Differences in balancing markets between France and Germany

Market design et transition énergétique – vers la multiplication des marchés?
June 19th 2019
Agenda

1. Who we are: PwC
2. Balancing at a glance
3. Innovation and Balancing
Who are we PwC
PwC’s international network & expertise

An international network guaranteeing you will have local support in every country where you do business...

Build trust in society and solve important problems are the primary reason for a committed firm such as PwC.

158 countries
736 offices
236,200 people

People
Americas 71,000

Western Europe 72,200
Central and Eastern Europe 10,500
Middle East and Africa 14,000
Asia 60,200
Australasia and Pacific Islands 8,300

...and across all of our lines of service

- Audit and certification of financial statements
- Strategy and consulting advisory services
- Transaction advisory services
- Tax and legal advisory services
- Chartered accountancy

Differences in balancing markets between France and Germany
PwC
June 19th 2019
Our Global Energy, Utilities & Resources industry network

What makes us different …

• Our dedicated energy team is working from strategy to execution, living and breathing the sector, understanding your issues and responding to your priorities.
• Global business serving marquee clients and generating $3.5bn in revenue in FY18
• Very close relationship with our industry networks (World Energy Council, World Economic Forum)
• 19,220 PwC Professionals are working across our four EU&R sectors
• Centers of competencies for each sector covering interdisciplinary expertise: public accountants, tax accountants, lawyers, engineers
• Extensive thought leadership and client roundtables program
• Invest and lead in technology-enabled innovation in serving our clients with the help of our global alliances with SAP, Workday, Salesforce, Microsoft, Oracle, Guidewire, HPE, Google and GE Digital
• Unique learning & education program for our network through annual Global EU&R Conference 2019
2 Balancing at a glance
Introduction to balancing

Since electricity is not storable in a large-scale today, the electricity grid, i.e. feed-in and feed-out, must be balanced at all times. TSOs manage the Balancing process to ensure that generation equals consumption considering the European Grid Frequency at 50Hz.

In case of an imbalance, flexibility in production and consumption is required to manage imbalances.

Flexibility providers
- **Generation side**: Power plants considering their technical capabilities
- **Demand side**: E.g. industries, end-users through aggregators (responsible of balancing)

Valuable products of flexibility
- **Capacity**: Remuneration (€/MW) for an activable power capacity during a period
- **Energy**: Remuneration (€/MWh) after an effective power capacity during a period

Differences in balancing markets between France and Germany
The ongoing transformation of the European energy system calls for the integration of the balancing markets.

The transformation of the European energy market asks for harmonised real time market for balancing products!

- Integration of more renewables
- Development of flexibility
- Management of system security

**Integration of balancing energy markets** in Europe until 2025 at least:

- Effective competition
- Non-discrimination
- Transparency
- European Integration
- Security of supply

Differences in balancing markets between France and Germany

June 19th 2019
Overview of European harmonised or being harmonised balancing mechanisms

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Call</th>
<th>EU platform Project</th>
<th>Deadline</th>
<th>Countries</th>
</tr>
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<tbody>
<tr>
<td>Frequency Containment Reserve (FCR)</td>
<td>&lt; 30s</td>
<td>Regelleistung.net</td>
<td>Operational</td>
<td></td>
</tr>
<tr>
<td>Automatic Frequency Restoration Reserves (aFRR)</td>
<td>30s to 15min</td>
<td>PICASSO</td>
<td>2021</td>
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<tr>
<td>Manual Frequency Restoration Reserves (mFRR)</td>
<td>Max. 15min</td>
<td>MARI</td>
<td>2021</td>
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<tr>
<td>Replacement Reserves (RR)</td>
<td>Min. 15min</td>
<td>TERRE</td>
<td>2019</td>
<td></td>
</tr>
<tr>
<td>Inbalance Netting (IN)</td>
<td></td>
<td>IGCC</td>
<td>2019</td>
<td></td>
</tr>
</tbody>
</table>

Other National mechanisms contributing to flexibility:
- Interruptibility (Consumers)
- Capacity Mechanisms (Producers)
- NEBEF – Demand Response (Consumers)
- Capacity Reserve (Producers)
- Quick and additional reserves
## French and German balancing products differ at some points due to ENTSO-E study

### Differences in balancing markets between France and Germany

**Source:** ENTSO-E survey 2018; published in March 2019  
*Storage, e.g. BEV batteries, small and large-scale batteries  
*June 19th 2019

**Procurement scheme**
- **Capacity**
  - Market only
  - Mandatory only
- **Energy**
  - Market only
  - Mandatory only

**Activation rule for energy**
- **FCR (Primary Reserve)**
  - Merit Order
  - Pro Rata (Parallel Activation)
- **aFRR (Secondary Reserve)**
  - Merit Order
  - Merit Order
- **mFRR (Tertiary Reserve)**
  - Merit Order
  - Merit Order

