Prioritizing Corporate Investments in R&D to build the RWE R&D Portfolio

IEA Committee on Energy Research and Development, Experts Group on R&D Priority Setting and Evaluation

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Alexander Wilmes, RWE AG
Agenda

1. **RWE**: Large integrated european utility, ranking third in the 2012 ESMT Innovation Index

2. **RWE R&D Portfolio Context**: The definition of a portfolio requires strategic/management guidelines and suitable processes

3. **RWE R&D Portfolio Development**: Some insight into...
   - **R&D Strategy**: Serves as an enabler of the Group wide strategy
   - **Roadmapping**: A process to derive RWE relevant R&D programmes
   - **R&D-Programmes**: The bridge between long term strategic orientation and mid term R&D targets and budget needs
   - **Selection of project ideas**: Projects must contribute to R&D value drivers
   - **RWE R&D Portfolio**: About 200 projects along the entire value chain
RWE is one of the major integrated utilities in Europe with business along the entire energy value chain.

**Key Facts RWE 2013**

- Revenues: € 54 billion
- EBITDA: € 8.7 billion
- Electricity Sales: 271 billion kWh
- Gas Sales: 335 billion kWh
- Workforce: 66,300
RWE currently ranked third among Europe’s 16 largest energy utilities in the ESMT Innovation Index

Innovative R&D has been a tradition at RWE that we want to continue.

R&D along the entire value chain, many projects help to make the energy transformation in Germany a success.

Further focus on reduction of CO$_2$ emissions.

R&D portfolio with more than 200 projects; around 30 - 50 patents per a year.

Most R&D projects are developed close to operations in co-operation with suppliers and research institutions.

Ranked third among Europe’s 16 largest energy utilities in the Innovation Index of the European School of Management and Technology (ESMT Berlin, 2014).
The definition of the “right” corporate R&D portfolio requires strategic/management guidelines and suitable processes.
R&D serves as an enabler of the group-wide strategy

<table>
<thead>
<tr>
<th>RWE Future Picture</th>
<th>Focus on R&amp;D relevant topics</th>
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<tbody>
<tr>
<td>“We will be the most trusted and high-performing partner for the sustainable transformation of the European energy system”</td>
<td><strong>Most trusted</strong></td>
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<td></td>
<td>&gt; Deliver innovative, value-adding energy and infrastructure products &amp; services to our customers in Europe</td>
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<td>&gt; Perceived by stakeholders as a positive &amp; reliable contribution for the transformation of the European energy system</td>
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<td><strong>High-performing</strong></td>
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<td>&gt; Have operational excellence in the top quartile compared to other utilities</td>
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<td>&gt; Bear that “cost efficiency” is particularly essential for the fossil generation business and parts of the retail business</td>
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RWE R&D focuses on three main development targets

<table>
<thead>
<tr>
<th>R&amp;D focus on:</th>
<th>Optimise existing products and processes</th>
<th>Make new technologies economically available</th>
<th>Keep technology options open</th>
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<tbody>
<tr>
<td>Horizon 1</td>
<td>(up to 5 years)</td>
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<tr>
<td>Horizon 2</td>
<td>(up to 10 years)</td>
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<tr>
<td>Horizon 3</td>
<td>(up to long-term)</td>
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### Commercial benefit to be expected in:

#### Horizon 1 (up to 5 years)
- Automation of lignite equipment, use of RFID
- Improvement of corrosions protections

#### Horizon 2 (up to 10 years)
- (Field-) Testing in “Ampacity”
- Development of wind offshore foundations

#### Horizon 3 (up to long-term)
- Technology monitoring and assessment, e.g. geothermal, marine energy, CCU
- Long-term studies e.g.: “Desertec”, “2030+ study for Germany”

### Examples:

#### Assets
- Automation of lignite equipment, use of RFID
- Improvement of corrosions protections

#### End-products
- Further development of Smart Home
- Adaption of charging poles (e-mobility)
- Development and testing of “Power to Heat” or “Intelligent PV”
Government targets strongly influence the R&D strategy, e.g. the "Energiewende" in Germany

Energy Concept of the German Federal Government (long term targets)

- Conventional Power Plants: 25%
- Renewable Energy: 58%
- Nuclear: 25%
- Import: 20%
- Efficiency: ~80%
- Local, National and European Level
- Technical, Economical and Regulatory Analyses
Government targets strongly influence the R&D strategy, e.g. the "Energiewende" in Germany

Energy Concept of the German Federal Government

- Decrease specific energy consumption and at the same time
- increased use of electricity, e.g. for e-mobility, heat pumps, etc.

2010  2020  2030  2040  2050

- European Grid
- HVDC
- Desertec

- Further Technological Development
- Cost Reduction
- Integration (Grid Expansion, Flexible Plants, Storage, Demand Side Management)

- Flexibility
- Lower CO₂ Emissions (Efficiency, CCS/CCU)

- Dismantling

Overarching System Analysis
- Local, National and European Level
- Technical, Economical and Regulatory Analyses

Source: EWI/Prognos/GWS Studie
A three step approach was carried out to deliver the mid-term R&D programme portfolio.

