Wind – challenges, opportunities, and PCS

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Vestas

Vestas

Industry Perspective

Challenges & Opportunities

PCS in Wind

…if I had more time, I would have written a shorter letter…Goethe

Vestas:
The largest wind turbine manufacturer in the world

TOP 10 GLOBAL WIND MANUFACTURERS 2005, 2010 (RANK ORDER BY PRODUCTION)

+25% per year

2005 Company	Country	Production (GW)	2010 Company	Country	Production (GW)
1. Vestas	Denmark	3.2	1. Vestas	Denmark	6.3
2. Enercon	Germany	2.7	2. GE Wind	US	6.0
3. Gamesa	Spain	1.9	3. Sinovel	China	5.3
4. GE Wind	US	1.3	4. Gamesa	Spain	4.4
5. Siemens	Denmark	1.1	5. Goldwind	China	3.6
6. Suzlon	India	0.9	6. Suzlon	India	3.5
7. Repower	Germany	0.9	7. Enercon	Germany	3.4
8. Goldwind	China	0.7	8. Dongfang	China	3.0
9. Nordex	Germany	0.5	9. Repower	Germany	2.9
10. Ecotecnica	Spain	0.3	10. Nordex	Germany	2.4

Europe | US | China | Other Asia

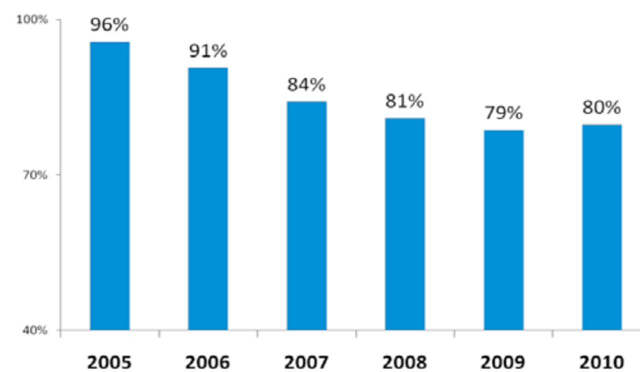
Source: Bloomberg New Energy Finance

Vestas in Top 10 Markets
Ranking

Market	MW	No. 1	No. 2	No. 3
China	18,928	Sinovel	Goldwind	Dongfang
USA	5,115	GE Wind	**Vestas**	Siemens
India	2,139	Suzlon Group	Enercon-India	**Vestas**
Germany	1,551	Enercon	**Vestas**	Suzlon Group
UK	1,522	Siemens	**Vestas**	Gamesa
Spain	1,516	Gamesa	**Vestas**	GE Wind
France	1,186	Enercon	Suzlon Group	**Vestas**
Italy	948	Gamesa	**Vestas**	Suzlon Group
Canada	690	Siemens	GE Wind	Enercon
Sweden	604	**Vestas**	Enercon	Siemens

Source: BTM Consult – part of Navigant Consulting – March 2011

Market share of top 10 suppliers
Per cent



Source: BTM Consult – part of Navigant Consulting – March 2011

On the way up…

bigger was better…

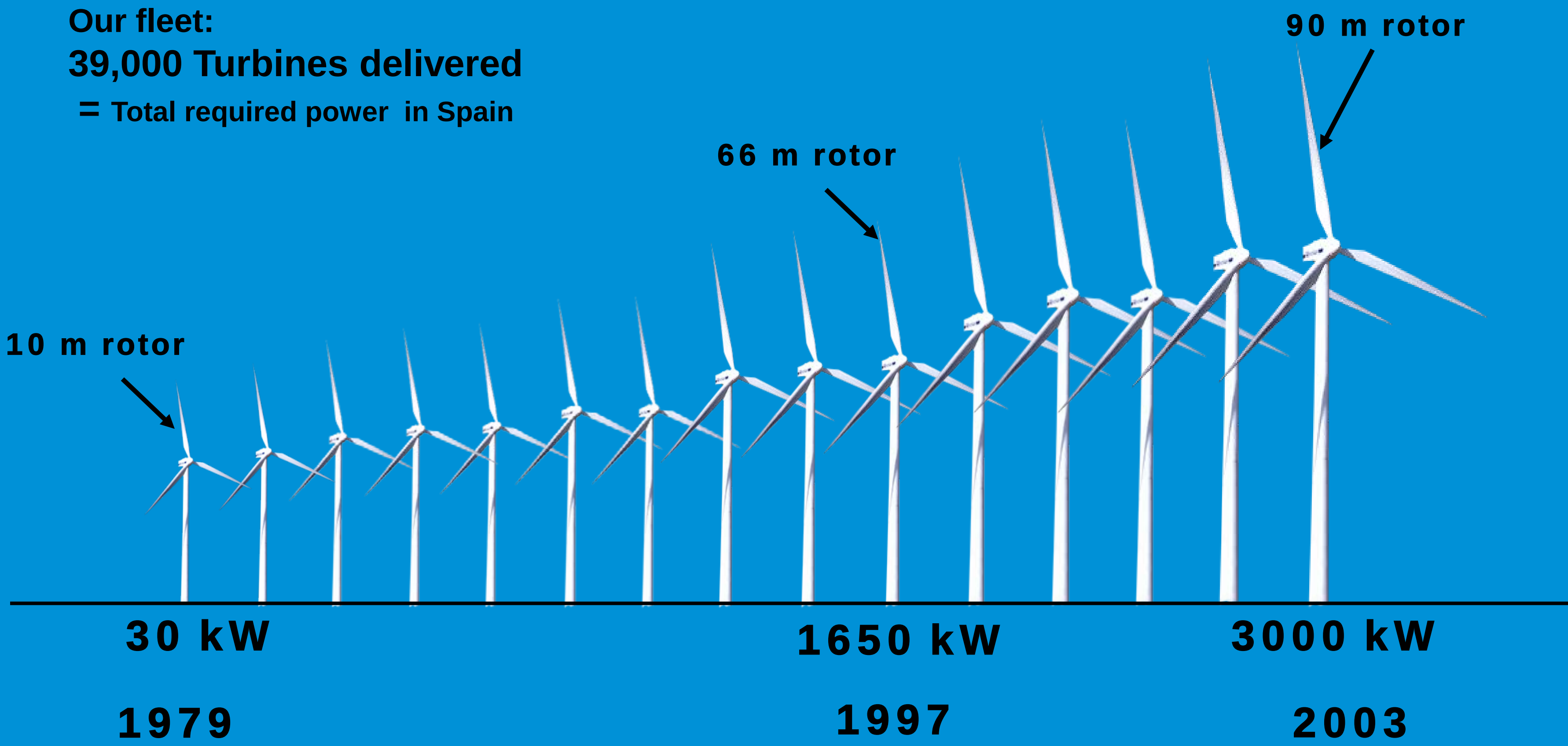
On the way *not* up…

Over the last 25 years, the output of a single Vestas turbine increased 100x – total annual energy increased 330x

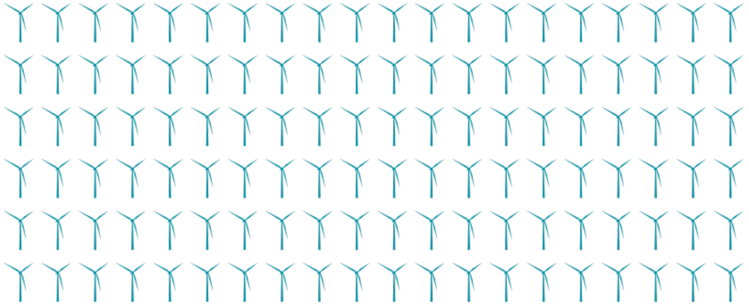
Our fleet:

