PLAN.
INNOVATE.
ENGAGE.

ETIP SNET
EUROPEAN TECHNOLOGY AND INNOVATION PLATFORM SMART NETWORKS FOR ENERGY TRANSITION

ETIP SNET position on Digitalization

Maher Chebbo
Chair of ETIP SNET Digital Energy Group (WG4)

More information:

etip-snet.eu

@etipsnet

info@etip-snet.eu

linkedin.com/groups/8208338

2050 Vision Goal

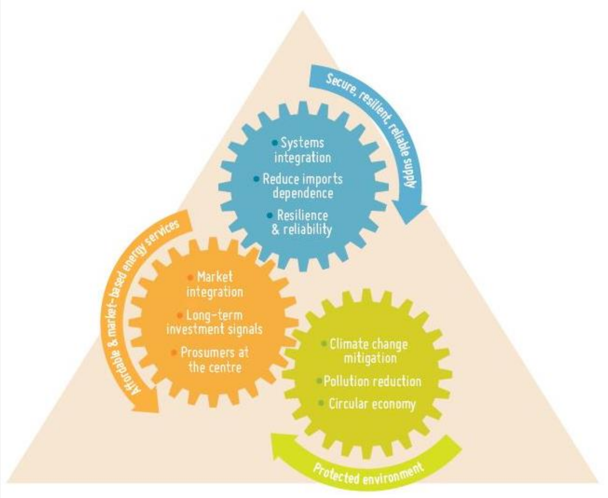
A low-carbon, secure, reliable, resilient, accessible, cost-efficient, and market-based **pan-European integrated energy system**

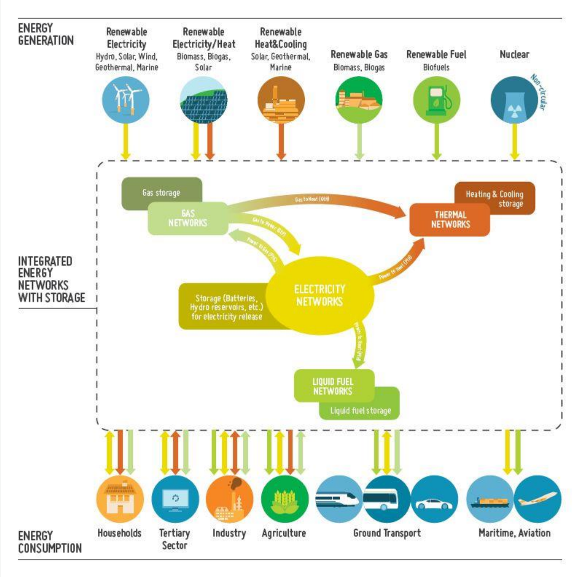
supplying the whole economy and paving the way for a **fully CO2-neutral and circular economy by the year 2050**,

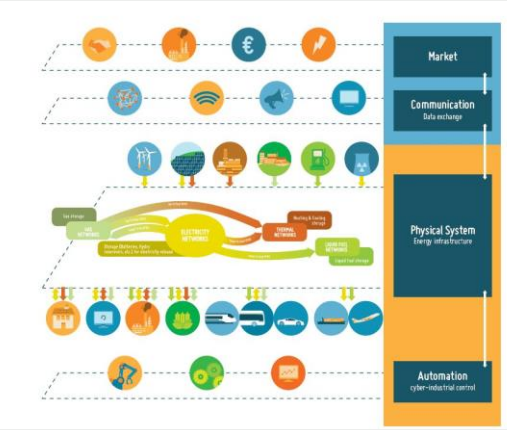
while **maintaining and extending global European industrial leadership** in energy systems during the energy transition.

The ETIP SNET Vision 2050

Goal 2050	The transition	RD&I Needs	RD&I Environment
Energy systems for European society	**Towards integrated energy systems**	**Building Blocks**	**Framework**
• Three pillars: environment, markets, security of supply • The Vision statement	• Today … Tomorrow • Challenges and opportunities • Storage and conversion transition	• Efficient organization • Enabling energy markets • Digitalization • Infrastructure for integration	• European Industry • Managing Economic Disruption • Strategic Approach to RD&I