<table>
<thead>
<tr>
<th>Energy world 2050</th>
<th>Technology-Roadmaps</th>
<th>RWE R&amp;D Programmes</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; Description of SYSTEM PERSPECTIVE of the ENERGY SUPPLY in 2050</td>
<td>&gt; Prioritisation of KEY TECHNOLOGIES</td>
<td>&gt; Focus on RWE specific R&amp;D AREAS</td>
</tr>
<tr>
<td>&gt; Identification of REQUIREMENTS of the energy system</td>
<td>&gt; Identification of DRIVERS of key technologies</td>
<td>&gt; PRIORITISATION on internal R&amp;D demand</td>
</tr>
<tr>
<td>&gt; Derivation of future, system relevant TECHNOLOGIES (resp. technology fields)</td>
<td>&gt; Projection of likely PATHS OF DEVELOPMENTS (Roadmaps)</td>
<td>&gt; Sharpening of R&amp;D STRATEGY</td>
</tr>
<tr>
<td>&gt; Identification of general R&amp;D FOCUS AREAS</td>
<td></td>
<td>&gt; Description of mid-term R&amp;D TARGETS and concrete RWE R&amp;D PROGRAMMES</td>
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**Step 1**
- Time horizon: Up to 2050

**Step 2**
- Time horizon: Up to 2030

**Step 3**
- Time horizon: Up to mid-term
Technology roadmaps have been jointly developed with a highly accepted consortium of scientific institutes.

**RWE R&D technology roadmapping**

**External expertise**

- Jülich Forschungszentrum
- Fraunhofer ISE
- Fraunhofer IWES
- Deutsches Zentrum für Luft- und Raumfahrt e.V.
- DLR in der Helmholtz-Gemeinschaft

**Internal assessment**

Judgment of experts within each focus area of various Operational Companies on:
- Conventional Generation and Mining
- Renewables
- Grid
- Retail & Prosumer Business
- Storage

**Consolidated results**

Key results:
- General technologies and R&D demands identified and described
- RWE-relevant technologies and R&D demands identified
- Future activities and R&D approach assessed
- Key technologies described (long version)
- Technology roadmaps derived (condensed version)
- Technologies clustered content-wise to R&D focus areas
R&D Programmes build the bridge between long term strategic orientation and mid term R&D targets framework

<table>
<thead>
<tr>
<th>R&amp;D Programme</th>
<th>abc</th>
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<tbody>
<tr>
<td>Description</td>
<td>&gt; ....</td>
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<tr>
<td>Targets</td>
<td>&gt; Target 1: Optimize … until</td>
</tr>
<tr>
<td></td>
<td>&gt; Target 2: Reduce … by x% until …</td>
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<tr>
<td></td>
<td>&gt; Target 3: …</td>
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</table>

**Programme budget**

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<tr>
<th>Average yearly budget (MTP time horizon) in € million p.a. :</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; Horizon 1 (Operational improvements):</td>
<td>X € million</td>
</tr>
<tr>
<td>&gt; Horizon 2 (Development of new technologies):</td>
<td>Y € million</td>
</tr>
<tr>
<td>&gt; Horizon 3 (Studies &amp; monitoring):</td>
<td>Z € million</td>
</tr>
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As measurable as possible (and suitable)

Link to strategic horizons
A systematic process is a prerequisite to successfully turn ideas into valuable “innovations”

Main Steps/Gates

- Idea/Project Selection (Budget Allocation)
- Project Confirmation/Update/Stop (Budget Allocation)
- Go/NoGo Launch (Budget Allocation)
- Technology Development/BM-/Product-Development
- Pilot/Fieldtest/(Demo)
- Commercialization/Implementation/Rollout
- Follow-up
- Lesson-learned

Relevance of commercial Business Case

- Indicative „1-pager“
- „40-pager“
All corporate R&D projects must contribute substantially to our R&D value drivers measured through three „KPIs“

Generation of value over time in 3 dimensions

- **Know-how**
  - Qualitative

- **Reputation (ext. Communication)**
  - Qualitative

- **Monetary Value**
  - Quantitative

**Idea generation** → **R&D project** → **Implementation** → **Application**
Prioritization/ranking of projects is a management issue, taking content, KPIs and budget restrictions into account.
The current RWE R&D portfolio covers about 200 projects along the entire value chain.

**Upstream**
- Gas/oil
  - Reservoir characterisation
  - Sedimentation and maturity history
  - Gas hydrates
- Mining
  - Automation
  - Diagnosis of large scale equipment
  - Groundwater modelling

**Power generation**
- Coal-/Gas-based
  - Plant flexibility
  - CCS/CCU
  - Lignite drying
  - Coal quality
- Renewable
  - Wind offshore
  - Wind onshore
  - Biomass/biogas
  - Marine energy

**Transport/Storage**
- Electricity Grids
  - Smart grids
  - HVDC
  - Super conductivity
- Electricity Storage
  - Compressed-air energy storage
  - Heat storage
  - Batteries

**Residential Households**
- Gas Grids/Reservoirs
  - Pipeline integrity monitoring
- Nuclear
  - Safety
  - Maintenance of know-how

**Application/Efficiency**
- Transport
  - E-mobility
  - Comparison H₂ vs. electric drive
- Industry/Commerce
  - Distributed electricity and heat supplies
  - Gas sensors

**Comprehensive technology and system analysis**
Thank you very much for your attention!

If you want to know more: www.RWE.com > Innovation