SEVENTH FRAMEWORK PROGRAMME

EUROPEAN COMMISION

Twenties
Transmitting wind

RED ELÉCTRICA DE ESPAÑA

Demos' main results & achievements

3rd Dissemination Event
Brussels, 11th June 2013

Concept-Idea

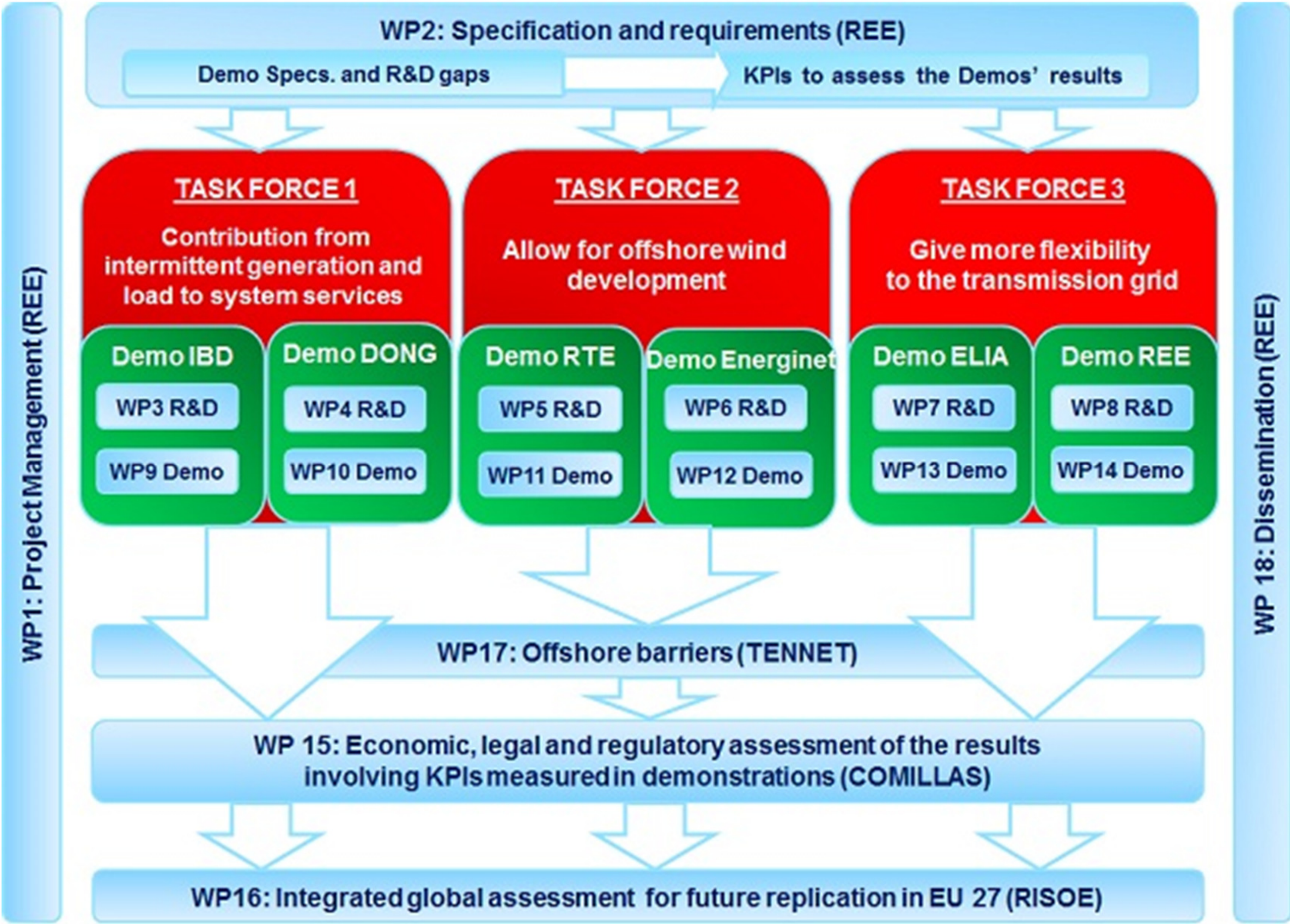
The TWENTIES project aims at:

