ISS4E

S. Keshav and Catherine Rosenberg
University of Waterloo
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ISS4E vision

To apply our expertise in Information Systems and Sciences
to find innovative solutions to problems in energy systems

http://iss4e.ca

Team

- **Directors**

    Prof. S. Keshav (CS)

    Prof. Catherine Rosenberg
     (ECE)

- **Affiliated Faculty**

    Prof. Tim Brecht (CS)
    Prof. Lukasz Golab (Management Sciences)
    Prof. Alex Lopez-Ortiz (CS)
    Prof. Bernard Wong (CS)

- **Postdocs**

    Yashar Ghiassi
    Kirill Kogan
    Negar Koochakzadeh

    Hanan Shpungin

- **Ph.D. Students**

    Adedamola Adepetu
    Omid Ardakanian
    Tommy Carpenter
    Rayman Preet Singh Matharu

- **Masters Students**

    Peter Xiang Gao
    Elnaz Rezaei

    Sahil Singla

- **Research Associates**

    Bo Hu
    Pirathayini Srikantha
    Hadi Zarkoob

Current and Recent Projects

Electric vehicles

- Car pools to reduce range anxiety (Carpenter)

- Optimal charging of vehicle fleets (Zarkoob)

- Distributed optimal charging (Ardakanian)

- App-based telemetry (Carpenter)

Smart homes and buildings

- Temperature setpoint market (Singla)

- Smart appliances (Srikantha)

- Home peak load prediction (Matharu/Gao)

- Analysis of home load seasonality (Rezaei/Adepetu)

- Automatic clustering of home loads (Matharu/Ardakanian)

- Optimal scheduling of home storage (Carpenter/Singla)

Smart homes and buildings (contd.)

- Personal thermal comfort (Gao)

- Regression models for building loads (Case)

- Per-panel solar load monitoring and anomaly detection (Hu)

- Private storage and analysis of home meter data (Matharu)

- Optimal battery sizing to deal with outages (Singla/Ghiassi)

Distribution network

- Optimal storage location (Shpungin)
- Optimal load scheduling in microgrids (Kogan)

Generation

- Firming up solar power (Ghiassi)

SAMPLE PROJECTS

Demand Response through a Temperature Setpoint Market in Ontario

- Ontario has peak load for a few hours in summers

- Peak load reduction possible by increasing thermostat during peak hours

- Payment of $2 per hour of setback can reduce operating costs by $688 million over 20 years

