#DigitalGrid: key enabler for the energy transition

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ENTSO-E IN FIGURES

43 TSOs
operating electricity systems & facilitating power markets in
36 countries
(EU + 8)

± 435 TWh of electricity exchanged across borders

± 480,000 km of interconnections
This is more than the distance between the Earth and the Moon

Highest load 581 TW 18/1/2017
Lowest load 265 TW 11/6/2017
ENTSO-E: enabling the energy transition
The European power system transformation...

Clean energy for all Europeans

Paris agreement

HORIZON 2020 Innovation

Regional security coordinators support grid operators

Digitisation

Regions
Large Scale Interconnections & Grid Scarcity

... significantly increases system complexity

Balancing & Distributed Energy Resources Integration

September 2016 in Denmark, one week
(source Energinet.dk)
Digital allows to deal with further complexity

**Facilitate the EU code deployment**

- **3 CONNECTION CODES**
  - Requirements for: Generators, Demand side, HVDC connections
  - Paving the way for offshore wind...

- **3 MARKET CODES**
  - Rules for: Day ahead / Intraday, Forwards, Balancing
  - Market coupling...

- **2 OPERATIONAL CODES**
  - Rules for: System Operation, Emergency situations
  - Regional cooperation to increase security...

**Increase Grid Transparency**

- Flow based Bidding zones review
- Real-time Markets
- TSO-DSO Flexibility Platforms
- Enhanced Regional security coordinators
- Capacity Calculations
- New Emergency Restorations
- Including links inside countries

**Foster cooperation at all levels**

- EU
- Stakeholders
- National
- Distribution
- Regulators & ACER
- TSOs & ENTSO-E

- Shared Data Sets
The Energy Transition: 
Transmission makes it happen

27% renewables by 2030 = +/- 45% for the power system

CHALLENGES

- System stability
- Resource variability
- New connections
- Changing power flows & congestions
- Integrating demand-side resources
- Empowering consumers & managing data
- Unlocking flexibility
- Digitalization
ENTSO-E TYNDP 2018: scenario framework
Realizing critical grid investments for sustainable security of supply in the region

Drivers behind grid investments

- Phase-out of conventional generation
- Market integration
- System stability and security of supply
- RES integration
- Interconnection with other systems
The cost of no action by 2040:

What would happen if we stopped all projects beyond those under construction?

European – Marginal cost yearly average
Range and average of all scenarios and climate years

+43 bln €/year
The Clean Energy Package: the right framework to address future challenges

- Active customer
- Wholesale and retail market integration
- DSR, retail markets, role of DSOs & aggregators
- European resource adequacy
- Risk preparedness framework and security of supply
- Ambitious regional cooperation
- TSO-DSO cooperation and coordination
Digitalization is key to support the new market orchestration and the energy transition
Digital technologies bring new opportunities

Gartner Hype Cycle for Emerging Technologies

Source: Gartner, 2018
New multi-sided orchestration platforms

Power generation & trading
Power transmission
Power distribution
Energy services (retail)
Electric devices

End-use customer

Data hubs
Information & services platform owner
Information services
Information devices & appliances

New market Orchestration role

TRADITIONAL ELECTRICITY VALUE CHAIN

EMERGING ELECTRICITY VALUE CHAIN

Distributed resources (generation, storage, electric vehicles)
TSOs are fully committed to innovate on digital technologies and implement them.
Data sharing platforms empowering different actors and resources to contribute to the energy transition

Smart & digital grids
- Smart devices

Integrated & efficient markets

Data Hubs

Pan-European Data Sharing

Connectivity platform

ECCo SP

Data Sources

Applications

Storage

Transport

Heating

Smart Apps

Residential

Industrial

Balance Responsible Parties
Sector coupling could be reached by the development of interoperable systems of systems

- Mobility+ Power & Gas networks (both transmission & distribution)
- Power + Gas
- Transmission & Distribution Interface
- Network interface with market participants
To build digital platforms multilayer and multiplayer that enable the single electricity market and put the customer at the centre.
Thank you for your attention, any question?