39,000 Turbines delivered

= Total required power in Spain



Today one turbine produces 3000 kW



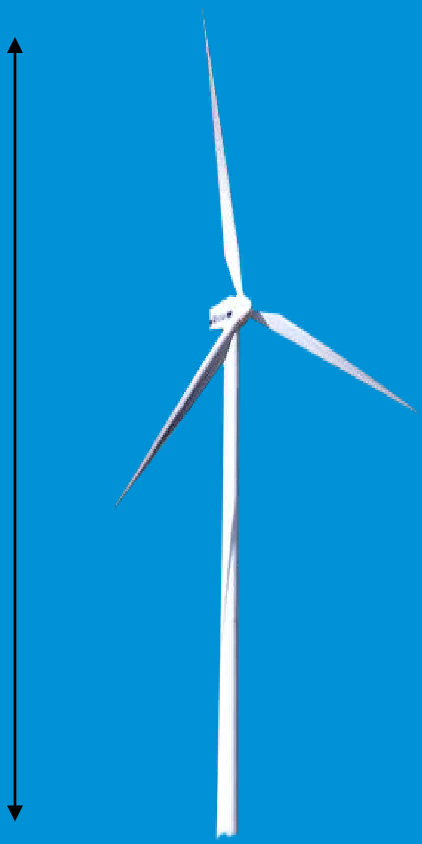
25 years ago, this was 3000 kW

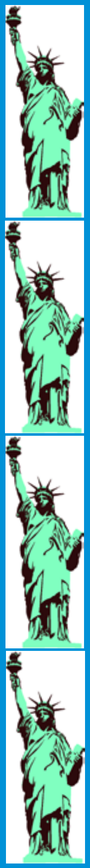
=

Today, 1 turbine is enough

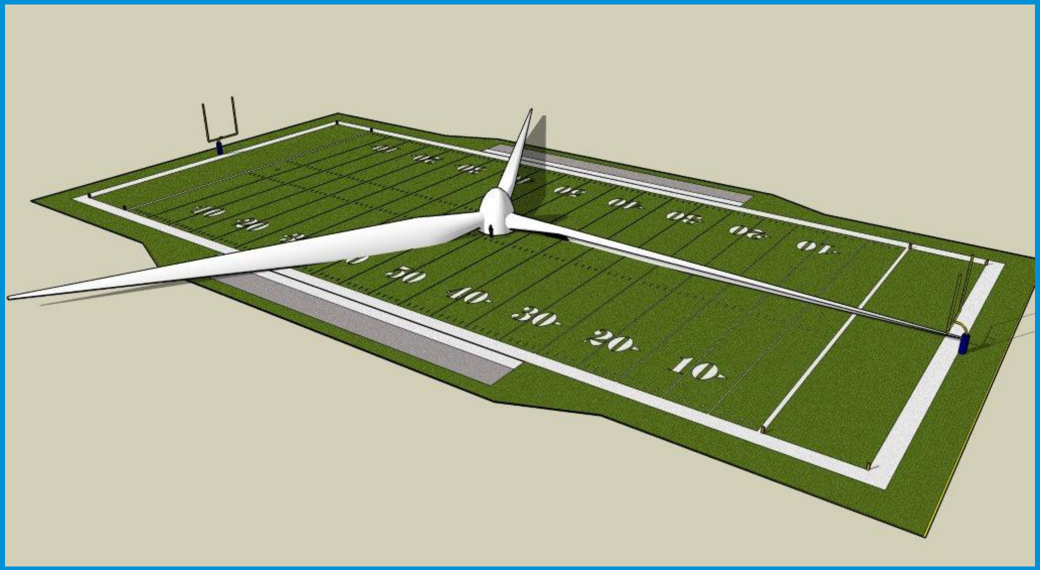
One V112 = 3.8 Statues of Liberty…

175 m

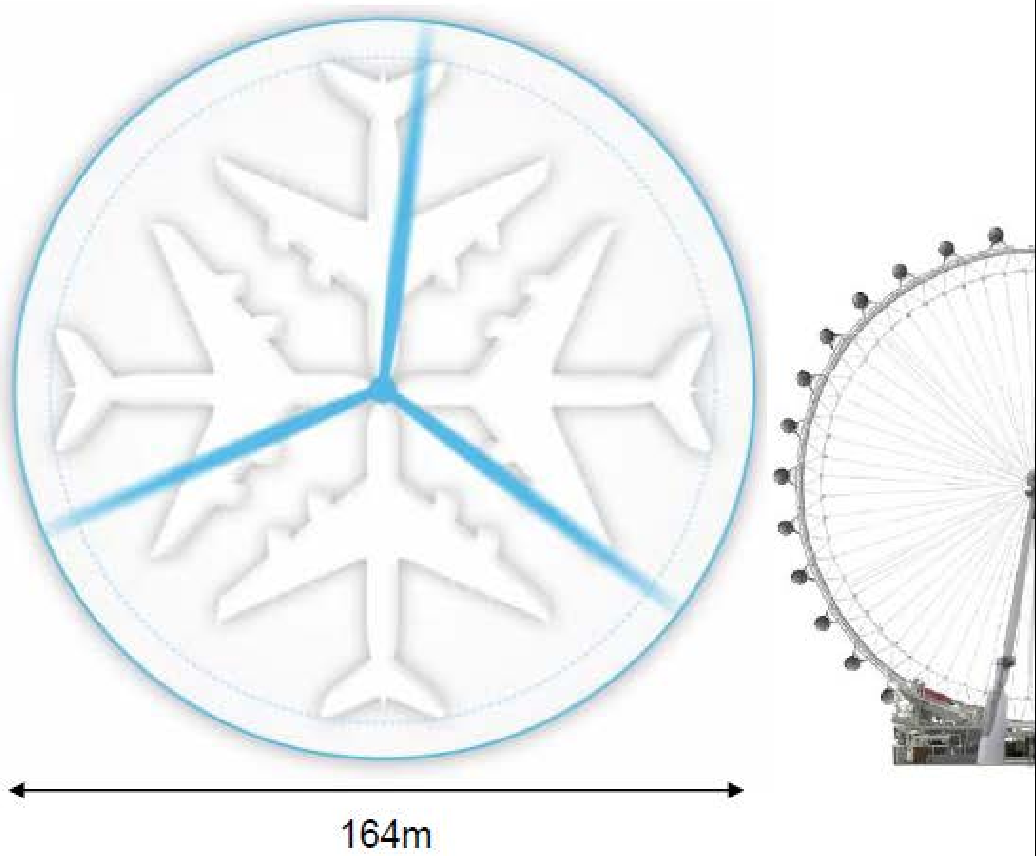




…and its rotor alone won’t fit in a football field



How big will be the recently announced V164?



V-164 7MW – rotor diameter: 164m

Airbus A380 – wingspan: 80 m, length: 73m

London Eye – diameter : 135m.

