HOW ENERGY IS CHANGING

Enrico Pochettino

19 Ottobre 2016

Disruption in the Energy Market

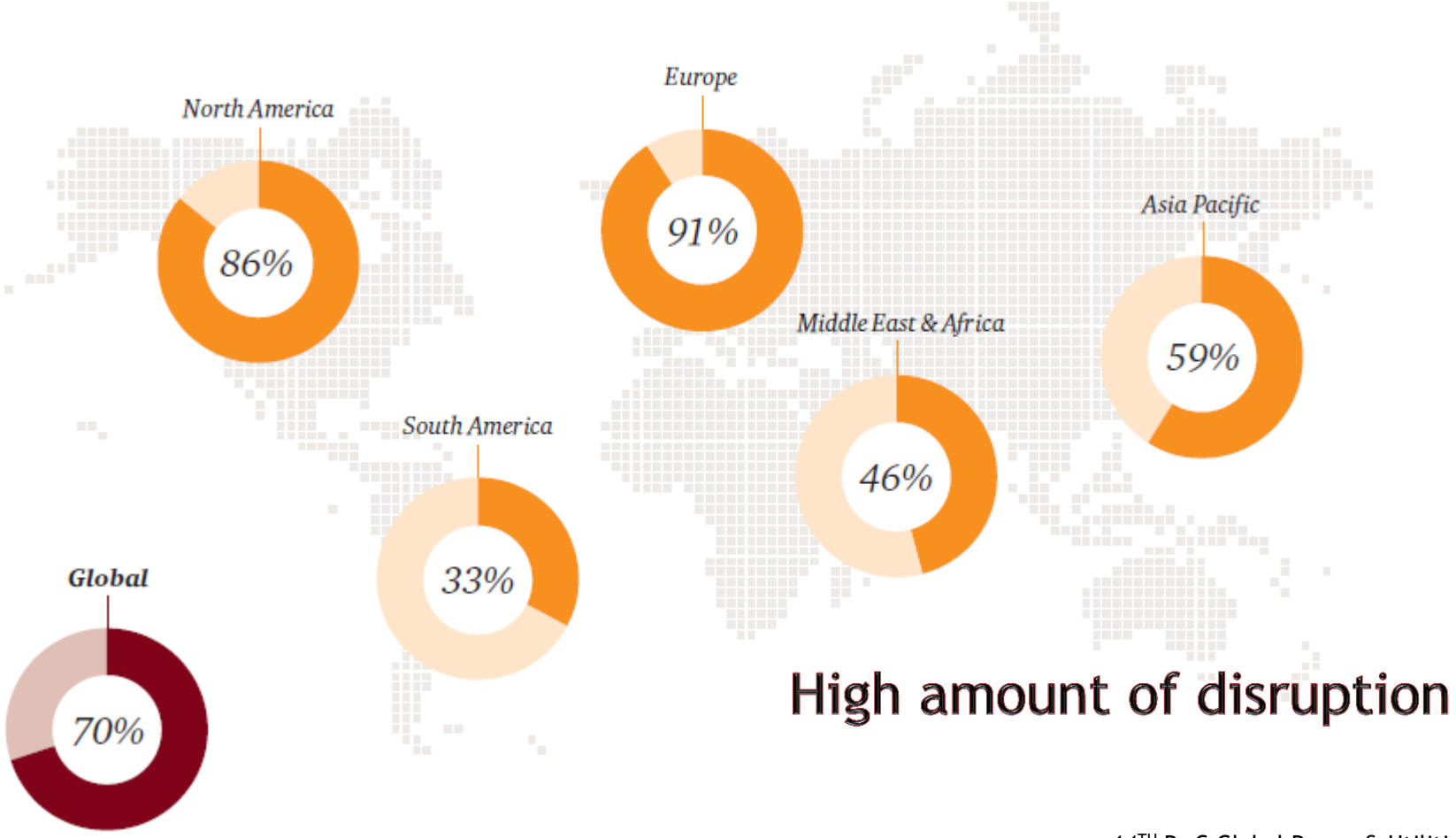
How will Energy Market change?

97% of world utilities expect by **2020** a **"medium to high amount of disruption" in the energy market**

14TH PwC Global Power & Utilities Survey

How will Energy Market change?

91% of European stakeholders expect by 2030 a "high amount of disruption" in the energy market



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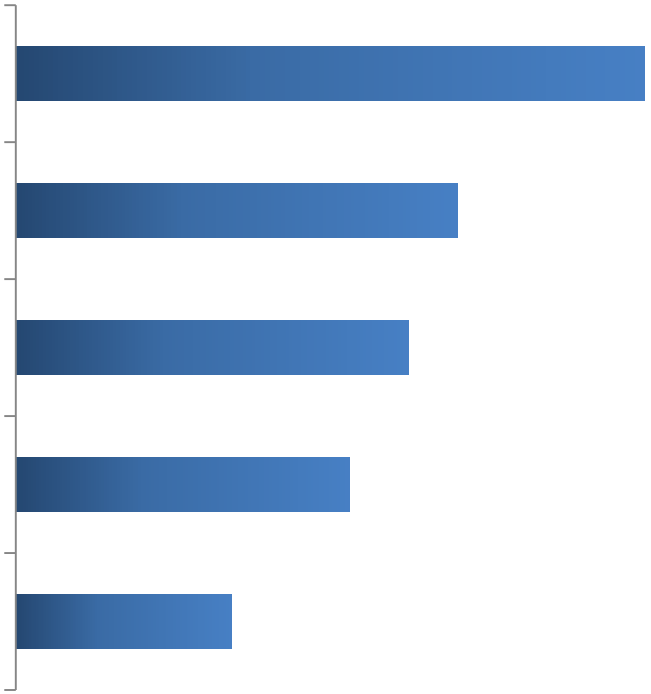
How will Energy Market change?

Megatrends in the Energy Sector

Key disruption causes

- Government and regulation changes
- Competition among existing competitors and new entries
- Energy production models (centralized/diffused, new energy sources)
- Distribution channels: new system for clients participation
- Consumer behavior



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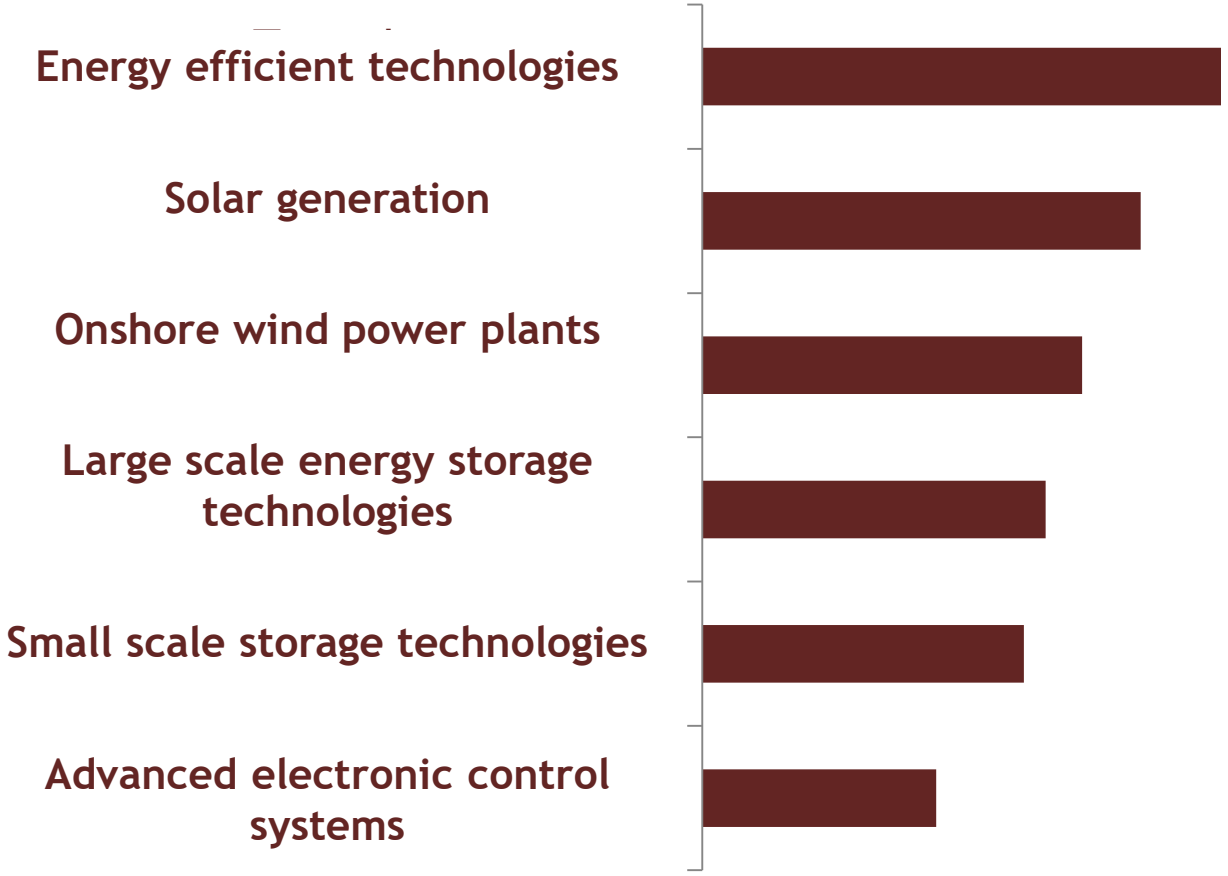
How will Energy Market change?

Technological Breakthroughs



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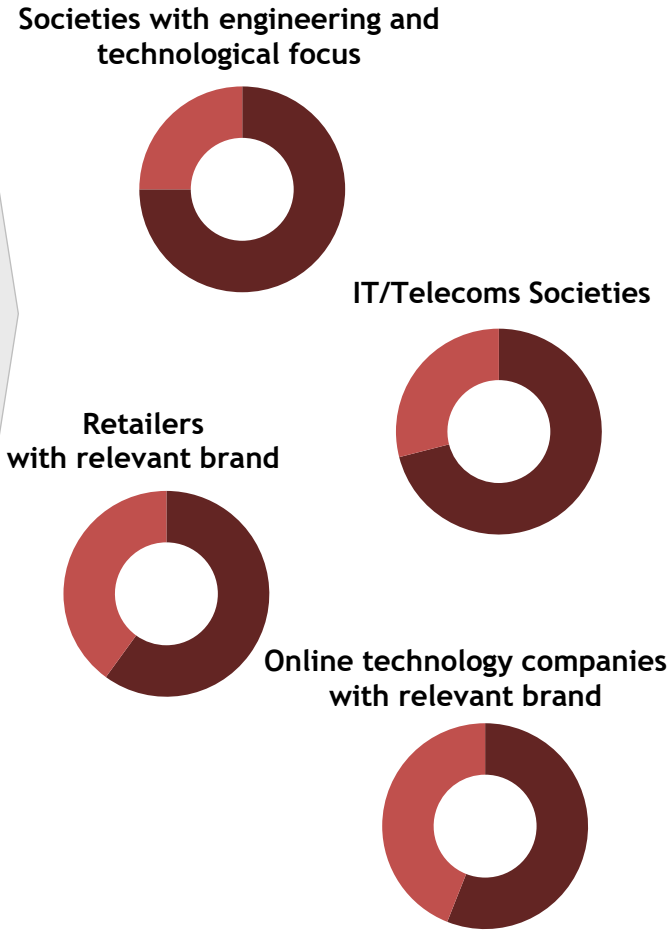
New comers in the energy world



Regulatory Framework

COP21 – Climate Change Conference 2015

United Nations
Treaty Collection

United nations conference on climate change
COP21/CMP11

https://goo.gl/rvTzpC

COP21 - Climate Change Conference 2015

« You've done it, reached an ambitious agreement, a binding agreement, a universal agreement »

Francois Hollande

- 175 Countries over 195, and the EU, signed the Paris Agreement on the 22nd April 2016
- Become law not before 2020

Ambitious Targets

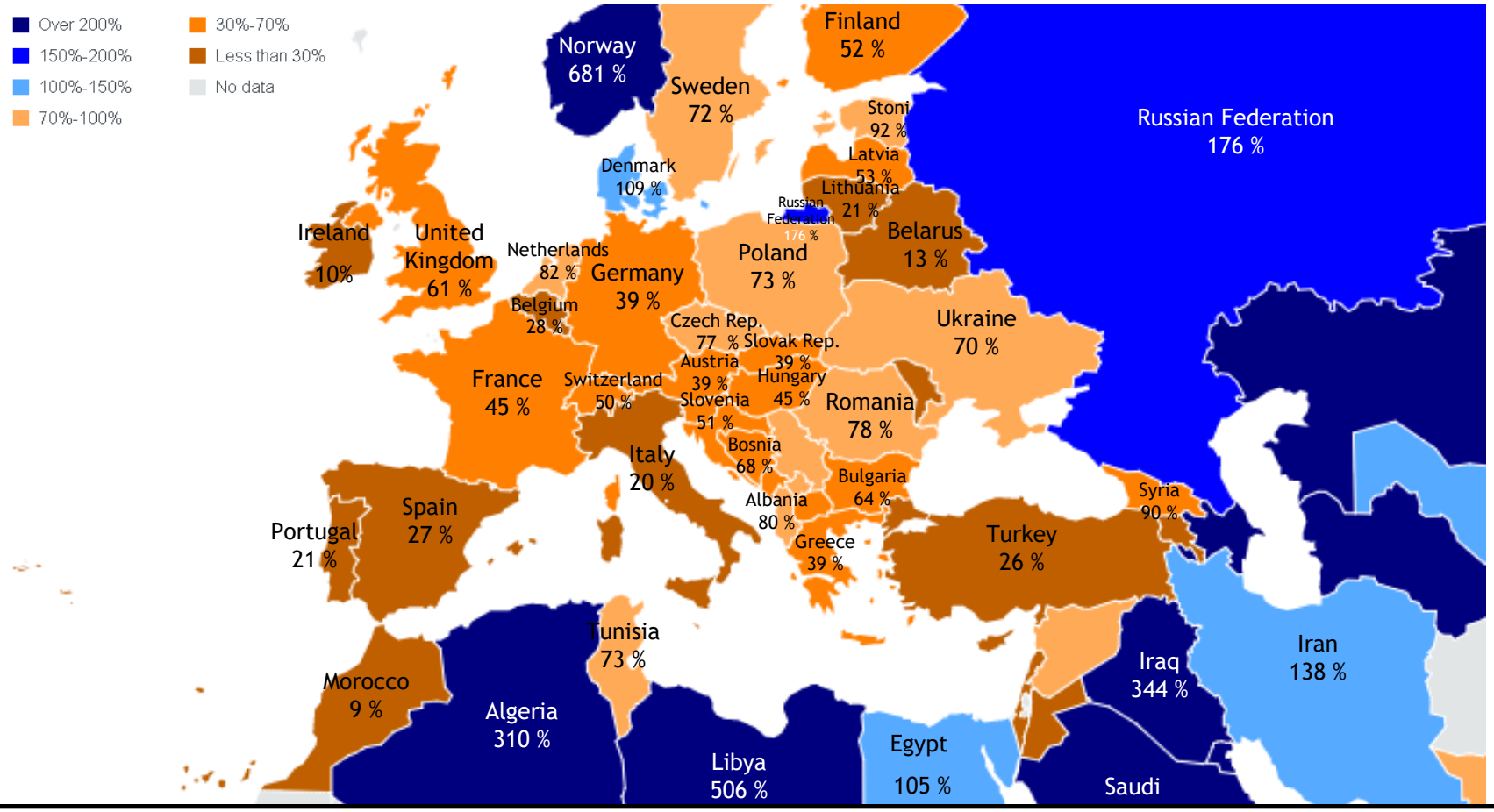
«main aim is to keep a global temperature rise this century well below 2 degrees Celsius and to drive efforts to limit the temperature increase even further to 1.5 degrees Celsius above pre-industrial levels.

The 1.5 degree Celsius limit is a significantly safer defense line against the worst impacts of a changing climate.»

