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Centro Nacional de
Control de Energía

WEBINAR

Innovations for operating power systems with increasing shares of variable renewables

A regional perspective

Moderated by:

Elena Ocenic, IRENA Innovation and Technology Centre

11 February 2021 • 16:00 – 17:00 CET / 9:00 – 10:00 CST



All microphones are **muted**



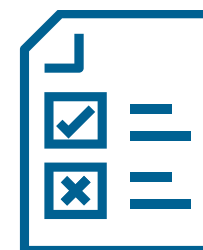
Use the **Chat** feature to introduce yourself and talk to other attendees



If you have **Questions** to the speaker please use the dedicated **Q&A** tab



The slides and recordings will be shared via email after the end of the webinar



Tell us how we did in the survey to help us improve

AGENDA

Innovations for operating power systems with increasing shares of variable renewables

– *A regional perspective*

- **Innovation landscape for a renewable-powered future, IRENA**
- **European regional market: *Balancing the system with increasing shares of variable renewables – Enhancing a balancing market, TransnetBW Germany***
- **Central American regional market: *Operational experiences of high integration of renewable energy resources in Costa Rica, ICE Costa Rica***
- **Panel discussion with Q&A**

IRENA's Collaborative Frameworks

Collaborative Framework on Enhancing Dialogue on High Shares of Renewables in Energy Systems

Co-facilitators



Achieved in 2020: Preparatory Phase

- **1st Virtual Meeting (July 2020)**
 - ✓ 81 participants from 40 Member States
 - ✓ Call for inclusion of other stakeholders
 - ✓ Establishment of 6 work streams
- **2nd Virtual Meeting (Oct 2020)**
 - ✓ 130 participants from 57 Member States
 - ✓ 8 key stakeholders
 - ✓ Pilot phase will focus on 3 work streams
 - ✓ Selection of co-facilitators

Planned for 2021: Pilot Implementation Phase

- **Pilot phase with 3 work streams:**
 - ✓ Energy system planning
 - ✓ Energy system operation
 - ✓ Cross-border interconnection
- Organisation of 7 virtual events for work streams on key topics of interest for countries
- **Ministerial Meeting of the Collaborative Framework (Q2 2021 – TBC)**



SPEAKERS



Arina Anisie
IRENA



Ana Carolina Burghi & Peter Scheerer,
TransnetBW (Germany)



Juan Carlos Montero
ICE (Costa Rica)



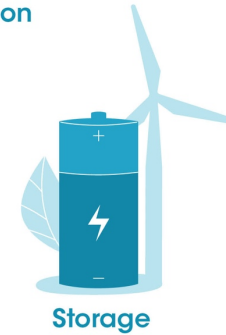
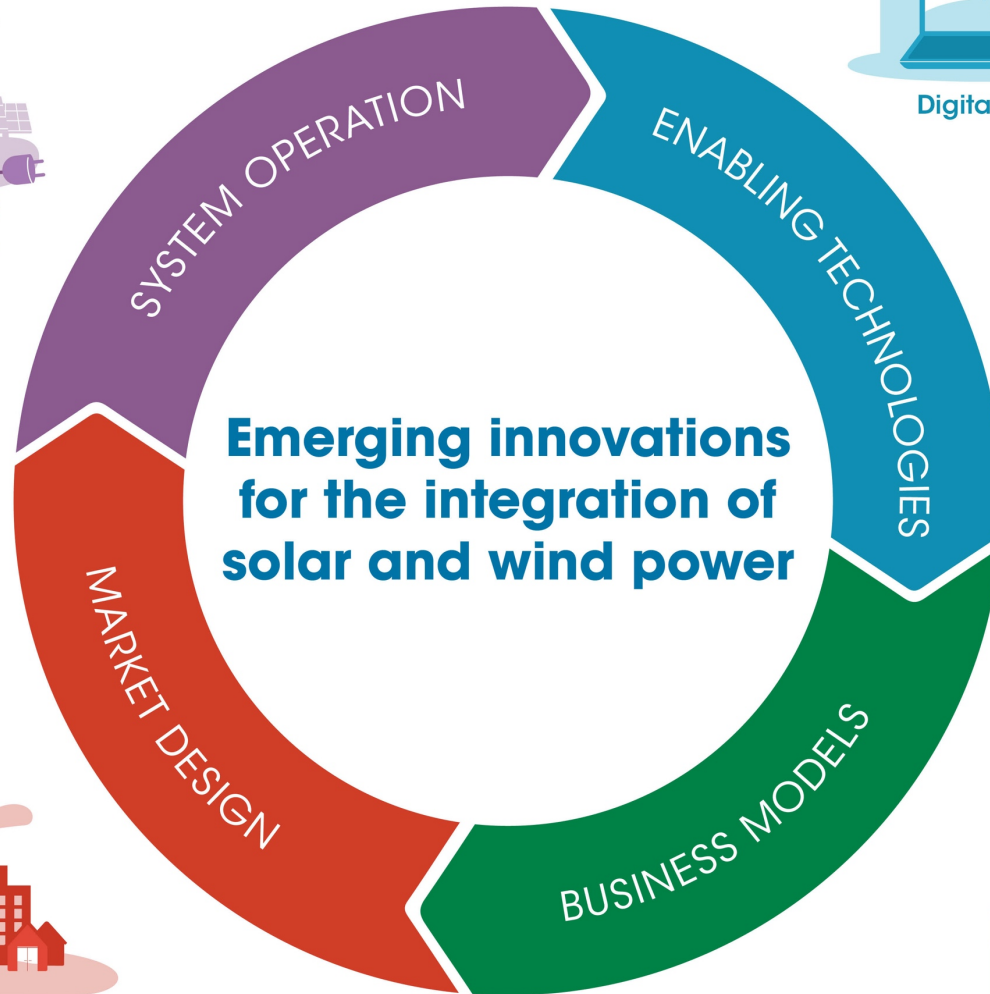
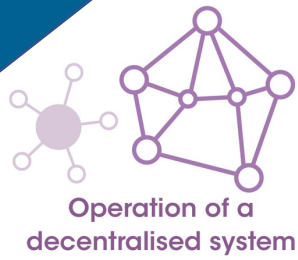
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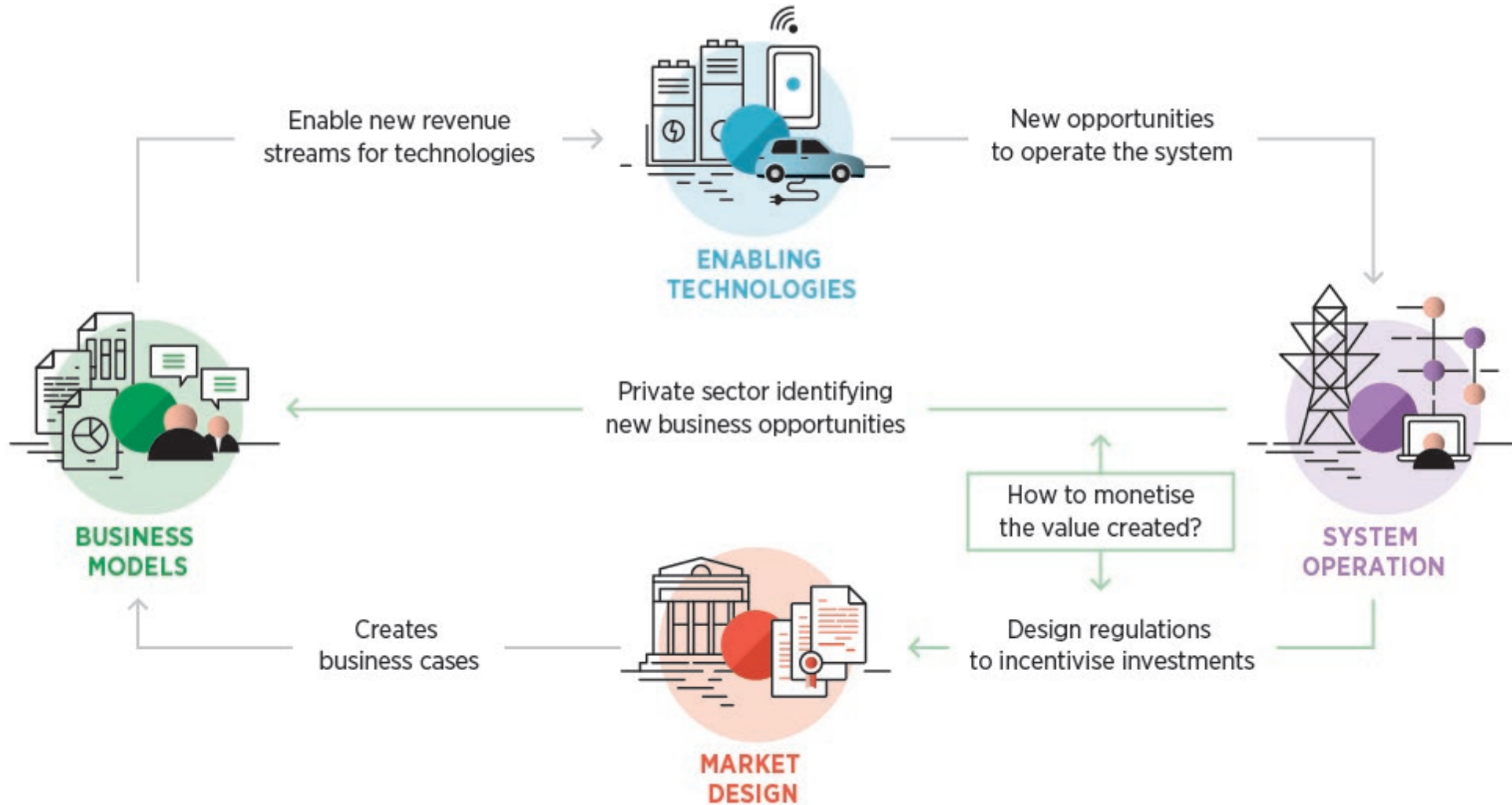
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Innovation landscape for a renewable-powered future

