Most Energy from Wind

Gordon Taylor

G T Systems

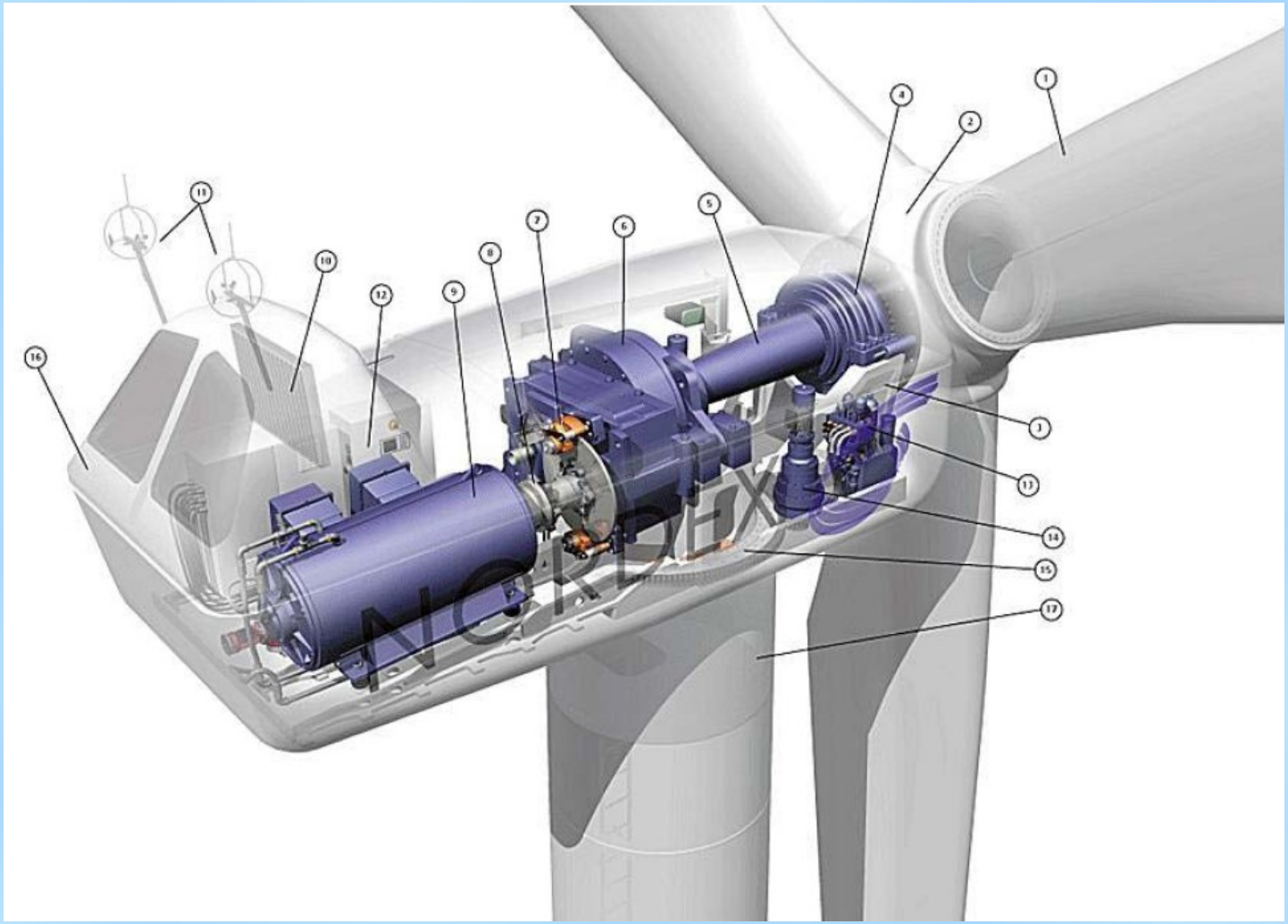
www.energypolicy.co.uk

January 2013

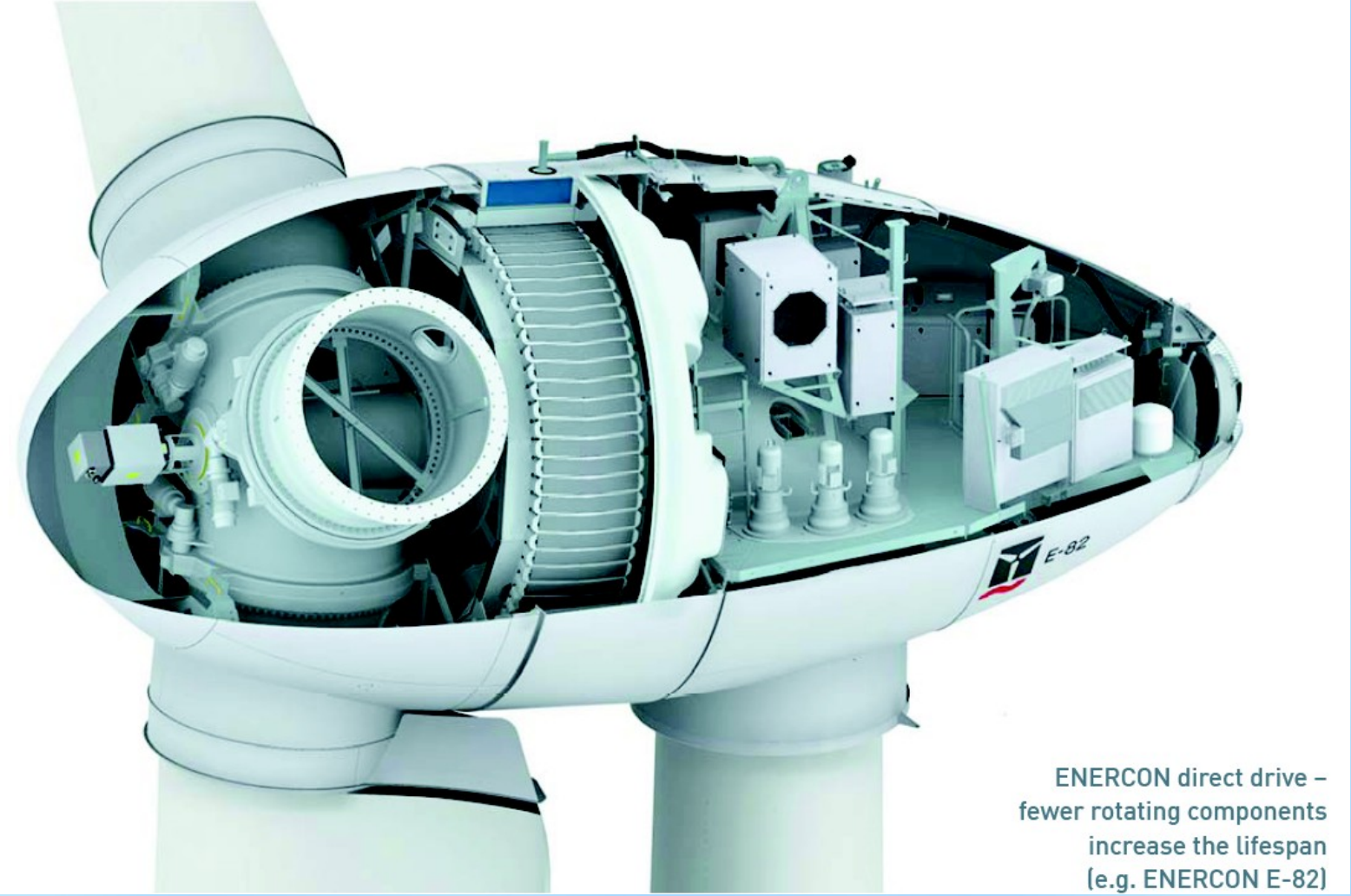
Renewables

- Only renewables are non-depletable with near-zero net carbon emissions and thus sustainable
- Hydro-power and geothermal energy are site-specific and relatively small overall
- Marine current turbines are also site-specific, while wave power has yet to be proven
- Only solar, wind and biomass could ever make major contributions to all countries and the world

