Innovative semiconductor solutions
for energy efficiency, mobility
and security

Il contributo di Infineon a un mondo più verde
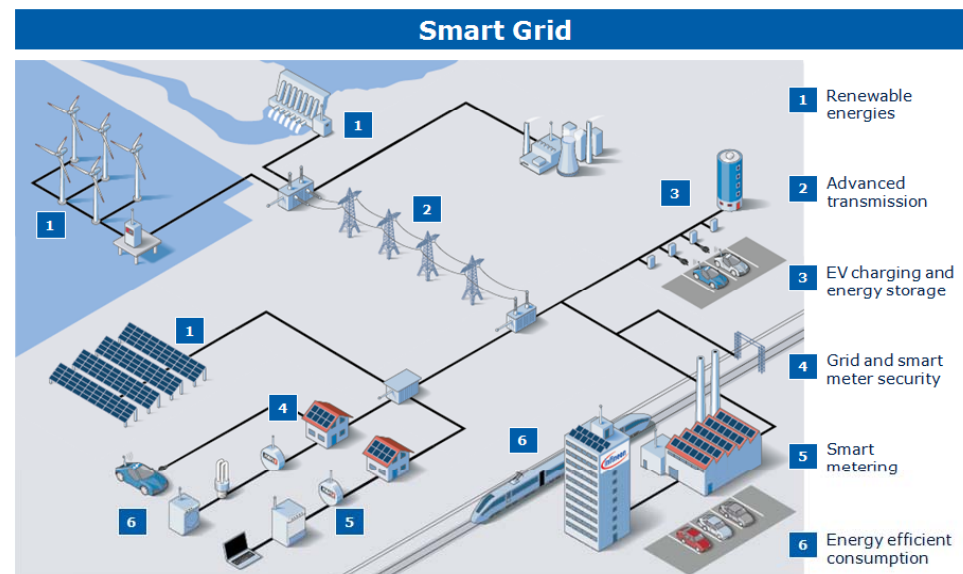## Sergio Rossi, Vice President Smart Meter

(infineon

Outline

Energy efficiency: a challenge for energy infrastructure
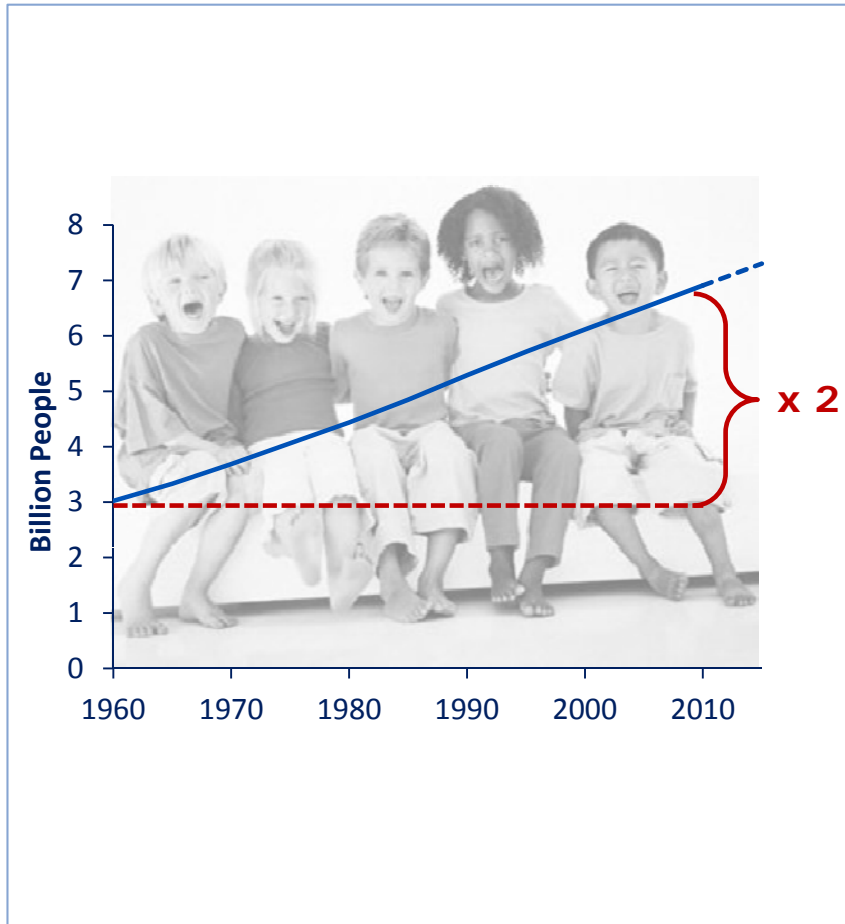
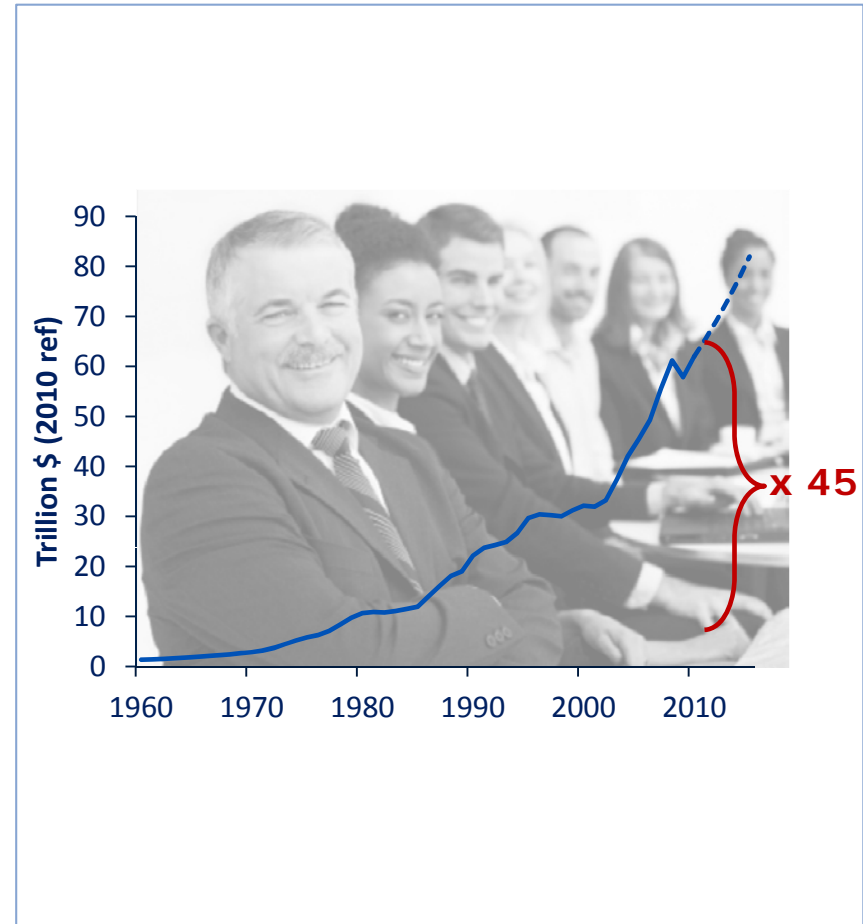Smart Homes and Smart Meters

Smart Cities

Growing Population and Increase in Wealth Continue to Drive Consumption ...
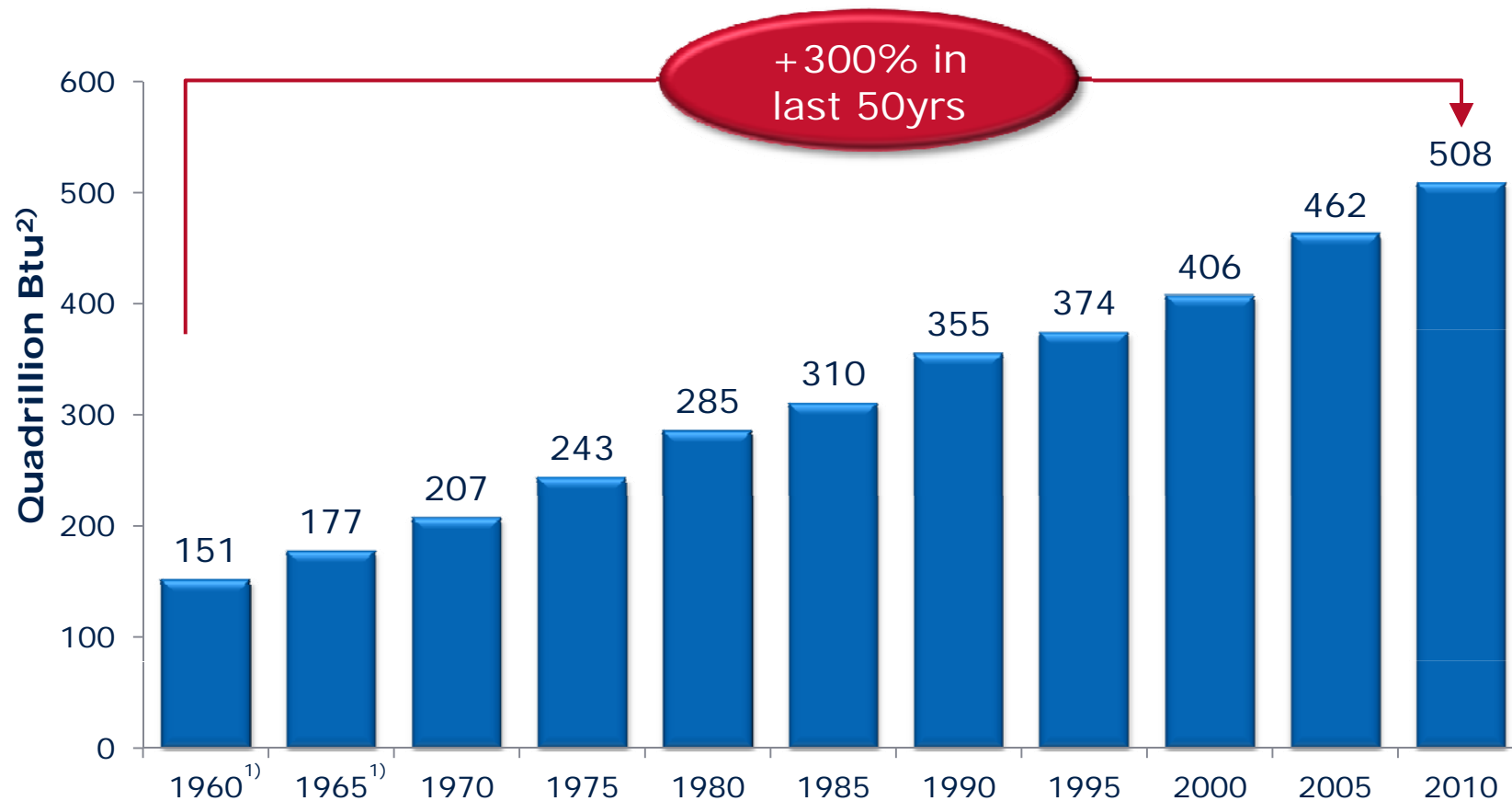

World population 1960-2010

Gross world product 1960-2010

Source: UN Data, IMF, Worldbank
    Gross World Product = the sum of all finished goods & services produced globally

... and Demand for Energy!