**Activation time**
- **FCR (Primary Reserve)**
  - x < 30s
  - 90s < x ≤ 5min
  - 5min < x ≤ 15min
- **aFRR (Secondary Reserve)**
  - 5min < x ≤ 10 MW
- **mFRR (Tertiary Reserve)**
  - 5min < x ≤ 10 MW

**Product Resolution in MW**
- **Capacity**
  - x ≥ 1 MW
  - 1 MW < x ≤ 5 MW
  - 5 MW < x ≤ 10 MW
- **Energy**
  - x ≤ 1 MW
  - 1 MW ≤ x ≤ 5 MW
  - 5 MW ≤ x ≤ 10 MW

**Product resolution in time**
- **Capacity**
  - Week(s)
  - Day(s)
  - Week(s)
- **Energy**
  - Hour or blocks
  - 30 minutes
  - Hour or blocks

**Distance to real time of reserve products auctions**
- **Capacity**
  - x ≤ 1 minute
  - 15 minutes < x ≤ 15 minutes
  - 15 minutes < x ≤ 15 minutes
- **Energy**
  - Day(s)
  - Year or more

**Distance to real time of reserve products auctions**
- **Capacity**
  - Week(s)
  - Day(s)
  - Day(s)
- **Energy**
  - Hour or blocks
  - 30 minutes
  - 30 minutes

**Providers**
- **FCR (Primary Reserve)**
  - Generators, Load, Pump, storages*, Batteries
  - Generators, Load, Pump, storages*, Batteries
  - Generators, Load, Pump, storages*, Batteries
- **aFRR (Secondary Reserve)**
  - Generators, Load, Pump, storages*, Batteries
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  - Generators, Load, Pump, storages*, Batteries
- **mFRR (Tertiary Reserve)**
  - Generators, Load, Pump, storages*, Batteries
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**Need for symmetrical product**
- **Capacity**
  - Yes
  - No
  - No
- **Energy**
  - No
  - No
  - No

**Settlement rule**
- **Capacity**
  - Pay as bid
  - Pay as bid
  - Regulated price
- **Energy**
  - Pay as bid
  - Pay as bid
  - Marginal price

**Cost recovery scheme**
- **Capacity**
  - 100% Grid Users (tariffs)
  - 100% Grid Users (tariffs)
  - 100% Grid Users (tariffs)
  - 100% Grid Users (tariffs)
- **Energy**
  - 100% BRP
  - 100% BRP
  - 100% BRP
  - 100% BRP

**Free bids allowed**
- **FCR (Primary Reserve)**
  - No
  - Yes
  - No
- **aFRR (Secondary Reserve)**
  - No
  - Yes
  - No
- **mFRR (Tertiary Reserve)**
  - No
  - Yes
  - No

**Activations possible for other purposes than balancing?**
- **Energy**
  - No
  - Yes
  - No

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### Table

<table>
<thead>
<tr>
<th></th>
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<td>mFRR</td>
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<td>No minimum bid size</td>
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<td><strong>Need for symmetrical product</strong></td>
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<tr>
<td>Capacity</td>
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<td>No</td>
<td>No</td>
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<td>Regulated price</td>
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<tr>
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<tr>
<td><strong>Activations possible for other purposes than balancing?</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>-</td>
<td>-</td>
<td>No</td>
</tr>
</tbody>
</table>

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3 Innovation and Balancing
Increasing decentralized generation by RES and conventional phase out lead to need for new flexible and other new technologies for providing balancing power

**Trends in energy markets**
- **"Old world" – until approx. 2025**
  - Mainly centralised conventional power plants, growing RES
- **"New world" – starting in approx. 2025**
  - Mainly decentralised electricity generation by RES
  - Mainly centralised in France

**Balancing power provided by**
- **Energy Production 2017**
  - Mainly centralised base load power plants e.g. coal and nuclear power plants and a few biomass power plants
- **Components of TSO costs of the Unit Transmission Tariffs 2017**
- **RES generation targets**
  - Mainly flexible and small, pooled, decentralised power plants e.g. few coal, mainly gas and biomass power plants and new technologies like storages, batteries, electric vehicles
  - Basically centralised base load power plants

**Balancing markets**
- Mainly national, in part European
- European and on local scale (DSOs)
The energy system on both sides – producer and consumer – will change

<table>
<thead>
<tr>
<th></th>
<th>Past</th>
<th>Present and future</th>
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</thead>
<tbody>
<tr>
<td><strong>Power generation landscape</strong></td>
<td>Few centralized power plants</td>
<td>High and further increasing number of decentralized power plants</td>
</tr>
<tr>
<td><strong>Consumer behaviour</strong></td>
<td>Passive consumption</td>
<td>Active prosumer</td>
</tr>
<tr>
<td><strong>Power flow</strong></td>
<td>Top-down</td>
<td>Top-down and bottom-up</td>
</tr>
<tr>
<td></td>
<td>One-directional</td>
<td>Bi-directional</td>
</tr>
<tr>
<td><strong>Network landscape</strong></td>
<td>Few network points</td>
<td>High number of localized network stations</td>
</tr>
<tr>
<td><strong>Network system Operation</strong></td>
<td>Predictable, demand based</td>
<td>Volatile (weather dependent)</td>
</tr>
</tbody>
</table>

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Regulations drive the electrification of drivetrains – globally. Admissions of electric vehicles will ramp up in all sectors in the coming years.
The growing number of BEVs show a high potential for providing flexibility. First pilot projects have been launched.

