LOAD SHIFTING POTENTIALS
IN SMALL AND MEDIUM-SIZED BUSINESSES
AND SUCCESS FACTORS FOR LEVERAGING THEM

Findings of qualified studies and an analysis of 30 enterprises in the Smart Grids Model Region Salzburg

(July 2013)
**Findings**: business enterprises have a high exploitable load shifting potential – one third of the daily peak load can be shifted for 15 min once a day

**Success Factors**: Existing communication technologies and energy management systems should be used for development by an energy suppliers, DSO sales or aggregators

**Benefits**: business flexibility becomes comprehensively available and, therefore, suitable for grid services on a local level and market activities in general

**Preconditions**: Appropriate framework conditions have to be provided in time for market introduction. These conditions have to enable grid-oriented business models, which are flexible in terms of time and location

**Need for research**: Cost-benefit analyses for econ. evaluation of effects regarding unburdening the grid and integration of renewables. (Merit Order of different flexibility options from grid reinforcement to DSR to DER and storage in a space and time pattern -> “traffic light” model)
Study & structure

1. Results from existing studies
2. Analysis of enterprises in Salzburg
3. Approaches concerning business models
4. Résumé and recommendations

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### Profile of 22 studies from Austria and Germany focusing on load shifting:

- **Potentials** (theoretical, technical, economical, exploitable),
- **types of devices** (generators, storages, loads),
- **framework conditions** (legal framework),
- **recommendations** concerning legal regulation,
- **business models** (utility/producer/operator/customer),
- **customer communication/sales**
- **technical implementation.**

#### Evaluated Studies

<table>
<thead>
<tr>
<th>Austria</th>
<th>Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Elektrischer Spitzenlastausgleich in Lebensmittelketten</strong></td>
<td><strong>Projekt MeRegio</strong></td>
</tr>
<tr>
<td><strong>Konzeption innovativer Geschäftsmodelle zur aktiven Netzintegration</strong></td>
<td><strong>Projekt eTelligence</strong></td>
</tr>
<tr>
<td><strong>Projekt IRON</strong></td>
<td><strong>Projekt moma</strong></td>
</tr>
<tr>
<td><strong>Projekt PEAP</strong></td>
<td><strong>Lastverschiebungspotentiale für DE</strong></td>
</tr>
<tr>
<td><strong>Energie neu denken</strong></td>
<td><strong>Simulation eines Lastmanagements</strong></td>
</tr>
<tr>
<td><strong>Projekt GAVE</strong></td>
<td><strong>DSI in elektrischen Verteilnetzen</strong></td>
</tr>
<tr>
<td><strong>Smart Distribution Grid im Großen Walsertal</strong></td>
<td><strong>Demand Response in der Industrie</strong></td>
</tr>
<tr>
<td><strong>Projekt LOADSHIFT</strong></td>
<td><strong>Potenziale der Wärmepumpe zum Lastmanagement</strong></td>
</tr>
<tr>
<td><strong>Regulierung und Smart Grids</strong></td>
<td><strong>Demand Side Integration</strong></td>
</tr>
<tr>
<td><strong>Handbuch LM</strong></td>
<td><strong>Möglichkeiten der Laststeuerung</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Energiewende im Strommarkt</strong></td>
</tr>
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</table>
## Potentials in Germany

### Technical potential

<table>
<thead>
<tr>
<th>sectors</th>
<th>Techn. shiftable power</th>
<th>Shiftable Energy</th>
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</thead>
<tbody>
<tr>
<td><strong>Household</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010: ca. 2,6 GW</td>
<td>2010: ca. 8,0 TWh per year</td>
<td></td>
</tr>
<tr>
<td>2020: ca. 3,8 GW</td>
<td>2020: ca. 12,4 TWh per year</td>
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</tr>
<tr>
<td>2030: ca. 6,0 GW</td>
<td>2030: ca. 32,3 TWh per year</td>
<td></td>
</tr>
<tr>
<td><strong>Tertiary sector</strong></td>
<td>9GW PSW, 40-70 GW load</td>
<td>7-15% total electricity consumption</td>
</tr>
<tr>
<td>2010: ca. 1,4 GW</td>
<td>2010: ca. 5,0 TWh per year</td>
<td></td>
</tr>
<tr>
<td>2020: ca. 1,7 GW</td>
<td>2020: ca. 5,6 TWh per year</td>
<td></td>
</tr>
<tr>
<td>2030: ca. 1,8 GW</td>
<td>2030: ca. 9,7 TWh per year</td>
<td></td>
</tr>
<tr>
<td><strong>Industry</strong></td>
<td>2010, 2020, 2030 load shift potential of 2,8 GW to 4,5 GW</td>
<td></td>
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</tbody>
</table>