smartset

Ref: S. Singla, S. Keshav: *Demand Response through a Temperature Setpoint Market in Ontario,* IEEE SmartGridComm, 2012
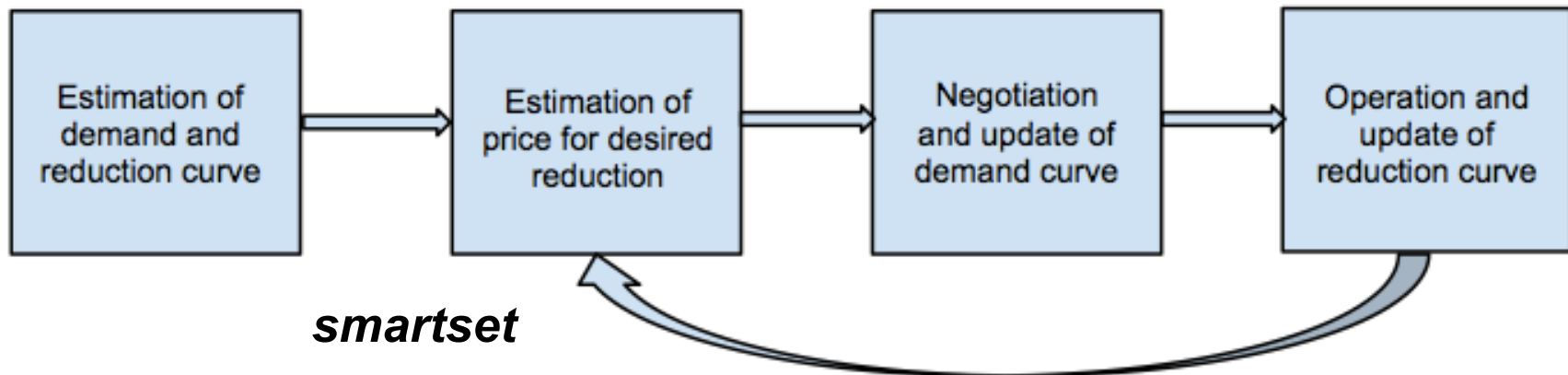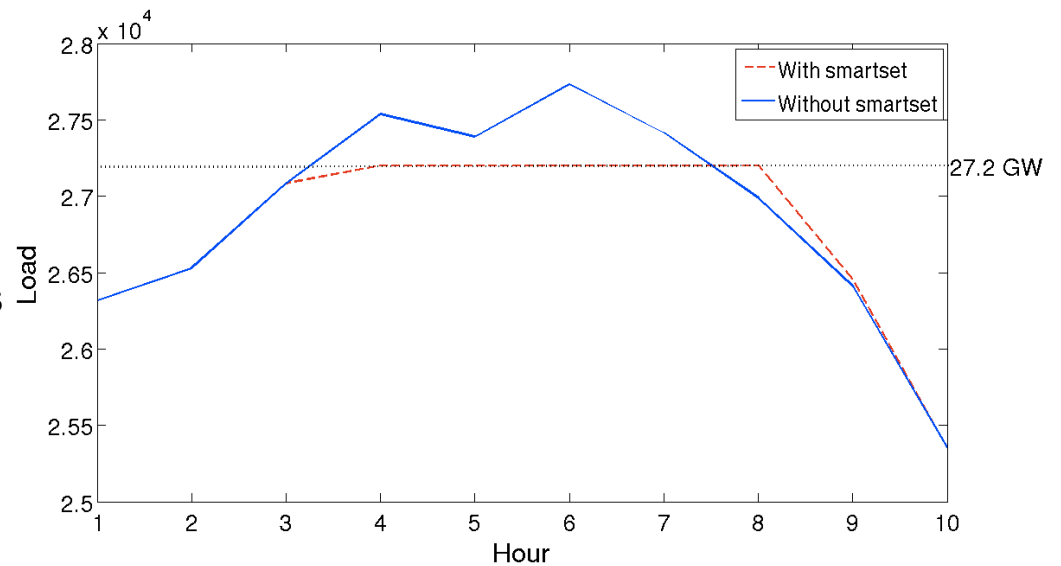
Firming up Intermittent Energy Sources
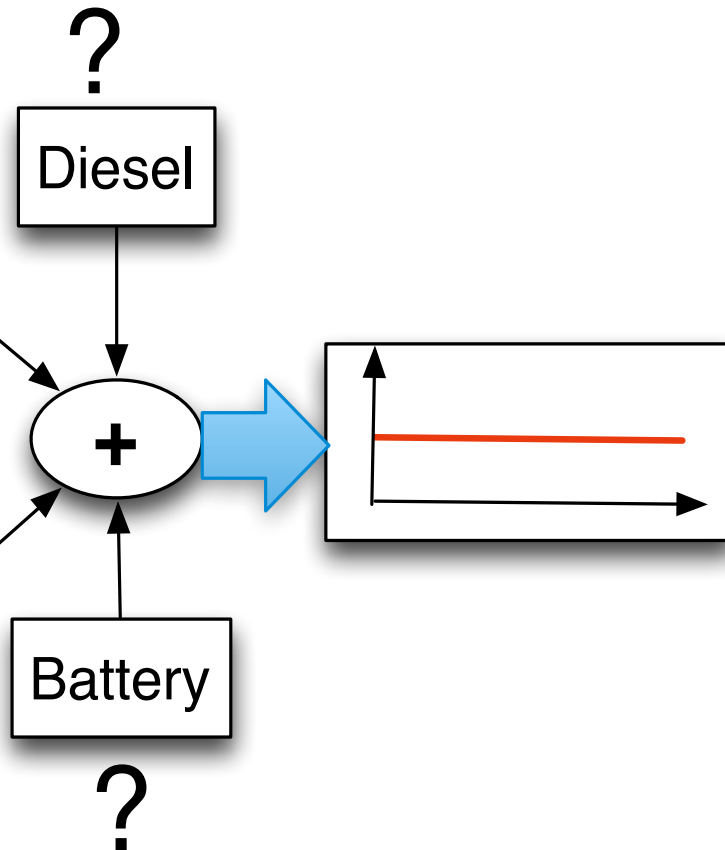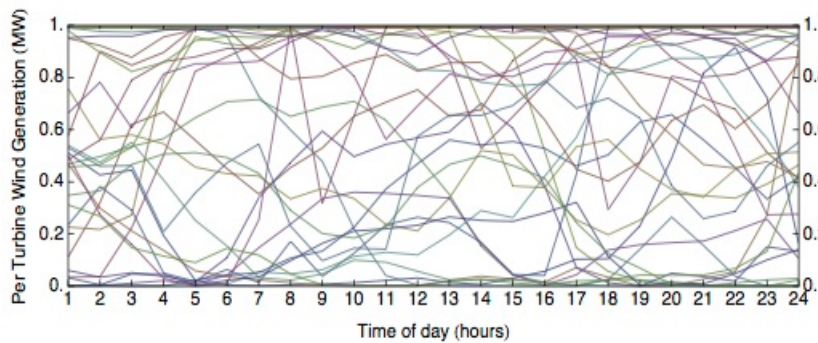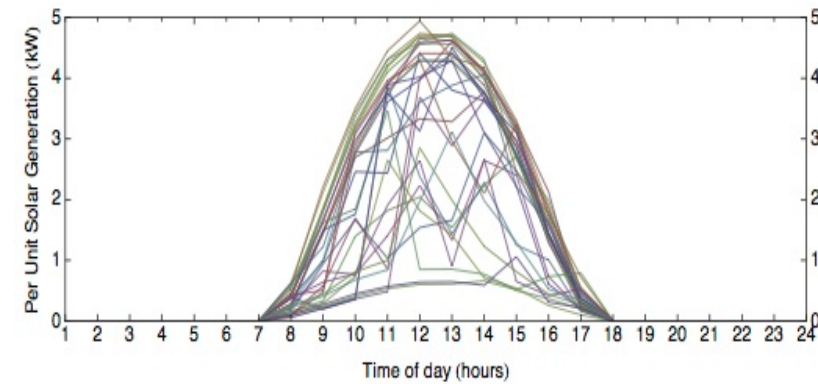
Personal Thermal Control System

