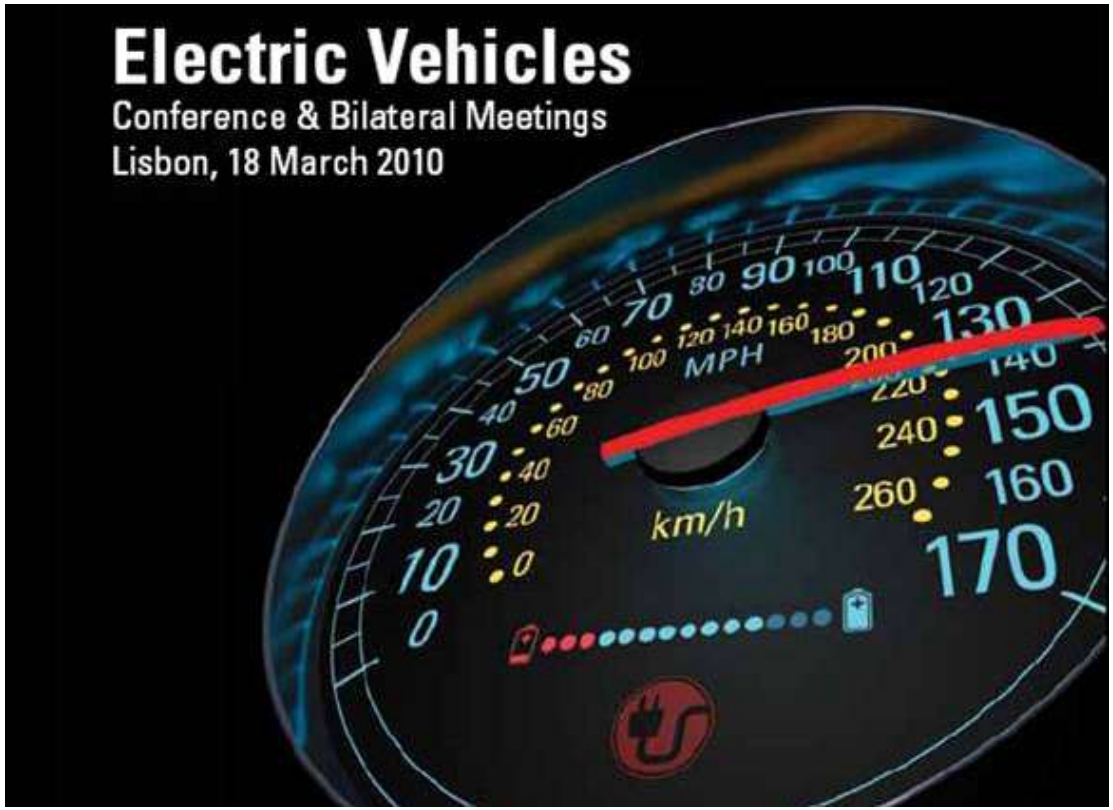
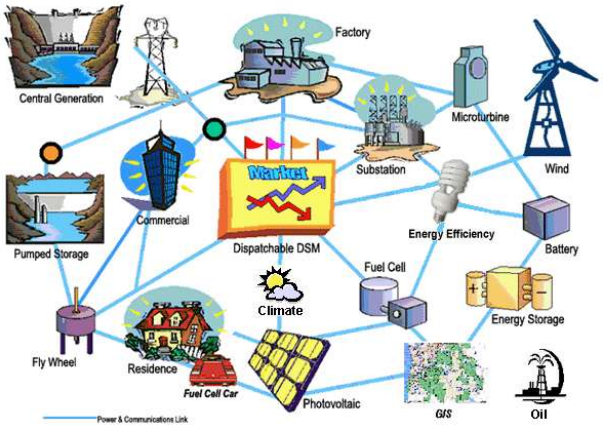




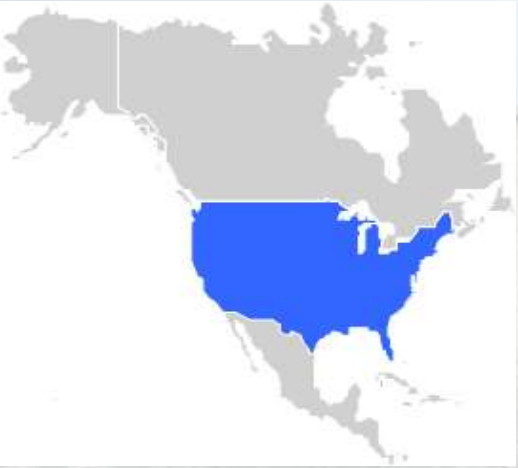
EDP perspective on Electrical Vehicles

António Vidigal

EDP Inovação

18th March 2010

EDP: A reference company in the Iberian market with leading presence in Brazil and strong investments in the US



