



International Workshop  
Innovative Electrical Network for a Sustainable Development in  
Low-Carbon Scenarios  
*Stresa - Italy*  
*August 27th, 2015*



# Smartainability®: assessing the sustainability of the technologies adopted for EXPO Milano 2015

A. Negri, P. Girardi, A. Temporelli



# Smartainability<sup>®</sup>: assessing the sustainability of the technologies adopted for EXPO Milano 2015

A. Negri (\*\*), P. Girardi (\*), A. Temporelli (\*)

(\*) «Sustainable Development and Energy Sources» Dept., RSE - Milan, Italy

(\*\*) present affiliation: Gestore dei Servizi Energetici - GSE Spa - Rome, Italy

## *Summary*

- ☐ *Smart cities and sustainability: the Expo Milan 2015 project*
- ☐ *Smartainability®: origin and definitions*
- ☐ *The “smart” technologies for Expo Milan 2015: a quick view*
- ☐ *The “Layer 1”: energy distribution and use*
- ☐ *The “Layer 2”: Telecommunication and IT*
- ☐ *The “Layer 5”: Mobility*
- ☐ *Some concluding remarks*

## Summary

- ☐ *Smart cities and sustainability: the Expo Milan 2015 project*
- ☐ *Smartainability®: origin and definitions*
- ☐ *The “smart” technologies for Expo Milan 2015: a quick view*
- ☐ *The “Layer 1”: energy distribution and use*
- ☐ *The “Layer 2”: Telecommunication and IT*
- ☐ *The “Layer 5”: Mobility*
- ☐ *Some concluding remarks*

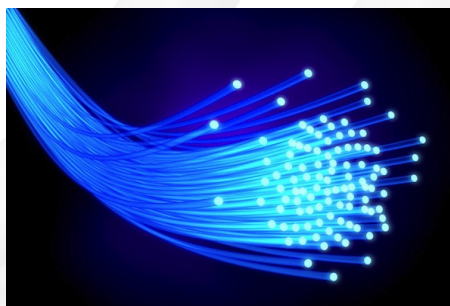
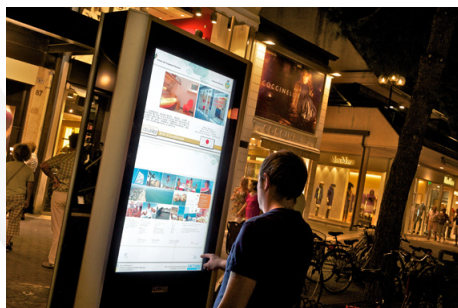


# Smart Cities



## Smart City:

urban environment that can actively work to improve citizens quality of life with the original and diffused use of Information and Communication Technologies (ICT), in the communication, mobility, environment and energy efficiency fields.

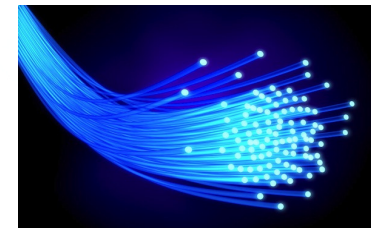


# Smart Cities and Sustainability: the key issues



A Smart City, thanks to the smart technologies deployed, is a more sustainable city than a traditional one

EXPO Milano 2015 site, like a Smart City model, will be more sustainable thanks to innovative technologies

