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The Evolution of Distribution Networks towards Decentralised (Renewable) Energy System

Distribution System Operators and PV-Prosumers

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Distribution networks – where we come from

- Top down power flows
- Networks built along established methodology of coincidence (peak) demand
- Monitoring of utilisation and smart operation are rare, usually only at high voltage level
- Most system services e.g. ancillary, balancing provided at transmission level
Distribution networks future perspective

- Increasing number / amount of feed-in on lower voltage level
- Bidirectional power flows
- Electrification of heat and transport
- Active and flexible consumers, incl. batteries
- Increasing data
- Decentralised trade / local markets

We expect from distribution network operators

• Connecting resources asap
• Fair connection conditions, punctual remuneration of feed-in
• Priority dispatch of small-scale RES
• Transparency on costs, cost allocation, network utilisation, congestions and investments,…

⇒ Most of all, we want a reliable and securely operated system at least-cost
Active consumers: From pro-sumers to energy communities

- Can’t wait to do it themselves (better)
- Don’t fit into current distribution networks
  - Standard contracts
  - Metering/measuring and billing approach
  - Balancing approach (standard load profiles)
  - Cost allocation and cost recovery
  - Thinking (?)
Prosumer vs. standard load profile

- **Prosumer**
  - 3 kW
  - Self-consumption

- **Standard load profile (SLP)**
  - Without self-consumption
  - With self-consumption

- **PV-generation**

- **New imbalances**
Toolbox for distribution networks

- Load/peak forecasts
- Copper-investments within life-time cycles
- Considering regulated CAPEX bias
- Cost allocation among given consumer classes

⇒ An outdated toolbox isn’t solving future needs
A road to nowhere?
“Tell us what you want us to do. Give us flexibility in how we do it. Give us the opportunity to recover the money we need to do it. And tell us how we’ll be measured, when we’ll be measured and then hold us accountable for the results.”

Joseph Viola
HECO’s VP for regulatory affairs

Source: https://www.hawaiibusiness.com/new-way-for-electricity/
Stick and carrot for distribution networks

- Obligations for obvious things
- Penalties, if delay is self-inflicted
- Re-adjusted profit opportunities for networks via performance-based regulation (PBR)
  - Standards required for cooperation (TSO-DSO) and system services
  - Defining short and long-term performance goals, incl. non-wire alternatives
Principles for electricity price incentives to activate customers

- Fair payment for provided local system services
- Fair share of investments and operational costs, as imbalances along (new) customer classes
- Network cost allocation based on utilization e.g. off-peak price reduction and peak pricing
1. “Dumb” use increases peaks & costs

Source: own compilation based on Westnetz, peak day 2017; red/green curves illustrative
Network pricing based on congestion provides incentives to all customers

Source: Denmark (Radius), TOU network tariff for households (winter season)
... as it reduces peak demand
2. Balancing challenges of active consumers in the run-up

• Imbalances from standard load profile (SLP) are socialised
  ⇒ All customers benefit from reduced costs

• When opportunities via self-consumption are privatised, this also applies to risks and costs
  ⇒ Self-consumption imbalances should be allocated among these customers, e.g. via extra SLP, aggregators / balancing responsible parties
German regulator suggests: Differentiation by use-case

- Full use of flexibility: forecast & balancing risks and chances for active customers, as for all non-SLP-customers
- Buy-all sell-all, for “keep-it-easy” customers
- Net billing & tracking for easy use of own supply
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3. Renumeration of feed-in

- Market value differs by time and predictability
- Value can be defined along a broad range

Renumeration should reflect all values, incl. provided services

Source: RAP, based on Rocky Mountain Institute 2015
Value of DER compared to NEM

Source: Institute for Policy Integrity 2019
Prosumerism is a chance for all customers

- Use the momentum of customers engagement
  - a great value, difficult to value in monetary terms
- Push and pull for network operators to speed up
- System structure (incentives, cost allocation) must
  - Consider long-term system costs
  - Avoid cost-shift to other customers
  - Maximise benefit for all customers
About RAP

The Regulatory Assistance Project (RAP)® is an independent, non-partisan, non-governmental organization dedicated to accelerating the transition to a clean, reliable, and efficient energy future.