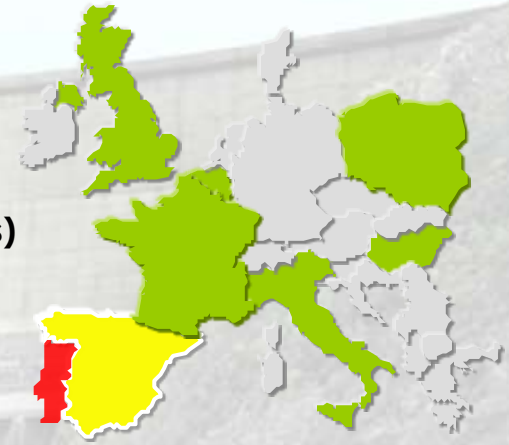
Renewables

U.S.A.
Generation capacity (Gross)
- 2,859 MW

Energy generated
- 5,905 GWh

Europe & Brazil
Generation capacity (Gross)
- 3,369 MW

Energy generated
- 5,001 GWh



Brazil

Generation capacity
- 1,725 MW

Electricity distribution
- 21,313 GWh
- 2,668 thousand customers

Portugal

Generation capacity
- 10,569 MW

Electricity distribution
- 49,422 GWh
- 6,120 thousand customers

Gas distribution
- 6,133 GWh
- 221 thousand customers

Spain

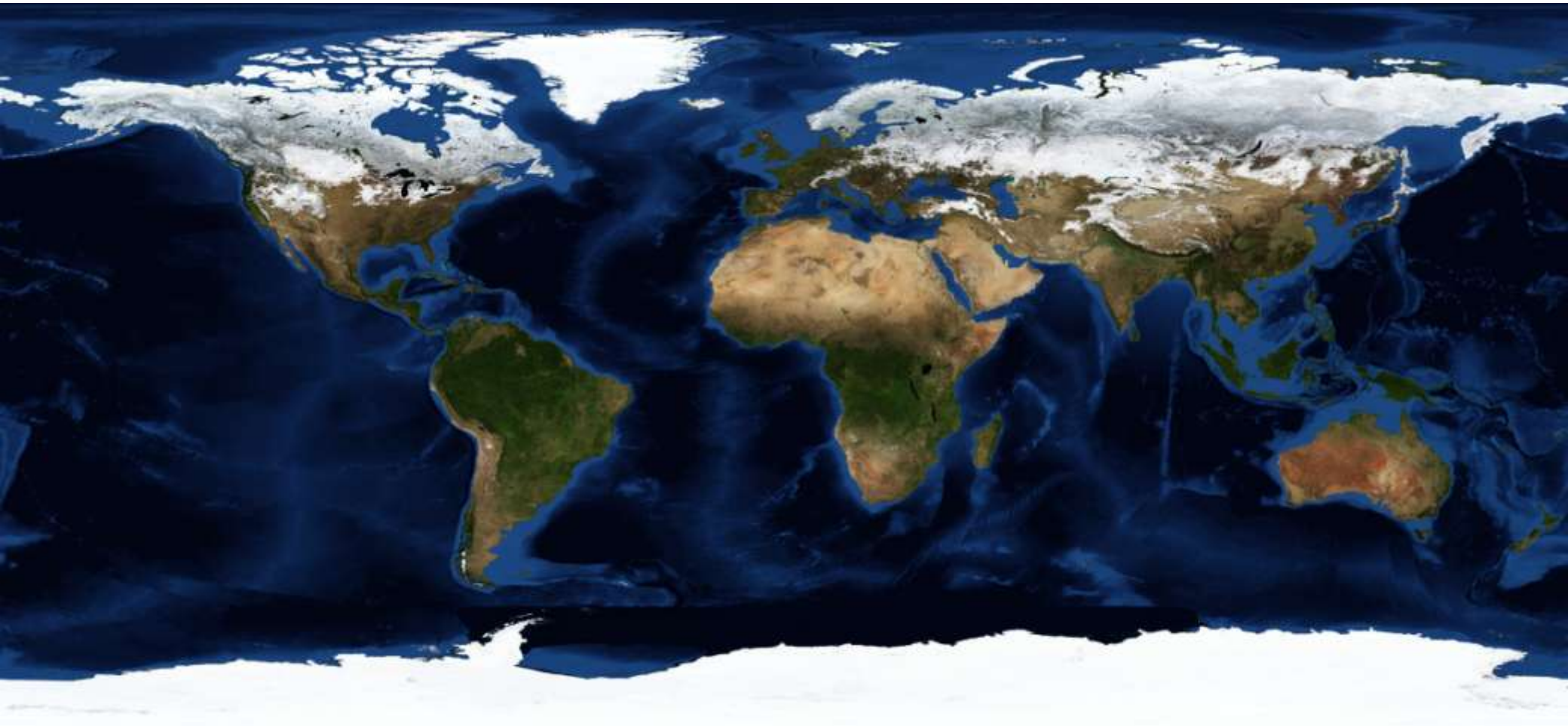
Generation capacity
- 5,288 MW

Electricity distribution
- 9,131 GWh
- 645 thousand customers

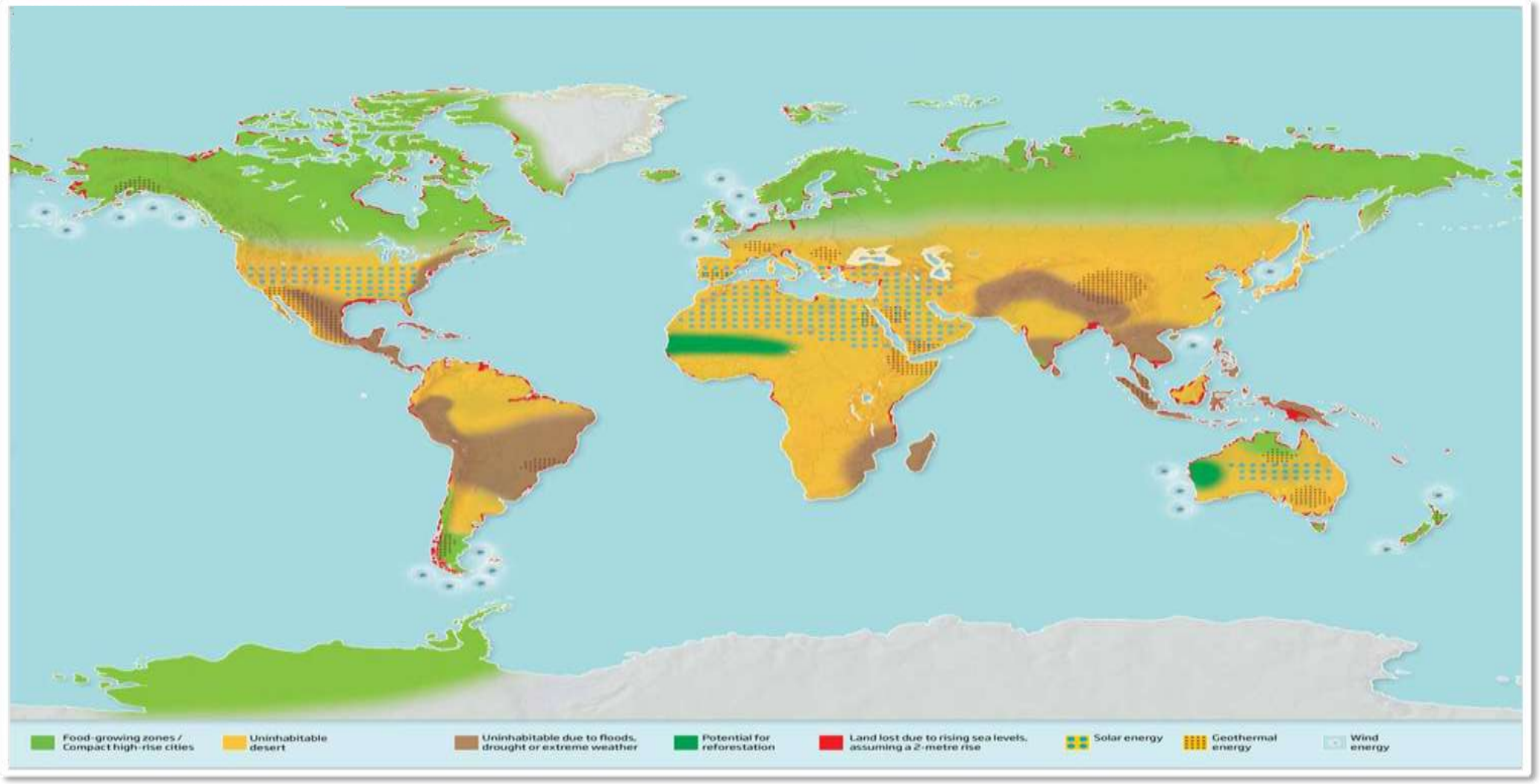
Gas supply
- 19,561 GWh
- 954 thousand customers

Core Business: Renewables and Innovation

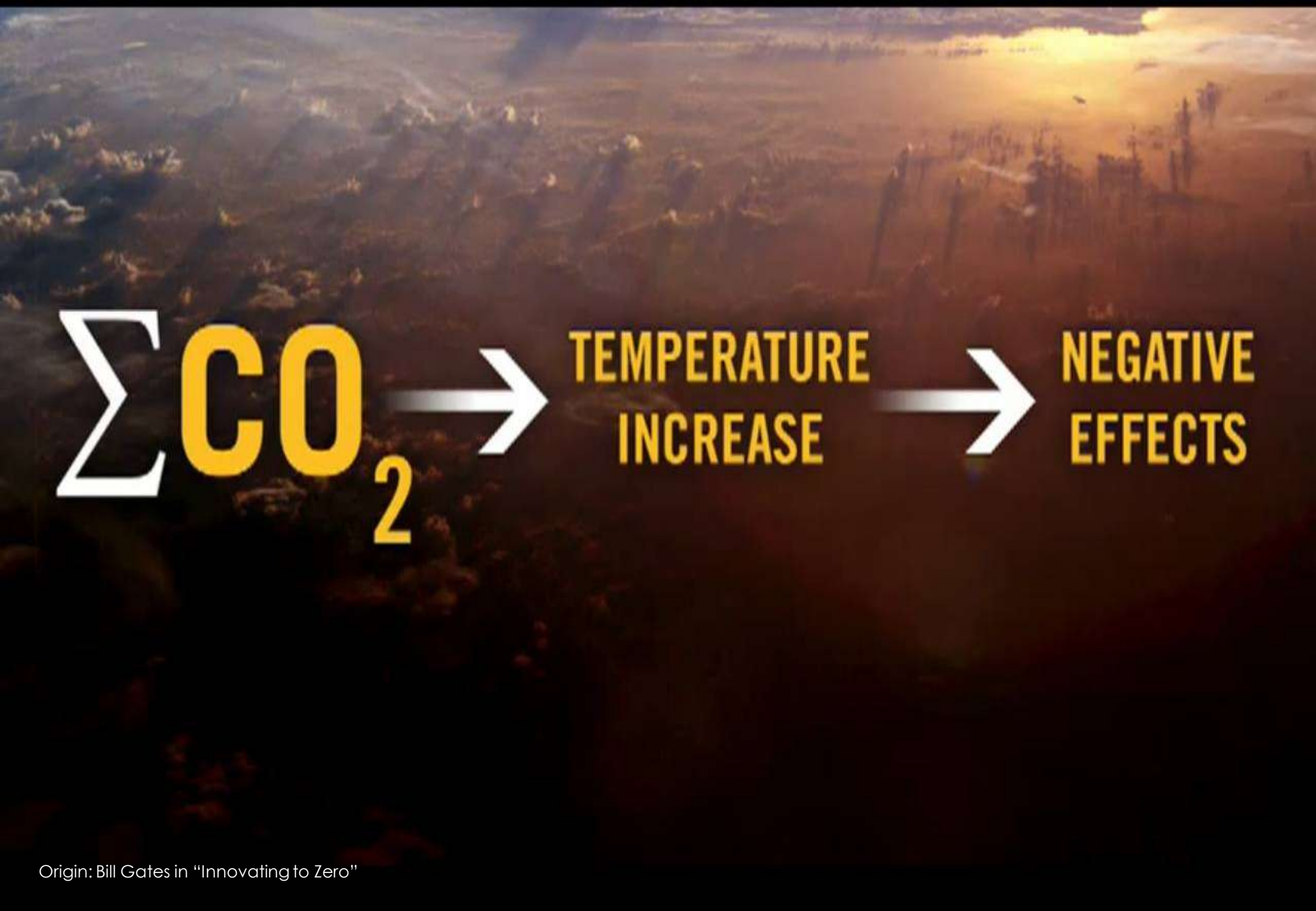
Why Innovation ? : Background
We Inherited a Blue Planet



Why Innovation?: Background
In 2050 the Planet may be 4ºC warmer. How will we survive ?



