Energy in Action

Comparison of fossil fuels & renewables

http://www.asge-national.org/Conference
ASGE conference June 3rd, Las Vegas
Dr. Gunther Berthold

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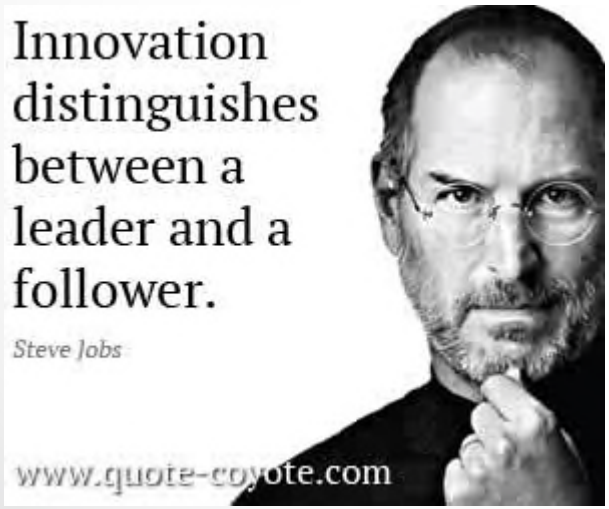
Comparison of fossil fuels & renewables – opportunity?

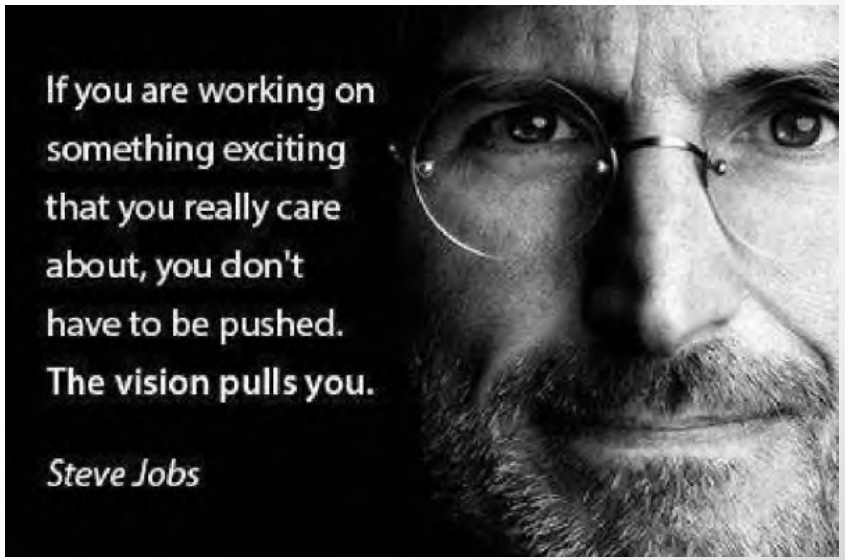
- **Market opportunity needs to be aligned with company vision.**
  - Brief introduction
- **Market opportunity: Renewable energy**
  - References
  - Consumption for individuals
  - Actual Energy resources in USA
  - Can the USA live on renewable only
  - Balance of consumption and renewable / sustanable enrergy consumption
  - The markets of opportunity and the vision based on facts
  - The timing and cost of invention
- **The strategic approach**
  - Product portfoglio

Market opportunity needs to be aligned with company vision

The only way to do great work is to love what you do

If you haven't found it yet, keep looking. Don't settle. As with all matters of the heart, You'll know when you find it.





Market opportunity needs to be aligned with company vision

Values

- A sustainable future, our focus is on the long term impact of our actions ensuring they will benefit our environment, our society, our clients and our company.
- Technology that is both innovative and pioneering, ensuring we stay at the leading edge in our field.
- Clarity in our intentions and communications.
- Respect for the individual.

Vision

- To be recognised for our pioneering technology, outstanding quality and service.
- To achieve continuous growth and be the strategic partner of choice in our sector.
- To develop innovative technologies that contribute to safeguarding our environment.
- To be recognised by partners, suppliers and customers for our loyalty and service.

Purpose

- To develop, produce and sell components for use in energy transformation products.
- To advance the efficient use of energy sources and exceed the most exacting environmental requirements.

Product range in line with our vision ?