Objectives:
- Measuring human thermal comfort automatically
- Saving electricity bill without affecting comfort

We use Kinect to detect activity and clothing

The system learns the user prefers warmer condition

- Senses environmental conditions
- Detects human activity and clothing
- Learns personal thermal preference

Personal Thermal Control System

The system can learn the insulation factor of a house, and hence make the optimal thermal control sequence accordingly
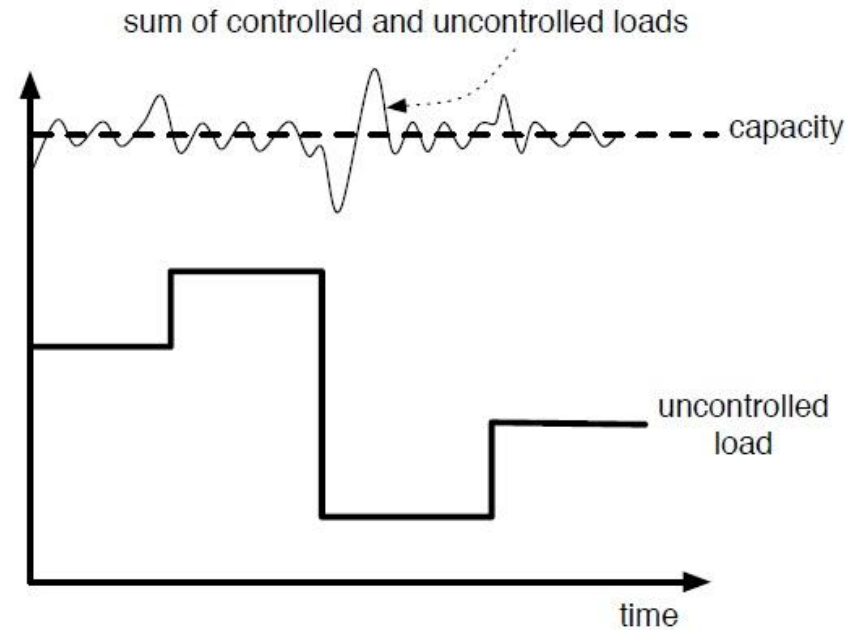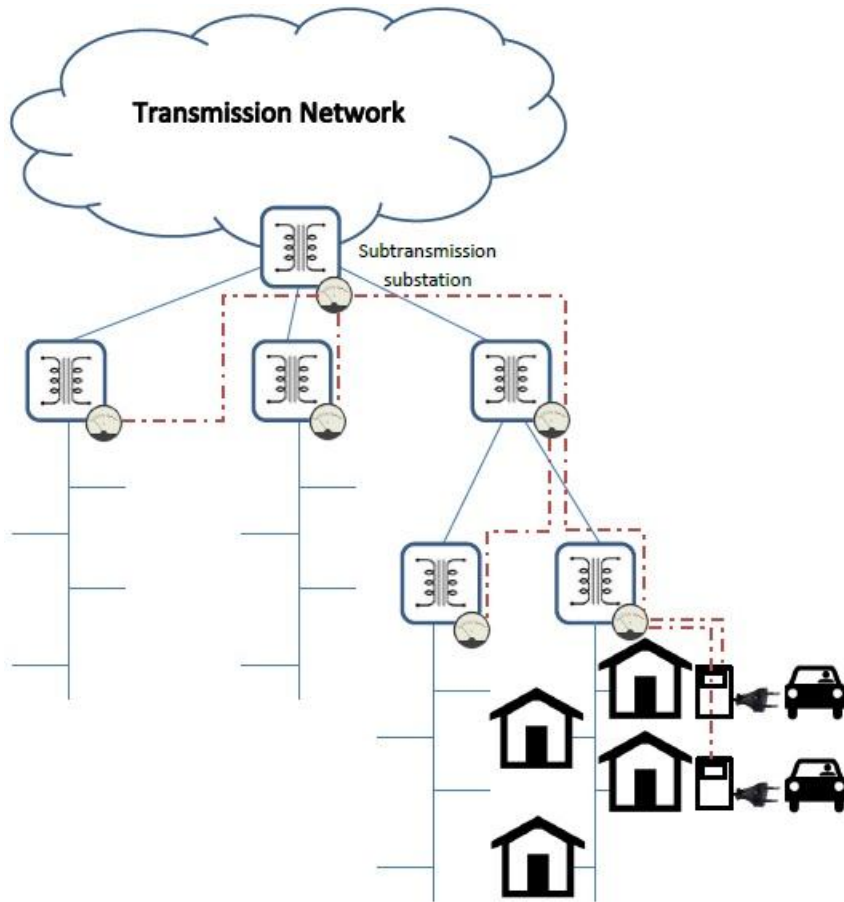
It gives energy saving tips to human:
wear your coat to save $15 per month