NewsScientist



Origin: Bill Gates in "Innovating to Zero"

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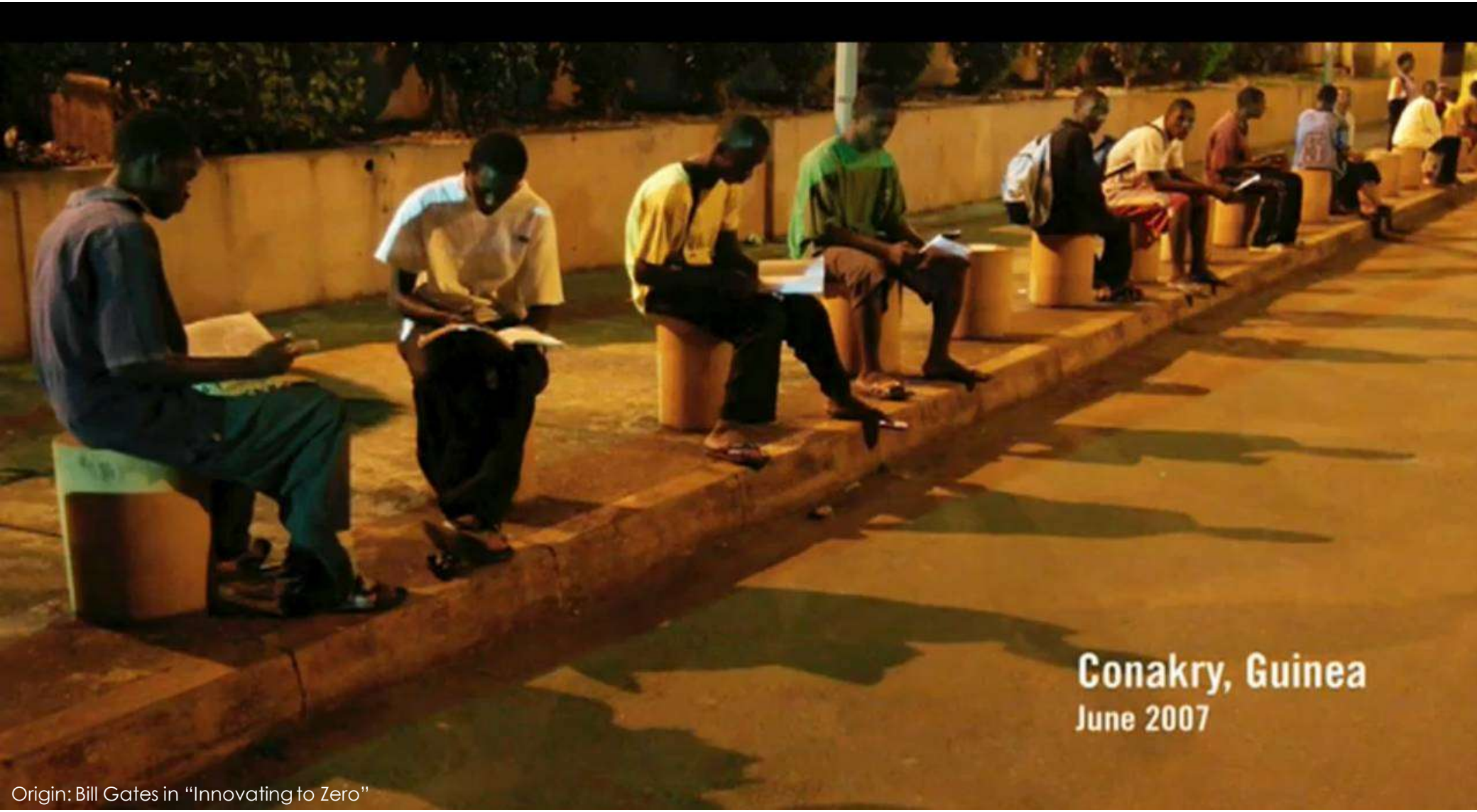


Origin: Bill Gates in "Innovating to Zero"

Electrical Vehicles are instrumental into meeting these objectives

Kaya decomposition analysis

$$CO_2 \text{ emissions} = P \times T \times E \times C$$

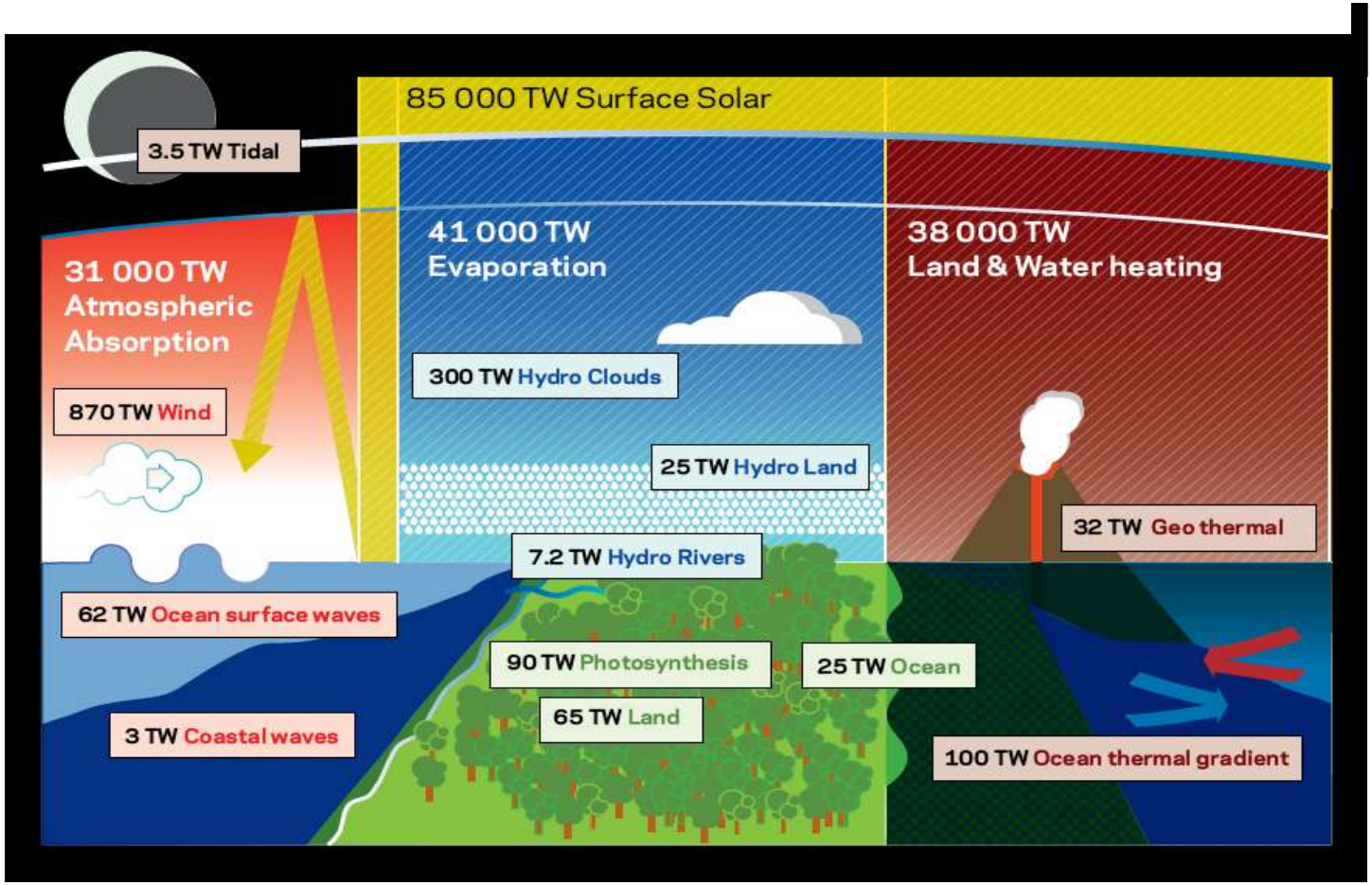
- T: **Transport intensity** (e.g., VMT/capita)
- E: **Energy Intensity** (e.g., MJ/mile)
- C: **Carbon Intensity** (e.g. gCO_2-eq/MJ)

GHG Emissions can be reduced by:

T: Decreasing Transport intensity (e.g., reduce VMT)
E: Decreasing Energy Intensity (e.g., improve fuel economy)
C: Decreasing Carbon intensity (e.g., lower-carbon fuels)

It must be possible …

- There within our reach an enormous amount of Renewable Energy to be captured ...



IF we could capture incident solar power over an area of 400.000 Km2 (half of Iberia) with 20% efficiency we would solve could supply present World energy needs (~15 TW in 2005).

