United Technologies Research Center

United Technologies Research Center:

Overview

15th June 2016

United Technologies Research Centre Ireland, Ltd.
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UNITED TECHNOLOGIES

Business units - 2014 Sales: $65.1 billion

Otis

Pratt & Whitney

UTC Climate, Controls & Security

UTC Aerospace Systems

UNITED TECHNOLOGIES

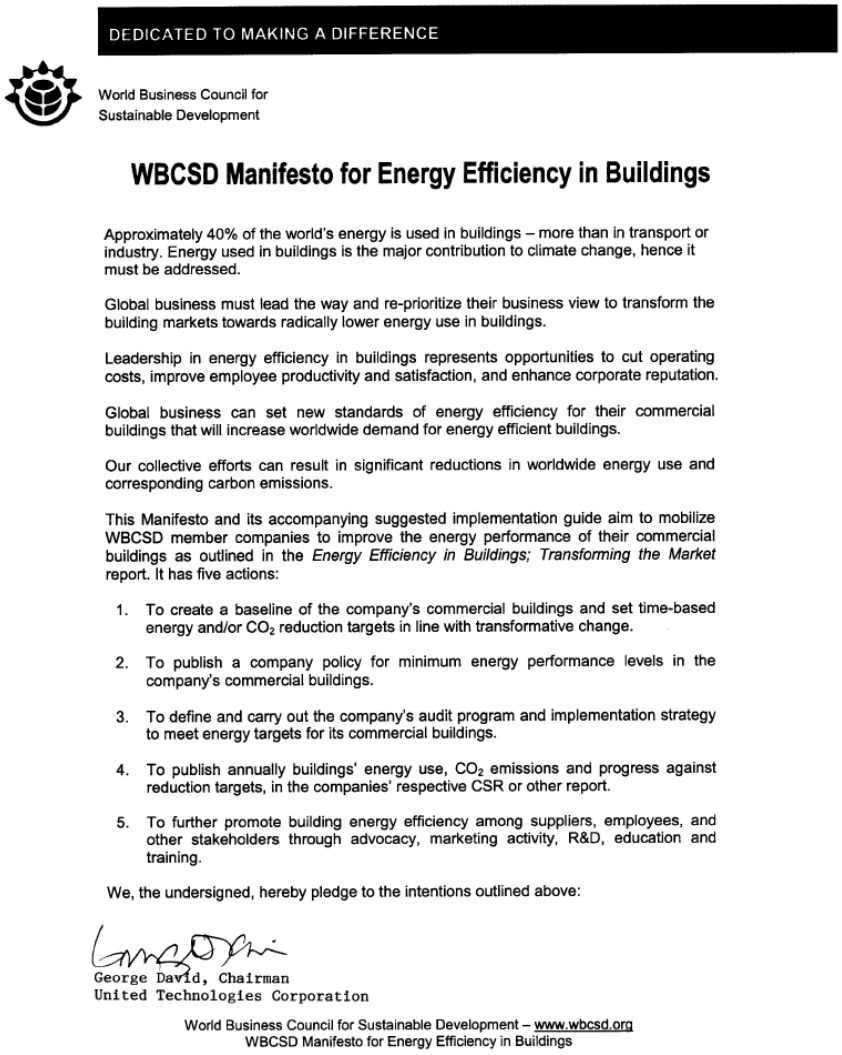
Sustainability and Building Energy Efficiency

UTC's first corporate sustainability goals were established in mid-1990s

UTC efforts undertaken between 2006 and 2013 have resulted in several significant environmental impact reductions:

- **-71%** Non-Greenhouse Gas Emissions
- **-26%** Greenhouse Gas Emissions
- **-42%** Industrial Process Waste
- **-53%** Worldwide Water Consumption

Every five years, UTC sets aggressive goals for our Environment, Health & Safety performance



DEDICATED TO MAKING A DIFFERENCE

World Business Council for Sustainable Development

WBCSD Manifesto for Energy Efficiency in Buildings

Approximately 40% of the world's energy is used in buildings – more than in transport or industry. Energy used in buildings is the major contribution to climate change, hence it must be addressed.