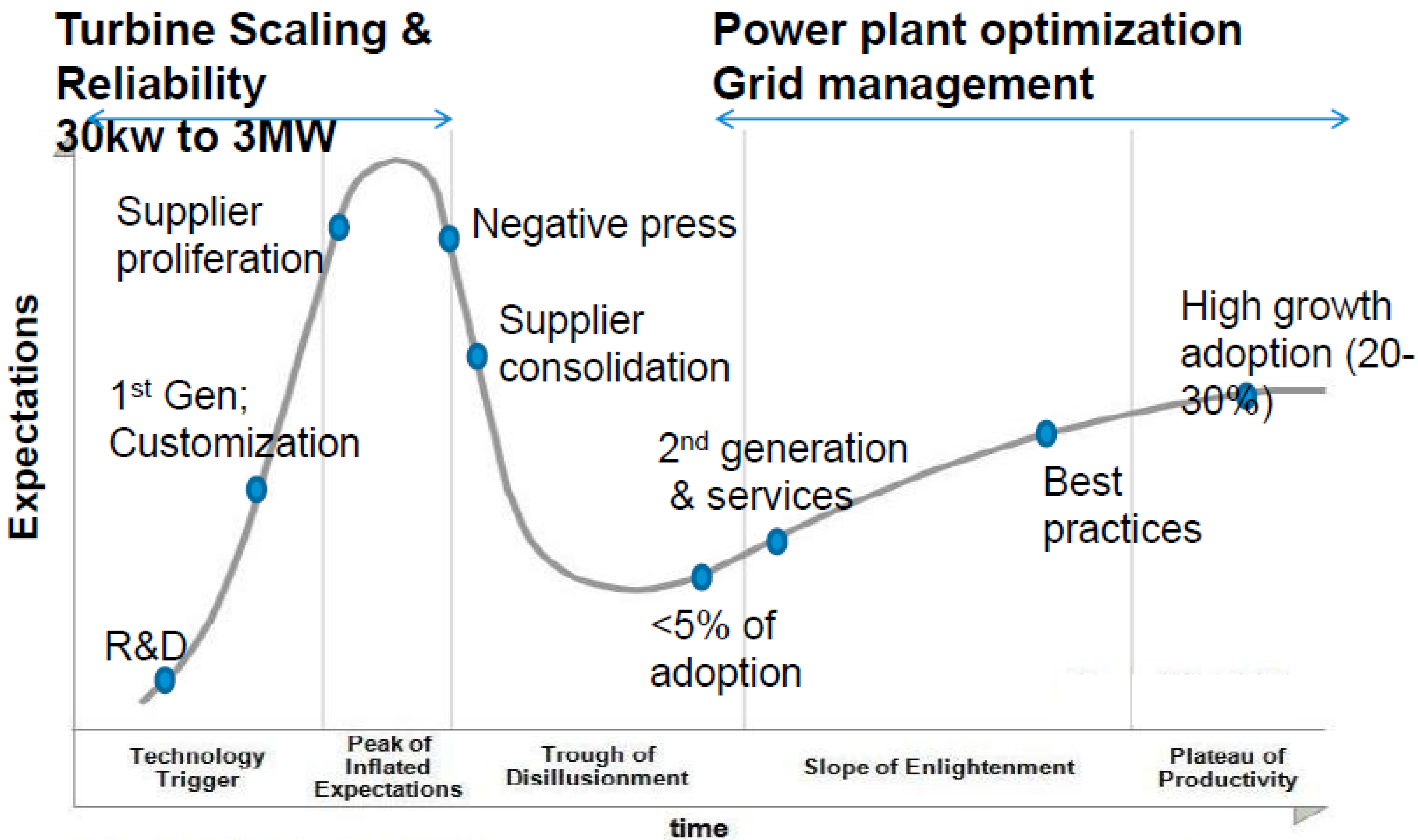
On the way up…

On the way *not* up…

participants becoming mature…

policy assistance shrinking…

The curve of maturity…



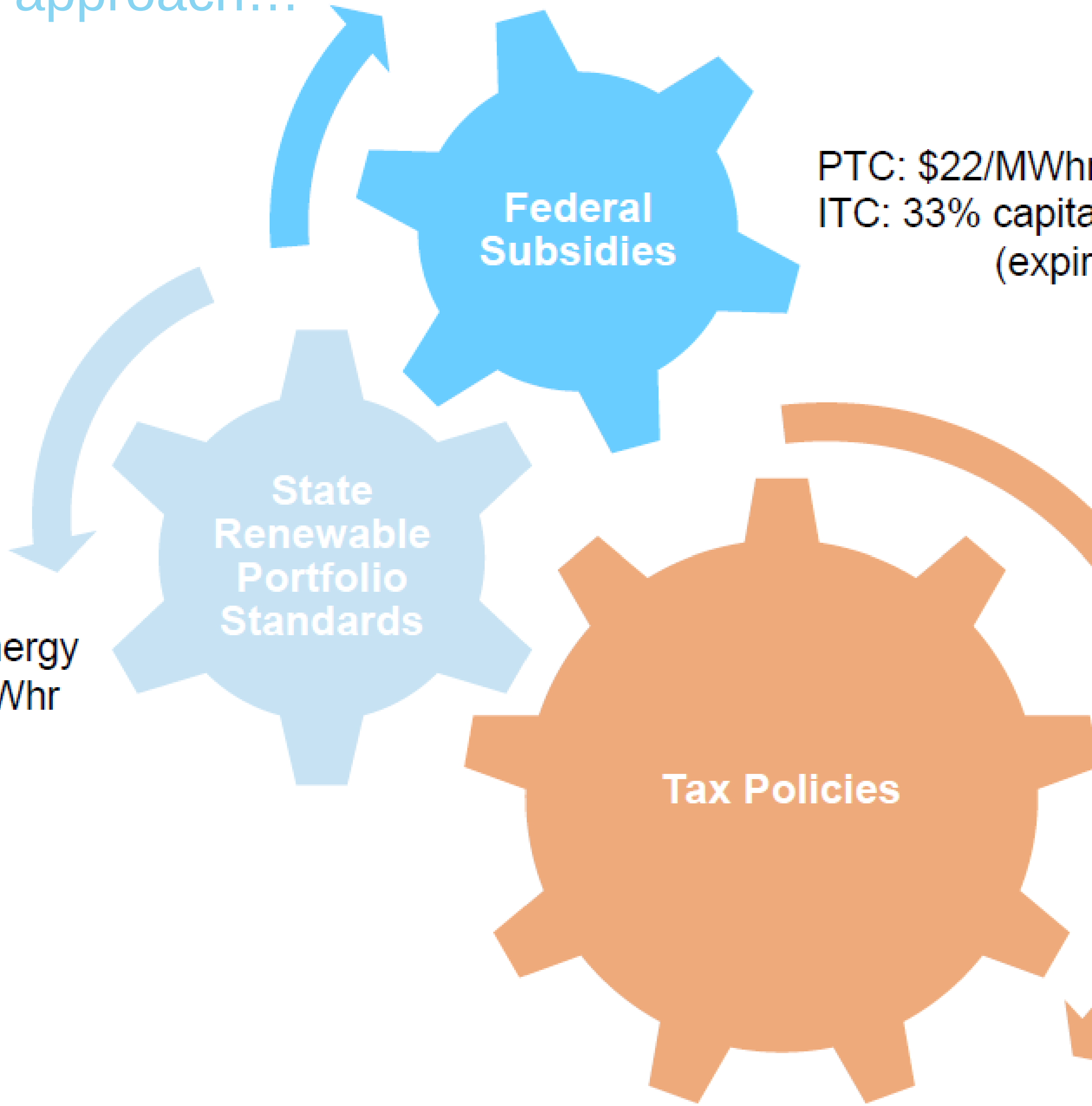
Source: Gartner´s hype cycle

THE WALL STREET JOURNAL.

“Prostitution, horse racing, gambling and electricity are irresistible to politicians.”

