‘Electric vehicle charging’ domain – EU perspective

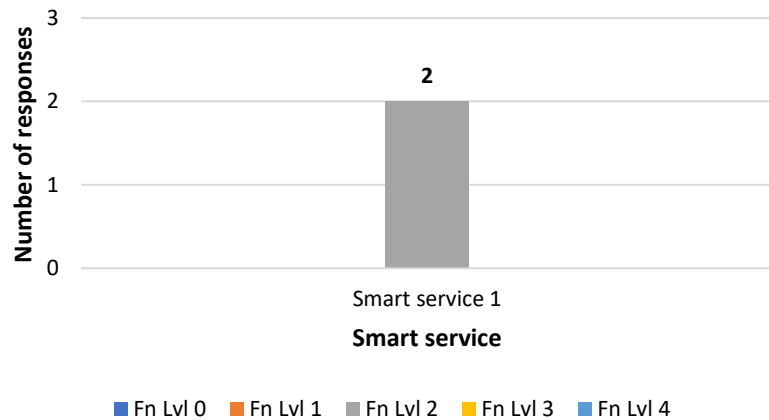
Mapping of potential impact of all smart services against SRI impact criteria

Highest impact		Moderate impact			Low impact		No Impact		
S.No.	Smart service name	Energy savings on site	Flexibility for the grid and storage	Comfort	Convenience	Wellbeing and health	Maintenance & fault prediction	Information to occupants	
1	EV charging capacity				Highest impact				
2	EV charging grid balancing		Highest impact		Moderate impact				
3	EV charging information and connectivity		Low impact		Low impact			Highest impact	



Results of the survey – Electric vehicle charging

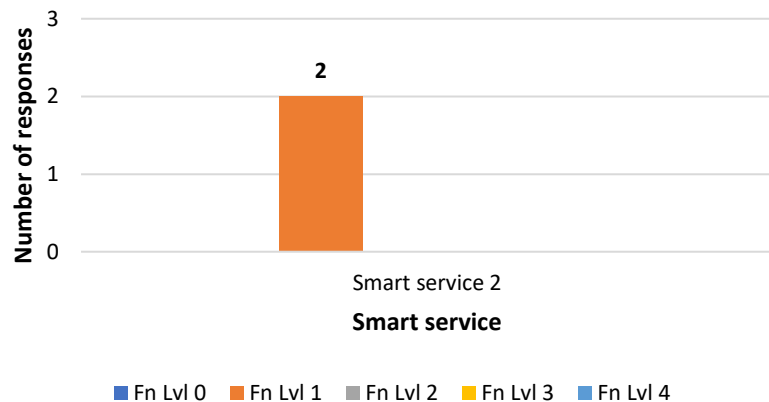
EV charging: Most established service in India



Smart service 1 - EV Charging Capacity

Fn Lvl 2 - 0-9% of parking spaces have charging points

EV Charging: To be established service in next 2-5 years



Smart service 2- EV Charging Grid balancing

Fn Lvl 1 - 1-way controlled charging (e.g., including desired departure time and grid signals for optimization)

Factors for successful establishment of smart services

1. Consumer awareness about energy efficiency
2. Convenience
3. No need for additional infrastructure

Drivers for successful establishment in next 2-5 years

1. Consumer awareness about energy efficiency
2. Convenience
3. Less maintenance of system



Summary – Electric vehicle charging

Market scenario of smart services in India

Smart service	Service name	Availability of the smart service	Market scenario of smart services			
			Most established along with EE impact		Potential to be established in the next 2-5 years along with EE impact	
1	EV charging capacity	Fn Lvl 2	Fn Lvl 2	0		
2	EV charging grid balancing				Fn Lvl 1	0
3	EV charging information and connectivity					