*"**demonstrating** by early 2014 through real life, large scale demonstrations, **the benefits and impacts of several critical technologies** required to **improve the pan-European transmission network,** thus giving Europe a capability of responding to the increasing share of renewable in its **energy mix by 2020** and beyond while **keeping its present level of reliability performance.**"*

To this extent it will be focused in removing several barriers which prevent:

- **pan European electric system** from welcoming more **renewable generated electricity.**
- **renewable-generated electricity** from contributing more efficiently **to the single European electric market.**

Project Structure



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Task Force 1:
Demo 1, SYSERWIND
Demo 2, DERINT

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SYSERWIND Demo Results & Conclusions (1/2)

- **Within TWENTIES demo 1, it has been tested:**
  1. **That the wind farms grouped in a cluster are able to control the 400 kV voltage in the REE's point of connection, according to the same operational procedure than the conventional generation requirement (P.O. 7.4).**
  2. **That a group of wind farms are able to control their active power, in real time and in a coordinated way, according to the REE's secondary frequency control requirements (RCP).**

- **The CAPEX for delivering theses ancillary services is quite reduced (around 100-150 k€ per 50-100 MW wind farm, in HW and SW) and there is not a clear impact in the OPEX.**

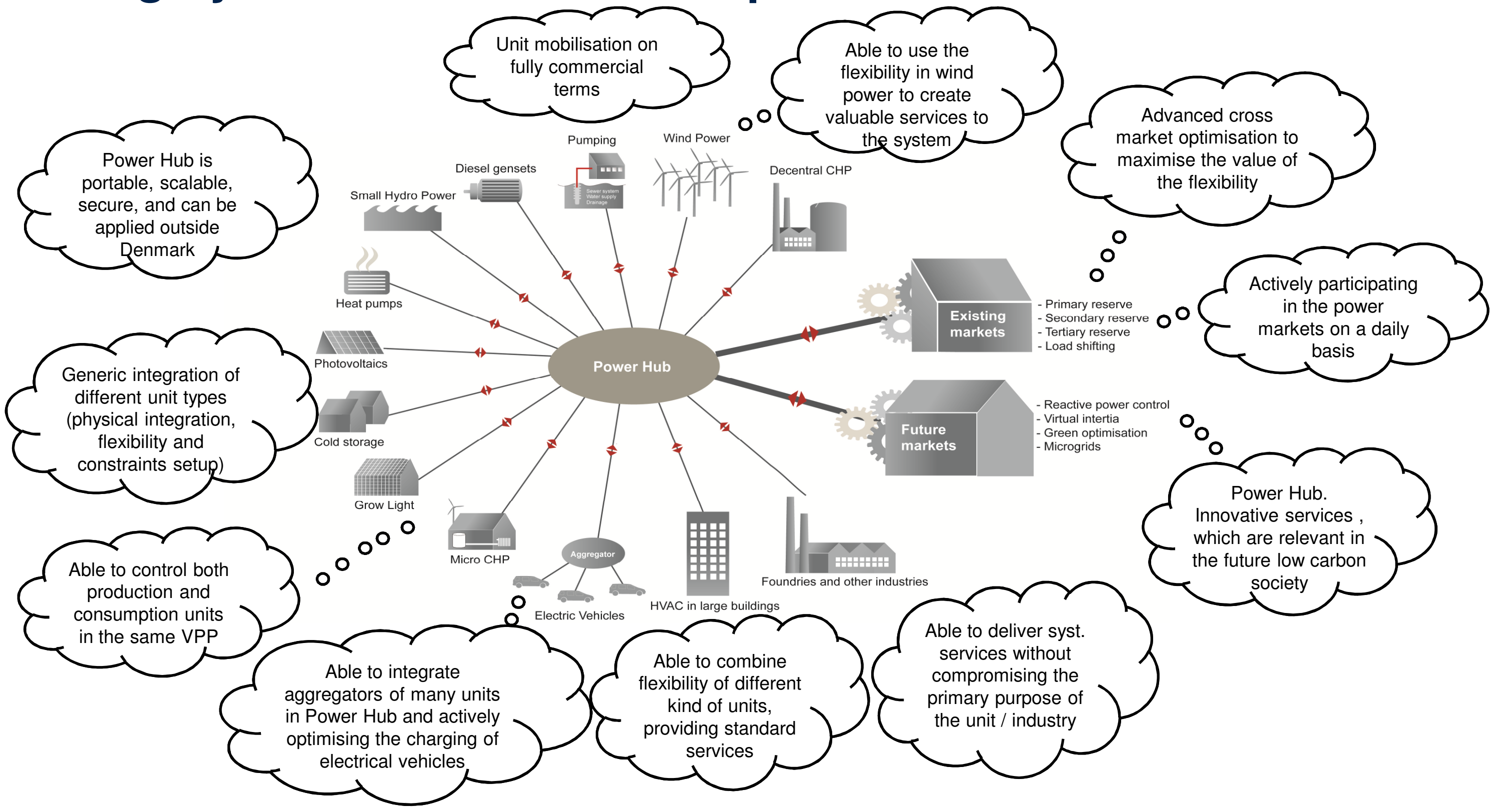
SYSERWIND Demo Results & Conclusions (2/2)