Global business must lead the way and re-prioritize their business view to transform the building markets towards radically lower energy use in buildings.

Leadership in energy efficiency in buildings represents opportunities to cut operating costs, improve employee productivity and satisfaction, and enhance corporate reputation.

Global business can set new standards of energy efficiency for their commercial buildings that will increase worldwide demand for energy efficient buildings.

Our collective efforts can result in significant reductions in worldwide energy use and corresponding carbon emissions.

This Manifesto and its accompanying suggested implementation guide aim to mobilize WBCSD member companies to improve the energy performance of their commercial buildings as outlined in the *Energy Efficiency in Buildings; Transforming the Market* report. It has five actions:

1. To create a baseline of the company's commercial buildings and set time-based energy and/or CO_2 reduction targets in line with transformative change.
2. To publish a company policy for minimum energy performance levels in the company's commercial buildings.
3. To define and carry out the company's audit program and implementation strategy to meet energy targets for its commercial buildings.
4. To publish annually buildings' energy use, CO_2 emissions and progress against reduction targets, in the companies' respective CSR or other report.
5. To further promote building energy efficiency among suppliers, employees, and other stakeholders through advocacy, marketing activity, R&D, education and training.

We, the undersigned, hereby pledge to the intentions outlined above:

George David, Chairman
United Technologies Corporation

World Business Council for Sustainable Development – www.wbcsd.org
WBCSD Manifesto for Energy Efficiency in Buildings

UTRC…UTC'S INNOVATION ENGINE

Defining what's next

Define new frontiers…

AIS
Autonomous
& intelligent systems

Advanced manufacturing

Big data

Co-develop new technologies…

Next Gen centrifugal

GTF lubrication

Solve tough problems…

Materials characterization

Surface topology and wear analysis

Measurement science

Digital imaging strain analysis

Failure analysis

Scattering to measure residual stress

Serve as hub for technical interchange…

Tech scouting

Rare Earth Magnets REM workshops

Leverage global network of innovation…

Monetize UTC intellectual property…

Alternative markets

New business models

UTRC EFFORTS IN BUILDING EFFICIENCY

Achieving high performance in multiple ways

Modeling Tools…

Current State: 3 audit levels, defined by ASHRAE

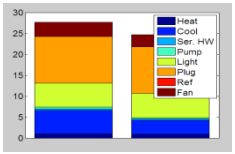
- I: Energy baseline (walkthrough and expert judgment) — 1-2 weeks*
- II: Detail assessment & retrofit evaluation (expert judgment) — 2-3 weeks
- III: Detailed modeling and verification — 3-4 weeks

Desired State:

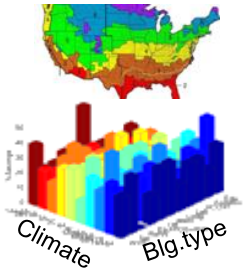
- I-II Combined — 1-2 days
- III: Detailed modeling and verification — ~1 week

Retrofit Tool (DOE Hub)

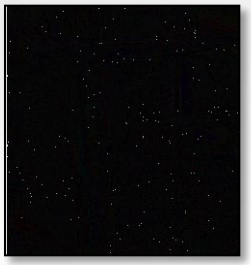
Portfolio Analysis (ESTCP)



Baseline Retrofit



Equipment…

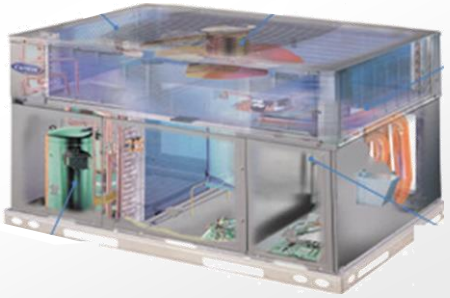


Outdoor

Indoor

Natural Refrigerant AC (BTO)
>30% energy savings

Cold Climate Heat Pump (BTO)
25% energy savings



Smart Grid Integration…

Flow Batteries (ARPA-E)

Micro-grid Demonstrations (ESTCP)

Controls and Diagnostics…

Fault Tolerant Optimal Control (ESTCP, DOE Hub)

Building Diagnostics (DOE)

