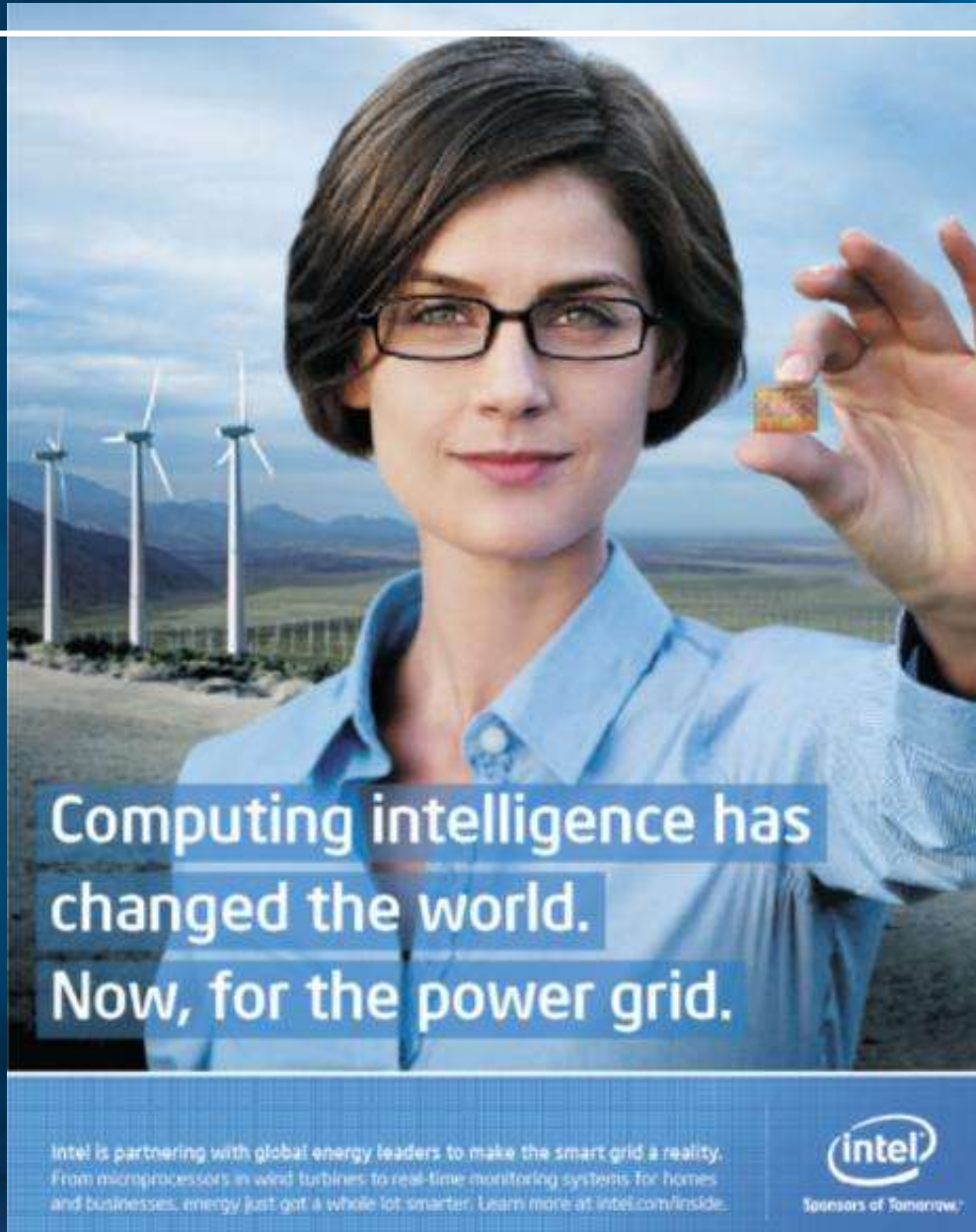



Energy & Sustainability



Computing intelligence has
changed the world.
Now, for the power grid.

Intel is partnering with global energy leaders to make the smart grid a reality. From microprocessors in wind turbines to real-time monitoring systems for homes and businesses, energy just got a whole lot smarter. Learn more at intel.com/inside.

 Sponsors of Tomorrow.

David Boundy
Director,
SAP – Intel Collaboratory, Intel Labs

Agenda

- A bit about Intel Labs
- The Opportunity for embedded intelligence
- What we're doing in Intel Labs on Energy and Sustainability
 - Personal Energy Management
 - Smart Cities
 - Smart Grid / Integration of Renewables
 - Smart Water / Oceans

Intel's Vision

This decade we will create and extend computing technology to connect and enrich the lives of every person on earth.



Intel Labs Overview

Delivering Breakthrough Technologies to Fuel Intel's Growth

World Class Research



Parallel Computing



Energy Efficiency



Trust & Security



Si Photonics
& Wireless



User Experiences

...and much more!

Strong Research Partnerships

UNIVERSITIES



GOVERNMENT



INDUSTRY



Technology Transfer

INTEL PRODUCT GROUPS

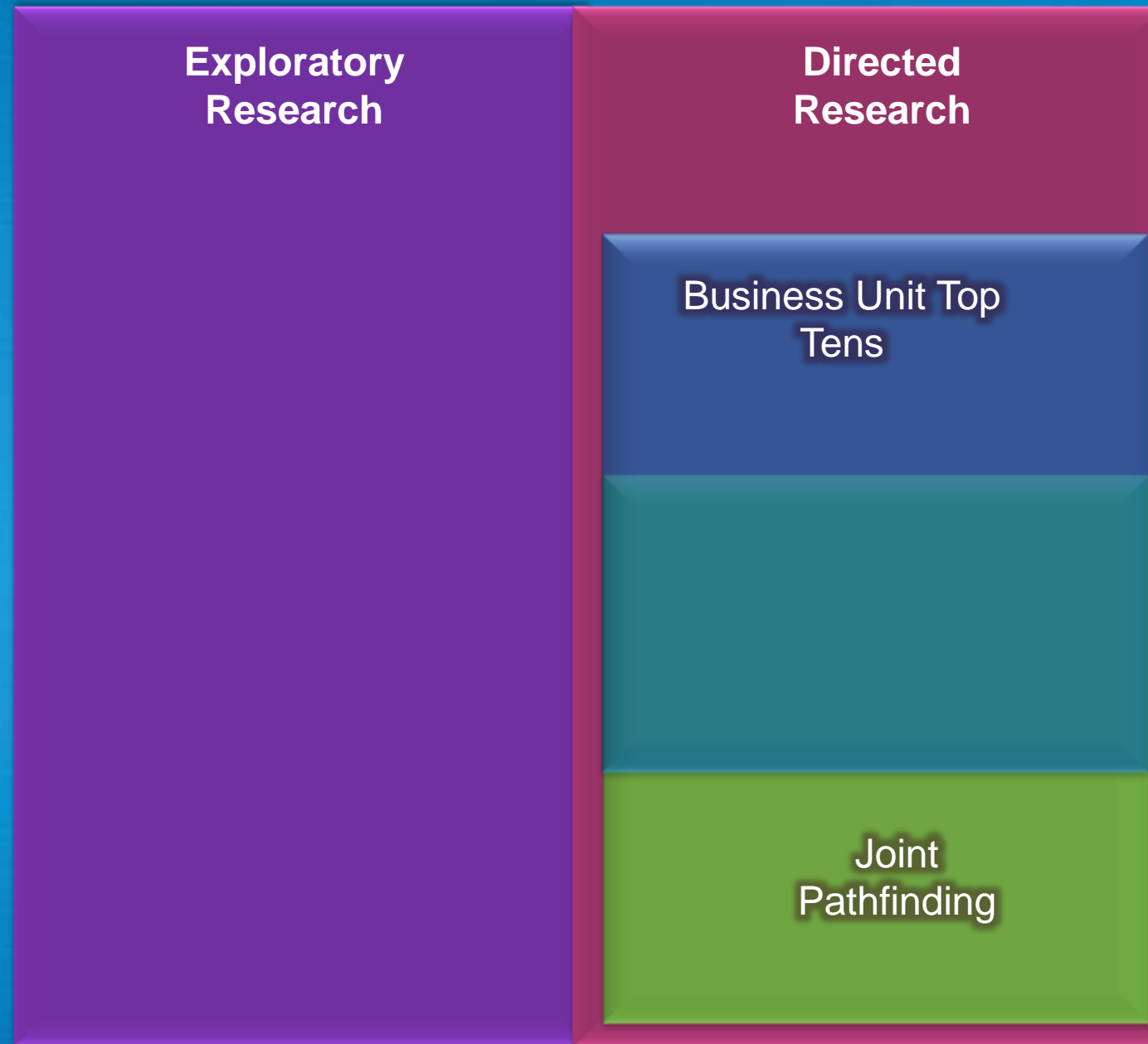


Driving Intel's Technology Pipeline

From Research to Plan of Record via Joint Pathfinding



Intel Labs Research Portfolio



Exploratory Research: 3-5 year horizon

Directed Research: 1-3 year horizon

- BU Top Tens: highest priority projects identified by business units
- Joint Pathfinder: joint projects with identified product intercept

