This project is funded by the European Union

EU-INDIA CLEAN ENERGY & CLIMATE PARTNERSHIP

EU-India High Level Platform on Smart Grids

EUI FLORENCE SCHOOL OF REGULATION

UNIVERSIDAD PONTIFICIA ICAI ICADE COMILLAS MADRID

ISGF India Smart Grid Forum

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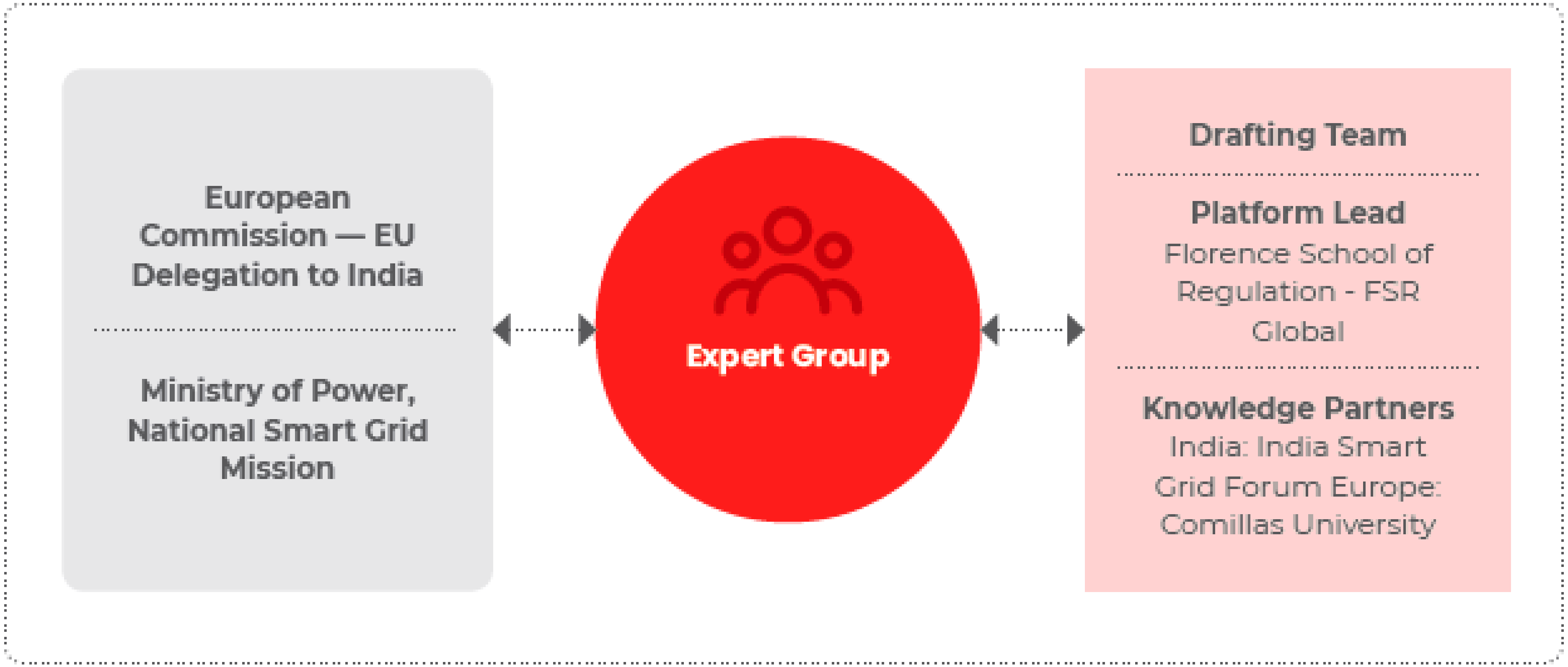
Smart Grid Replication

Handbook for India

UNIVERSIDAD PONTIFICIA ICAI ICADE COMILLAS MADRID

ISGF India Smart Grid Forum

15 months of work – 30+ experts from EU and India



What to expect from this handbook!

