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Customer-centric Energy Usage Data Management for Balancing Tradeoff of Benefit and Privacy

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Growing Availability of Energy Usage Data

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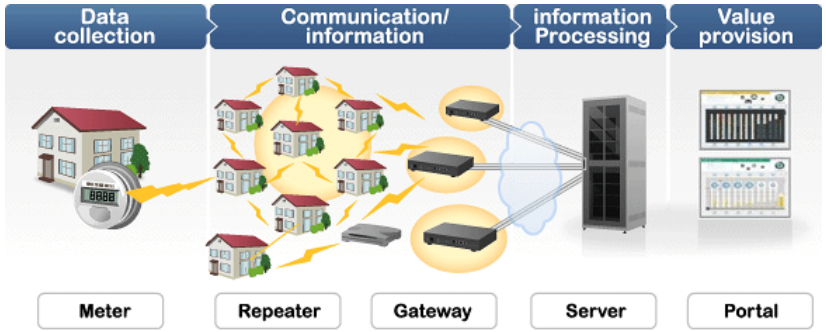
- Fine-grained electricity usage data is now available.



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Utilization for Electricity Customers

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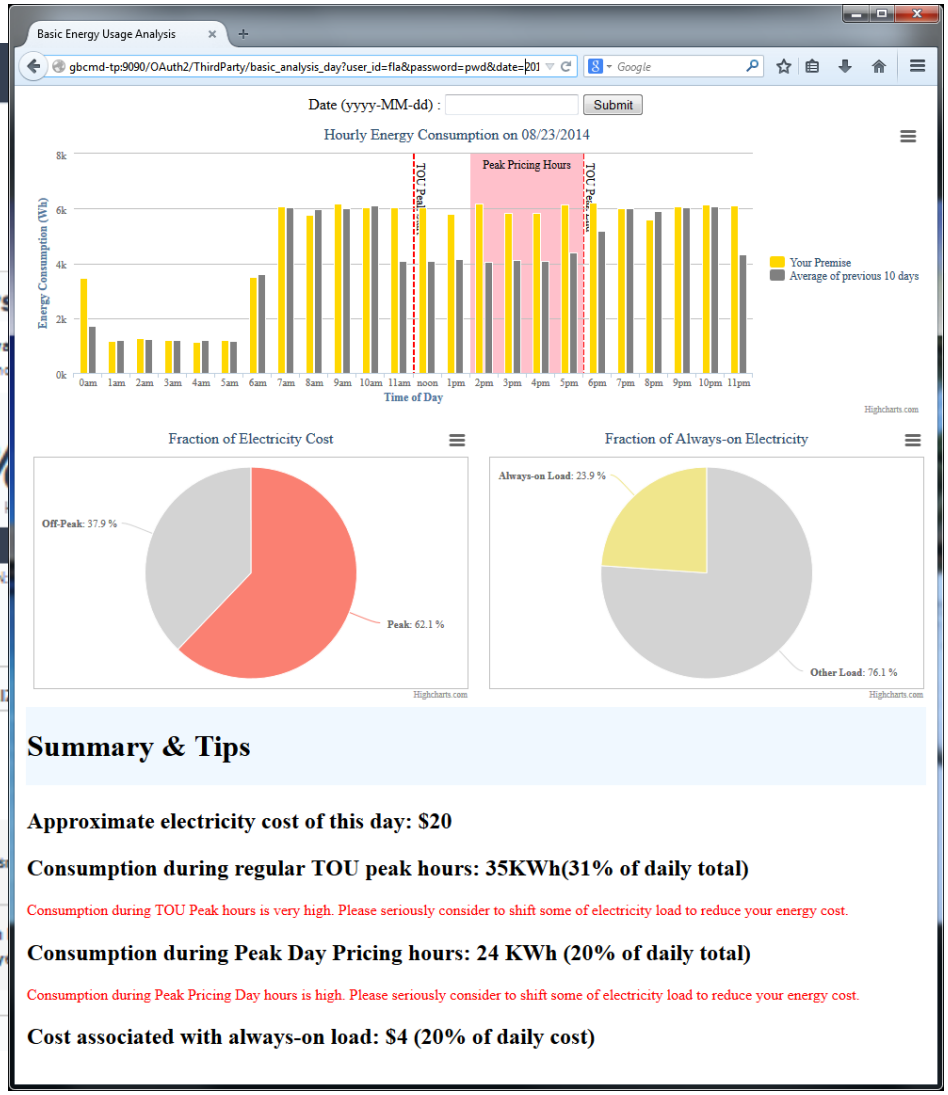
- Energy Usage Data Analytics Services by third parties