World energy consumption, 1960-2010

+300% in last 50yrs

Quadrillion Btu[2]

Year	Value
1960[1]	151
1965[1]	177
1970	207
1975	243
1980	285
1985	310
1990	355
1995	374
2000	406
2005	462
2010	508

Sources: Energy Information Administration (EIA), International Energy Outlook 2005, 2010
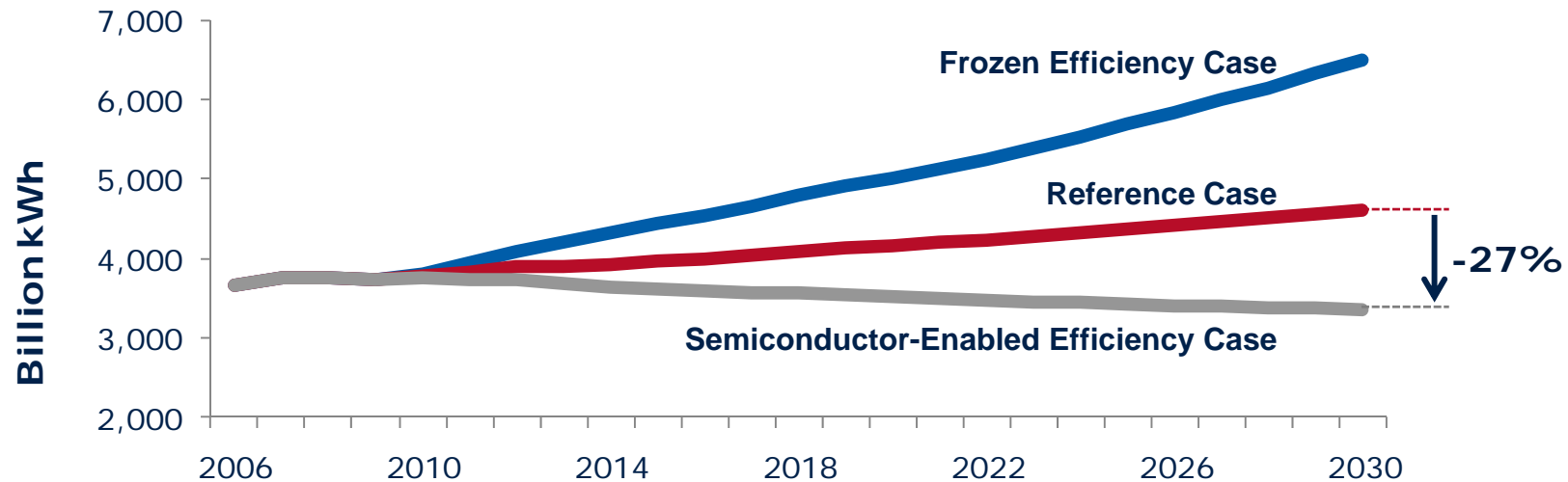1) Infineon estimates based on EIA 2005
2) British thermal unit (Btu): 1 Btu = 1.05506 kJ

Semiconductors are Expected to Enable 27% Energy Savings Until 2030*

Scenarios of U.S. electricity growth assuming 2.5% annual GDP growth (2008-2030)

Chart showing Billion kWh (y-axis 2,000 to 7,000) versus years (2006 to 2030):
- **Frozen Efficiency Case** (blue line, rising to ~6,500)
- **Reference Case** (red line, rising to ~4,600)
- **Semiconductor-Enabled Efficiency Case** (gray line, declining to ~3,400)
- **-27%** difference indicated between Reference Case and Semiconductor-Enabled Efficiency Case

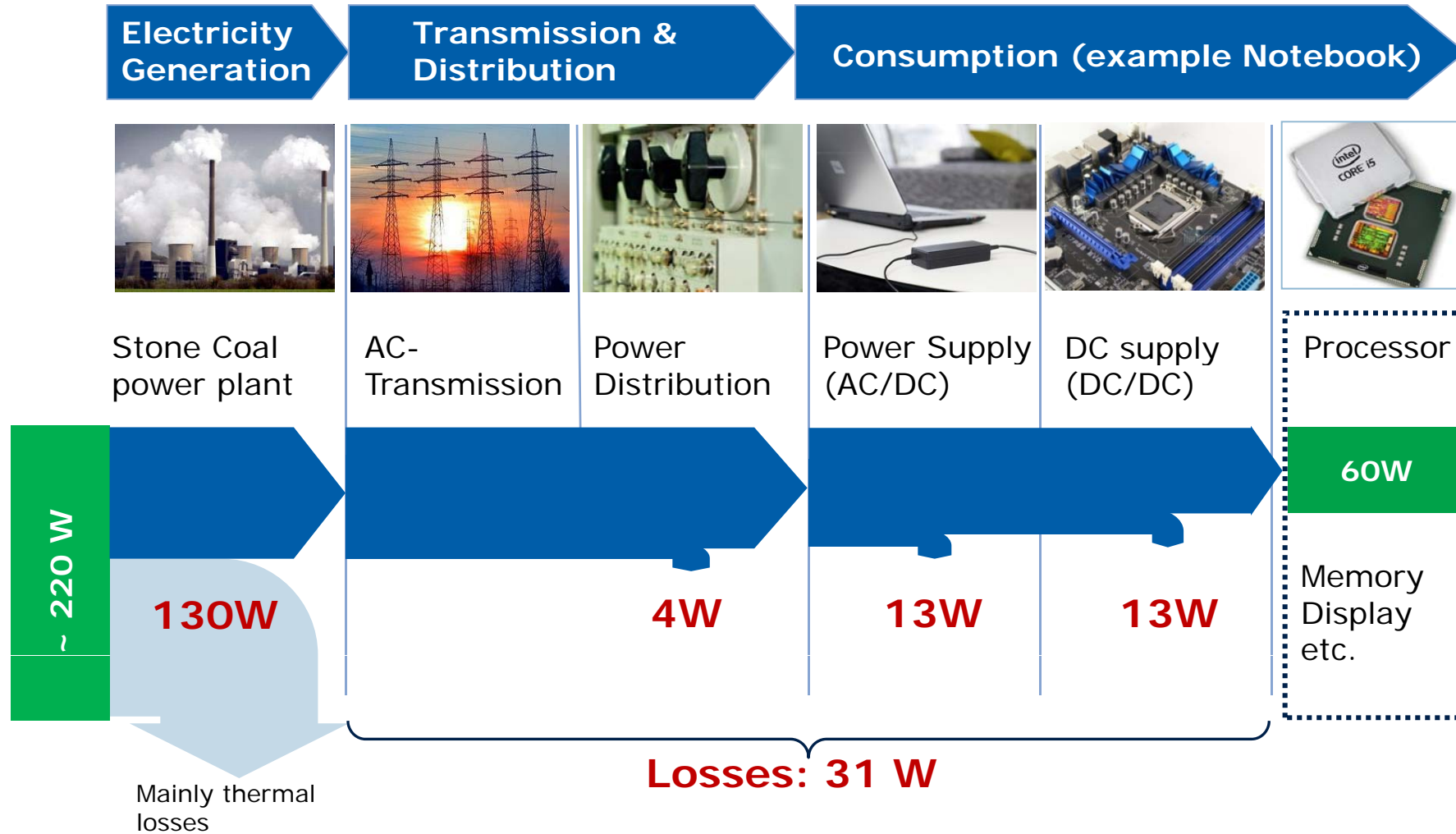| Scenarios	Descriptions
Frozen Efficiency Case	Electricity demand intensity remains at 2009's levels
EIA** reference Case	EIA Annual Energy Outlook 2009 anticipates decrease of electricity intensity of 1,5% annually, driven by technology advances
Semiconductor-Enabled Efficiency Case	Includes **policies and incentives** stimulating a greater investment in semiconductor-enabled efficiency technologies

*Source: American Council for an Energy-Efficient Economy, Report Number E094, May 2009
** EIA: Energy Information Administration

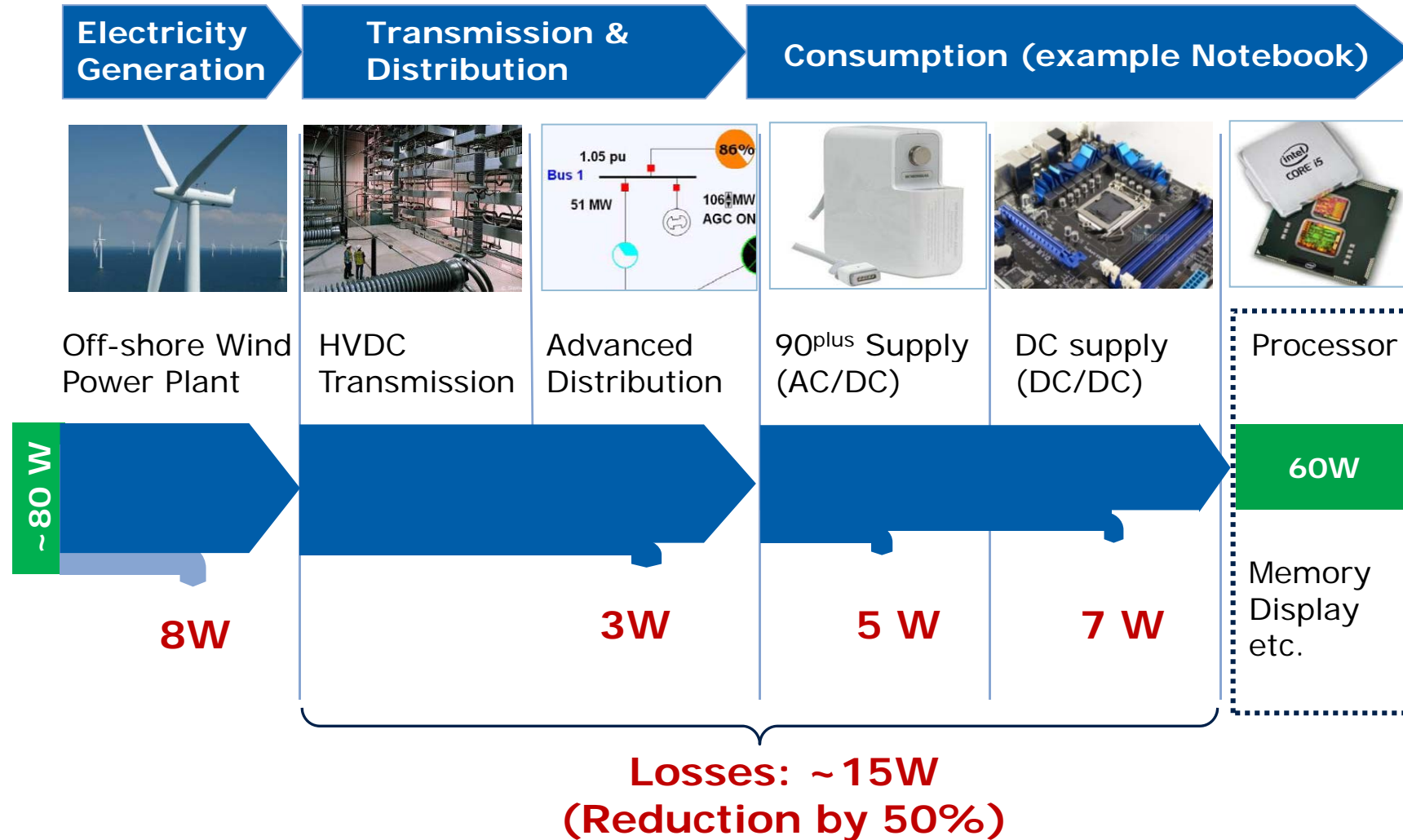# Most of the Energy is Actually Not "Consumed" But "Lost" on the Way!