Services available and established in India

Smart services with most energy savings potential as per EU analysis

Smart services with potential to be established in future in India

- Smart service 2

Most promising smart services

1. **Smart Service 2**- EV charging grid balancing

Only smart service 1 with intermediate functionality level is available in India



Impact of smart services under ‘Monitoring & control’ domain – EU perspective

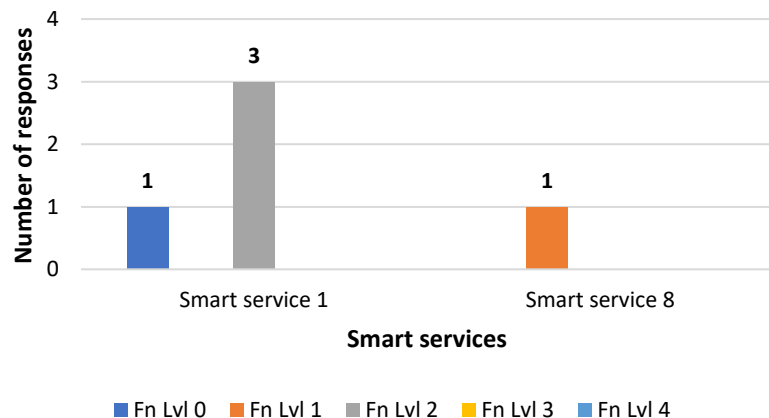
Mapping of potential impact of all smart services against SRI impact criteria

Highest impact		Moderate impact		Low impact			No Impact	
S.No.	Smart service name	Energy savings on site	Flexibility for the grid and storage	Comfort	Convenience	Wellbeing and health	Maintenance & fault prediction	Information to occupants
1	Run time management of HVAC systems	Green	Orange	Orange	Green	Yellow		
2	Detecting faults of technical building systems and providing support to the diagnosis of these faults				Green	Green	Green	Green
3	Occupancy detection: connected services	Yellow		Yellow	Yellow		Orange	
4	Central reporting of TBS performance and energy use	Yellow	Green		Yellow			
5	Smart Grid Integration	Yellow	Green		Yellow			
6	Reporting information regarding demand side management performance and operation		Orange				Yellow	Green
7	Override of DSM control		Green		Green		Yellow	
8	Single platform that allows automated control & coordination between TBS + optimization of energy flow based on occupancy, weather and grid signals	Orange			Green		Yellow	



Results of the survey – Monitoring & Control

Monitoring & control: Most established services in India



Smart service 1 - Run time management of HVAC systems

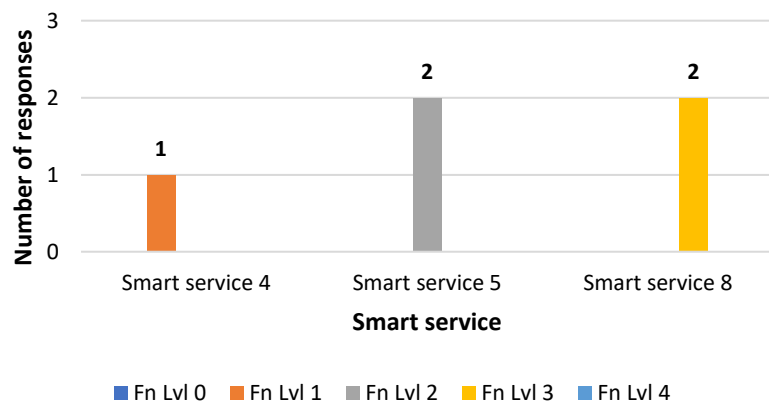
Fn Lvl 2 - Heating and cooling plant on/off control based on building loads sequencing

Fn Lvl 0 - Manual Setting

Smart service 8 - Single platform that allows automated control & coordination between TBS + optimization of energy flow based on occupancy, weather, and grid signals

Fn Lvl 1 - Single platform that allows manual control of multiple TBS

Monitoring & control: To be established in next 2-5 years



Smart service 8 - Single platform that allows automated control & coordination between TBS + optimization of energy flow based on occupancy, weather, and grid signals

Fn Lvl 3 - Single platform that allows automated control & coordination between TBS + optimization of energy flow based on occupancy, weather, and grid signals

Smart service 5 – Smart Grid Integration

Fn Lvl 2 - Coordinated demand side management of multiple TBS

Smart service 4 – Central reporting of TBS performance and energy use

Fn Lvl 1 – Central or remote reporting of real-time energy use per energy carrier