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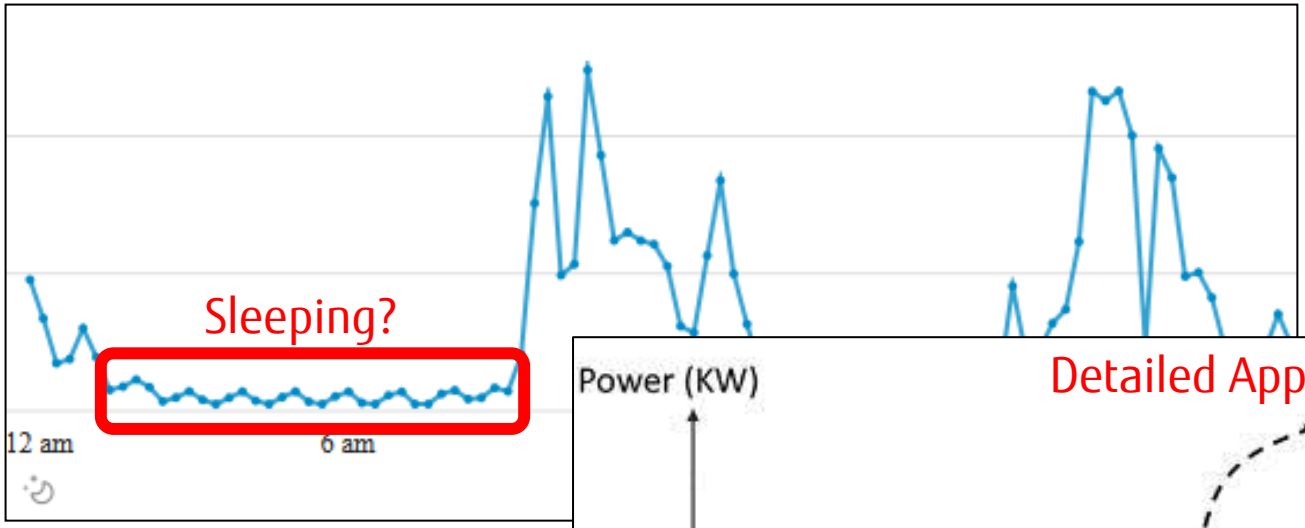
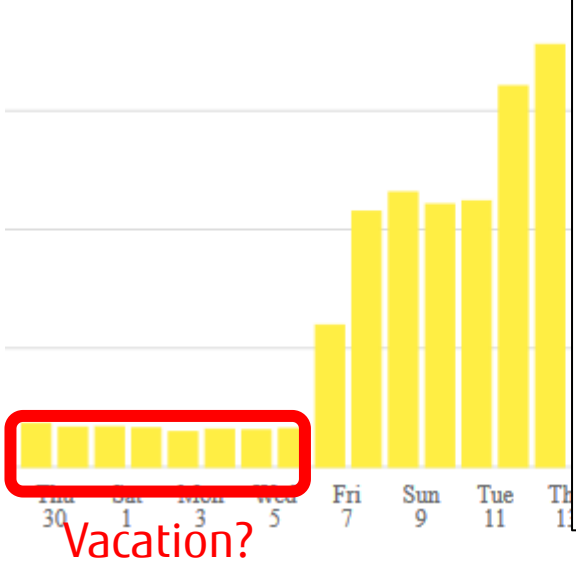
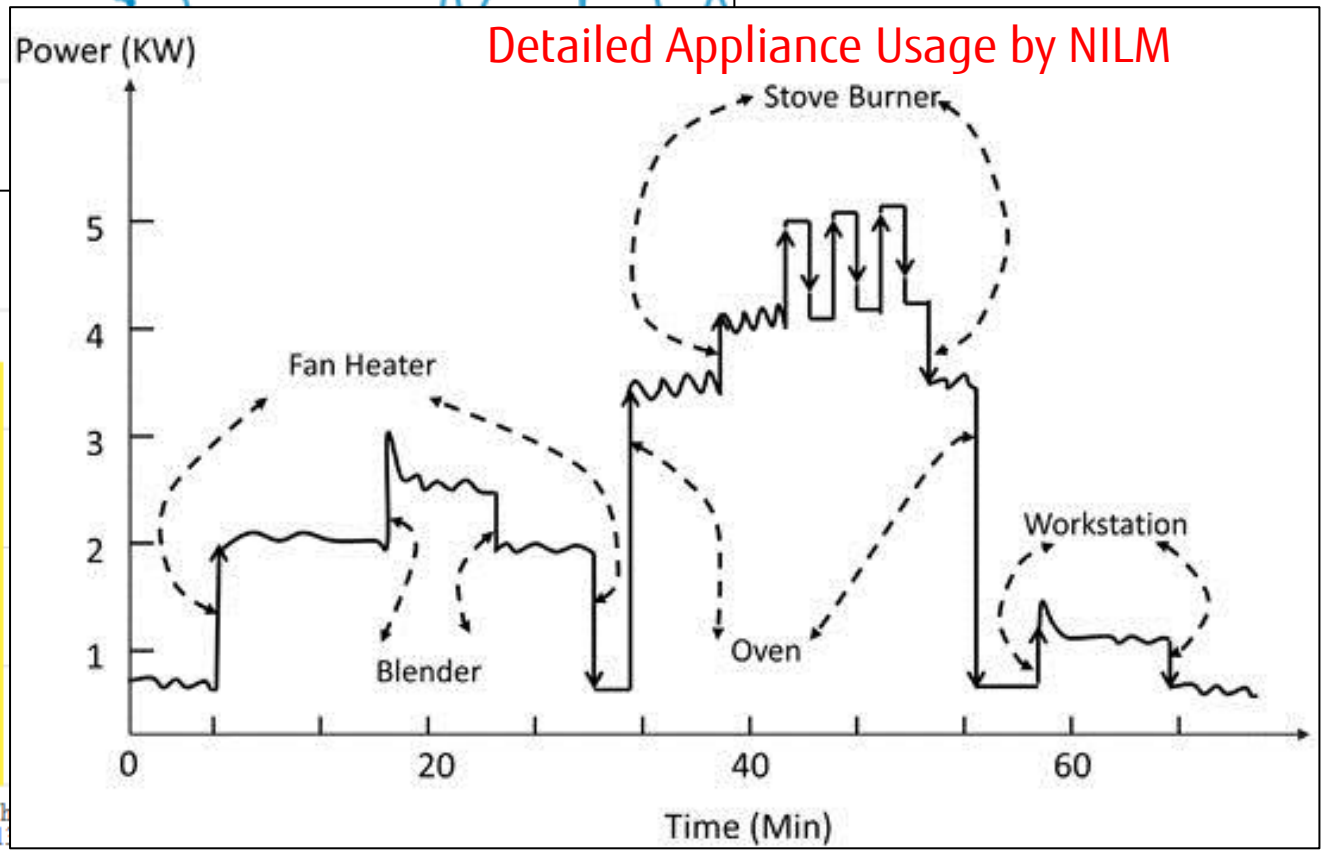
Privacy Risks?