Other key points

- **Climate finance - Diversified** financial tasks according to the different historical responsibility on climate and emission between Developed and Developing Countries
- **Adaptation and Resiliency**
- **Transparency and Emission audit**

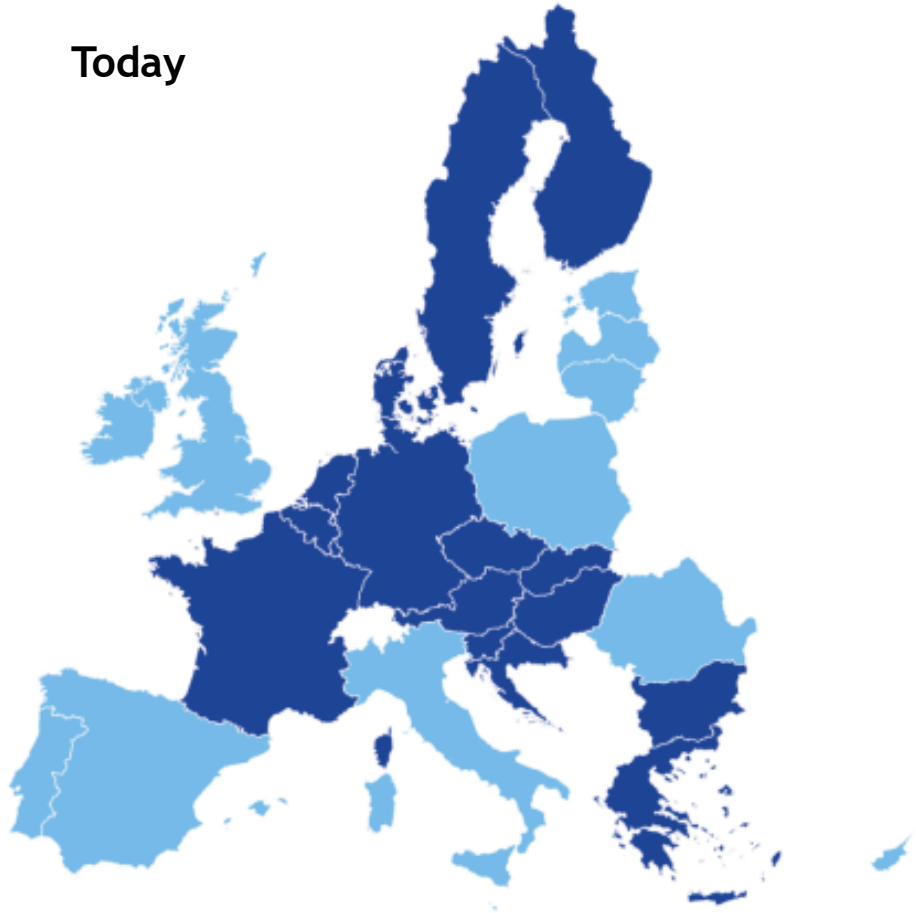
Energy : present self-sufficiency of European States

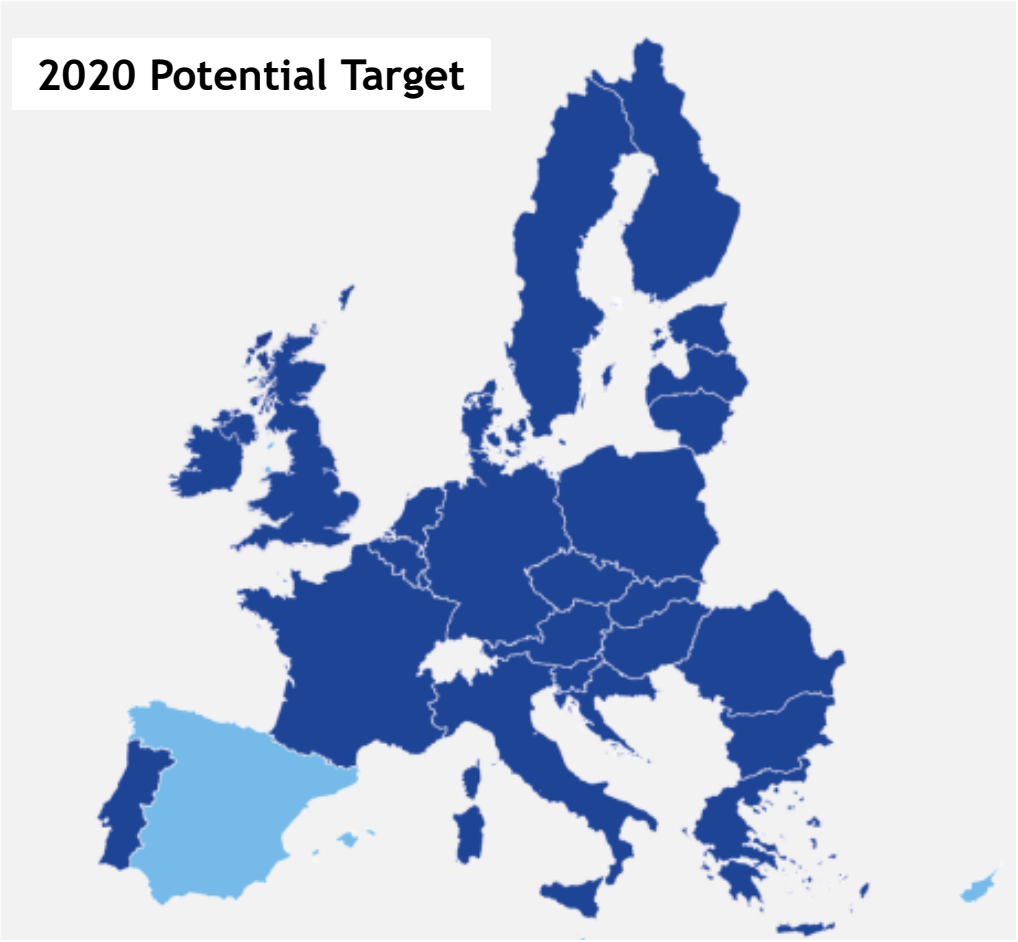


EU IMPORTS THE 53% OF ITS ENTIRE ENERGY DEMAND*
with a disbursement of
400 mil€/year

*Total Primary Energy Demand

Electric energy market - today and tomorrow





Countries that reached the 10% interconnection target

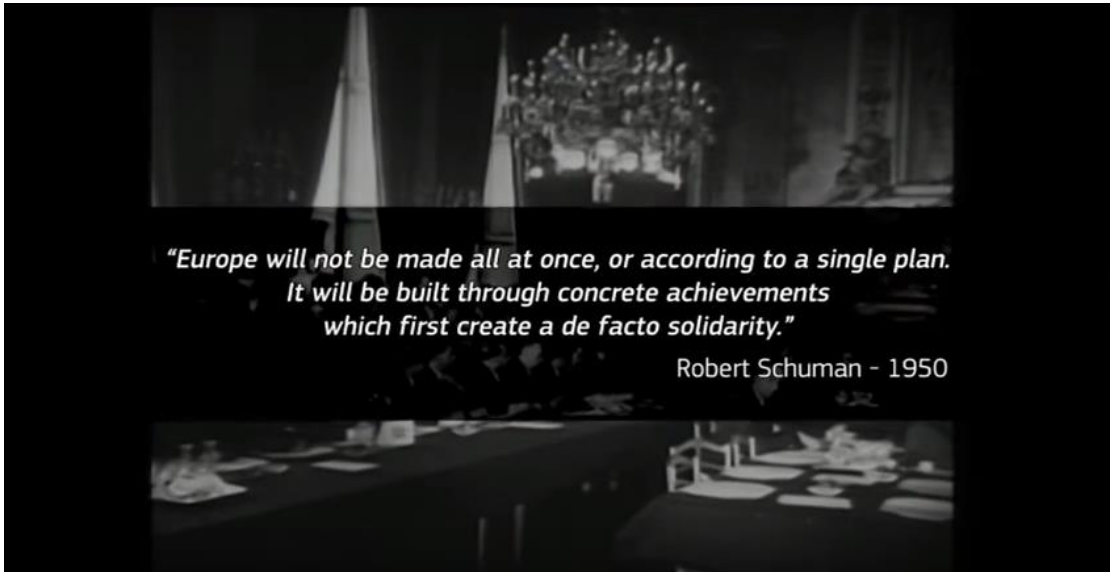
Countries that have not reached the 10% interconnection target

Necessary efforts in order to achieve the European 10% target by 2020 (aiming to reach the 15% by 2030)

Source: European Commission

L'Energy Union

"I want to reform and reorganise Europe's energy policy into a new European Energy Union"



Jean-Claude Juncker

European Commission President

The Energy Union – Objectives and Dimensions

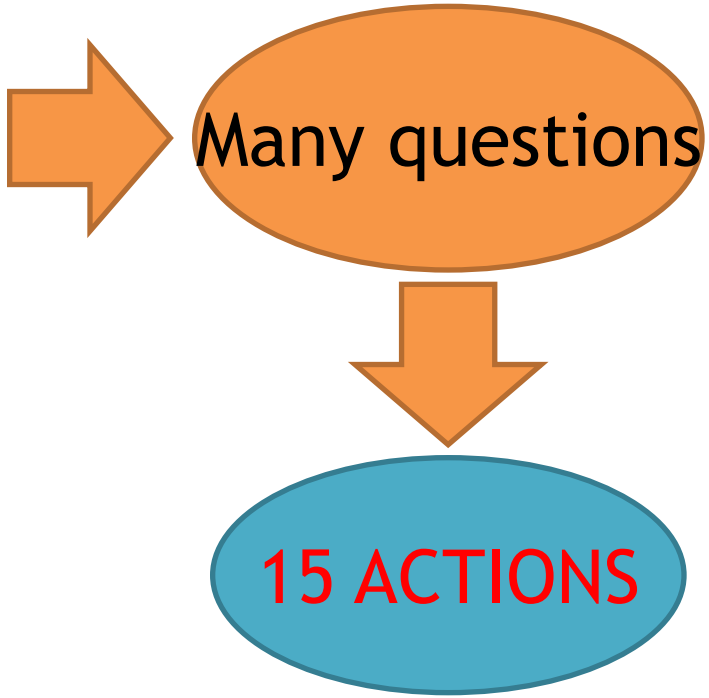
The Energy Union will assure Europe energy that will be:

- **secure**
- **sustainable/affordable**
- **competitive**

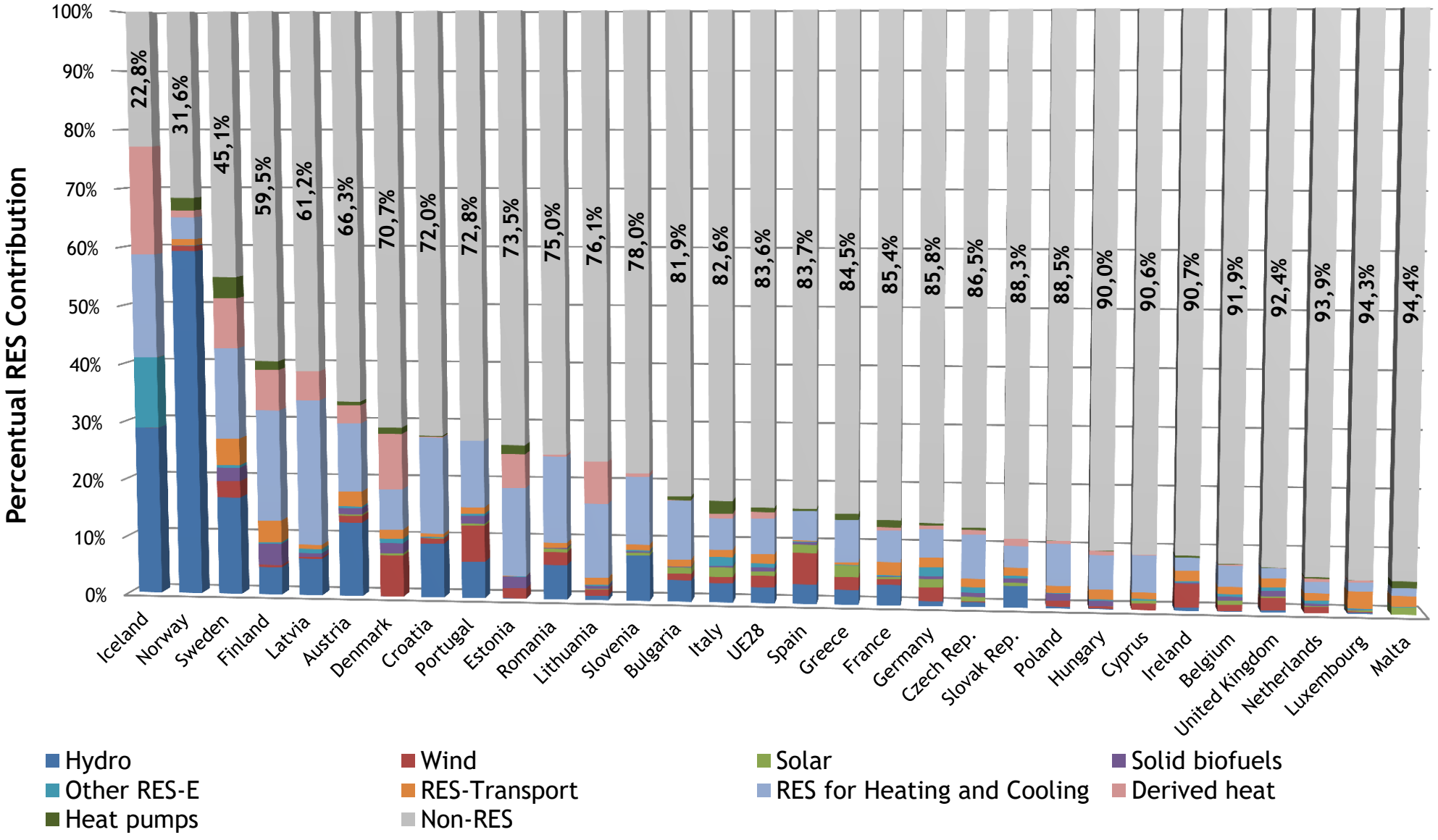
It will granted a new economic growth and provide new jobs

5 DIMENSIONS

1. Energy security, solidarity and trust
2. Full European energy market integration
3. Energy efficiency
4. Decarbonisation of the economy
5. Research, innovation and competitiveness

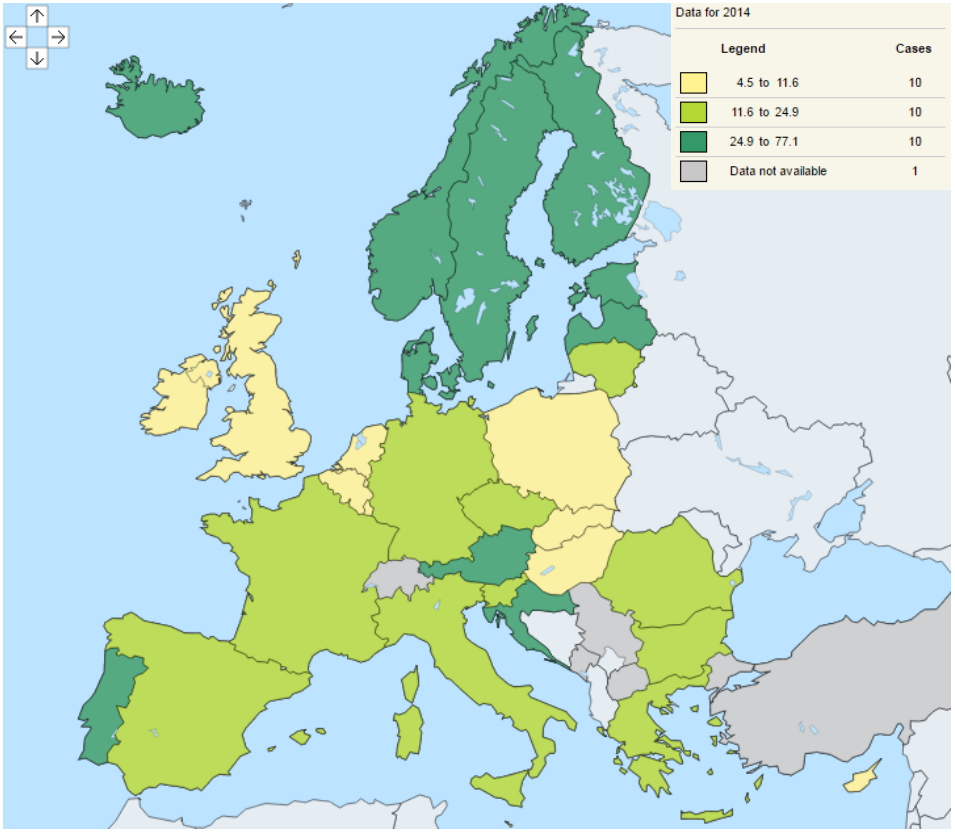


Europe States Renewable Energy Share 2014



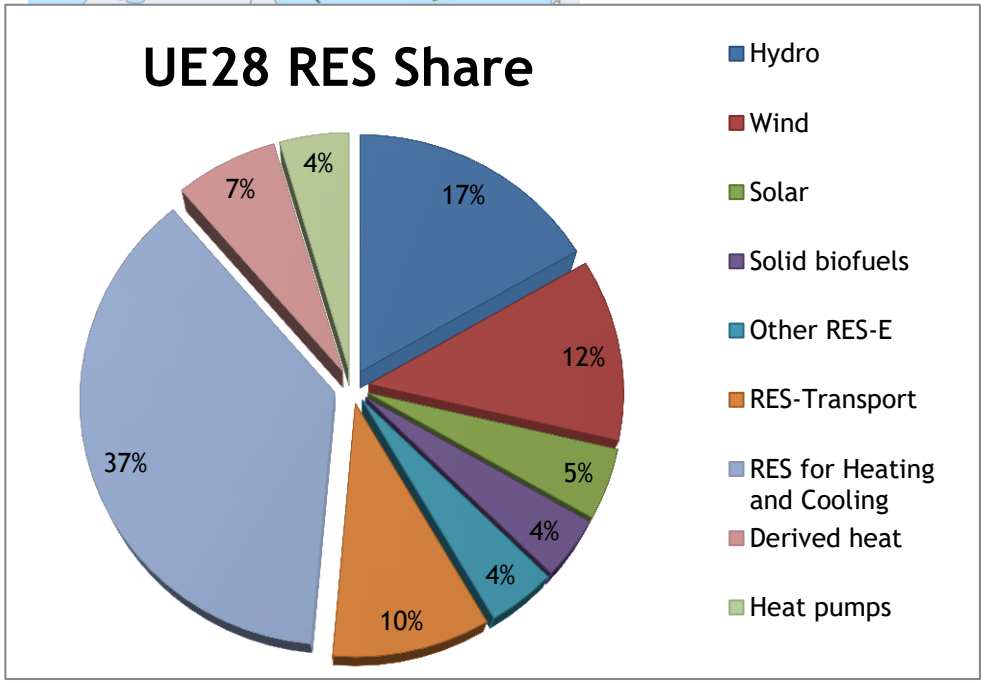
Source: EUROSTAT

Europe States Renewable Percentages at 2014



Yellow: under 2020 TARGET

Green: over 2020 TARGET



Source: EUROSTAT

Renewable Energy Sources Technologies Framework

Source	Electricity and Cogeneration	Heat/Chilled

Air/Wind	• Wind power
	  • Traditional
	  • Mini
	  • Micro
		• Air HP/chiller (powered by RES electricity)