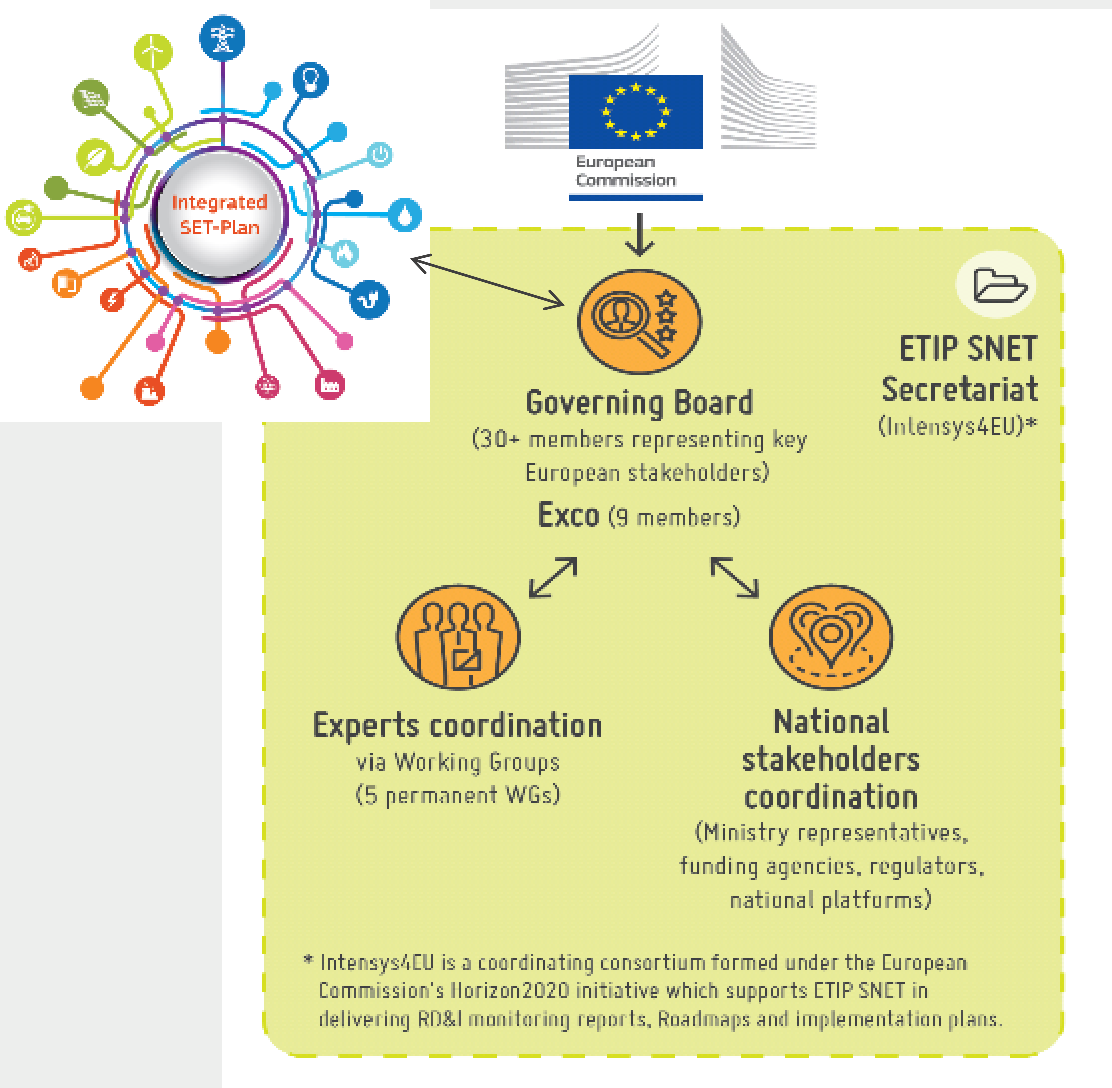



VISION 2050
A SYSTEM OF SYSTEMS
Wind farm
Cross-border connections
Farm Biogas production
Carbon capture & use
HV/MV substation
Gas substation
Positive energy house
100% RES community
Biogas cleaning
Methanation
Pumped Hydro Storage
Electrolyzer
Underground gas storage
grid-forming inverter
Solar PV plant
small scale battery
Air/air Heat pump
AC/DC Converter station
Compressor station
Power to gas
Large scale battery
Electric substation
Combined Cycle Gas Turbine
Nuclear power plant
Off-shore wind farm DC network
ICT network for digitalization of energy system
Zero energy building
Micro CHP
Fast charging station
Airport
Demand Response
Hybrid bus
Electric/Hydrogen
Industry park
Gas to Power
Gas to Heat
Liquid fuel
Harbour
Peer-to-peer energy trading
Peer-to-peer energy trading
Electric tram
Waste heat
Biomass CHP plant
Vehicle-to-grid
small scale storage
Solar thermal
Hydrogen station
Liquid fuel station
Air/water Heat pump
Geothermal Heat pump
NETWORKS
Electricity
Heating & Cooling
Gas
Data
ETIP SNET

ETIP SNET's Stakeholders

Transmission System Operators (TSOs)	Distribution System Operators (DSOs)	National Representatives	Research & Academia
Storage (technology and services providers)	Consumers (aggregated and not aggregated)	Thermal Generation (flexible)	Renewable Energy Sources Generation
ICT, Network and Software providers	Equipment manufacturers and suppliers (non-ICT)	Interface to Other Energy Carriers (Heat, Transport, Gas, ...)	Regulators

ETIP SNET's Organisation



WG1
Reliable, economic and efficient smart grid system

WG2
Storage technologies and sector interfaces

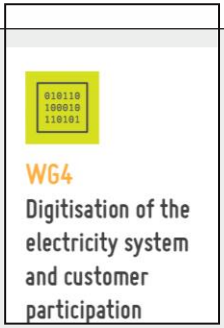
WG3
Flexible Generation

WG4
Digitisation of the electricity system and customer participation

WG5
Innovation implementation in the business environment

NSCG
National Stakeholders Coordination Group

ETIP SNET WG4 : Digital Energy



Maher Chebbo (Chair)
Esther Hardi (Co-Chair)
Miguel A. Sánchez Fornié (Co-Chair)

Task Force 1

Antonello Monti
George Huitema

Digital Technologies (enablers)

Task Force 2

Elena Boskov-Kovacs

Digital Use Cases (services)

Task Force 3

Marcus Meisel

Digital Cyber Security (Robust)

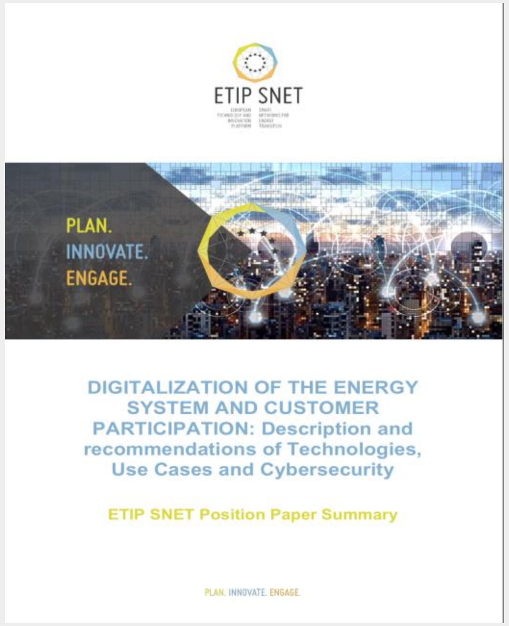
ETIP SNET Vision 2050 & Digital vision (NEW)

Published in June 2018

Published in September 2018

Published in October 2018

Technical detailed (170 p)



Executive Summary (24 p)