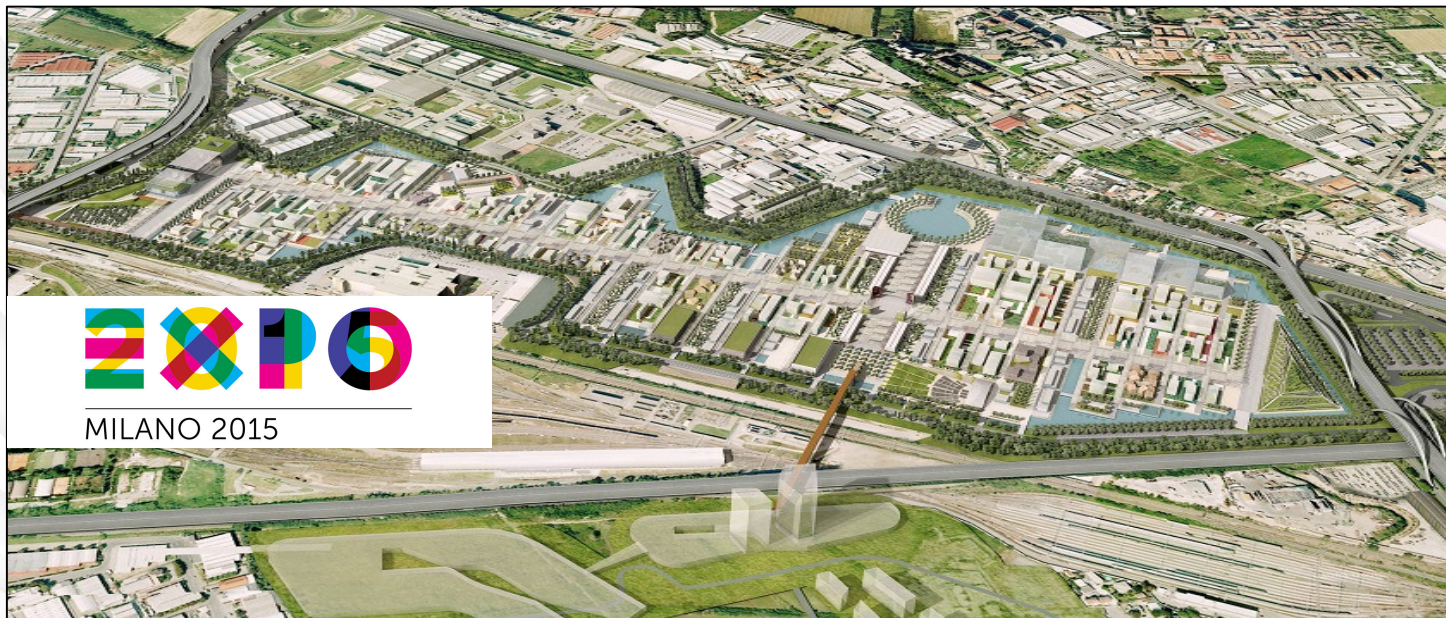


# Smartainability® : the Expo Milan 2015 project



The Project goals:

- to develop and apply a new methodology for the combined assessment of smartness and sustainability of technical solutions for Smart Cities
- to evaluate and confirm, with qualitative and quantitative facts, how Expo Milano 2015 district is more sustainable thanks to smart technologies used.





## *Summary*

- ☐ *Smart cities and sustainability: the Expo Milan 2015 project*
- ☐ ***Smartainability®: origin and definitions***
- ☐ *The “smart” technologies for Expo Milan 2015: a quick view*
- ☐ *The “Layer 1”: energy distribution and use*
- ☐ *The “Layer 2”: Telecommunication and IT*
- ☐ *The “Layer 5”: Mobility*
- ☐ *Some concluding remarks*

# Smartainability®



What's the meaning for Smartness and Sustainability?



**Smartness:** the ability, with ICT (Information and Communication Technologies) implementation, to offer better and accessible services.



**Sustainability:** the ability of reducing environmental impacts (e.g. pollutant and GHG emissions), reducing costs, improving economy and life quality.