Diverse Fields of Research



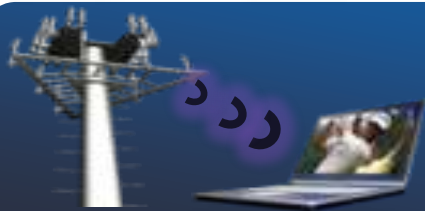
Health &
Assisted Living



Transportation
& Automotive



Embedded &
& Mobile Computing



Wireless
Communications



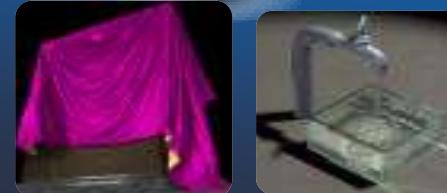
High Tech
Low Carbon



Security and Trust



Exa-scale & Cloud
Computing



Visual Computing



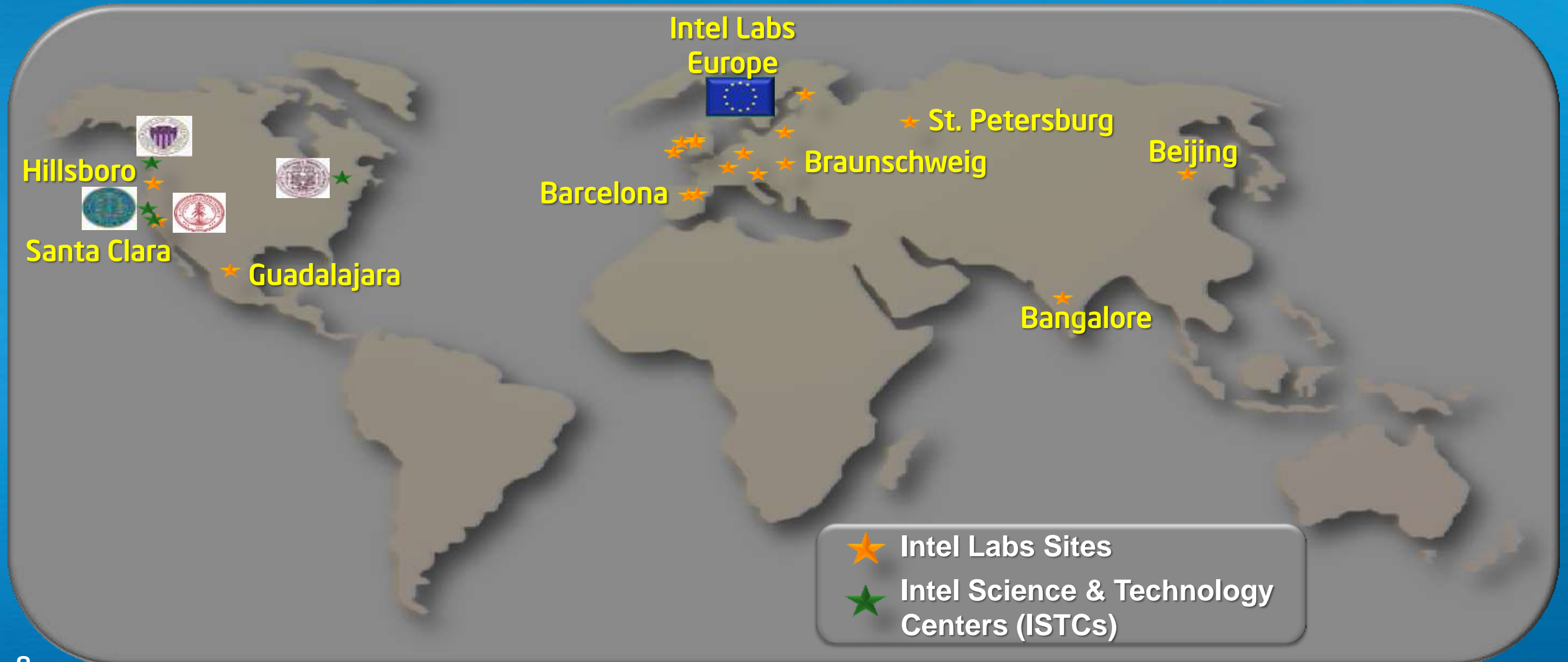
Microprocessor
Architecture



IT Capability &
Services

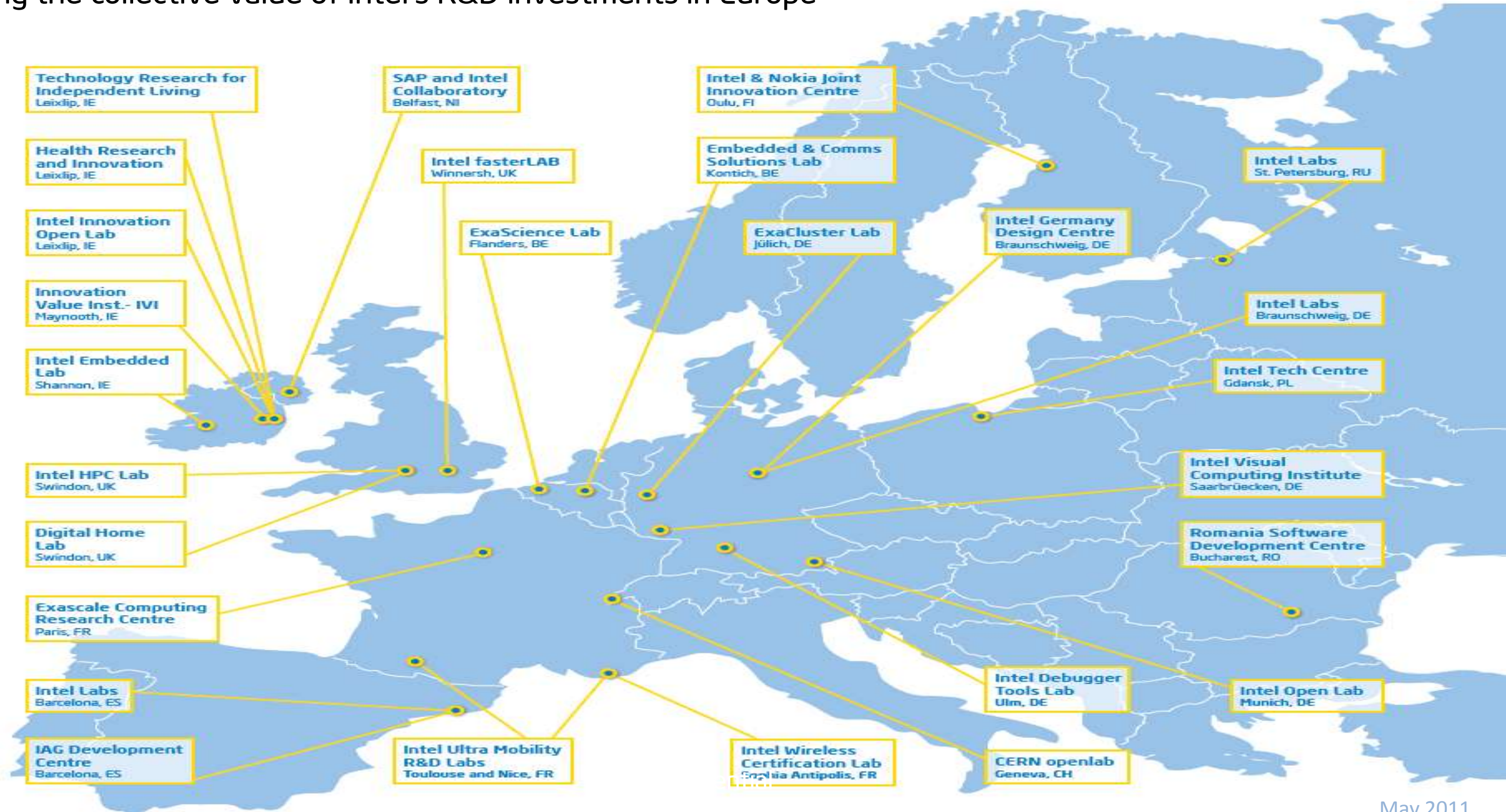
Intel Labs Research Locations

1000 People Worldwide



Intel Labs Europe Network

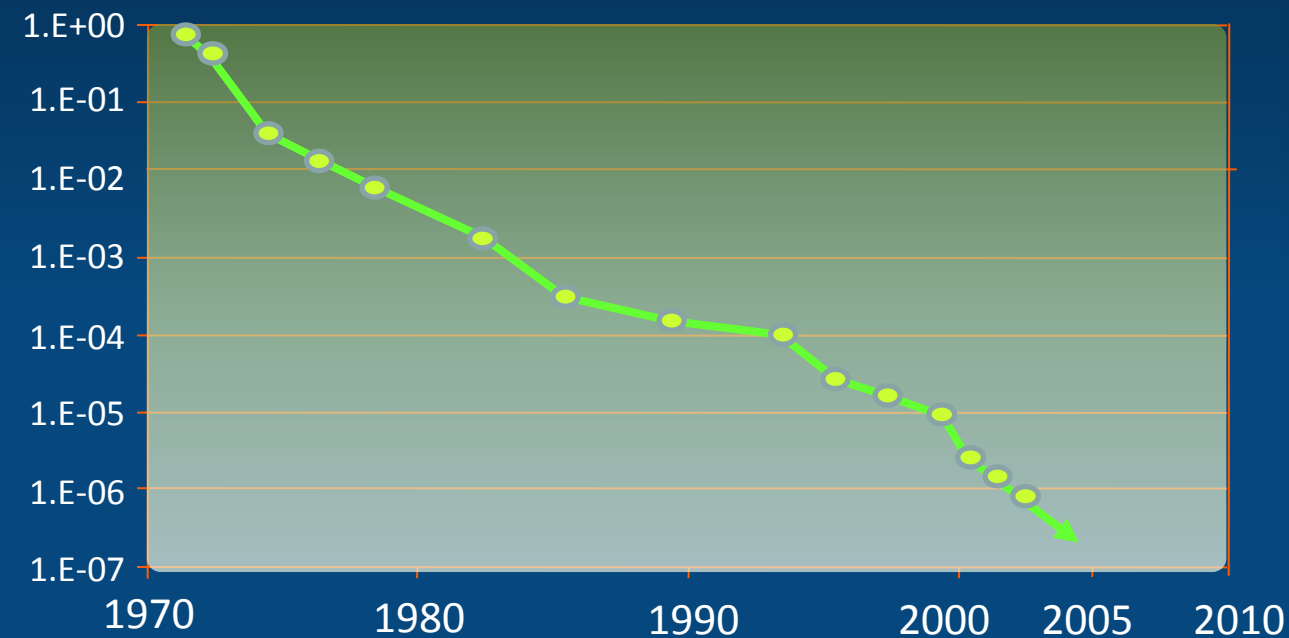
Harnessing the collective value of Intel's R&D investments in Europe