1,5 GW load shifting potential in Germany especially through thermal applications
Studies identified attractive load shifting potentials in the economy (incl. municipalities) – especially thermal systems are suitable due to relatively low storage costs and ever-present availability.

sectors:
- Food retail sector (cooling, freezing)
- Baths (hot water)
- Sewage treatment plants
- Hospitals

appliances:
- Thermal storages (HP, night storage heater)
- Thermal storage (cooling- freezing appliances)
- Air conditioning, white goods
- Compressed air energy storage, pumped storage
- Battery, e-mobility
- Emergency power, CHP
Variable generation needs a more flexible system

Energy transition – flexibility – load shift – industry

**Flexible generation**
- Central (controllable gas power plants)
- Decentralized (control of self-consumption)

**Storage**
- Long-term storage (days - seasonal)
- Short-term storage (seconds - hours)

**Demand-Side Management**
- Incentive based control (Variable tariffs)
- Direct control (VPP, grid control)

**Import-/Export**
- Cellular grids (European wide area - micro grids)
- Regional market (local balancing, capacities)

**Hybrid systems**
- Power to gas (combined power plant, gas grids)
- Thermal control (CHP, heat grid)

Only ICT can leverage all necessary flexibility options, which are necessary for a stable power or energy supply.

Integration of distributed generation through local control
(voltage range, reversed load flow, grid frequency)
System efficiency = optimal utilization RES -> minimized usage of fossil resources

Source: moma
Who can for how long?
Study & structure

1. Results from existing studies
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30 enterprises studied in Salzburg

### Verteilung Gewerbe Fokusgruppen in Salzburg 2012

<table>
<thead>
<tr>
<th>Branche</th>
<th>Geschäftsfeld</th>
<th>geeignete Verbraucher</th>
<th>Anzahl Teilnehmer</th>
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</thead>
<tbody>
<tr>
<td>Handel</td>
<td>Einzelhandel Lebensmittel</td>
<td>Kühlaggregate, Kältgeräte</td>
<td>9</td>
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<tr>
<td></td>
<td>Großhandel Lebensmittel</td>
<td>Kühlaggregate, Kältgeräte</td>
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<tr>
<td></td>
<td>Handel Baubedarf</td>
<td>Batterien</td>
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<tr>
<td></td>
<td>Versandhandel</td>
<td>Batterien</td>
<td>1</td>
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<tr>
<td>Gesundheit/ Pflege</td>
<td>Pflegeheime</td>
<td>alle gesteuerten Verbraucher</td>
<td>1</td>
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<tr>
<td></td>
<td>Bäckerei</td>
<td>Backöfen, Kühlanlagen</td>
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<td>Betonwarenerzeuger</td>
<td>alle gesteuerten Verbraucher</td>
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<td>Kunststoffverarbeitung</td>
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<td>Brauerei</td>
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<tr>
<td>Tourismus/Gastronomie</td>
<td>Hotels, Gasthöfe, Pensionen</td>
<td>Kühlaggregate, alle gesteuerten Verbraucher</td>
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<tr>
<td>Kommunale Einrichtungen</td>
<td>Abwasserentsorgung (Kläranlagen)</td>
<td>Belebungsbecken, Faulturm, Rührwerke</td>
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<tr>
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<td>Schule</td>
<td>alle gesteuerten Verbraucher</td>
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</table>