Arina Anisie, IRENA



Systemic innovation for an integrated renewable energy system



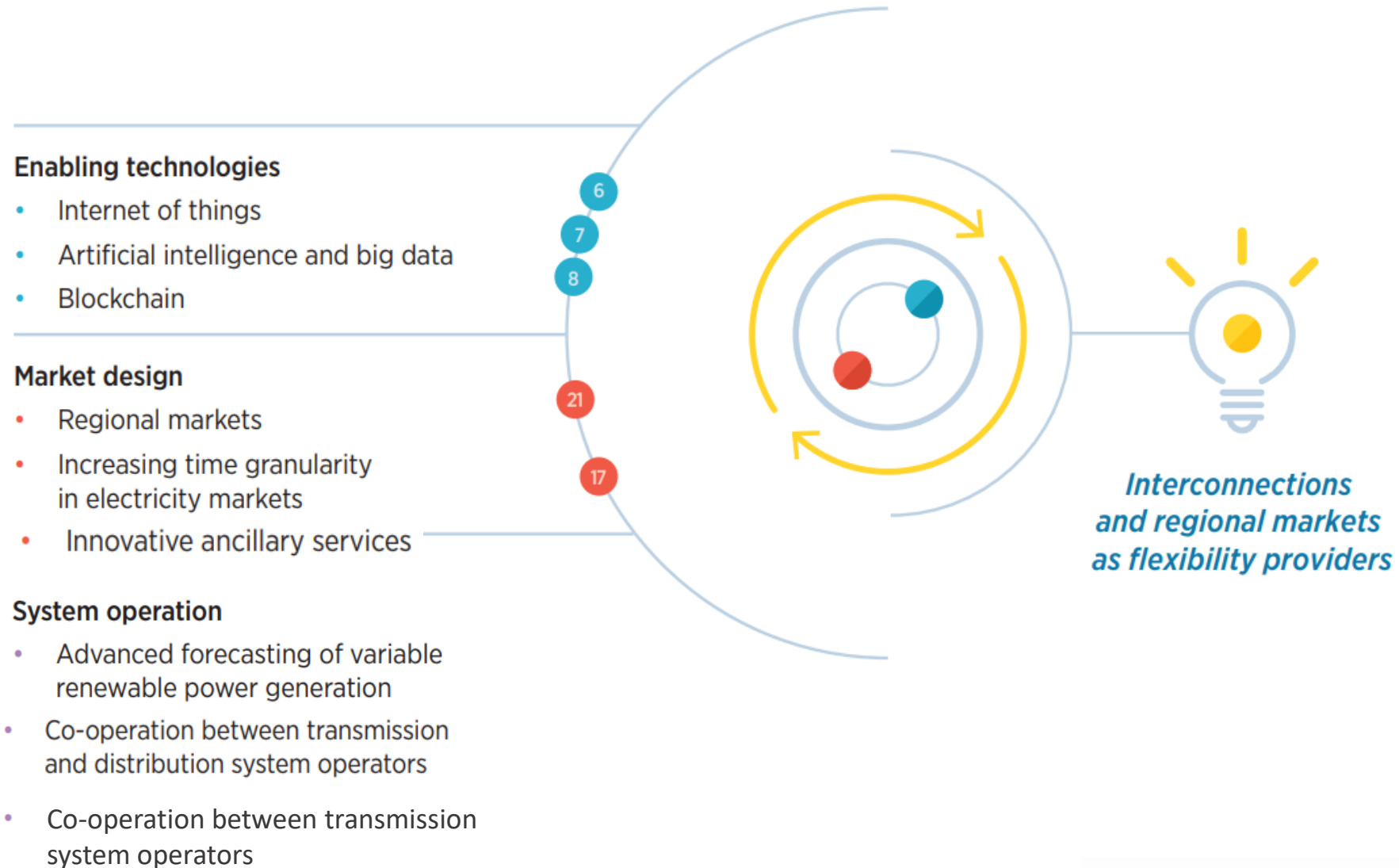
Emerging innovations for wind and solar PV integration



Innovation Landscape Report

● ENABLING TECHNOLOGIES	● BUSINESS MODELS	● MARKET DESIGN	● SYSTEM OPERATION
1 Utility-scale batteries	12 Aggregators	17 Increasing time granularity in electricity markets	25 Future role of distribution system operators
2 Behind-the-meter batteries	13 Peer-to-peer electricity trading	18 Increasing space granularity in electricity markets	26 Co-operation between transmission and distribution system operators
3 Electric-vehicle smart charging	14 Energy-as-a-service	19 Innovative ancillary services	27 Advanced forecasting of variable renewable power generation
4 Renewable power-to-heat	15 Community-ownership models	20 Re-designing capacity markets	28 Innovative operation of pumped hydropower storage
5 Renewable power-to-hydrogen	16 Pay-as-you-go models	21 Regional markets	29 Virtual power lines
6 Internet of things		22 Time-of-use tariffs	30 Dynamic line rating
7 Artificial intelligence and big data		23 Market integration of distributed energy resources	
8 Blockchain		24 Net billing schemes	
9 Renewable mini-grids			
10 Supergrids			
11 Flexibility in conventional power plants			

Combining innovations for renewable solutions








Ancillary services are vital to support power system operation

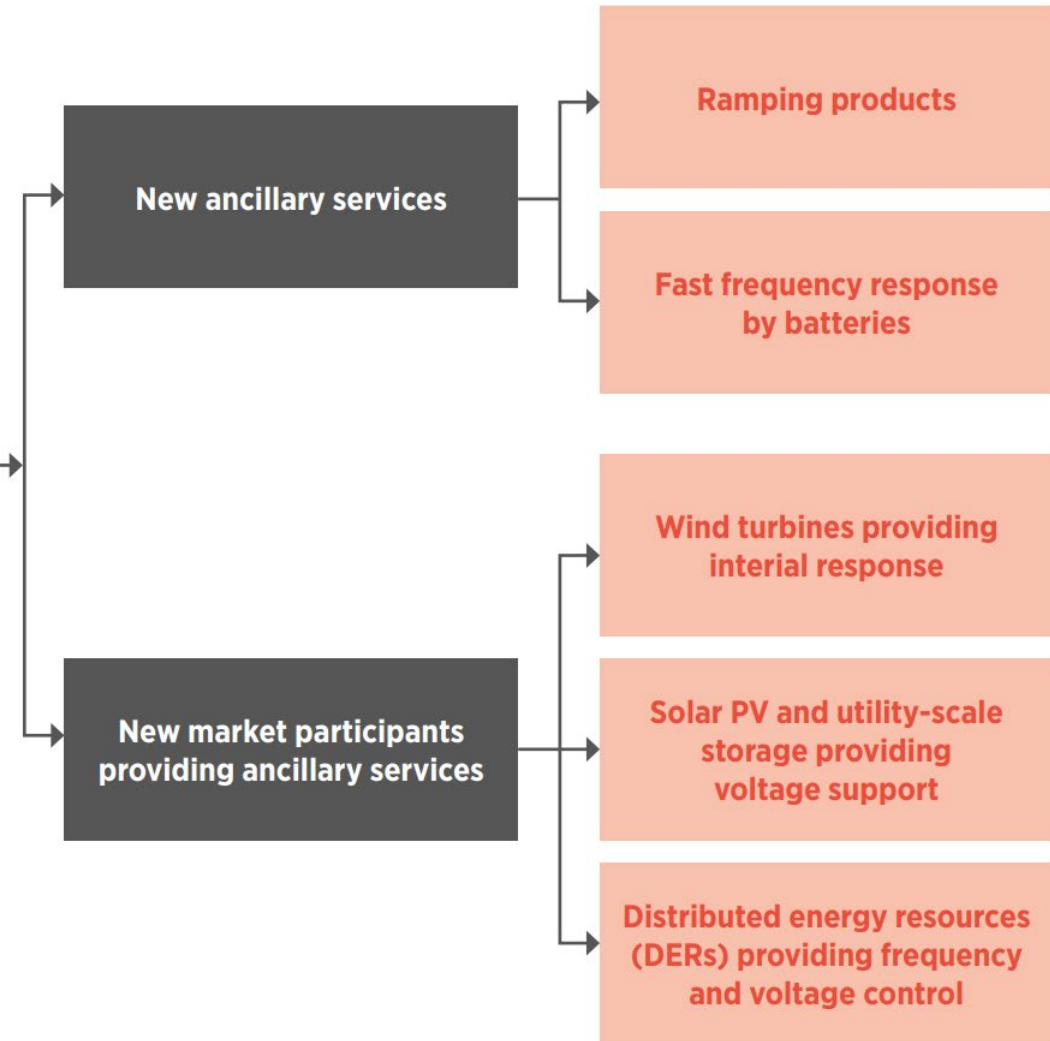
Innovative ancillary services:

- Ancillary services need to be adapted to increase system flexibility.
- The ancillary service market should be open to all participants.