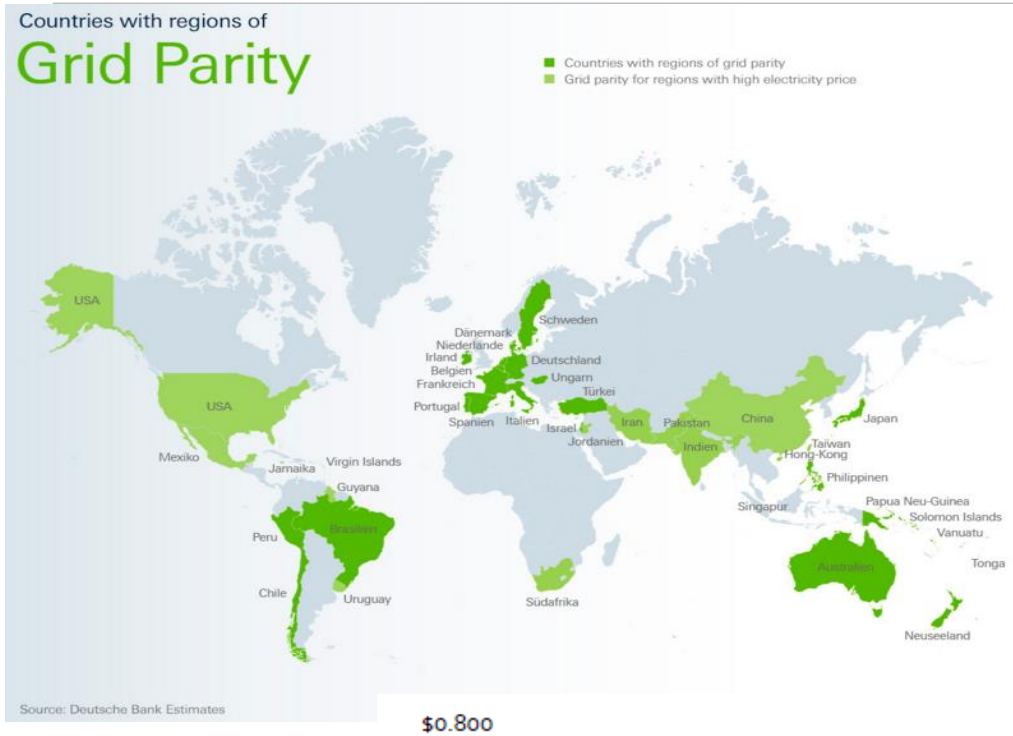
Water	• Hydroelectric
	  • Traditional
	  • Mini
	  • Micro
	• Tide/wave
		• Superficial water HP/chiller (powered by RES electricity)

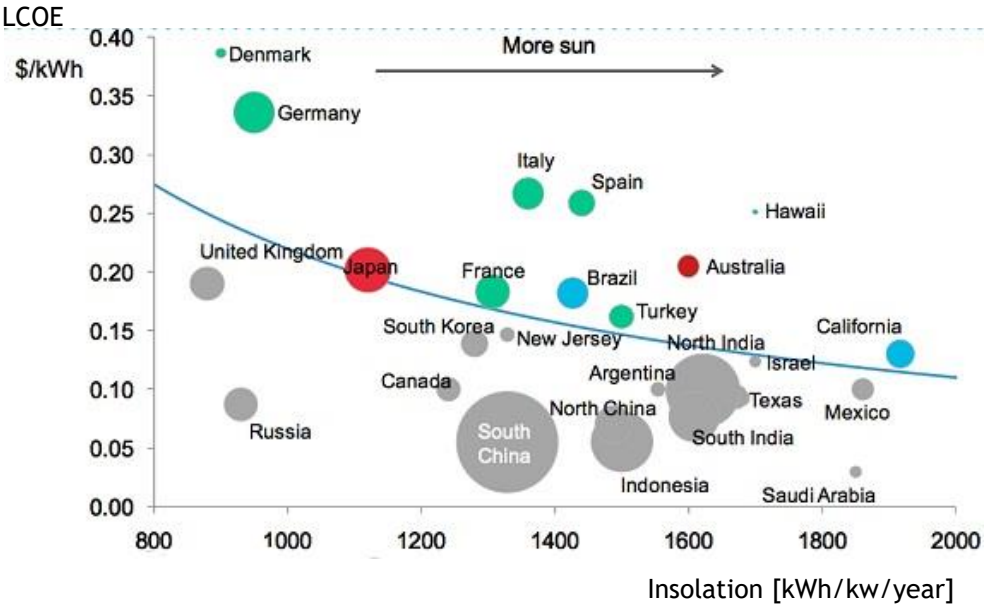
Sun	• Photovoltaic
	• Concentrated solar power
		• Thermal Solar
		  • Flat
		  • Concentrating

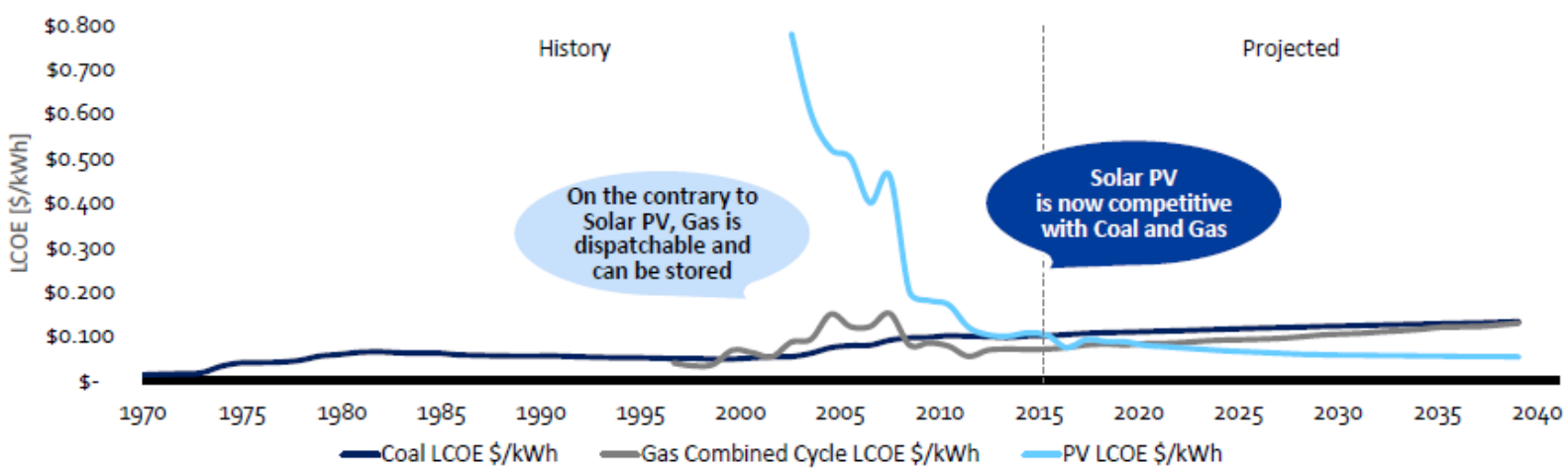
Geothermal	• Steam turbines/ORC at high enthalpy
	  • Superficial sounds
	  • Depth sounds
		• Medium enthalpy for direct uses
		• Low enthalpy coupled with HP

Biomass	• ORC turbines
	  • Solid (pellet, corn…)
	  • Liquid (vegetable oil)
	  • Gas (pirogassification)
		• Boilers
		  • Solid (pellet, corn…)
		  • Liquid (vegetable oil)
		  • Gas (bio-digestion, …)

Photovoltaic Power Plant

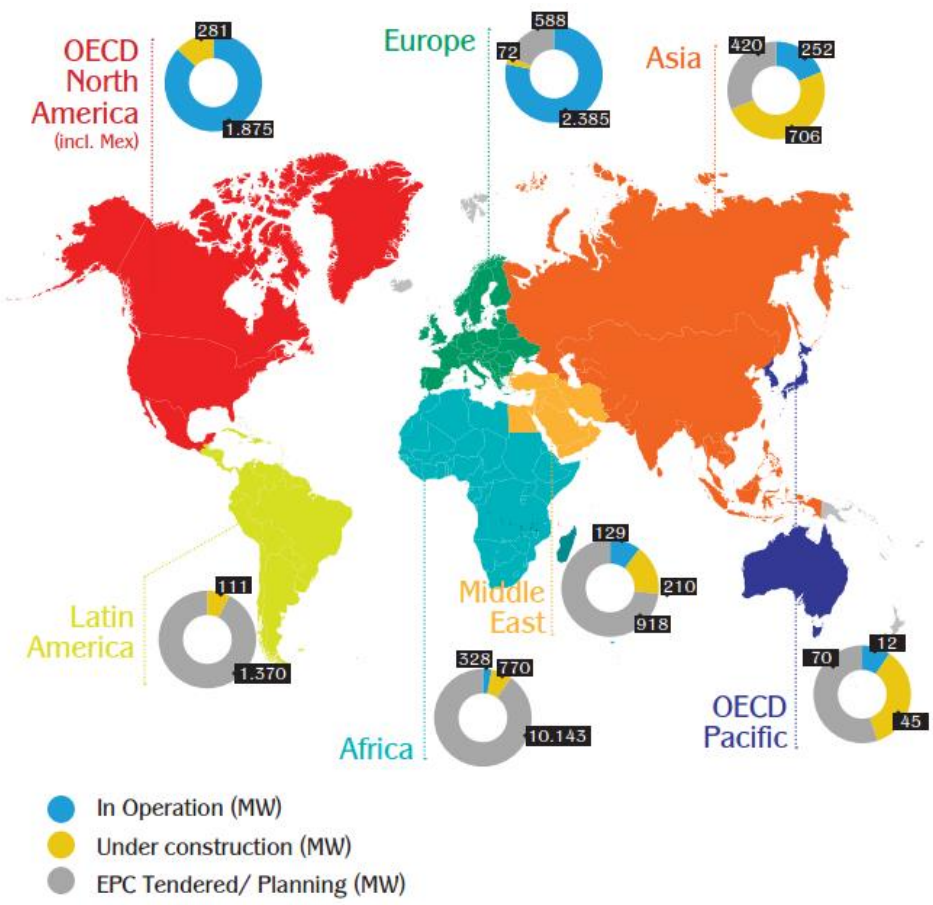


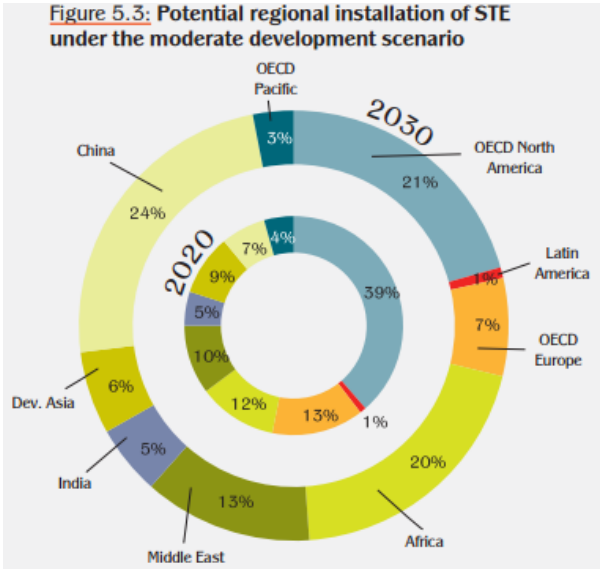


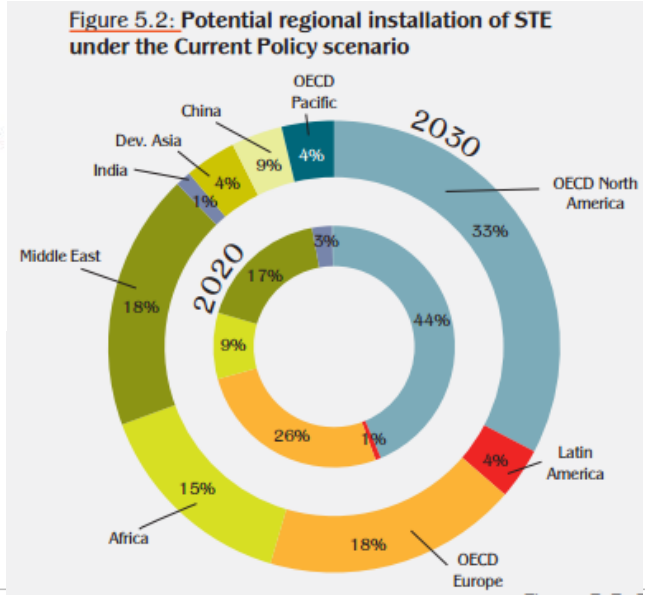


Source: Deutsche Bank; Samsung; SunShot

Concentrated Solar Power Plant



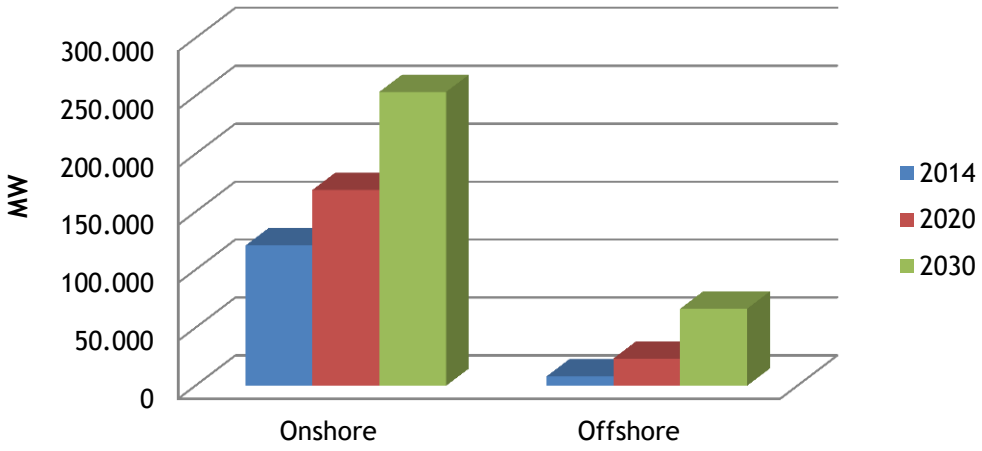




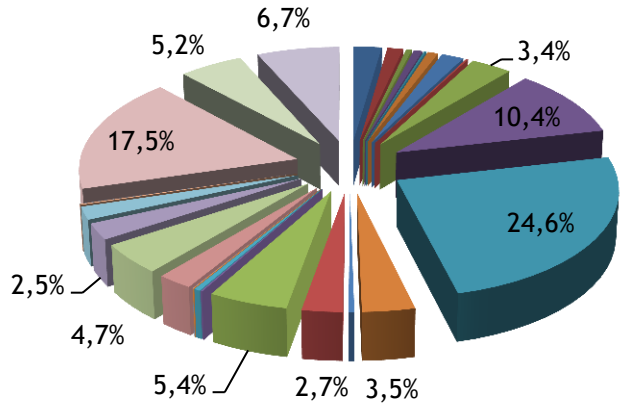
Source: Solar Thermal Electricity Global Outlook 2016