200 experts

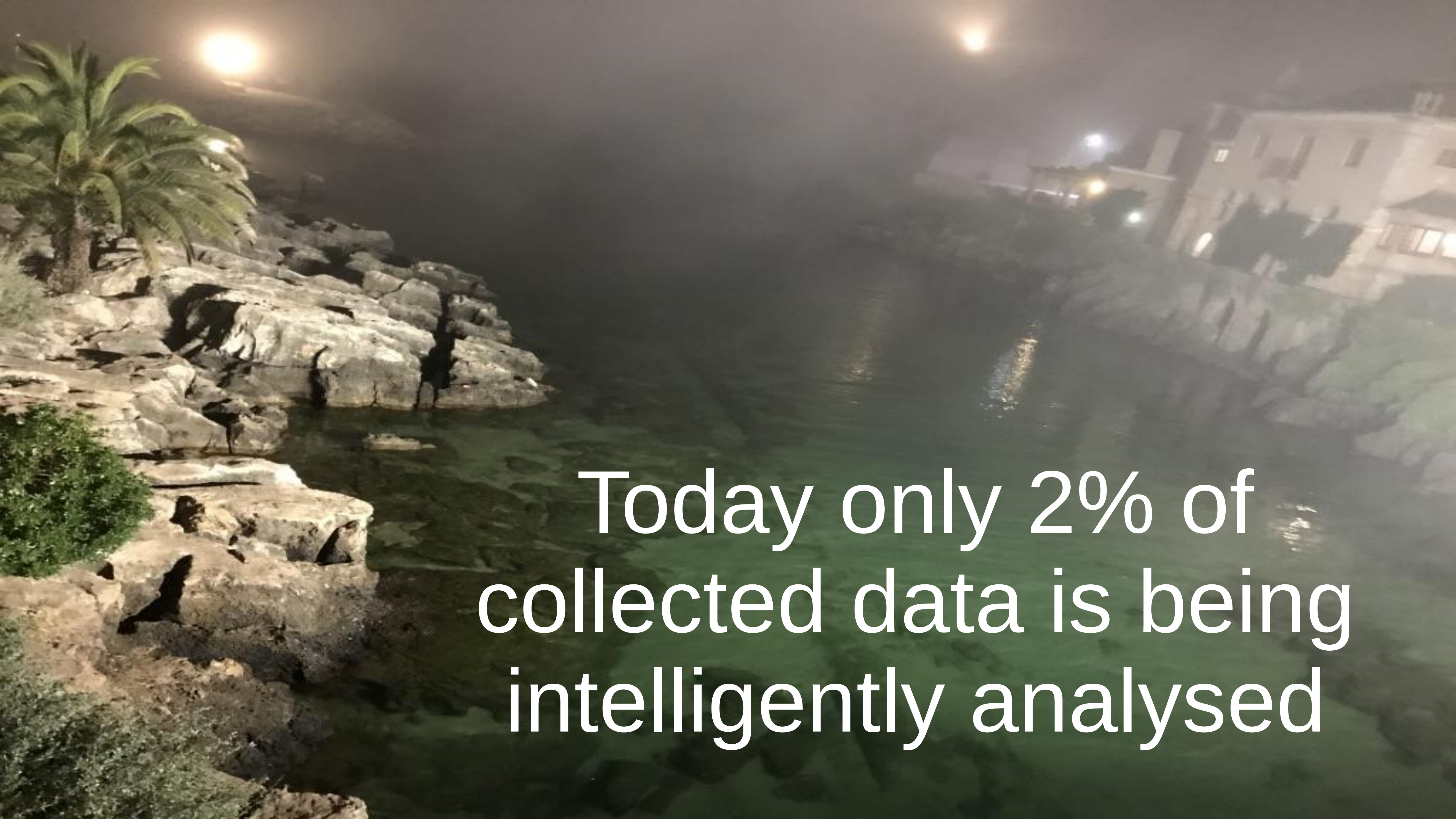
60 experts

Key figures, key benefits

- **50% population online**, **3.2 B Social Media** & **5.1 B Mobile users**
- **20 B IOT** in **2017** growing to 30 B by 2020 and **75 B IOT in 2025**
- **AI** is **70 years old** but only **4% had deployed AI** in their organizations (Gartner CIO survey)
- **Global AI** applications market will reach **127 B$ by 2025** (McKinsey Global Institute)
- AI contributes **16 T$** to the global economy & boost **GDP** growth by 26% in 2030 (PWC)

- Net Electricity **Generation** in EU28 is **3 TW**
- **2400 Power Distribution** Companies in Europe at **400 B€ business**
- **4000 Retailers** in Europe, 260 M Customers, **200 M** with **Smart Meters** in 2020
- **Global SmartGrids** investments in **2017** at **28 B$** growing to **32 B €** in **2020** (67% is SM)
- **Europe** counts **950 SmartGrids projects** (2002-2017), amounting to **5 B€** (JRC)
- Almost a **quarter of the world** generation comes from **renewables** (IRENA)
- **Smart Cities** investments at **80 B$** in **2018** growing to **135 B$** in **2021** (IDC)

- **1% of efficiency** in Power, Oil & Gas, Aviation, HC & Rail equals **276 B$ savings 15 years** (GE)
- **10 M jobs** in **REN today**. Predicted **15 M BAU**. With decarbonisation **29 M by 2050** (IRENA)


Today only 2% of
collected data is being
intelligently analysed

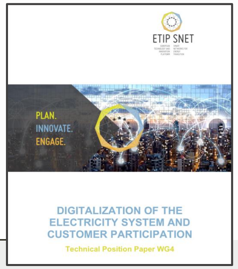
ETIP SNET WG4
Digital recommendations Highlights

Digitalization is affecting the energy system at every level. In particular, the transformation from an electromechanical system to an electronic system is a fundamental change that will transform the fundamental principles around which the energy system is operating.

With respect to the traditional concept of a Smart Grid and Smart Networks, the digitalization process involves other new factors such as Customer involvements and possible disruptive new business models that could emerge from this involvement

Cyber-security is a crosscutting issue enabling the safe and secure use of new products, services, and technologies, in an increasingly more distributed energy system with a tighter inclusion of customers as prosumers.

ETIP SNET WG4
Digital recommendations



ARTIFICIAL INTELLIGENCE/ML EVERYWHERE

DIGITAL TWIN DISRUPTIVE

IOT & INDUSTRIAL IOT PLATFORMS

BLOCKCHAIN, TRANSPARENCY & TRUST

OPEN PLATFORMS, INTEROPERABILITY, API

CUSTOMER FOCUSED ARCHITECTURES

ROLE-BASED PREDICTIVE ANALYTICS

DATA HUBS, DATA ECONOMY

DEMOCRACY BY DESIGN

MONITORING, DIAGNOSIS, VISUALIZATION

BLOCKCHAIN P2P USE CASES

VALUE CHAIN USE CASES

MASSIVE NEW DIGITAL USE CASES

ENVIRONMENT

MARKETS

SECURITY OF SUPPLY

FAVORABLE LEGISLATION & INVESTMENT

CYBERSECURITY FOCUSED REGULATION

LEVERAGING INFRASTRUCTURE INVESTM

CONVERGENT TRAINING ENERGY & DIGIT

SOCIETY, USERS READINESS & AWARENE

SHARING BEST PRACTICES

CROSS-SECTORS COUPLING

LOCAL ENERGY COMMUNITIES

TSO-DSO & OTHER MARKET EXCHANGE

CYBERSECURITY SUPPORTED BY AI/ML/BC

CYBERSECURITY COSTS/BENEFITS/KNOWLEDGE SHARING

CYBERSECURITY QUANTUM CRYPTOGRAPHY. NANO-TECHNOLOGY, ROBOTICS, AV C

ETIP SNET PLAN. INNOVATE. ENGAGE.