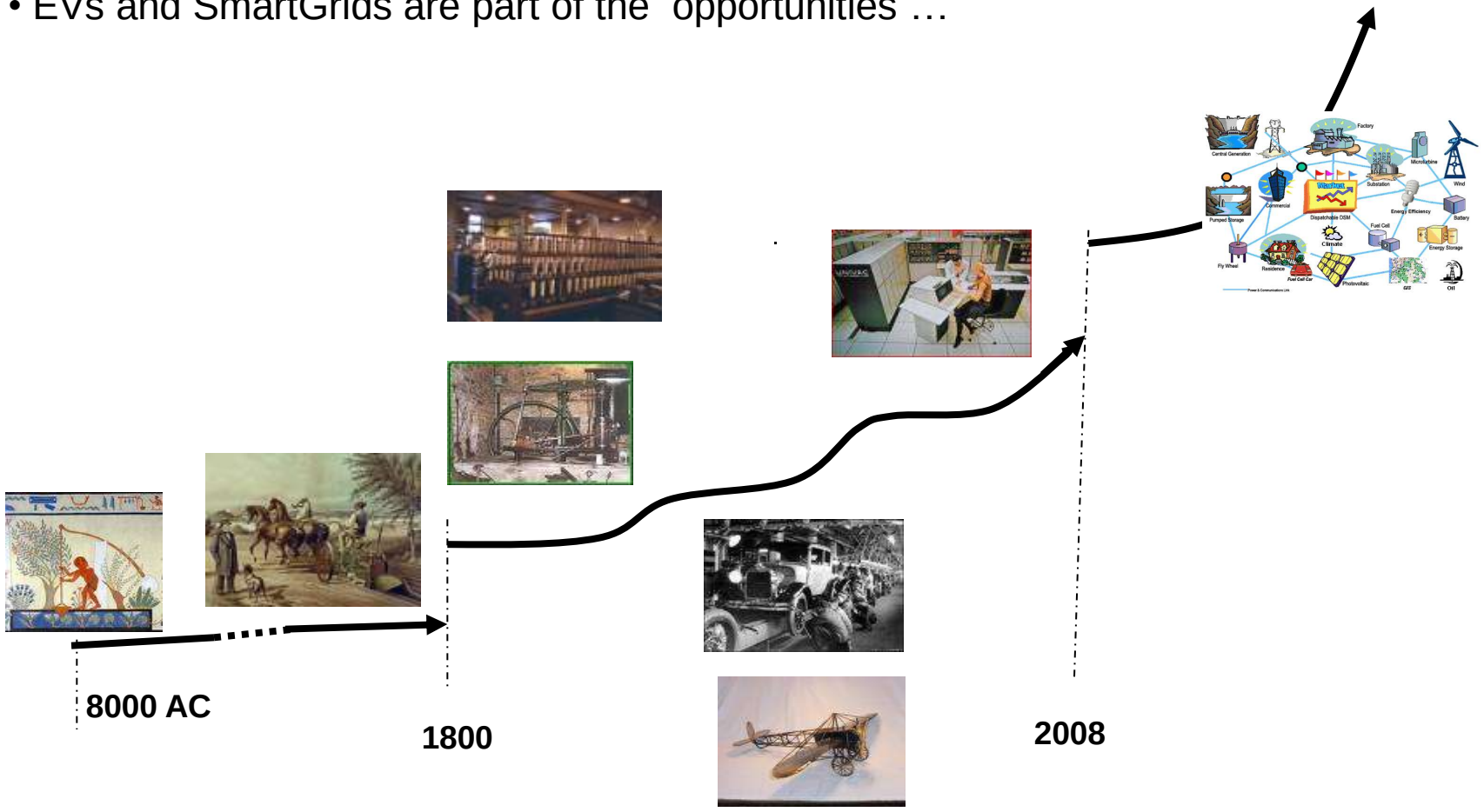
Innovation Areas

EDP Innovation Priorities

1. 
   Offshore Energy
2. 
   Solar Energy
3. 
   Electric mobility
4. 
   Smart grids
5. 
   Energy efficiency

But energy systems will have to change a lot …

- There will be inflection points with threats and opportunities
- EVs and SmartGrids are part of the opportunities …



Power Systems need to be reinvented

Origem: Documento da UE sobre SmartGrids

If Marconi came back to Earth, he would be amazed.

Edison not so much …

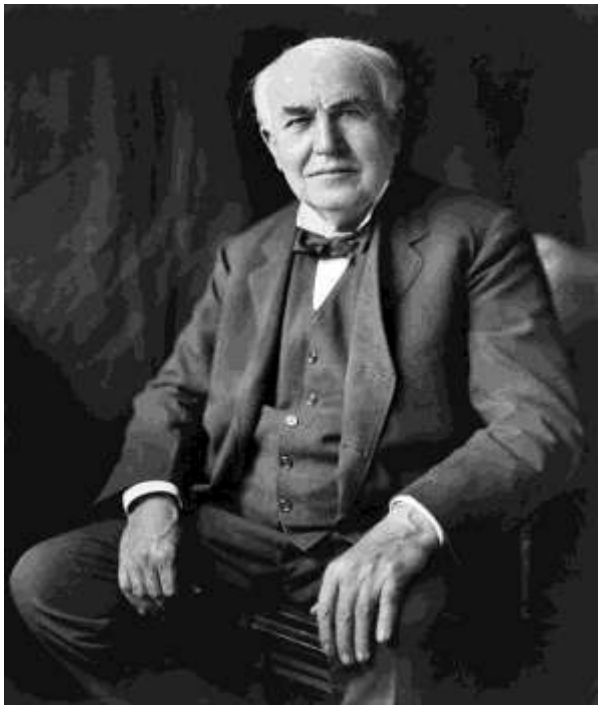
Guglielmo Marconi

Inventor Wireless Telegraphy

1874 –1937

Thomas Edison

Inventor of the Electrical Bulb and of the concept of Distribution Grid



1847 - 1931

Future is difficult to forecast even for Gurus

"I think there is a world market for maybe five computers." ”

Thomas Watson, President ofIBM , 1943

"There is no reason for any individual to have a computer in his home."

Ken Olsen, the founder and CEO of Digital Equipment Corporation 1977

"The beautiful thing about Unix is that it doesn't do anything."

Ken Olsen at the same conference

“640 K ought to be enough for anybody."

Bill Gates, Nasa Conference 1981

Future is difficult to forecast even for Gurus

1. “It is impossible to feed the Grid with more than 30% of renewable energy”
xxx , 2010

2 . “No individual will want to generate his own energy”
yyy, 2010

3. “EVs are just ‘gadgets’ and will not replace the ICE in the near future "
zzz, 2010

4. “It will be impossible, in the foreseeable future, to store on batteries of reasonable price and weight the energy needed to travel 600 Km”
www. 2010

Cars need to be a species in fast evolution …

Forget the old car. The new car has an extension cord …

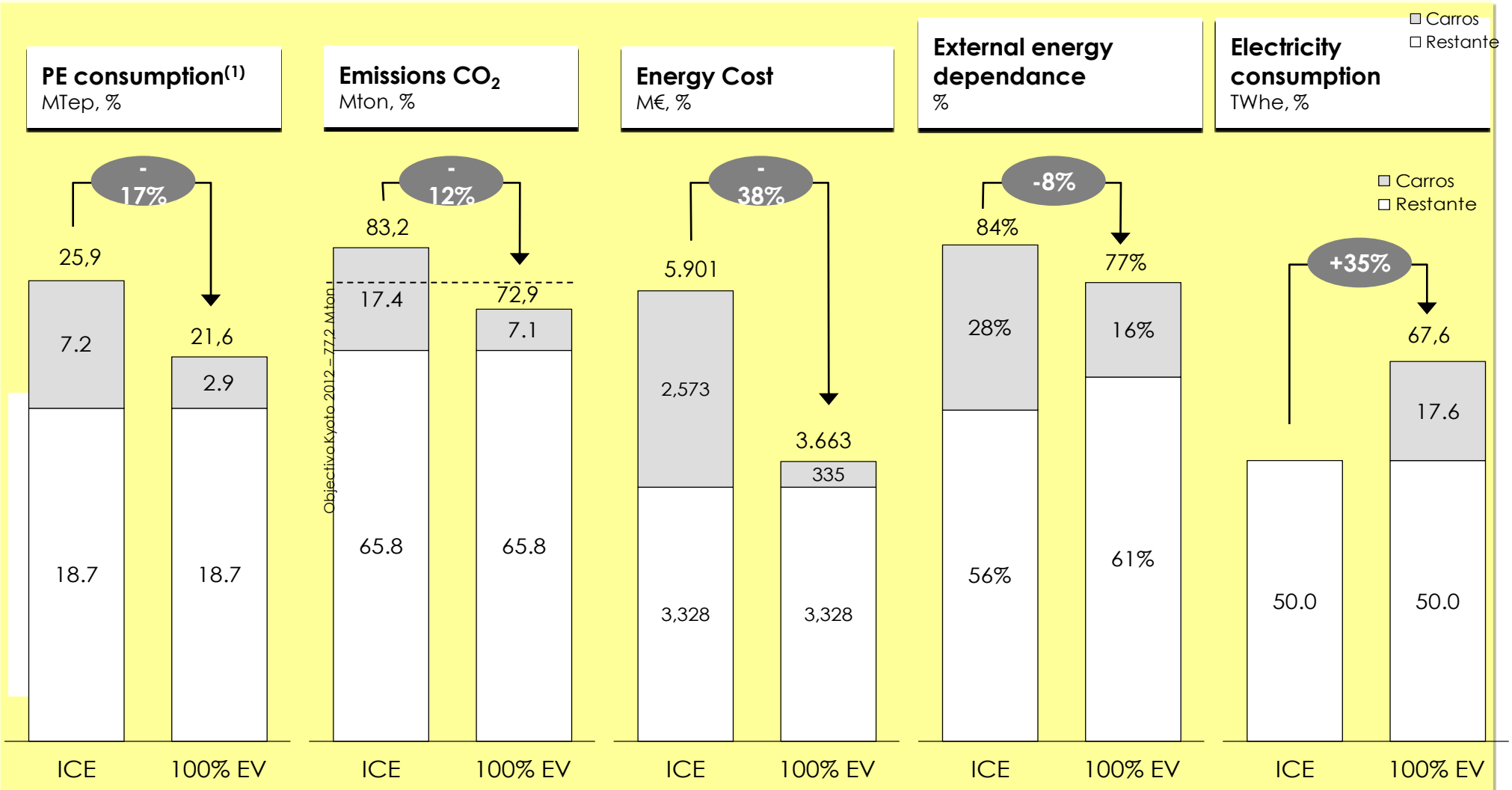
Let’s look at the differences …

Origin of photos: Wired

Can the Grid Cope ? Yes, if we bring in Smart Grids !