### Verteilung teilnehmende Gewerbebetriebe im Projekt

<table>
<thead>
<tr>
<th>Komponente</th>
<th>Branche</th>
<th>Geschäftsfeld</th>
<th>geeignete Verbraucher</th>
<th>Anzahl Teilnehmer</th>
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<td></td>
<td>Schule</td>
<td>alle gesteuerten Verbraucher</td>
<td>1</td>
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</tr>
</tbody>
</table>

**Total**: 30
• flexibility: once per day unscheduled 15-min. switch-on/off
• 21 enterprises analyzed
• 2-2.5 MW loadshifting potential (neg./pos.) identified (=third of daily peak load)
• Extrapolated to focus groups Salzburg (2GW -> 600MW)
• Emphasis pos. Flex. because of familiarity with peak shaving
• Suitability of enterprises depends on internal processes, compatibility with existing energy management systems and assessment from managers; labor costs, not energy costs are driving forces
• Thermal storage, esp. cold storages (groceries, supermarkets), are suitable and available
• Duration of disconnection <= 15 Min.; flexible power decreases with increasing duration of activation and increasing requirements concerning short-term availability and reliability
Results in Salzburger Land
30 enterprises analyzed - retail food industry, tourism

- Business enterprises show surprisingly high willingness for load shifting: One third of the daily peak load can be shifted once for 15 minutes, especially thermal flexibilities.
- The retail (food) industry can offer the highest flexibilities due to its cooling appliances.
- The load shifting potentials of these enterprises are available area-wide; and are therefore available where fluctuating generation will have to be compensated.
- The top 5 enterprises account for approx. 60%-70% of this effect.
Energy management of many chain stores can be controlled centrally ⇒ large leverage

<table>
<thead>
<tr>
<th>Department</th>
<th>Quantity</th>
<th>Peak load</th>
<th>Flexible load (minimum available)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>subsidiary Merkur</td>
<td>122</td>
<td>400 kW</td>
<td>100 kW</td>
<td>12 MW</td>
</tr>
<tr>
<td>subsidiary Billa</td>
<td>1000</td>
<td>70 kW</td>
<td>20 kW</td>
<td>20 MW</td>
</tr>
<tr>
<td>logistics, production</td>
<td></td>
<td></td>
<td></td>
<td>2 MW</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>34 MW</td>
</tr>
</tbody>
</table>

REWE-Group: an extrapolation for Austria
Businesses are flexible, if...

- ... the activation happens via existing communication lines (network sales, suppliers, „product requiring explanation“)
- ... existing energy management systems can be used for exploitation (easy, error-free integration through plug&play solutions)
- ... the load shift does not interfere with the enterprises’ core processes (system security “emergency shutdown”, and legal certainty -> certification?) and does not increase personnel expenditure (shift operation)
- ... attractive conditions are being offered by energy suppliers, network sales or aggregators (low-threshold investments (standards, p.r.n. prosumer management or pooling of subsidiaries)
- ... the benefit is clearly visible (energy cost savings, improved image)
Results concerning customer approach I

• Enterprises rate *investments in load management* similarly to *investments in energy efficiency* (ROI in 3-5 years)
  -> Offers made by aggregator should account for that, *investment barriers* should be designed accordingly *low*

• **Core processes** of enterprises must not be interfered with
  -> emphasis should be put on appropriate security („Off“-Switch)

• **Internal load management** is being conducted (partially) very professionally, the *supply of flexibilities* as a service for external subjects will initially be perceived as a disturbance and *competition*.
  -> thus, the supply of flexibilities has to be introduced within an *intensive consultation* and “bit by bity”, beginning with the non-critical processes.

• Many business customers brought up the topic of *PV subsidies*
  -> *combined business model* possible
Results concerning customer approach II

• **Labor costs** are usually considerably **larger than energy costs** therefore, processes, which **influence the staff planning the least**, should be used in the beginning. Exception: sustainable changes of procedures, for permanently achieving beneficial load profiles

• **Multiplier effects** are a **key for success** concerning distribution branches, purchasing associations, producers of EMS systems and locally successful electricians have to be taken into account for future distribution strategies

• “Efficiency” and “cost savings” have been named the most important benefits. In experience, those are not the benefits, which are most important in the course of the implementation of these measures. **The companies most interested in the pilot phase have been either very idealistic or desired a green image.**
  -> focus on benefits, which make people take action.
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8 remuneration system