ATMOSPHERIC


Low Noise Single Injector


Low Noise Multi Injector


Traditional Tubular


Low NOx Tubular


Ring

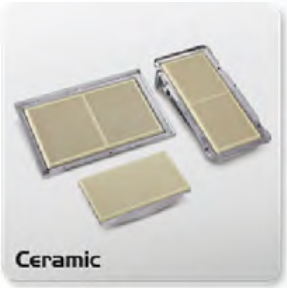
PREMIX


Cylindrical metal fiber


Cylindrical Metal


Cavity


Flat metal fiber


Ceramic


Flat metal

OTHERS


Decorative

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COMPANY HISTORY in line with our vision?

BURNERS
COMBUSTION SYSTEMS
ENERGY INNOVATION

1965

Worgas Bruciatori Foundation.
With almost 50 years of experience, Worgas has always been working in partnership with customers.

1987

Development and Patent of a pioneering combustion method that produces **Low NOx and CO emission (Butterfly Wings).**

NOx..CO.. stop

1997

Development and Patent of a wide range of **Premix Burners** for domestic, commercial, industrial capacities, and with different type of materials: metallic, ceramic and home-made metal fabric (WorgasTEXI).

2000

Opening of Worgas, Inc (USA).

2009

WORGAS
Aeromatix

Aeromatix Acquisition, with over 65 years of history, is the most important UK company producing gas burners. **ISO9001:2008 Certificated.**

ANAB BSI

2010

Launch of Energy Innovation Department, dedicated to the study and development of sustainable energy systems, particularly in **Combined Heat &Power (CHP), hydrogen generation and domestic solar applications.**

2011

"Powered by H_2O Gen" first Prototype.

H_2O GEN

2012

ISO9001:2009 Quality Certification. Opening of **a new Sales Office in China.**

ANAB BSI

2013

Opening of **a new Sales Office in Turkey.**

Today

Worgas Group is a Worldwide team with local experts, thanks to its production plants in:

- **Italy**
- **UK**

and sales offices in

- **USA**
- **China**
- **Turkey**

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Worgas IDendity kit

Sales	19.000.000 EUR, 14 % growth in 2013 through innovative world leading products, stable on existing products
People	140
Location	Formigine, Italy (1965), South Normington, UK (1945 – acquisttion in 2009); Bowling Green, USA (2001)
Facility in Formigine	13.000 sqm, full recovery of test facility heat, 50% of electrical energy made by roof PV system, state of the art gas appliance testing from kW to MW,
Pioneering Technology	over 150 patents, world leadership in flat premix burner, second on commercial premix,
Product	combustion technology and systems, gas burner, H2 generator
Application	boiler, co-generation, Stirling, Fuell Cell (reformer), gas absorption heat pump, Portable power generator

Worgas IDendity kit - customer

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  - Energy resources in USA
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  - Balance of consumption and renewable / sustanable enrergy consumption
  - The markets of opportunity and the vision based on facts
  - The timing and cost of invention
- The strategic approach
  - Product portfoglio

References

- **Energy** - **without the hot air**; David MacKay
  - Chief Scientific Advisor to the Department of Energy and Climate Change.
  - Regius Professor of Engineering at the University of Cambridge
  - **http://www.withouthotair.com**
- **Worgas part of company presentation; 2013**
- **Energy wave and tide**; Gianmaria Sannino, Adriana Carilli, Andrea Bargagli; Emanuela Caiaffa; ENEA 2001, Energia, Ambiente e Innovazioni
- **LE RISORSE GEOTERMICHE DI MEDIA E BASSA TEMPERATURA IN ITALIA;** Ferrara, 21-22 Settembre, 2010; B. Della Vedova, M. Piller, Dip. Ingegneria Civile e Amb., UniTS e UGI; G. Buonasorte, Membro del Consiglio UGI
- **Wind energy in Italy, potential;** ANEV; 2011; www.anev,org
- **BP energy outlook 2010, 2013**
- **World energy outlook 2011, IEA,** www.worldenergyoutlook.org
- **NREL, Renewable Electricity futures study, executive summary, 2012**
- **DOE/EIA September 2012, Annual Energy Review 2011,** www.eia.gov/aer