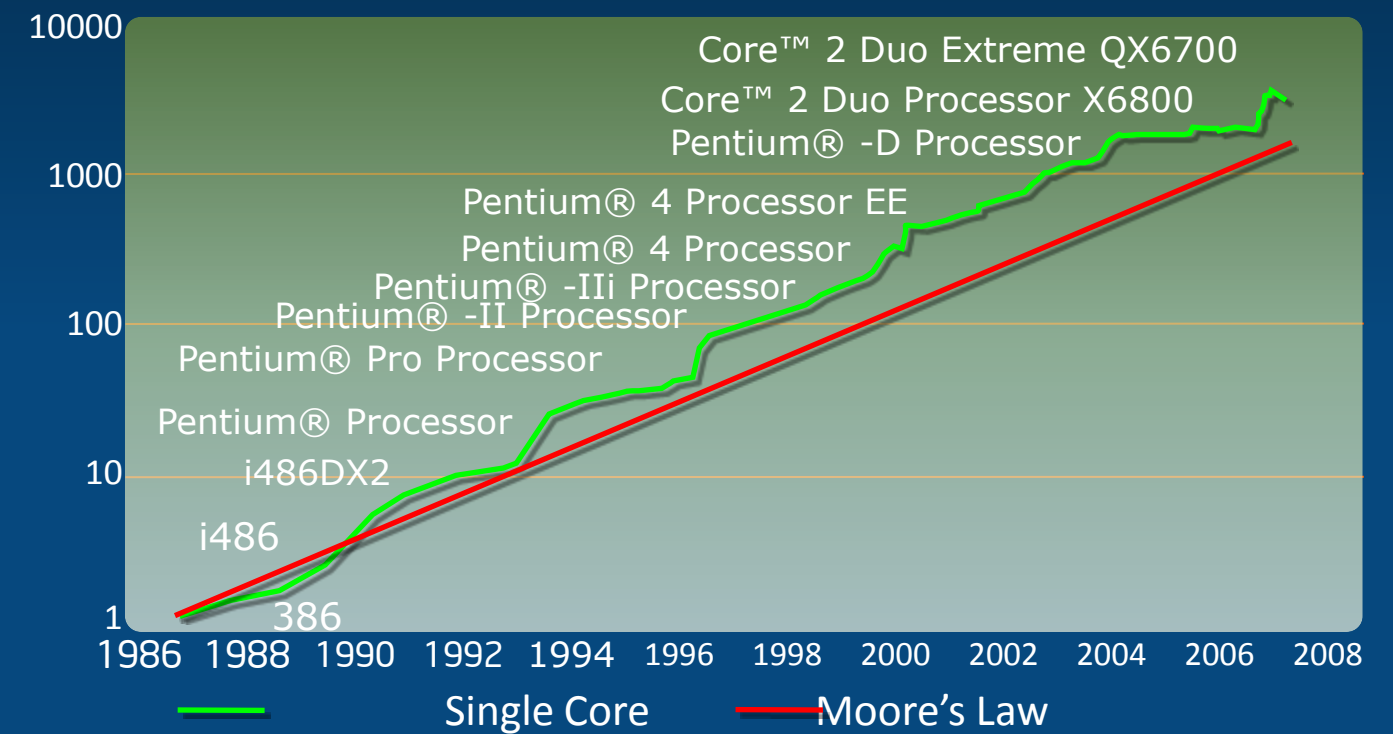
THE ROLE OF ICT IN SMART SUSTAINABLE SOCIETY

MOORE'S LAW DRIVES CONTINUOUS CHIP-LEVEL ENERGY EFFICIENCY

Power reduction Over Time*



Core Integer Performance Over Time*



1 million x factor reduction in energy/transistor over 30+ years

Smaller, faster transistors = faster AND more efficient chips and computer systems

And The Trend Continues...

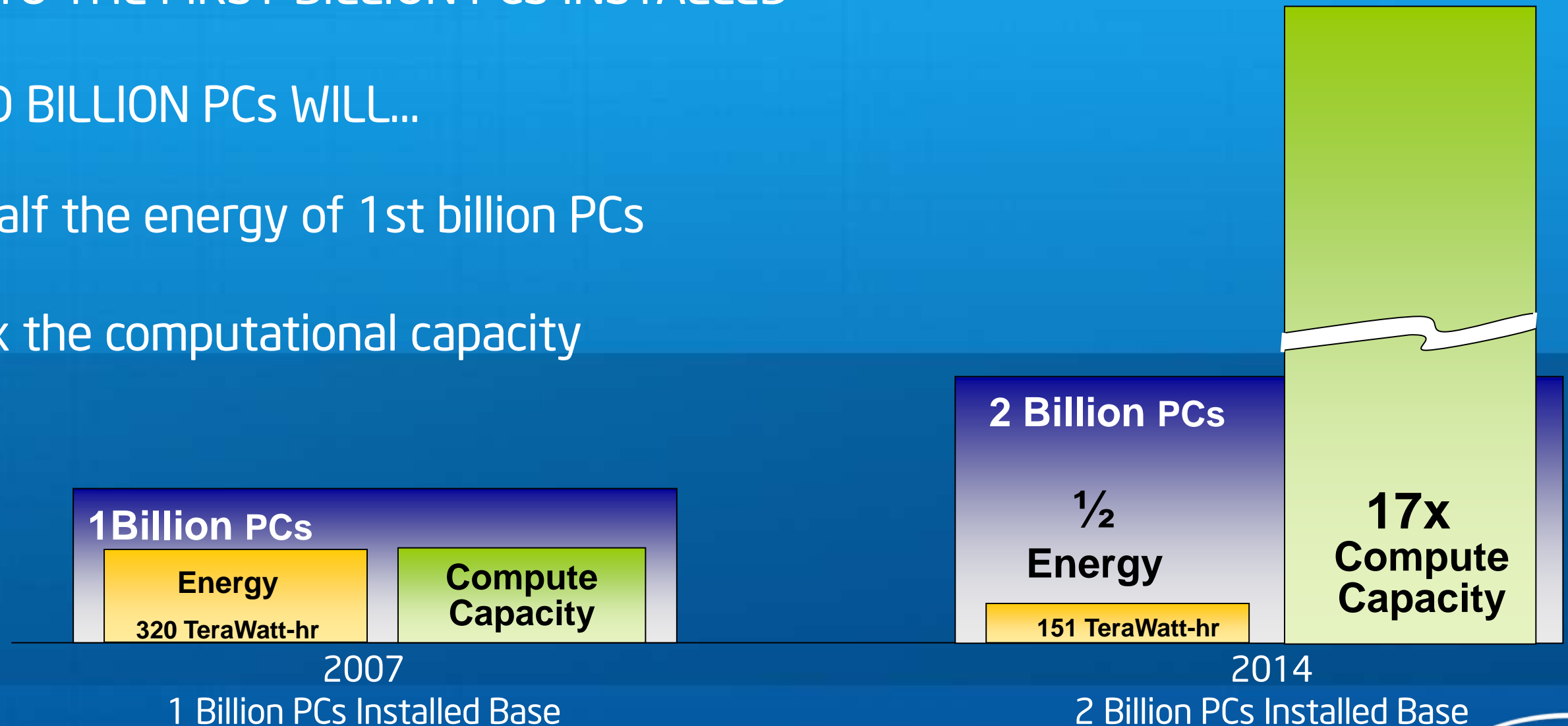
Source: Intel Corporate Technology Group

COMPARED TO THE FIRST BILLION PCS INSTALLED

THE SECOND BILLION PCs WILL...

...consume half the energy of 1st billion PCs

...deliver 17x the computational capacity



Source: Intel Microprocessor Marketing and Business Planning, and Intel iAG/PCCA Power Initiative team, PBCA-PPM



Intel Labs Europe

Intel technology for the environment

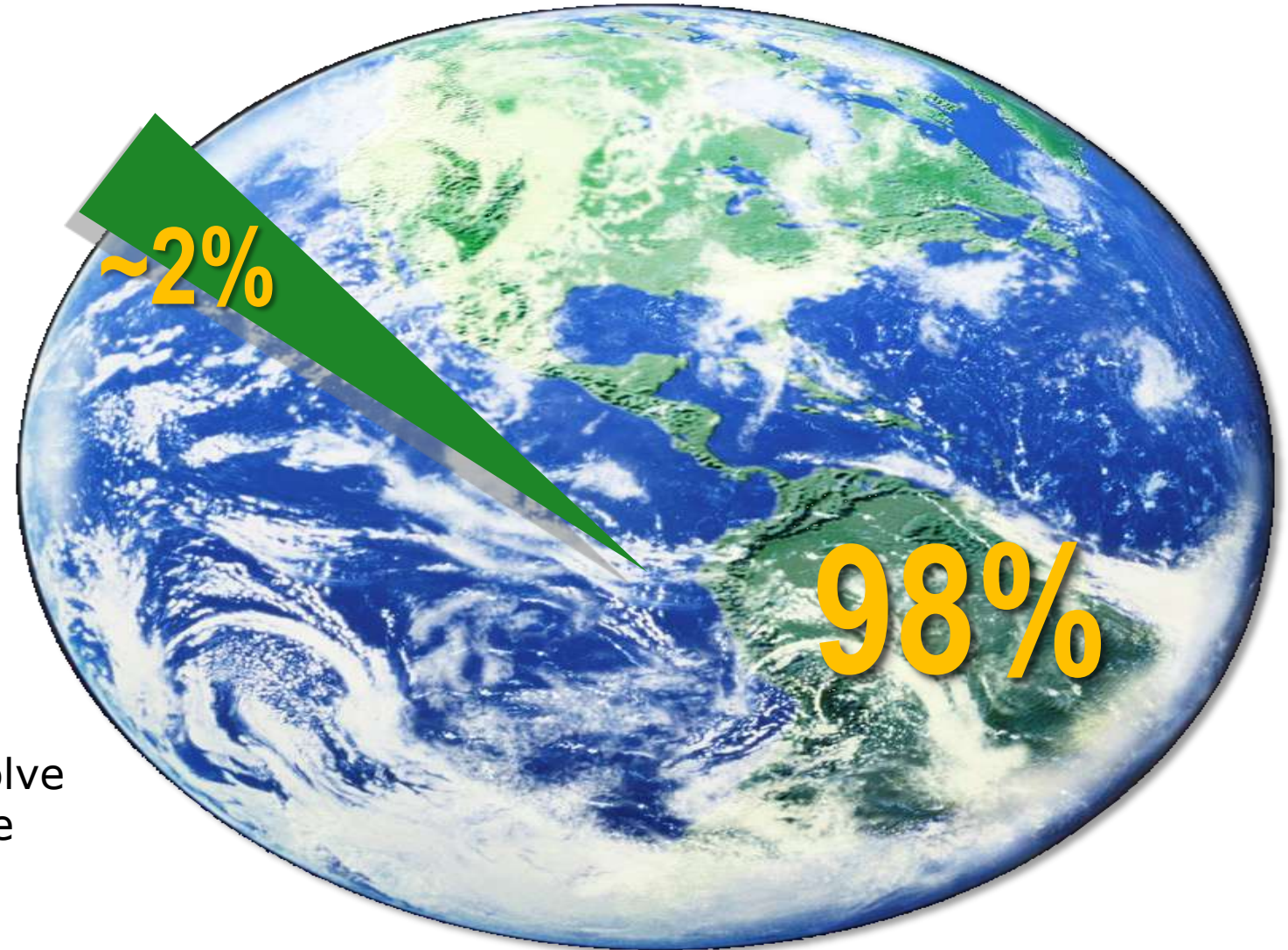
2% Opportunity

Enable IT industry
to be more
energy-efficient

26 trillion watt-hours of
electricity saved between
2006-2009*

98% Opportunity

Use energy-efficient computing to help
others reduce their own consumption and solve
complex environmental challenges facing the
planet