Factors for successful establishment of smart services

1. Less maintenance
2. Consumer awareness about energy efficiency
3. Less capital cost

Drivers for successful establishment in next 2-5 years

1. Less capital cost
2. Consumer awareness about energy efficiency
3. Less maintenance



Summary – Monitoring & Control

Market scenario of smart services in India

Smart service	Service name	Availability of the smart service	Market scenario of smart services			
			Most established along with EE impact		Potential to be established in the next 2-5 years along with EE impact	
1	Run time management of HVAC systems	Fn Lvl 0	Fn Lvl 0			
		Fn Lvl 2				
		Fn Lvl 3	Fn Lvl 2			
2	Detecting faults of technical building systems and providing support to the diagnosis of these faults	Fn Lvl 2				
		Fn Lvl 4				
3	Occupancy detection: connected services	Fn Lvl 2				
4	Central reporting of TBS performance and energy use				Fn Lvl 1	+
5	Smart Grid Integration	Fn Lvl 1			Fn Lvl 2	+
6	Reporting information regarding demand side management performance and operation	Fn Lvl 2				
7	Override of DSM control					
8	Single platform that allows automated control & coordination between TBS + optimization of energy flow based on occupancy, weather and grid signals	Fn Lvl 1	Fn Lvl 1		Fn Lvl 3	++
		Fn Lvl 2				

Services available and established in India

Smart services with most energy savings potential as per EU analysis

- Smart service 1

Smart services with potential to be established in future in India

- Smart service 4
- Smart service 5
- Smart service 8

Most promising smart services

1. **Smart Service 1**- Run time management of HVAC systems
2. **Smart Service 4**- Central reporting of TBS performance and energy use
3. **Smart Service 5**- Smart grid integration
4. **Smart Service 8**- Single platform that allows automated control & coordination between TBS + optimization of energy flow based on occupancy, weather and grid signals

Most of the available smart services in India have functionality levels which are still in the nascent stage and there are very few smart services with intermediate or advanced functionality levels.



Summary on penetration of smart services in India

Technology wise availability of smart services as per survey results

Technology domains with availability of smart services in India

- Cooling
- Controlled ventilation
- Lighting
- Electricity
- EV charging
- Monitoring & control

Technology domains with non availability of smart services in India

- Heating
- Domestic hot water
- Dynamic building envelope

Most common drivers for the establishment of smart services

1. Consumer awareness about energy efficiency
2. Less capital cost
3. Less maintenance



Conclusion

Highest impact	Moderate impact	Low impact	No Impact
Smart service	Smart service name	Availability of the service	Impact on energy savings potential
<i>Cooling</i>			
Smart service 1	Cooling emission control	✓	
Smart service 2	Emission control for TABS (cooling mode)		
Smart service 5	Interlock: avoiding simultaneous heating and cooling in the same room	✓	
Smart service 8	Sequencing of different cooling generators		
<i>Controlled ventilation</i>			
Smart service 1	Supply air flow control at the room level	✓	
Smart service 3	Heat recovery control: prevention of overheating	✓	
Smart service 4	Supply air temperature control at the air handling unit level	✓	
Smart service 5	Free cooling with mechanical ventilation system	✓	
<i>Lighting</i>			
Smart service 1	Occupancy control for indoor lighting	✓	
Smart service 2	Control artificial lighting power based on daylight levels		

<i>Electricity</i>			
Smart service 2	Storage of (locally generated) electricity	✓	
Smart service 3	Optimizing self-consumption of locally generated electricity		
Smart service 7	Reporting information regarding electricity consumption	✓	
<i>Electric vehicle charging</i>			
Smart service 2	EV charging grid balancing		
<i>Monitoring & control</i>			
Smart service 1	Run time management of HVAC systems	✓	
Smart service 5	Smart grid integration	✓	
Smart service 8	Single platform that allows automated control & coordination between TBS + optimization of energy flow based on occupancy, <u>weather</u> and grid signals	✓	

The survey results indicate that most of the smart services under each domain are either not well established or only have a low or medium functionality level, although for each smart service there is some presence of technology. Nevertheless, a market for smart technologies is available in India, although a push from both regulatory and financing bodies would make the availability wider and encourage further market adoption.



Thank You