3 SNAPSHOT

-  Batteries can provide ancillary services in Australia, Belgium, Germany, Netherlands, UK and USA
-  Wind power generators can provide balancing services in nine European countries
-  A US system operator uses separated ramping products to help the system meet ramping needs
-  The exchange of balancing services across borders in Europe is increasing
-  Local flexibility markets emerge in Germany and UK, where ancillary services are procured by the DSOs

Increased flexibility through innovative ancillary service markets



Regional markets and exchange of services across borders

2 BENEFITS

- Increased flexibility through expanding balancing area
- Advantages of spatial complementarity of VRE generation
- Co-ordinate generation planning
- Reduce system operation cost

3 KEY ENABLING FACTORS

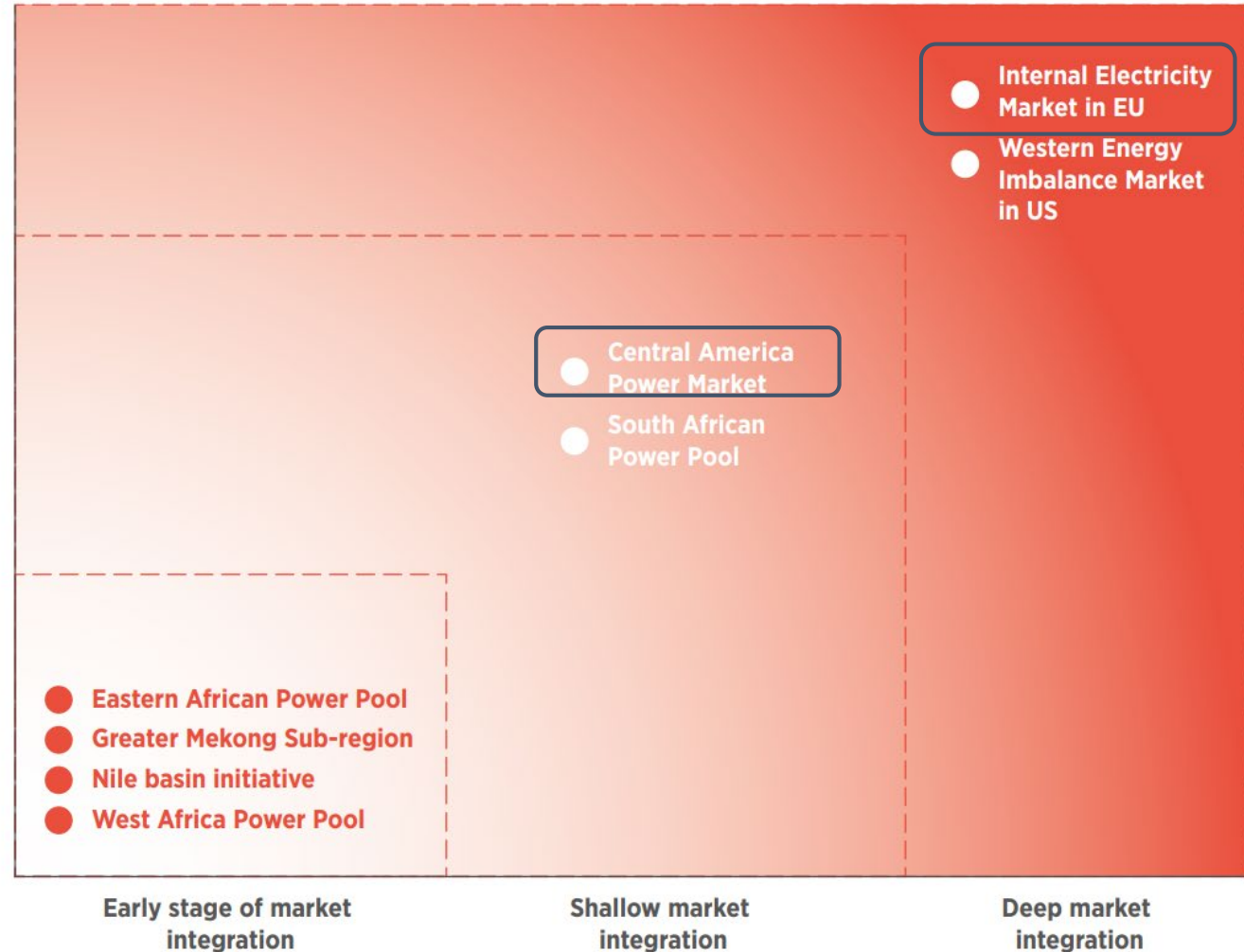
- Physical interconnections with sufficient capacity
- Regional mindset, strong institutional arrangements and governance model
- Robust IT system for market operation

Capacity market harmonisation

Ancillary market harmonisation

Wholesale market harmonisation

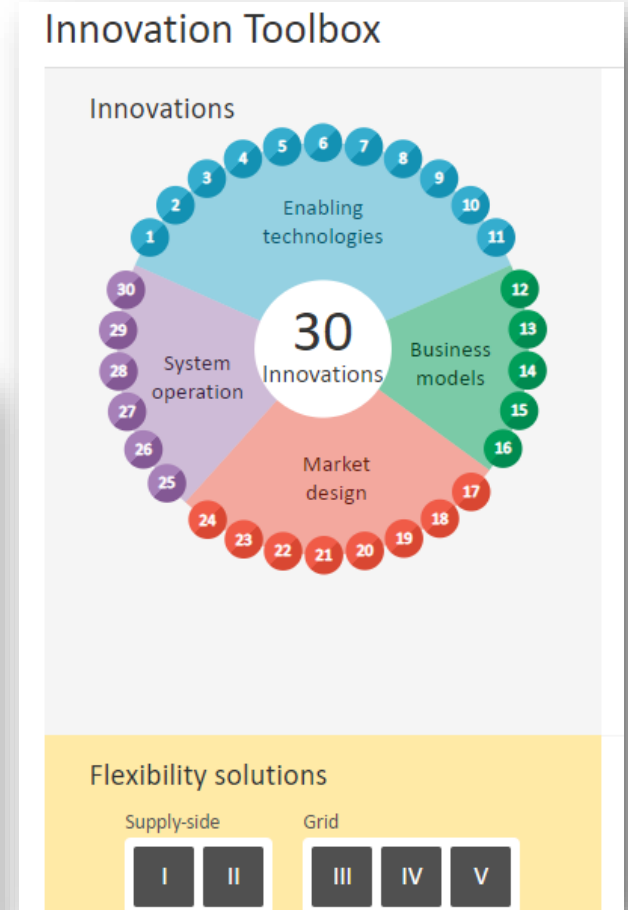
Bilateral contracts



Thank you!

Further reading:

- IRENA (2019), **Innovation Landscape for a renewable-powered future: Solutions to integrate variable renewables**: [Link](#)
- IRENA (2019), **Innovation Landscape Briefs**:
 - ✓ Market design briefs: [Link](#)
 - ✓ Enabling technologies: [Link](#)
 - ✓ Business models: [Link](#)
 - ✓ System operation: [Link](#)
- IRENA **Innovation Toolbox**: [Link](#)
- IRENA (2020), **Innovative solutions for 100% renewable power in Sweden**: [Link](#)





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European regional market: Balancing the system with increasing shares of variable renewables – Enhancing a balancing market

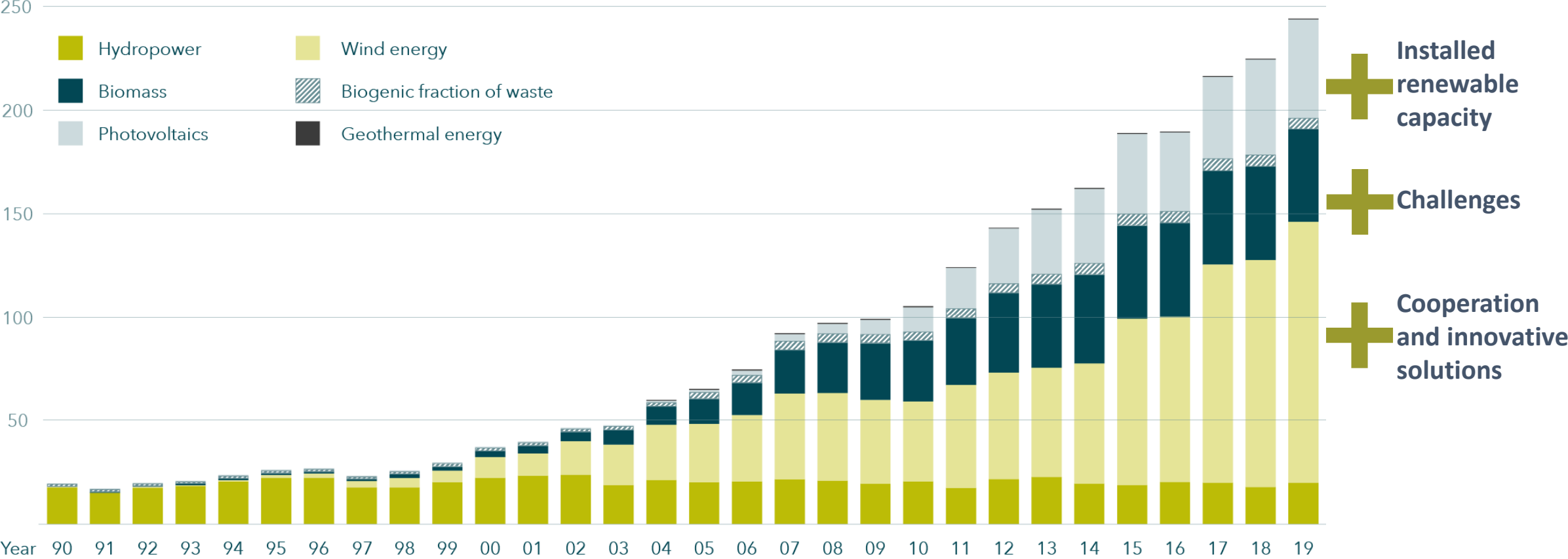
Ana Burghi, Peter Scheerer and Dominik Schlipf, TransnetBW Germany