# Smartainability®

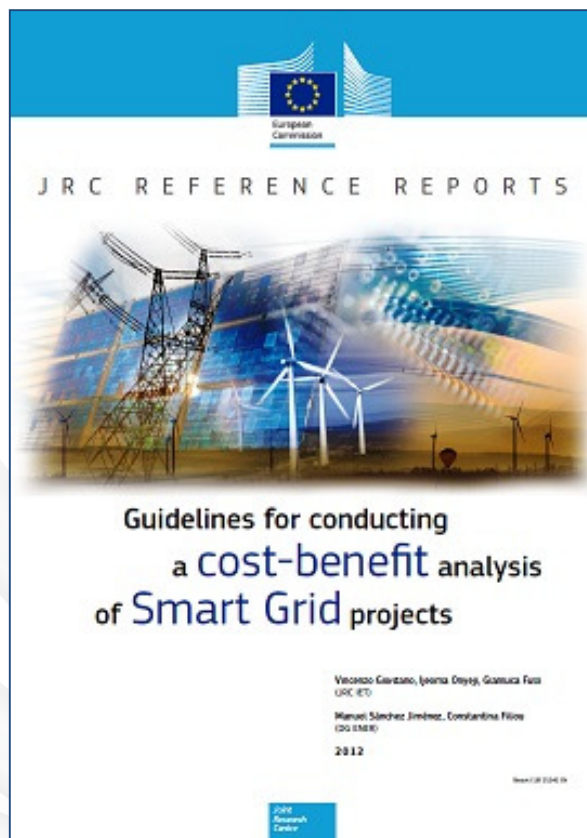


**RSE**  
Ricerca  
Sistema  
Energetico

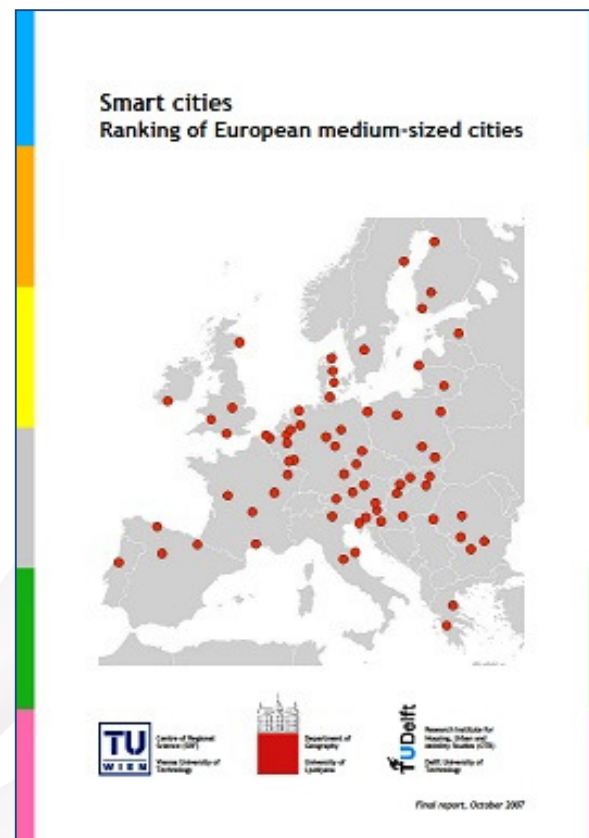


**Smartness + Sustainability =  
Smartainability**

## Smartainability® methodologies



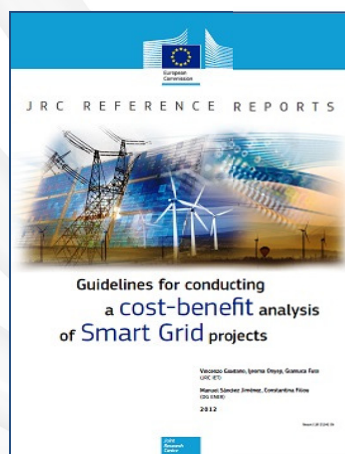
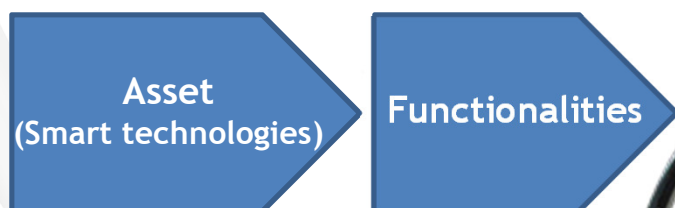
Smart Grids assessment