EXAMPLE

Electricity Generation	Transmission & Distribution		Consumption (example Notebook)		
Stone Coal power plant	AC-Transmission	Power Distribution	Power Supply (AC/DC)	DC supply (DC/DC)	Processor
~ 220 W					60W
130W		**4W**	**13W**	**13W**	Memory Display etc.

Mainly thermal losses

Losses: 31 W

Source: Infineon estimate

However, it is Possible to Reduce Energy Losses With Use of Power Semiconductors

EXAMPLE

Electricity Generation	Transmission & Distribution		Consumption (example Notebook)		
Off-shore Wind Power Plant	HVDC Transmission	Advanced Distribution	90^{plus} Supply (AC/DC)	DC supply (DC/DC)	Processor
~80 W					60W
					Memory Display etc.
8W		**3W**	**5 W**	**7 W**	

Losses: ~15W
(Reduction by 50%)

Source: Infineon estimate

Semiconductors Play an Important Role in the Whole Electrical Energy Supply Chain

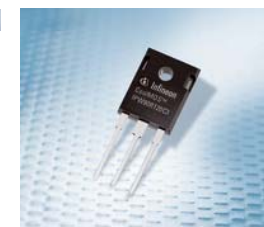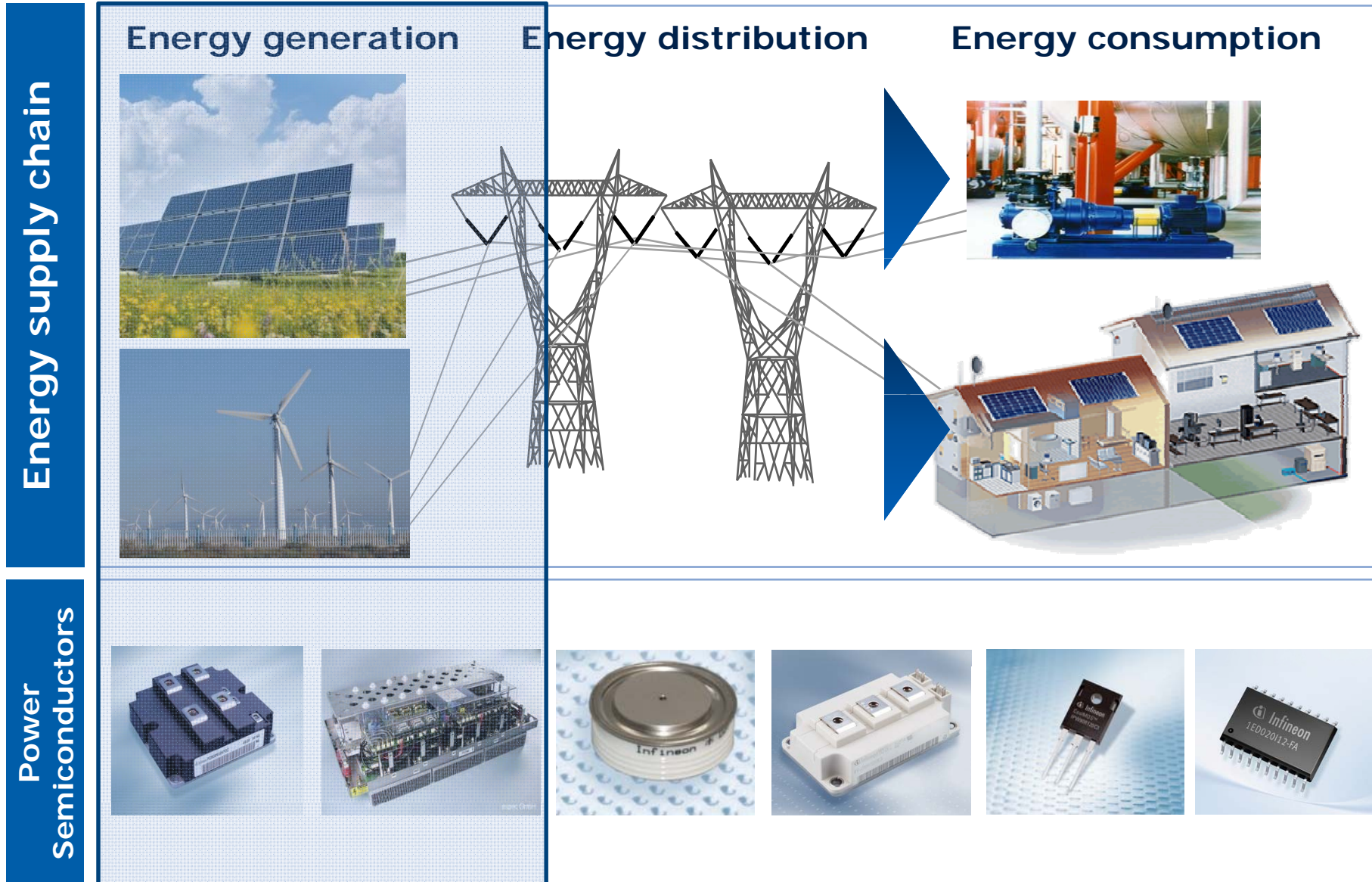**Energy generation**　　**Energy distribution**　　**Energy consumption**
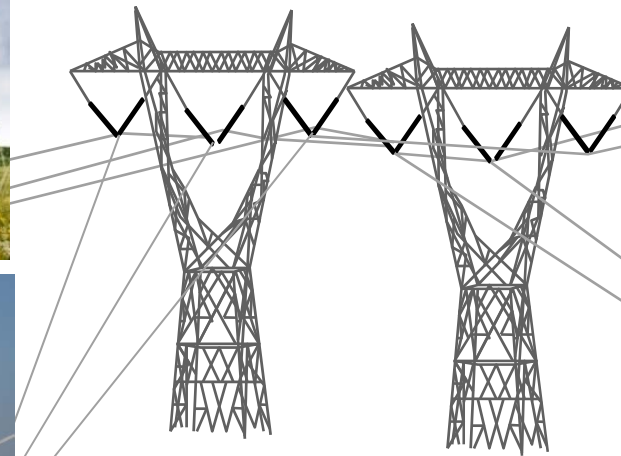
Energy supply chain

Power Semiconductors

Semiconductors Play an Important Role in the Whole Electrical Energy Supply Chain

Energy supply chain

Energy generation

Energy distribution

Energy consumption

Power Semiconductors

Windmills and Their Output Power Grow Along With Consciousness on Renewables

1987 - 1990	1993 / 1994	1996 / 1997	2002 / 2003	Cologne cathedral	2007 – today*)
1. Generation	2. Generation	3. Generation	4. Generation		5. Generation
30 - 165 KW	225 - 500 KW	1.000 - 1.500 KW	2.500 - 3.500 KW		6.000 KW

≈ 22 m, ≈ 35 m, ≈ 30-40 m, ≈ 42-62 m, ≈ 60 m, ≈ 100 m, ≈ 80-100 m, ≈ 130-150 m, 157 m, 135 m, 200 m
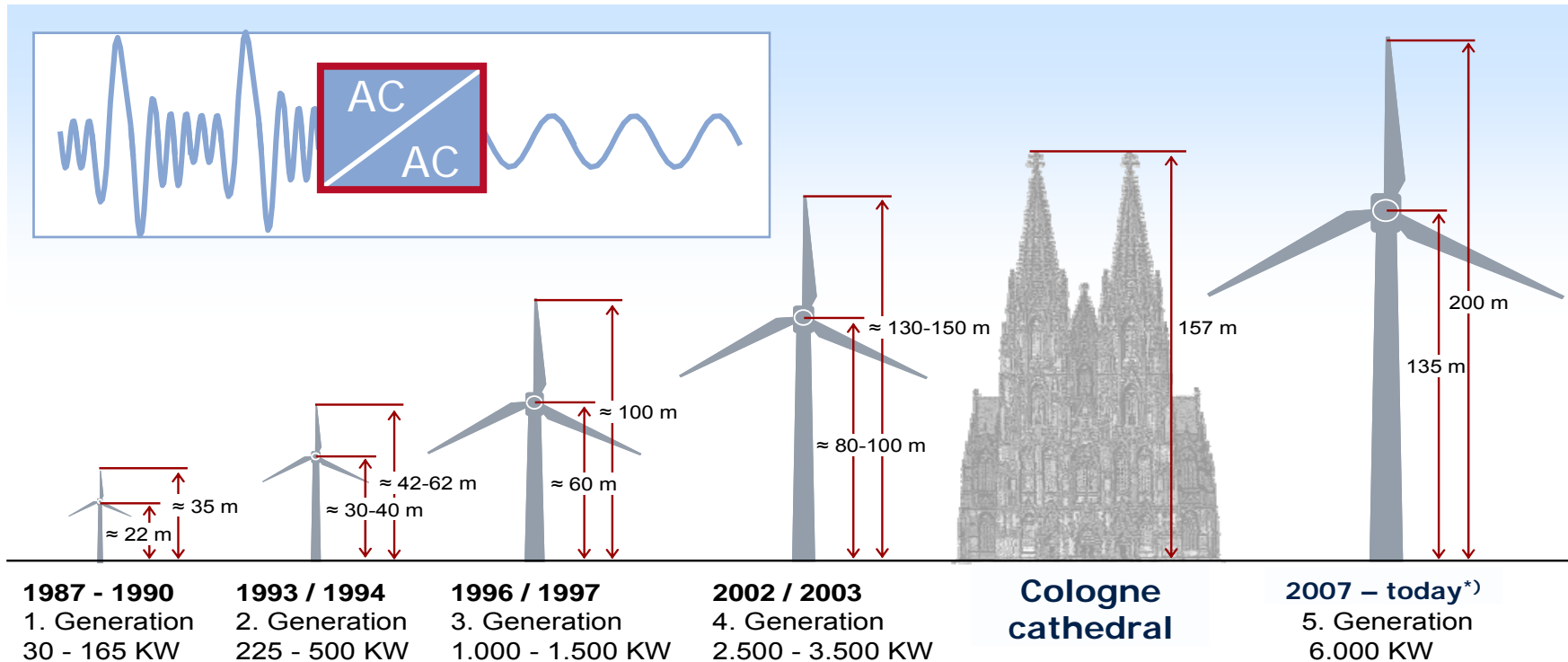
BARD Offshore 1 (Germany's first off-shore wind park)