http://www.mdpi.com/1424-8220/12/12/16838

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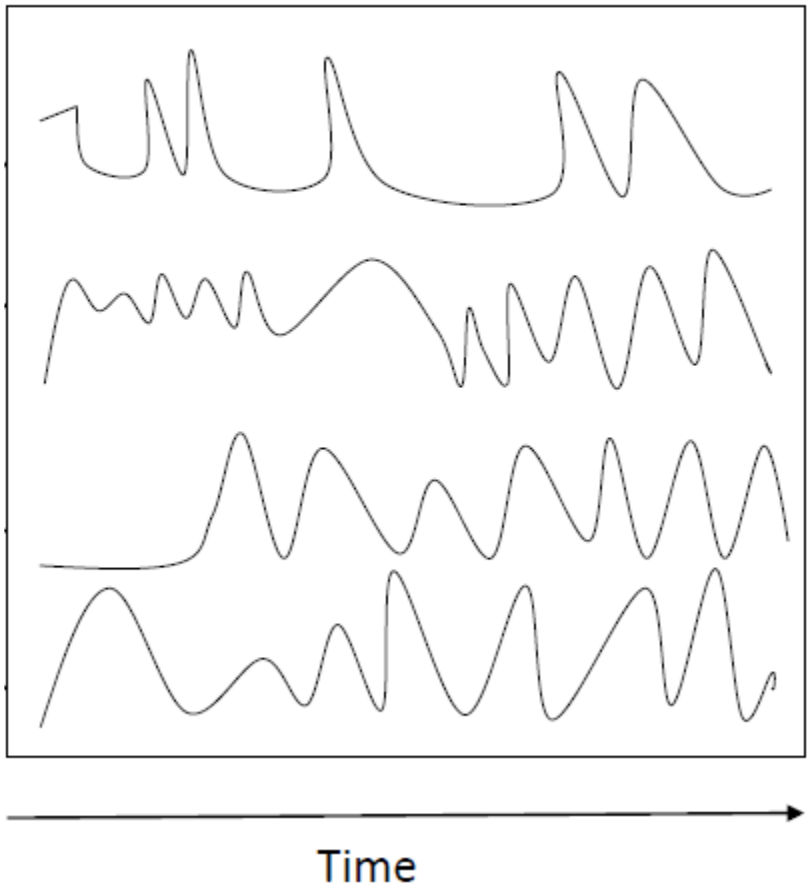
Re-identification