John Rowe, CEO of Chicago-based utility Exelon
*Wall Street Journa*l, Oct. 22, 2011

US policy approach…

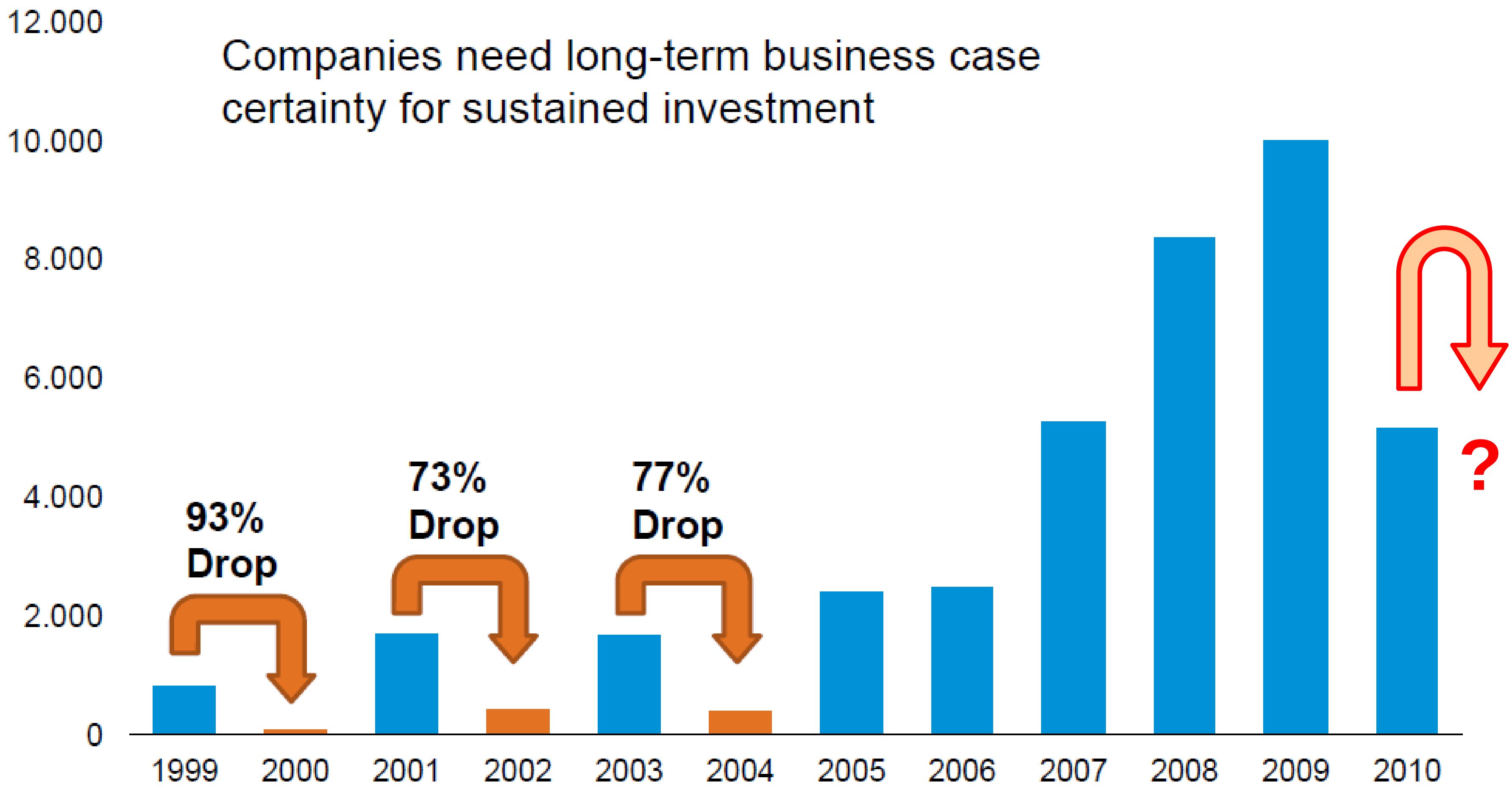


PTC: $22/MWhr (expires '12)
ITC: 33% capital costs (expired '11)

Renewable energy Credit: $17/MWhr

Effects to the business…

Annual Wind Installed [MW]