HIGH PERFORMANCE BUILDINGS

Global demonstration strategy

Understanding what is possible

Risk Reduction

Pre-Commercial Customer Demo

CERL (ESTCP)

Navy Great Lakes (ESTCP)

Bldg101 (DOE Hub)

Cork Institute of Tech (IDA)

Integrated Building Energy & Safety (Tsinghua - UTC Institute)

Berkeley

East Hartford

Cork

Rome

Shanghai

UTRC Test Bed

CCS Europe

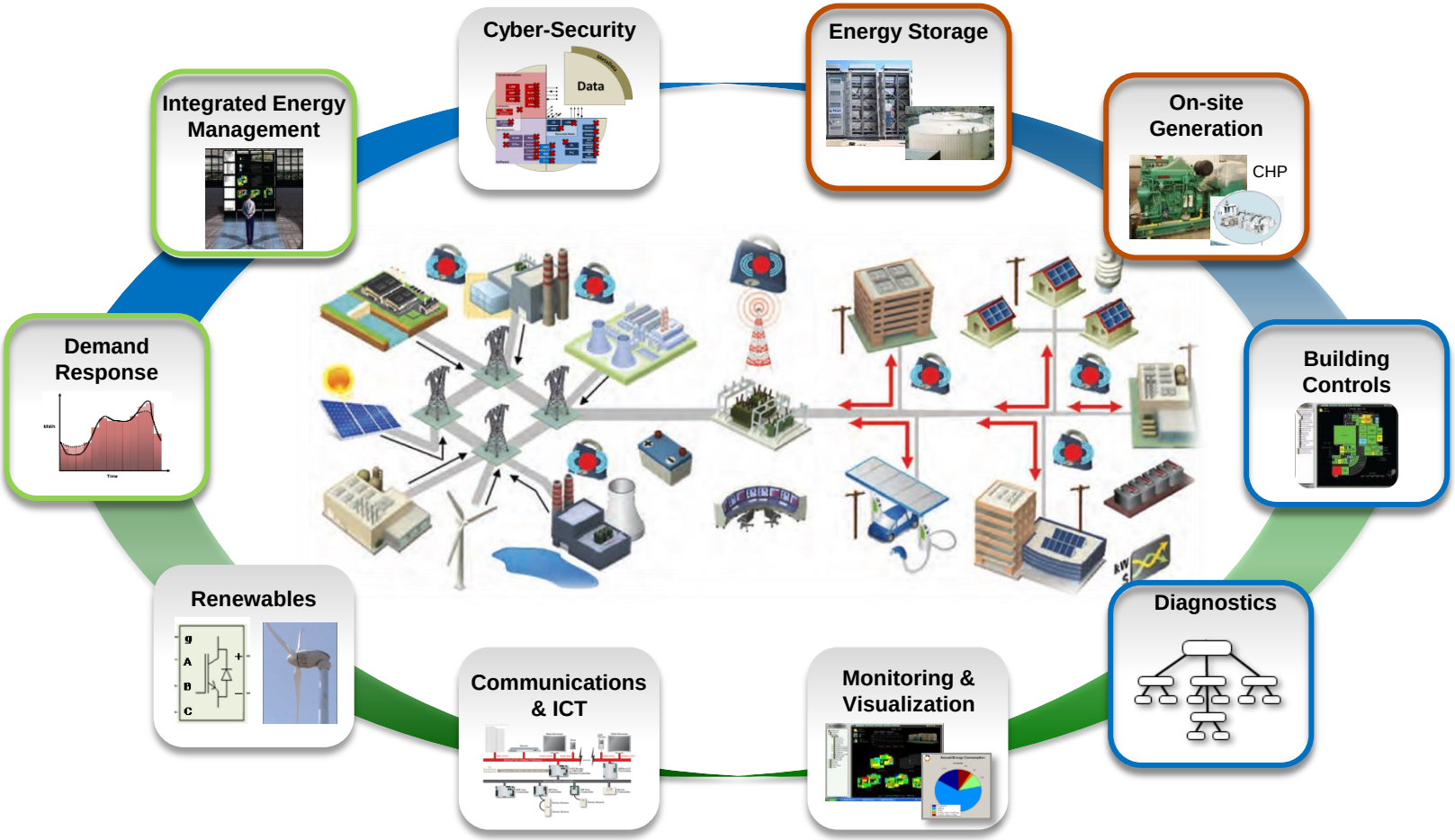
CCS Asia

India Demo

China Demo

UTRC IRELAND ENERGY RESEARCH

Innovative solutions for system integration, monitoring and operation



Developing key technology enablers for the **new generation** of **energy services and products**