ID	Consumption Last Semester
Alex	70
Anita	60
Eve	120
Bob	96



- Mustafa Faisal, Alvaro Cardenas, and Daisuke Mashima, “How the Quantity and Quality of Training Data Impacts Re-identification of Smart Meter Users?” In Proc. of IEEE SmartGridComm 2015.

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Balancing Benefit vs Privacy

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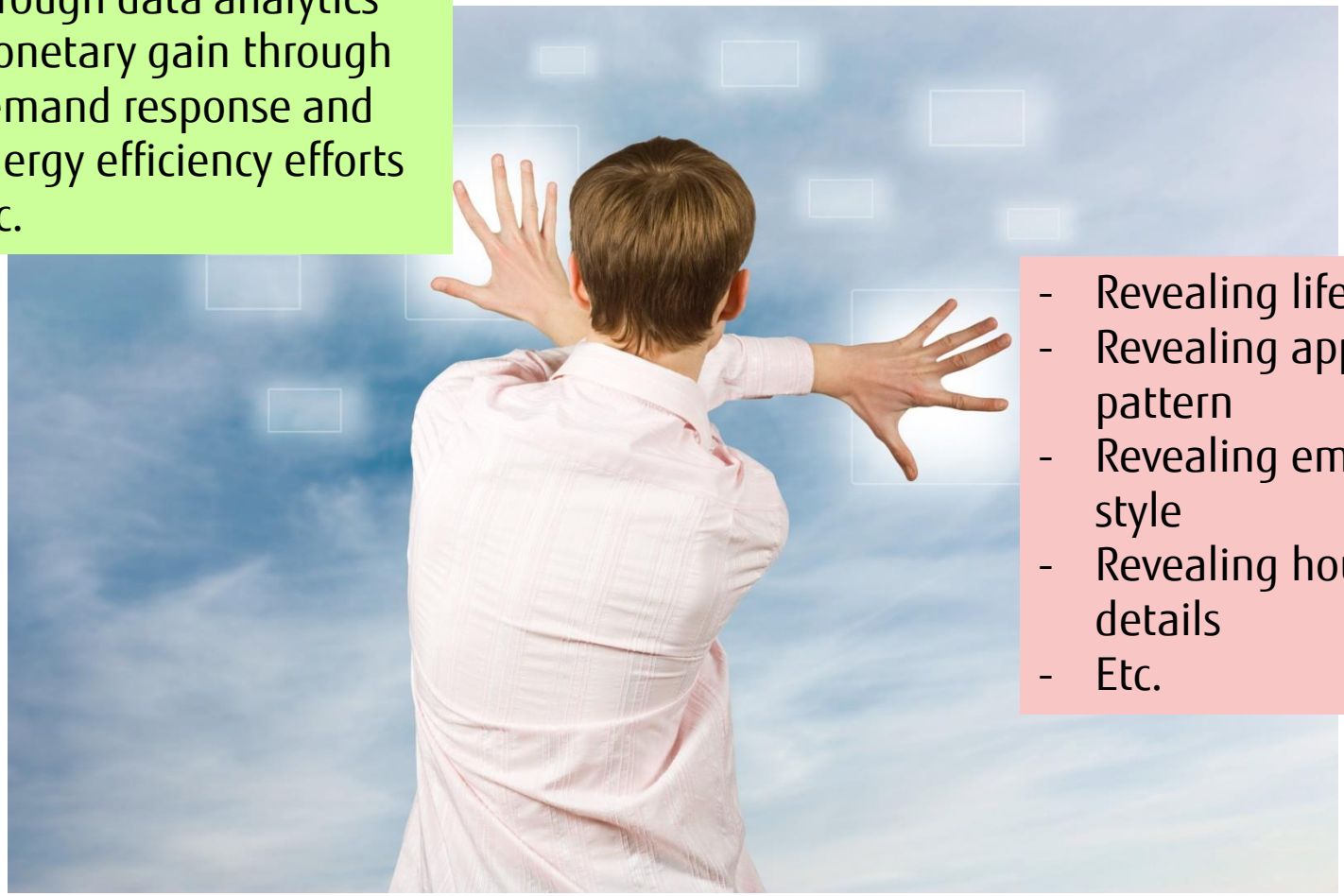
- Better understanding through data analytics
- Monetary gain through demand response and energy efficiency efforts
- Etc.