Origin: SmartGarage Report

If we assume all cars EVs, Portugal would benefit a lot …



(1) Primary Energy
Nota: Assumes generation mix of 35% CCGT, 25% Coal and 40% Renewabls
Source: DGEG, Balanço Energético 2006

What may happen on a massive adoption of EVs ?

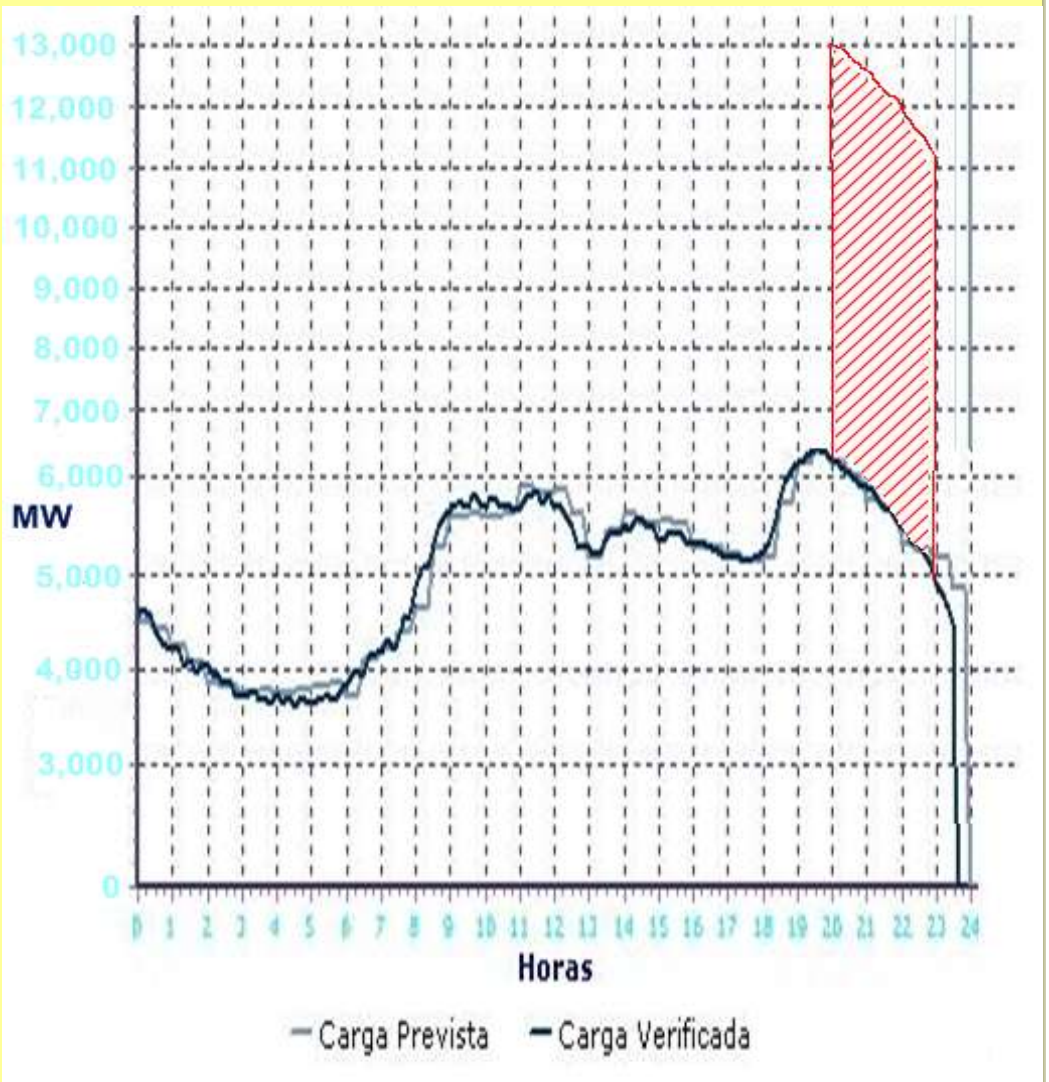
First Scenario – Worst case uncontrolled charging with 100% occurring in Synchronism between 20h às 23h.

Assumptions:

- 4.5 million vehicles in Portugal;
- Maximum power taken from Grid: 230V x 16A, 3,68kW;
- Daily travel ~30km;
- Power consumption 15kWh/100km;

An additional 6,75GW would be needed in the Grid!

Power taken

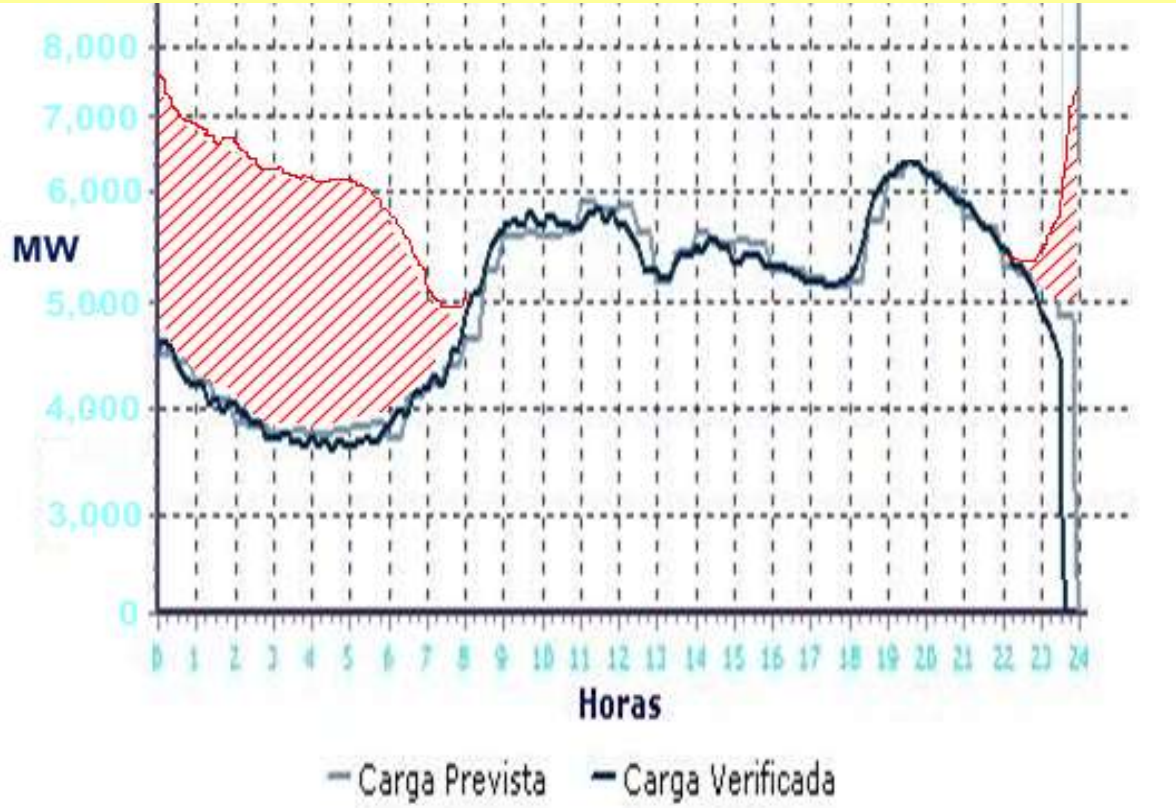


What may happen on a massive adoption of EVs ?