Wind Power Plant

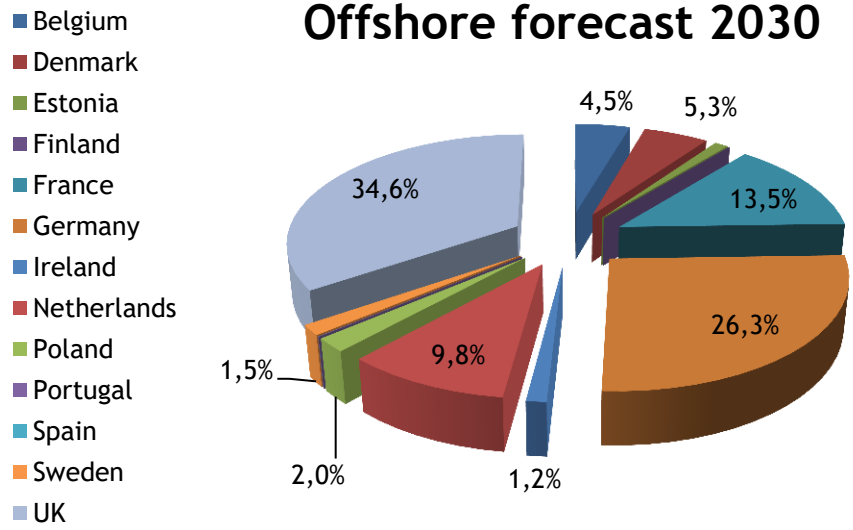
Wind Installed Capacity Comparison



Onshore forecast 2030



Offshore forecast 2030

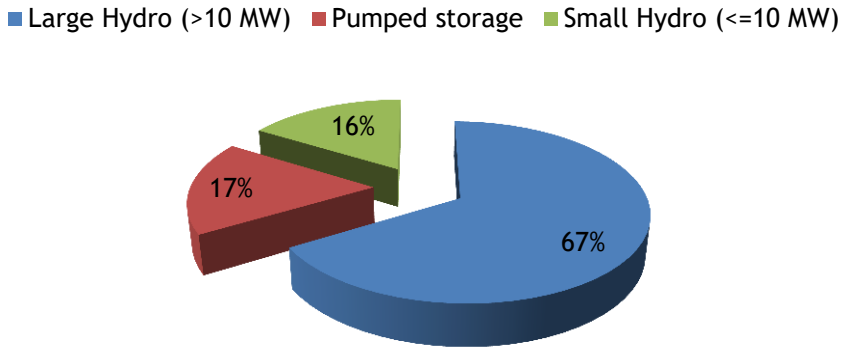


Austria | Belgium | Bulgaria | Croatia
Cyprus | Czech Rep. | Denmark | Estonia
Finland | France | Germany | Greece
Hungary | Ireland | Italy | Latvia
Lithuania | Luxembourg | Malta | Netherlands
Poland | Portugal | Romania | Slovakia
Slovenia | Spain | Sweden | UK

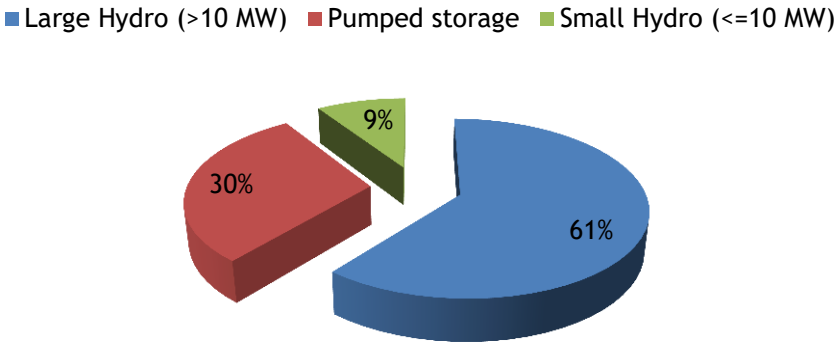
Source: European Wind Energy Association

Hydroelectric Power

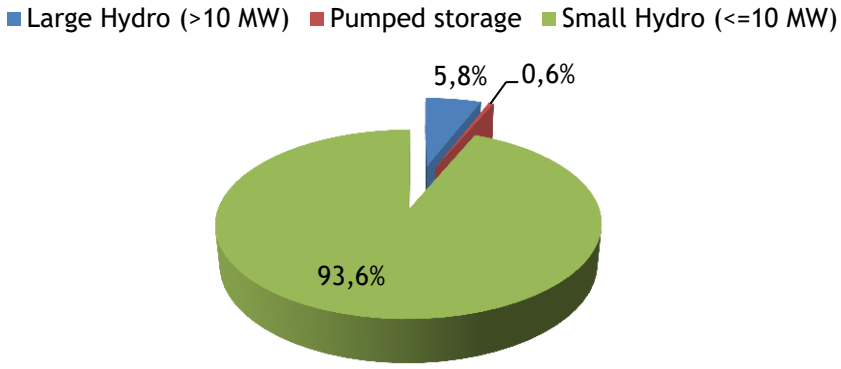
Gross Electricity Generation (GWh/year) forecast at 2020



Installed capacity (MW) forecast at 2020

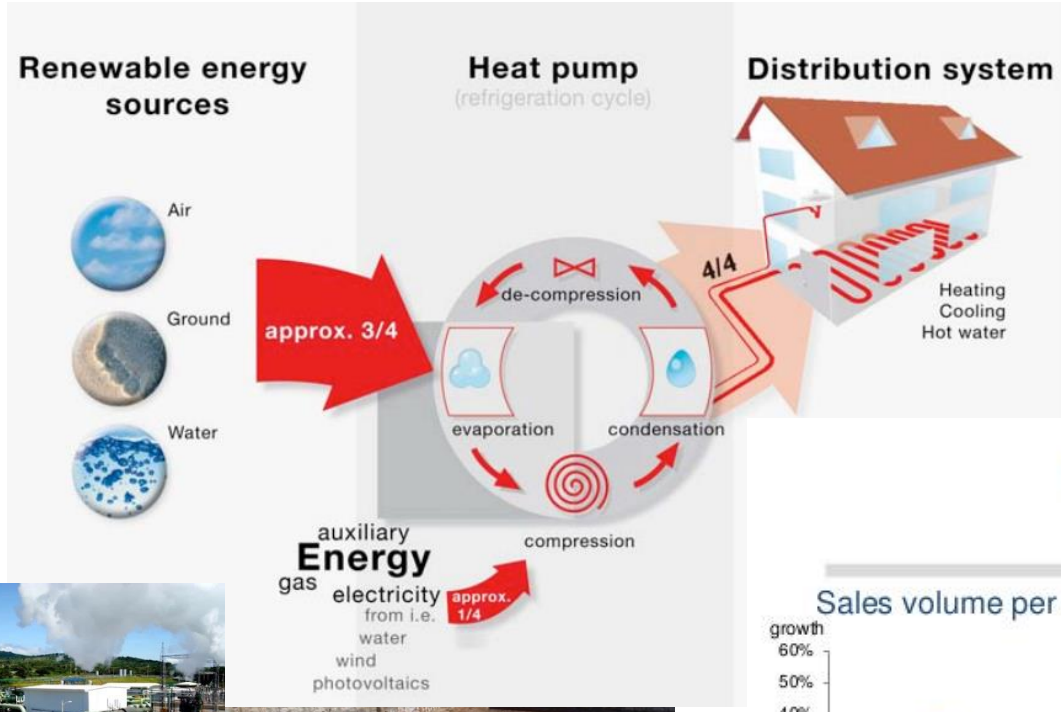


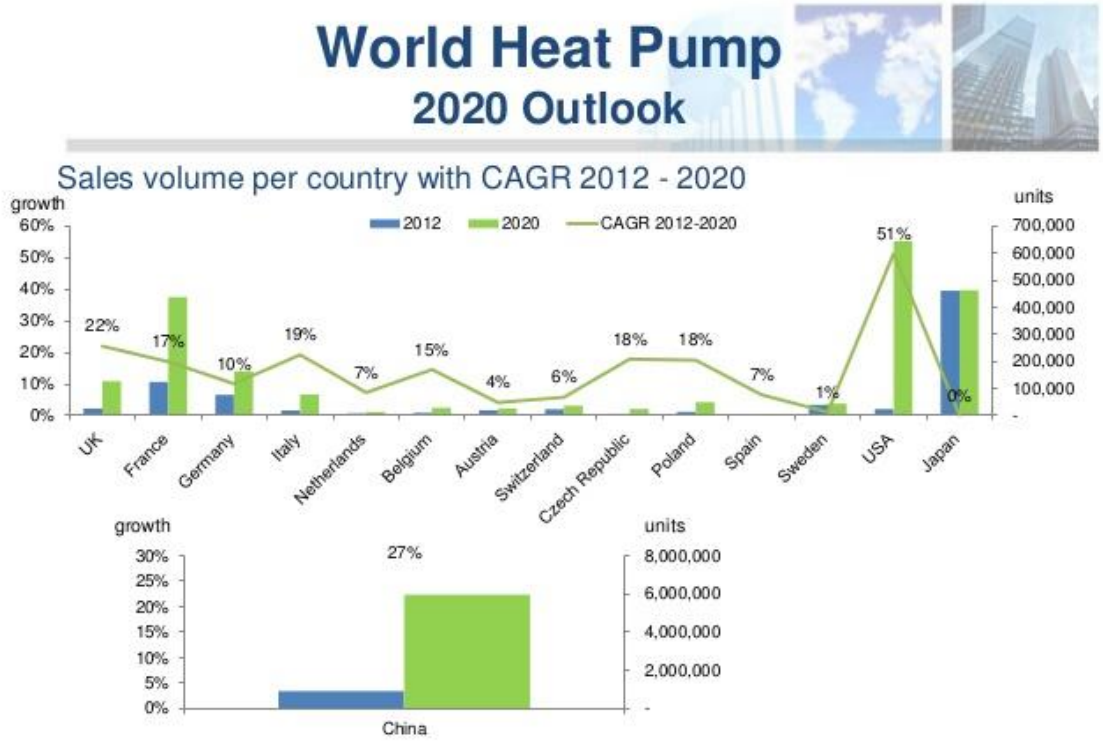
Number of new forecasted plants at 2020



Source: European Small Hydropower Association

Heat Pumps

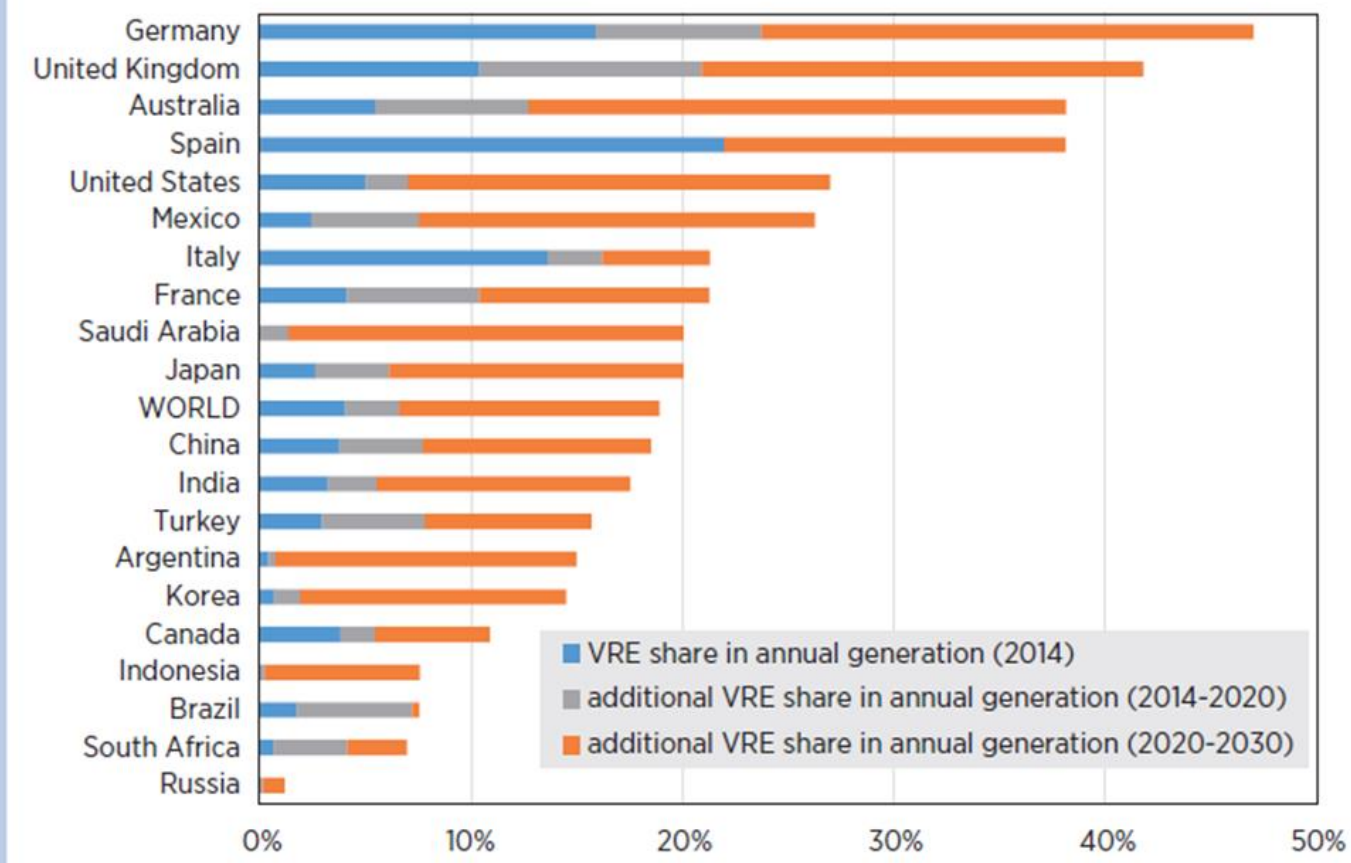




Source: European Heat Pump Association; BSRIA

Non-Programmable RES contribution

Figure 2: Current and future VRE share in annual generation for G20 countries between 2014 and 2030

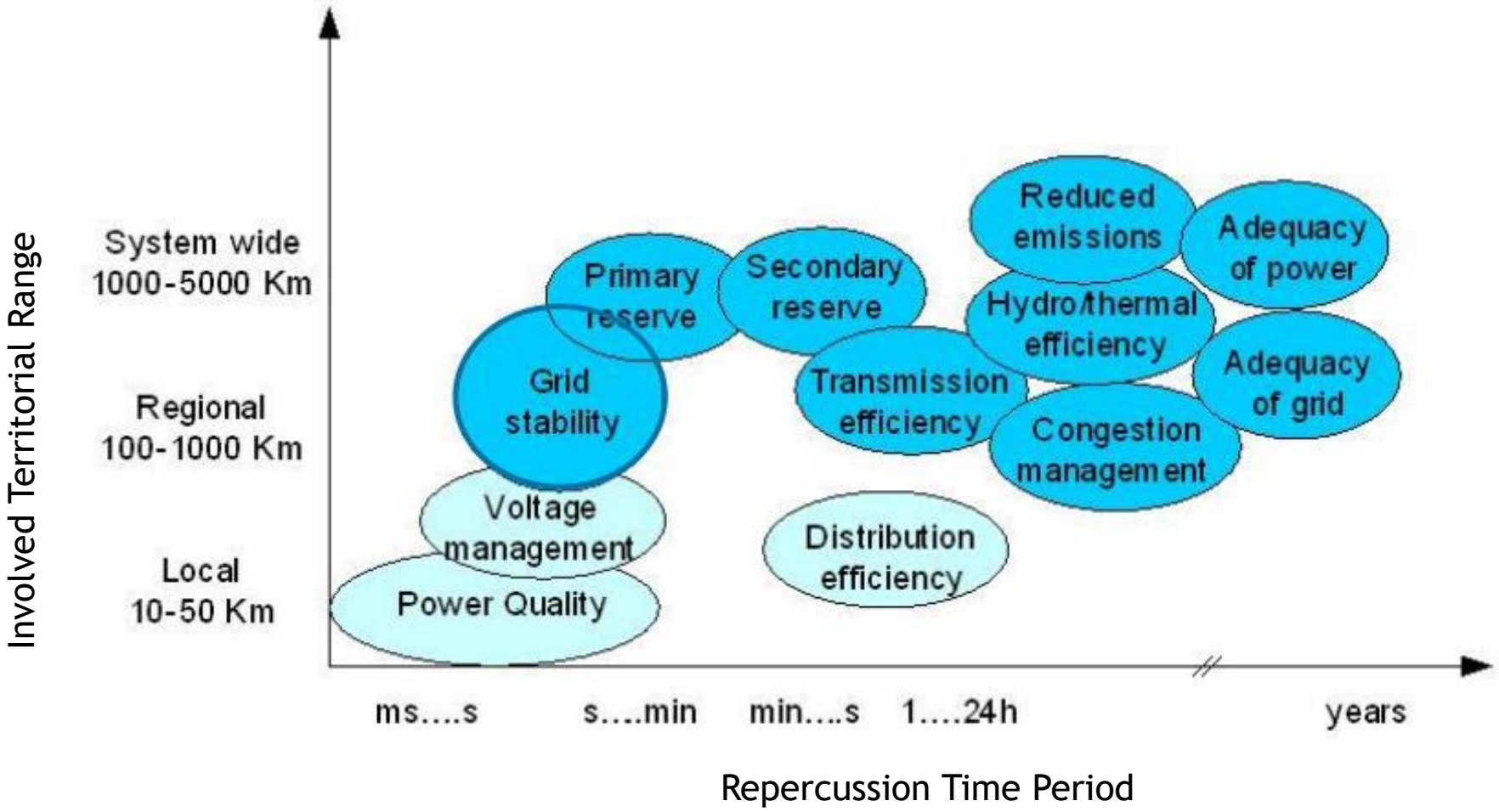


Note: 2014 is based on the latest statistical information available, 2020 data is based on IEA's medium term renewable energy market report, and 2030 is based on IRENA's REmap 2030 results of renewable power potential.