- Revealing life cycle
- Revealing appliance usage pattern
- Revealing employment style
- Revealing household details
- Etc.

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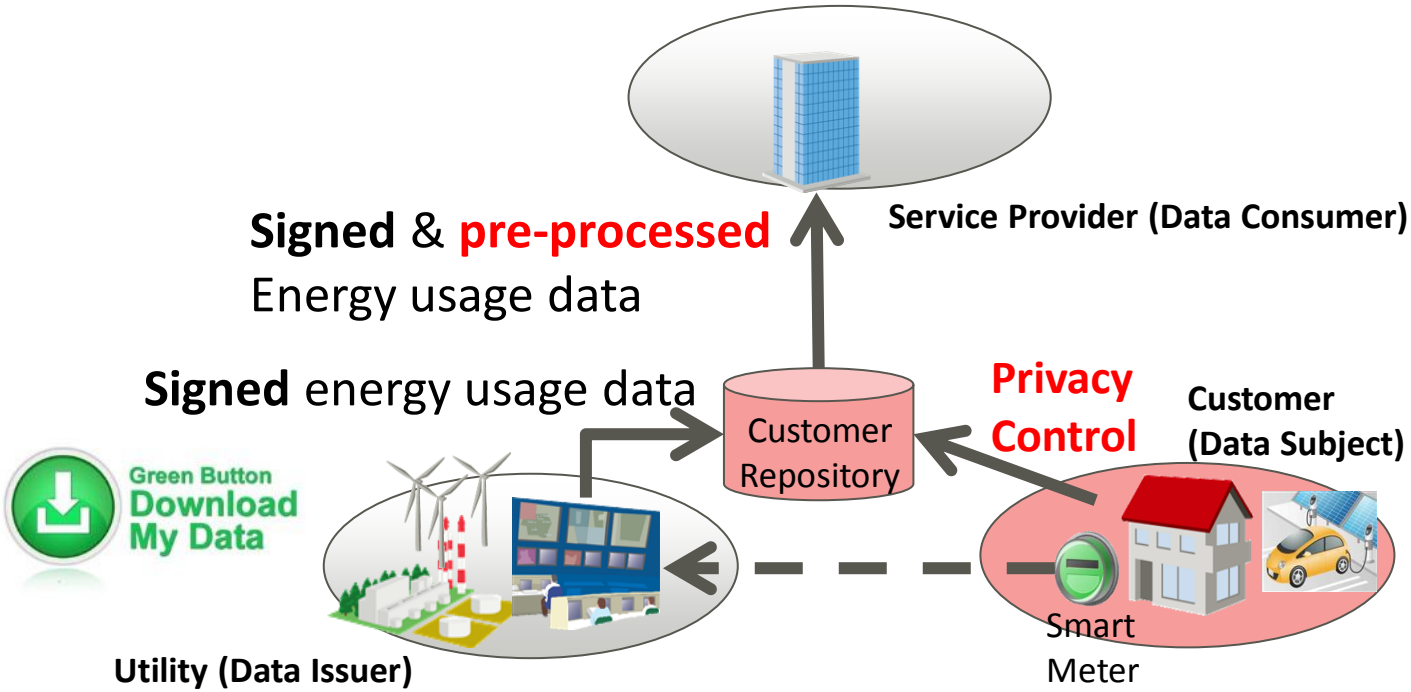
Customer-centric Data Management

- Customer's electricity data is collected and signed by utility (or a trusted metering device), then is downloaded by a customer.
- Downloaded data is stored on a customer's "Repository".
- Upon sharing with Service provider, data can be **pre-processed** for controlling privacy risks.
- **Authenticity** of pre-processed data is verifiable.