- Insights into opportunities and barriers in replicating smart grid projects in India.
- The SRA tool to assess the scalability and replicability of smart grid use cases in India
- A framework for selecting use cases based on their relevance to India.
- Insights from applying the above-mentioned tools to both European and Indian case studies.
- The CBA tool to assess the costs and benefits of smart grid use cases in India

The selection of use cases – a unique challenge

EU Use cases	Final Score
Demand response/consumption optimisation at end-user premises	194.64
LV supervision and control	153.73
Local management of flexible DER to alleviate network constraints	149.73
Controlled islanded operation	129.82
Voluntary demand response based on advanced tariff schemes or through gamification	122.82
Advanced voltage control in MV grids	117.91
Anti-islanding protection	114.36
MV automation and reconfiguration	106.73
Predictive maintenance of network assets	93.18
Aggregation of DERs to provide balancing services to the TSO	68.27

Indian Projects	Final Score
Tata Power DDL	279.18
TSSPDCL, Telangana	255.45
CESC Mysore	247.82
UGVCL, Gujarat	247.82
TSECL, Tripura	247.82
APDCL, Assam	247.82
POWERGRID	137.18
Tata Power DDL	90.27
POWERGRID	71.00
POSOCO	35.73

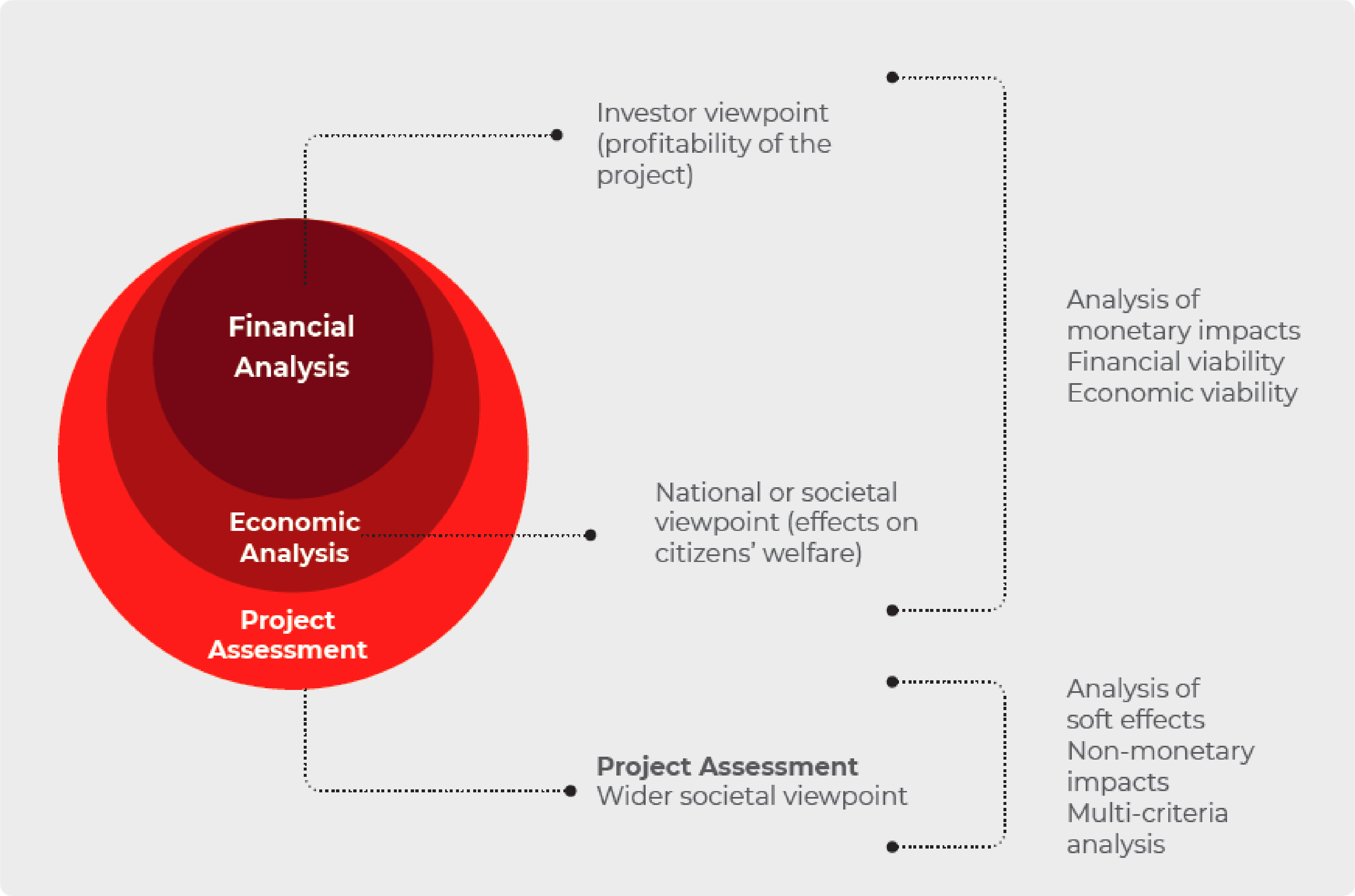
The use cases examined in this handbook are:

Demand response/ consumption optimisation

LV supervision and control (including AMI)

MV grid automation and reconfiguration

CBA Methodology



CBA is a well-known tool applied to assess smart grid projects following the EC Joint Research Center methodology

Form **technologies**, to map **functionalities**, to assess **benefits and costs**

CBA Use Cases and Projects - EU

Analysis		Use Cases		
		Demand response/ consumption optimisation	LV supervision and control (including AMI)	MV grid automation and reconfiguration
CBA	Financial (investor perspective)	InteGrid HEMS (Swedish demo) InteGrid DSM programme (Swedish demo) InteGrid HEMS (Portuguease demo) InteGrid Flexibility Market (Portuguese demo)	Malagrotta and Rome Smart Grid Project (AMI not included)	Malagrotta and Rome Smart Grid Project Optimal Smart MV/ LV Substations
	Economic (Social perspective)		Malagrotta and Rome Smart Grid Project (AMI not included)	Malagrotta and Rome Smart Grid Project Optimal Smart MV/ LV Substations

CBA for Demand response

a) Home Energy Management: HEMS in active houses for energy efficiency

b) Demand Side Management Programs: LocalLife social network

c) Behind-the-meter flexibility from LV prosumers: aggregation for flexibility markets

Benefits

- electricity consumption reduction (a, b)
- CO_2 emission reduction (a, b)
- flexibility sold on the secondary reserve market (c)

&

Costs

Capex and Opex for

- Home Energy Management System (a, b)
- Smart home appliances ((a, b)
- Ausiliary equipment (e.g. ICT costs) (a, b, c)
- Auxiliary Meter Equipment (c)

Result

a) Positive NPV for both single and 2-members apartments, negative for family apartments

b) Positive NPV, increases as the available controllable equipment. Negative NPV for PV equipped households

c) Positive NPV with high margins

CBA Conclusions - EU

- CBA of demand response
  - New **business opportunities** for obtaining flexibility from third parties
  - Monetary **incentives foster participation** by customers, in all the cases
  - **Benefits vary** according to the type of **investment**, type of **consumers**, consumer **behavior** and **tariff** structure
- CBA of MV and LV grid automation
  - Upgrade of network infrastructure produces **benefits for the DSO** investing and **connected customers** because of increased security of supply
  - How much a DSO should invest would require **implementing a CBA** analysis to determine the **optimal level of investment** in a given network
  - Initial **negative CBA for pilot projects** may become **positive for scaled-up** implementations