Location:	90 km northwest of Borkum, North Sea, Germany
Key data:	■ 80 wind turbines of 5 MW each ■ 400 MW total power generation ■ first turbines connected to the grid in Dec 2010
Components:	Power module IHM 1700V

*) Source: Siemens Renewable Energy Division, 2009

CO$_2$ Reduction: Both in Ancient as Well as Modern Buildings is State-of-the-Art

Vatican's Auditorium

Location: Auditorium Paolo VI, Rome, Italy

Key data:
- 220 kW power generation,
- saving of 225 t CO$_2$ / year

Efficiency: ~98%

Components: CoolMOS™, discrete IGBT, IGBT modules

Toyota North America Part Center

Largest Single-Roof solar installation in North America. Bigger than four football fields and capable of generating enough energy to meet 60% of the demand from the manufacturing plant.
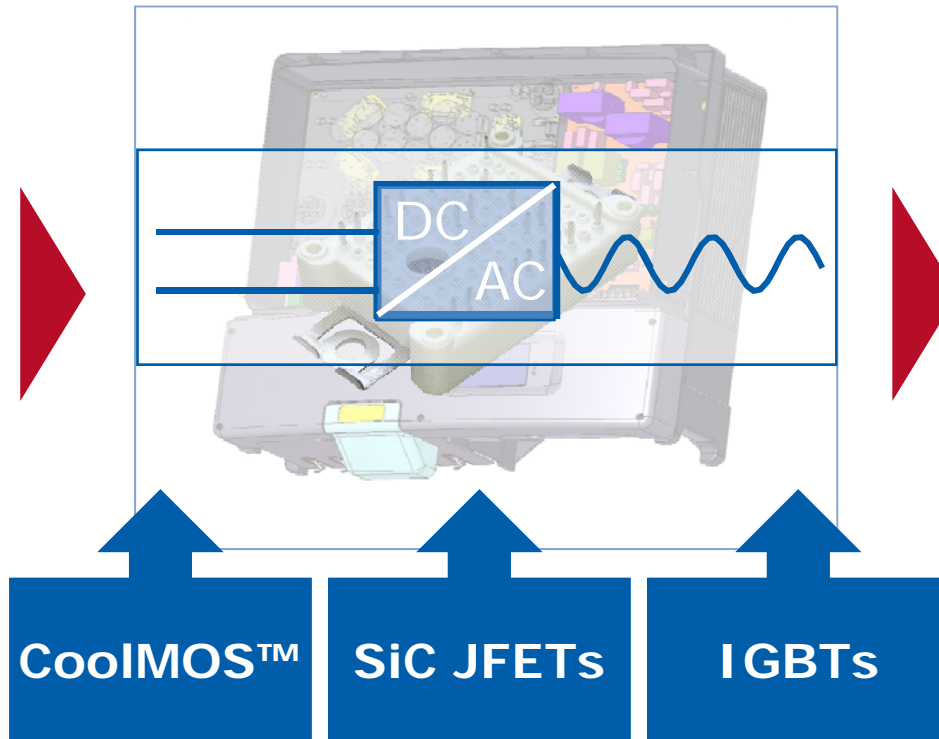
Location: Ontario, California

Key data:
- 242,000 square feet solar panel area
- 10,417 solar modules with 2.3MW capacity
- saving of 6.4 mio pound CO$_2$ emission per year

Components: CoolMOS™, IGBT modules
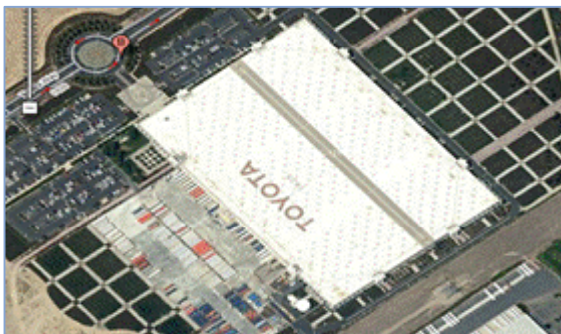
# What's Next? SiC JFET Enabling a Path Towards 99% Efficiency

DC / AC

CoolMOS™   **SiC JFETs**   **IGBTs**

Today	Tomorrow
CoolMOS™, Silicon Carbide diodes, IGBT discretes and modules → efficiency of solar inverter: **~98%**	**Silicon-Carbide JFET** → efficiency of solar inverter: **~99%** reduction of power losses: **~50%**

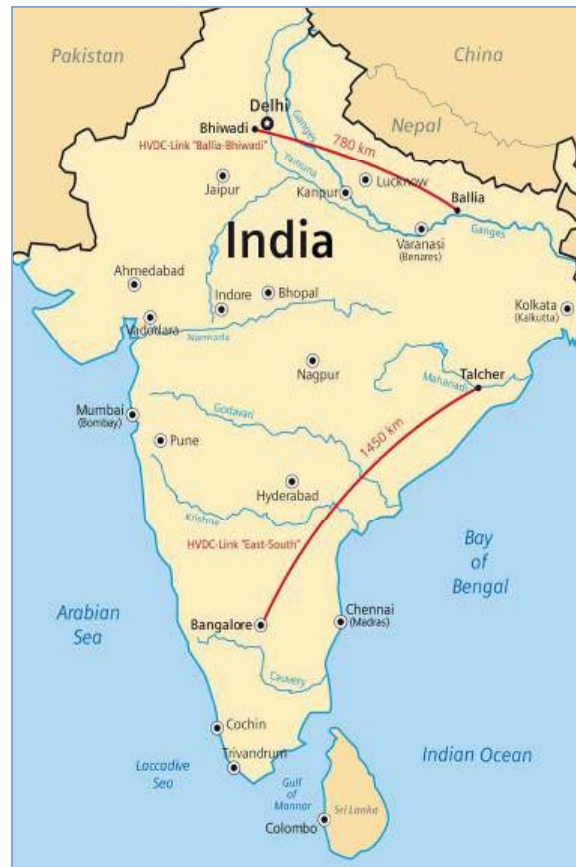# Semiconductors Play an Important Role in the Whole Electrical Energy Supply Chain

Energy supply chain

Energy generation | **Energy distribution** | **Energy consumption**

Power Semiconductors
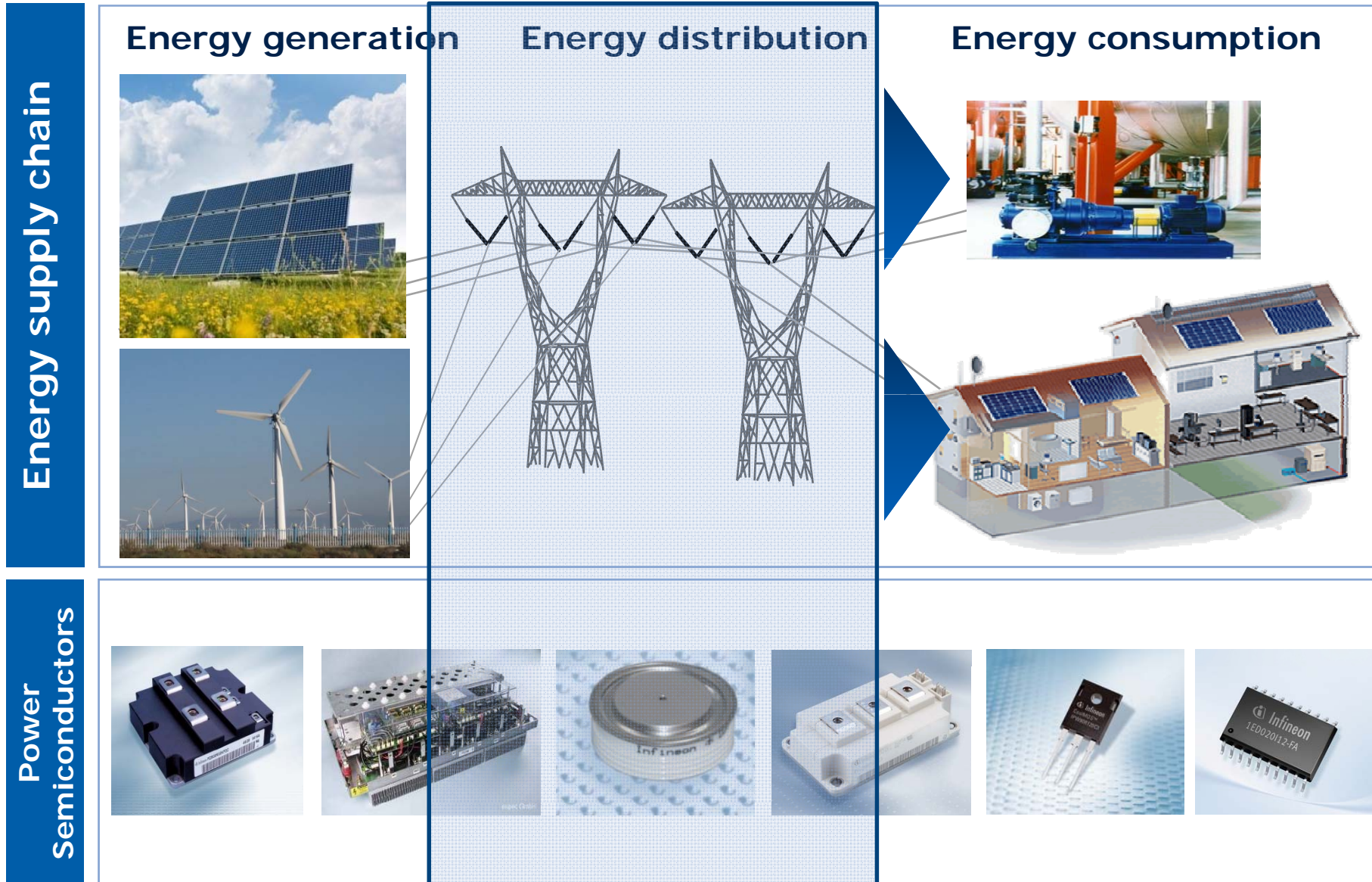
HVDC Transmission to Transport Large Amounts of Electric Energy Point-to-Point