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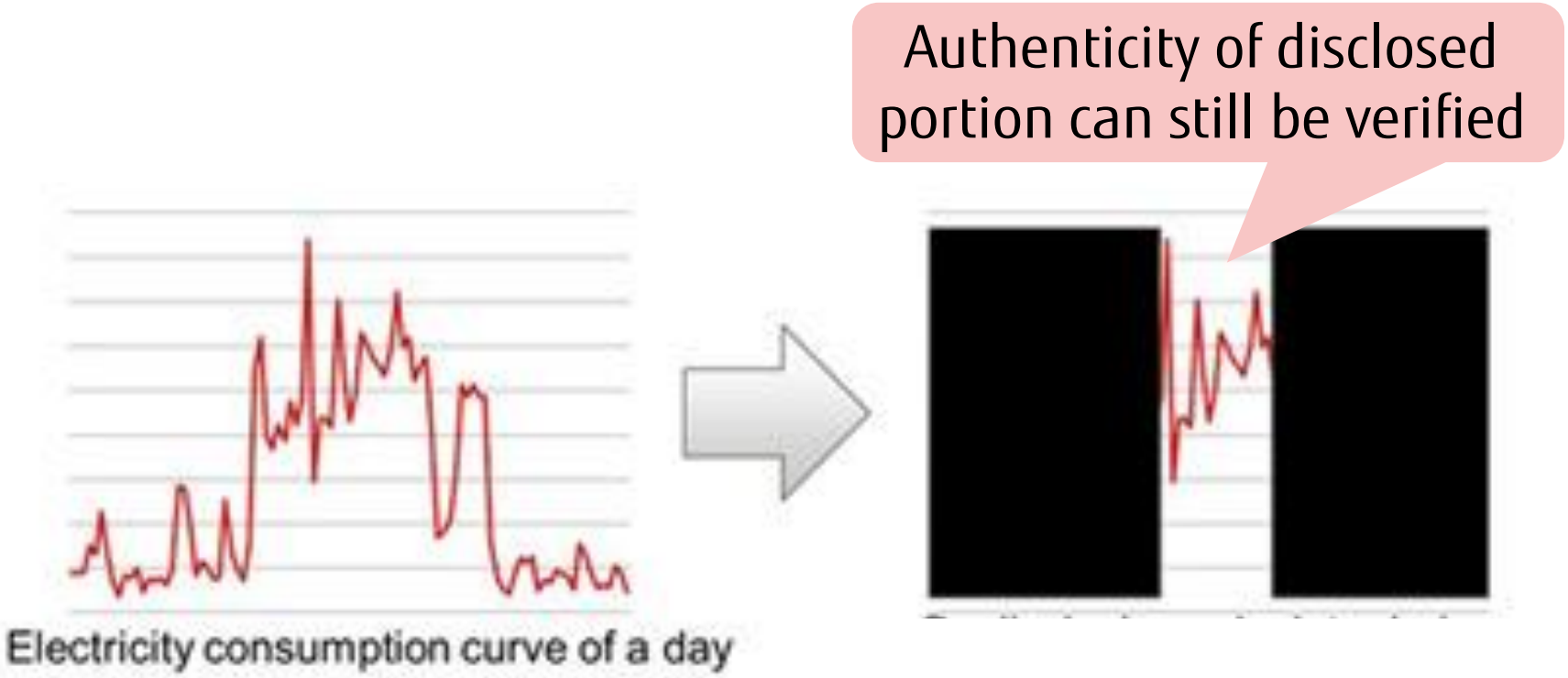
Privacy by Redaction



- Hide non-essential part for minimal disclosure
  - Application of Redactable Digital Signature scheme
  - Gaurav Lahoti, Daisuke Mashima, and Wei-Peng Chen, "Customer-centric Energy Usage Data Management and Sharing in Smart Grid Systems." In Proc. of ACM Smart Energy Grid Security Workshop, Berlin, Germany, 2013.

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Privacy by Artificial, Bounded Noise