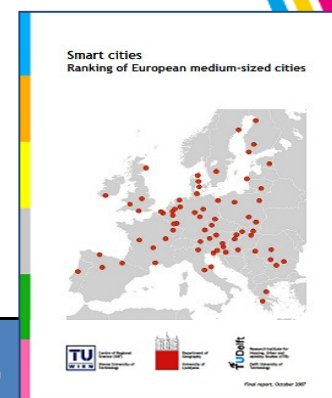
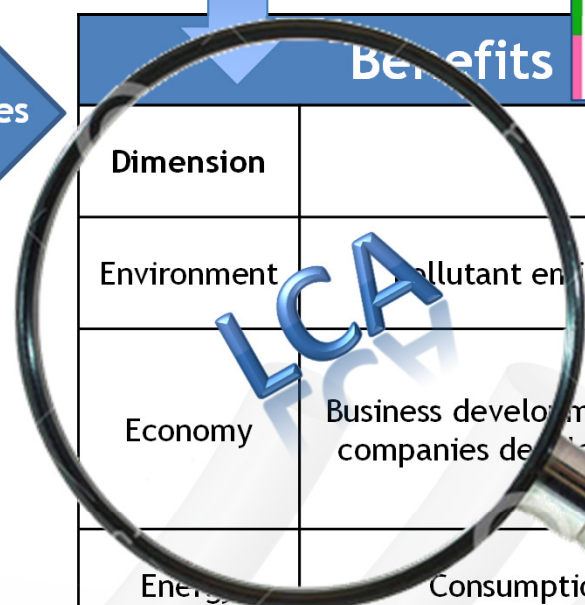
Smart Cities assessment



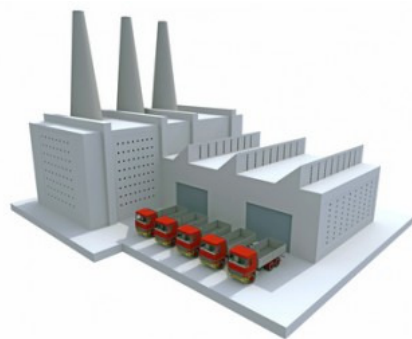
# Smartainability® approach



Benefits	
Dimension	KPI examples
Environment	Pollutant emissions; noise; waste water; etc.
Economy	Business development; SME development; eco-friendly companies development; employment increase; etc.
Energy	Consumptions.
Living	Security; time use; entertainment; etc.



# Life Cycle Perspective



Production



Use



Disposal

## *Summary*

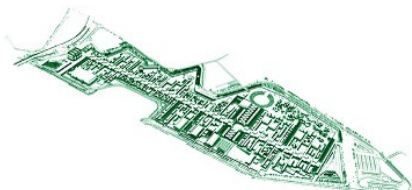
- ☐ *Smart cities and sustainability: the Expo Milan 2015 project*
- ☐ *Smartainability®: origin and definitions*
- ☐ *The “smart” technologies for Expo Milan 2015: a quick view*
- ☐ *The “Layer 1”: energy distribution and use*
- ☐ *The “Layer 2”: Telecommunication and IT*
- ☐ *The “Layer 5”: Mobility*
- ☐ *Some concluding remarks*

# Expo Smart City Layers



## The five Expo Milano 2015 Smart City Layers

Layer 1: Smart Buildings and Smart Energy



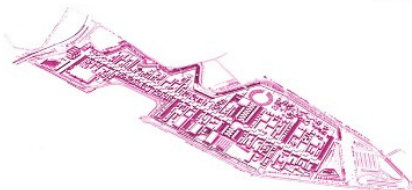
Smart lightning, Power distribution with smart metering, Electrical charging points

Layer 2 : Telecommunications and IT Systems



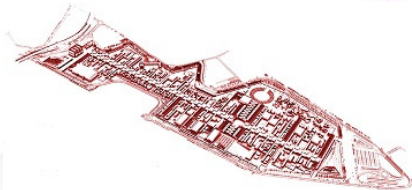
Telecommunication network, Enhanced telecommunications services, IT services, Cloud services