Stela Nenova
ENTSO-E
Back-up slides
TSO balancing evolution with the rise of new technologies

10s flexible units

100s+ units

1000s+ units!
The different shades of digital@entso-e

**Network optimisation**
- Common Grid Model, European Awareness System, Regional cooperation, Integrated adequacy assessment, Integrated capacity calculation

**Market & Prosumers**
- ENTSO-E Transparency platform & extensions, TSO/DSO platform link to future balancing platforms, prosumers and demand response data hubs

**Innovation**
- H2020 projects, best practice sharing, information on big trends in the EU power system to shape the debate
DIGITAL GRID and innovation projects

Source: Digital Grid Draft Policy Paper ENTSO-E
#DigitalGrid Strategic UseCases

**RESILIENCE**
- Real-time Asset conditions & limits assessment
- Low inertia Grid Stability, Wide Area Defense Plan & Natural Disaster Recovery
- New Regional Security coordination role

**EFFICIENCY**
- TSO Flow Based markets & DSO Market facilitation
- Digital Substation
- Integrated Grid Edge/OT & IT/cloud architectures
- New Energy Data Hubs

**DER INTEGRATION**
- Enable DER (renewable, storage, demand) Virtual Power Plant Aggregation
- Real-time DER integration into Grid Economic Dispatch & reserves
- New Smart Connection planning with renewable & community Microgrids
Develop architecture, standards & interoperability

The Common Grid Model

Smarter data sharing among TSOs for both market and security of supply

Tighten the ENTSO-E Cybersecurity agenda

New expertise
- MOUs with ENCS, ENISA, ACER & CENELEC
- Strenghtened implication into EC SmartGrid Taskforce / EG2
- New ENTSO-E Cyber Strategy Paper

New tools
- Roll-out of the Integral Security Framework (Sep 2017)
- New cooperation tool for Cyber Incidents (2018-19)

New Infrastructures
- New robust security plans e.g. CGM Security Plan (Oct 2017)
- Evolve TSO Electronic Highway into new E-SCN (COMO) architecture

How the CGM works:
https://www.youtube.com/watch?v=0bm4hqiNTyl
ENTSO-E/DSO/Customer European Innovation Project

Partners: ENTSO-E/TSOs/DSOs/Aggregators/IT Providers

INTEGRATE RENEWABLES

REDUCE CUSTOMER BILLS

DEVELOP NEW SERVICES

Interoperable digital platforms

#enablers

Flexibility/Balancing

Crossborder congestion management (dynamic pricing)

Peer to Peer transaction

Services produced in a coordinated manner

Congestion management (dynamic pricing)

OPTIMISE USE & COST OF GRID

Horizon 2020
€15 billion for Research and Innovation 2014-2017
Foster innovation in future Digital apps

Innovation

TSO-DSO-Consumer Call 2018

What
• New TSO-DSO flexibility platforms

Legend

Value Created
App ecosystem
IT Enabler

Interoperability /Many IT platform

New revenue streams/increased DR

Cost efficiency in network operation

Reduce customer bills

Increase RES integration
Services procured in coordinated manner

flexibility/balancing
congestion management (dynamic pricing)
DER/Prosumer clearing market/cross border
Peer to peer transaction
Going further in connecting different data hubs
ECCo SP with Elering

Services connect via single API (secure, simple)

Customers interact via existing channels

Data exchange offers:
- Transport layer (ECCo SP)
- Permissions layer (TO BE ADDED)
- API
- Example UI
- Example service
Power to road transport and V2G services

Using Blockchain technology to enable flexibility from the electrical vehicle.

TENNET: HOME STORAGE BLOCKCHAIN PILOTS

- Pilot project with TenneT and sonnen (battery manufacturer) in Germany
- Pilot project with Tenet and Vandebron (energy company) in the Netherlands
- Pool of home energy storage systems (flexible devices – home batteries and electric vehicles), which TenneT can use for balancing
- A blockchain solution (designed by TenneT and IBM) records energy transfer between the grid and the flexible devices

- Balancing the power system
- Needs flexibility

- Providing flexibility

- Secure data transfer
Future challenges for system operations

Higher generation variability

- Ramps management
- Volatile loop flows over larger distances – congestions
- Imbalances
- Forecast, observability and controllability of RES
- Improving Operational Planning

Decentralized generation & stakeholder management

- TSO/DSO - balancing support
- Demand side response
- Data management
- TSO role (unique platform & market)
- National choices + sharing of best practices

Integration of new technologies

- Lower system inertia
- Voltage control
- Potential for >10000Km of DC lines (TYNDP 2016) and other transmission assets
- NCs implementation
ENTSO-E TYNDP 2018 requires increased flexibility

- RES - up to 70% of demand and developed in non coordinated manner with the network
  - Need for physical layer
    - Grid costs: 150 billion Euros in total (TYNDP2016): new investments needed after 2030
    - “No grid” in 2040: extra bill by 2040: 43 billion Euros/year
      - threaten reliable access to electricity
      - 156 TWh/year of RES wasted (annual consumption of BENELUX)
  - New needs in a new set-up
    - More frequency variation
    - Impact of inertia reduction especially on small systems
    - Stability aspects
  - Observability and controllability of distributed resources and coordination between TSOs/DSOs

Source: ENTSO-E 2018