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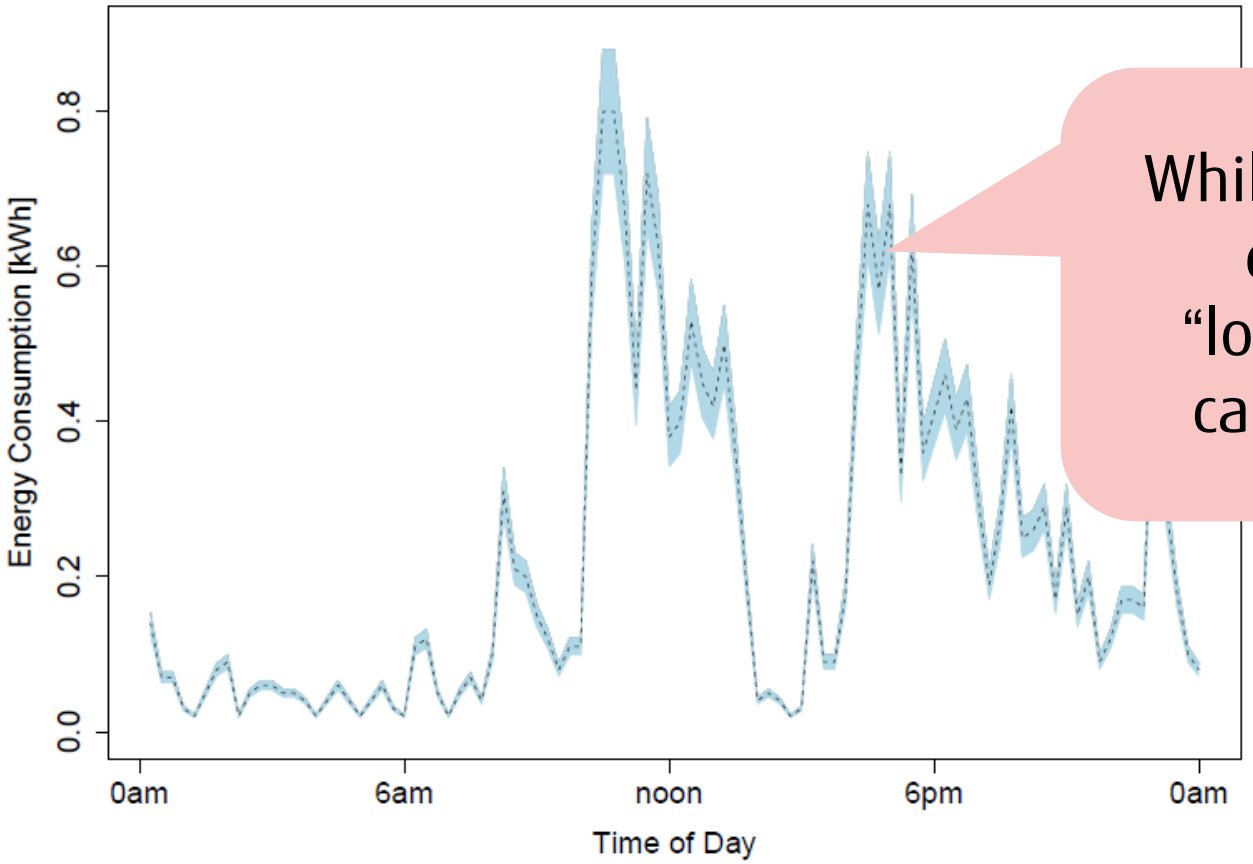

While detailed pattern can be hidden, "loose authenticity" can still be verified

- Adding artificial, bounded noise to counter attacks such as signature-based NILM
  - Protocol based on Non-interactive Zero-knowledge Proof system
  - Daisuke Mashima and Arnab Roy, "Privacy Preserving Disclosure of Authenticated Energy Usage Data." In Proc. of IEEE SmartGridComm 2014.