- Learning based home modeling
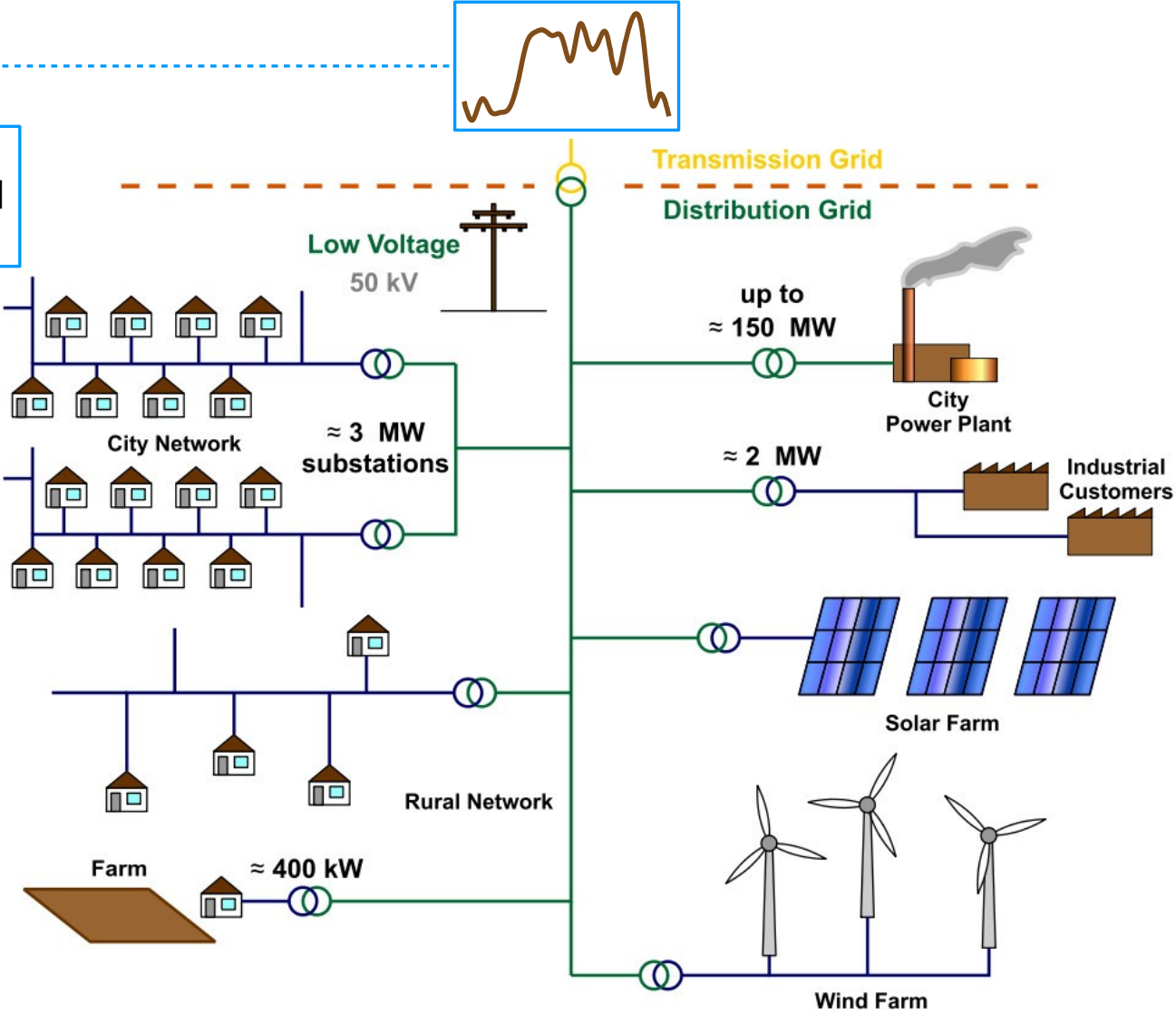- Human in the loop control