Renewables in the German System

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RENEWABLES / GERMANY

TWh/yr

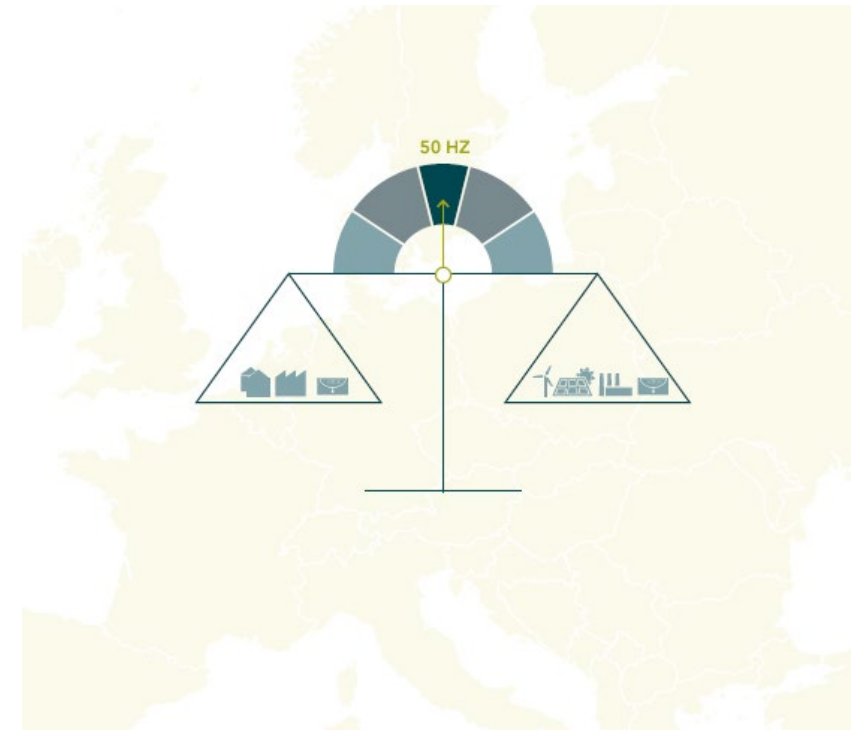


Source: German Federal Ministry for Economic Affairs and Energy

The European Energy Market

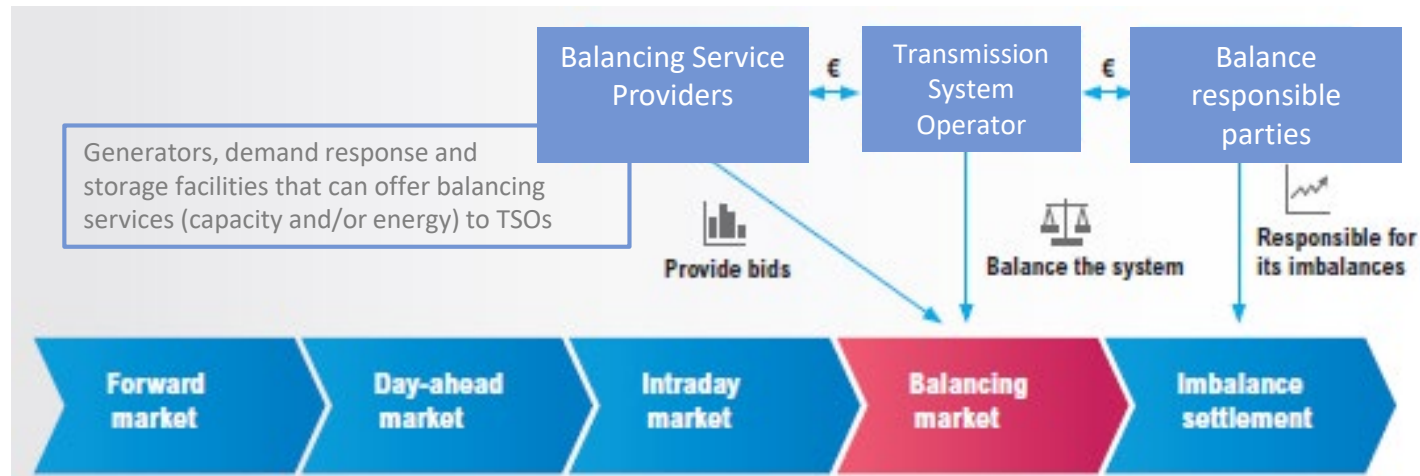
The Balancing Process

- **Balancing: actions and processes performed by transmission system operators (TSOs) to continuously ensure the maintenance of system frequency within a predefined stability range**
- **Balancing process' steps:**
 1. TSOs dimension their need for balancing reserves
 2. TSOs procure the required balancing capacity
 3. TSOs procure balancing energy



The Balancing Market

- **Balancing energy markets represent the institutional, commercial and operational arrangements that enable a market-based balancing of the system**
- **Well functioning day ahead and intraday markets act as a foundation for the balancing market**
- **TSO's role: considering the markets' results, to ensure that demand and supply remain balanced by operating the system close to real time**

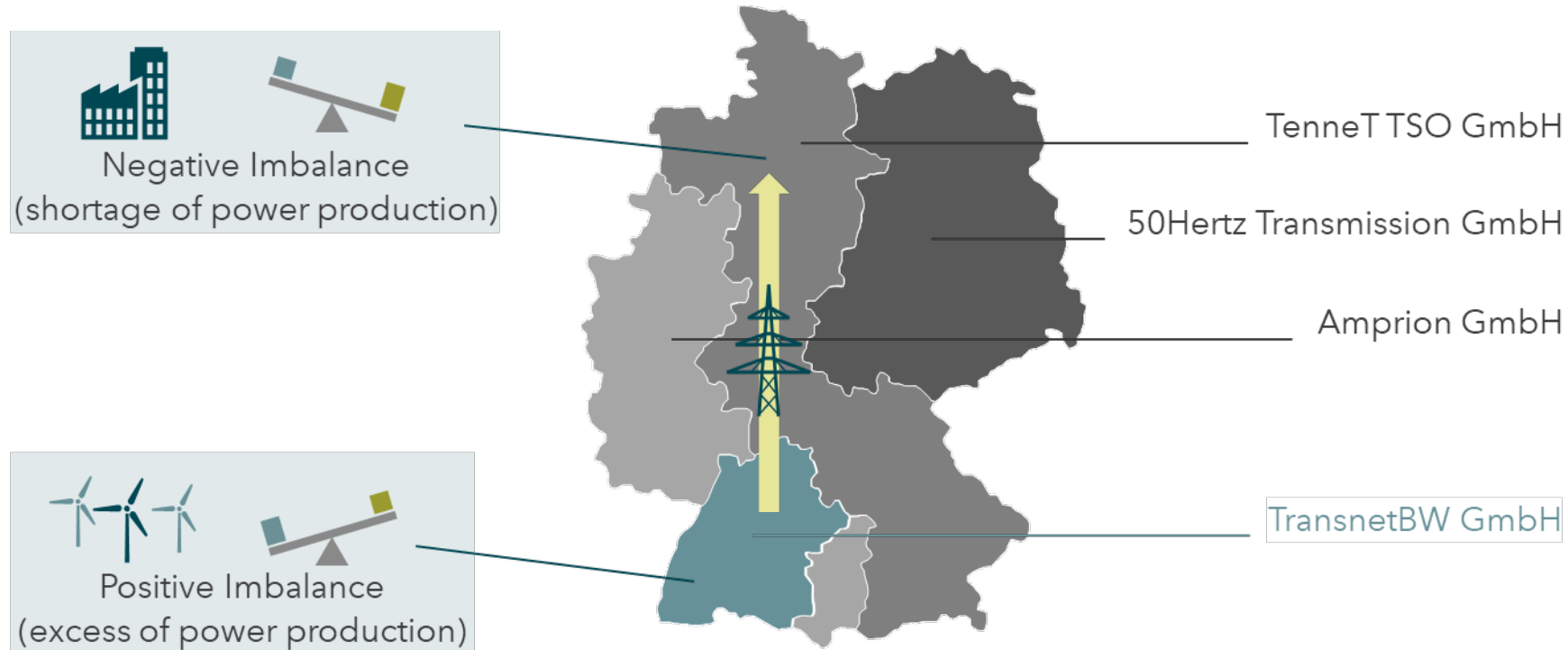


Source: ENTSO-E, 'An Overview of the European Balancing Market and Electricity Balancing Guideline', 2018.