Sources: IEA, 2014a; IRENA, 2014b; GlobalData, 2015a; GWEC, 2015

Grid Stability Issues

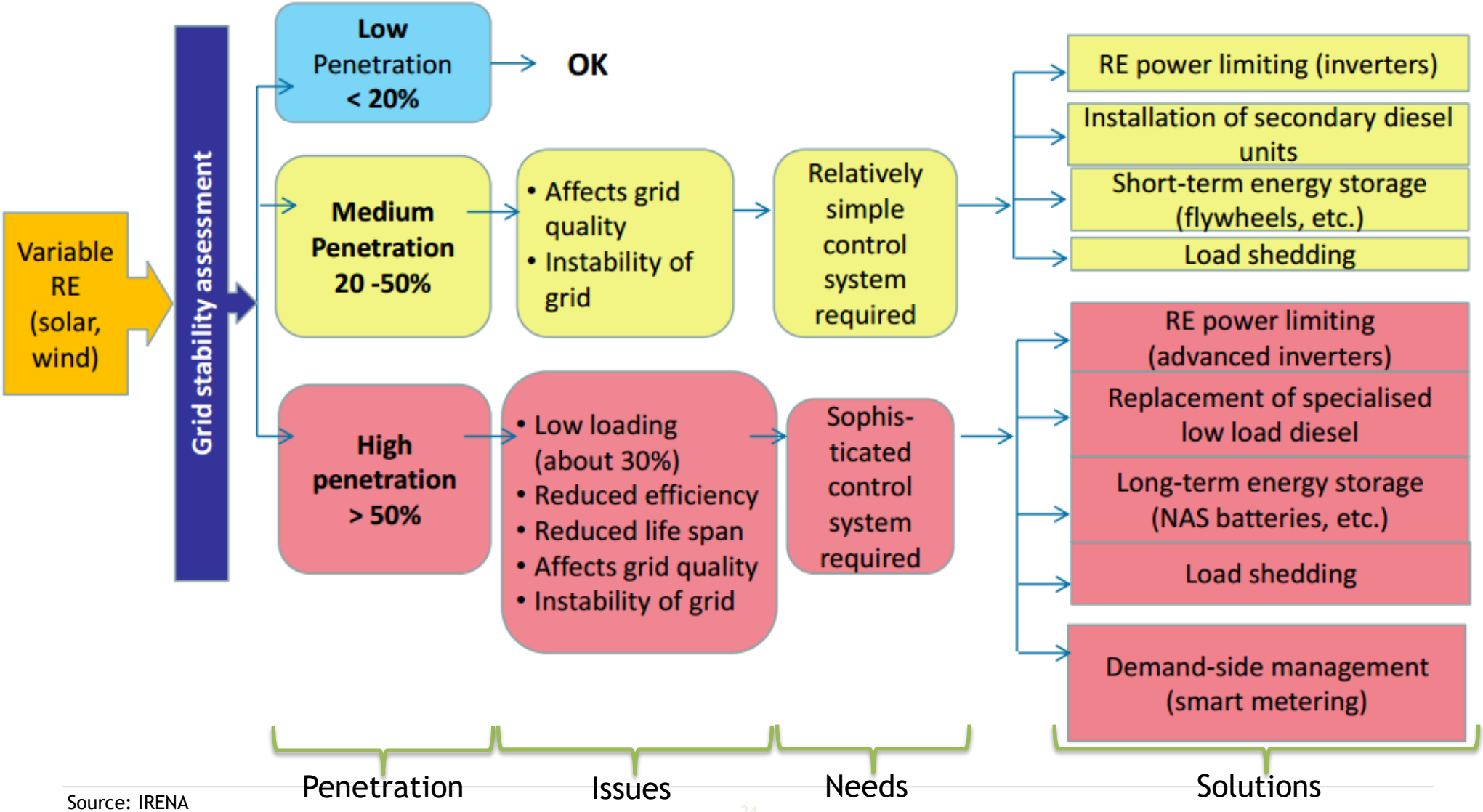
Example of wind power impacts on the electric systems:



Source: IRENA

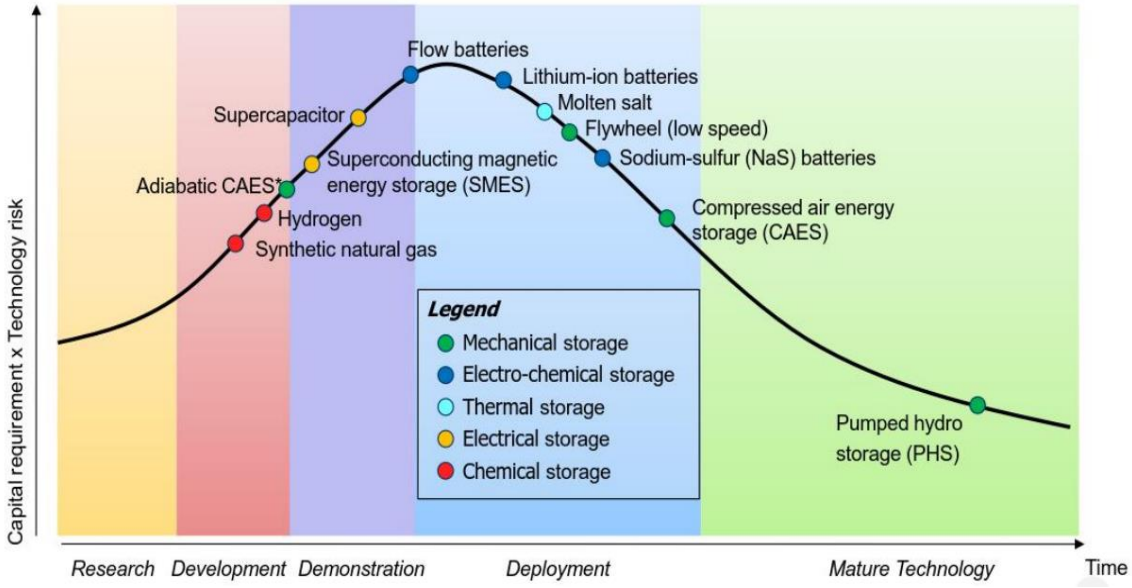
Grid Stability Issues

Best stability strategies depend on the level of renewable integration



Source: IRENA

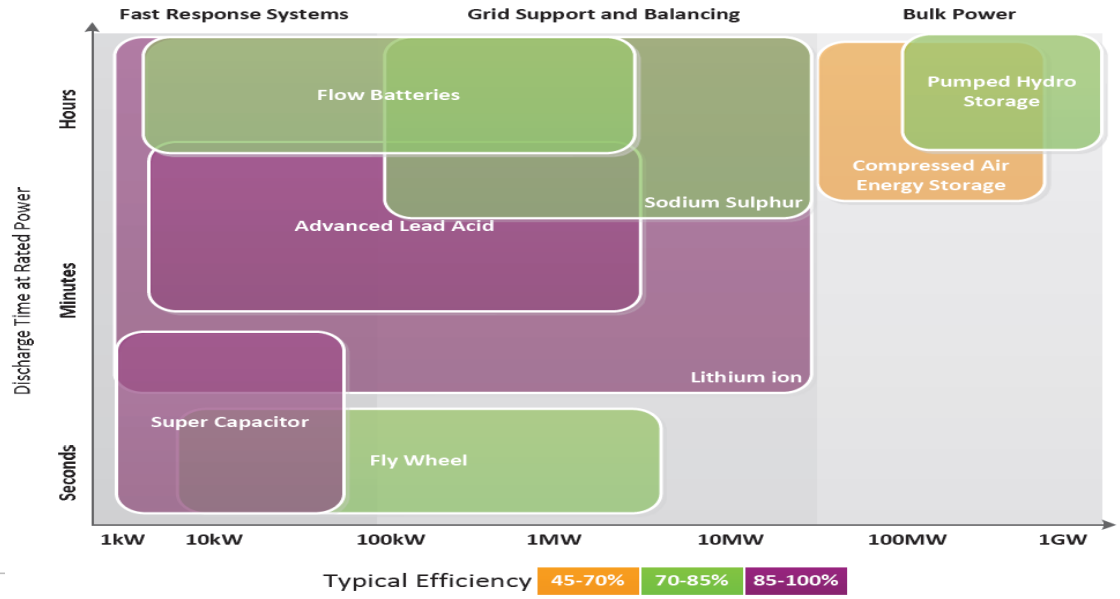
Electric Energy Storages



Future Applications Fields:

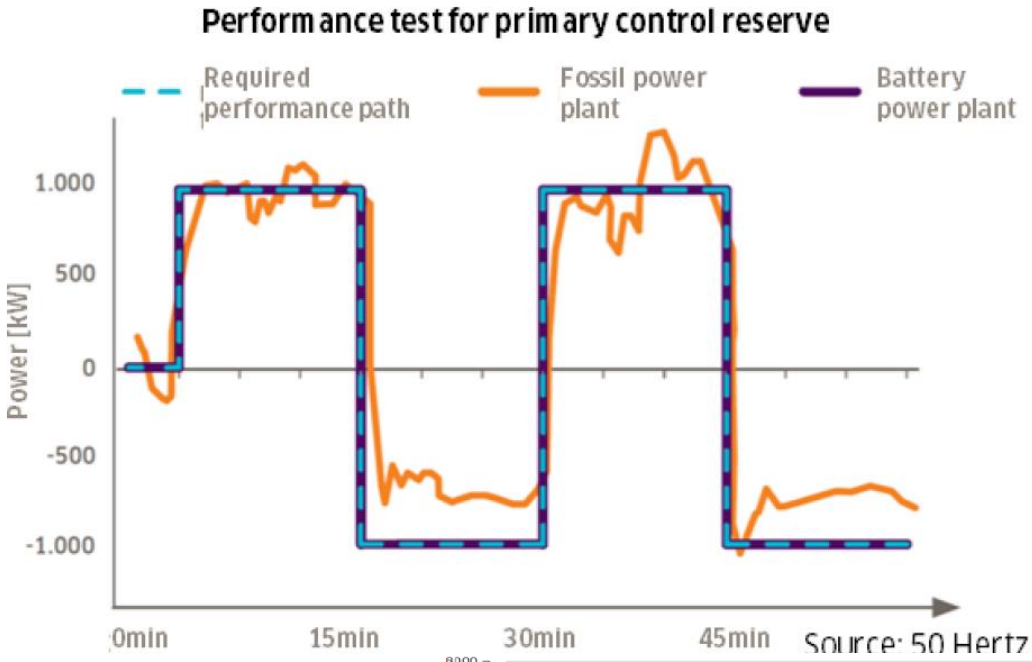
- Reserves and avoid **RES curtailment**;
- Power smoothing and time shifting;
- Optimize **prosumer self-consumption**;
- Demand Side Management;
- **Ancillary services**;
- **E-mobility**;
- Avoid Grid development and stress.

- **Different applications** and needs covered by a **adequate mix** of various technologies;
- Storages **modularity** and territory **diffusion** for extreme system **flexibility**;
- **Decreasing costs** allow market feasibility.



Source: AECOM

Electric Energy Storages

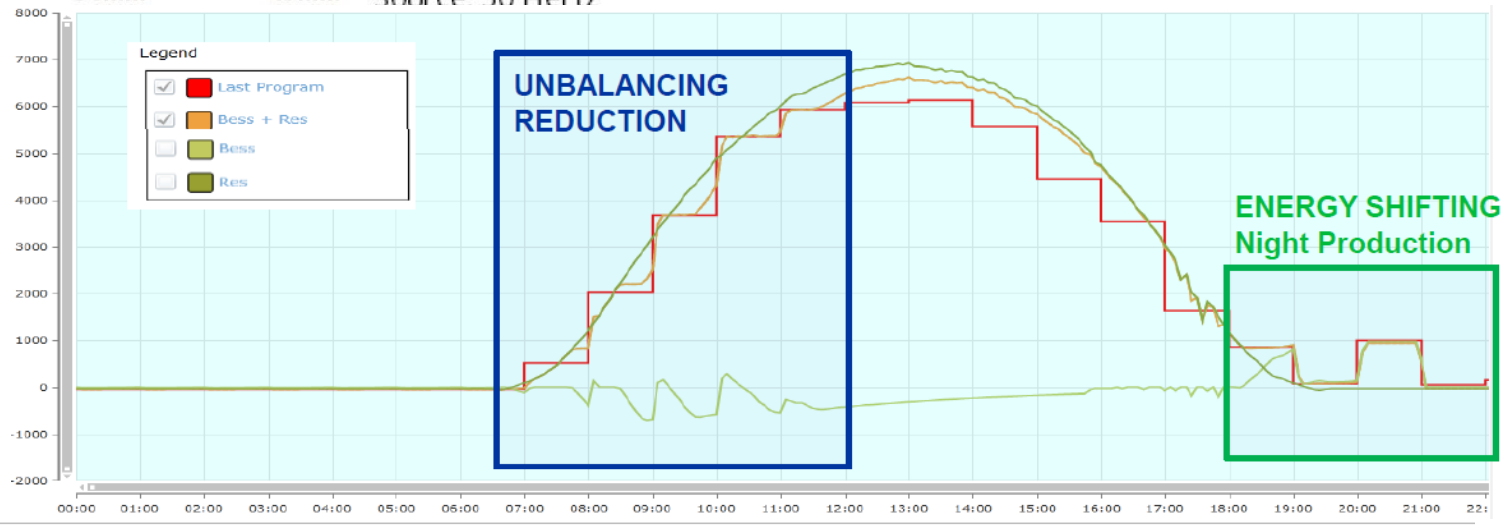


Examples of Batteries contribution for:

- primary control reserve

and for:

- 10 MW PV plant dispatchability



Source: Younicos; Enel Green Power

Thermal Energy Storages

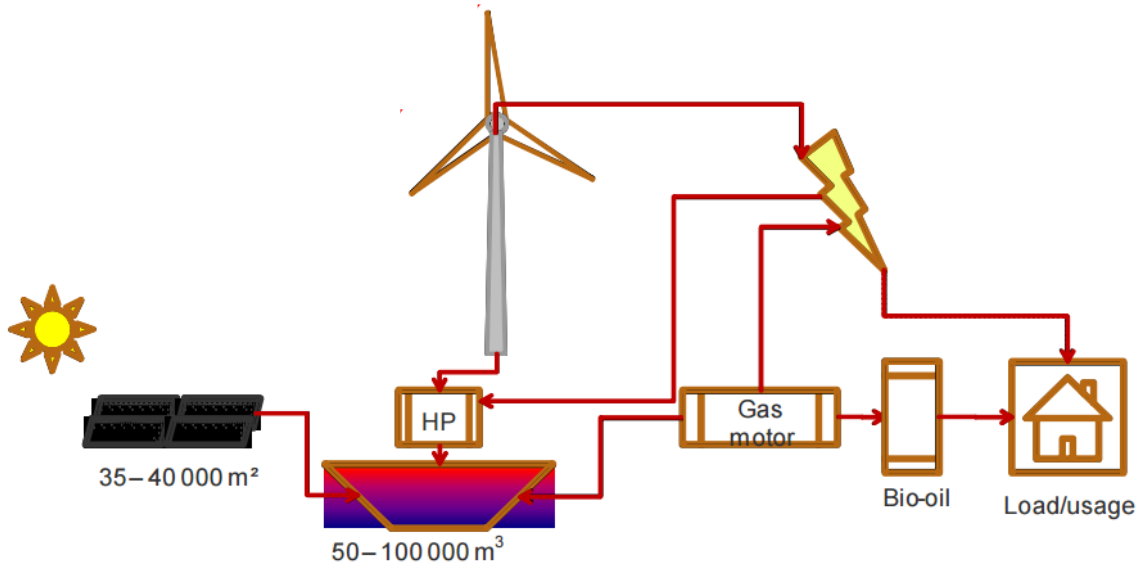
TES technology	Capacity [kWh/t]	Power [kW]	Efficiency [%]	Storage time	Cost [€/kWh]
Water tank	20-80	1-10 000	50-90	day-year	0.08-0.1
Chilled water tank	10-20	1-2 000	70-90	hour-week	0.08-0.2
ATES low temp.	5-10	500-10 000	50-90	day-year	varies
BTES low temp.	5-30	100-5 000	50-90	day-year	varies
PCM-general	50-150	1-1 000	75-90	hour-week	10-53
Ice storage tank	100	100-1 000	80-90	hour-week	4.7-15.6
Thermal-chemical	120-150	10-1 000	75-100	hour-day	7.8-40.6

Note: ATES stands for aquifer thermal energy storage and BTES stands for borehole thermal energy storage

Proper TES allows:

- Developing smart grid solutions;
- Optimizing CHP production use;
- Integrating heat and electricity management and conversion.