Real Time Distributed Congestion Control for Electrical Vehicle Charging

Smart Grid Architecture

Utilizing energy storage in distribution networks.
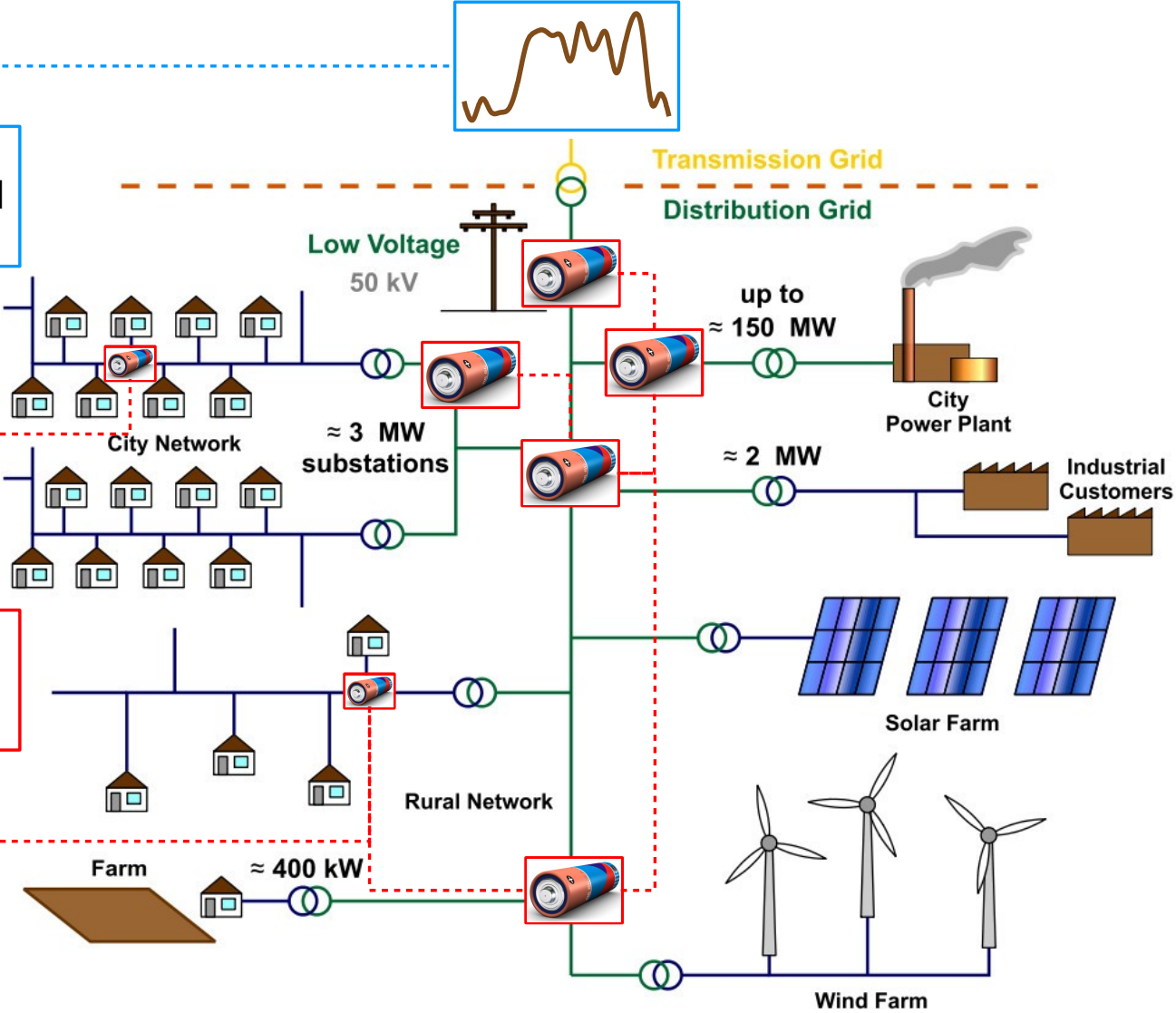
Goal:
Flatten energy demand
= **min** (peak/avg)

Transmission Grid

Distribution Grid

Low Voltage
50 kV

City Network

≈ 3 MW
substations

Rural Network

Farm

≈ 400 kW

up to
≈ 150 MW

City
Power Plant

≈ 2 MW

Industrial
Customers

Solar Farm

Wind Farm

Utilizing energy storage in distribution networks.

Goal:
Flatten energy demand
= **min** (peak/avg)

Solution:
Use energy storage to balance load

Transmission Grid

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Low Voltage
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Utilizing energy storage in distribution networks.

Goal:
Flatten energy demand
= **min** (peak/avg)