Market opportunity:Renewable Energy USA

- Numbers by person by day

Population 2013	:310,000,000 p
Land surface	:10,000,000 km^2
Land surface/person	:32,000 m^2/p
GDP (2013)	:17,000 bn USD
GDP per person	:55,000 USD/p
GDP per person per day	:150 USD/p/day

1 barrel oil =159l
Price average 2013: 0,69 USD/l
1l oil = 10kWh

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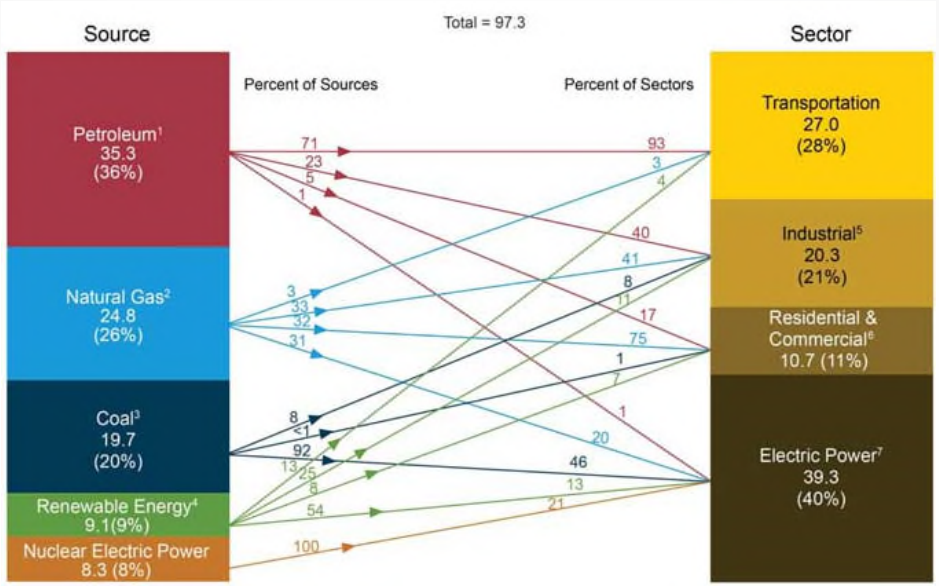
Total primary energy consumption share by sources & sector



Total primary energy consumption 2012 :25,000 TWh

Equals: 220kWh/p/d

25,000TWh/310Mp/365d

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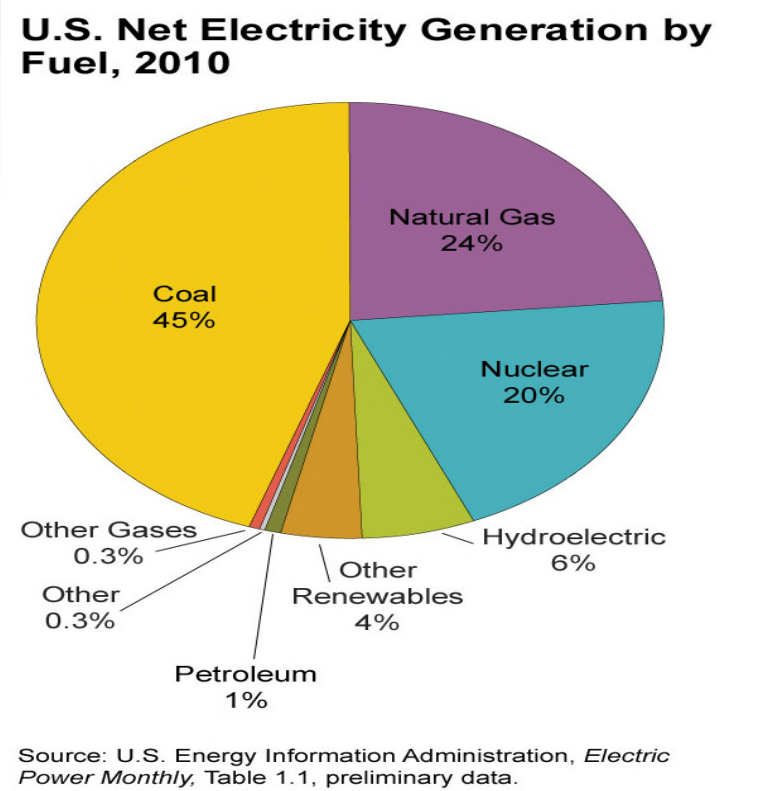
Total electricity generation by fuel



Source: U.S. Energy Information Administration, *Electric Power Monthly*, Table 1.1, preliminary data.

