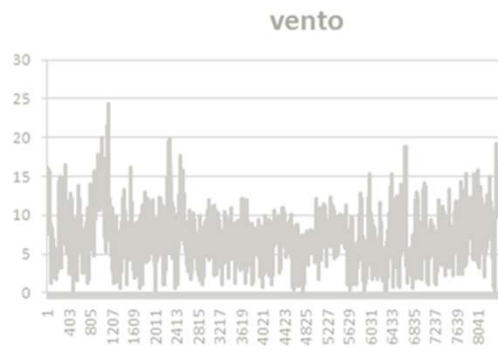
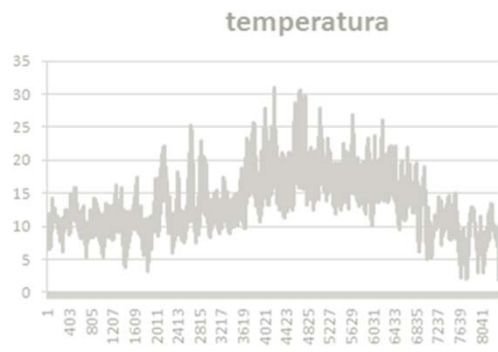
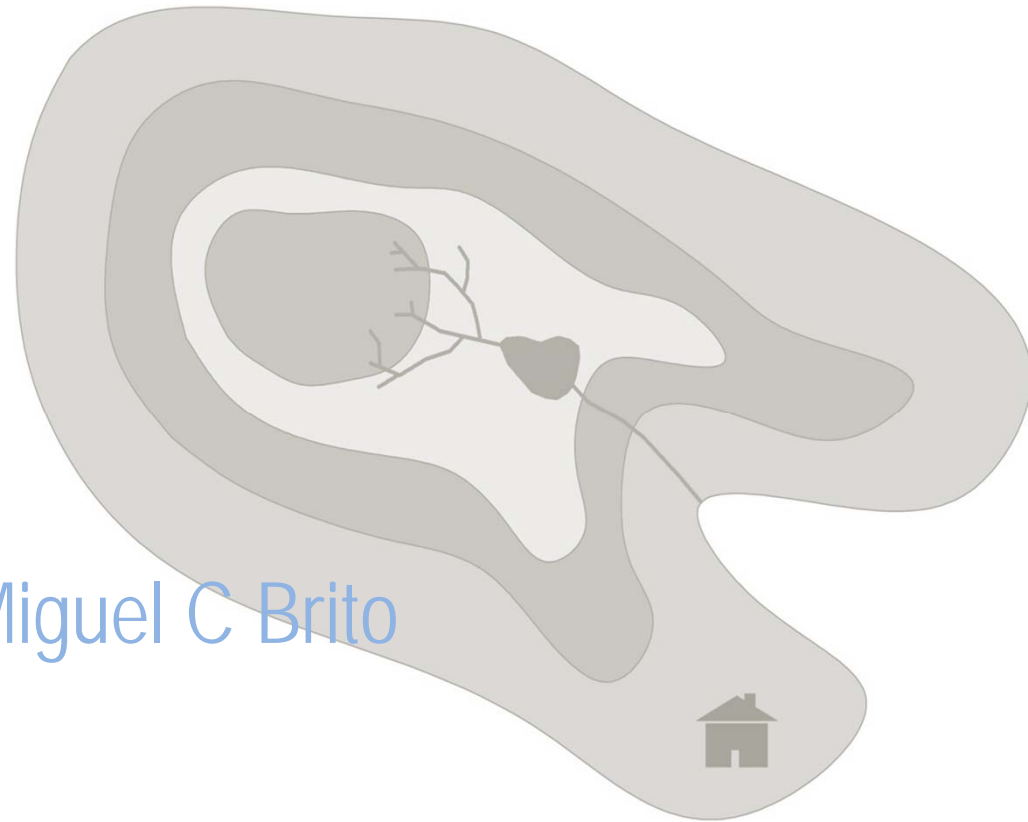