placement *sizing*

Solution:
Use energy storage to
balance load

scheduling
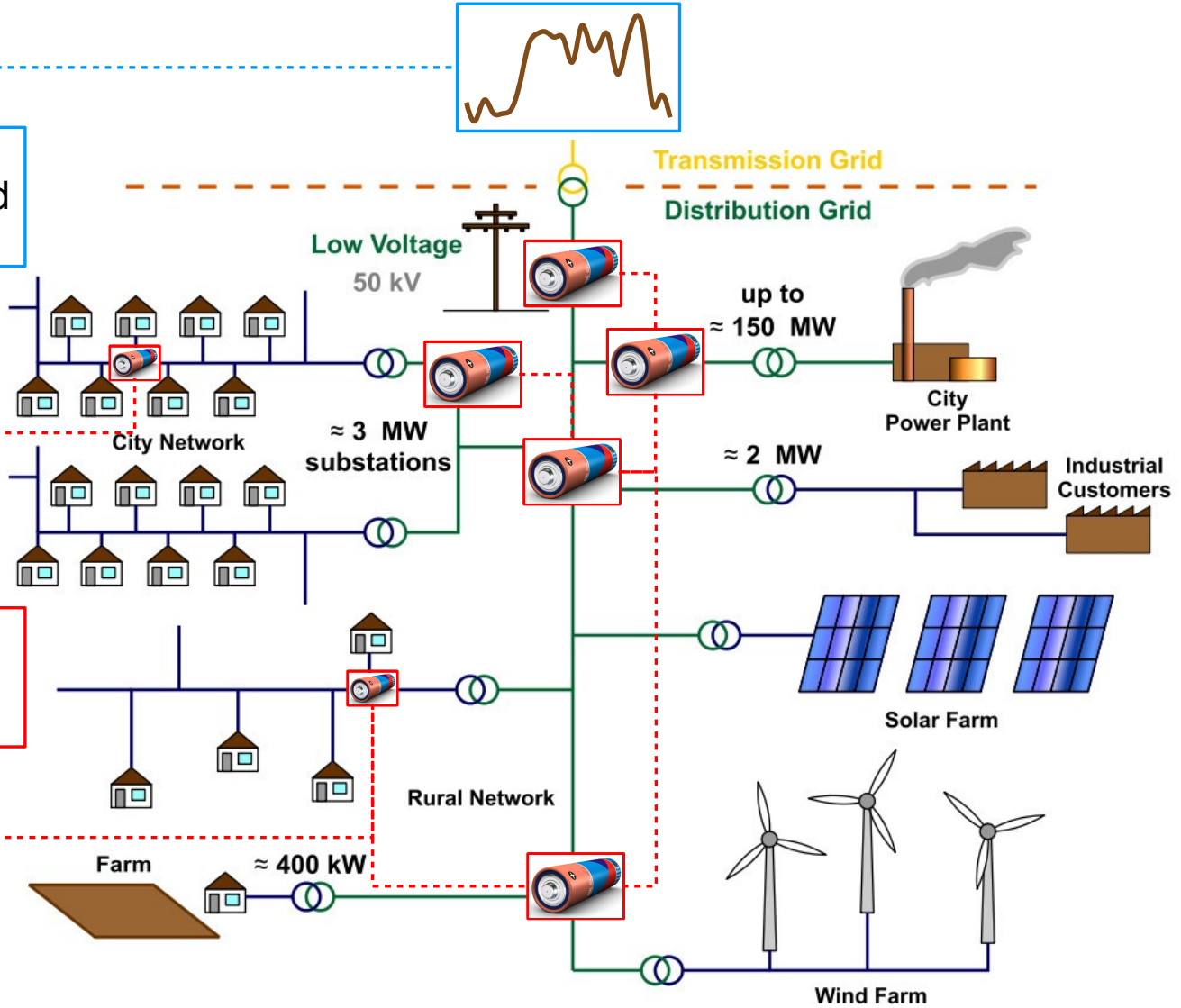
Utilizing energy storage in distribution networks.

Area summary

Storage usage

Generation settings

Solution summary

Consumer-centric Smart Grid

The Traditional Grid

Residential neighbourhood

Apartment complex

Commercial building

Poletop transformer

Home

Appliances

Smart Meter

EV

Consumer

AMI data base

LDC private cloud

Local Distribution Company (LDC)