- Goodwill
- Non-monetary (badge „Energy Transition Business“)
- Subsidies for additional effort
- Compensation (free energy audit)
- Cooperation (help for installing PV systems)
- Separate grid tariff (indiv. arrangements for dis-/connection)
- Multi-step tariffs (fixed times with different costs)
- Dynamic grid fees (short-term changeable fees, nodal prices)

➤ respect local conditions and non-discrimination!
Electricity price business clients (SAG)

- Energy Price: 41%
- Taxes: 17%
- Fees: 16%
- Network Utilization: 23%
- Network Losses: 2%
- Metering activities: 1%
Peak shaving

- Technically secure load
- Connected load
Consumption by schedules
Options for intervention
Connection of flexibilities for grid and market (via IEC 61850)

Central energy manager

Aggregator

grid operator/electr. trader

Enterprise A

Energy-Manager* A

Energy-Manager B

Energy-Manager C

Enterprise B

Enterprise C

Connection flows:
- Request
- Offer
- Call

* Energy manager react to requests and offer flexibilities in accordance with predefined parameters.

- Compr. air
- Batteries
- Cold storage
- Switchable loads
10 business cases

a) Limitation of peak load (classic DSM use case)
b) Schedules for loads and feed-in (agreed upon well in advance)
c) Options for direct control (contracted near-term available for switch-on/off, space- and location-specific)
d) Day-ahead adjustment of feed-in/load curve
e) Neartime / Realtime adjustment of the load curve

X) Prosumer-Models
   x1: schedule oriented prosumer (direct marketing)
   x2: optimized self-consumption (unpredictable, esp. with storage)
   x3: system-guided prosumer (supply-side storage management)

Y) Group models (heterogeneous aggregation of small loads, p.r.n. locally)

Z) Branch model (decentralised control of homogenous enterprises, chains)
## Business cases

<table>
<thead>
<tr>
<th>Model and its effects (o=neutral, +=advantage, -=disadvantage, §!=not backed by regulation)</th>
<th>grid</th>
<th>customer</th>
<th>supplier</th>
<th>aggregator</th>
<th>regulator</th>
</tr>
</thead>
<tbody>
<tr>
<td>A limitation of peak load (classic DSM use case)</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>ok</td>
</tr>
<tr>
<td>B schedules for loads (agreed upon well in advance)</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>§!</td>
</tr>
<tr>
<td>C direct control options (contracted near-term available, switch-on/off, time- and location-specific)</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>§!</td>
</tr>
<tr>
<td>D day-ahead adjustment of feed-in /load curve</td>
<td>+</td>
<td>+</td>
<td>0</td>
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<td>§!</td>
</tr>
<tr>
<td>E near time / real-time adjustment of the load curve</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>§!</td>
</tr>
<tr>
<td>X1 schedule oriented prosumer (direct marketing)</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>§!</td>
</tr>
<tr>
<td>X2 optimized self-consumption (unpredictable, esp. with storage)</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>Ok</td>
</tr>
<tr>
<td>X3 system-guided prosumer (supply-side storage management)</td>
<td>+</td>
<td>0</td>
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<td>0</td>
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<tr>
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Résumé

- Load shifts can be leveraged in the commercial sector via ICT and have a market potential, if the framework conditions will be adapted.
- Flex-readiness is available in enterprises, (via known channels, without interference of production processes, based on existing systems, noiseless, comfortable, lucrative)
- Several MW can be exploited from a technical point of view in different qualities (space, time, reliability), <-> communication infrastructure (area coverage, standards, speed)
- Especially attractive potential based on thermal storages (cold and heat). One third of the installed power can be used for flexibility considerations (switching once per day for 15-30 minutes). The occurring potential accounts for up to 200 MW in the case of Salzburger Land alone.
- Barriers are trending towards self-consumption, shortage of specific offers, no possibility of aggregation, lacking communication connection and legal uncertainty
  -> cost-benefit-analyses are missing (costs for integration, system benefits, system needs, „price tags“ nodal, temporary)
Thank you for your attention

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