Layer 3: Safe City



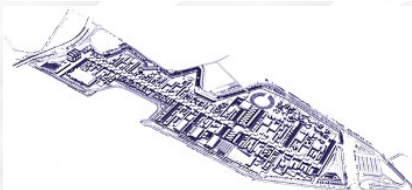
Main Operation Center, Security services, Staff secure communication, Access control system

Layer 4: Edutainment



Digital signage, Pavilion solutions, Mobile experience, Smart Electronic Ticket (SMET)

Layer 5: Services



Electronic payment, Transportation, E-Health, Solutions for disabled people



# System boundary



The Smartainability<sup>®</sup> project for Expo Milan 2015 focused:

- ☐ on the “infra-structural” technologies of the Expo site.
- ☐ on the technologies implemented within Expo Milano 2015 perimeter

## Technologies boundary

Typology	Examples	Included
Infrastructural technologies abroad implemented within Expo Milano 2015 perimeter	Smart-Grid; ICT; outdoor lighting; security; etc.	YES
Technologies offered to exhibitors and installed within expositive spaces	HVAC; Wi-Fi; telepresence; Mobile POS; etc.	YES
Demonstrative technologies displayed by participants/Partners within expositive spaces	Waste water systems; lighting not offered by Expo Spa; etc.	NO

## Geographic boundary



**What's included...**  
In site services; lighting; etc.

**What's excluded...**  
Mobility to/from the expositive site (air transportation, trains, cars); etc.

## *Summary*

- ☐ *Smart cities and sustainability: the Expo Milan 2015 project*
- ☐ *Smartainability®: origin and definitions*
- ☐ *The “smart” technologies for Expo Milan 2015: a quick view*
- ☐ *The “Layer 1”: energy distribution and use*
- ☐ *The “Layer 2”: Telecommunication and IT*
- ☐ *The “Layer 5”: Mobility*
- ☐ *Some concluding remarks*

## Energy distribution

- Protection and remote control system
- Sensors
- SF<sub>6</sub> switchboard
- Smart Meter
- Energy management system
- Storage
- Advanced design





## Outdoor lighting (Piastra and Pavilions)

- LED outdoor lamps Piastra and Pavilions
- Remote control system LED outdoor lamps (Piastra)



# Layer 1: Smart Buildings and Smart Energy

Energy distribution and outdoor lighting (Piastra and Pavilions)



## Assets-Functionalities matrix

Assets	Functionalities						
	Advanced grid security	Advanced grid detection	Energy loads knowledge and control	Loads optimization	Advanced lighting management	RES optimization	Hosting capacity increase
Protection and remote control system							
Sensors							
SF <sub>6</sub> switchboard							
Smart meter							
Energy Management System							
LED outdoor lamps Piastra							
LED outdoor lamps Pavilions							
Remote control system LED outdoor lamps (Piastra)							
Storage							
Advanced design							

# Layer 1: Smart Buildings and Smart Energy

Energy distribution and outdoor lighting (Piastra and Pavilions)



## Functionalities-Benefits matrix

Functionalities	Benefits					
	Better service quality	Higher security	Losses decrease and higher energy saving	Renewable resources best use	Higher reliability	Pollutant emissions reduction
Advanced grid security						
Advanced grid detection						
Energy loads knowledge and control						
Loads optimization						
Advanced lighting management						
RES optimization						
Hosting capacity increase						

# Layer 1: Smart Buildings and Smart Energy

Energy distribution and outdoor lighting (Piastra and Pavilions)



## Benefits-KPI matrix

Benefits	KPI								
	Environment			Economy		Energy		Living	
	Greenhouse gases	Acid gases	Particulate (PM10 PM2,5)	Investment cost	Costs variation by service suspension	Consumed energy	Renewable energy used	Service suspension number	Service suspension duration
Better service quality									
Higher security									
Losses decrease and higher energy saving									
Renewable resources best use									
Higher reliability									
Pollutant emissions reduction									