Solutions for an Enhanced Balancing Market

Balancing in Germany

- Germany as pioneer in balancing among different control zones
- Balancing occurs among 4 German TSOs since 2010



Balancing in Europe

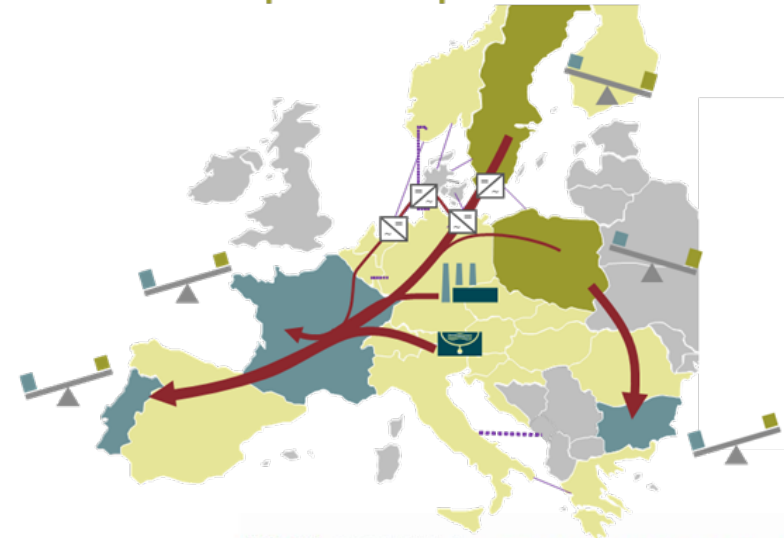
PREVIOUSLY

- / Imbalances were dealt in a **national/regional** manner
- / Frequent opposing imbalances
- / Different cost structures for balancing energy
- / Different generation structures
- / Inefficient local regulation

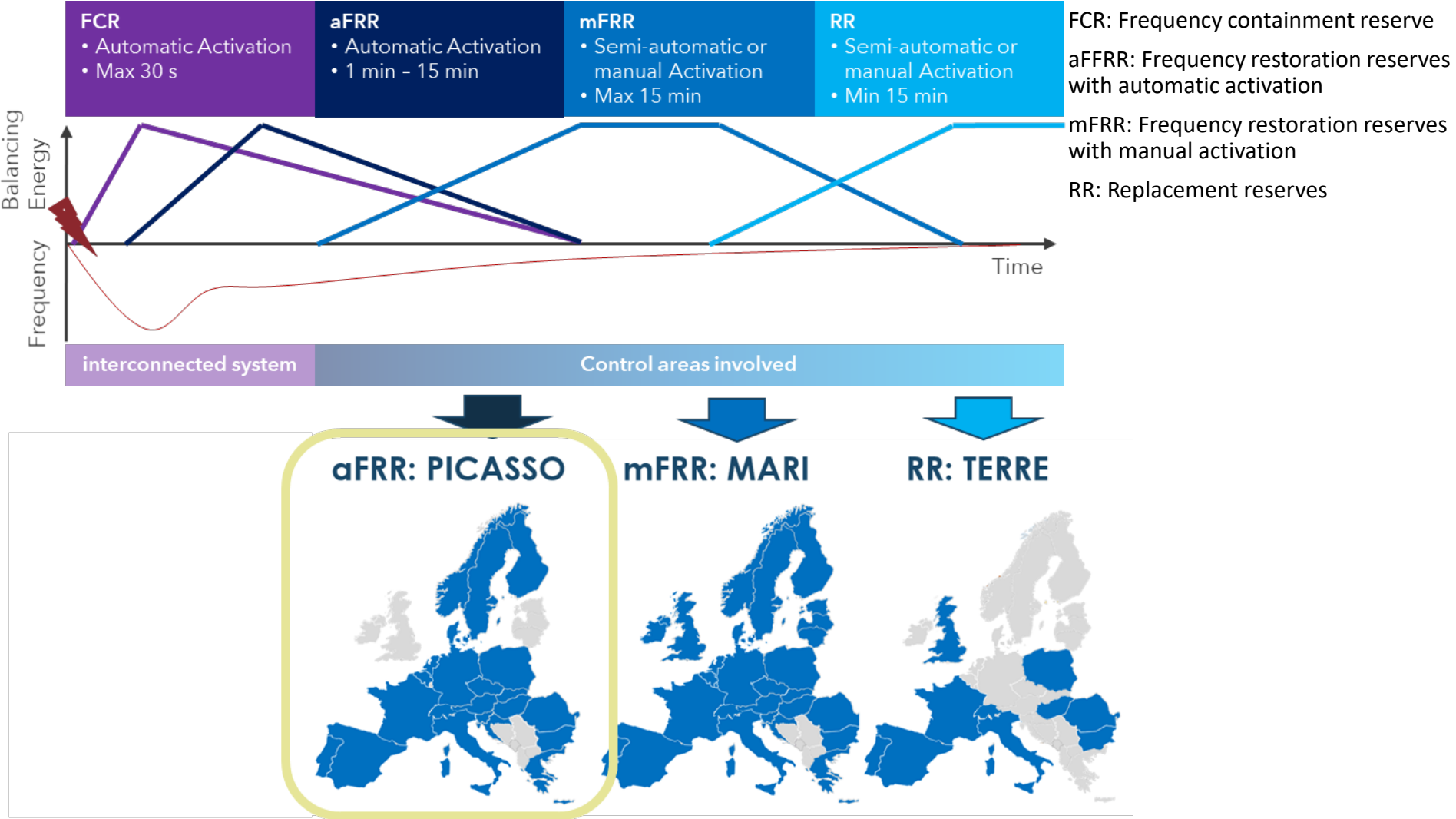


ONGOING / FUTURE

- / Imbalances dealt in a **cross-border** manner
- / **Electricity Balancing Guideline:**
 - determination of platforms for cross-border optimization of balancing energy use
- / Avoidance of opposing activation
- / Activation of the most favorable flexibilities
- / Consideration of available transmission capacities
- / Use of HVDC systems
- / Creation of a **pan-European market**

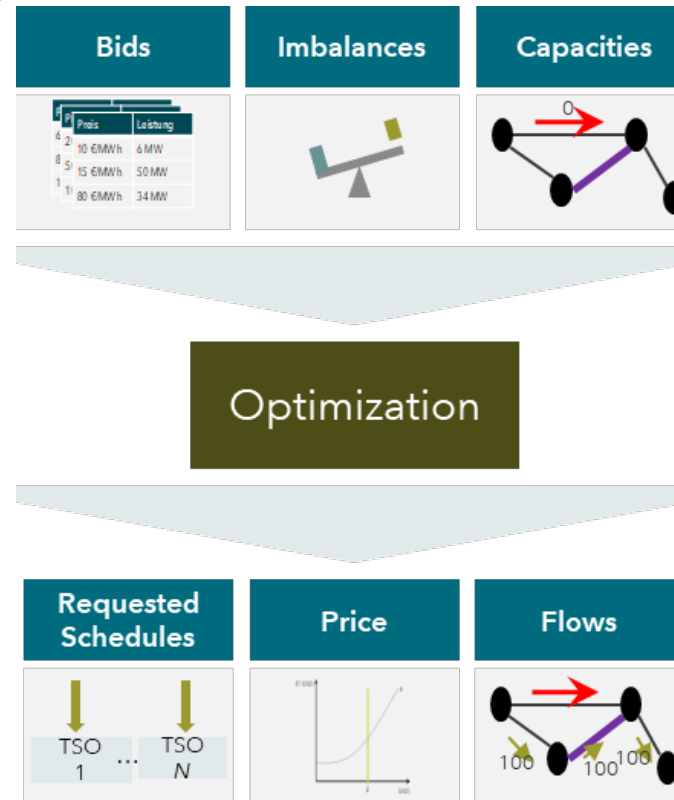


Balancing Platforms



PICASSO (Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation)

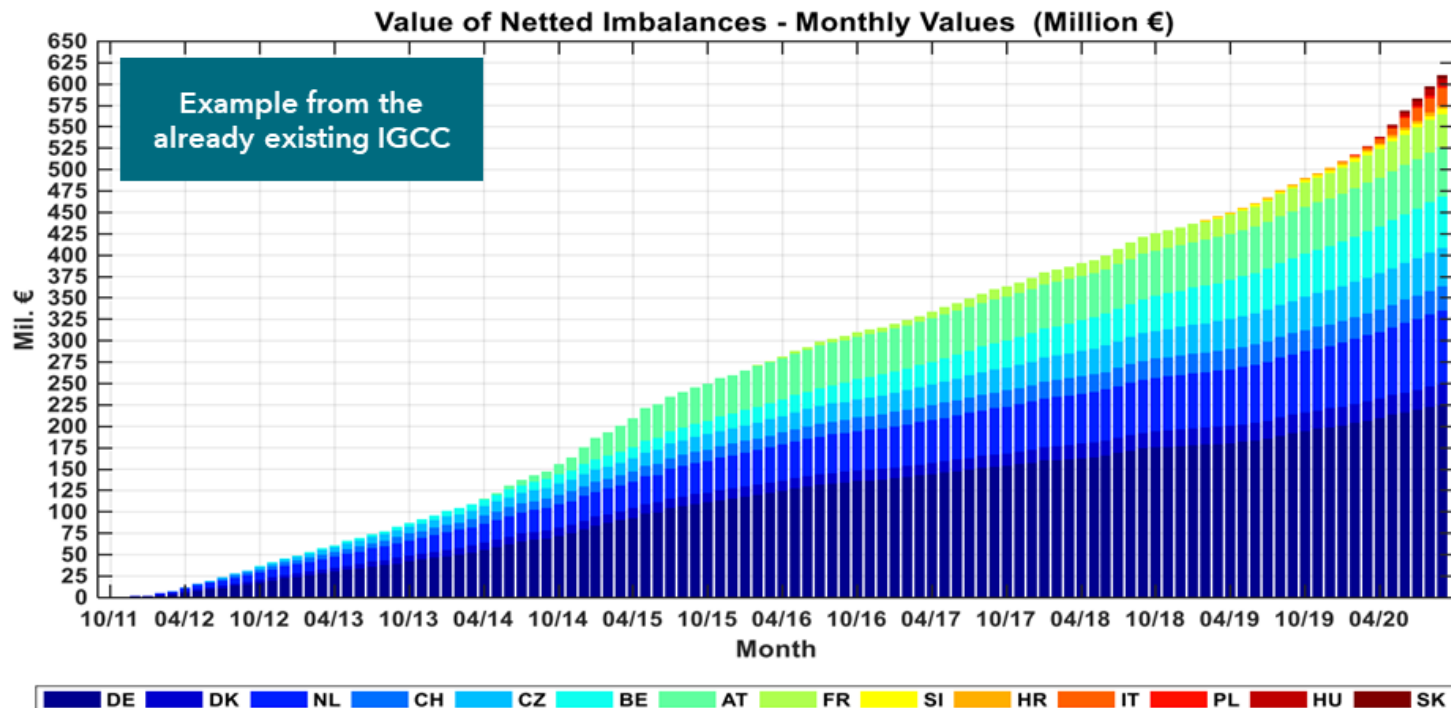
- Integration of the European frequency restoration reserves with automatic activation (aFRR) markets
- Compliance with the **Electricity Balancing Guideline**, as well as other regulations
- Planned launch: November 2021