Intel Confidential

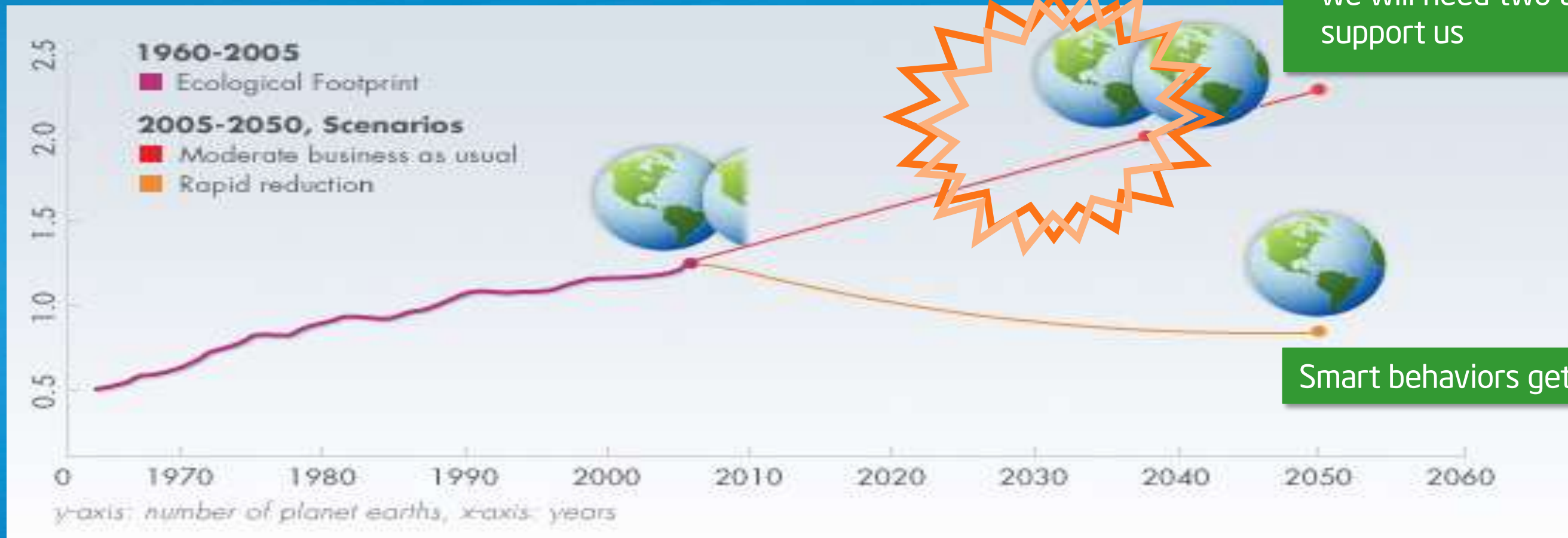
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THE ROLE OF TECHNOLOGY AND PEOPLE IN A SMART SOCIETY

YOU NEED A SMART SOCIETY TO HAVE A SUSTAINABLE SOCIETY

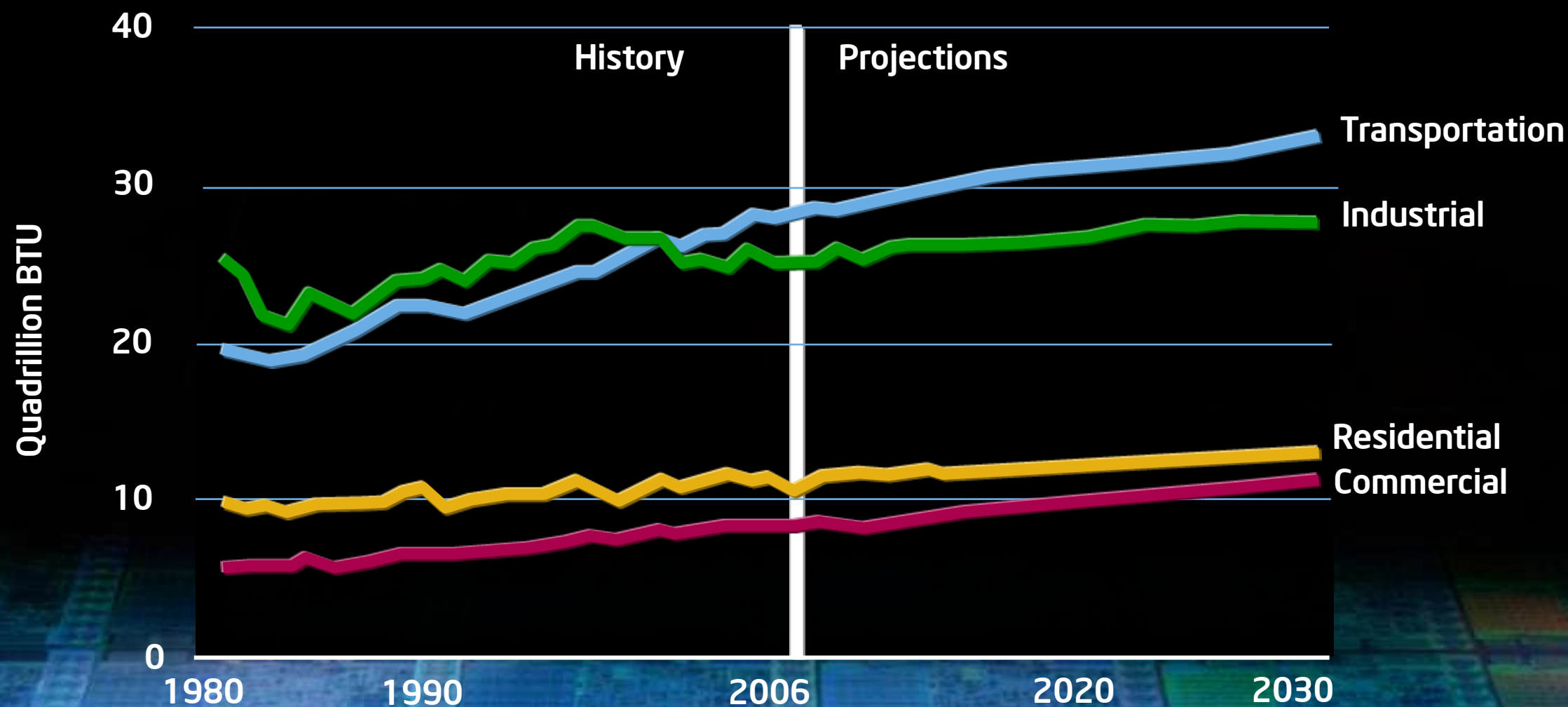


If consumption trends continue, we will need two Earths to support us

Smart behaviors get us here

The Most Energy Intensive Sectors...

Delivered Energy Consumption by Sector



Source: EIA Annual Energy Outlook 2008



... Have Been the Least [Smart] IT-intensive

Company Segment	Percentage of Revenue Spent on IT
Media	8.2%
Professional Services	6.9%
Information Technology	6.9%
Financial Services	5.9%
Electronics	5.6%
Banking	5.6%
Pharmaceuticals	5.5%
Health Care	4.6%
Cross Industry	4.5%
Construction & Engineering	4.4%
Transportation	3.9%

Source: Gartner Consulting (July 2005), Smart 2020 report



Make the World More Energy Efficient

Manufacturing



Construction



Transportation



Government



Broadband



Energy



Healthcare



Education



THE ROLE OF TECHNOLOGY AND PEOPLE IN A SMART SOCIETY

A SMART GRID NEEDS SMART PEOPLE TO HAVE AN IMPACT

At Home

Average US household could:
Reduce energy consumption by up to 31%

An equivalent to taking 16.5 million cars off the road or
reducing annual coal demand by 11.5 million metric
tons

At Work

Average US commercial building could:

Reduce energy consumption by at least 10%

An Equivalent of taking 9.5 million cars off the road or
reducing carbon emissions by 42.9 million metric tons

A COMBINED POTENTIAL OF
26 MILLION CARS
54 MILLION METRIC
TONS OF COAL

Sources:

Wipro Consulting Services, Sept 2009-- Next Generation Home Energy Management Systems – A Mass Deployment Impact

US DOE Building Energy Databook 2008-- US Average Monthly Electric Bill by Sector <http://www.eia.doe.gov/cneaf/electricity/esr/table5.xls>