Source: AWEA

Challenges with Wind

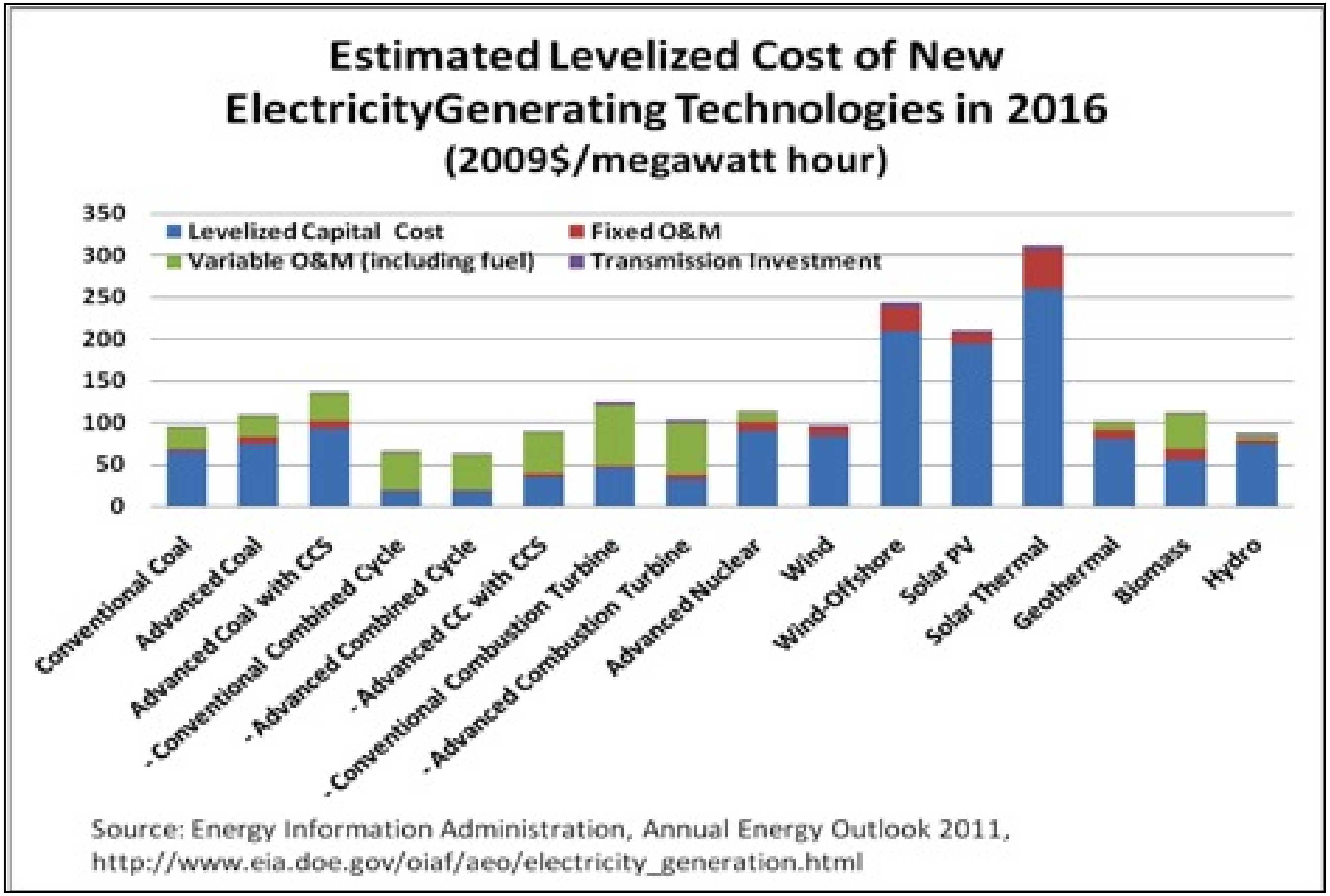
comparative LCOE

Opportunities with Wind

variability at grid interface

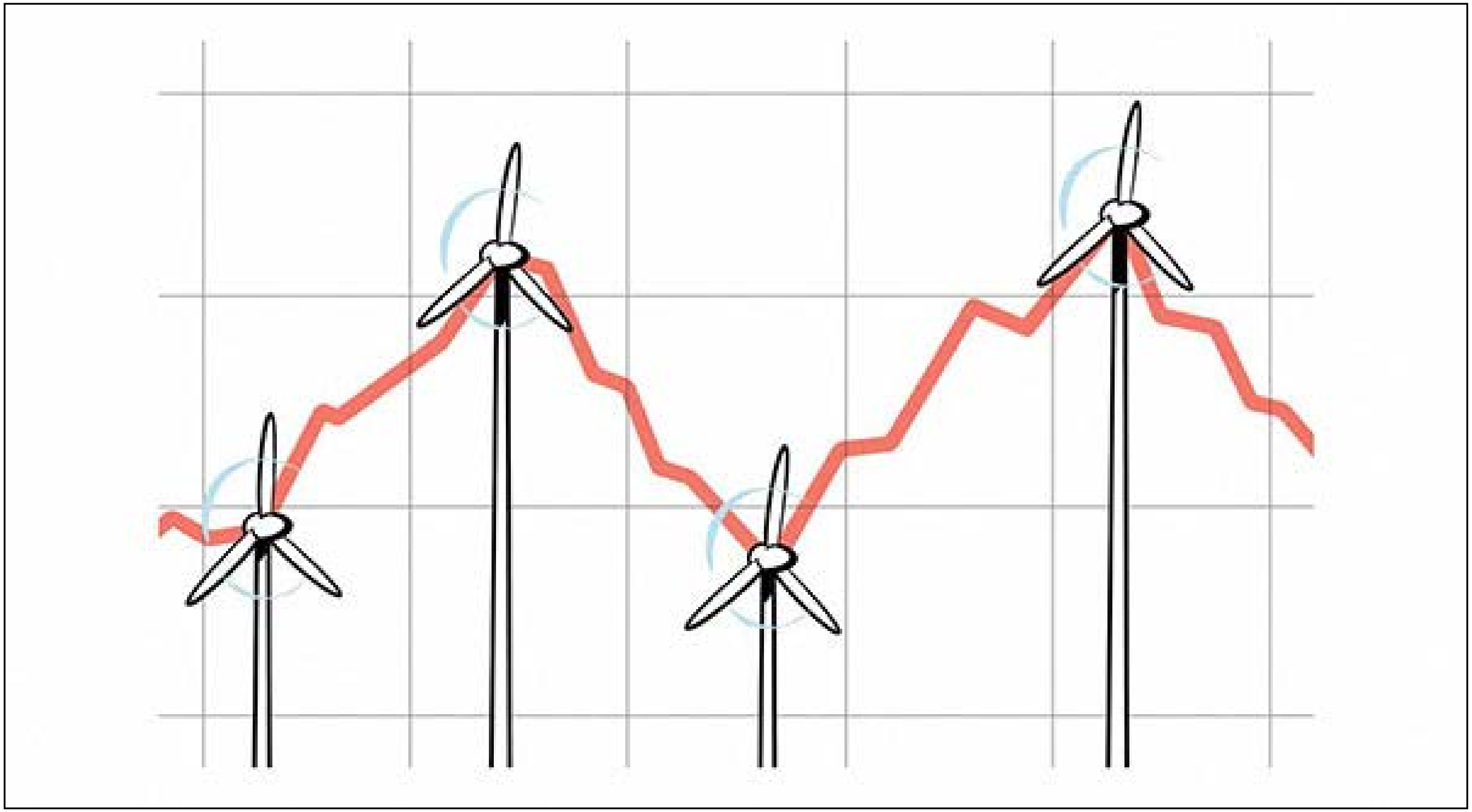
- Impediments for wide proliferation of wind assets are cost of wind generation (capital and maintenance), and risks associated with variability of wind (intermittency and unpredictability)

Challenge 1: Levelized Cost of Energy



- Wind industry participants have been focused on selling turbines in the PPA market
- Financial models are based on double digit EBIT through high contribution margins
- Elimination/reduction of PTC for renewable generation will limit contribution margins
- Way to profitability will be in making wind LCOE (w/o PTC) less than LCOE with gas
- Falling gas prices will further challenge competitive advantage w/ wind generation

Challenge 2: Variability at Grid Interface

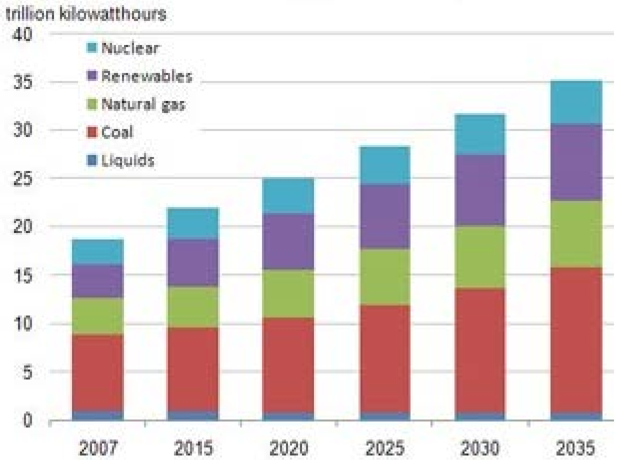


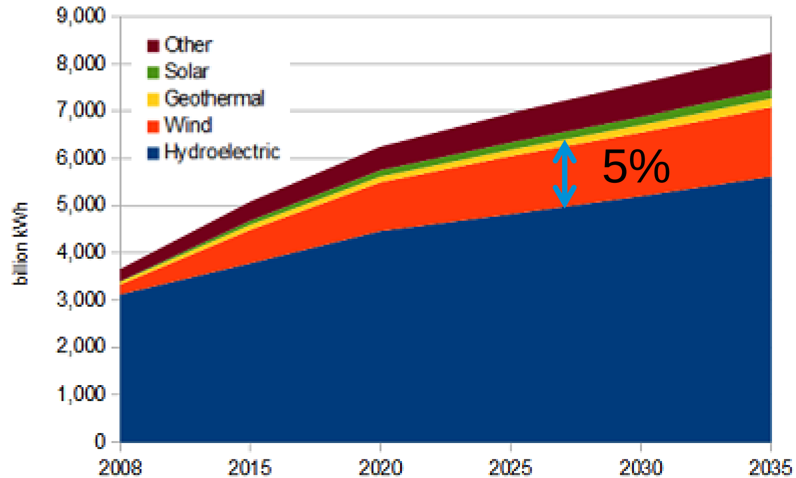
- Variability at grid interface is caused due to intermittency and unpredictability of wind
- Improved forecasting techniques quantify/limit the risks associated with variability
- Energy storage relieves short term variability, however increases system costs
- Low cost, high efficiency transmission (e.g. HVDC) further balances variability at grid

Challenges with Wind

Opportunities with Wind

reaching 20% proliferation





Source: EIA

Challenges

competitive LCOE

5%

Opportunities

variability at grid interface

power transmission barriers

smart grid integration

15%

Besides cost of wind generation that will gain 5% market, impediments for wider (20%) proliferation of wind assets are variability of wind (unpredictability and intermittency), barriers for transmission (transportability), and compliance with smart grid infrastructure