Digital WG4 activities 2019

- Continuous **Feedback** to vision 2050, R&I roadmap & IP
- Participate in the ETIP SNET **Regional Workshops 2019**
- Communicate the **Digital reports** of the WG4 in **Public Events 2019**
  - ➢A **Technical white paper** (170+ pages) published in September 2018
  - ➢An **Executive white paper** (24 pages max) published in November 2018
- Identify Top 3 to 5 **BIG Digital Disruptive Projects** for Europe
- Provide advising inputs about the **Digital Platforms** to **EC** (paper)
- Respond to specific **Digital recommendations** requests from **EC** (paper)

ETIP SNET
EUROPEAN TECHNOLOGY AND INNOVATION PLATFORM
SMART NETWORKS FOR ENERGY TRANSITION

Identify Top 3 to 5 BIG Digital Disruptive projects for Europe

PLAN.
INNOVATE.
ENGAGE.

ETIP SNET PLAN. INNOVATE. ENGAGE.

Summary

Proponent	Description
Mark McGranaghan	Developing an **Integration and Services Platform for Distributed Resources**
Gerhard Kleineidam	Develop the **Cellular Energy System**: install the „internet of energy“. Trading of energy through the EEX is rigid and inflexible, like telecommunication in the 1980’s.
Jean-Luc Dormoy	Define a standard / general architecture describing the use and **easing the introduction of a new information architecture** and on top of it of artificial intelligence algorithms to facilitate increasing interaction between the numerous actors and sub-systems that compose a power system
Guillaume GIRAUD	**Distributed Grid Control** The idea is to identify and to build the blocks for a distributed control system for the whole European energy system.The position would be more to architect the system and integrate different technologies than to develop them. The core principles could be: • Distributed intelligence • System of Systems approach • Loose coupling between components • Open Source based software
George Huiltema	Realization of an **open, transparent, multi-stakeholder, multi-level energy flex market**, • plug and play, i.e. uniform digital interfaces • real-time operation, digital communication • for all relevant parties (local energy communities, aggregators, DSO, TSO). • mixing and matching of demand and supply should be AI -based. • SMART goal: >= 90 renewable energy in 2050 (resp x% in 2035)
Nemceck, Monti, G_Huiltena	**EU wide HV, MV and LV electricity grid digital twin** with flow optimizer based on AI&ML
Jeff Montaigne	• 1 single **standardized “energyID”** which could link a customer (European e-Identity) to a meter (contract + metering data – historical or RT) • 1 standardized access to it (through world widely deployed interfaces like APIs / OAuth2 / ..

PLAN.
INNOVATE.
ENGAGE.

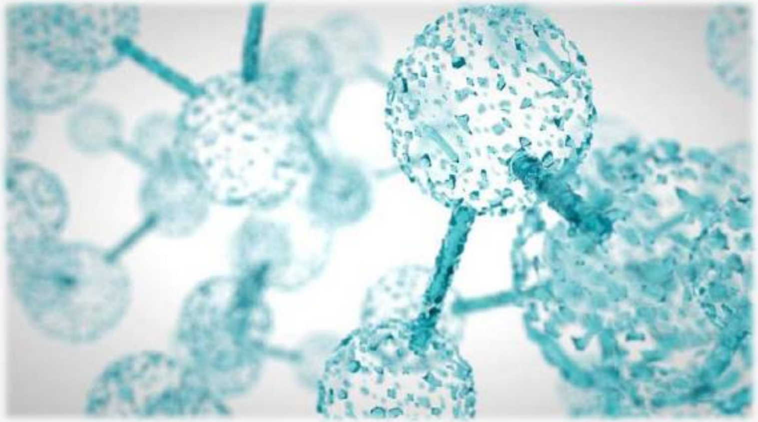
ETIP SNET

EUROPEAN TECHNOLOGY AND INNOVATION PLATFORM — SMART NETWORKS FOR ENERGY TRANSITION

Distributed Grid Control

Guillaume GIRAUD

Rte



Distributed Grid Control

Guillaume GIRAUD

- Status quo
  Centralized control at the control center level and simple local automation at the substation level.

- Which is the proposal?
  A **flexible distributed control system** at the **area** level would be more suitable to optimize the load flows on the transmission lines with the rise of decentralized production.

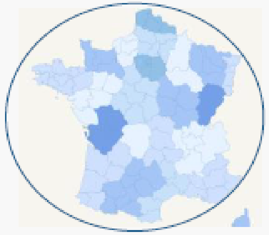
- Why is it new?
  A distributed architecture, with action at the area level, combined with advanced algorithms and new levers like batteries, dynamic line rating or exchange with DSOs could unleash new ways to operate the grid.

- Which are the benefits the will bring this proposal?
  Operating the grid closer to its limits enables to connect **more renewables** without building new transmission lines.
  Distributed architecture leads to a better **resilience** of the grid during large scale events.

- What are the challenges that shall be faced?
  Exchanges and interoperability between **TSOs and DSOs** has to be improved.
  Development of **simulation tools** are mandatory to keep the interactions between area’s under control.
  Trust in those new algorithms must be build among system operators.

Distributed Grid Control

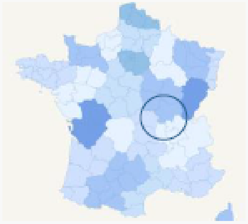
Guillaume GIRAUD



CSC
CENTRALISED SLOW CONTROLS

- 2^{ry} frequency control
- 2^{ry} voltage control
- Battery set point
- ...

View : global & forecasted
In a control center room
Goals : anticipated set-points + global supply-demand balance



ASC
AREA SLOW CONTROLS

- Ring opening / PST
- Renewable
- Capacitors / On-load tap changers
- Battery
- DLR
- ...

Autonomous Area : substations (~10)
Goals : closed loop control - using Model Predictive Control + applying actions and set-points received from higher layer

SSFC
SUBSTATION SLOW & FAST CONTROLS

- Ring opening / Auto-reclose
- Overload
- ...