Example 1: United Kingdom

Norwich

NORTH SEA

Sizewell Village
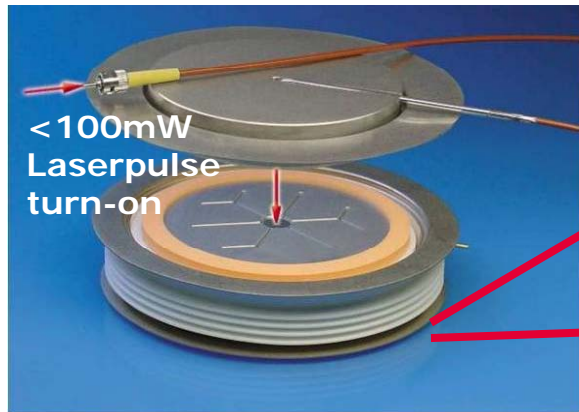132 kV

Ipswich

Greater Gabbard
500 MW
140 x 3.6 MW

Example 2: India

Pakistan

China

Delhi
Bhiwadi
HVDC-Link "Ballia-Bhiwadi"
780 km
Nepal

Jaipur Kanpur Lucknow
Ballia
India
Ganges
Varanasi
(Benares)
Ahmedabad

Indore Bhopal
Kolkata
(Kalkutta)
Vadodara Narmada

Nagpur
Mahanadi
Talcher
Mumbai
(Bombay)
Godavari
1450 km
Pune

Hyderabad
Krishna
HVDC-Link "East-South"

Bay of Bengal

Arabian Sea

Bangalore
Chennai
(Madras)

Cauvery

Cochin
Trivandrum
Laccadive Sea
Gulf of Mannar
Sri Lanka
Colombo

Indian Ocean

Example 3: China

China

Zhijiang Taiyuan Jinar

Xi'an Zhengzhou Nanjir

Chengdu
1200 MW 1040 km
Tianshengqiao Gezhouba Wuhan
Nanx

Changsha
Yangtze
1800 MW 860 km
Guiyang
Anshun
3000 MW
Xingren
3000 MW 940 km
1225 km
Kunming
Yunnan
5000 MW 1400 km
Guangzhou
Shenzer
Zhaoqing Hong Ko

Vietnam
Laos
Gulf of Tonking
Haikou
Hainan

Thyristors Used in Transmission Stations to Boost Voltage up to 800,000 Volt

LTT	Module	Transmission station

<100mW Laserpulse turn-on

>1MW Power switched
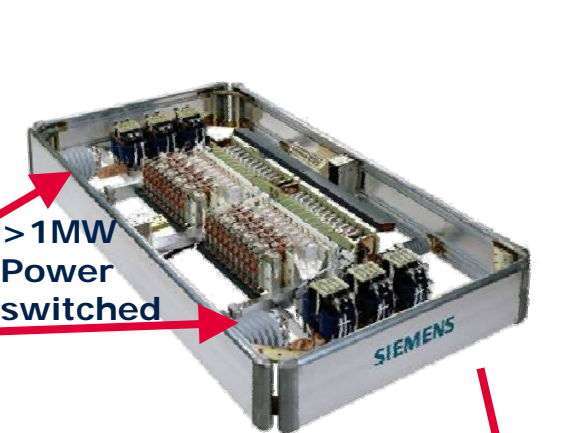
HVDC transmission station, Tasmania

HVDC transmission station, Yunnan, PRC

HVDC transmission station, Long Island, NY

HVDC = High-Voltage Direct Current; LTT = Light-Triggered Thyristor.

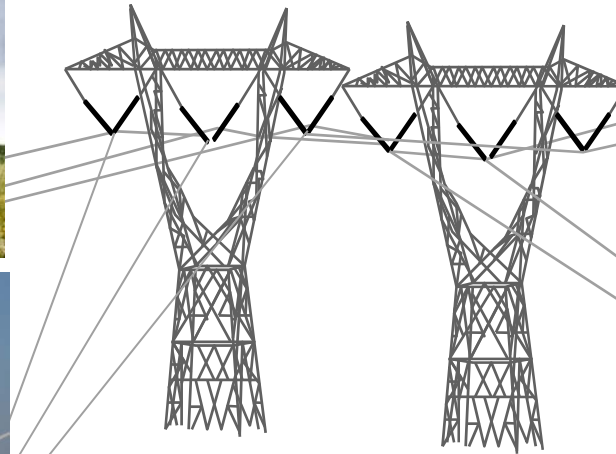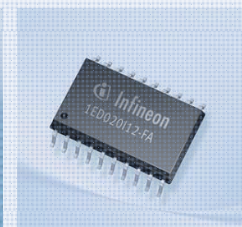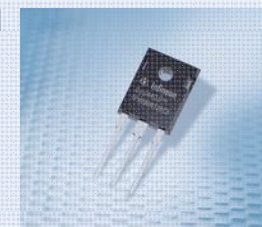# Semiconductors Play an Important Role in the Whole Electrical Energy Supply Chain

Energy supply chain

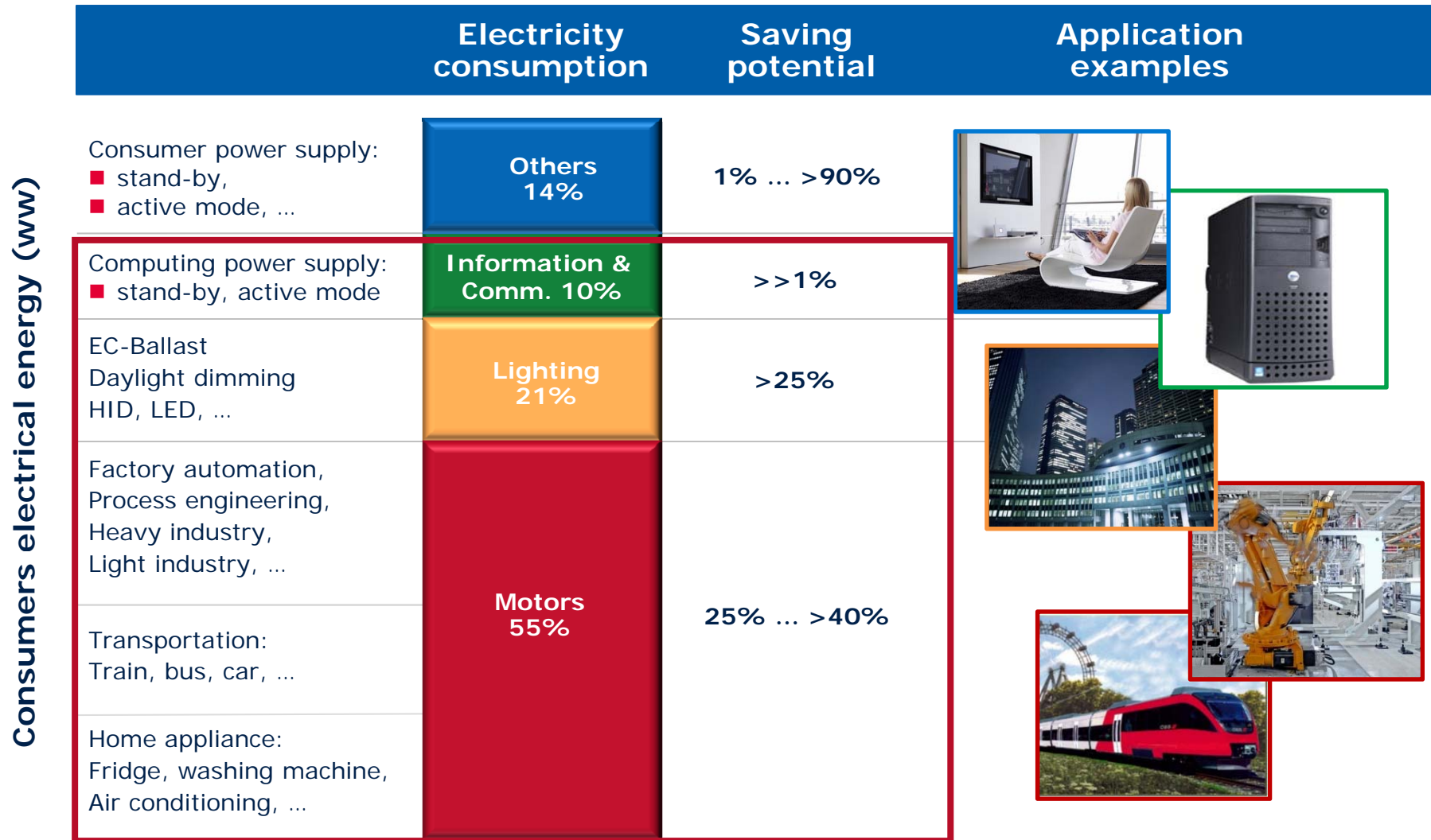**Energy generation**   **Energy distribution**   **Energy consumption**

Power Semiconductors

In the Consumption Arena, Significant Energy Savings are Possible Today

Consumers electrical energy (ww)

	Electricity consumption	Saving potential	Application examples
Consumer power supply: ■ stand-by, ■ active mode, …	Others 14%	1% … >90%	
Computing power supply: ■ stand-by, active mode	Information & Comm. 10%	>>1%	
EC-Ballast Daylight dimming HID, LED, …	Lighting 21%	>25%	
Factory automation, Process engineering, Heavy industry, Light industry, …	Motors 55%	25% … >40%	
Transportation: Train, bus, car, …			
Home appliance: Fridge, washing machine, Air conditioning, …			

Sources: ZVEI, Infineon, 2008.

Motor Drives are About RPM Control Enabling Increase in System Efficiency

Applications

Example:

In Germany, the recovery of braking energy saved 300 GWh, equivalent to the annual energy consumption of a small town of 30,000 citizens (including heating energy)

Power Semiconductor

Braking energy recovery

Energy saving app. 20- 30%

Optimized acceleration of the train system

Source: BVG (Berliner Verkehrsgesellschaft) 2004; DB Energie 09-2006.