Scenario 2 – Load controlled and automatically distributed between 23h and 07h

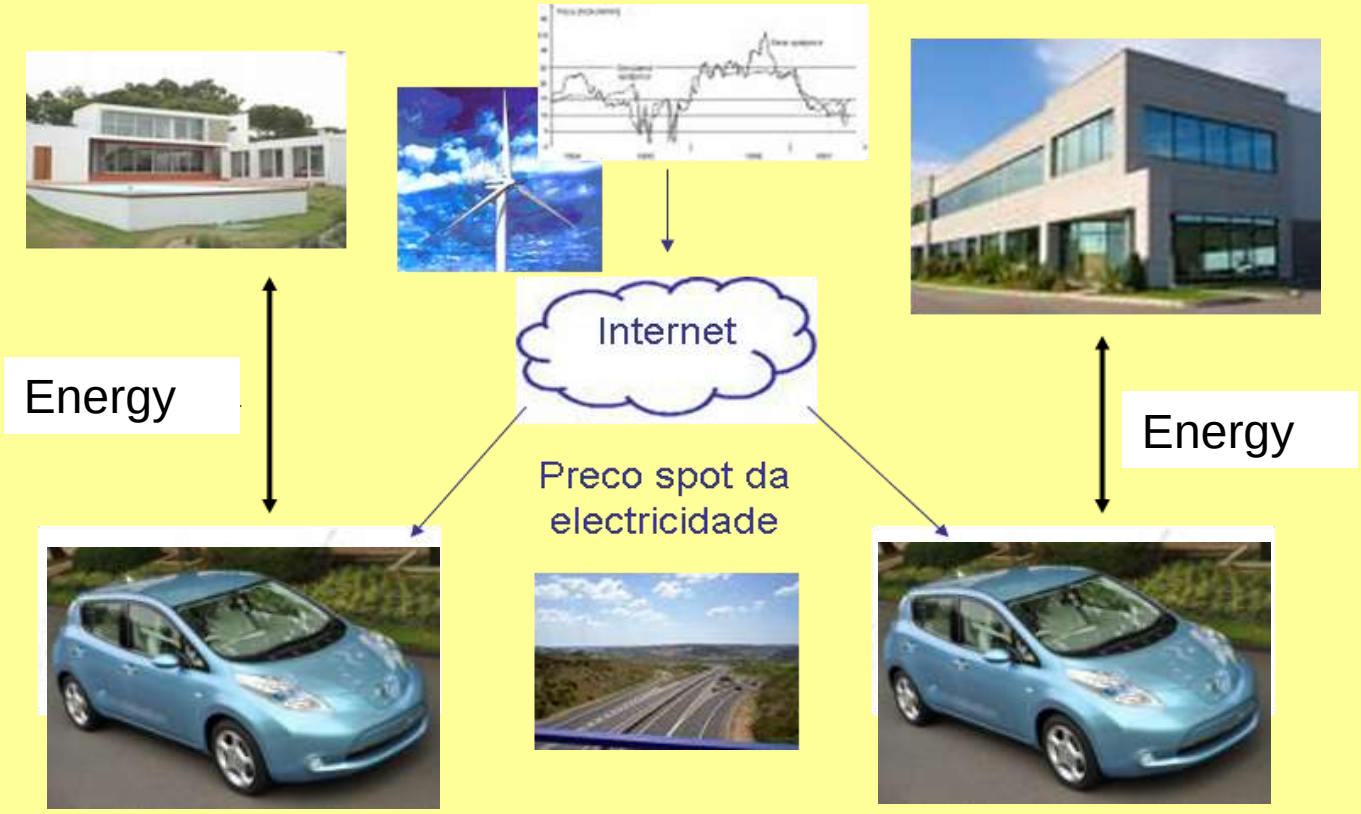
An additional 2,9 GW would be needed in the Grid !

The average power taken by each vehicle would reduce to 0,64 kW



V2G comes to the rescue …

EVs and plug-ins, will decide when to buy or sell electricity according to the "spot" price of energy, taking into consideration constraints set up by their owners.

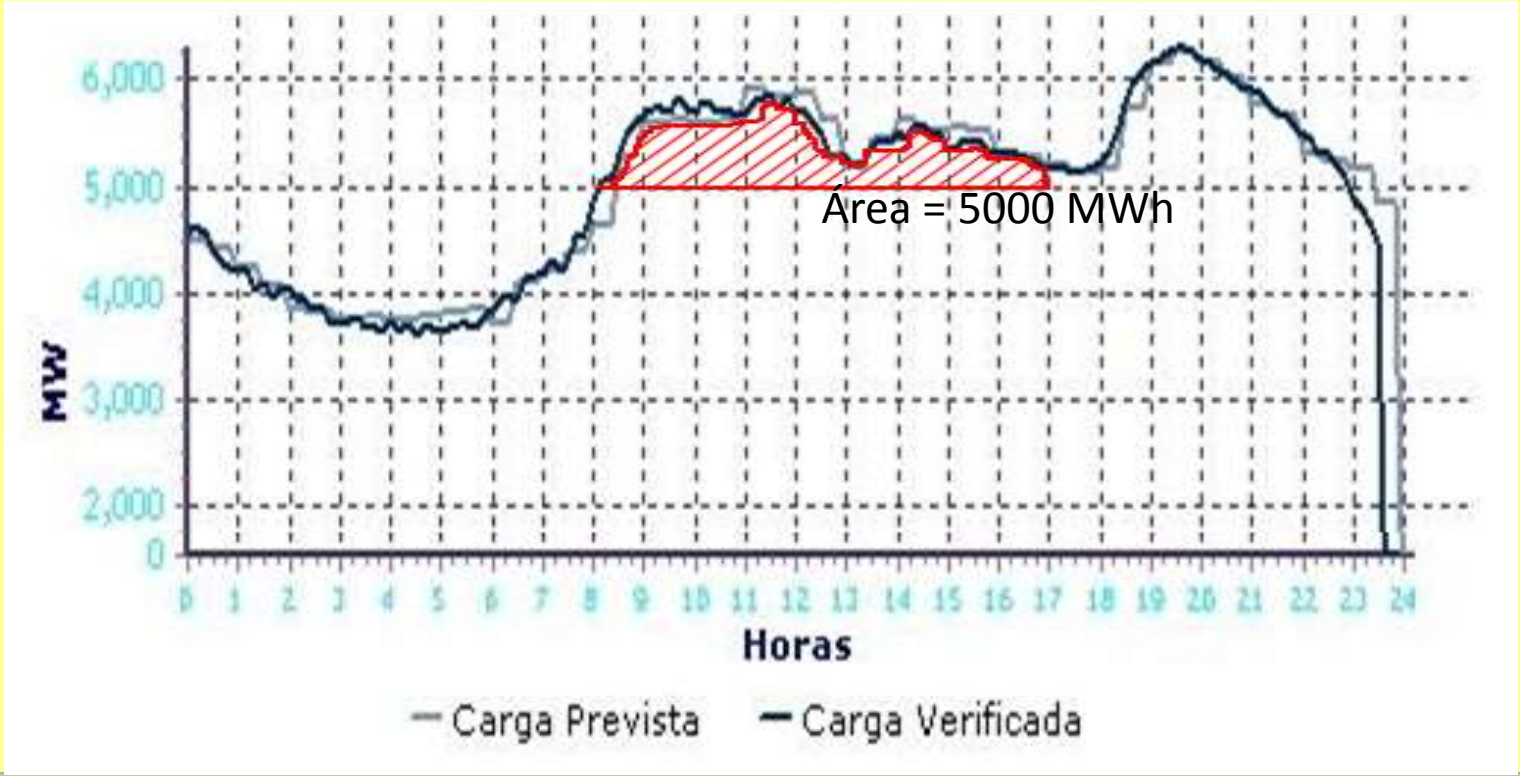


What may happen on a massive adoption of EVs ?

- **Scenario 3 – V2G, it is possible to use the energy stored in car batteries in order to store energy and feed it back to the Grid whenever convenient.**

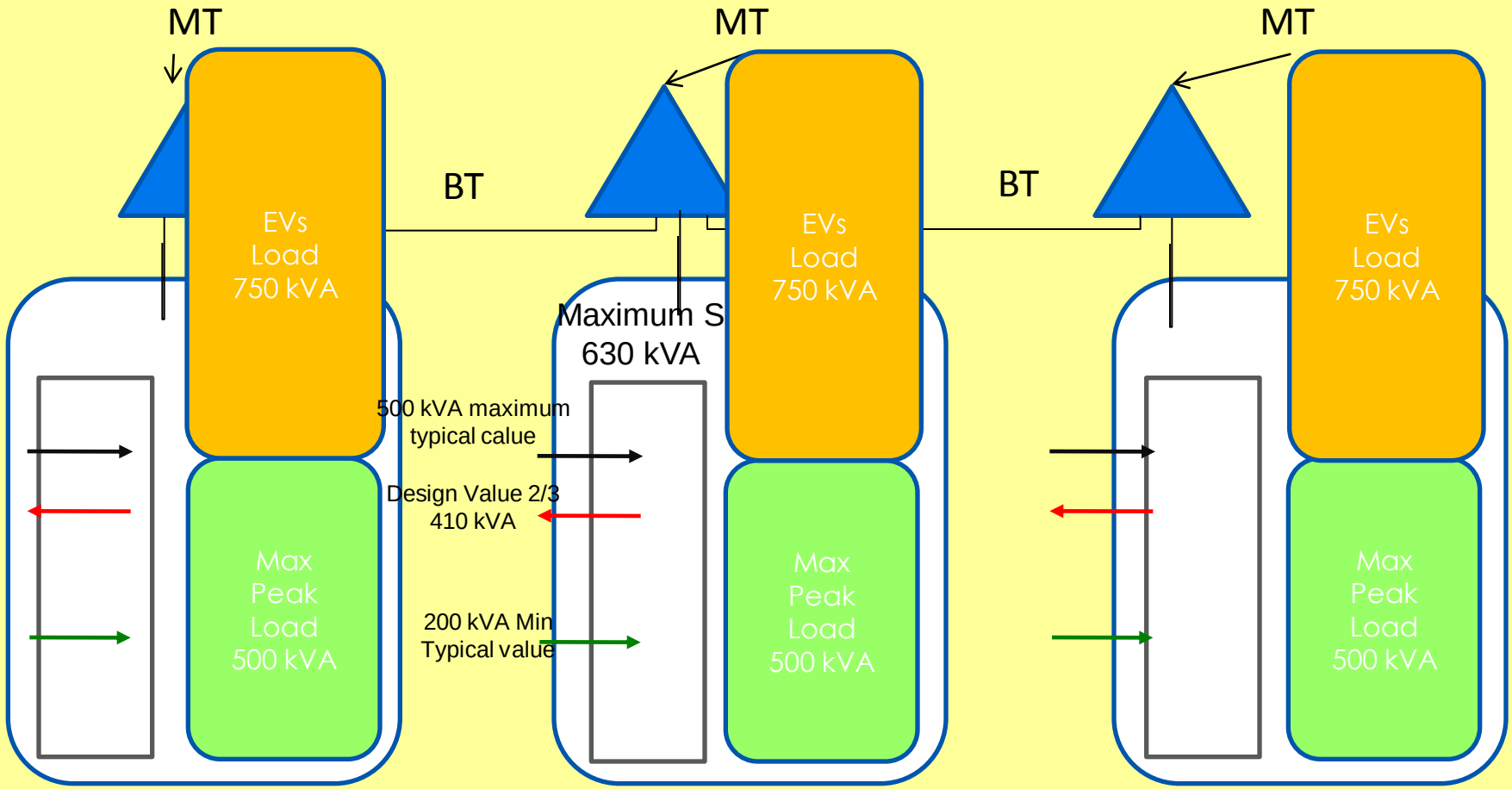
Here we are using 5 GWh to peak shaving energy in daytime .