Oregon Sustainability Center, Project Research & Analysis

The "Compute Continuum" and the Environment



Intel has the trust and
the technology to
contribute end-to-end



Desktops



Laptops



Netbooks



Personal Devices



Smartphones



Smart TVs



Embedded

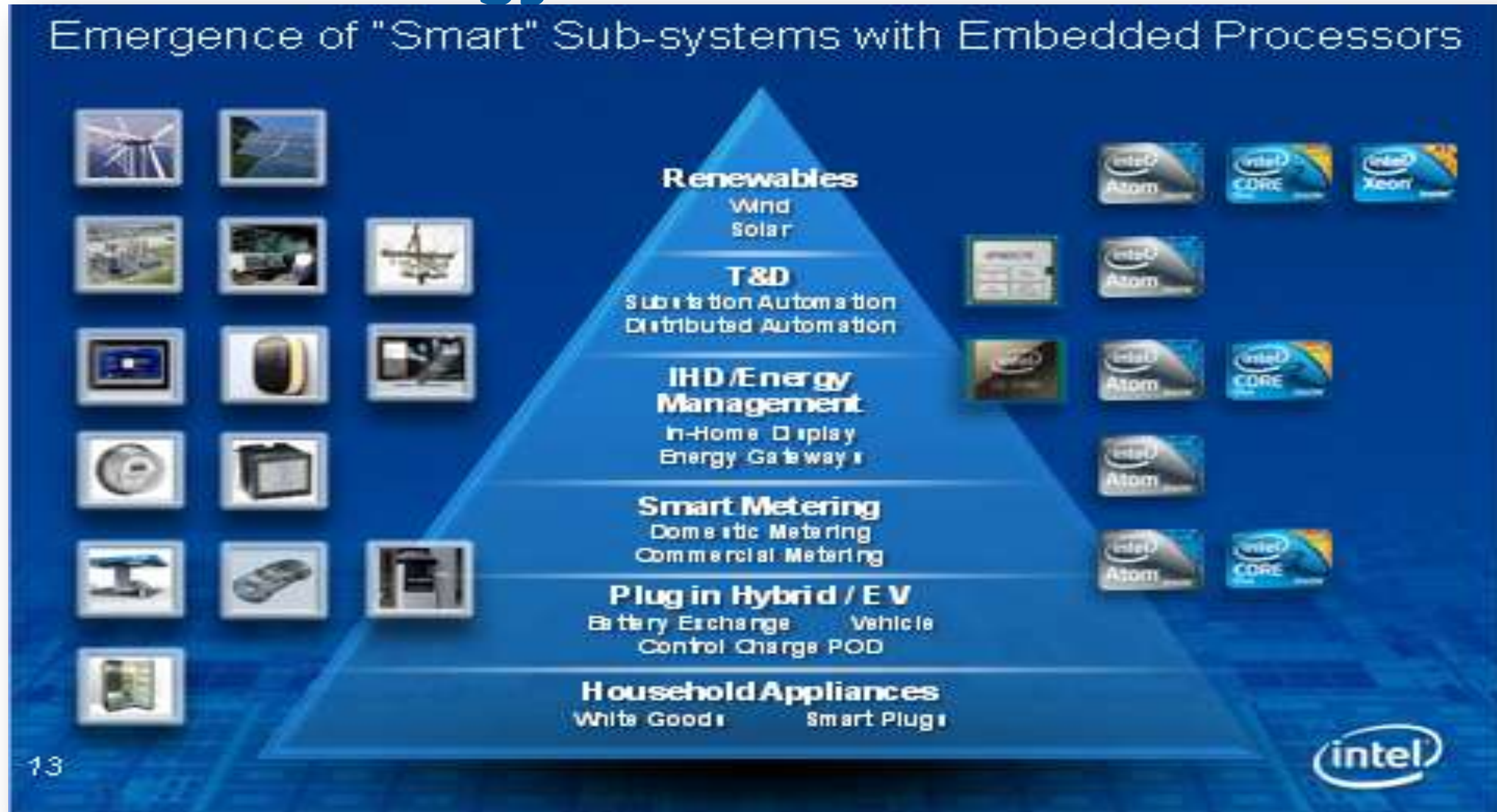


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Embedded energy solutions



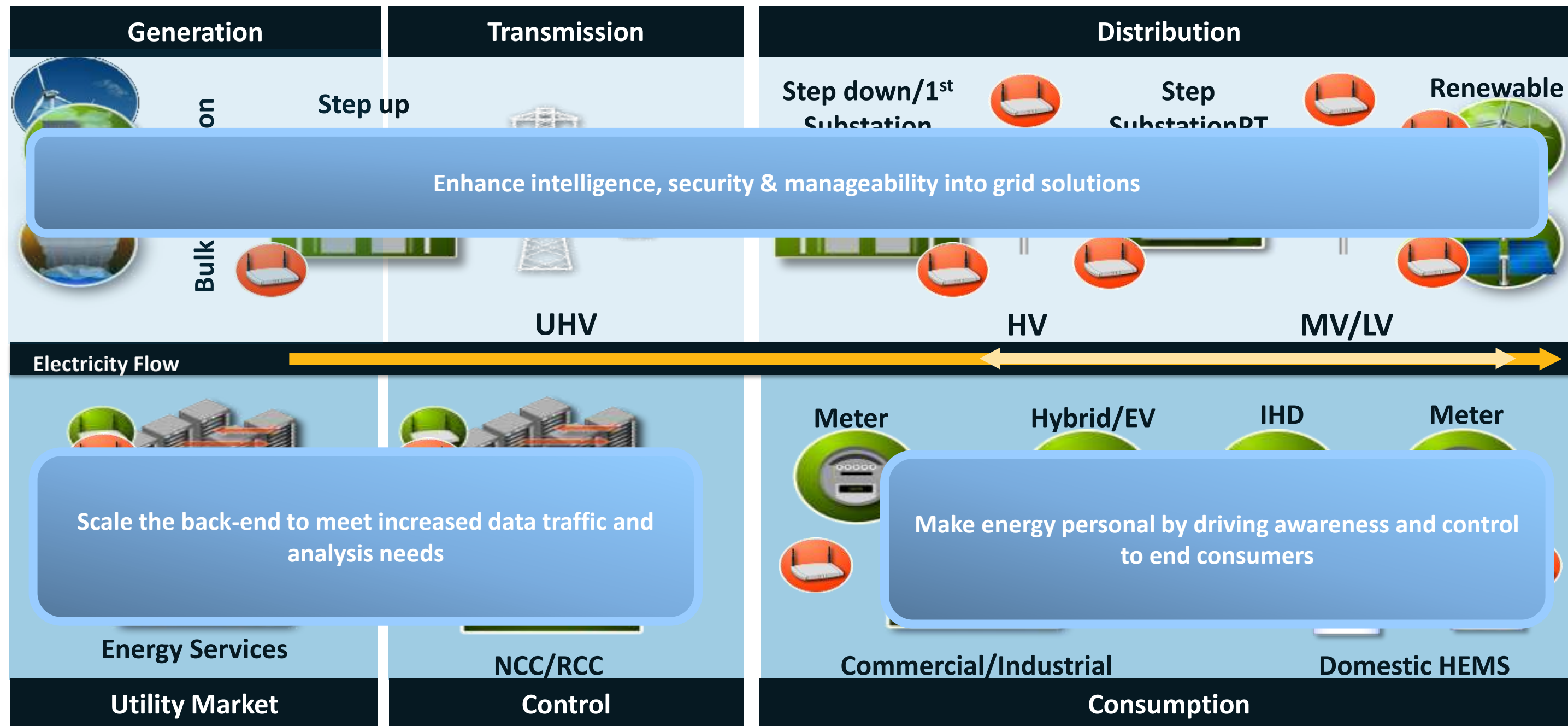
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EVOLVING ENERGY GENERATION AND DISTRIBUTION

The case for advanced ICT



Where ICT will play

Remote Manageability
Big Data Analytics
Security
Wireless Communication
Data Center Technology
HPC
Embedded Solutions



Smart Grid Control Center

Supply & Demand Forecast / Pricing
Simulation (Weather & Grid)
Grid Information Systems
Predictive Analytics
Automated Control
Real Time Billing
Demand Response



Communications



Control & Protection



Security



Standards



Field Crews



Asset Health



Performance



Virtual Power Plants

Peak Load Management



Transmission



Substation



Distribution Feeder



DG, EV, PV Renewable



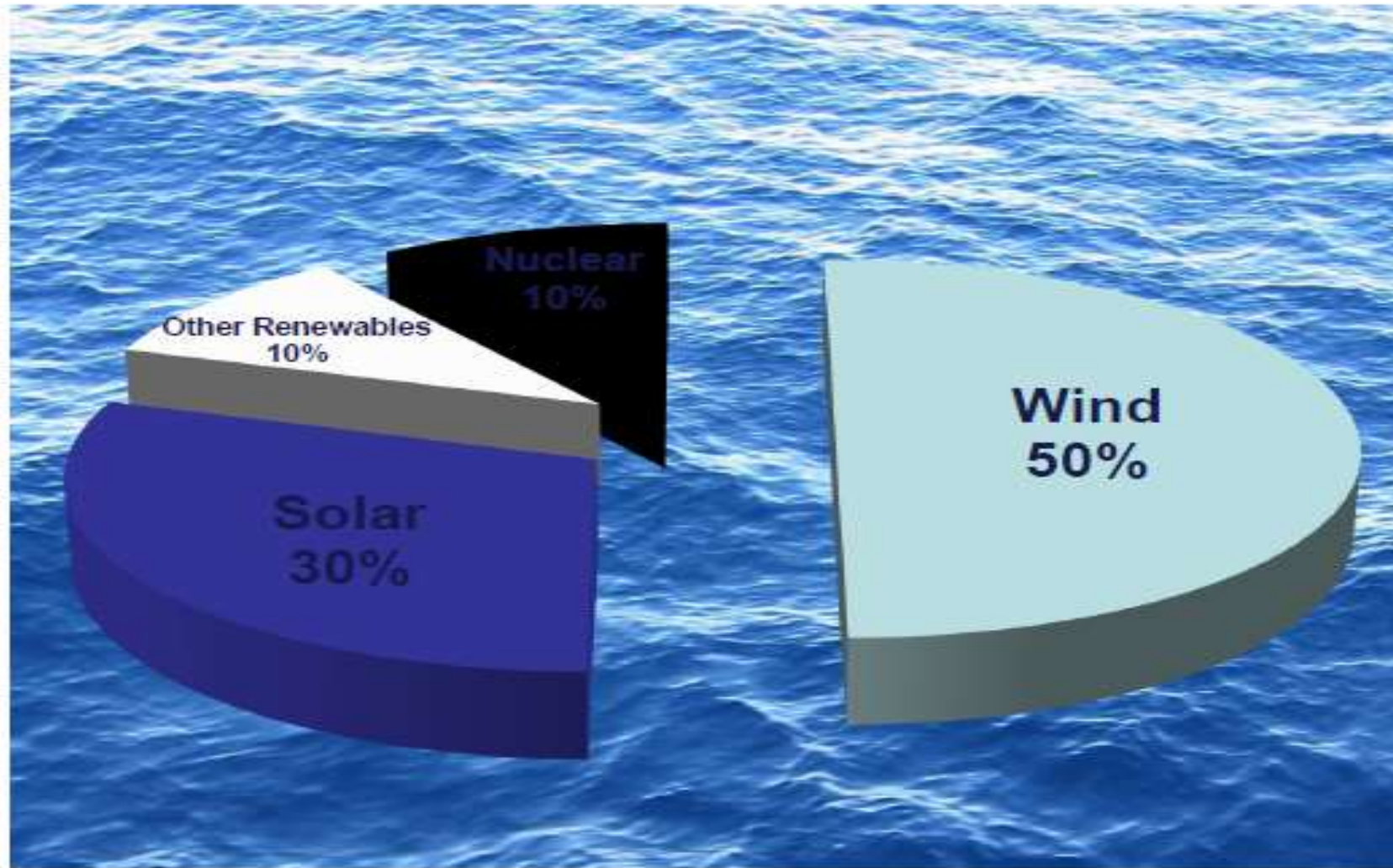
Smart Meters



DR, HAN, Customers

CONNECTED. MANAGED. SECURE. **FAST.**

Europe's future energy supply 2050?