Incandescent Lamp Replacement With LED Bulbs Offers Huge Savings Opportunity

Best performance @ lowest cost with ICL8001G LED bulb driver IC

TYPE	Efficacy (lm/W)	Lifetime (hours)
HB-LED	60 – 130	>50000
Fluorescent	45 – 110	20000 – 30000
Halogen	12 – 20	10000
Incandescent	10 – 17	1000

60W equivalent LED lamp

While light output efficiency of other lighting sources is fixed, the efficacy of LEDs is steadily improving

LED replacement lamps saved ~ 1TWh in 2010 equivalent to ~500,000 t CO_2

Source: Infineon estimate based on Strategies Unlimited June 2009, CO_2 values from literature ranging from 375g CO_2/kWh (EU-commission) to 750 g CO_2/kWh (Solar World).
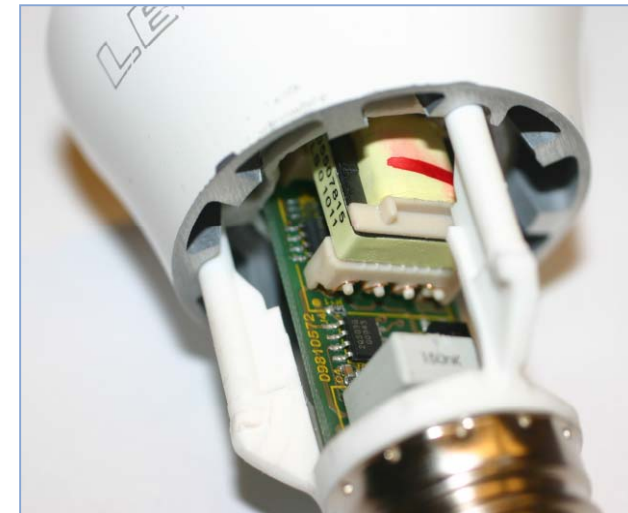
Modern Data Centers are Very Efficiency Conscious and are Setting Benchmarks

Example: Facebook's first company-owned data center in Prineville, Oregon uses 38% less energy compared to their other facilities.

CoolMOS™ C6/CP

Power supply

Outline

Energy efficiency: a challenge for energy infrastructure

Smart Homes and Smart Meters

Smart Cities

Smart Grid

1. Renewable energies
2. Advanced transmission
3. EV charging and energy storage
4. Grid and smart meter security
5. Smart metering
6. Energy efficient consumption
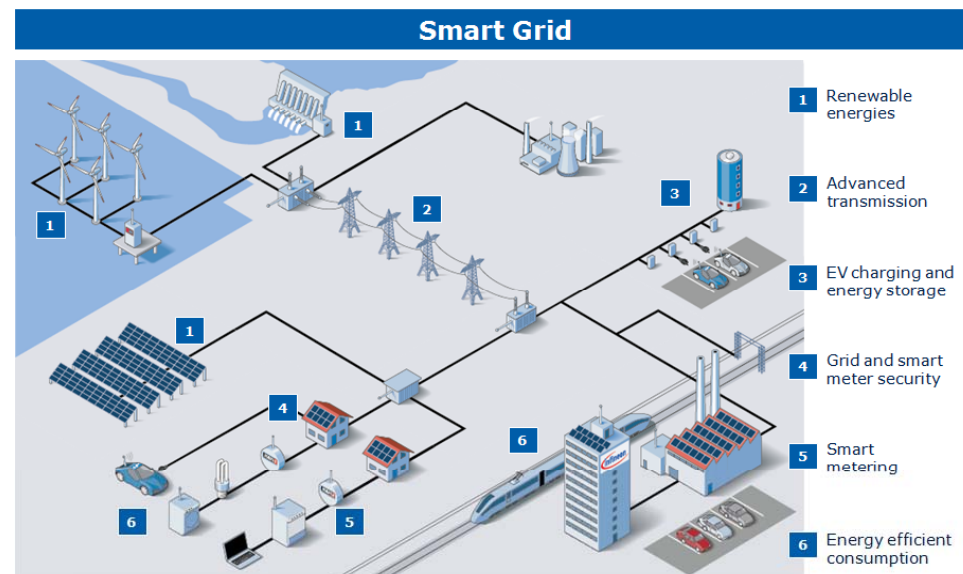
Reducing power losses is good …
# But reducing power consumption is better !

EXAMPLE

Electricity Generation	Transmission & Distribution		Consumption (example Notebook)		
Off-shore Wind Power Plant	HVDC Transmission	Advanced Distribution	90^{plus} Supply (AC/DC)	DC supply (DC/DC)	Processor