Each EV just contributing wiht 1,2 kWh, which represents 4% of an average battery



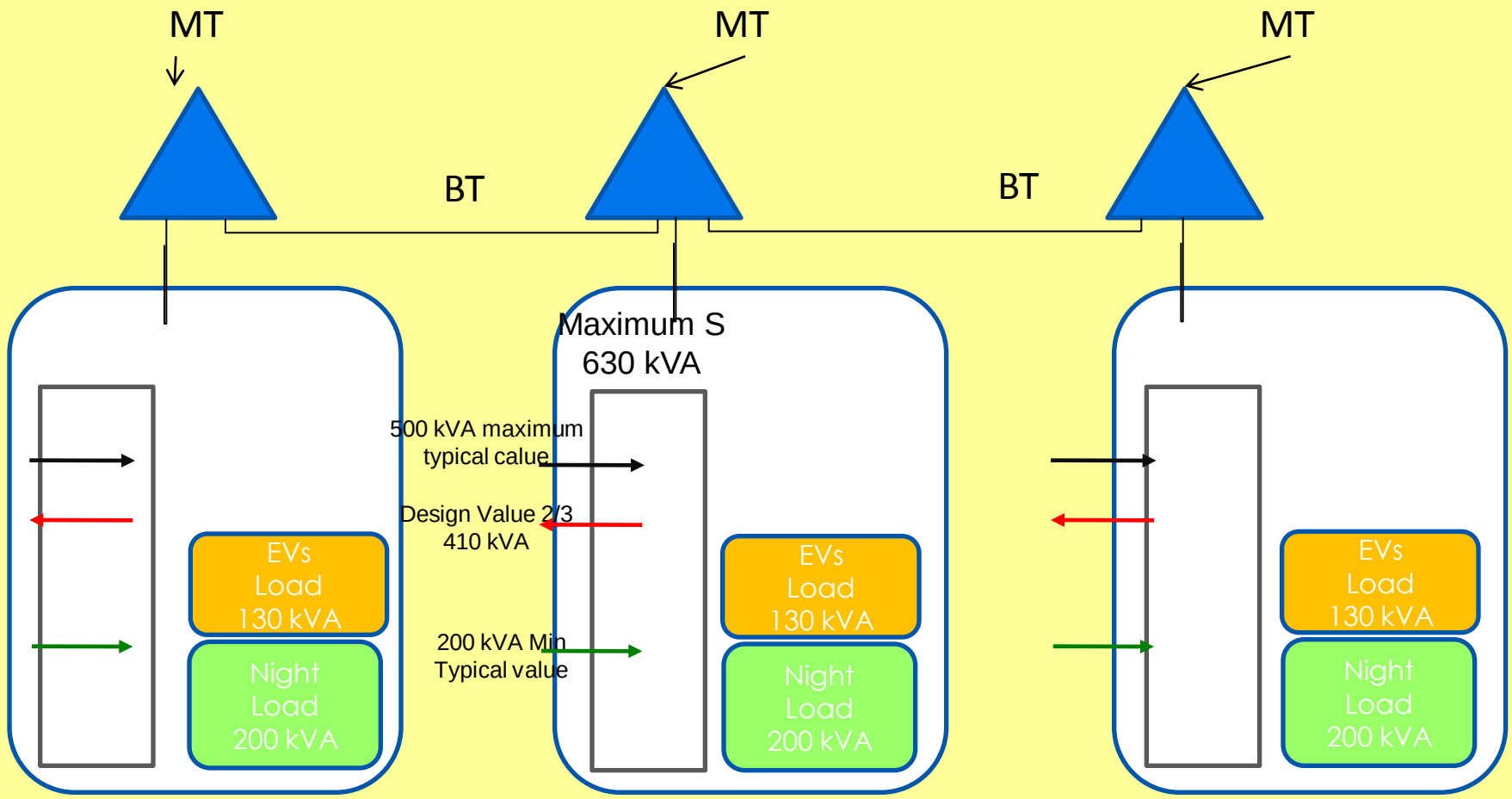
What about the Distribution Network ?

- **Scenario 1:**
- Assumptions: An average transformer station 630 kVA – 300 clients – 200 of them with Electrical Vehicles
- **Vehicles are charged wihout control at Peak Hour: Peak may reach 500 + 750 kVA =1250 kVA**

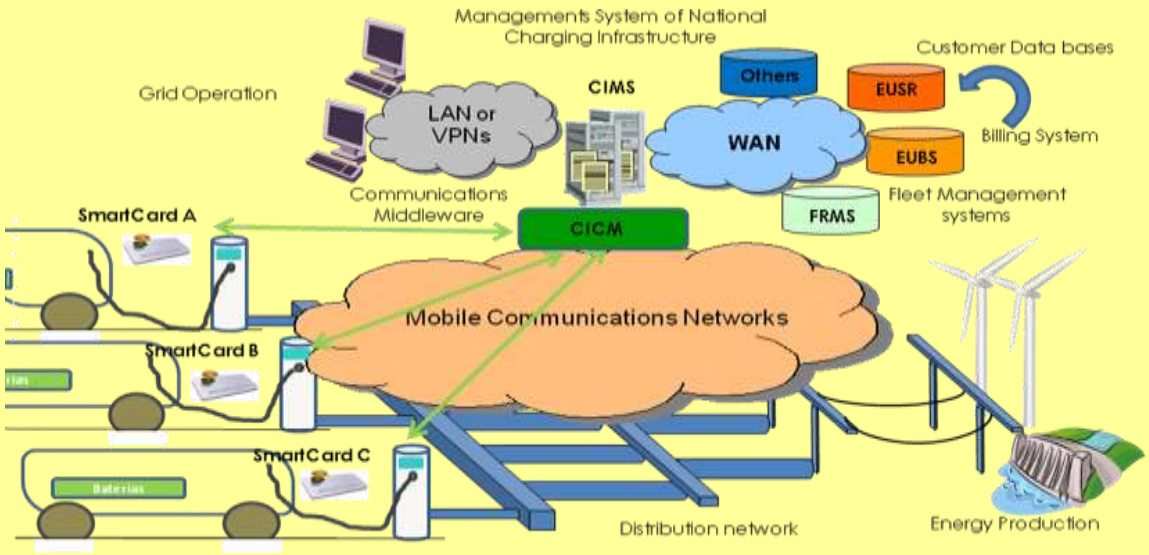


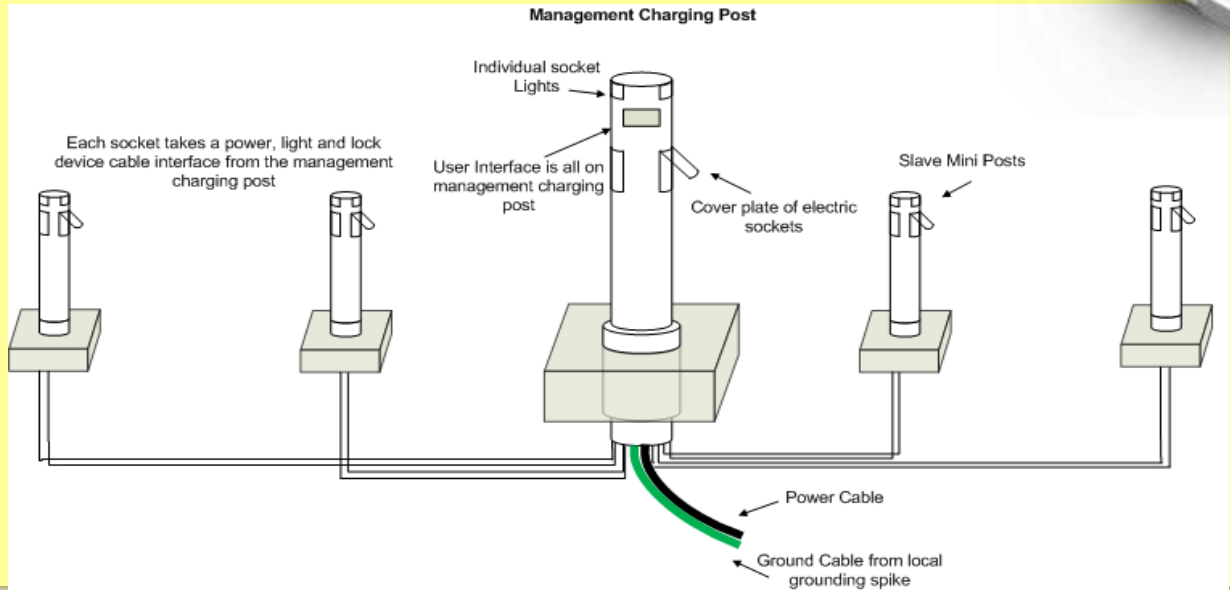
What about the Distribution Network ?