Energy Demand

Offshore Winds farms are needed for Europe to meet Green House Gas Targets

Interconnection across EU member states is needed to enable Offshore Wind

Interconnection, or Supergrid is vital for delivery of any 2050 scenario

2020 offshore grid connections must be Supergrid-compliant

Energy & Sustainability Lab

Drive sustainability into and beyond our platforms through novel sensing, actuation, analytics and services to enable innovative, sustainable and energy efficient solutions.

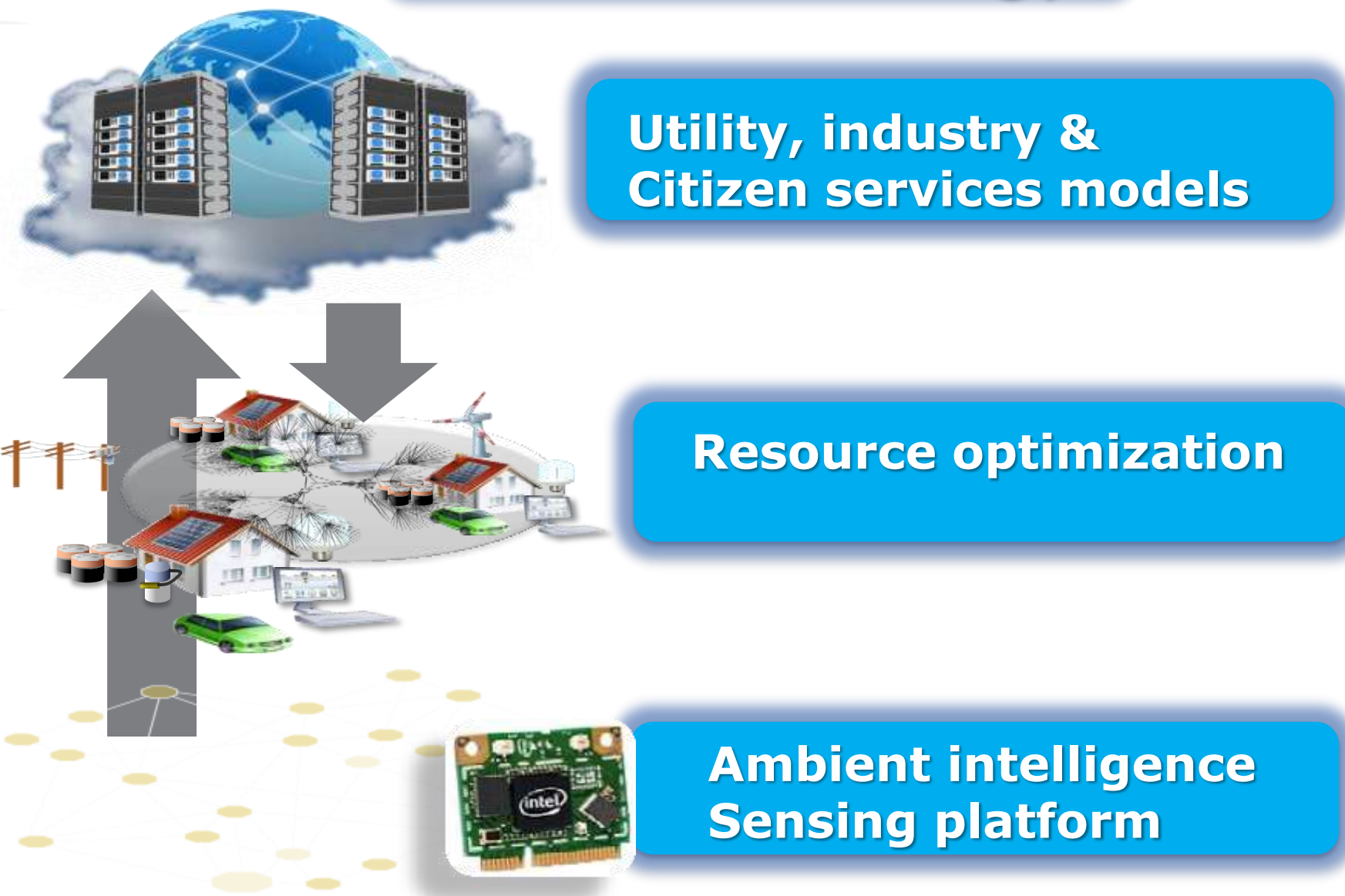
- Increased trend / need for ubiquitous intelligence
- Decrease in fossil fuels and increased consequence of climate change
- Increased population growth and increased urbanization
- Increased water scarcity and need to monitor / manage marine resources



Sensing, Actuation, Analytics and Services for
Energy, Environment and Sustainability domains

Energy and Sustainability Lab research program

Research strategy



Domains



Test beds



Research Problems and Opportunities

New Socio-Economic Model

Electric Vehicle Integration

Moore's Law working with Sustainability

Sustainable and Dependable Cloud Computing

DC Adoption in the Datacentre

Renewables Integration

European Supergrid

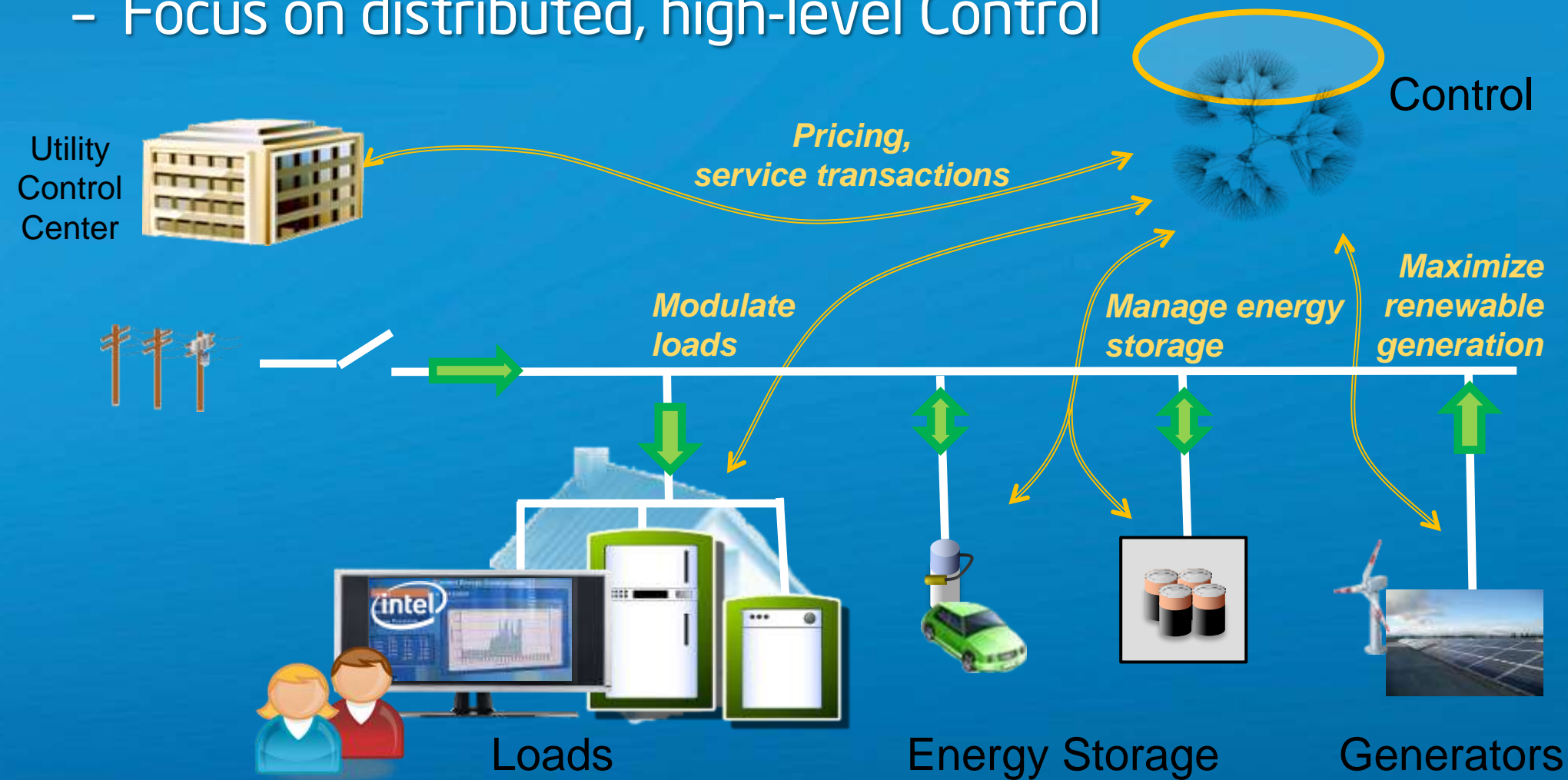
Automation, Dematerialization, Substitution