United Technologies Research Center

Smart consumers and smart buildings: The active role of buildings in a transforming energy system

15th June 2016

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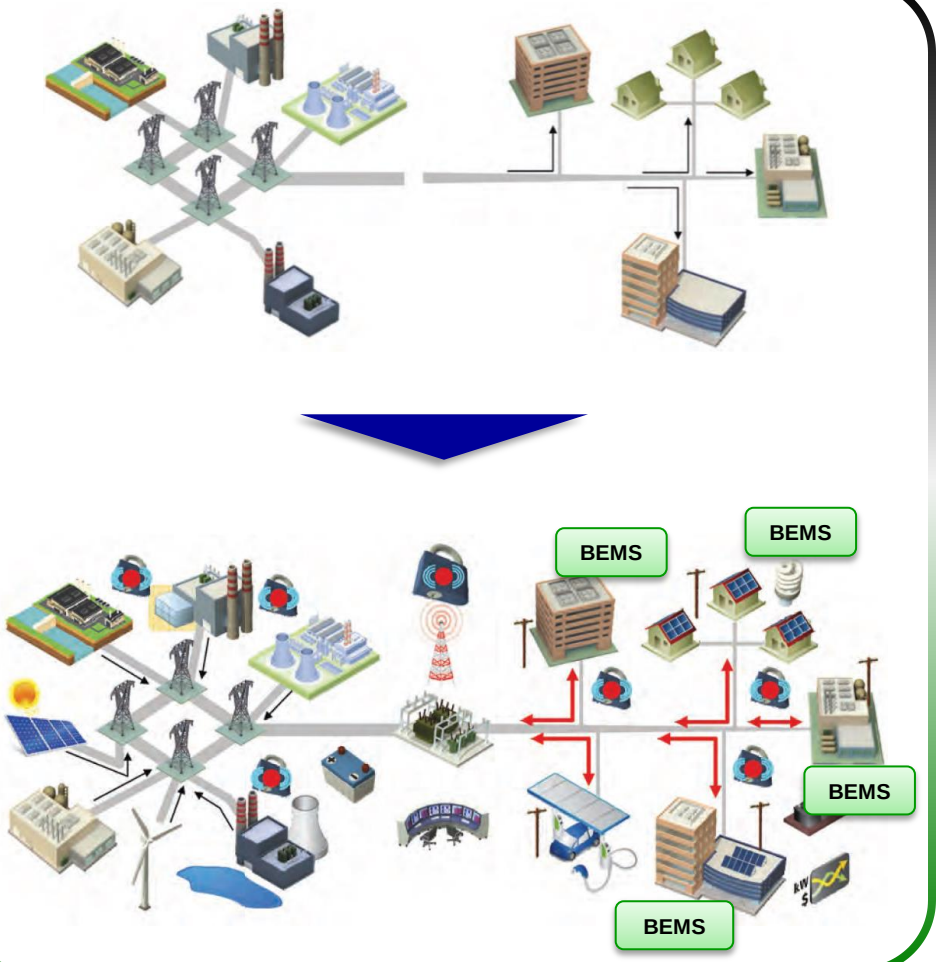
SMART GRID