PICASSO (Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation)

- **Benefits:**

- Harmonization of requirements
- Enhanced number of market participants
- **More opportunities for renewables to play in the balancing market**
- Increase of economic and technical efficiency within the limits of system security
- Lower costs for electricity consumers

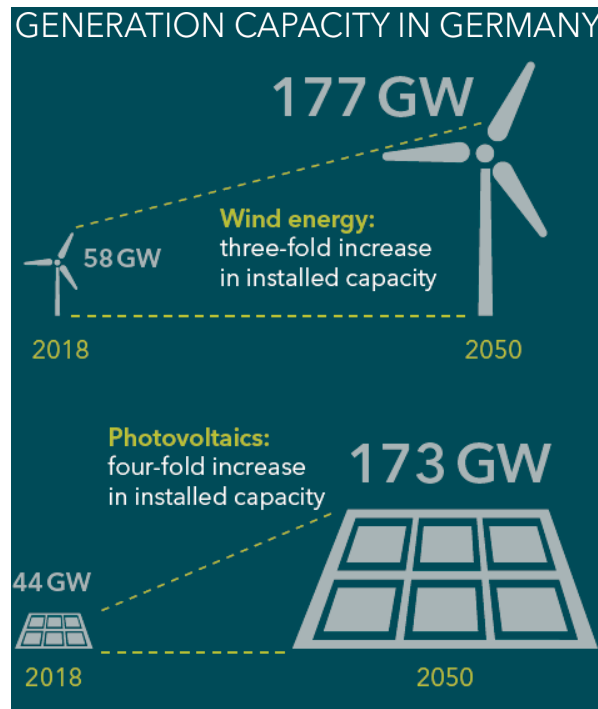


Source: IGCC Regular Report on Social Welfare, Q3 2020.

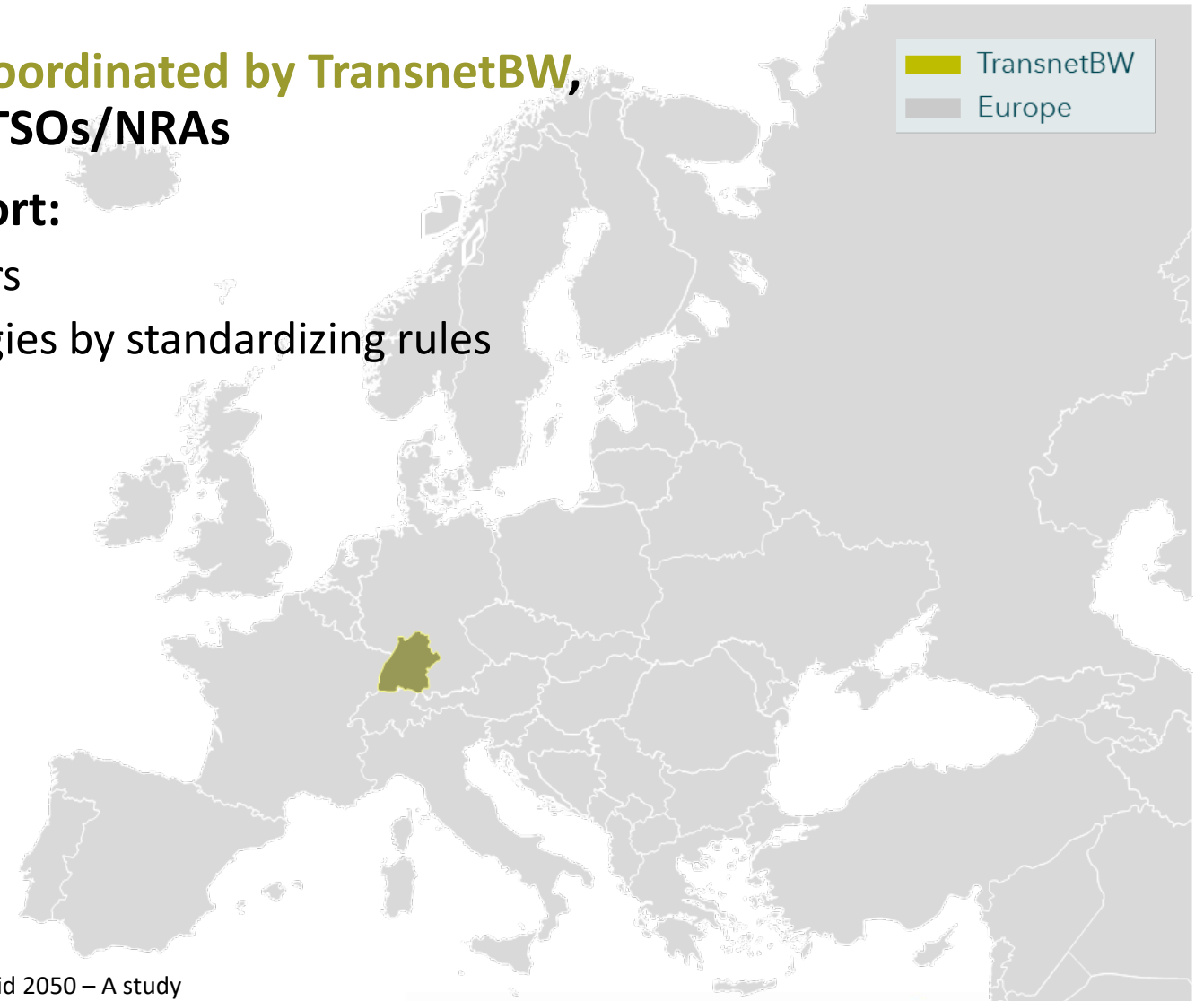
Example of excellent European Cooperation
Only winners: the more TSOs joining, the higher the social welfare

TransnetBW Role

- IGCC and PICASSO Platforms are **hosted/coordinated by TransnetBW**, under the governance of all participating TSOs/NRAs
- **“Energiewende” (Energy Transition) Support:**
 - More efficient adjustment of forecast errors
 - Market entry facilitation for new technologies by standardizing rules



Source: Electricity Grid 2050 – A study by TransnetBW GmbH (2020).



THANK YOU!

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Central American regional market: Operational experiences of high integration of renewable energy resources in Costa Rica

Juan Carlos Montero Quirós, ICE Costa Rica

Costa Rica



- Capital: San José
- Area: 51100 km²
- Population: 5 million

Language: Spanish
No oil resources
Access to electricity: 99.4%



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99.78 % Renewable Energy 2020



Count on fully
renewables days
337 on 2020



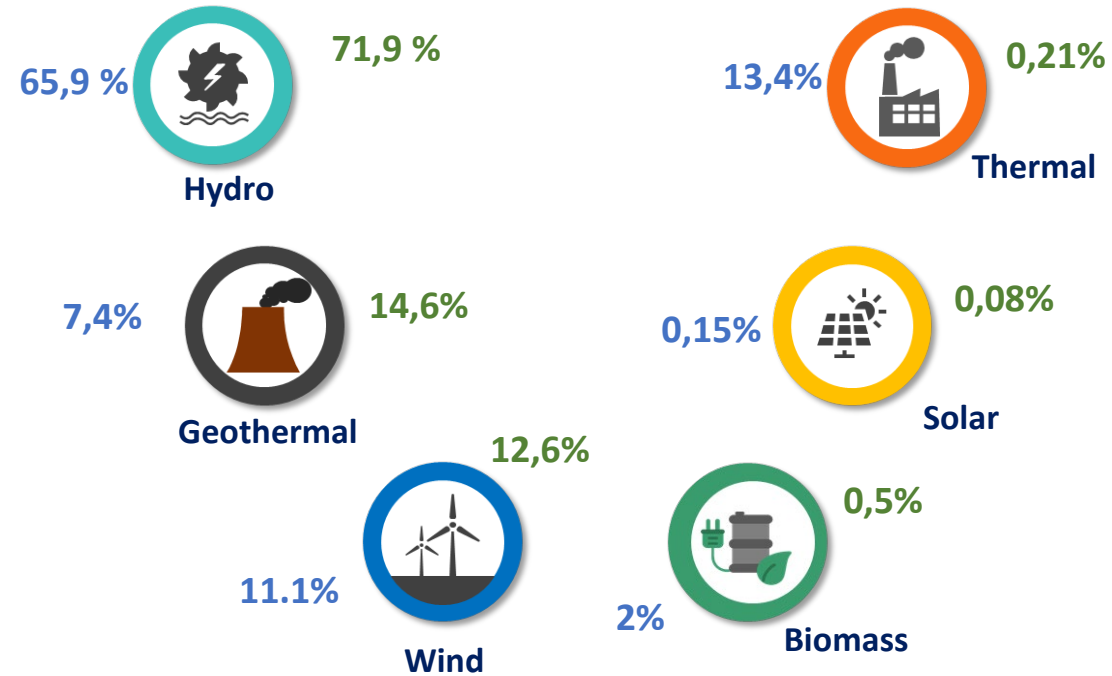
99,0% on 2019
98,6% on 2018
99,7% on 2017
98,1% on 2016



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Installed Capacity: 3,537 GW