CBA Conclusions - Indian Projects

Use Case: LV/MV Automation, Supervision and Control

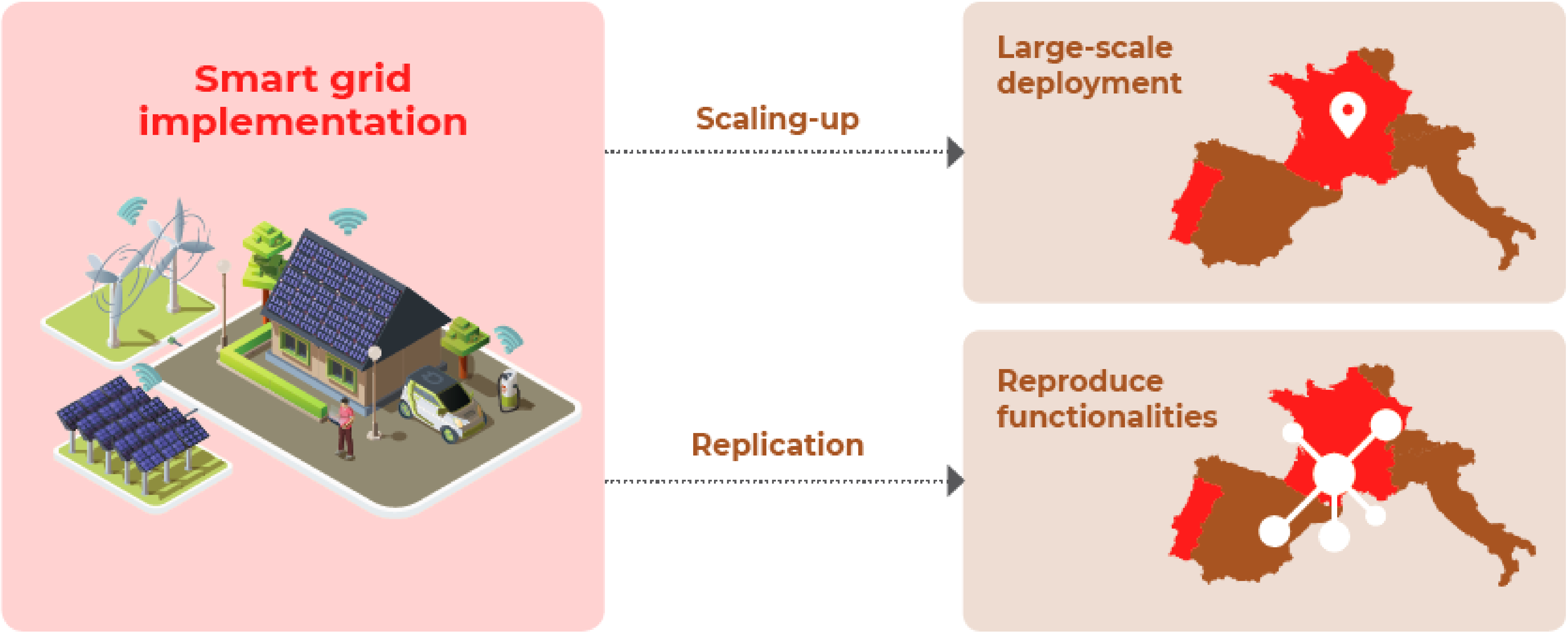
Uttar Gujarat Vij Company Limited (UGVCL)

•Included AMI with RF mesh technology, peak load management and outage management system
•The project saw a significant improvement in KPIs such as SAIFI and SAIDI over a period of 4 years. CBA analysis shows that for investments in this system upgrade the payback period was in fact shorter (by ~3.5 years) than without the system upgrade.

Tripura State Electricity Company Limited (TSECL)

•The assets in this project included a control centre along with complete AMI including smart meters, data concentrator units, a head end system, meter data management and hardware and software for the control centre and peak load management system.
•The benefits were mostly due to AMI implementation and are close to 37 crore a year, with an overall payback period of ~18 years.

SRA


Smart grid implementation
Scaling-up
Replication
Large-scale deployment
Reproduce functionalities