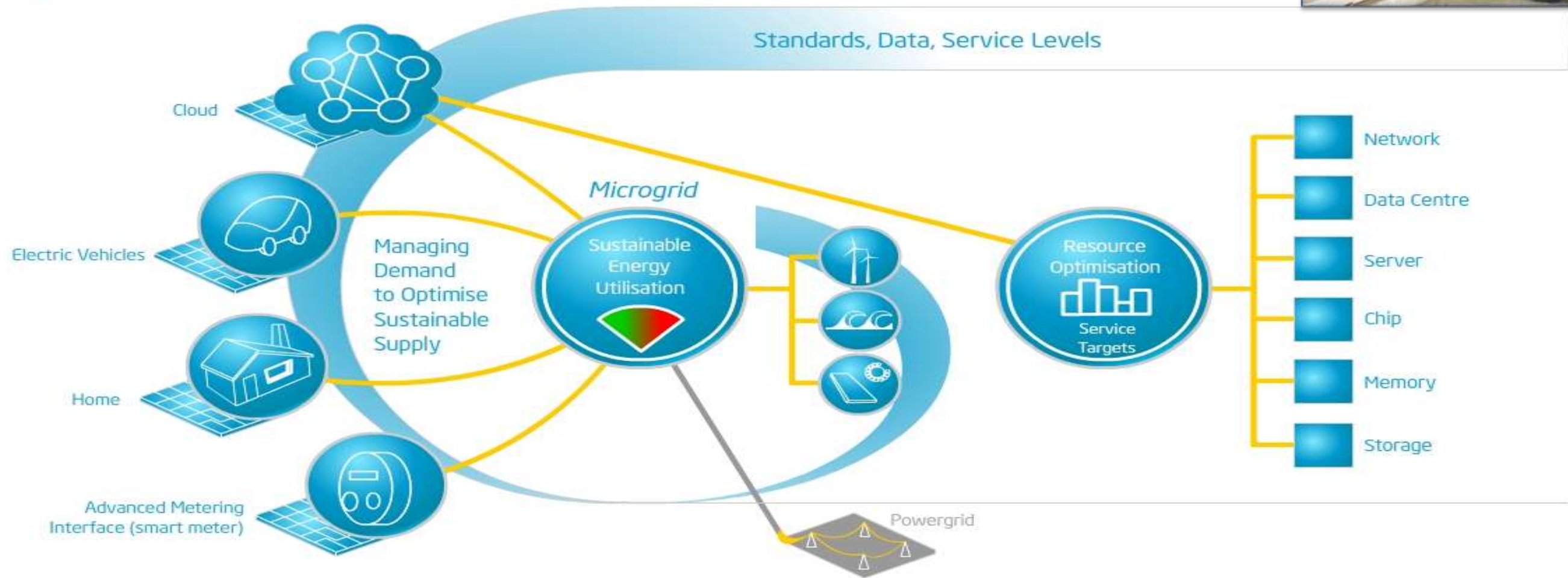
Personal Energy Management

Personal Energy Systems

- Local (Loads + Generators + Energy Storage + Control)
 - May have ability to operate independently from main grid (if grid-tied)
 - Focus on distributed, high-level Control

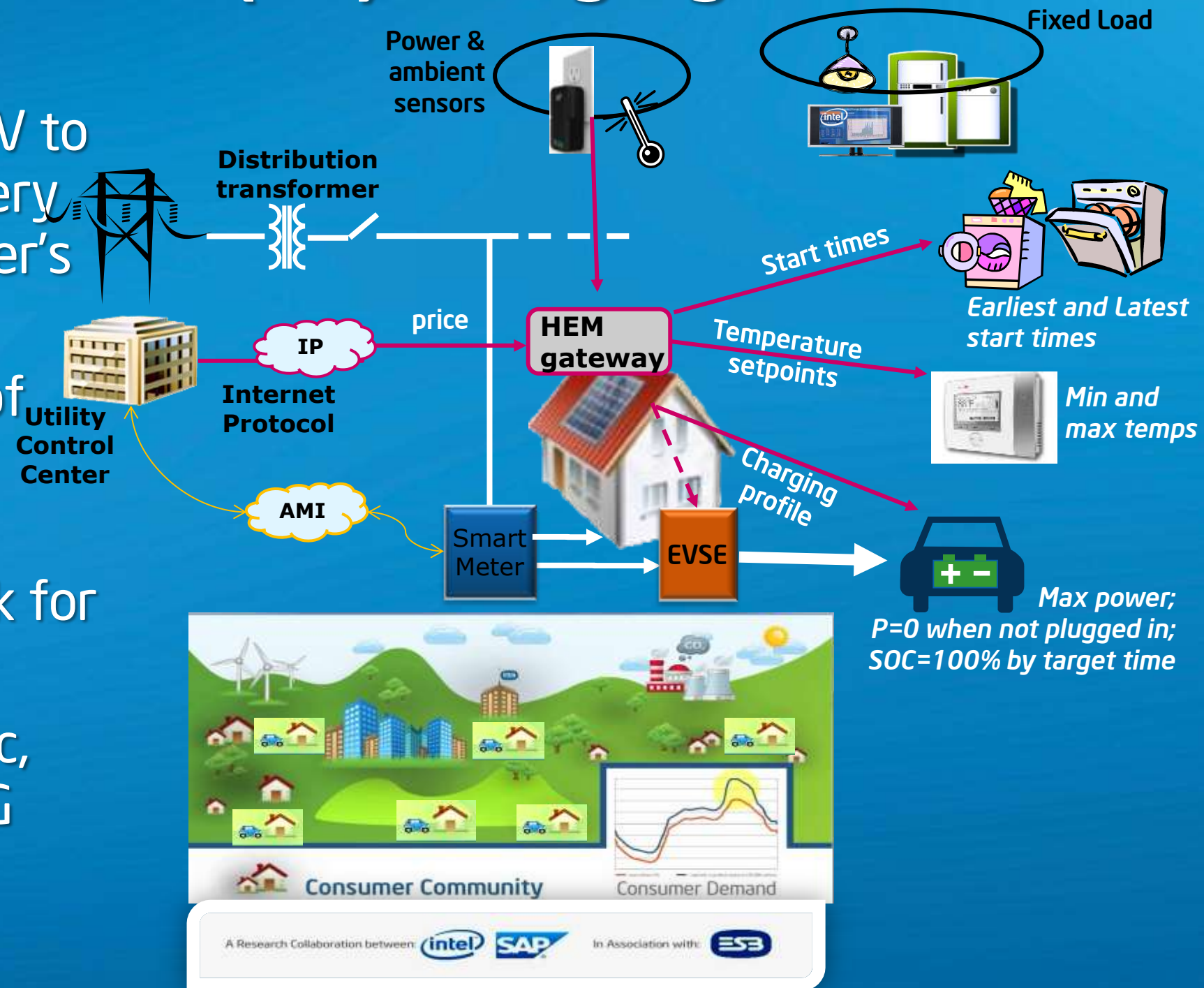


SAP-Intel co-Lab



Optimized Electric Vehicle (EV) charging at home

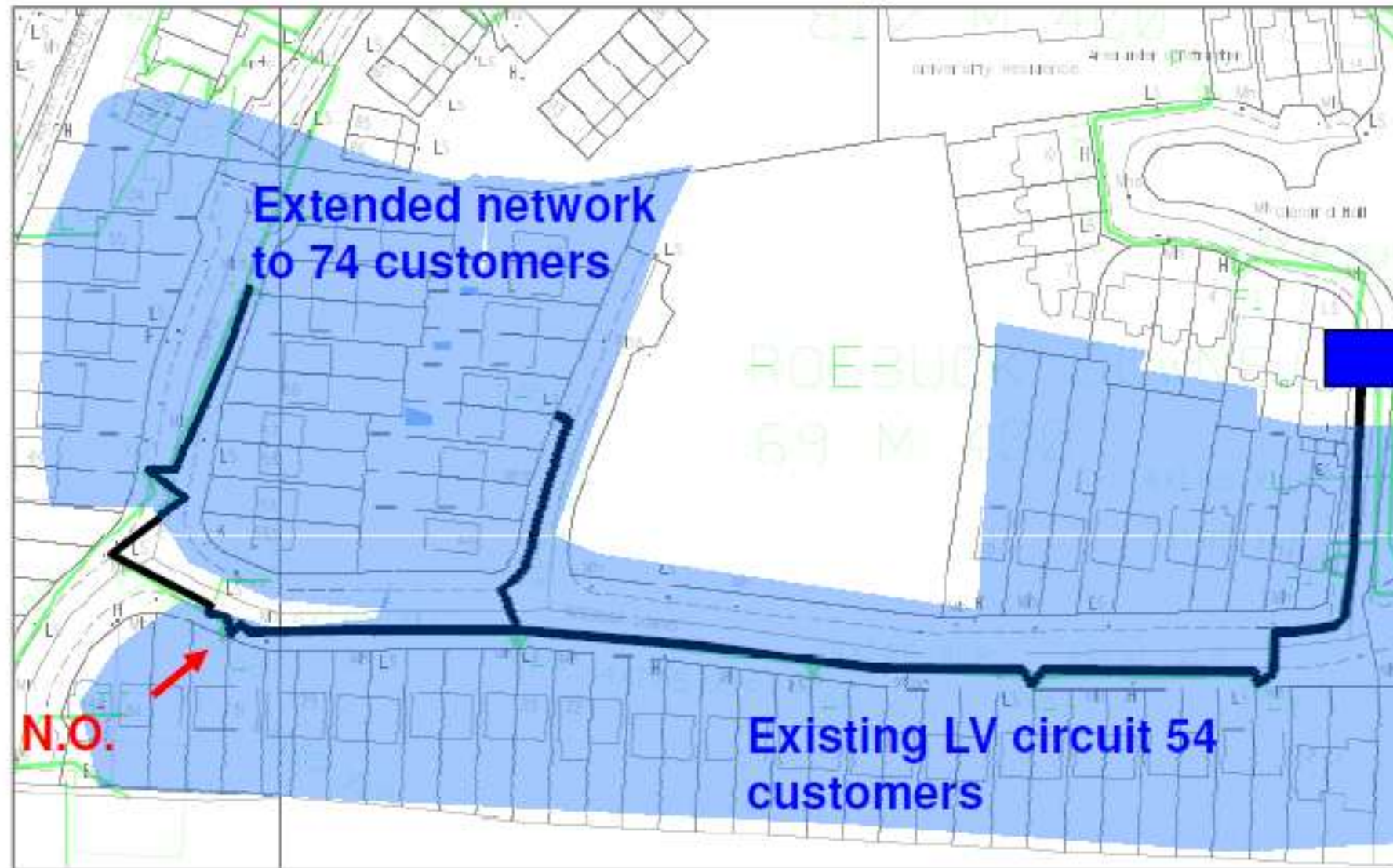
- Objective : Control charging of EV to minimize cost (electricity + battery degradation) while meeting driver's (learned) preferences
- Scope : a) single home, as part of overall HEM* solution, b) several homes, EV only
- End goal : analytics building block for Smart Grid applications
- Ext/Int partner : Pecan Street Inc, SAP, ESB, Renault / ISG and MCG



*HEM = Home Energy Management

EV Load Aggregation in Response to Line V

Network Reconfiguration



POEM- An Overview

Personal Office Energy Monitor

- Holistic, visual representation of personal energy consumption in the work place
- Mechanism for energy mgt. services for building occupants & building management
- Adds People as “sensors”

User Experience, Sensor Enabled

- Garden of Flowers Metaphor
- Visual feedback relative to target goals... and comparison to others
- Alerts (sample shown)
 - Integration with Windows 7 allows for notifications
 - Notification will have different states based on energy use relative to target goals
- Mimics Intel's Ultrabooks from a sensor-enabled POV

“Cloud” based Services (ESB)