~55 W

40W

8W   3W   5 W   7 W

Source: Infineon estimate

19.12.2011   Page 22
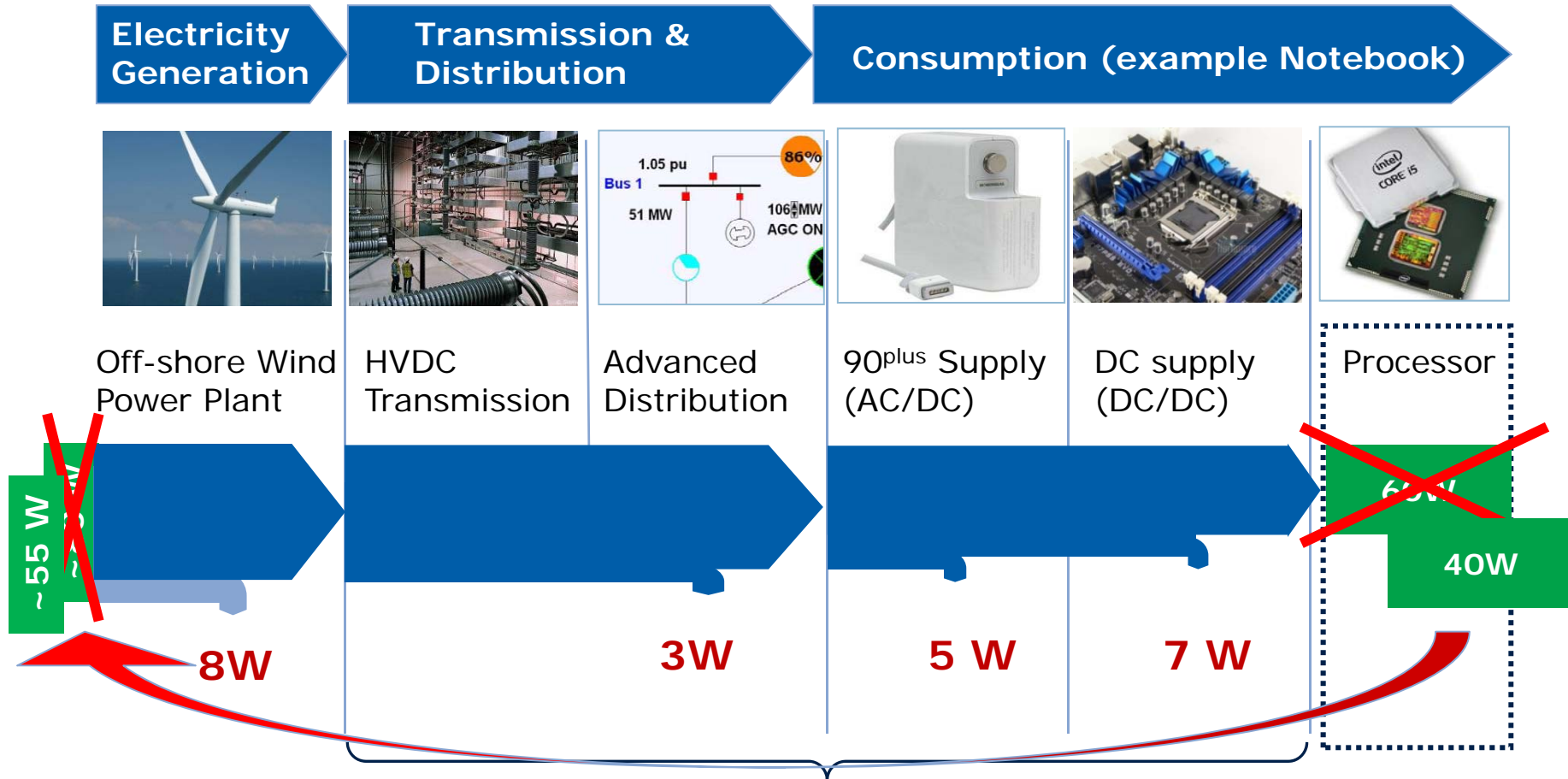
Homes are getting smart ... and complex

Sub meter

Sub meter

Internet

Home Controller

Load Control

iPlug

iPlug

Gas / Water meter

Communication

Smart meter

Communication
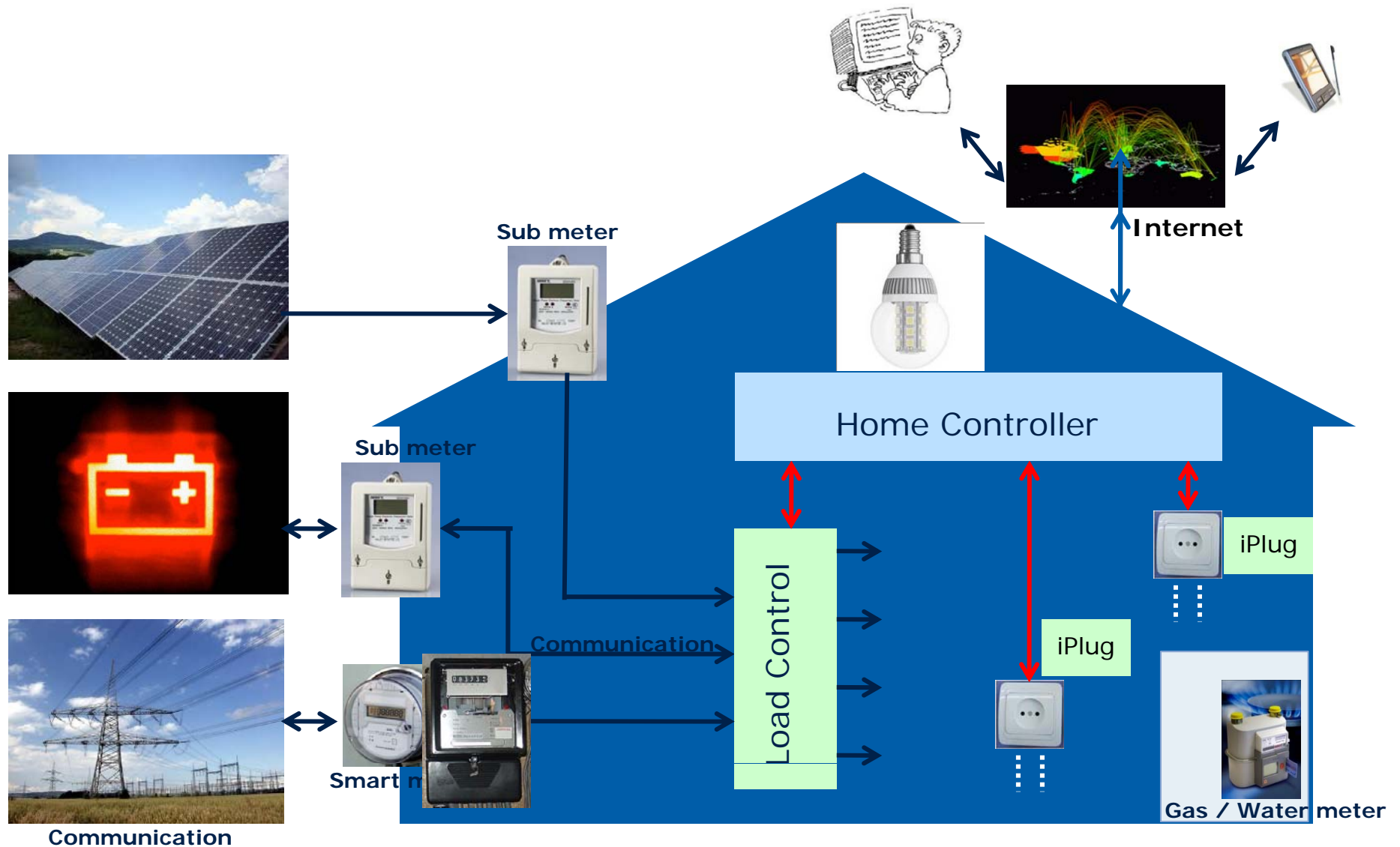
Smart meters and beyond

Intelligent power meter

| Disconnect device | Current and Voltage sensing | Metrology | MCU | Communication |
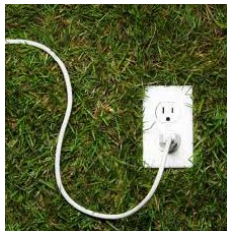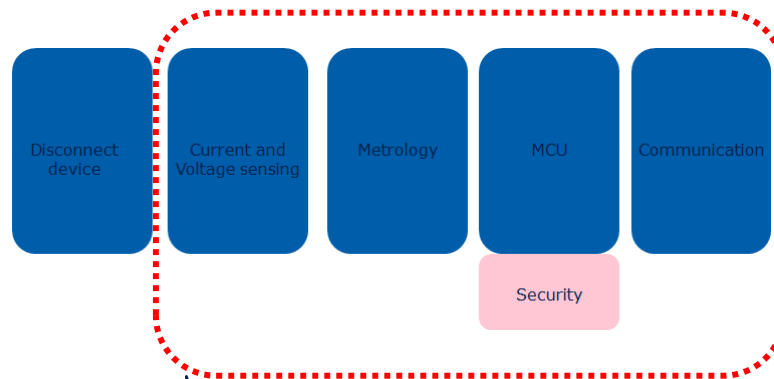
Security

Smart Meters (Electricity, flow)

Smart Major Home Appliances

Smart Plugs

Grid monitoring and sub-meters

Infineon's smart meter dedicated solutions

Electric energy meter ICs

- Highly integrated
- High accuracy
- Embedded security
- Complete family

Smart Grid Communication ICs

- Huge flexibility
- Power Line Communication
- Wireless super low power
- Integrated Analogue Front End

Security

- Flexible and scalable
- Negligible cost: embedded
- Low cost: Origa2
- High security: HSM
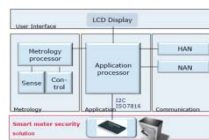
Gas & Water meter ICs

- Extreme low power
- Embedded flow sensing
- Highly accuracy RTC
- Embedded security

Outline

Energy efficiency: a challenge for energy infrastructure

Smart Homes and Smart Meters
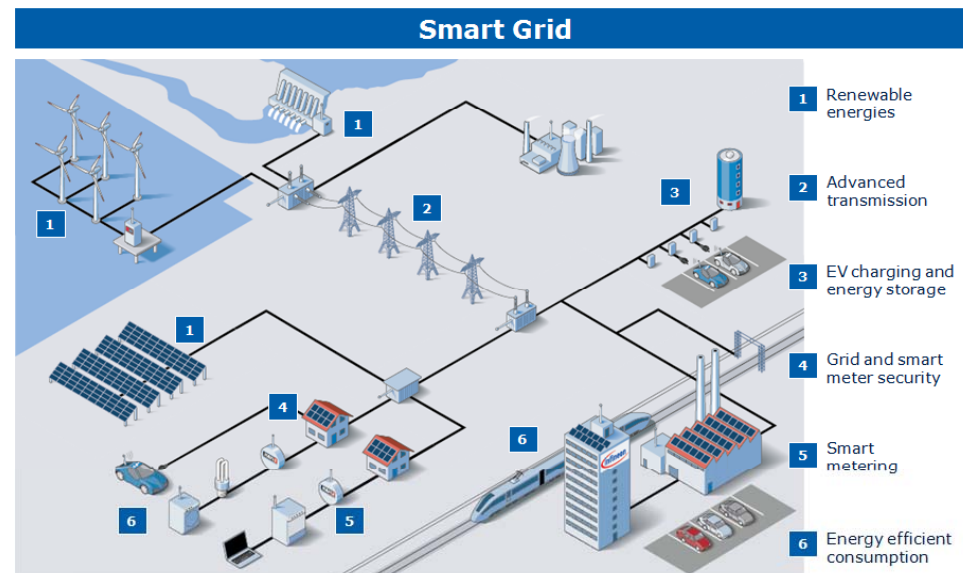
Smart Cities

Electromobility

Public transportation

Smart city

Public lighting Renewables

Security

Trend towards eco-friendly hybrid and electric vehicles

- Infineon solutions for the entire infrastructure

  - E-Cars

  - E-bikes

  - Charging stations

  - Energy and network technology
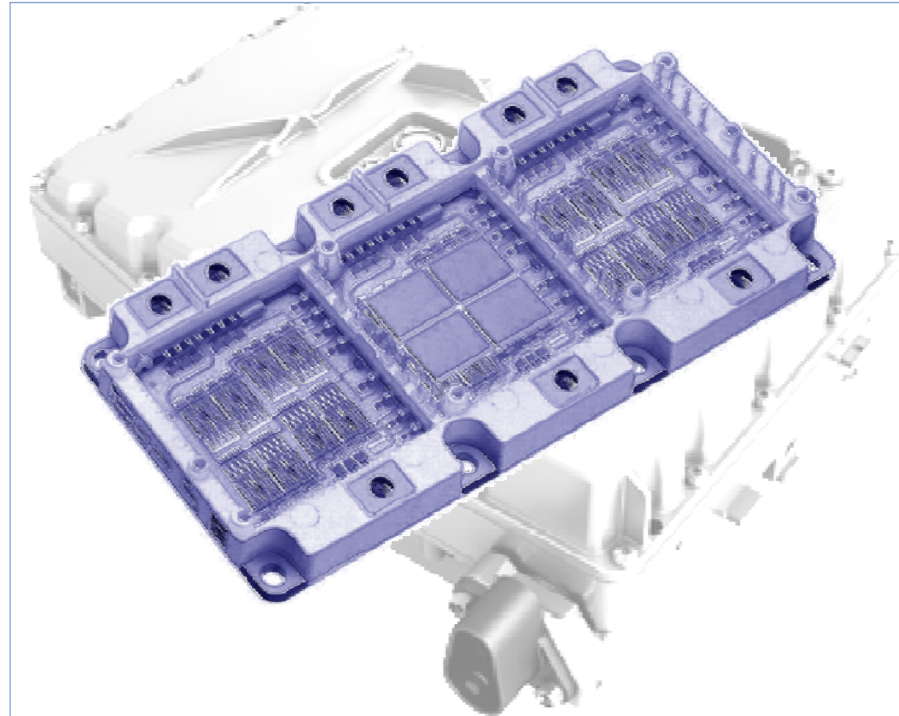
Paradigm Shift:
IGBT's are the Injectors of Tomorrow
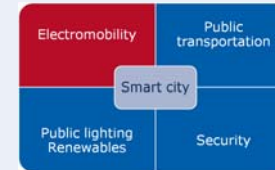
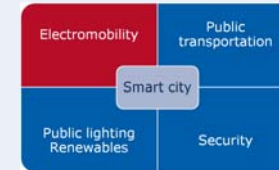| **Today** Fuel Injectors in Combustion Engines	**Tomorrow** IGBT's in Electrical Inverters