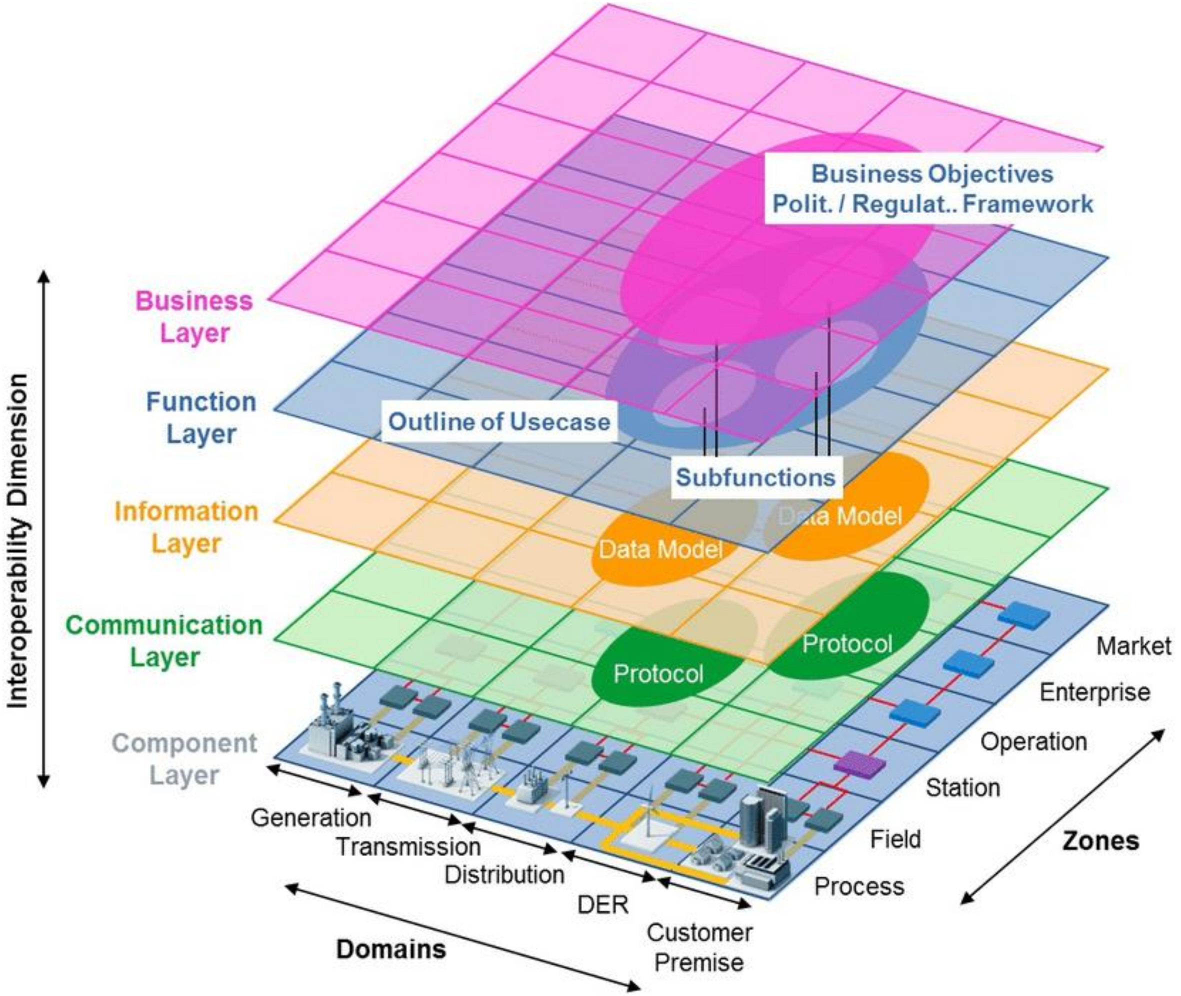
SRA Methodology

Guidelines under the EU H2020 BRIDGE initiative

Four dimensions:

- Functional (technical)
- ICT
- Regulatory
- Stakeholders

The SGAM can be helpful to map different SRA implementations



SRA Use Cases and Projects - EU

Analysis		Use Cases		
		Demand response/ consumption optimisation	LV supervision and control (including AMI)	MV grid automation and reconfiguration
SRA	Functional	German demo in InterFlex, Portuguese demo in InteGrid, Swedish demo in InteGrid.	Swedish demo in GRID4EU, Austrian demo in IGREENGrid	German demo, Spanish demo and Czech Republic demo in GRID4EU
	ICT	German demo in InterFlex, Portuguese demo in InteGrid.	Portuguese demo in InteGrid	
	Regulatory Framework	Cluster 2 in InteGrid	Swedish demo in GRID4EU	German demo, Spanish demo and Czech Republic demo in GRID4EU
	Stakeholders Perspective	GRID4EU SuSTAINABLE	GRID4EU	GRID4EU