In addition to the ASC offer
In substations
Goals : ensure last resort equipment and persons protection

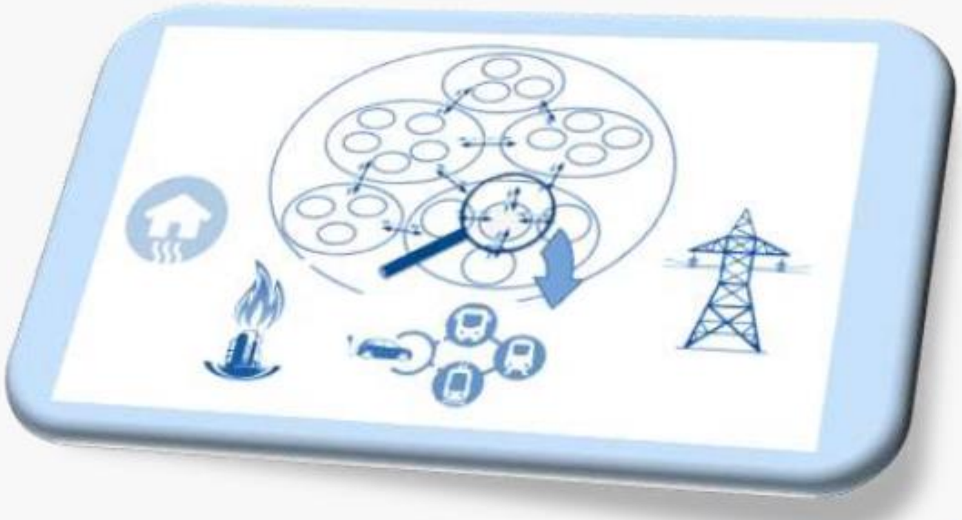
PLAN.
INNOVATE.
ENGAGE.

ETIP SNET

EUROPEAN TECHNOLOGY AND INNOVATION PLATFORM
SMART NETWORKS FOR ENERGY TRANSITION

The Cellular Energy System

VDE Working Group “Energy Supply 4.0”



The Cellular Energy System
VDE Working Group "Energy Supply 4.0"

- Status quo
  The energy market has been designed for a centralized energy production, which works against physics in a growing world of decentralized renewable energy sources.

- Which is the proposal?
  *Millions of micro power plants like rooftop PV, CHP systems, or wind power plants have been installed in the last decades. Unfortunately they do not just supply us with renewable energy but also tremendously increase the efforts necessary to stabilize the electrical grid. A cellular energy system is able to balance supply and demand on regional / local level and helps to decrease the efforts of TSOs to avoid grid congestions. Facility managers of companies **already use** the cellular principal by implementing intelligent energy management systems and energy storages to increase self-sufficiency and to diminish power demand.*

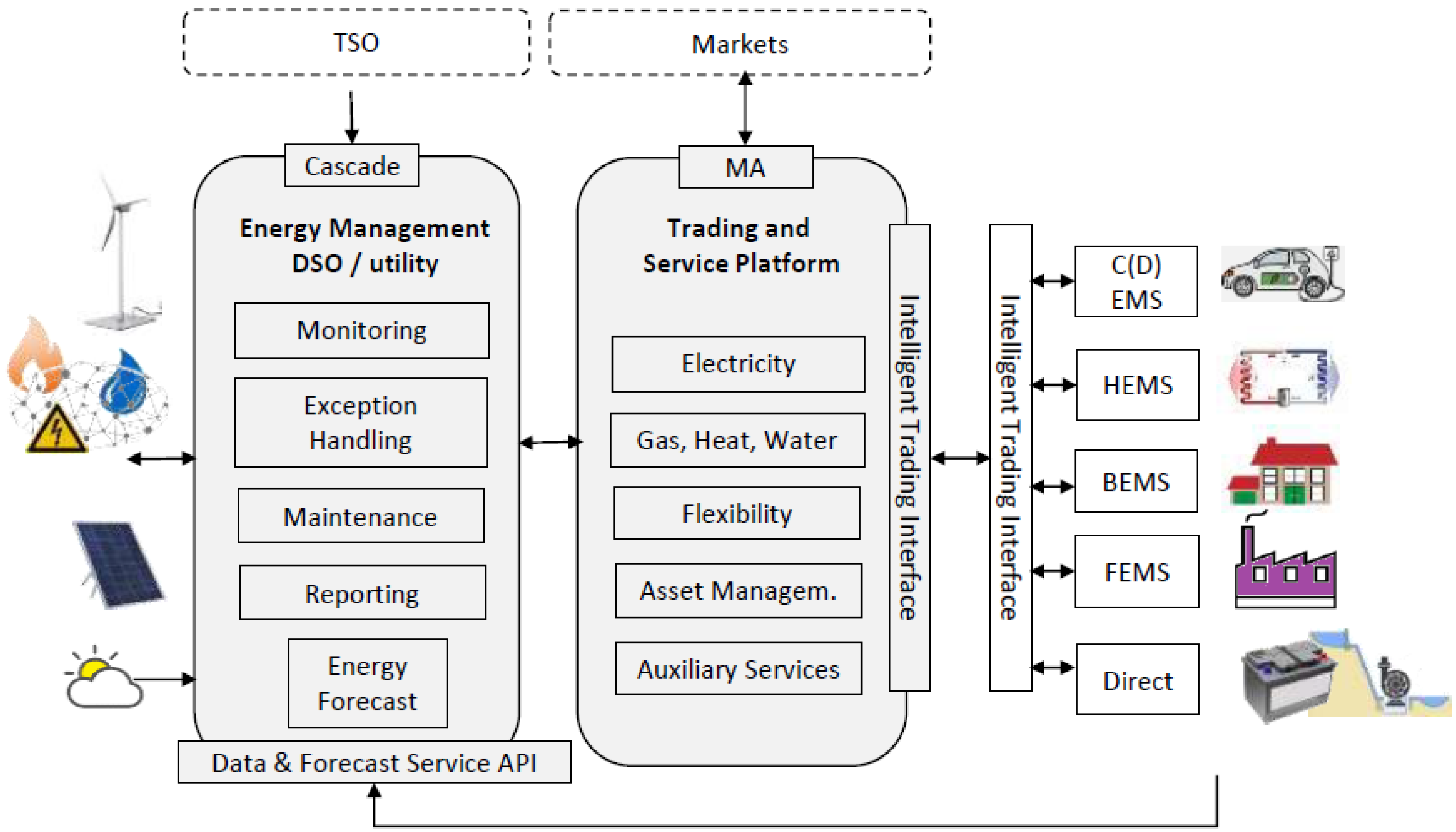
- Why is it new?
  By the "Cellular Approach" it will be possible that grid services can be provided by distributed decentralized energy management software systems on local / regional level.