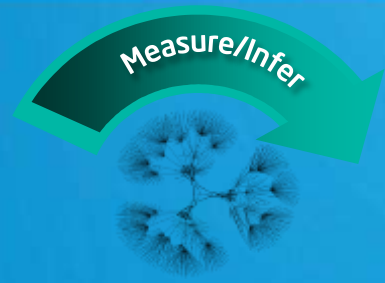
- Sensor data base & analytic services in the “Cloud” feeds POEM clients: Targets, Comparisons, Alerts
- Custom Analytics provides insight to Building Management Systems
- Energy goal-setting on per-user basis
 - Building occupants view energy usage relative to targets
 - Building manager sets goals /manages overall building



Makes people aware of energy ...
...Makes building aware of people

Unobtrusive Sensing

Load Disaggregation in concert with utility metering



Infer Appliance Operation by Sensing AC Line Signals



Simple, Low-cost Wireless Sensor
Anyone Can Install



Compute Detailed Home Appliance
Operation from Only One or Two
Sensors

Sustainable Electrical Energy Systems (SEES) Cluster

- Flexibility to complement renewables while maintaining reliability
- Optimisation and control of dispersed generation and demand side resources
- New loads and storage, and their characteristics
- Stochastic processes and optimisation
- Electricity market and policy issues
- ICT to enable the smart, flexible power system



Sustainable cities



Cities opportunities & challenges

By 2008 > 50% of the world's population lived in urban areas

– vibrant

– efficient

By 2050 it will be > 70%
– lower carbon footprint per inhabitant than rural living

This presents significant opportunities and challenges

– a major opportunity for integrated city systems is estimated to be worth £200bn a year by 2030. The market opportunity for effective

– transport systems is already valued at over £190bn per year.

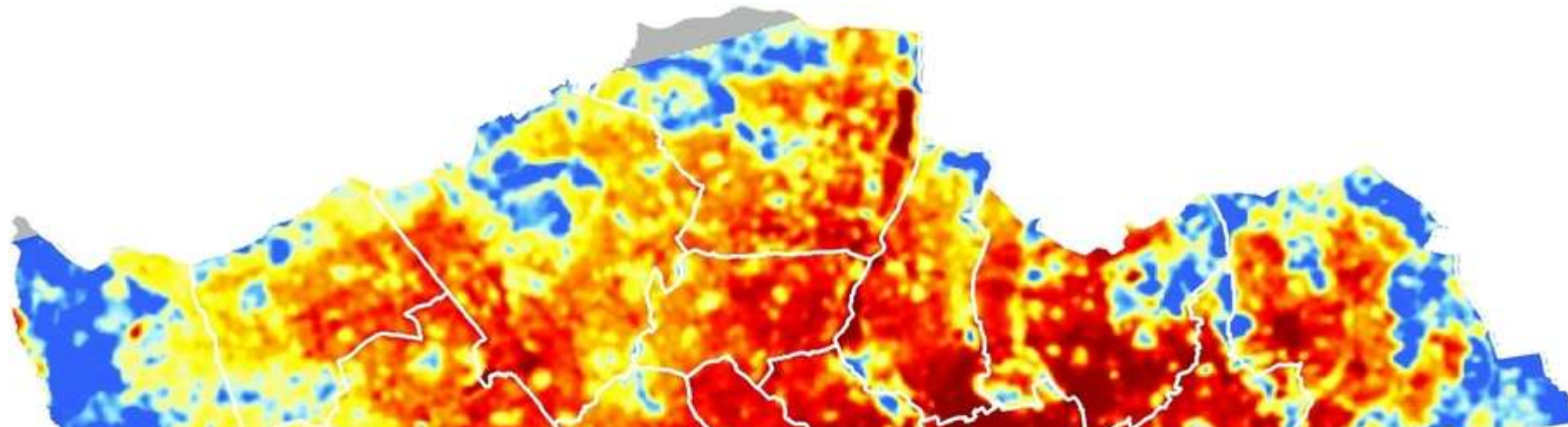
– all resources by many

– congestion

– pollution

– crime

– social isolation



Central London is 8 centigrade hotter than the surrounding countryside



We need to comprehend many variables when looking at sustainable solutions for sustainable cities.....



Citizens need to be the central focus.....



Path to Intelligent, connected sustainable cities



SMART People
(Using SMART Devices via
Semi-connected Systems)



Intelligent
Neighborhoods
(SMART Homes all
Connected via a
System of Systems)



Citizen Centric
(Sustainable Interconnected & Secure
Economy-Society- Environment)

A New - EXTENDED - View of the Computing / Communications Continuum



Intelligent Homes
(Ubiquitous SMART Devices in a
single Semi-connected System)



Intelligent Communities
(Mega-SMART, Secure Infrastructures in
Interconnected System of Systems)

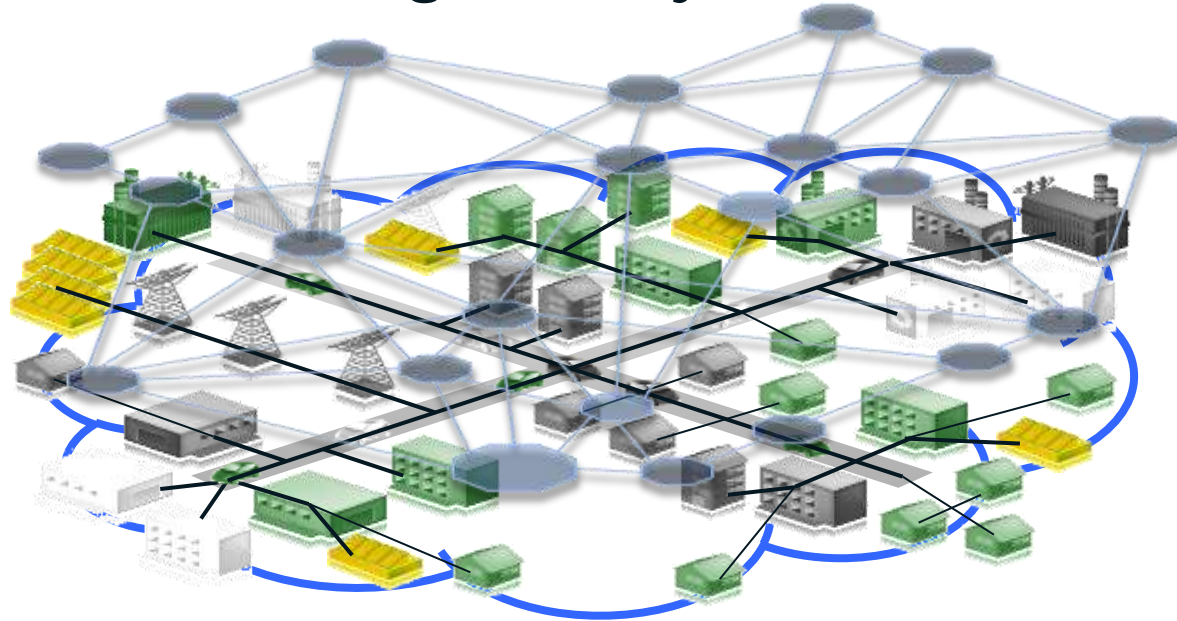


SMART Devices /
Appliances (Isolated
Systems)



Intel Sustainable & Connected Cities Institute

***The Concept: driving the computing continuum
and inventing the city of the future***



**Imperial College
London**



The World-Class Research Universities: UCL & ICL



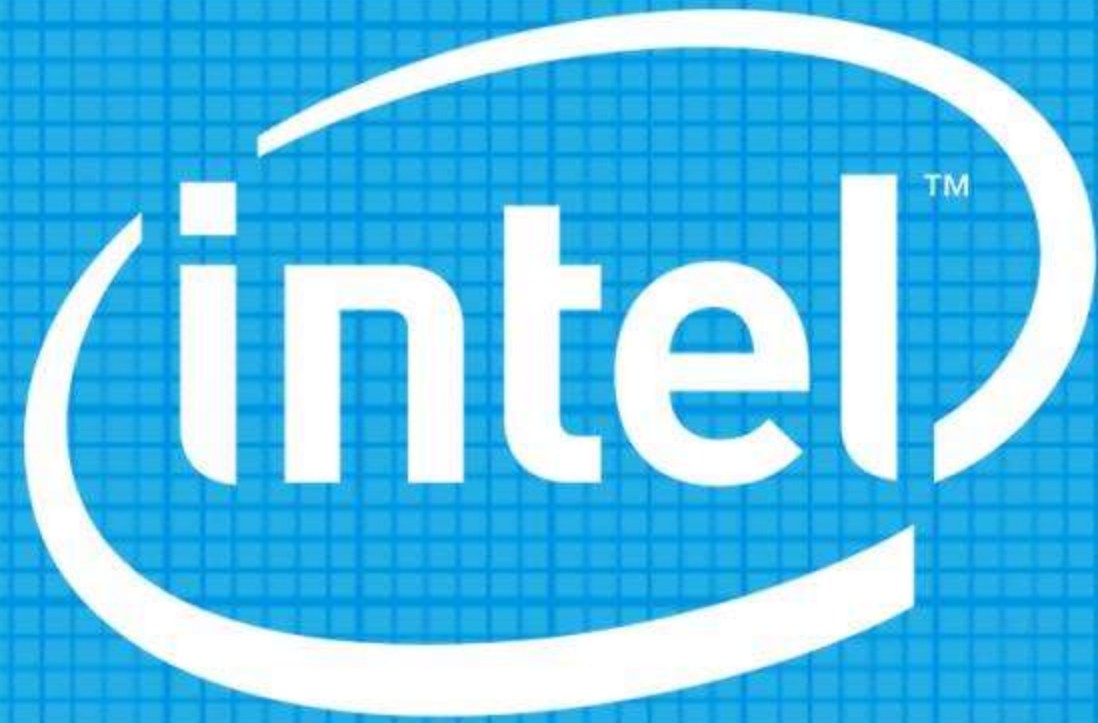
The Testbed: London

The Opportunity

- Create sustainable future city vision
- City of London offering test bed access
- Two world-class universities joining forces to lead the initiative
- Partnership with other fellow travellers

Application Areas

1. Compute Continuum & Ubiquitous Information Access
2. Asset management
 1. Utilities (Energy, Water, Sewage)
 2. Transport
 3. Services (Police, Fire, Ambulance)
 4. Environment
3. Intelligent Buildings and Urban Spaces
4. Community Wellbeing
5. City Security and Disaster Response



Sponsors of Tomorrow.™