# KPI quantification: Traditional Technology VS Smart Technology



Example: outdoor lighting lamps



Traditional Technology:  
Metal-Halide Lamp







Smart Technology:  
LED Lamp

# Layer 1: Smart Buildings and Smart Energy

Energy distribution and outdoor lighting (Piastra and Pavilions)



## KPI quantification

Technology	Dimension	KPI	Quantification
Energy distribution and Outdoor lighting (Piastra and Pavilions)	Environment 	Greenhouse gases	-20.761 ton CO <sub>2</sub> -Eq
		Acid gases	-34,31 ton NO <sub>x</sub> -60,29 ton SO <sub>2</sub>
		Particulate (PM10 PM2,5)	-5,19 ton PM10 -3,92 ton PM2,5
	Economy 	Investment cost	-5.425.432 €
		Costs variation by service interruption	-58%
	Energy 	Consumed energy	-28.580 ÷ -36.580 MWh
		Renewable energy used	+5%
	Living 	Service interruption number	-25%
		Service interruption duration	-45%

## *Summary*

- ☐ *Smart cities and sustainability: the Expo Milan 2015 project*
- ☐ *Smartainability®: origin and definitions*
- ☐ *The “smart” technologies for Expo Milan 2015: a quick view*
- ☐ *The “Layer 1”: energy distribution and use*
- ☐ ***The “Layer 2”: Telecommunication and IT***
- ☐ *The “Layer 5”: Mobility*
- ☐ *Some concluding remarks*



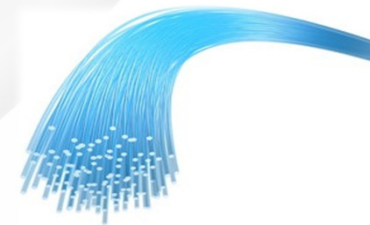
# Layer 2: Telecom Italia - Cisco



## Telecommunication system

- Local MAN (Metropolitan Area Network)
- Ultra-bb optical access network
- Access gateway and terminations
- Ultra Broadband / 4G mobile
- Cloud
- Routers
- Switches
- WiFi access
- IP Phones

  
**wifi**



# Layer 2: Telecommunications and IT Systems

## Telecommunication system



### Assets-Functionalities matrix

Assets	Functionalities										
	Fast internet connection	Remote data access	Information security	Cloud computing	Increase of network performance	Backup	Network resources sharing	IT infrastructures access	Mobility connection	Energy management	Network dynamic adjustment
Local MAN											
Ultra-bb optical access network											
Access gateway and terminations											
Ultra broadband / 4G mobile											
Cloud											
Routers											
Switches											
WiFi access											
IP Phone											

# Layer 2: Telecommunications and IT Systems

## Telecommunication system



### Functionalities-Benefits matrix

Functionalities	Benefits											
	Faster transmission data	Greater data security	Better data accessibility	Pollutant emissions reduction	Greater energy safe	Greater network security	Safer and more efficient money transfers	Better quality of experience	Better innovative services access	Costs reduction	Better damages impact mitigation	Greater service continuity
Fast internet connection												
Remote data access												
Information security												
Cloud computing												
Increase of network performance												
Backup												
Network resources sharing												
IT infrastructures access												
Mobility connection												
Energy management												
Network dynamic adjustment												

# Layer 2: Telecommunications and IT Systems

## Telecommunication system



### Benefits-KPI matrix

Benefits	KPI									
	Environment			Economy	Energy	Living				
	Green house gases	Acid gases	Particulates (PM10, PM2,5)	Costs	Energy used	Saved time	Information points	Foiled cybernetic attacks	Simultaneously connected users	Services and applications availability
Faster transmission data										
Greater data security										
Better data accessibility										
Pollutant emissions reduction										
Greater energy saving										
Greater network security										
Safer and more efficient money transfers										
Better quality of experience										
Better innovative services access										
Costs reduction										
Better damages impact mitigation										
Greater service continuity										

# Layer 2: Cisco



## Telepresence

- Client video
- WebEx
- Immersive room with three monitor
- Visual display units
- Codec
- Client Jabber