- Sensible Storage: high deployment, important R&D on insulation and stratification.
- Phase Change Materials and Thermal-chemical Storage: need of materials development and cost reduction.

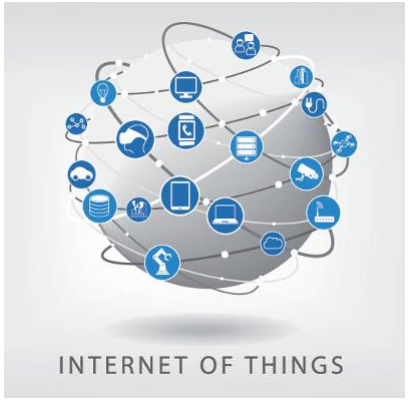


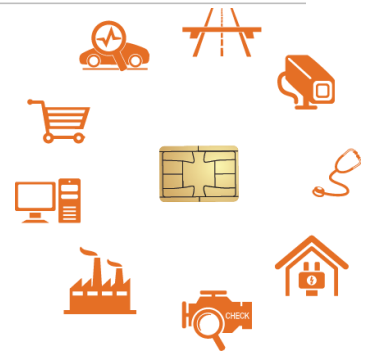
Source: AGFW and Solites on Solar District Heating

Place the citizens at the heart

Towards a Smart City

- **Digitalization** will enable a **collaborative** and **smart city**;
- Today there are almost 10 billions «*smart objects*»
- By 2020 more than **50 billions** connected objects (human to human, human to machine, machine to machine).





CITIZEN ROLE

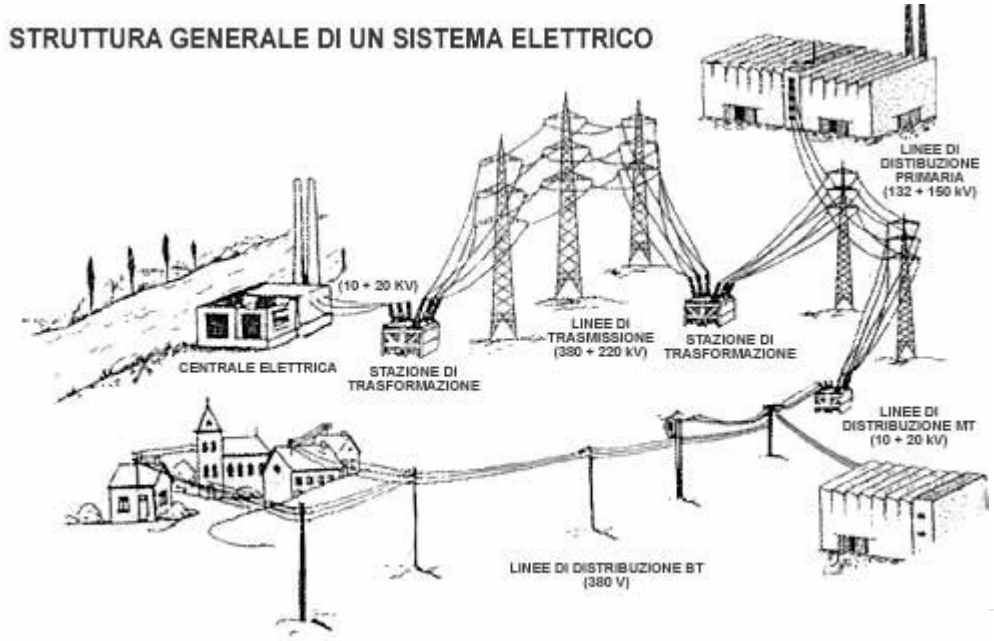
- Citizen will become a **Prosumer** and not only a Consumer;
- Citizen: from services user to «**human *sensor and actuator***»;
- Also Cities will become «**producers**»

In order to reach these goals, the electrical networks need radical changes

From a Traditional network to a Smart Grid

TRADITIONAL NETWORK

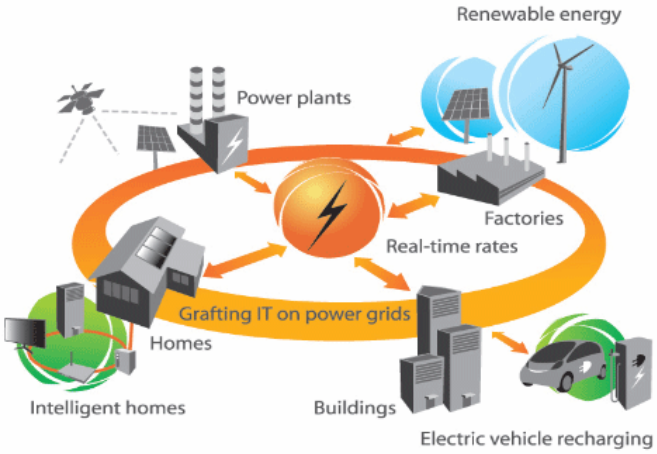
- One-way, localized network
- Producers VS Consumers
- A single level for one-way energy management



WHAT ABOUT A SMART GRID?

At least 2 levels:

- 1° level for bi-directional energy management
- 2° level for information



Smart Grid should also be:

- more Flexible
- more Efficient

than traditional networks

How will Energy Market change?

PRODUCTION → TRANSMISSION → DISTRIBUTION → SALE

ONLY CLIENTS AVAILABLE INSTRUMENT

How will Energy Market change?

PRODUCTION → TRANSMISSION → DISTRIBUTION → SALE

What is the role of Citizen?

Citizen plays even more a major role in energy market

From **dispatching service user to grid balancing actor**

from **Consumer to Prosumer**

from **passive consumer to active consumer**

From **monopoly client to liberalized market client**

How will Energy Market change?

Is He ready to play as protagonist?

Technological evolution

Regulatory and legislatives interventions

Commercial offers

They will provide new instruments to modify its behavior

L'Energy Footprint

The **empowerment process**, beyond being justified by technological evolution and market contest, is highly promoted by authorities.

The authorities intervened on such subjects at different levels:

- Directive 2021/27/UE on energy efficiency
- AEEGSI 232/2014/R/com: “Technological opportunities in order to place at disposal to low voltage final users their electric energy consume data"
- D.Lgs. 102/20144 that implement the EU Directive
- AEEGSI 186/2015/R/eel: **"Energy Footprint: make historical electric energy consumption data available to low voltage final users"**

Other intervention to make consumers feel responsible

The authorities intervened with other regulations in order to rise consumers awareness of their consumptions

1. "**Bolletta 2.0**" (AEEGSI 69/2014/R/com):
    - Identify instruments alternative to the bill to place historical data at disposal
    - Data set with higher granularity than invoicing data
2. Recon on how to make historical e.e. consumption data available for clients (AEEGSI 232/2014/R/eel): subdivision among
    - Historical data referring to invoicing period
    - **Historical data corresponding to consumption time trends**
    - Identify client Energy Footprint (even through simplified energy audit)
3. **Electric energy tariffs reform** (AEEGSI 34/2015/R/eel):
4. Electric energy **second generation metering devices**

The Bill

PRESENT

iren mercato

MERCATO LIBERO

Quadro sintetico della bolletta dell'energia e
Periodo: Settembre-Ot

Gentile Cliente,

Cliente
Codice Fiscale
Fattura n.
Emessa il

Fornitura
POD (punto di prelievo)
Tipologia di contratto
Potenza disponibile
Potenza impegnata
Tensione di alimentazione
Indirizzo

Tipologia Offerta

Data di attivazione della fornitura

Come contattarci
- CONTACT CENTER: NUMERO VERDE 800 03
- SALONE CLIENTI:
- FAX: 011 0703553
- E-MAIL:
- WEB: www.irenmercato.it

Sintesi bolletta

	Euro
Totale Servizi di vendita	25,83
Totale Servizi di rete	16,20
Imponibile iva 10%	**42,03**
Iva 10%	**4,20**
Saldo arrotondamenti	**0,77**
Totale Bolletta	**47,00**

Nelle pagine successive trova il dettaglio degli importi della bolletta.

Letture del contatore e consumi

Matricola del gruppo di misura: 069695

Energia Attiva

Consumo misurato nel periodo dal 1/9/2014 al 30/9/2014

Fasce orarie	Lettura precedente rilevata	Lettura attuale rilevata	Consumi rilevati (kWh)	Percentuale
F1	2.601	2.631	30*	22%*
F2	3.207	3.262	108**	78%**
F3	3.587	3.640		
Totale Consumi rilevati			138	100%

Consumo stimato per il periodo dal 1/10/2014 al 31/10/2014

Fasce orarie	Lettura precedente rilevata	Lettura stimata attuale	Consumi stimati già fatturati (kWh)	Consumi stimati fatturati nella presente bolletta (kWh)	Percentuale
F1	2.631	2.662		31*	22%*
F2	3.262	3.318		112**	78%**
F3	3.640	3.696			
Totale Consumi stimati			0	143	100%

Legenda:
* Nella casella e' riportato il Suo consumo in fascia F1, ad alto costo (dal lunedi' al venerdi' dalle ore 8.00 alle ore 19.00)
** Nella casella e' riportata la somma dei Suoi consumi nelle fasce F2 a basso costo (dal lunedi' al venerdi' dalle ore 7.00 alle ore 8.00 e dalle ore 19.00 alle ore 23.00, il sabato dalle ore 7.00 alle ore 23.00) e F3 a basso costo (dal lunedi' al sabato dalle ore 0.00 alle ore 7.00 e dalle ore 23 alle ore 24.00, la domenica e i festivi tutte le ore della giornata)

Consumi fatturati nella presente bolletta	**kWh**
Consumo dal 1/9/2014 al 31/10/2014 in Fascia F1	61 (22%)
Consumo dal 1/9/2014 al 31/10/2014 in Fascia F23	220 (78%)
Consumo dal 1/9/2014 al 31/10/2014 non distinto per fasce	281

Consumo annuo fatturato	**kWh**
Consumo dal 1/11/2013 al 31/10/2014 in Fascia F1	332 (18%)
Consumo dal 1/11/2013 al 31/10/2014 in Fascia F23	1.500 (82%)
Consumo dal 1/11/2013 al 31/10/2014 non distinto per fasce	1.832

Il consumo relativo alla fascia F23 e' composto dalla somma dei consumi delle fasce F2 e F3 .

Andamento consumi medi giornalieri
Nella seguente tabella sono riportati i consumi medi giornalieri degli ultimi periodi.

Inizio Periodo	Fine Periodo	Consumo medio Giornaliero Fascia F1	Consumo medio Giornaliero Fascia F2	Consumo med Giornaliero Fascia F3
01/09/2014	30/09/2014	1,0 kWh (22%)	1,8 kWh (40%)	1,8 kWh (38%
01/09/2013	30/09/2013	0,9 kWh (18%)	2,0 kWh (38%)	2,3 kWh (44%
01/09/2012	30/09/2012	0,8 kWh (17%)	1,9 kWh (41%)	2,0 kWh (42%

7 pages!!

FUTURE

PROVA 2 ELETTR

Servizio di maggior tutela

Bolletta per la fornitura di energia elettrica

Mario Rossi
Via del Lorem Ipsum, 23
00195 San Pietro in Vincoli
Roma

Dati di fornitura
C.da S.Tommaso 25 - 83100 Avellino
Codice di fornitura POD IT001E8217560713)
c.f. SDFCUF15203ITUY103

Totale spesa AGOSTO - SETTEMBRE 2013

Fattura del XX ottobre da pagare entro il **XX OTTOBRE 2013**
Le confermiamo che tutte le bollette precedenti risultano pagate

SPESA PER L'ENERGIA
Totale €AB

IVA
SU IMPONIBILE DI XXX
Totale €F

IMPOSTE
Totale €F

ONERI DI SISTEMA
Totale €E

SPESA PER TRASPORTO E GESTIONE DEL CONTATORE
Totale €CD

TOTALE DA PAGARE
FG,00 €

Costo medio della spesa per l'energia x,xx centesimi di euro per kilowattora

CONSUMI E LETTURE

Fasce orarie	Lettura effettiva 31/07/2013 XXXX	Lettura effettiva 30/09/2013 XXXX	Lettura stimata 31/10/2013 XXXX	Consumo YYY
F1	XXXX	XXXX	XXXX	YYY
F2	XXXX	XXXX	XXXX	YYY
F3	XXXX	XXXX	XXXX	YYY

CONSUMO FATTURATO ABC kWh

RICALCOLI**
Periodo di riferimento: xx/xx/13 xx/xx/13
Motivo: XXXX (p. es. errore di lettura, malfunzionamento contatore, cada di fatturazione, lettura stimata)
Importo: xxxxx euro già considerato nel totale spesa

PROVA 1 GAS

olletta per la fornitura gas naturale

ario Rossi
a del Lorem Ipsum, 23
195 San Pietro in Vincoli
oma

CHE TUTTE LE BOLLETTE PRECEDENTI

CB,CD €

EF,FH

metro cubo (smc)

03K

Ricalcoli**

The Bill: European Project

OBJECTIVES

- Achieve measurable energy saving
- Increase clients awareness and motivation toward energy efficiency

HOW?

- **Energy information**
  - Comparison between similar clients, comparison with own previous consumption
  - Clearer performance output

Test sites in italy:

2000 electricity clients in Turin;

500 TLR clients in Turin;

600 TLR clients in Reggio Emilia

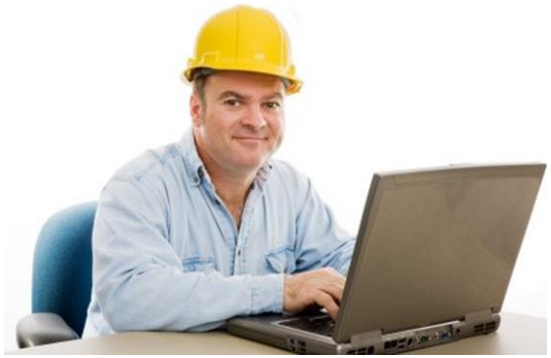
A real example

Measuring devices

PAST

- Only 2 o 3 data collection per year
- Billing based on estimations
- No info on failures or malfunctioning