- Which are the benefits that will bring this proposal?
  (i) Increased potential for RES installations, (ii) avoid grid congestions, (iii) remuneration of grid services on regional level for those who invest into intelligent energy management systems and energy storages

- What are the challenges that shall be faced?
  (i) Current rules & regulations, (ii) roadblocks that limit speed of digitalization, (iii) changing roles and responsibilities (TSO, DSO, retailers)

The Cellular Energy System

VDE Working Group "Energy Supply 4.0"



In a *[Cellular Energy System](#)* digitalization helps to utilize flexibility and forecast capabilities to stabilize the grid and to stimulate local / regional energy trading.

MA	Market Agent
xEMS	Energy Management
⟷	Communication
SW	Software Module

https://shop.vde.com/en/vde-study-the-cellular-approach

ETIP SNET

EUROPEAN TECHNOLOGY AND INNOVATION PLATFORM SMART NETWORKS FOR ENERGY TRANSITION

PLAN. INNOVATE. ENGAGE.

Thanks for your attention

ALL FOLLOWING SLIDES ARE APPENDIX

More information:

etip-snet.eu

@etipsnet

info@etip-snet.eu

linkedin.com/groups/8208338

Technical Position Paper WG4 – TF1

Progress on ETIP SNET

Digitalization is affecting the energy system at every level. In particular, the transformation from an electromechanical system to an electronic system is a fundamental change that will transform the fundamental principles around which the energy system is operating.

Recommendations:

- Need for new principles of operations in a power electronics driven grid
- Enabling sharing of infrastructures such as 5G to support joined investments schemas
- New and overarching architectures able to include customers and the interactions with other verticals
- Creating a culture of open API to exploit the strength of open source in the energy sector
- Development of open platforms for a data economy
- Need for trust technologies such as, e.g. Blockchain
- Need of adequate service management and operations exploiting modern data analytics
- Need of adequate education breaking barriers between energy and ICT
- Adaptation of legislation and regulation to better support investments in software solutions

Technical Position Paper WG4 – TF2

Progress on ETIP SNET


ETIP SNET
PLAN.
INNOVATE.
ENGAGE.
DIGITALIZATION OF THE ELECTRICITY SYSTEM AND CUSTOMER PARTICIPATION
Technical Position Paper WG4

With respect to the traditional concept of a Smart Grid and Smart Networks, the digitalization process involves other new factors such as <u>Customer involvements</u> and possible <u>disruptive new business models</u> that could emerge from this involvement

Recommendations for Research:

- Enabling monitoring, visualization, and analytics for every stakeholder group
- Building data hubs with new data sets
- Cross-sector coupling – needed to offer complete service to customer
- Local energy communities – offer benefits but need further work on regulation and ownership structure
- strong collaboration between industry leaders and utilities
- Existing infrastructure such as smart metering should be further exploited and utilized
- Establishing Innovation/Expert centers – case in point for EV penetration
- Data transformation – digital twin
- Decomposing blockchain challenges through research
- Customer empowerment – needs not only technology but behavioural change
- TSO-DSO cooperation and coordination

Technical Position Paper WG4 – TF3

Progress on ETIP SNET

Cyber-security is a crosscutting issue enabling the safe and secure use of new products, services, and technologies, in an increasingly more distributed energy system with a tighter inclusion of customers as prosumers.

Recommendations for Research:

Technology (now)

1. AI helps cybersecurity industry monitoring sophisticated threats
2. Blockchain promising: authentication, authorization, consensus, immutability
3. Blockchain offers secure decentralized guarantee of veracity of transactions
4. Digitalization relies on massive deployment of sensors for analysis
5. IoT enabled devices make energy system more transparent and efficient
6. Highly networked components: safety is not reachable without cybersecurity
7. Machine Learning enables predictive analytics, helps detecting cyber attacks
8. OT/IT cybersecurity raises question of on-premise vs cloud-based calculation
9. Grid optimization applications require decentralized grid asset deployment

Policy (now-midterm)

1. Metrics and frameworks to be developed for decision making of risks
2. Stakeholders operating in isolated silos need a communication platform
3. Cybersecurity research at a meta level should be stimulated
4. Transparency of data flows & standardized data models required for GDPR
5. Cost benefit analyses shall be considered (e.g., black out simulators)
6. Research on regulation securing cybersecurity investments recommended
7. NIS good but go further, large-scale interdisciplinary attack scenarios
8. Knowledge databases should be shared to access known vulnerabilities
9. Regular trainings are key for our critical infrastructure resilience

Future challenges (midterm)

1. Society and energy users need awareness about cybersecurity in energy
2. Involvement of energy users necessary to achieve desired risk protection
3. Quantum cryptography is a promising disruptive computing technology
4. Simulation is promising to quantify cyber-attack impacts on energy systems
5. In field demonstrations cryptographic open protocol solutions preferred
6. New communication technologies (5G) need new methods to guarantee SLAs
7. Bio- and nano-technologies raise cyber threats; Tools, education etc. needed
8. Robotics introduces new threats , which requires research e.g., identification
9. Autonomous vehicles, such as drones, cars, require new mitigation strategies

PLAN.
INNOVATE.
ENGAGE.

ETIP SNET

EUROPEAN TECHNOLOGY AND INNOVATION PLATFORM
SMART NETWORKS FOR ENERGY TRANSITION

Developing an Integration and Services Platform for the Shared Integrated Grid

Mark McGranaghan - EPRI

Developing an Integration and Services Platform for the Shared Integrated Grid

Mark McGranaghan

- **Status quo**
  - *Customer and distributed resources are used locally and can be aggregated by system aggregators for participation in markets. These are usually customized and proprietary systems that are special purpose and do not facilitate additional services or cross-use of data for the benefit of the customer or grid optimization.*