## Layer 2: Telecommunications and IT Systems

Telepresence



### Assets-Functionalities matrix

Assets	Functionalities	
	Collaboration	Telepresence
Client Video		
WebEx		
Immersive rooms with videos		
Video terminals		
Codec		
Client Jabber		

## Layer 2: Telecommunications and IT Systems

Telepresence



### Functionalities-Benefits matrix

Functionalities	Benefits			
	Pollutant emissions reduction	Time saving	Costs reduction	Better innovation visibility
Collaboration				
Telepresence				



## Layer 2: Telecommunications and IT Systems

Telepresence



### Benefits-KPI Matrix





Benefits	KPI					
	Environment			Economy	Living	
	Greenhouse gases	Acid gases	Particulates (PM10, PM2,5)	Costs	Effectiveness decisions growth	Exposure index
Pollutant emissions reduction	■	■	■			
Time saving					■	
Costs reduction				■		
Better innovation visibility						■

## Layer 2: Telecommunications and IT Systems

### Telecommunications system and Telepresence



#### KPI quantification

Technology	Dimension	KPI	Quantification
Telecommunications system and Telepresence	Environment 	Greenhouse gases	-702 ton CO <sub>2</sub> -Eq
		Acid gases	-1,60 ton NO <sub>x</sub> -1,77 ton SO <sub>2</sub>
		Particulate (PM10 PM2,5)	-0,14 ton PM10 -0,11 ton PM2,5
	Economy 	Investment cost	-838.843 €
	Energy 	Consumed energy	-836 MWh
	Living 	Saved time	High
		Information points	High
		Foiled cybernetic attaches	High
		Simultaneously connected users	High
		Services and applications availability	High
		Effectiveness decisions growth	+9,7%
		Exposure index	High

## *Summary*

- ☐ *Smart cities and sustainability: the Expo Milan 2015 project*
- ☐ *Smartainability®: origin and definitions*
- ☐ *The “smart” technologies for Expo Milan 2015: a quick view*
- ☐ *The “Layer 1”: energy distribution and use*
- ☐ *The “Layer 2”: Telecommunication and IT*
- ☐ *The “Layer 5”: Mobility*
- ☐ *Some concluding remarks*

# Layer 5: FCA e CNH Industrial



## Sustainable mobility

- Electric cars
- Multifuel cars
- Multifuel buses
- Car sharing
- “Eco:Drive”



# Layer 5: Services

Sustainable mobility



## Asset-Functionalities Matrix

Assets	Functionalities						
	Sustainable service mobility	Sustainable private mobility	Sustainable public mobility	Vehicles sharing	Parking area reduction	Driving optimization	Driver training
Electric cars							
Multifuel cars							
Multifuel buses							
Car sharing							
Eco:Drive							



# Layer 5: Services

## Sustainable mobility



### Functionalities-Benefits Matrix

Functionalities	Benefits					
	Pollutant emissions reduction	Costs reduction	Greater energy safe	Greater use of renewable resources	Best Quality of Experience	Greater awareness
Sustainable service mobility						
Sustainable private mobility						
Sustainable public mobility						
Vehicles sharing						
Parking area reduction						
Driving optimization						
Driver training						

# Layer 5: Services

Sustainable mobility



## Benefits-KPI Matrix





Benefits	KPI								
	Environment			Economy	Energy		Living		
	Greenhouse gases	Acid gases	Particulates (PM10, PM2,5)	Costs	Fossil energy used	Renewable energy used	Customer engagement	Saved time	Driving stress level
Pollutant emissions reduction									
Costs reduction									
Greater energy safe									
Greater use of renewable resources									
Best Quality of Experience									
Greater awareness									