PCS in Wind

components of a turbine

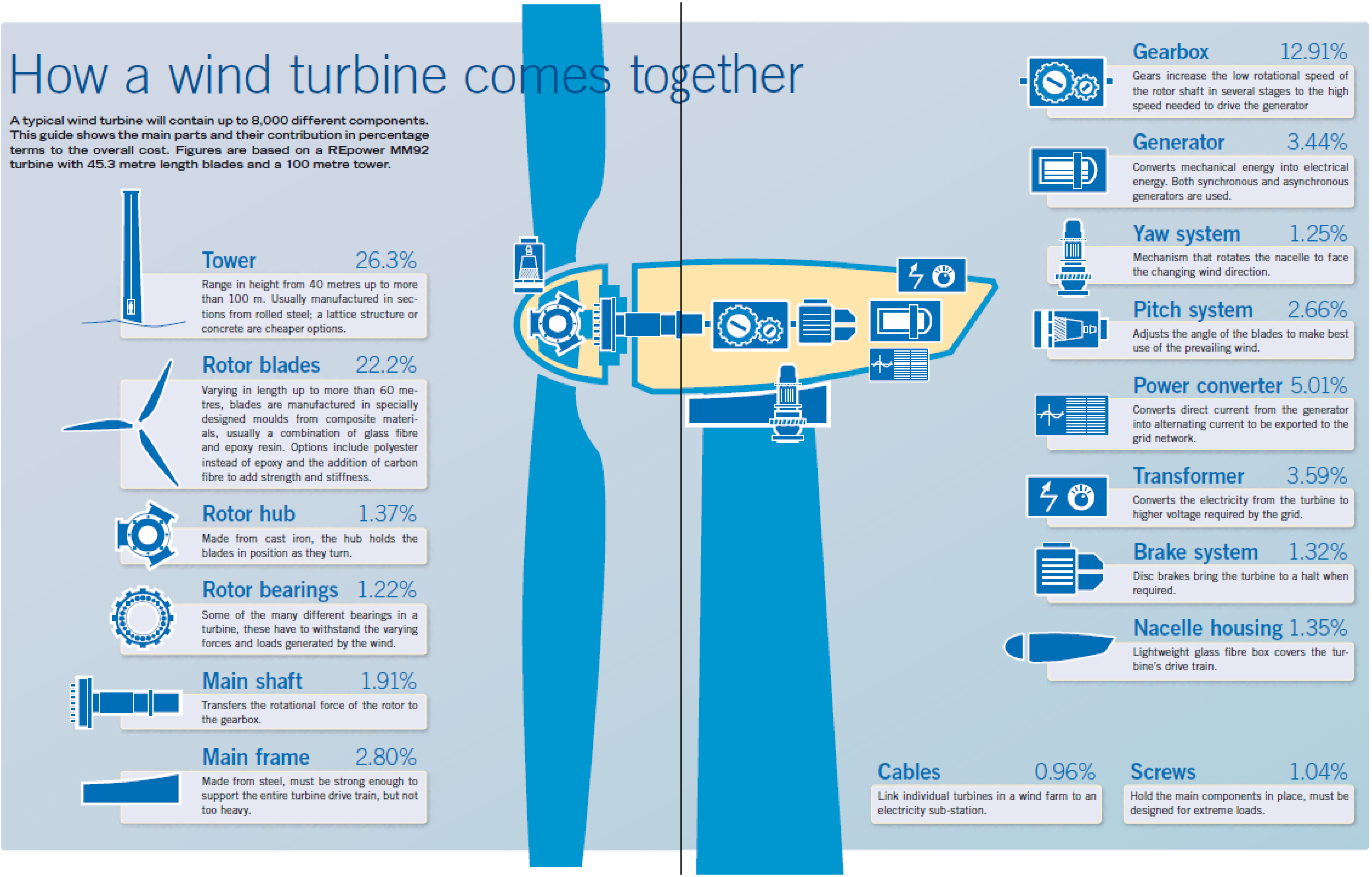
PCS in turbine

PCS in storage interface

PCS in energy collection

PCS in power transmission

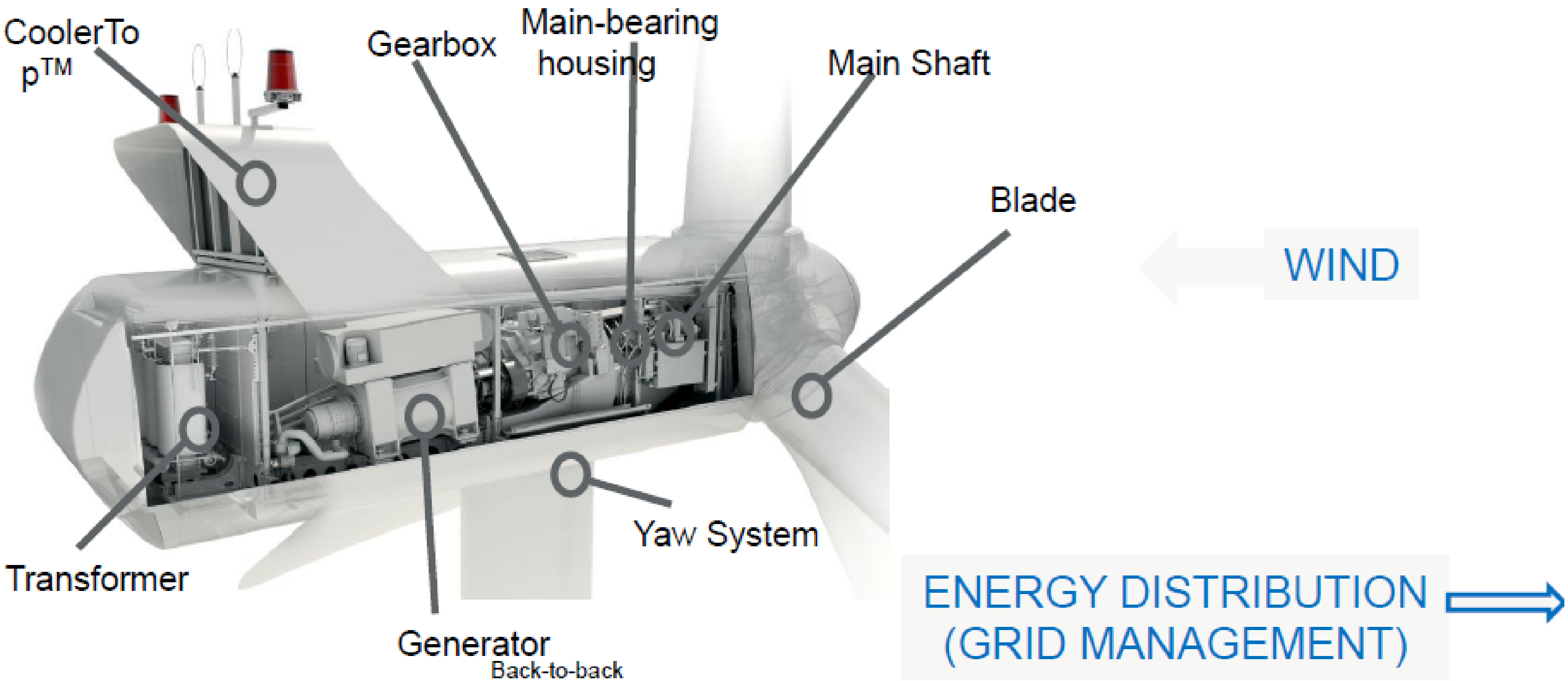
Components of a turbine…

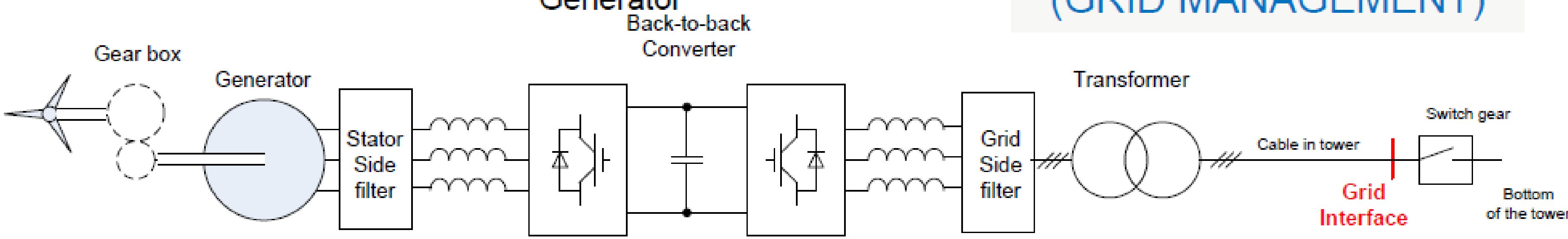


Components of a turbine…

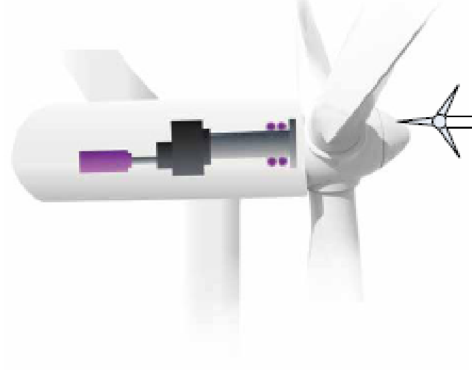
ENERGY CONVERSION (DRIVE TRAIN)