Functional SRA – EU
LV grid supervision and control

Project demo	Sensitivity parameters	KPIs	Main lessons learned
GRID4EU **Swedish demo.** Supervision of operational problems and phase unbalance in LV networks	- Type of network. - DER characteristics - Loading - Level of EV penetration.	- Loss factor. - Nº buses with over-voltages.	- Power losses must be monitored in **heavily-loaded, unbalanced, networks.** - **EV slow-charging** strategies and **DR mitigate the power losses** of the EV charging infrastructure - **50-75% of PV is better**, in terms of losses, **than very high or very low shares** of PV.
IGREENgrid **Austrian demo** Voltage control solutions: - VoltVar Control (VVC) - Wide Area Control (WAC)	- Type of voltage control solution. - Installed solar PV	- % increase in the network hosting capacity.	- **High potential** in voltage-constrained, not overloaded, rural feeders - **Average increase in hosting capacity**: - WAC ➔ 250% - VVC ➔16% - WAC + VVC combined ➔ 340% - **Deployment potential:** - WAC ➔ 30% of feeders - VVC ➔ 70% of feeders - In a network **with a non-homogeneous penetration of PV**, the hosting capacity provided by **VVC might be enough** for actual requirements.

Technical SRA – Indian Projects

Project Demo	Scope	Sensitivity Parameters	KPIs	Main Lessons Learned
UGVCL, Gujarat	· AMI implementation · Peak load management · Outage management · Power quality	· Increase in peak load · Loading of the network · Phase balancing of the network · Type of communication infrastructure · Reliability improvement · Voltage, current and harmonic levels	· Decrease in peak load consumption · Decrease in AT&C losses · Voltage levels · Reliability index · Phase balance	· Transformer failure rates depend on AMI implementation of the network · Time of use (ToU) pricing can help peak load management · Power quality management ensures a better network voltage level
TSECL, Tripura	· AMI implementation · Peak load management	· Increase in peak load · Load balancing of the network · Reliability improvement · Type of communication infrastructure	· Decrease in peak load consumption · Decrease in AT&C losses · Phase balance	· Transformer failure rates depend on AMI implementation of the network · Time of use (ToU) pricing can help peak load management

LV grid supervision and control

SRA conclusions (i)

- Technical SRA
  - In unbalanced LV networks, for voltage control and higher PV hosting capacity, **control of OLTC transformers with data from smart meters** may be better than **local control of PV**
  - For MV grid automation and reconfiguration, **network automation in urban and sub-urban** areas provides benefits in terms of reliability for **automation levels up to 20-40%**
  - MV network **reconfiguration** effect on **hosting capacity** is higher in the case of **over-voltages** than overloading of lines caused by concentrated DG
- ICT SRA
  - The ICT part is usually developed **ad hoc for the demonstrator**, according to the actual needs and infrastructure
  - For **demand response**, **Zigbee to communicate with controllable loads** is a possible solution
  - For LV grid monitoring and control, **implementations in the cloud** instead of a dedicated devices may be more reliable

SRA conclusions (ii)

- Regulatory and stakeholders SRA
  - **Dynamic regulated charges and retail tariffs** are key for providing **flexibility** through DR as insufficient compensation is the main limiting factor
  - Regulation of **DSO revenues** and different types of **incentives** should be evaluated for implementation of **smart grid solutions** in LV and MV networks
  - For LV solutions, **regulation of smart metering** (deployment, functionalities, management and data access) must also be well established since multiple other innovations depend on it
  - The **experience of operators** is relevant in MV grid automation and reconfiguration
  - **Stakeholders´ views** are particularly relevant when **end-user participation** is pursued

Lessons for India

Key takeaways from the handbook

Technology

- To decide the optimal level of automation it is important to first ascertain what is actionable and available to have a positive business case for the discom
- Customer willingness to participate in the process at the required level of involvement.
- Utilities need to build a vision based on local needs both at a centralised and decentralised level.
- Basic technology can build on other basic technology. Therefore, a mostly linear development can be expected, while innovative pilot tests will occur in parallel.