Total electric energy consumption 2012 :4,100 TWh

Coal 37%, NG 30%, nuclear 19%, hydro 7%, renewable 5%, rest 2%.

Equals to: 36kWh/p/d

4,100TWh/310Mp/365d

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Consumption per person
summing up to estimated 205 kWh/d/p

- **Cars - 40 kWh**
  - distance travelled per day/distance per unit fuel
  - (50km)/(12km/litre) x (10kWh/litre)
- **Intercontinental & continental flight on Boing 747 – 33 kWh**
  - [(2x 5,000km)+(2 x 10.000km)]/(0,06km/litre) x (10kWh/litre) =5,000MWh
  - Per day per person 5,000 MWh /416person /365 days
- **Shower - 4kWh**
  - shower 10 min, 10litre/minute, heat capacity 4,2kJ/litre/K
  - (10 min x 10 litre/minute) x 4,2kJ/K/litre x 35 K
- **Cooking - 4kWh**
  - Gas range 3kW x 1 h
  - Oven 2,5kW x 3h per week
- **Washing-cleaning – 4,4kW**
  - Dishwasher 2,0kW x 1h
  - Washing machine 2,5kW x 3h per week
  - Cloth dryer: 3kW x 3h per week
  - Iron 1kW x 1h per day
  - Vacuum cleaner 1600 W x 0,25h per day

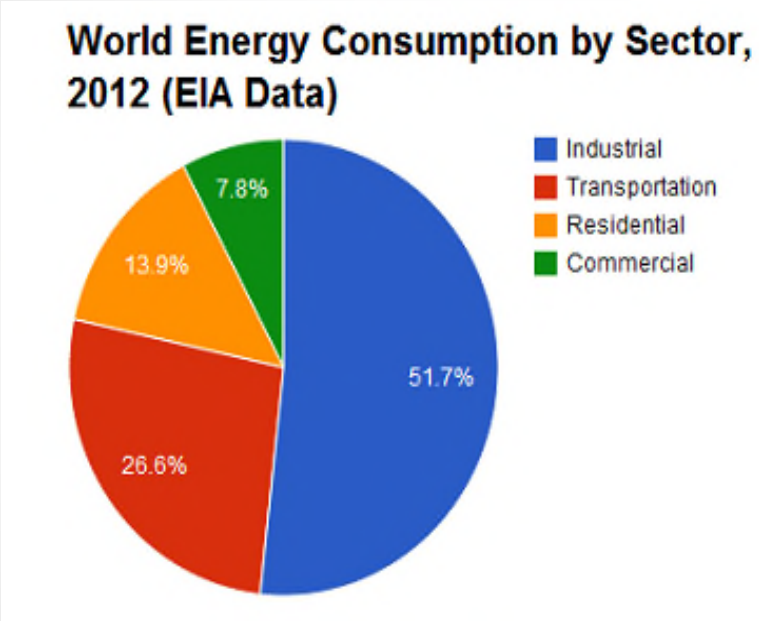
Consumption per person
summing up to estimated 205 kWh/d/p