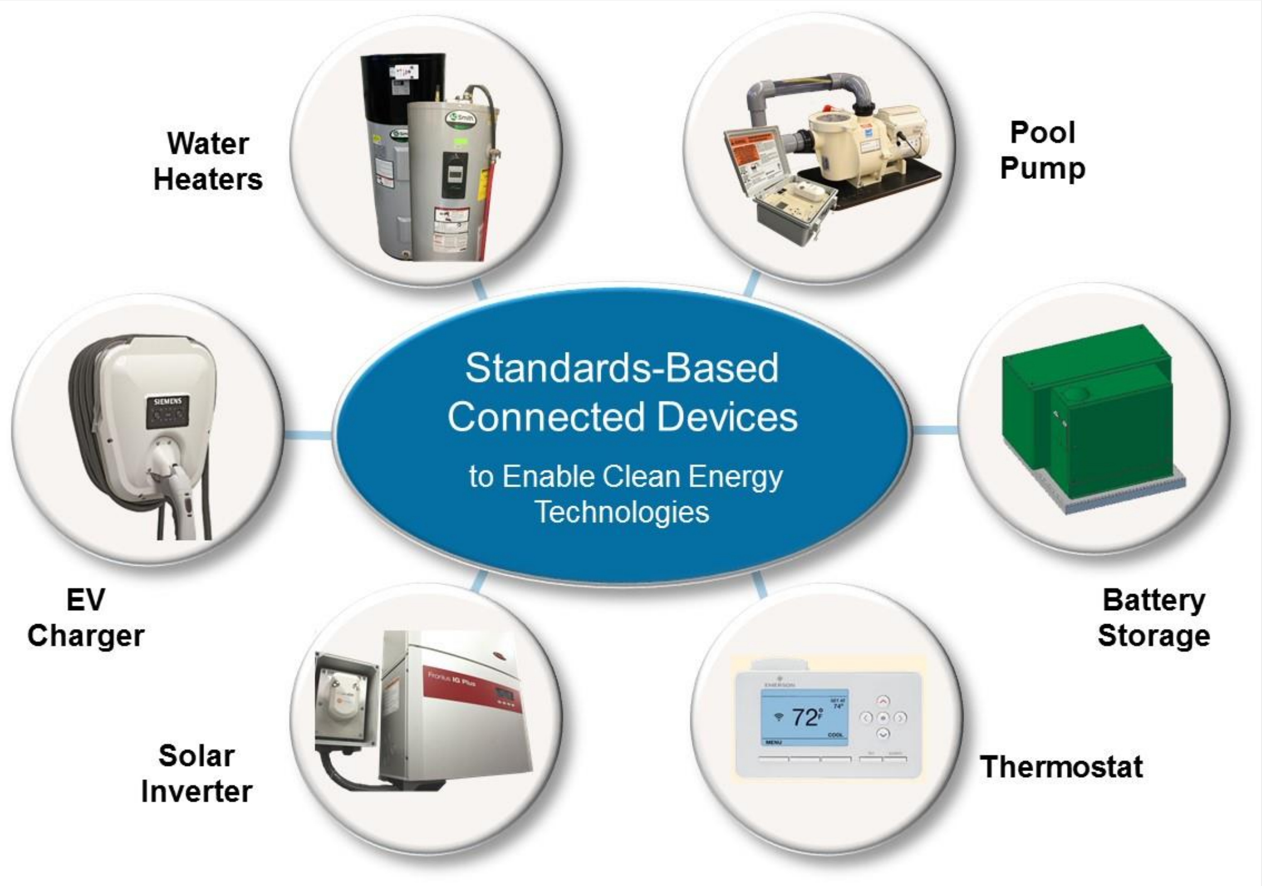
- **Which is the proposal?**
  - *Develop an open source platform with appropriate data models for information exchanges associated with a wide variety of distributed resources and IoT technologies.*

- **Why is it new?**
  - *The platform will facilitate broad participation in providing new and innovative services to benefit the customer, market efficiency and grid optimization*

- **Which are the benefits will this proposal bring?**
  - *Flexible implementation of a wide variety of services based on common data platforms and interfaces*
  - *More efficient markets with integration of a wide variety of distributed resources*
  - *Wide range of customer services that can have substantial benefit for energy efficiency, comfort, economics and technology adoption*
  - *Participation of a wide variety of stakeholders without barriers to entry*

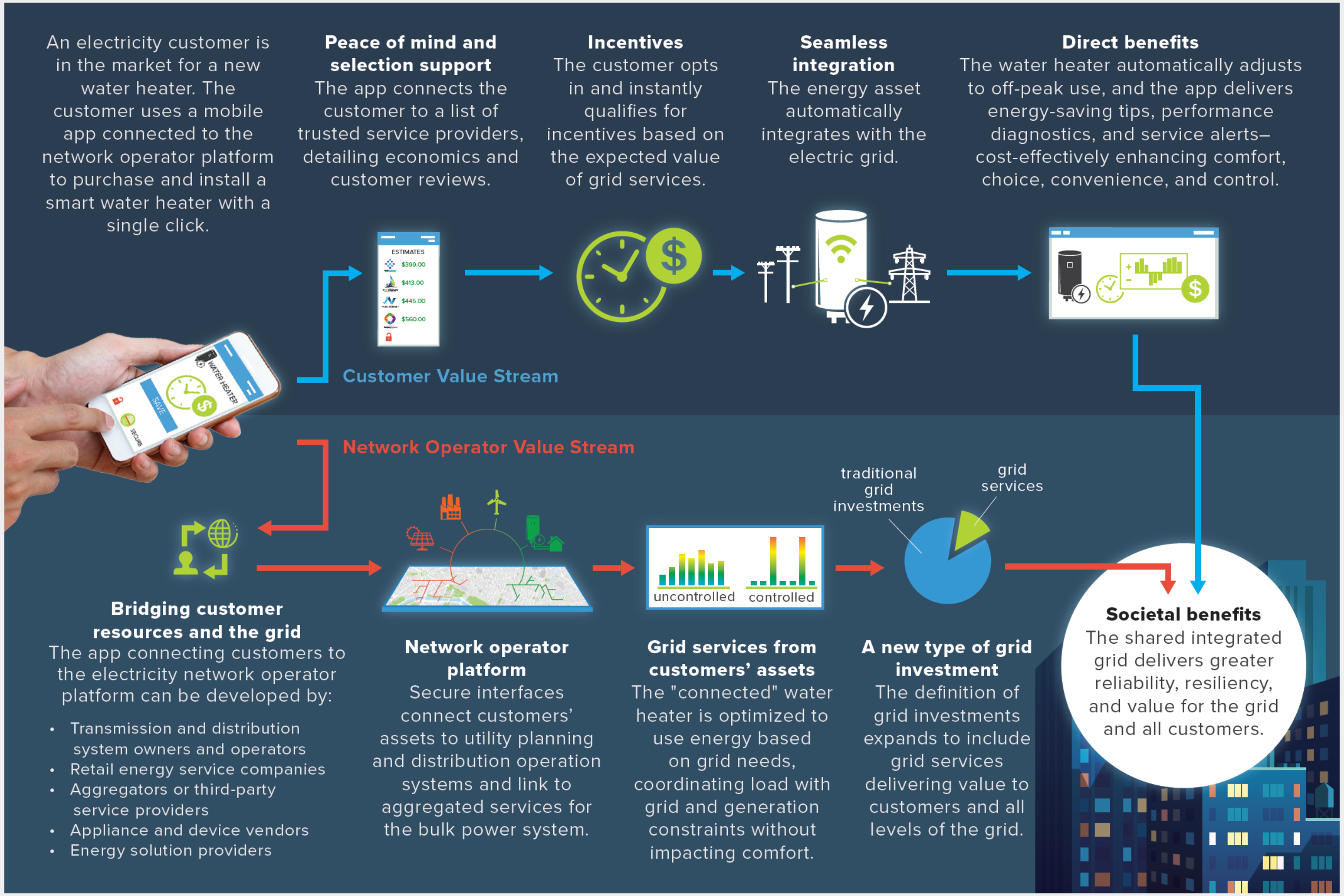
- **What are the challenges that shall be faced?**
  - *Developing common data models across multiple resources*
  - *Developing the platform for data management and integration*
  - *Data privacy, permission management and cyber security*
  - *Managing open interfaces for broad participation in energy services and other services*
  - *Integrating with planning and operations of TSOs and DSOs to realize grid optimization benefits*