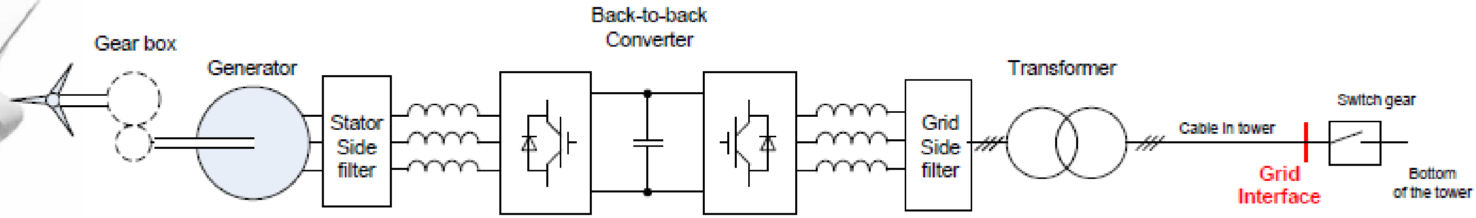
ENERGY CAPTURE (ROTORS)





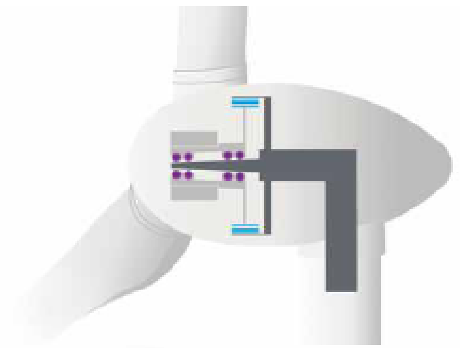
PCS in a turbine…cost competitive conversion



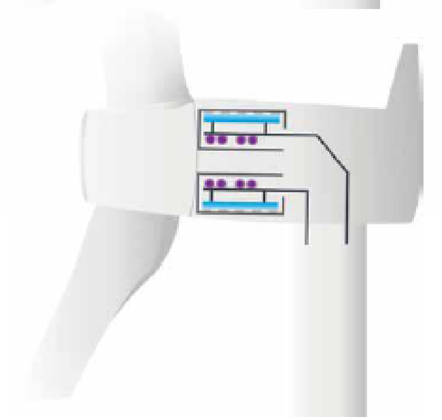


- Main drive train topologies and their advantages

Geared	Gearless
Lower cost Lower weight Proven technology	High reliability (yet to be proven)

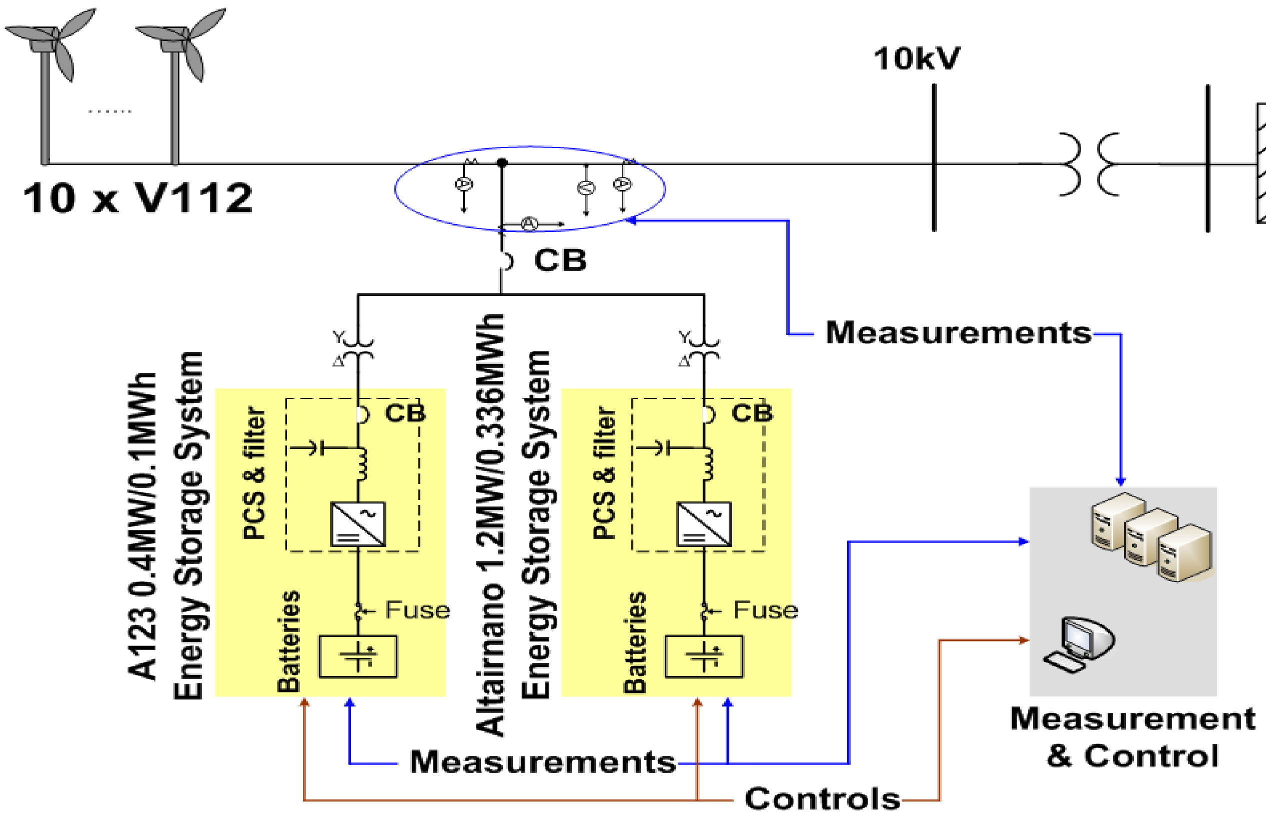


- The technology adoption will be influenced by
  - Cost
  - Reliability in very long term operation >20 years
  - Scalability > 10MW