Evolution of the grid: from passive to active buildings



Traditional grid

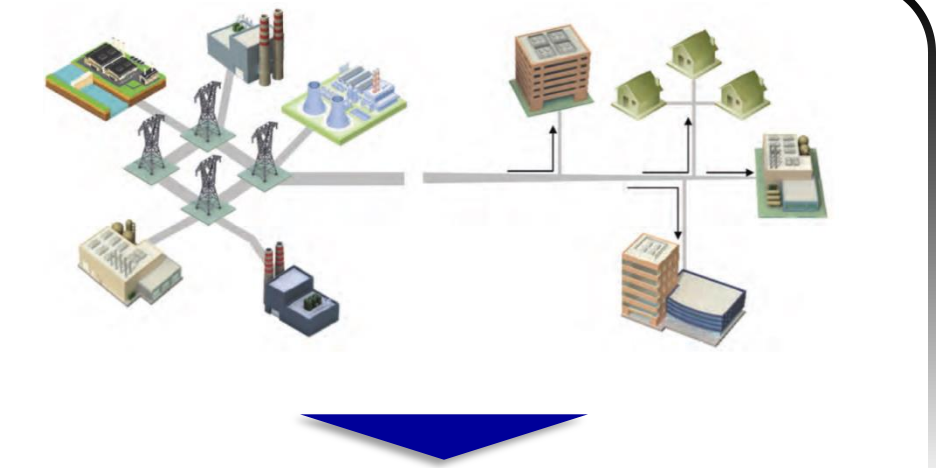
- Consumers and buildings **passive** in the grid
- **No** distributed and intermittent generation sources
- **No** distributed and intermittent loads
- **No** distributed operations (monitoring and controls)

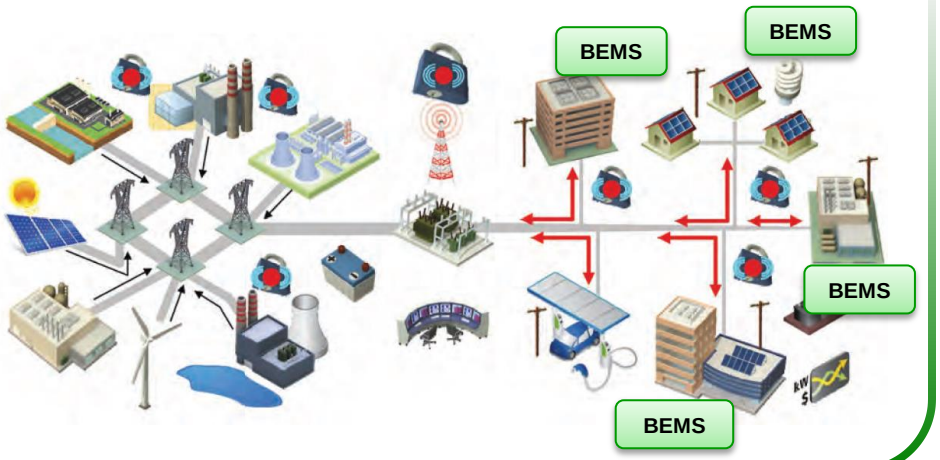
Smart grid

- Consumers and buildings **active** in the grid
- **Many** distributed and intermittent generation sources
- **Many** distributed and intermittent loads
- **Many** distributed operations (monitoring and controls)

SMART GRID

Evolution of the grid: from passive to active buildings





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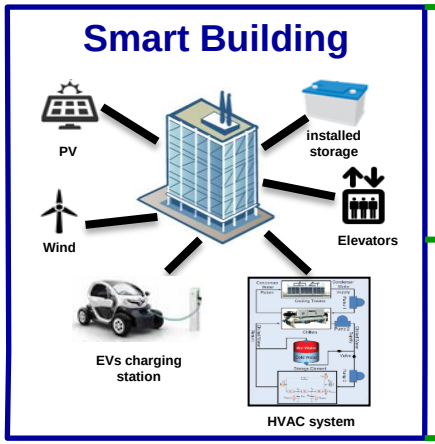
Storage systems

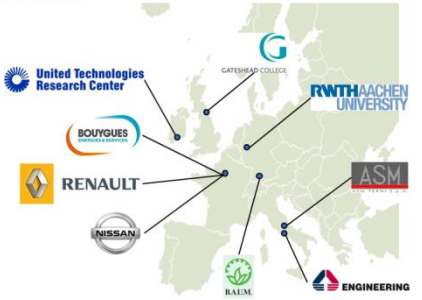
SMART BUILDING

What storage systems?