Learn more about our work at raponline.org
Self-use and self-sufficiency

Comparison of self-use and self-sufficiency shares by system size and customer

<table>
<thead>
<tr>
<th>System Size</th>
<th>Consumption</th>
<th>Generation</th>
<th>Self-use</th>
<th>Self-sufficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 kW Residential</td>
<td>300 kWh</td>
<td>300 kWh</td>
<td>100%</td>
<td>4%</td>
</tr>
<tr>
<td>1.3 kW Residential</td>
<td>300 kWh</td>
<td>300 kWh</td>
<td>94%</td>
<td>37%</td>
</tr>
<tr>
<td>3 kW Commercial</td>
<td>500 kWh</td>
<td>500 kWh</td>
<td>94%</td>
<td>29%</td>
</tr>
</tbody>
</table>

Source: OECD/IEA 2014
Net energy metering: Not consistent with market rules

Source NREL  https://www.nrel.gov/docs/fy18osti/68469.pdf
Buy-all sell-all: No active component

Source NREL  https://www.nrel.gov/docs/fy18osti/68469.pdf
Net billing
<table>
<thead>
<tr>
<th></th>
<th>Net Energy Metering</th>
<th>Buy All, Sell All</th>
<th>Net Billing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-Consumption Allowed</strong></td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Netting Frequency</strong></td>
<td>Billing Cycle</td>
<td>Billing Cycle</td>
<td>Instantaneous</td>
</tr>
</tbody>
</table>
| **Quantities Measured and Billed** | 1) Net consumption over the billing cycle  
2) Net excess kWh credits to be compensated or banked | 1) Gross consumption over the billing cycle  
2) Gross DG production over the billing cycle | 1) Instantaneous net consumption throughout the billing cycle  
2) Instantaneous net exports throughout the billing cycle |
| **Sell Rate Applicability**        | Accrued net excess generation credits that have expired after credit reconciliation period | Gross DG production | Instantaneous DG exports |
| **Value of DG to Customer**        | • Retail rate for self-consumption and exported generation  
• Sell rate for expired net excess generation credits | • Sell rate for gross DG production | • Retail rate for instantaneous self-consumption  
• Sell rate for instantaneous net DG exports |
| **Intra-Billing Cycle Banking of Kilowatt-Hours** | Yes | No | No |
| **Key Benefits**                   | Simplicity          | No reduced sales for utility  
Potential for more precise compensation for DG production  
Can encourage self-consumption (if desired) | Potential for more precise compensation for net injections |
| **Challenges**                     | Reduced utility sales  
Retail rate compensation may not be aligned with DG value | Customers may illegally wire for self-consumption if more economically desirable and utility enforcement unlikely | Reduced utility sales |

Source NREL [https://www.nrel.gov/docs/fy18osti/68469.pdf](https://www.nrel.gov/docs/fy18osti/68469.pdf)
Socket parity emerging as potential deployment driver for distributed PV

- Economic attractiveness from offsetting electricity bill requires self-using most of the PV electricity
  - Currently limits potential, in particular for households
- Reaching socket parity is a driver for private actors
  - But PV may still have significant impact on total system costs, in particular depending on allocation of fixed network costs
Self-consumption (SC) varies

Match of PV supply and power demand for a residential/commercial customer in France

- Self-consumption higher for:
  - Some office and commerce buildings with high daily consumption, and relatively small systems on multi-storey dwellings
  - Self-consumption potentially increased with DSI, storage

Source: IEA - ETP 2014, EDF
Distributed PV at grid-parity: 3 options

Bu' all – sell all
- Remuneration EP na
- Specific rate for PV production

Self-consumption and separate EP rate
- Avoided cost SC grid electricity rate
- Remuneration EP special EP tariff

Net-metering
- Avoided cost SC grid electricity rate
- Remuneration EP grid electricity rate

Source: OECD/IEA
Self-consumption with DSI and small storage

Self-consumption: 40%

With DSI: 50%

... with DSI and small storage: 60%