PRESENT



- Monthly data collection
- Real consumption
- Effective maintenance

Measuring devices

PRESENT

INFO

INFO

FUTURE

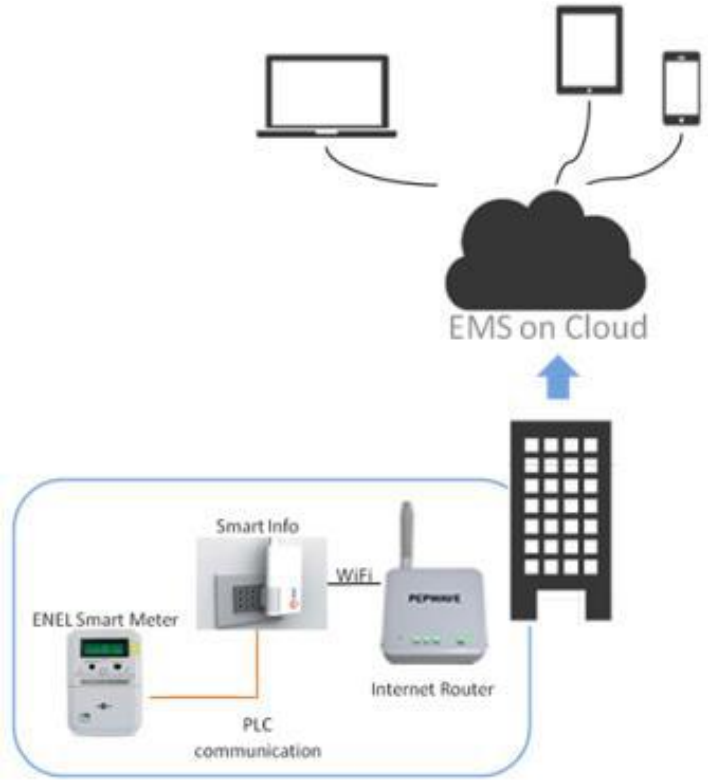
INFO

- Real time data
- Energy services available
- Demand Side management

Waiting for Meters 2.0: solutions for consumer data availability

SMART INFO

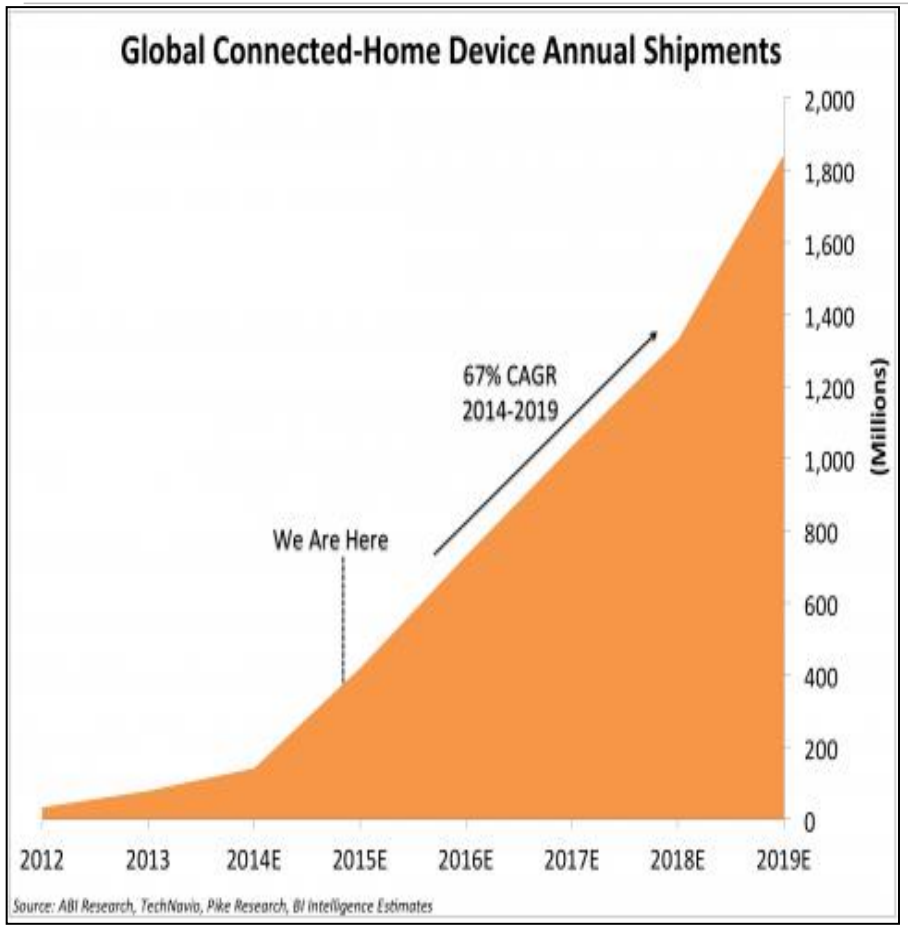
This solution provides (PLC from meter to smart info, WI-FI from smart info to home router) consumption data with 1-10Hz frequency that can be displayed and managed on web interfaces and smartphones

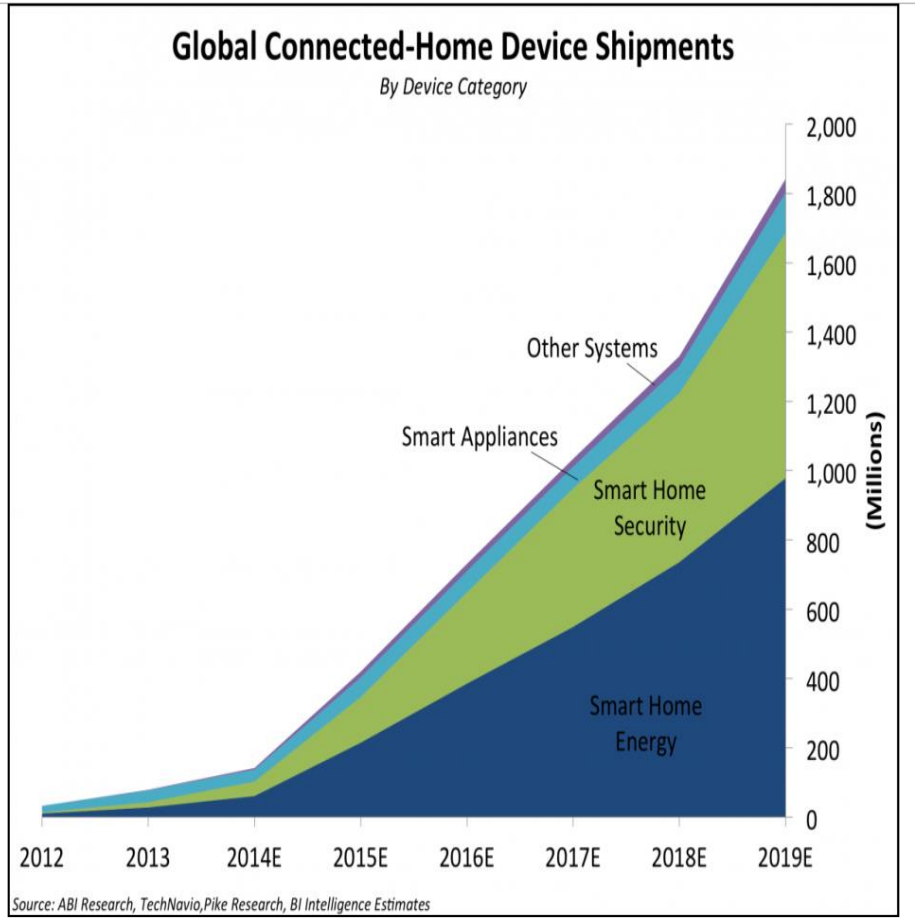


OPTICAL SENSOR

An optical sensor couple with the present meter, able to «read» the meter led (each led blink is equivalent to the consumption of 1 Wh)

Smart Home market





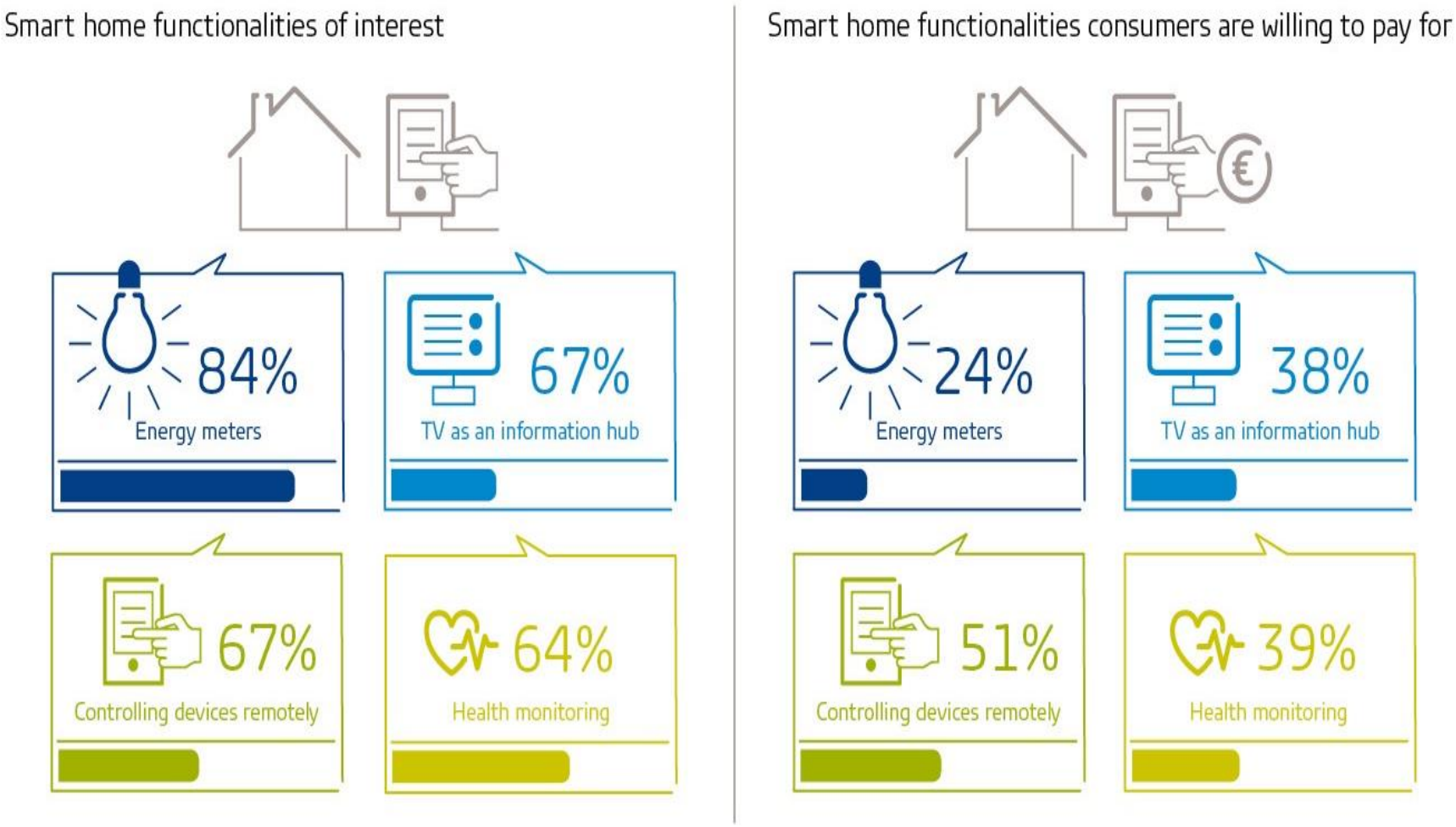
Home device number currently increases with a **67%** annual rate.

Over 90% of such devices belong to **Smart Energy and Smart Security**

It has been forecasted that in 2020 there will be globally around **2 billion home devices.**

Safety and energy saving will be qualifying parameters for Smart Homes

Smart home: Customer needs



http://www.gfk.com/news-and-events/press-room/press-releases/pages/smart-home-uk.aspx

Service for Citizens: Smart Home Ecosystem

Energy Efficiency

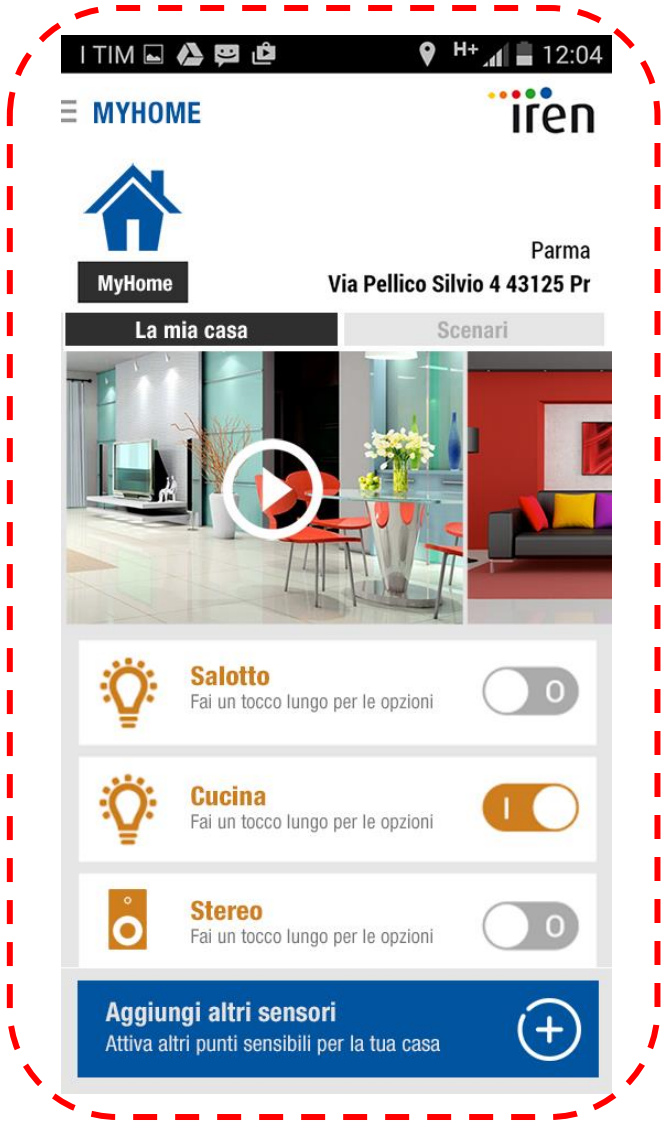
Smartphone GPS notices that user is approaching home. (model Google Now)

It sends such information to the gateway.

MyTEC understands when users are coming back home and prepares the desired conditions, activating/turning off various home devices

A message advise user when desired climate conditions are achieved

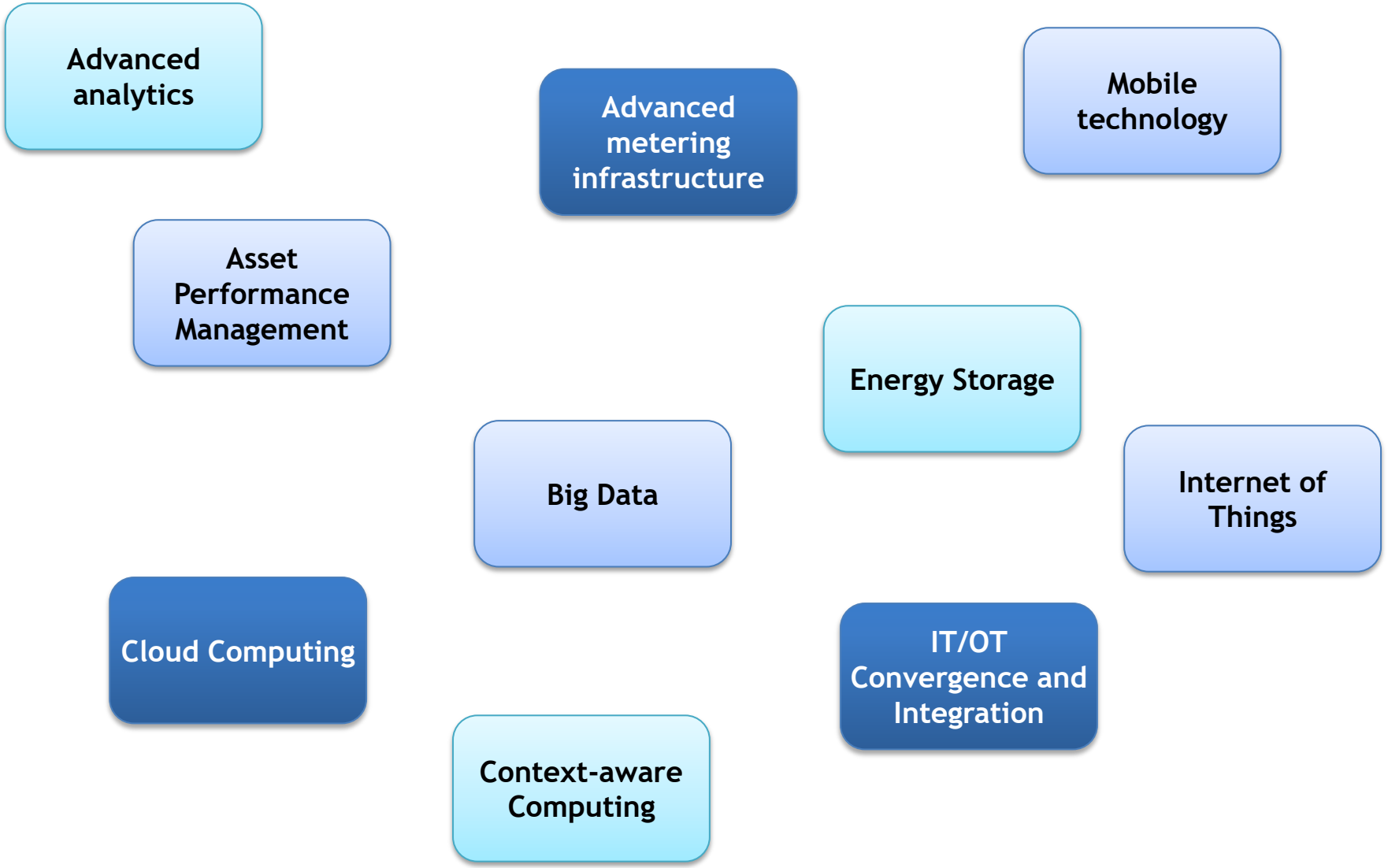
Remote control interface



Electric Market Macro Trend

- Storage systems coupled with Renewable Energy Sources
- Domestic small scale energy storages
- Storage systems for Distribution Network
- E-mobility
- Citizens as active player for distribution grid balancing management
- Internet of Things (IoT) development to propose new services
- New stakeholders participation at the energy world