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Privacy by Down-sampling

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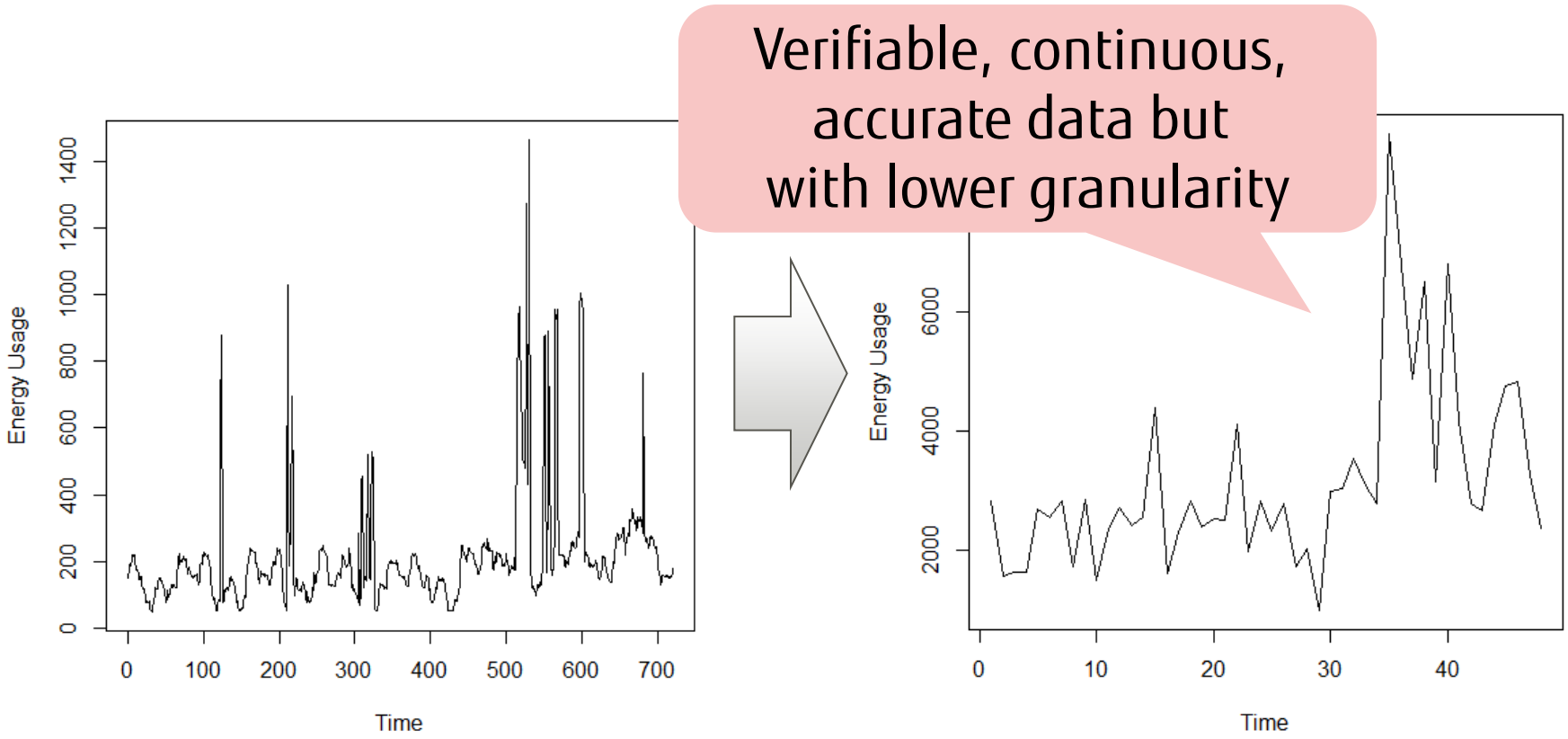

- Lower data granularity to counter risks caused by data analytics
  - Extension of Redactable Digital Signature based on Merkle Hash Tree
  - Daisuke Mashima, “Authenticated Down-Sampling for Privacy-Preserving Energy Usage Data Sharing.” To appear at IEEE SmartGridComm 2015.

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Summary

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- Utilization of electricity usage data benefits not only utility companies but also electricity customers.
- Electricity customers should be aware of associated privacy risks.
  - Quantification of privacy risk is a challenging future work.
- Addressing privacy concerns will further encourage sharing and meaningful utilization of electricity data.
- To empower customers to control privacy risks, customer-centric data management and sharing are essential.
  - Allow electricity customers to pre-process data
  - Retain data verifiability for services that require trustworthy data

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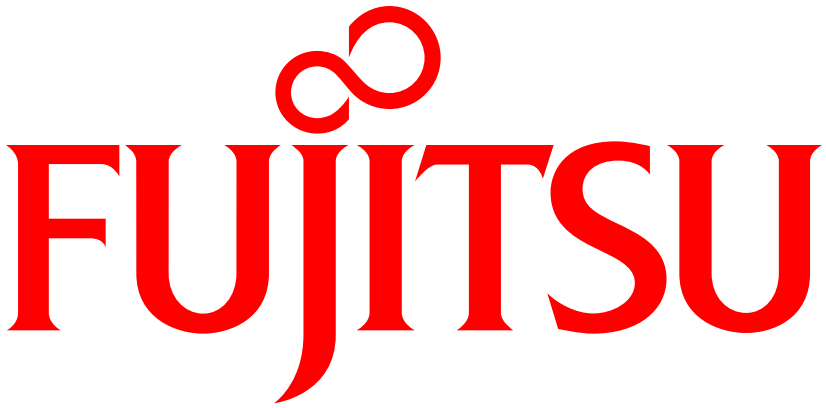

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