2020 Annual Production

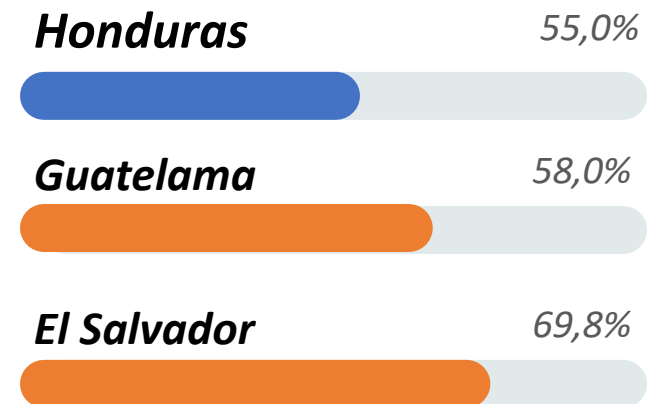
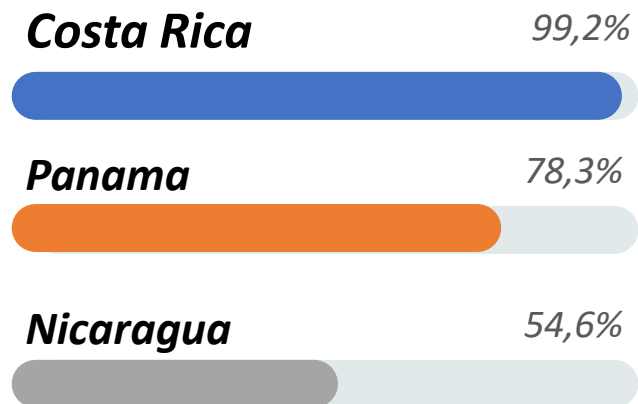


Max. Peak Demand: 1,717 GW

2019 Annual Demand 11 TWh

Renewable Energy in Central America

Renewable Energy in Central America 2019 Annual Energy Generation



Source: Comisión Económica para América Latina y el Caribe (CEPAL), 2019



PP. Arenal
(Pluriannual)



PP. Cachí



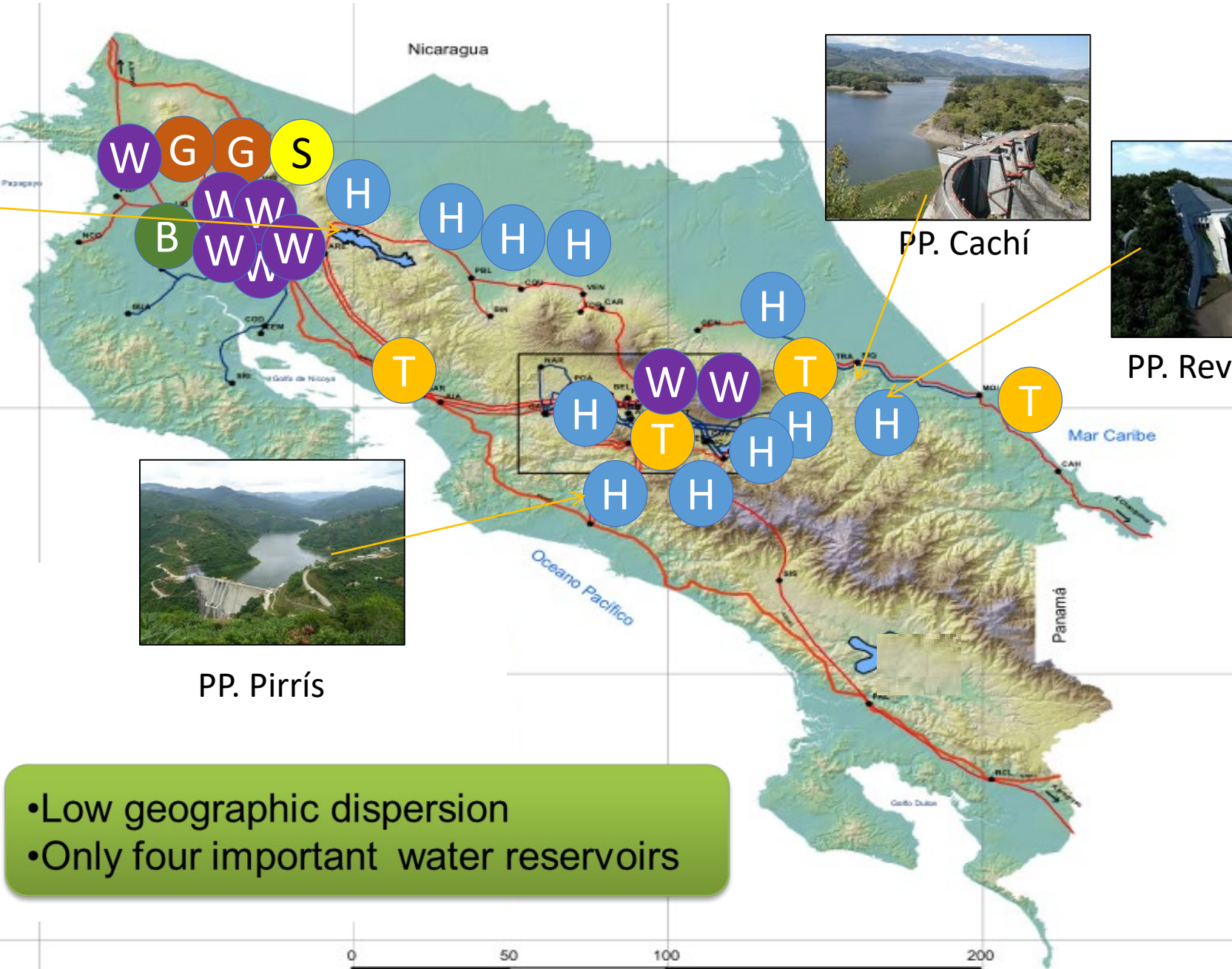
PP. Reventazón



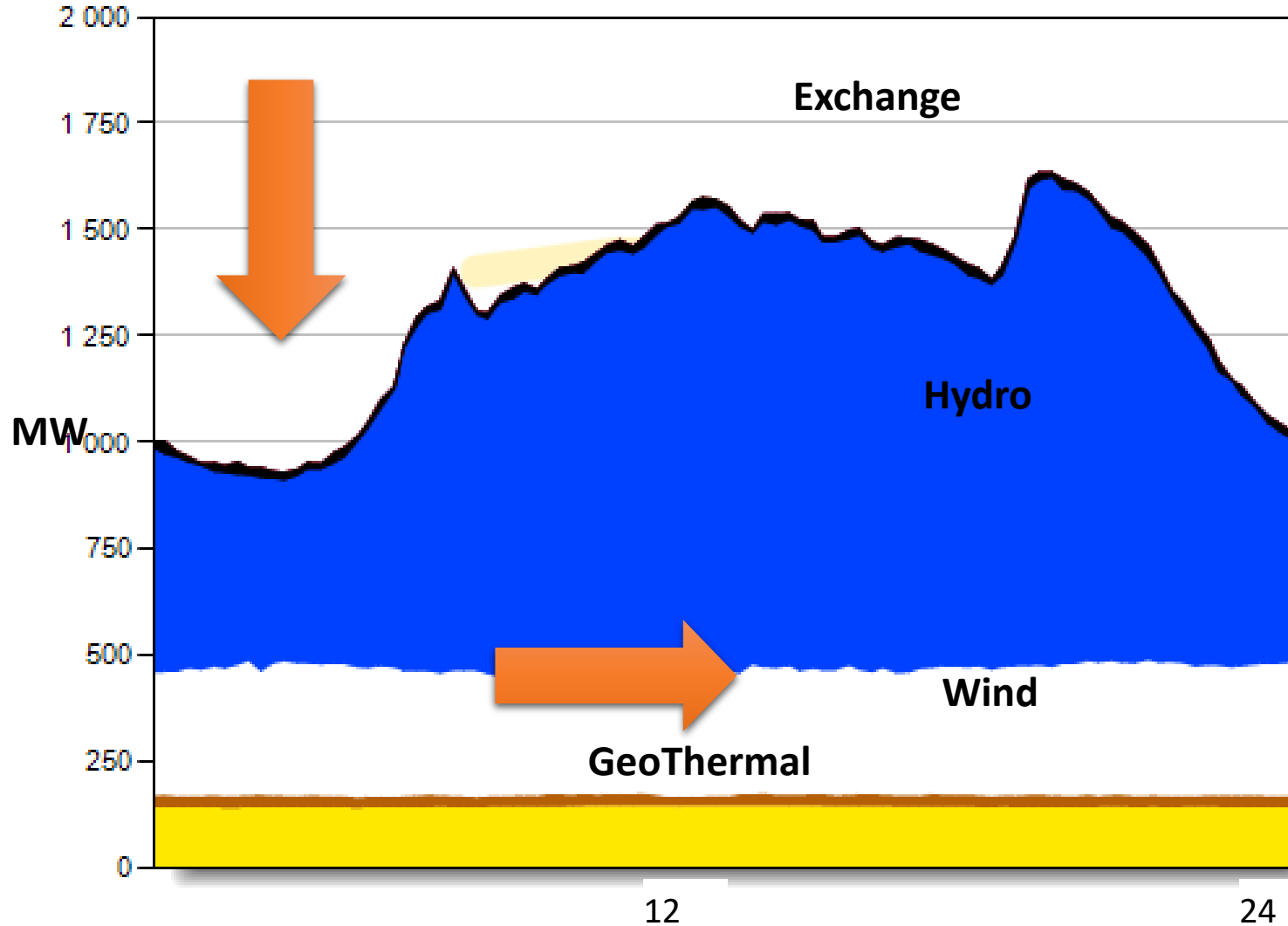
PP. Pirrís

- H Hydroelectric
- W Wind
- S Solar
- T Fuel Oil/Diesel
- B Biomass
- G Geothermal