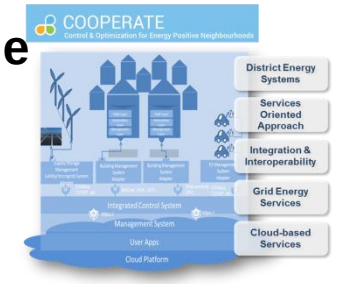
Electrical storage

Elsa
ENERGY LOCAL STORAGE ADVANCED SYSTEM
European Commission
Horizon 2020 European Union funding for Research & Innovation

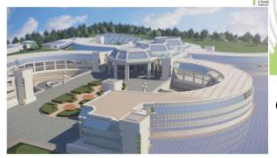


Thermal storage

SEVENTH FRAMEWORK PROGRAMME



- Multi-site supply and demand optimization
- Distributed energy generation and storage



Bouygues Challenger Campus Demonstrator

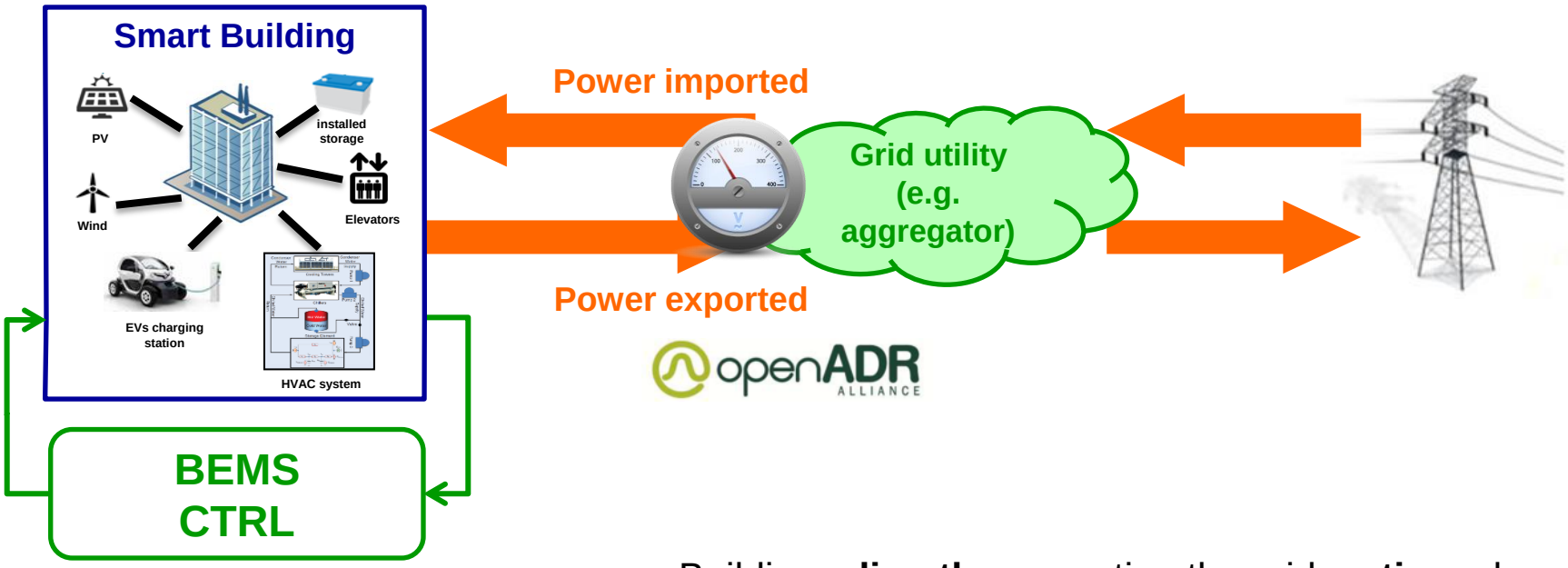
Cork Institute of Technology Demonstrator

Virtual storage

Efficient buildings

BUILDING2GRID

Smart buildings supporting the smart grid through aggregation



Buildings **directly** supporting the grid: **active** role

Buildings communicating **flexibility**

openADR allows for automated demand response services

BEMS **coordinates** building operations, **guaranteeing comfort**