Key takeaways from the handbook

Finance

- It is important to focus on resolving issues with solution which goes beyond just monetary considerations.
- Therefore, a broad set of KPIs should be defined and compared across various projects.
- To evaluate benefits and translate from pilot to large-scale deployment, data sharing is crucial as lesson sharing is key to avoid negative duplication.
- Furthermore, implementation in states that are lagging behind can possibly result in higher benefits, but a key constraint here could be a lack of skilled staff, which entails investment in capacity building.

Key takeaways from the handbook

Policy and Regulation

- It is important to assess the trade-off between societal level benefits and discom benefits to ensure equitable distribution of benefits from smart grid solution deployment.
- Furthermore, local regulation should work with a long-term vision for discoms to make long-term investments.
- Regulators should also move away from one-off projects to a KPI-driven planning approach to smart grid solution deployment.

Key takeaways from the handbook

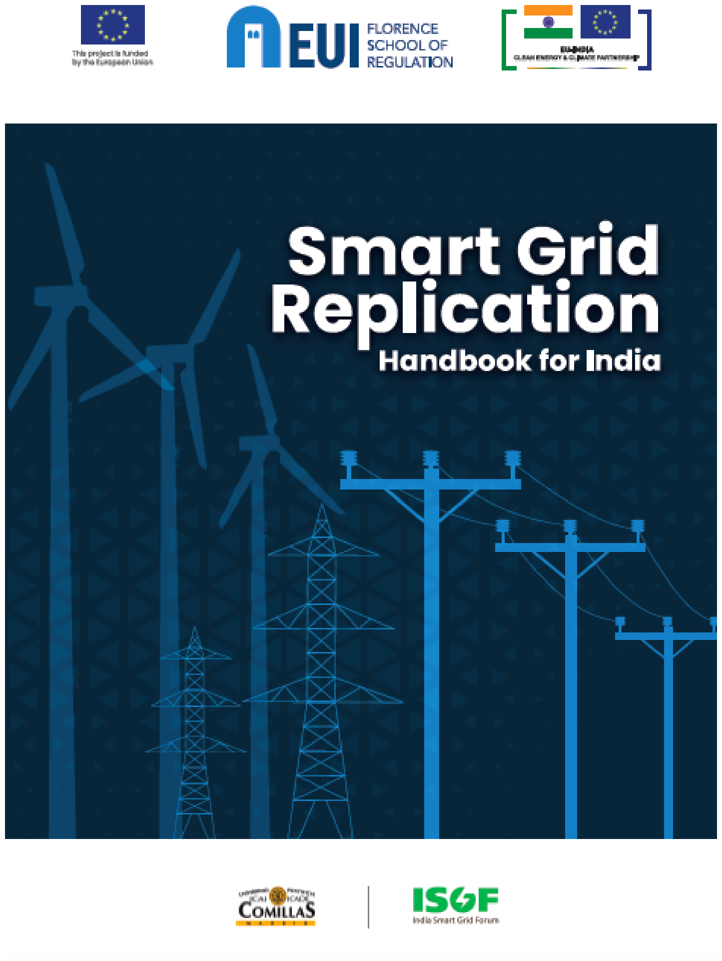
Social Acceptance

- The key insight from the experts was that customers need to be provided with incentives to participate in such innovative smart grid projects.
- On the other hand, it is important to help de-risk such projects by providing service providers with long term contracts.
- Furthermore, using open standards will lead to better solutions by accelerating participation and deployment.

The way forward

- National level smart grid observatory
  - Data sharing is key to avoid negative duplication
  - An open access data platform to evaluate projects needs to be developed
  - Monitoring development and implementation of smart grid projects across India both at central and state level
- Smart grid platform extension
  - To study and support implementation of smart grid projects at selected states
  - To further study and develop smart grid solutions based on the experts' recommendations

Thank you!



Download the report using this link:
https://fsr.eui.eu/wp-content/uploads/2022/02/Handbook_Smart-Grid-Replication.pdf

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