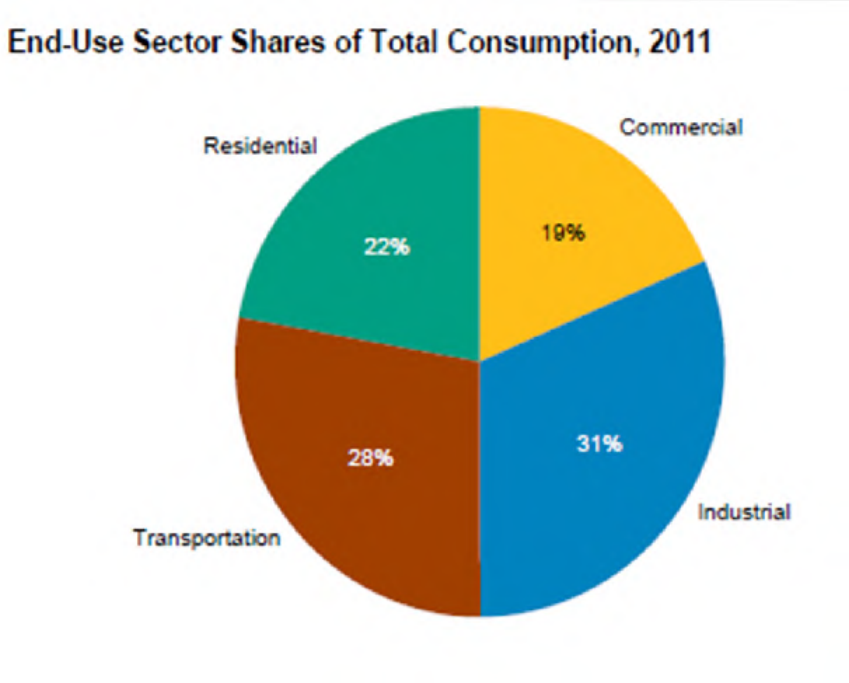
- **Heating – 30kWh**
  - Boiler 15kWh x 12h/day x 180 day /365 day / 3 person per home
- **Cooling – 8,5kWh**
  - Split 2x 1,5kW x 12 h/day x 150 day / 365 day / 3 person per home
  - Refrigerator 0,15kW x 24 h/day
- **Light – 4kWh**
  - 8 rooms x 100 W/room x 5h
- **Gadgets –5,4kWh**
  - Phone charger battery 40 Wh x 3 devices (computer , tablet, phone)
  - Computer (100W), television (200W), radio (100W), other 500W x 6 h/day

Consumption per person
summing up to estimated 205 kWh/d/p

- **Food and farming – 2,3kWh+1,5kWh**
  - Consumption 2600 Calories = 2600 kcal x 4,1 J/cal =3kWh
  - Meat from pork, lives 150 days , average weight 100kg, meat consumption 250g/day,
  - Milk and cheese about 1 liter / day, cow 450kg, consumption proportional to human, 450/65 x 3kWh=21kWh, a cow deliveres about 16 liter of milk per day,
- **Stuff -66 kWh/d**
  - Making raw material
  - Production
  - Disposal
  - Transport (commercial)
- **Public services – 2,64kWh/d**
  - Military 1,7 kWh/p/d, 5% energy =0,7KW/d/p
  - University 0,24kW/d/p

End-Use consumption sector share





Potential renewable Energy resources in the US of 259 kWh/d/p

- **Wind 15kWh (today : 1,5 kWh/p/d)**
  - On-shore: 15 kWh/p/d = 1% x 32.000m^2/p x 2W/m^2 x 24h
  - potential given by NREL =327kWh/p/d
- **Solar 154kWh (today: 0,09kWh/p/d)**
  - Solar Power 154kWh/d/=2% x 32.000m^2 x 100W/m^2 x24hx10%
  - Potential given by NREL = 3,500 kWh/p/d
- **Solar biomass 77kWh**
  - 10% x 32,000m^2/p x 1W/m2 x24h
  - Wine 6750 l/ha/365d, 10% alc. = 6,39kWh/l x 0,675l/m^2 /365d x 10% = 1,2 Wh/m^2
- **Hydroelectricity 6 kWh (today: 2,5 kWh/p/d)**
  - max potential guessed:6 kWh
- **Wave and tide 1kWh**
  - 5kW/m, Weak potential , maybe 3% of total electric consumption about 1 kWh/d/p (EPRI)
- **Geothermal 6kWh/p/d (today: 0,13 kWh/p/d)**
  - Potential 6kWh/p/d

Can the USA live on renewables only?