- Driver of vehicle performance: **Mechanical** components and subsystems
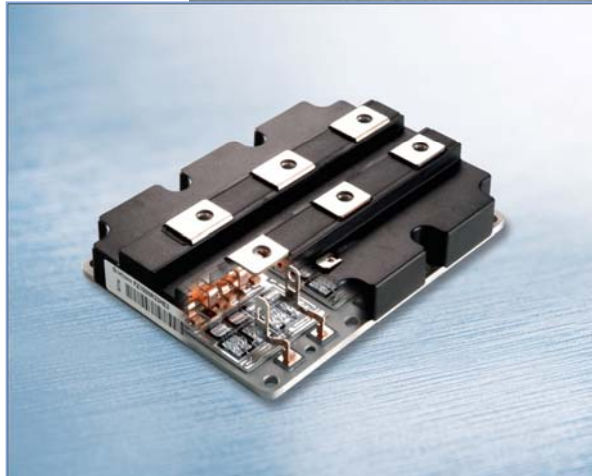- Assisted by **semiconductors**
- On-board electrical power: ~1 kW
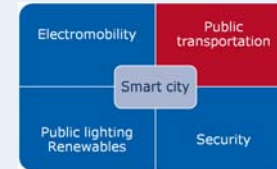
- Driver of vehicle performance: **Semiconductor** components and subsystems
- Assisted by **mechanicals**
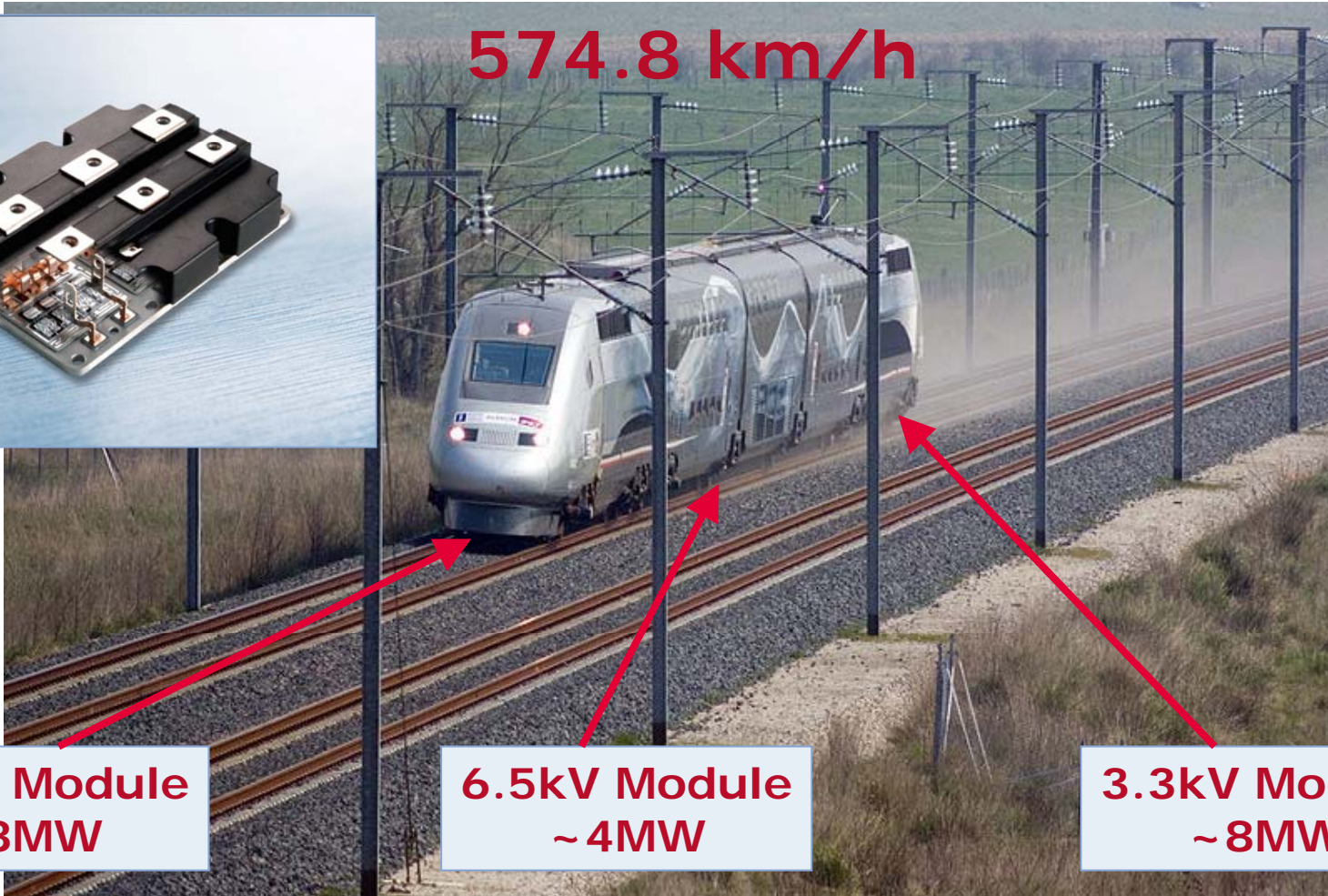- On-board electrical power: ~100 kW
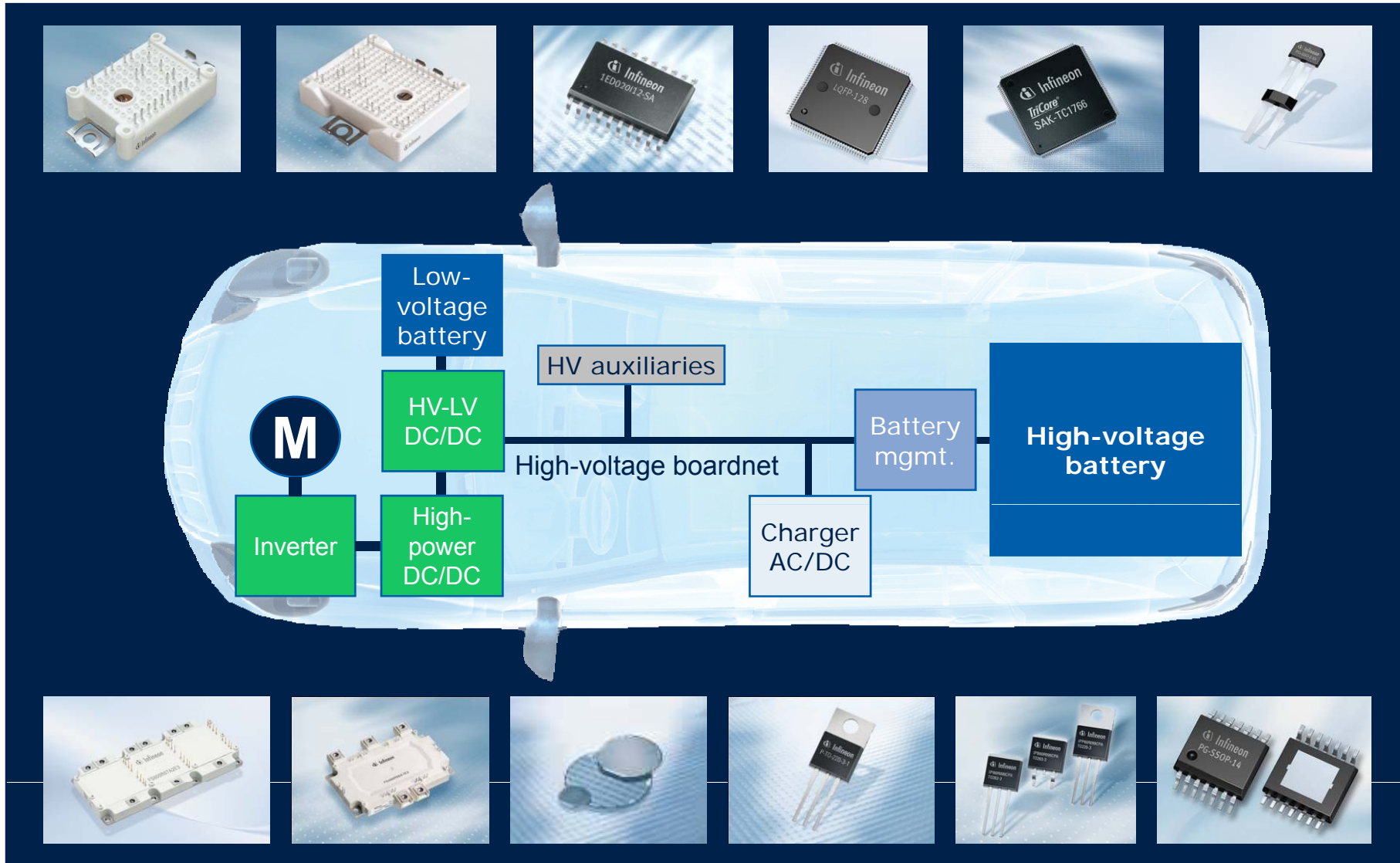
Power Semiconductors also help to achieve record speeds!

574.8 km/h

3.3kV Module ~8MW

6.5kV Module ~4MW

3.3kV Module ~8MW

340 IGBT modules inside
>120 wafers, >2m^2 silicon area!

LED Street Lights become more efficient with Infineon

Infineon's highly efficient semiconductors enable boosting up the electrical efficiency to 92%
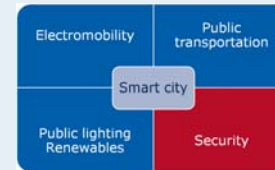
Infineon 120W
LED Ballast

The new **Digital Platform** dramatically increases flexibility and time to market

System Security for Connected Devices

Market Requires System Security

- Storing, processing and exchanging data in numerous distributed devices is the backbone of our economy.

- HW based security provides protection against physical attacks.

2010 Security Need

2000 Connectivity

1990 Functionality

Cyber War is a real threat for the Smart Grid

JPost.com > Iranian Threat > News

'Stuxnet virus set back Iran's nuclear program by 2 years'

By YAAKOV KATZ
12/15/2010 05:15

Top German computer consultant tells 'Post' virus was as effective as military strike, a huge success; expert speculates IDF creator of virus.

March 29, 2010

Smart Products | Smart Meters Vulnerable to Hack Attacks

By David Sims
TMCnet Contributing Editor

The new smart meters designed to help deliver electricity more efficiently are inviting – and vulnerable – targets for hackers, security analysts say. The Associated Press (News - Alert) reports that hackers can access the power grid "in previously impossible ways" from hacking the meters.

Smart Meter Worm Could Spread Like A Virus

By Katie Fehrenbacher | Jul. 31, 2009, 7:39am PDT | 2 Comments

Tweet 0   Gefällt mir Registrieren, um sehen zu können, was deinen Freunden gefällt.

Black Hat
BRIEFINGS AND TRAINING

For a utility that's in the process of installing smart meters, there are probably few things more terrifying than the simulation of a smart meter worm that IOActive's Mike Davis showed off at the annual security conference Black Hat on Thursday. During Davis' presentation, he showed how he and his team at the security consulting
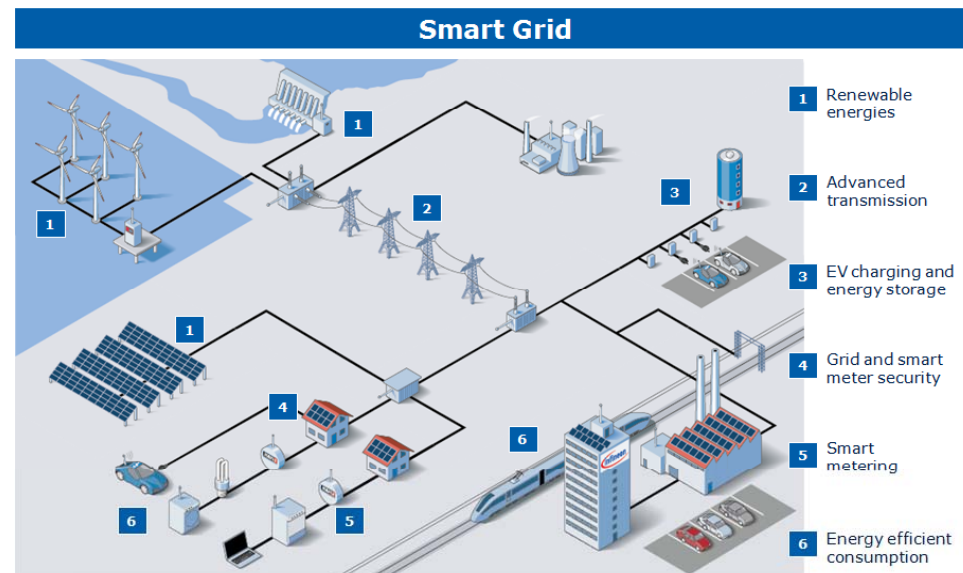
Applications using Security controller
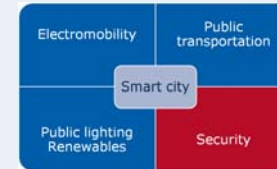
Since 25 years security controllers have used in IT- critical infrastructure and supported excellent security.

Outline

Energy efficiency: a challenge for energy infrastructure

Smart Homes and Smart Meters

Smart Cities

Conclusions

- **Infrastructures** are a focus area to improve efficiency in Generation, Distribution, Consumption

- **Citizens** can contribute to reduce energy consumption and peaks through Smart Meters and Smart Homes

- **Public Administrations** have the duty to trigger the next step, evolving cities in Smart Cities

| Electricity Generation | Transmission & Distribution | Consumption (example Notebook) | | | |
| 220 W | | | | | 60 W |

-75%

| Electricity Generation | Transmission & Distribution | Consumption (example Notebook) | | | |
| 55 W | | | | | 40 W |

- **Infineon** focused all its efforts on Energy Efficiency, Mobility and Security, where is currently holds leading WW positions

- **Infineon** aims at being your semiconductor partner to implement efficient infrastructures, smart homes and cities

ENERGY EFFICIENCY MOBILITY SECURITY

Innovative semiconductor solutions for energy efficiency, mobility and security.