### Current pilot project idea

<table>
<thead>
<tr>
<th>Who?</th>
<th>The Mobility House</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ENERVIE</td>
</tr>
<tr>
<td></td>
<td>Amprion</td>
</tr>
<tr>
<td></td>
<td>Nissan</td>
</tr>
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<table>
<thead>
<tr>
<th>Where?</th>
<th>Hagen, Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>When?</td>
<td>Since October 2018</td>
</tr>
<tr>
<td>What?</td>
<td>FCR supply</td>
</tr>
</tbody>
</table>

### Assumptions by PwC

<table>
<thead>
<tr>
<th>CAPEX</th>
<th>OPEX</th>
<th>Revenue FCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICE (Nissan QASHQAI) Euro 30.170</td>
<td>Maintenance ICE/BEV Euro/a 500/350</td>
<td>Average price FCR (June 2019) Euro/MW/week 1.300</td>
</tr>
<tr>
<td>BEV (Nissan LEAF) Euro 36.800</td>
<td>Insurance ICE/BEV Euro/a 400/350</td>
<td>FCR capacity of BEV kW 10</td>
</tr>
<tr>
<td>Charge point without/with FCR Euro 1.000/3.000</td>
<td>Distance per year (60km/d, 260 d/a) km 15.600</td>
<td>FCR remuneration BEV Euro/a 676</td>
</tr>
<tr>
<td>Charge point installation Euro 450</td>
<td>Consumption ICE l/100km 5,7</td>
<td>Availability for supplying FCR % 75</td>
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<tr>
<td>Duration of life a 6</td>
<td>Consumption BEV kWh/100km 19,55</td>
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<tr>
<td>Interest rate % 6</td>
<td>Gasoil price €/l 1,46</td>
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<tr>
<td>Electricity price €/kWh 0,28</td>
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</table>

### Annualised costs (yearly) without consideration of any subsidies

<table>
<thead>
<tr>
<th>Annual Revenue</th>
<th>ICE BEV without FCR</th>
<th>BEV with FCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euro</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Annual Costs</td>
<td>8.434</td>
<td>9.333</td>
</tr>
<tr>
<td>Vehicle (incl. Battery for BEV)* Euro 6.135 7.484 7.484</td>
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<td></td>
</tr>
<tr>
<td>Charging Point* Euro 0 203 610</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charging Point Installation* Euro 0 92 92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumption Euro 1.298 854 854</td>
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<tr>
<td>Maintenance Euro 500 350 350</td>
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<tr>
<td>Insurance Euro 400 350 350</td>
<td></td>
<td></td>
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<tr>
<td>Tax Euro 100 0 0</td>
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</tr>
</tbody>
</table>

- Today's high price difference between BEVs and ICES consume the potential FCR revenues.
- Yet, decreasing purchase costs for BEVs in the future will improve the FCR business case.
Enera demonstrates the change of a static, centralised energy system to a dynamic, decentralised one by combining digitalization and flexibility options on a local scale (1/2)

Current pilot project idea

Who?
- EWE AG
- 32 consortium partners
- > 75 Partners

Where?
- Lower Saxony: Emden, Aurich, Friesland, Wittmund
- 20 kV, medium-voltage
- 2,655 km²
- Population of ± 390,000
- ± 200,000 households
- 2 GW of RES generation capacity
- 1,5 GW Wind capacity
- Production/consumption coefficient: 230%

When?
- 01.01.2017 to 31.12.2020

What?
- Local smart energy system
- Project value: 155 mio. €
- SINTEG funding: 51 mio. €

The aim of Enera is to optimize the interaction of grid, market and data

| Smart Grid | Business Model Development |
| Smart Metering | Training & Certification |
| Smart Market | Smart Grid Components |
| Smart Data | Smart Grid Operation Concept |
| Flexibility Utilisation |

Source: enera

Differences in balancing markets between France and Germany

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Enera demonstrates the change of a static, centralised energy system to a dynamic, decentralised one by combining digitalization and flexibility options on a local scale (2/2)

ENERA - An innovative solution of market-based congestion management by striving to enable:

- **Decentralisation**
  - Shifting the network focus from transmission to distribution level.

- **Demand side management / flexibility market**
  - Creating an ecosystem of active participation of consumers in balancing the network based on "smart grid" infrastructure.

- **Transparency and data security**
  - Smart meter and mobile app enable users to monitor and optimized their consumption behaviour through secure data acquisition, processing and visualization.

Differences in balancing markets between France and Germany

Source: enera, EWE

June 19th 2019
Any questions?

Thank you for your attention.

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June 19th 2019
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