- **All the considerations didn't include any social, economic and technological aspect. Therefore, the real potential will be smaller, but the numbers look promissing.**

- **Fossil proven energy reserves in the World (60y-240y)**
  - (BP 2013 energy outlook), real resevres might be **4 times higher**

  - **Coal 861 Gt:** **40 year** (6 billion people, 100kwh/d)
    - R/P world= 109 year (reserve / present rate of consumption) – R/P USA = 257 year
  - **Oil 1700 G barrels:** **12 year** (6 billion people, 100kwh/d)
    - R/P world= 52.9 year (reserve/ present rate of consumption) – R/P USA = 10.7 year
  - **Gas 187 Tm^3:** **8 year** (6 billion people, 100kwh/d)
    - R/P world= 55.7 year (reserve / present rate of consumption)- R/P USA = 12.5 year
  - **Nuclear :** **up to several hundred of years**
    - Fission U235 U238, fast breader 60 times more efficient
    - Fusion Lithium (land and water) 1000 year (6 billion people, 100kwh/d)

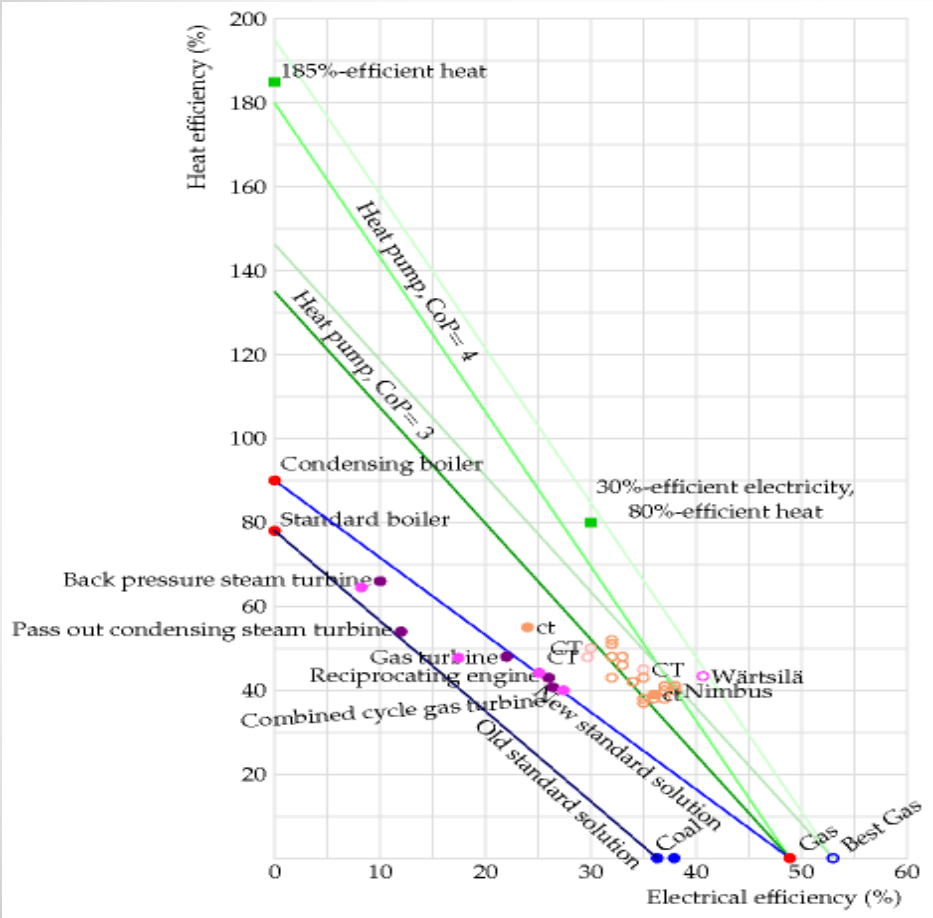
- ***Opportunities*** **are as well in** ***energy saving*** **technology as in** ***renewable energy production & storage***

The markets of opportunity vision based on facts

- **Electrical car: 15kWh/100km**
  - 1/5 of consumption of medium gasoline car (80kWh/100km)
  - Tesla: sports car 400km distance
- **Train: 4,4 kWh/100km/p**
  - 1/18 with respect to present car , already existing
- **Bus: 8kWh/100km/p**
  - 1/10, already existing
- **Heating demand: <30kWh/m^2**
  - ¼ with respect to a home of clima E <120kWh/m^2
- **Storage technology**
  - To balance production and consumption

- **Heating appliance with better effciency**
  - Condensing Boiler + furnace(+10% to +30%)
  - Heat pump (electric + gas) (+20% to 60%)
  - CHP (fuel cell + Stirling) (+10% + 40%)