•Low geographic dispersion
•Only four important water reservoirs

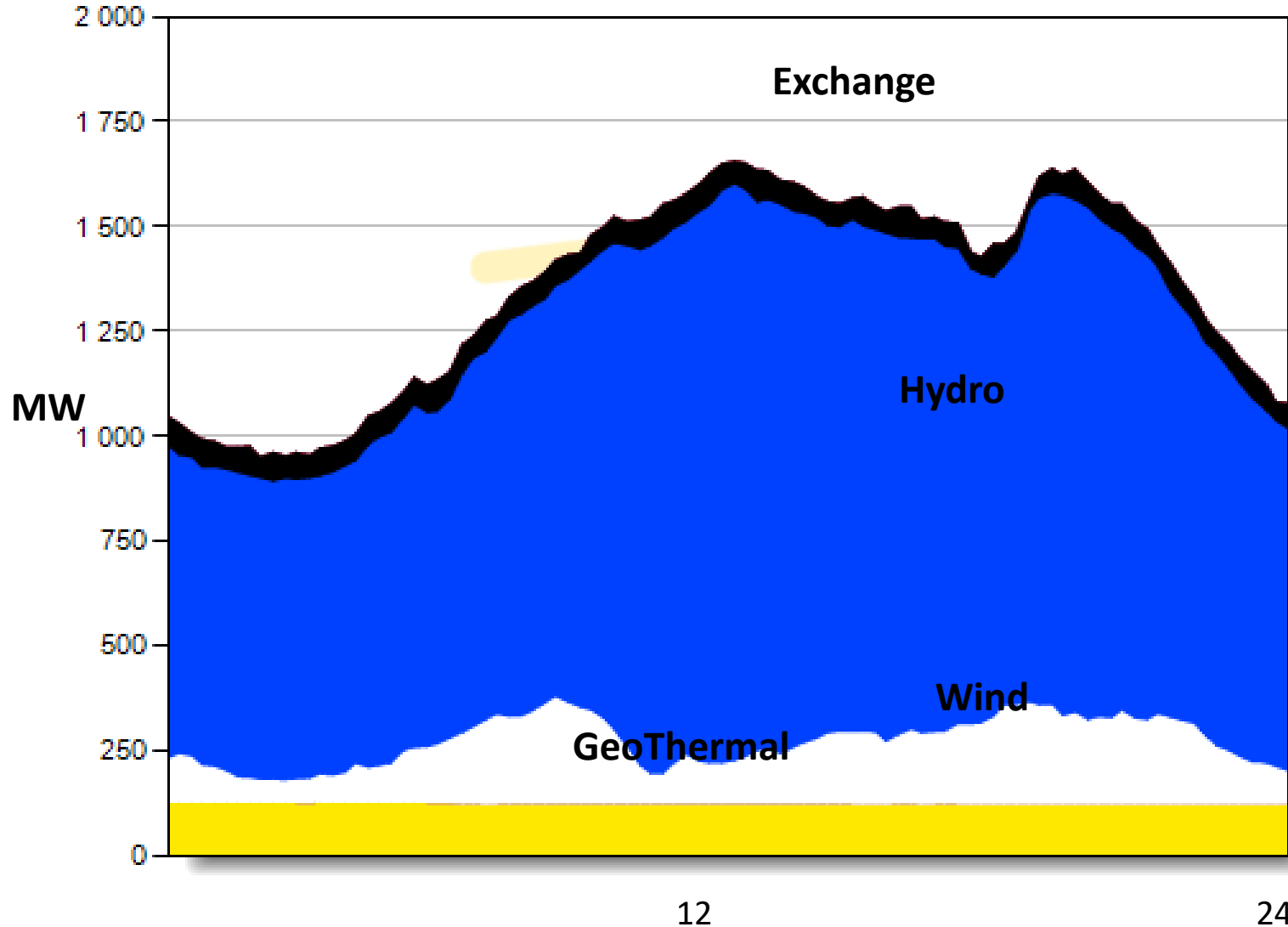


Dry Season (Typical Day)



- Wind production increases due to trade winds, complementing the decreased production of run-of-river hydroelectrical plants.
- Operation reserves issues on low demand
- Geothermal 24/7 firm energy

Rainy Season (Typical Day)



- Decrease in winds
- Energy excedents even all the day

2018 Installed Capacity – Central America

México:
400 kV AC Tie line



Future:
Colombia
HVDC



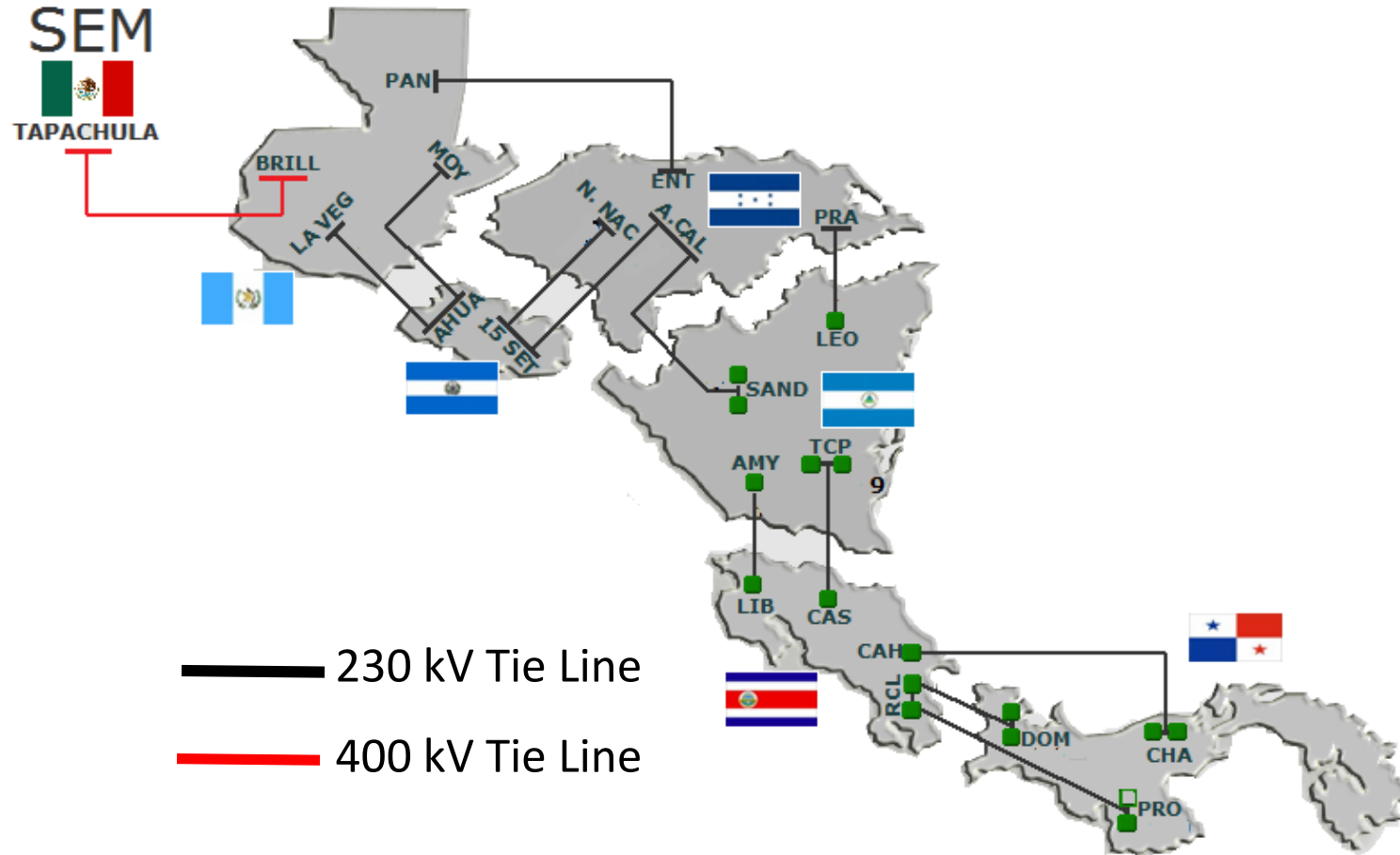
One Grid

One frequency



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Regional Electricity Market



- Longitudinal System
- 6 Balancing Areas and internal Markets
- Regional Day Ahead Market
- Regional System Operator (EOR) defines maximum transfer capacities between countries and check reliability in the part of the network



<https://www.enteoperador.org/>





DERs are increasing on all the countries.



Emerging technologies requires a review of our structure and operational practices



Regional Market provides support to Integrate Renewable Energy Sources



Regional Market promoting improvements on market rules





Pura Vida!! Thank you

National Energy Control Center – CENCE
<https://apps.grupoice.com/CenceWeb>

Costa Rican Institute of Electricity – ICE
www.grupoice.com



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Panel discussion with Q & A
15 min



Panellists



Arina Anisie
IRENA



Dominik Schlipf
TransnetBW (Germany)



Juan Carlos Montero
ICE (Costa Rica)



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Panel discussion with Q & A
15 min



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NEXT WEBINARS

Tuesday, 23 February 2021, 12:00 – 12:30 CET

"Skill Building for the Energy Transition"

Tuesday, 09 March 2021, 10:00 – 10:30 CET

"Hydrogen series – Part 1: Green hydrogen: A guide to policy making"

Tuesday, 23 March 2021, 10:00 – 10:30 CET

"Hydrogen series – Part 2: Green Hydrogen Cost Reduction: Scaling up Electrolysers to Meet the 1.5°C Climate Goal"

Link to register: <https://www.irena.org/events/2020/Jun/IRENA-Insights>



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www.irena.org/events