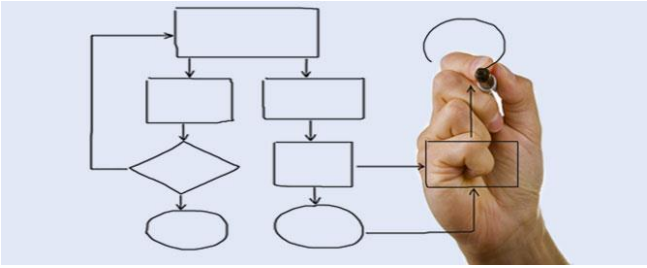
10 Technological Trends impacting majorly on the Utilities in 2015



Gartner research

From Hardware to Software

UTILITY



ASSETS

PROCESSES

COMMODITIES

SERVICES

STAKEHOLDERS

PASSIVE ROLE

ACTIVE ROLE

Some IREN Projects

For the citizens of the future: EDEN project for PA and business clients

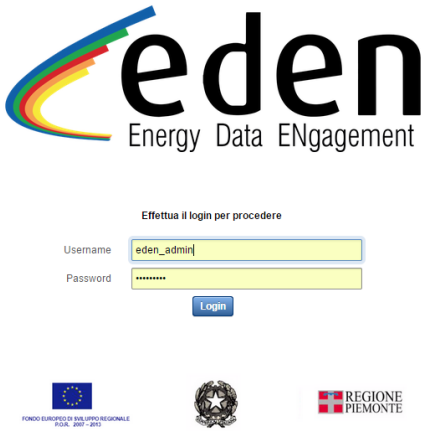
PROJECT DETAILS

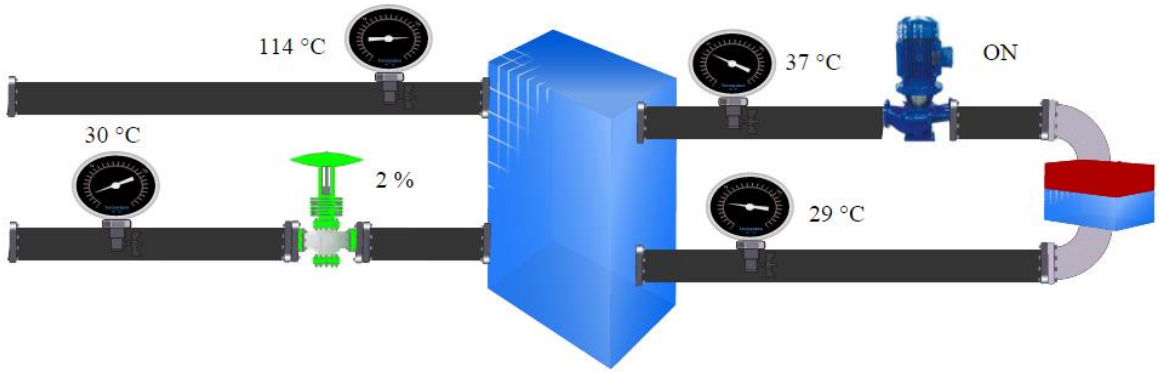
- **Focus area**: energy efficiency for public authorities
- **Funding**: POR/FESR Regione Piemonte 2007/2013 (EU Regional funds)
- **Period**: 1 September 2014 – 31 July2015
- **Pilot**: 3 primary schools in Turin
- **«Innovation community»**: Tech Enterprises, Academia, SMEs
- **Stakeholders** : school staff, professors, students, families, Energy Manager, ESCOs

PROJECT CONTENTS

Development of a multi-level system able to **collect energy data** from the field and produce **tailored visualization platforms**

Project EDEN example for3 schools in Turin



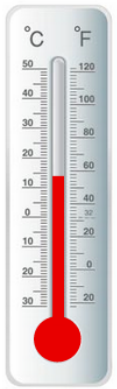


Condizioni ambientali interne

Posizione	Sonda Temp	Temperatura (°C)	Setpoint (°C)	Differenza da setpoint (°C)	Sonda umidità	Umidità (%)	Temp Percepita (°C)
PIANO T CORRIDOIO CENTRALE	CAP_MIS_03	22,84	24,00	1,16	CAP_MIS_18	34,16	22,55
PIANO T CORRIDOIO LATO VIDUA	CAP_MIS_05	21,87	24,00	2,13	CAP_MIS_20	32,69	21,07
PIANO INT MENSA	CAP_MIS_09	21,33	24,00	2,67	CAP_MIS_24	39,59	21,35
PIANO 1 AULA 3C	CAP_MIS_10	24,24	24,00	-0,24	CAP_MIS_25	37,63	25,00
PIANO 1 AULA 3B	CAP_MIS_11	23,48	24,00	0,52	CAP_MIS_26	37,56	23,95

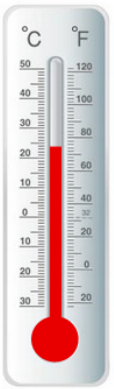
1 - 5

Temperatura esterna



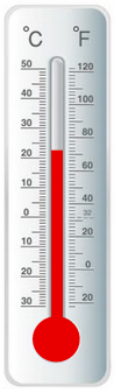
14 °C

Temperatura set point



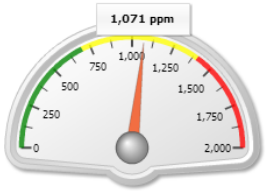
24 °C

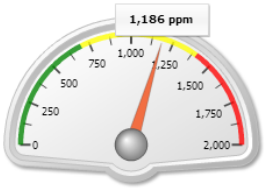
Temperatura interna media



22.75 °C

Sonde CO2

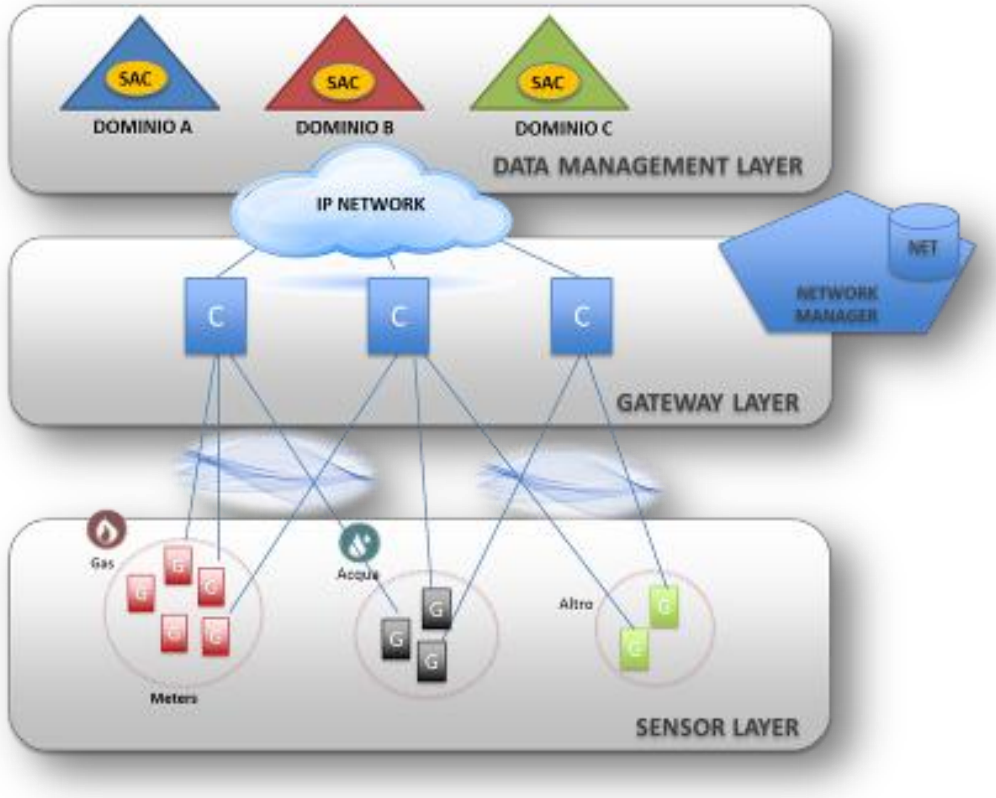




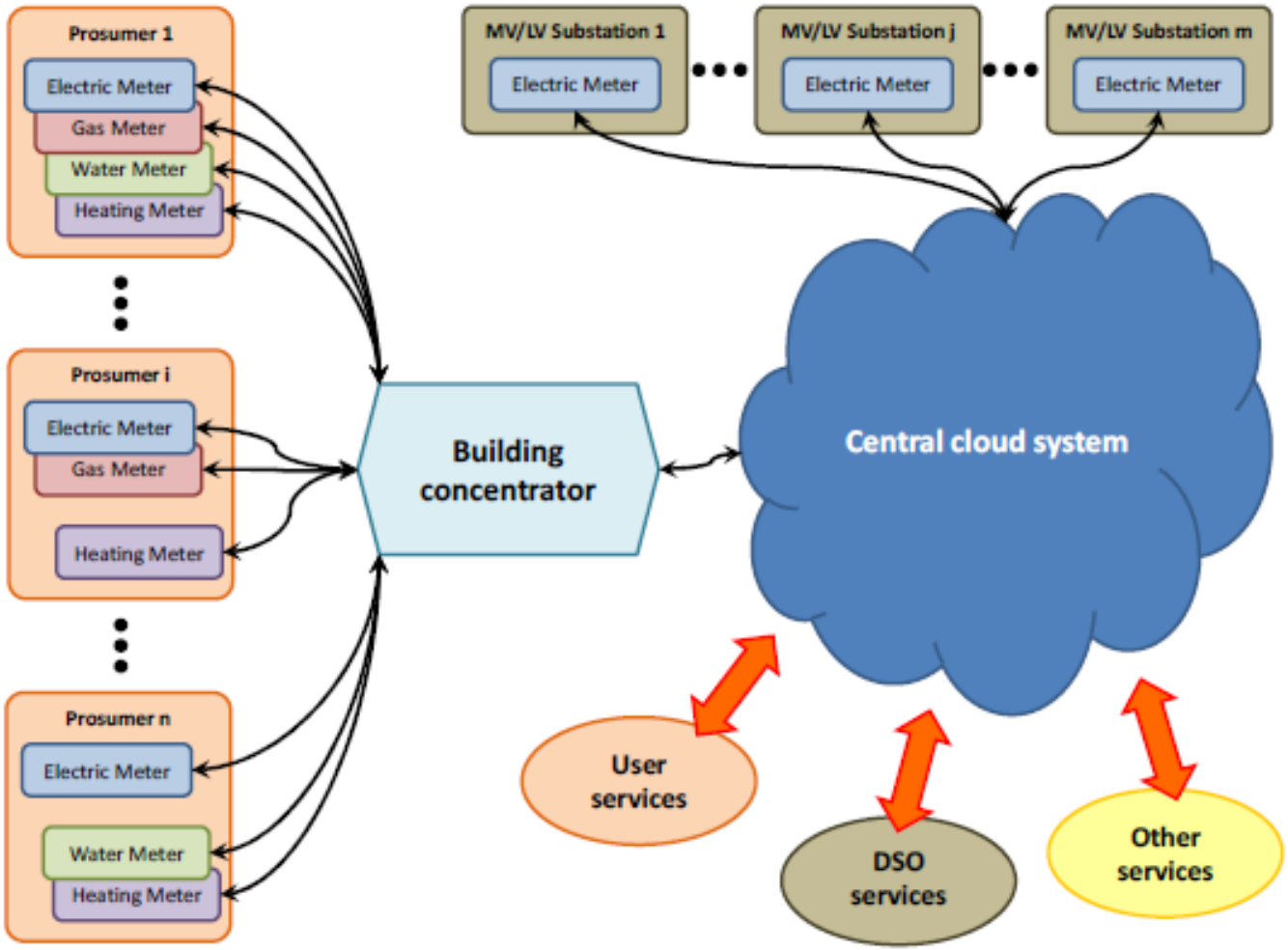
Multi-service Smart Meter

The task is testing a control system able to manage multi-service Smart meters, based on a open data and interoperable platform. First tests have been done in FLEXMETER project:

- Gas (developments available)
- Water (in collab. with SMAT)
- District Heating
- Electric energy
- Wastes (developments available)
- Lighting



FLEXMETER

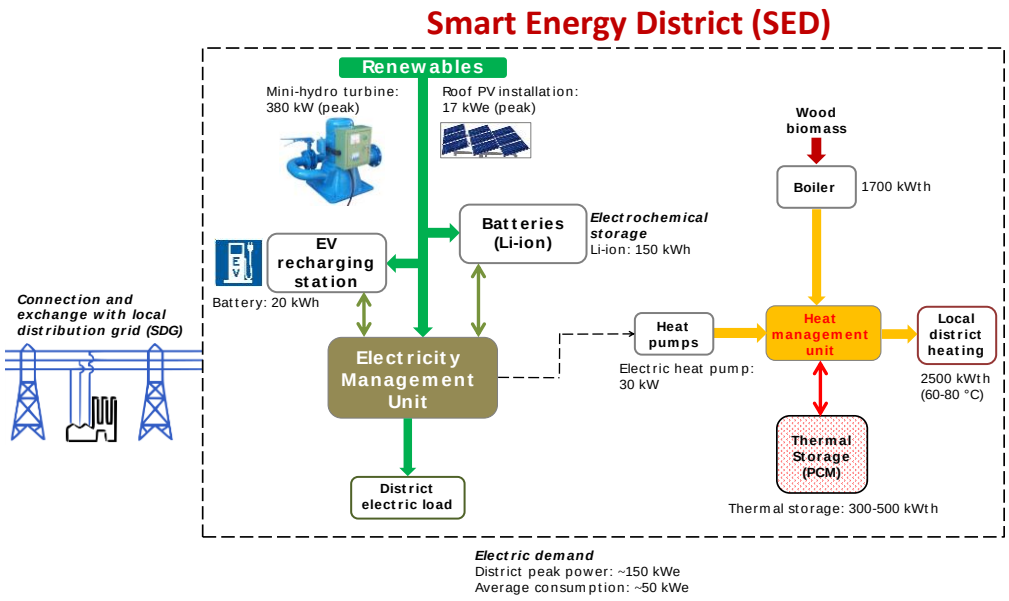

Prosumer 1
Electric Meter
Gas Meter
Water Meter
Heating Meter
Prosumer i
Electric Meter
Gas Meter
Heating Meter
Prosumer n
Electric Meter
Water Meter
Heating Meter
Building concentrator
MV/LV Substation 1
Electric Meter
MV/LV Substation j
Electric Meter
MV/LV Substation m
Electric Meter
Central cloud system
User services
DSO services
Other services

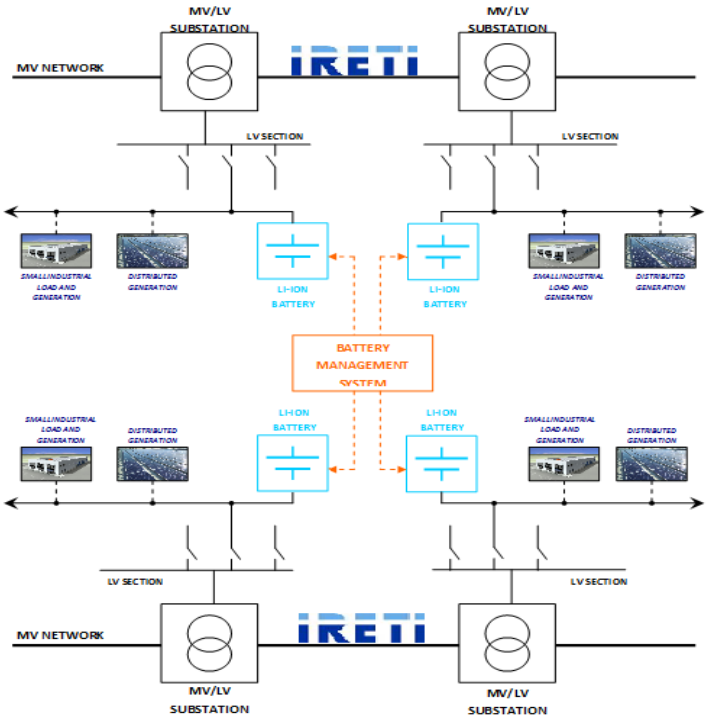
FOCUS ON: Proposal LCE 2/2016 - DERinGRID

Tasks:

- Effective management of energy fluxes in complex urban contests, realizing different solution for grid conduction;
- Test electric storages integration with the distribution grid;
- Test ICT components to develop grid monitoring and management automation;
- Test demand-response systems, aiming to demonstrate and validate new possible business model

The Pilot duality





FOCUS ON: Proposal H2020-INFRAINNOV-2016-201- ERIC

ERIC project aims to create a European laboratory network able to support al the stakeholders (public and private) in developing and transforming the energy sector, and particularly the electric one.

Specifically, ERIC will contribute to the creation of a multi-scale model of European electric infrastructure, allowing near-real time simulations.

IREN, main industrial partner with EDF, will contribute to the project providing data and use cases related to MT/BT grids, taking advantage of useful simulations for the future incentive output based system, provided for by the Authority.