Energy systems



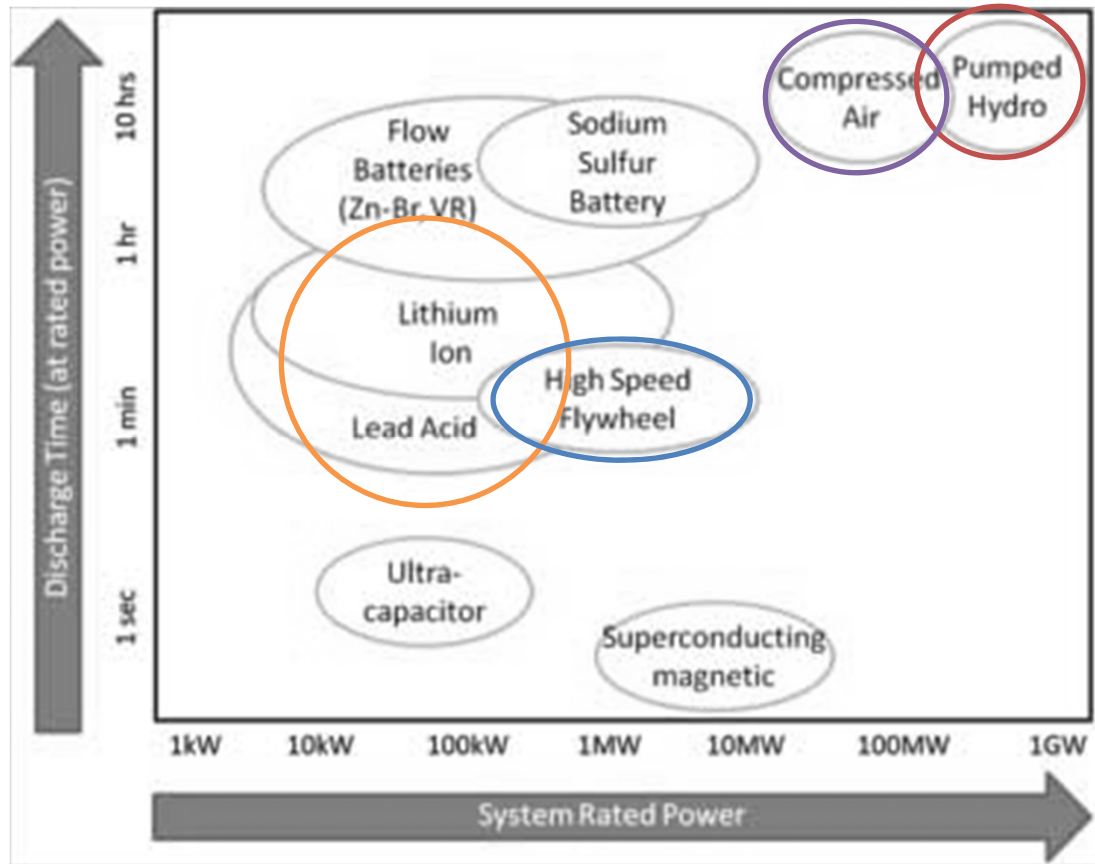
Miguel C Brito



Class	Topics	Deliverables
1	Energy Supply.	
2	Tutorial work	Biblio revision
3	Students' presentations (1).	PPT1 & DOC1
4	Students' presentations (2).	
5	Energy demand.	DOC1_final
6	Tutorial work	Biblio revision
7	Students' presentations	PPT2 & DOC2
8	Energy storage and transmission	
9	Students' presentations	PPT3 & DOC3
10	Energy system	
11	Tutorial work	
12	Students' presentations	PPT4 & DOC4

Group	Application	Obser	Questions
1	Electricity	Batteries	kW kWh €/kWh Kg/kWh
2		H2	
3		Compressed air	
4		Flywheel	
5		Pumped storage	
6		Transmission	
7	Heat	<i>District heating</i>	

Storage electricity



<http://www.greentechmedia.com/research-blog/post/VCs-Energy-Storage-and-The-Smart-Grid/>

Storage electricity | parameters

Capacity (kWh)

Density energy/power(MW/kg; MWh/kg)

Specific density (MWh/m³)

Efficiency (%)

Charge/discharge time

Operation cost(€/MWh)

Investment cost (€/MWh)

Lifetime (years/days)

Storage electricity

Examples:

Car battery capacity

Assuming traditional battery
 $40\text{Ah} \times 12\text{V} = 480\text{Wh}$
x number of cars
/ people
= [kWh/person]

Assuming EV battery
30kWh
x number of cars
/ people
= [kWh/person]

Assuming different scenarios EV penetration

$100\text{ hp} \times 0.7\text{ kW/hp} = 70\text{kW/car}$
x number of cars
/ people
= [kW/person]

Domestic battery capacity

Assume 1 battery per home / 2 days autonomy
(discuss ownership)

Storage electricity

Examples:

Pumped storage

Available power

- assume max waterflow

Capacity

- dam size (500 x 500 x 18 m³),
- conversion efficiency (75%)
- output in kWh/person.

and

Compressed air

Flywheels

(timescale, costs, capacity, etc)

Storage electricity

Hydrogen

- H₂ production from electricity
- Conversion efficiency (overall)
- Heat?
- Domestic or mobility use
- Costs: actual, not foreseen

Transmission electricity

Grid characterization

- Customers/line km

(depends on geography and population density, e.g. Madeira = 3x continental Portugal)

- AC or DC?
- Underground or aerial lines? Health impacts,
- Losses (transport and distribution)
- Costs(ERSE)

Heat transmission

- Technology, range
- Cost €/kWh and losses
- Final discussion of heat system management.

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The role of district heating in future renewable energy systems

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Next class

- 10 min presentation
- 5 pages tops!