- **However, from the wind generator point of view, there are some major costs and problems in delivering the secondary frequency control service by wind farms:**

  1. **A high amount of energy must to be spilled for providing the upwards power reserve service, so it is not currently attractive from the economical point of view.**
  2. **According to the forecast system analysis done, the more wind farms are grouped to provide the service and the shorter term the forecast calculation is, the lower the necessary energy curtailment is. However, the amount of energy to be curtailed is still quite representative.**
  3. **The current secondary reserve market is a day-ahead one, and wind energy would need a short term market, almost in real time, or to offer this upwards reserve only once we have been curtailed by technical constraints, or just to offer the downwards reserve.**
  4. **In other markets, on the other hand, it could be of interest if providing this service allows to produce with competitive advantages, as is the case in some markets in the USA.**

DERINT Demo Results & Conclusions (1/2)

- **VPP is highly advanced and can help balance renewables.**



Vision: To show the full potential of the VPP technology.

DERINT Demo Results & Conclusions (2/2)

- Demo 2 shows that advanced VPPs are possible, but strong barriers to commercialization prevail.
- The main conclusions from Twenties Demo 2 are:

1. It is technically possible and economical attractive to start-up a VPP controlling a wide variety of DER (production and consumption).
2. VPP can deliver a wide range of services, that will all be needed from new sources when the future low carbon power system has to be balanced.
3. VPP can transform a portfolio of units with stochastic behaviour into reliable services while still fulfilling the primary purpose of the industrial units.
4. Mobilizing industrial units is a challenging task, including unit flexibility assessment and unit owner re-education in concepts like VPP's, power markets and the future of the energy system.
5. Barriers exists in relation to regulation and market structures. A low carbon energy system requires changes in the regulatory regime to make it work optimally.

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Task Force 2:

Demo 3, DC-GRID
Demo 4, STORM MANAGEMENT
WP 17, Off-shore barriers

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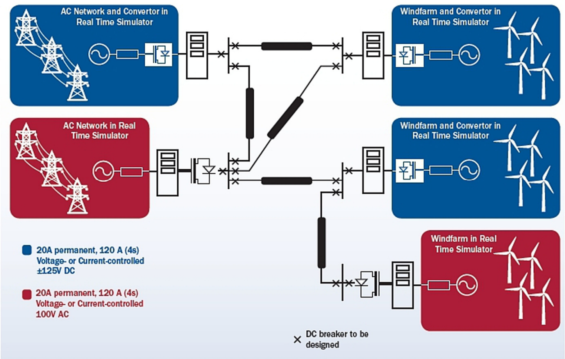
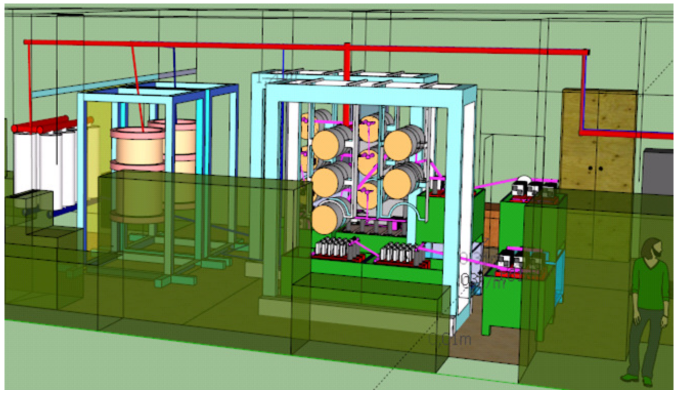
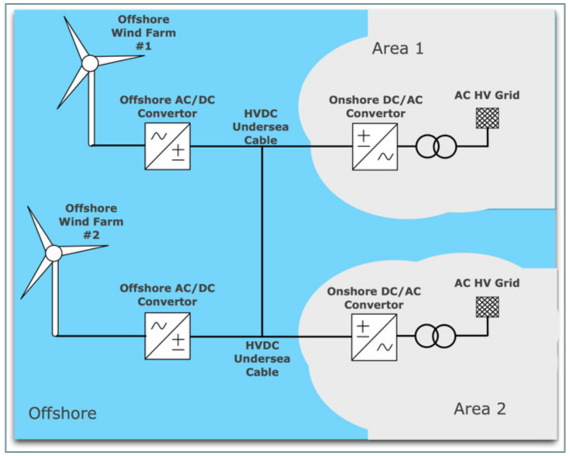
DC-GRID Demo Results & Conclusions (1/3)

- **Areas of activity**
  - **Five-terminal DC grid**
  - **DC breaker prototype**
  - **AC/DC systems interaction**







- **CO2 emission and new DC technology costs have been detected as influent economic parameters in the economic drivers analysis**

DC-GRID Demo Results & Conclusions (2/3)

- **2030 & beyond**
  - **All DC grid topologies remain potential candidates (radial, point-to-point interconnectors, multi-terminal, or meshed).**
  - **Multi-terminal structures provide more flexibility for ancillary services.**

- **Medium-term (2020-2030)**
  - **Simple structures (backbones) are feasible from both technical and regulatory standpoints:**
    - Power flow control in normal and disturbed conditions are based on local controllers, with easy extension to coordinated control
    - Protection relies on existing AC breakers only
    - Provision of ancillary services (voltage support, frequency control, PSS), and Fault Ride-Through capability.
  - **A DC fault detection & selection algorithm was and successfully tested on the low-scale DC grid mock-up**

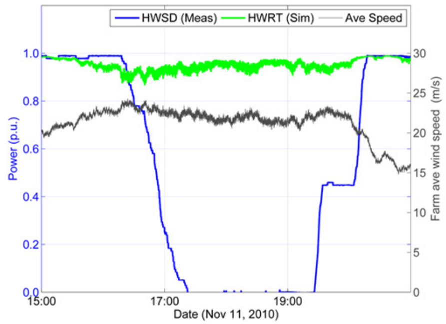
DC-GRID Demo Results & Conclusions (3/3)

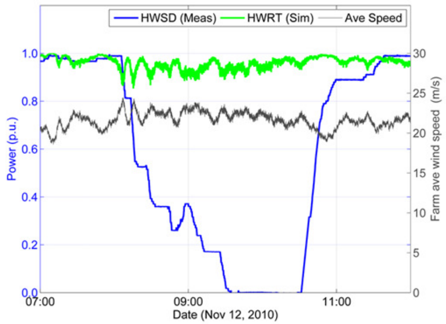
- **DCCB prototype**
  - **The technical feasibility of an innovative DCCB was proven through successful medium-voltage power tests:**
    - current conduction in closed state,
    - fast current interruption,
    - voltage withstand in open state.
  - **Power interruption tests were witnessed by an independent observer, the EC technical reviewer and TC members.**
  - **The assembly of the high-voltage DCCB demonstrator is nearly completed.**