# Layer 5: Services

## Sustainable mobility



### KPI quantification

Technology	Dimension	KPI	Quantification
Sustainable mobility	Environment 	Greenhouse gases	-142 ton CO <sub>2</sub> -Eq
		Acid gases	-1,90E-01 ton NO <sub>x</sub> -2,71E-01 ton SO <sub>2</sub>
		Particulate (PM10 e PM2,5)	-1,27E-02 ton PM10 -1,83E-02 ton PM2,5
	Economy 	Costs	-69.651 €
	Energy 	Fossil energy use	-1.488 MWh
		Renewable energy used	+798%
	Living 	Customer engagement	High
		Saved driving time	+3,3%
		Driving stress level	Low

## *Summary*

- ☐ *Smart cities and sustainability: the Expo Milan 2015 project*
- ☐ *Smartainability®: origin and definitions*
- ☐ *The “smart” technologies for Expo Milan 2015: a quick view*
- ☐ *The “Layer 1”: energy distribution and use*
- ☐ *The “Layer 2”: Telecommunication and IT*
- ☐ *The “Layer 5”: Mobility*
- ☐ *Some concluding remarks*

# Smartainability®: overall result



Technology	Dimension	KPI	Quantification
Energy distribution and Outdoor lighting (Piastra and Pavilions) + Telecommunications system and Telepresence + Sustainable mobility	Environment 	Greenhouse gases	-21.595 ton CO2-Eq
		Acid gases	-36,09 ton NOx -62,32 ton SO2
		Particulate (PM10 e PM2,5)	-5,34 ton PM10 -4,05ton PM2,5
	Economy 	Costs	- 6.333.926 €
		Costs variation by service interruption	-58%
	Energy 	Fossil energy use	-29.416 ÷ -37.416 MWh
		Renewable energy used	-82.628 ÷ -104.695 MWh
	Living 	Service interruption number	-25%
		Service interruption duration	-45%
		Saved time	High
		Information points	High
		Foiled cybernetic attacks	High
		Simultaneously connected users	High
		Services and applications availability	High
		Effectiveness decisions growth	+9,7%
		Exposure index	High
		Customer engagement	High
		Saved driving time	+3,3%
		Driving stress level	Low



# Example: KPI quantification

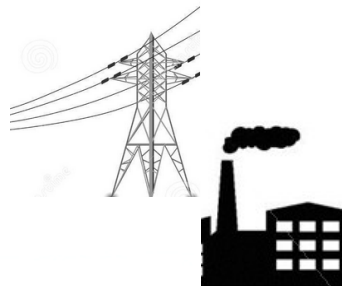


## Smart technologies

Protection and remote control system
Sensors
Smart meter
Energy Management System
LED outdoor lamps Piastra
LED outdoor lamps Pavilions
Remote control system LED outdoor lamps (Piastra)
Storage

## Functionalities

Energy loads knowledge and control
Loads optimization
Advanced lighting management
RES optimization



## Benefits

Pollutant emissions reduction

## KPI

CO <sub>2</sub> emissions reduction
NO <sub>x</sub> emissions reduction
SO <sub>x</sub> emissions reduction
PM10 emissions reduction
PM2.5 emissions reduction

Energy savings estimate

Electric energy emission factors

Saved emissions

# Strength and weakness points



Ex-ante evaluations

Indicators evaluate benefits, not functionalities/assets

Sustainability and smartness combined evaluation

Monitoring/evaluation ex post thanks to KPI



Technologies data mainly from Partners: need of a better “third party” assessment

KPI assessment based on estimated values and hypothesis

Difficulty to agree on a *Smart technology* definition

Guide lines definition (*work in progress*)

# Other contexts applicability



Reproducible for other similar events



Up-scalable from EXPO site to (smart) cities



# Aknowledgements



**Smartainability® is a project financed by the Italian fund “Ricerca per il Sistema Elettrico Nazionale”, decree of Italian Economic Development Ministry November 9<sup>th</sup> 2012 and following**

**The development and application of Smartainability® to the Expo Milano 2015 site has been made in co-operation with Expo 2015 Spa, in the frame of a “ad hoc” agreement**

**The detailed assessment made in the project has been performed thanks to the co-operation of Expo Milano 2015 Partners, who made available data and information about the relevant technologies and allowed fruitful discussion with RSE technicians**





Thank you for your attention