The markets of opportunity vision based on facts



- How do we get best all year round efficiency?
- Heat pump combined with best class electrical generation has best all year efficiency
- CHP makes sense where the heat and electrical load remain fitted to demand

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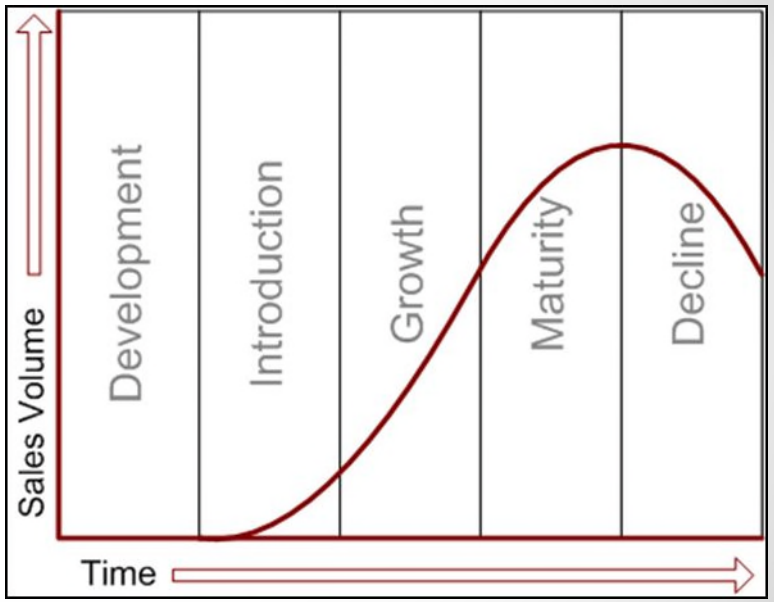
The timing and cost of invention

- Development phase with high risk on success, time and cost
- Need to have sufficient strength with products in growth and maturity
- Global worldwide investment $257 billion, China $52 billion, USA $51 billion (0,3% GDP) (Forbes),
  - US congress stated a need for about $120 billion per year to maintain and improve roads (Reuters)
- Solar Industry has been hidden strongly by strong competition. USA and European leaders are wiped out or do bad. China's comanies are geeting the lead role, despite of unprofitability.
- venture capital



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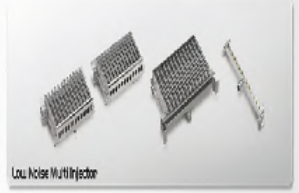
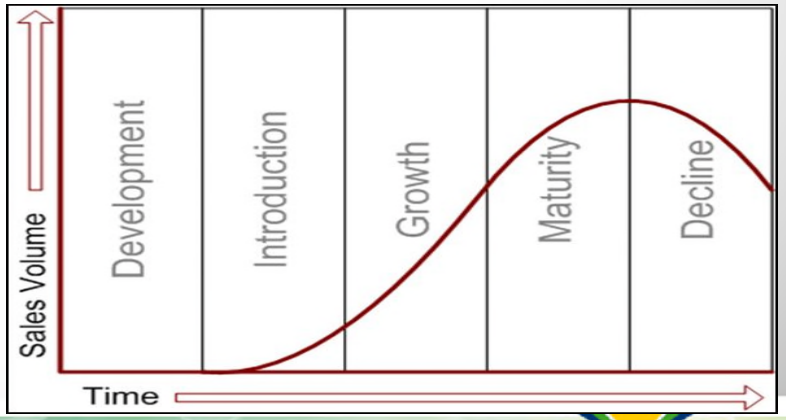
The stragetgic approach: Product Portfoglio

- **Product mix on all phases of life time cycle**
  - long term sustainability
- **Focus on energy transformation**
  - Market approach: component /subassembly supply with innovative technology
  - Gas combustion
  - Added value through sub assembly
- **Partnership with customer – early involvement**
- **Global presence – local support**
  - Italy, UK, US, China





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..... and what is your approach???

Market **opportunity** needs to be **aligned** with company **vision, strategy, product portfoglio & the right people**

“If you haven't found it yet, keep looking. Don't settle. As with all matters of the heart, You'll know when you find it” Steve Jobs

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Thank you for your attention

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