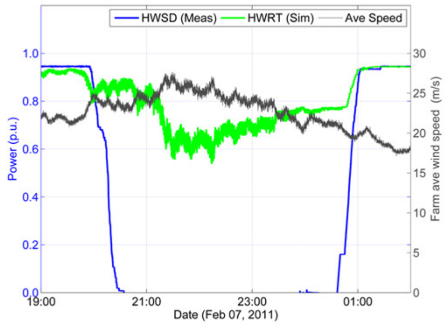
- **Recommendations**
  - **Complete protection chain (from detection to the complete fault isolation) to complement the DCCB, is needed.**
  - **Further simulations including AC network, the DC grid and wind farms is required for time scales ranging from µs to seconds.**
  - **Assessing multi-vendor DC interoperability is a necessary step.**

STROM MANAGEMENT Demo Results & Conclusions (1/2)

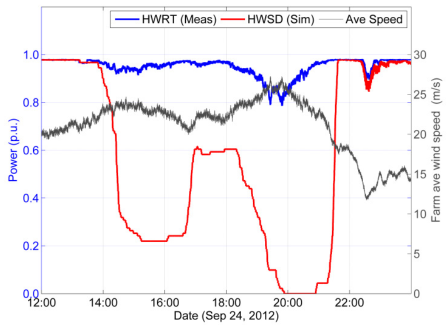
- **Observed storms before the High Wind Ride Through™ was installed**

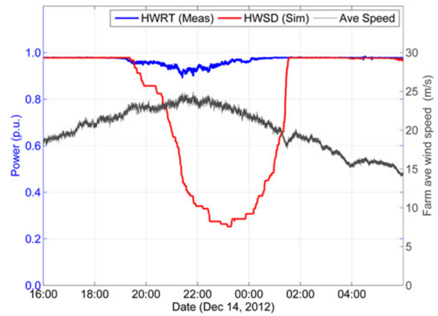


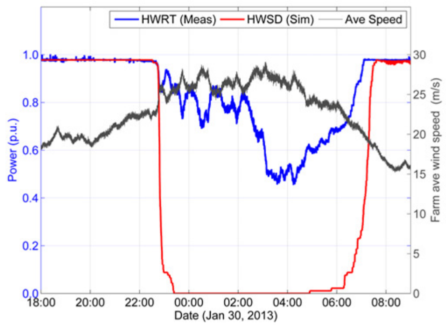




- **Observed storms after the High Wind Ride Through™ was installed**







STROM MANAGEMENT Demo Results & Conclusions (2/2)

- Summary of results
  - Max forecast errors reduced

Event	Max forecast error [p.u.]	Average forecast error [p.u.]	Difference [p.u.]
11-Nov-10	0.80	0.77	0.51
12-Nov-10	0.80		
07-Feb-11	0.72		
24-Sep-12	0.26	0.26	
14-Dec-12	0.18		
30-Jan-13	0.35		

  - Energy production during storms is increased

Event	Energy [MWh]		
	HWSD	HWRT	Difference [MWh]
11-11-2010	656	1194	537
12-11-2010	600	1003	403
07-02-2011	886	1556	671
24-09-2012	1391	2296	905
14-12-2012	3680	4186	506
30-01-2013	1390	2510	1120

- High Wind Ride Through™ reduces the challenge of maintaining a high security during windy conditions
- Possibilities of using HVDC to maintain balance has been assessed
- Results from this demo is input to simulations for an European future system with large amounts of offshore wind power

OFF-SHORE BARRIERS WP Results & Conclusions

- **Focus on EU level**
  - Early political commitment and multilateral cooperation,
  - Maritime spatial planning – coordinated in e.g. the North Sea,
  - Harmonisation of planning processes between member states,
  - Clarifying the technical and environmental criterion,
  - Prepare reference studies on the impact on protected areas.
- **Focus on National and trans-National level**
  - Coordination and cooperation between national authorities to facilitate overall evaluation of cable route design. One-stop-shop on a national level
  - Use of reference cases (standards, impact assessments).
- **Focus on TSO level**
  - Improving project management, stakeholder management and dialogue with the appropriate regulatory and advisory authorities
  - Focus on onshore part.