Transformer

Substation

Wind

Nuclear

Fossil Fuel

Hydro-electric

Transmission Grid
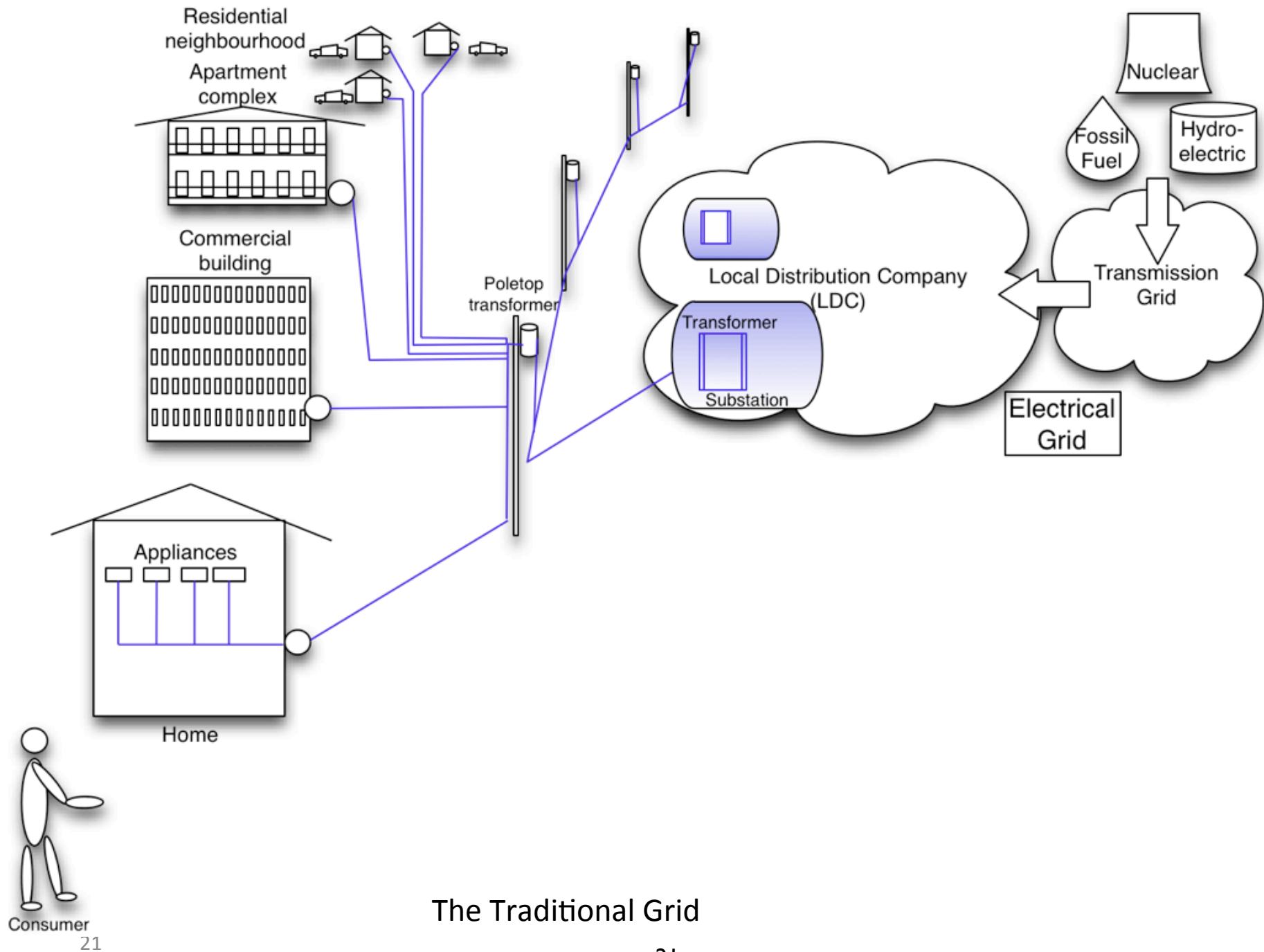
Electrical Grid
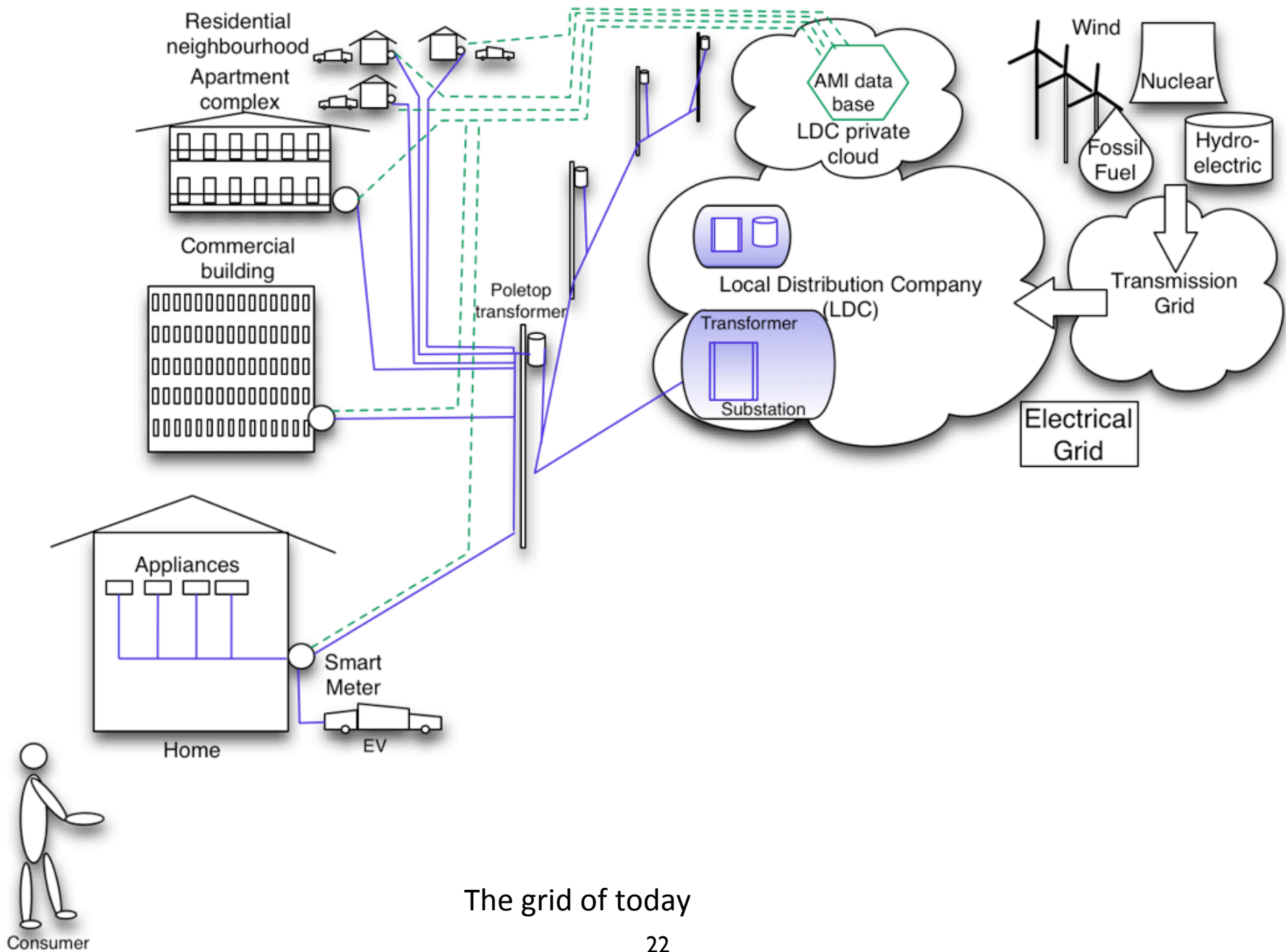
The grid of today
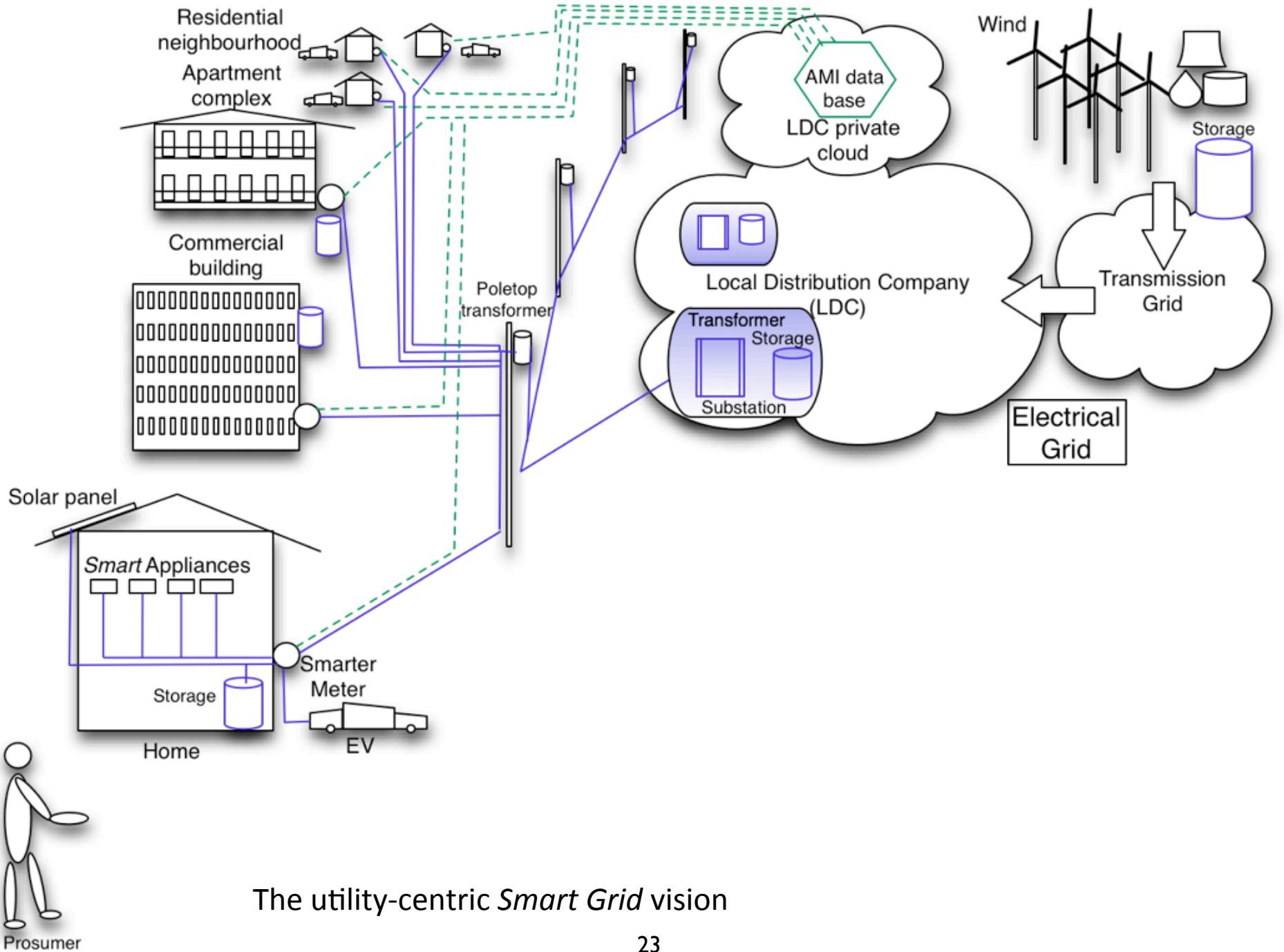
The utility-centric *Smart Grid* vision

Residential neighbourhood

Apartment complex

Commercial building

Poletop transformer

AMI data base
LDC private cloud

Wind

Storage

Local Distribution Company (LDC)

Transformer
Storage
Substation

Transmission Grid

Electrical Grid

Solar panel

Smart Appliances

Gateway

Storage

Home

Smarter Meter

EV

Mobile connected device

Prosumer

Public Internet Cloud

vHome   vHome   vHome

vApartment

vBuilding

vHome

AS
WS
db

AS = App server
WS = Web server
db = Database
a = app

Network Services Tier

LDC meter data

vHome app store

vHome neighbourh'd

RTO/ Regulator

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