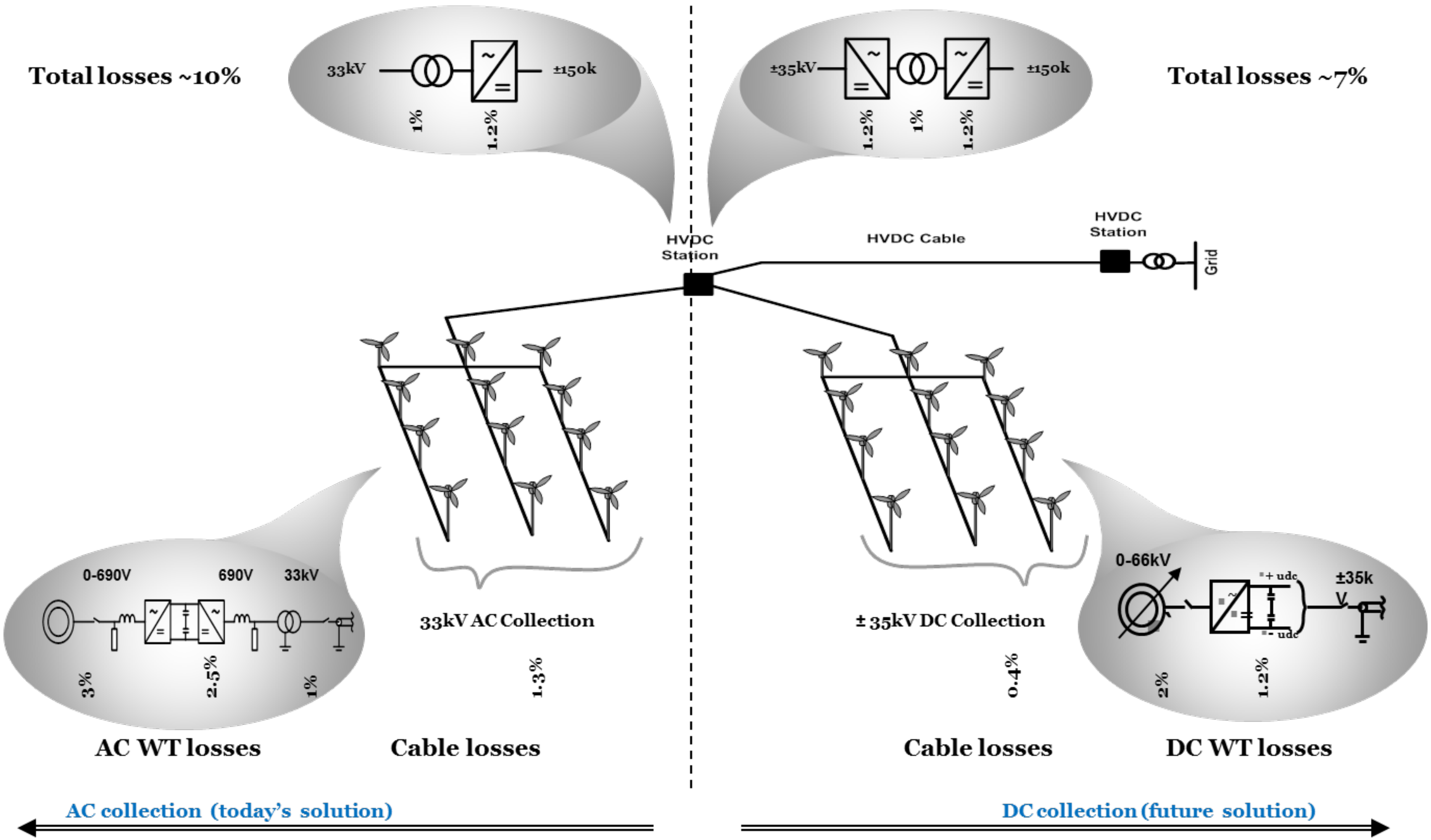
- On-going R&D on power conversion topics
  - Crossover from low voltage to medium voltage to HVDC
  - Do not use power electronics all together? E.g. hydraulic transmissions with synchronous generators coupled to the grid.

PCS in energy storage interface…cost effective invariability



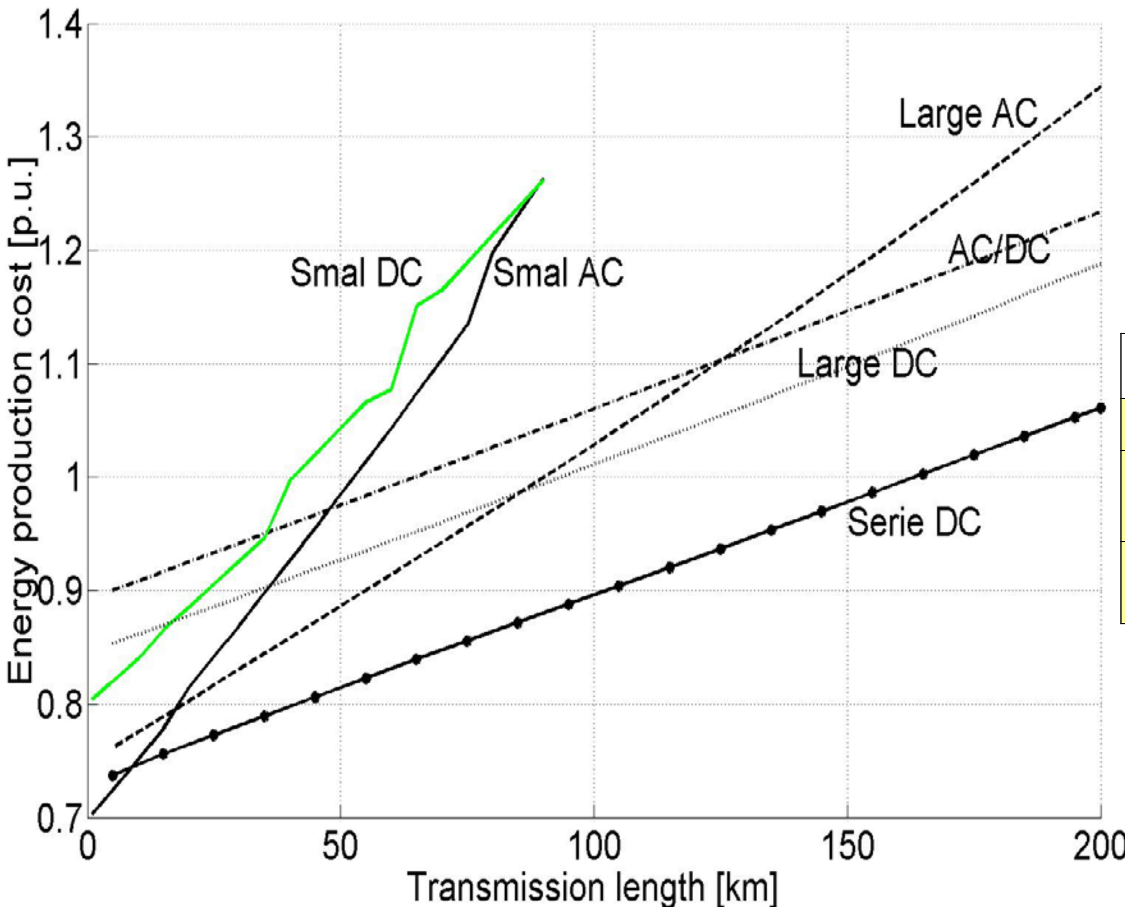
- 1.6MW energy storage combined with 30MW wind power plant
- Offers energy buffer for wind to participate in ancillary services market
- Challenge is in making the system attractive from RoI perspective

PCS in energy collection…maximize efficiency



DC turbines combined with DC collection has a potential to offer up to 30% improvement in reducing energy losses. This improvement is obtained through reduction of turbine-side and station-side converters. However, the challenge is in realizing such high power DC/DC converters

PCS in power transmission…maximize power plant AEP



Vestas Offshore Options	
Current (HVAC)	***Future (HVDC)***
High Losses	Low Losses Reactive power not required
High Costs	Low Costs One less cable + converter

HVDC is appearing to be the technology of choice to transport power from wind power plants over long distances (e.g. from deep water offshore to onshore). However, significant challenges are in protection and control of such DC architectures.