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Task Force 3:
Demo 5, NETFLEX
Demo 6, FLEXGRID

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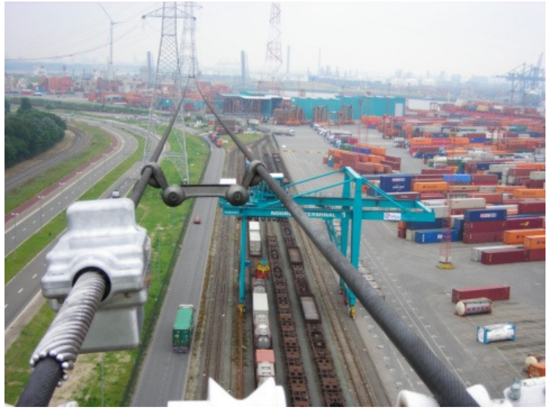
NETFLEX Demo Results & Conclusions (1/2)



- **Forecasting Dynamic Line Rating (DLR)**
  - **Average gain in capacity of 10-15% in D-1/D-2 (P98)**
  - **Varying capacity over the course of the day**
    - Operational constraints for using it
  - **Ampacimon sensors can be quickly deployed**

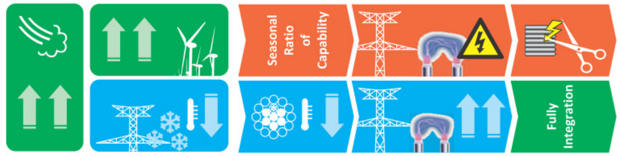
- **Smart Power Flow Controller**
  - **PSTs and HVDC links can provide more**
    - Increased security – decreased actions
    - Enhanced preparation to wind fluctuations
  - **Average margin of 26% for wind fluctuations** (Jan 2013)
  - **Varying margin over the course of the day**

NETFLEX Demo Results & Conclusions (2/2)

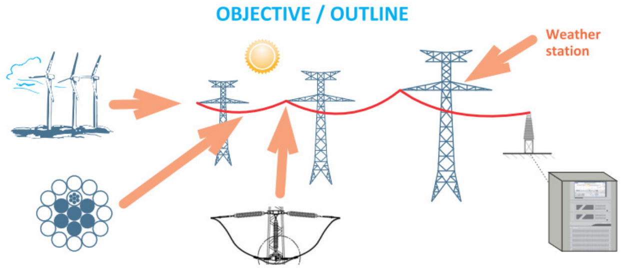
- **Forecasting damping**
  - **Damping is generally sufficient (at the moment)**
  - **Damping can be forecasted based on Load Flow (I/O)**
  - **Existing PFCs do not significantly influence damping**
    - Future research needed to control damping
- **Enhanced Network Flexibility (combination)**
  - **The grid can be planned more audaciously**
    - i.e. higher capacities for the market and for wind power while delivering the same level of reliability

    to closes the gap caused by long lead times in building out new lines
  - **The implementation costs are relatively small in comparison with the impact on variable generation costs.**

FLEXGRID Demo Results & Conclusions (1/2)



- **Dynamic Line Rating (DLR)**
  - **Based on OPPC technology**
  - **In operation at Maria-Fuendetodos 220kV OHL since the end of 2012**
  - **Provides 100% reliability to SO staff**
    - 15.000 real temperature data every 10 minute



- **Innovative Power Flow Controller**
  - **Based on mechanically switched series reactors, managed by a high-end control system (Mach2).**
  - **In operation at Magallón 220 kV S/S, OHL bay to Entrerios S/S, since May 2013**
  - **Maximum impedance injected 18.1 Ω, equivalent to 30% of the OHL impedance.**
  - **Able to adjust power flow in the Entrerrios-Magallón-Tudela-Orcoyen 220kV corridor**

FLEXGRID Demo Results & Conclusions (2/2)

- **Dynamic Line Rating (DLR)**
  - **Monitoring along the entire line without estimation or.**
  - **Notable increase of available capacity maintaining the reliability criteria.**
    - Maximum of 65% of additional capacity.
    - 50% of additional capacity during more than 60% of the time.
  - **Hot spot detection is being located for maintenance purposes.**

- **Innovative Power Flow Controller**
  - **Control of power in steady state and contingency state is obtained.**
  - **Quasi-continuous control.**
  - **Control strategies following set points from dispatching center, based on real-time system status.**
  - **Limited CAPEX and OPEX compared with other power electronics solutions.**
  - **Modular solution:**
    - transferable to another location if necessary.
    - scalable solution as regards size and number of reactors.

THANKS FOR YOUR ATTENTION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