Customer Resources as Grid Resources



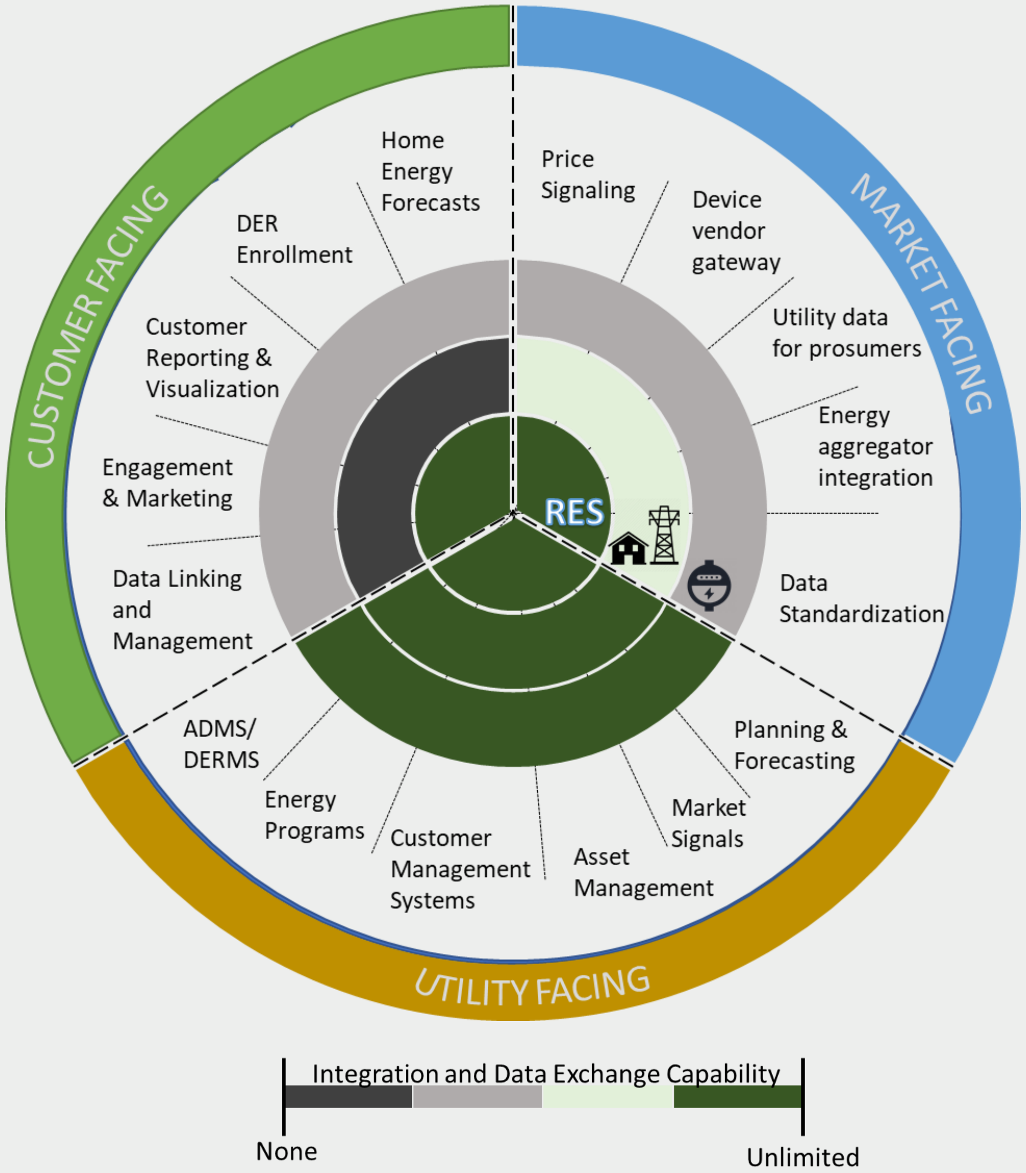
IoT makes it possible

The concept of the shared integrated grid (#sharedgrid)



Project – Developing the Platform for the Shared Integrated Grid

- A specialized energy data platform focusing on **data brokerage and aggregation** to facilitate utility engagement in the smart energy market
  - **Connect** with technology vendors and customers to collect data, integrate capability, and empower analytics and energy program opportunity
  - **Manage** data using advanced Big Data techniques to speed analytics and integration
  - **Distribute** data to new or existing systems supporting residential, C&I, vendor and utility partner programs



Project elements

- Architecture
- Use cases for each technology
- Information Model structure for each technology based on the use cases
- Data collection services
- Data management services
- APIs to support information exchanges
- Cyber security, data privacy, permission management
- Demonstration of applications that build on the platform
- Industry standards coordination (NAESB, IEC CIM, etc.)

https://www.youtube.com/watch?v=e5B9pfuVrMU