- **Scenario 2:**
- **Here the EV's charging is controlled and pushed towards the night: Peak power Reduces to 200 + 130 kVA =330 kVA**

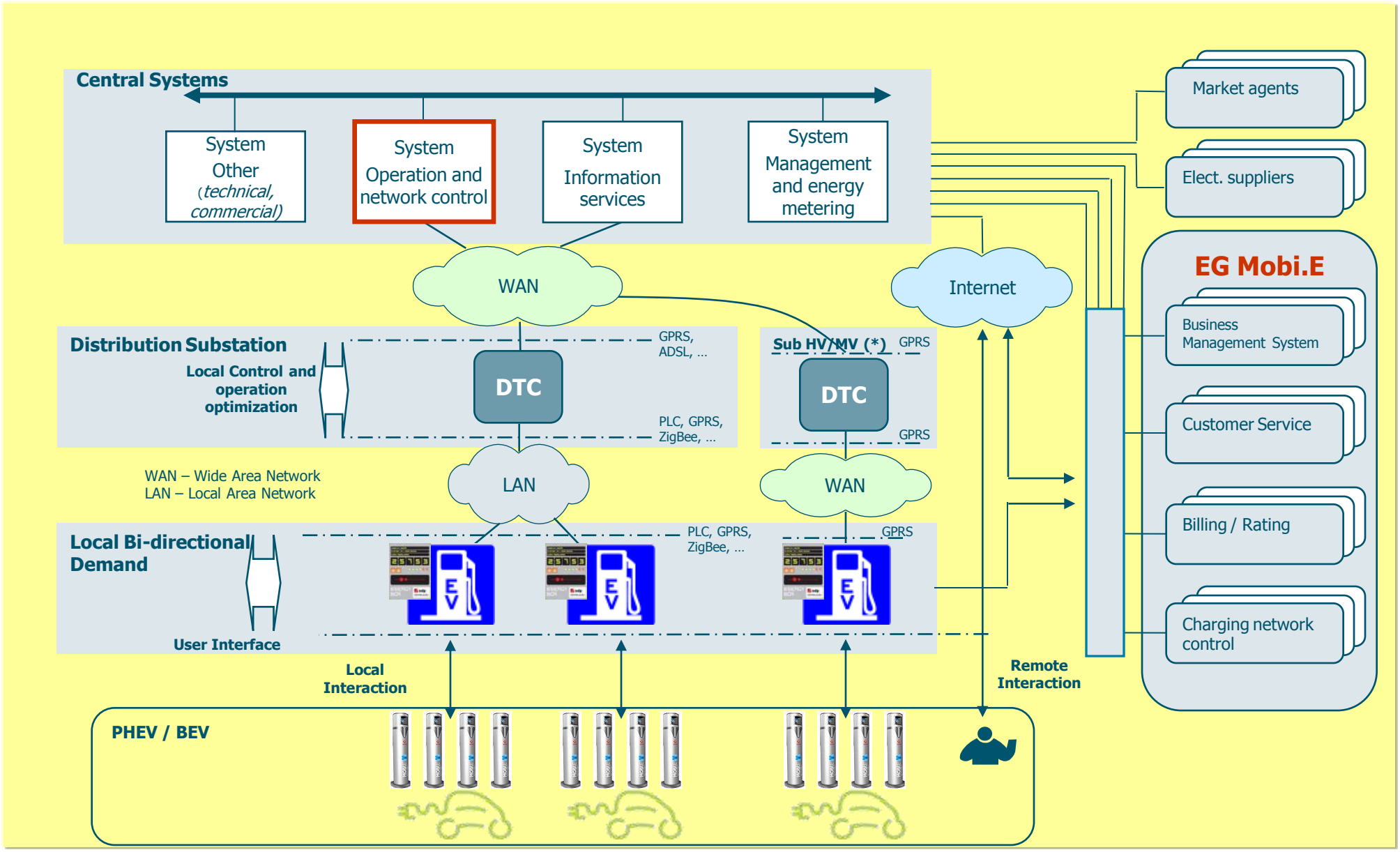


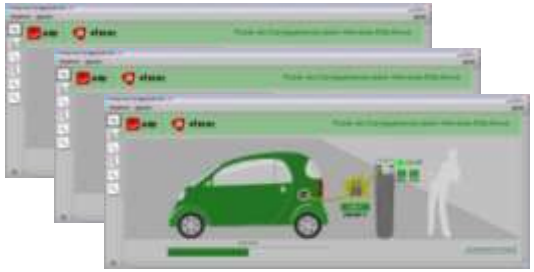
EDP is partnering with Portuguese companies to design a complete System

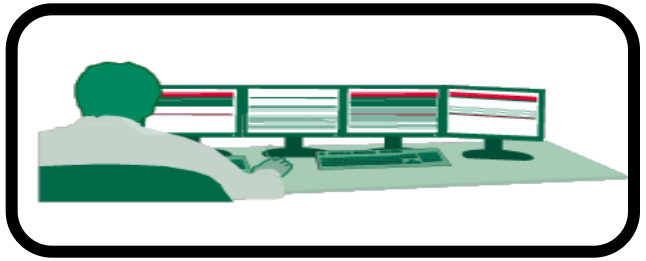




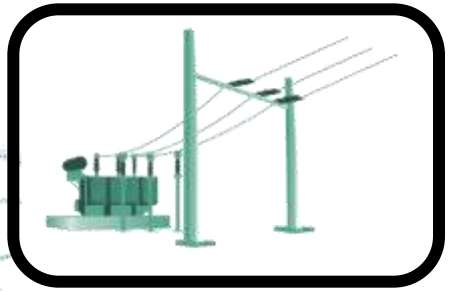
The System will interplay with InovGrid







Real Time Monitoring and Control



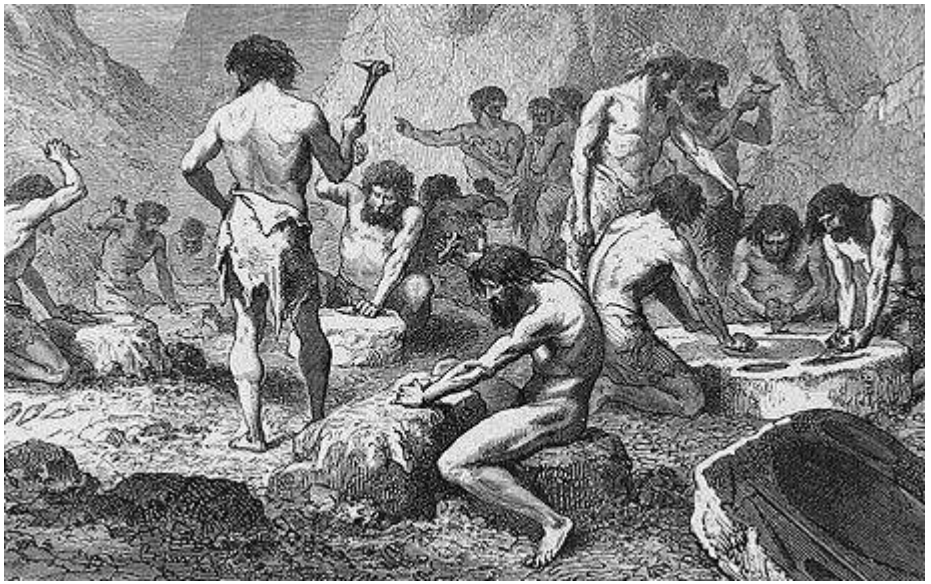
New opportunities for network operation:

- **Higher renewables penetration**
- **Micro and distributed generation**
- **Distributed automation and intelligence**
- **Demand side management**
- **Outage Management**
- **Fault detection and management (self-healing)**
- **Losses minimisation**
- **Voltage VAr control**
- **Microgrids**
- **Real Time Markets**

- **“- Dad where were you during the War ? “**

  [against Global Warming]

- **EDP wants to be a part of the solution**



It is time to bet on Clean Tec. After all the Stone Age did not end by lack of stones.

Thank you !