Wind Turbine Design: Geared Drive



Wind Turbine Design: Direct Drive



ENERCON direct drive – fewer rotating components increase the lifespan (e.g. ENERCON E-82)

Wind Turbine Design: Steel Tower

Several tapered cylinders, bolted together

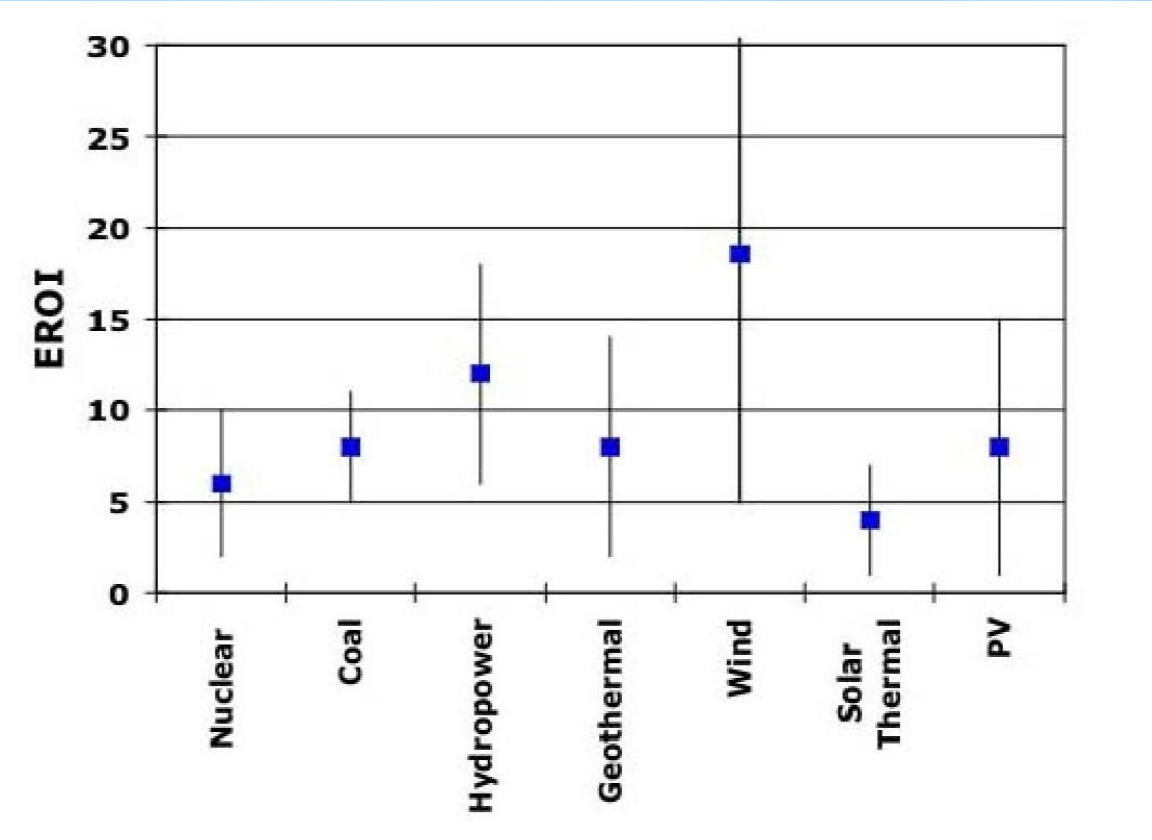
Wind Turbine Design: Concrete Tower

Cast in segments and rings, then linked and pre-stressed

Energy Return On Investment (EROI)

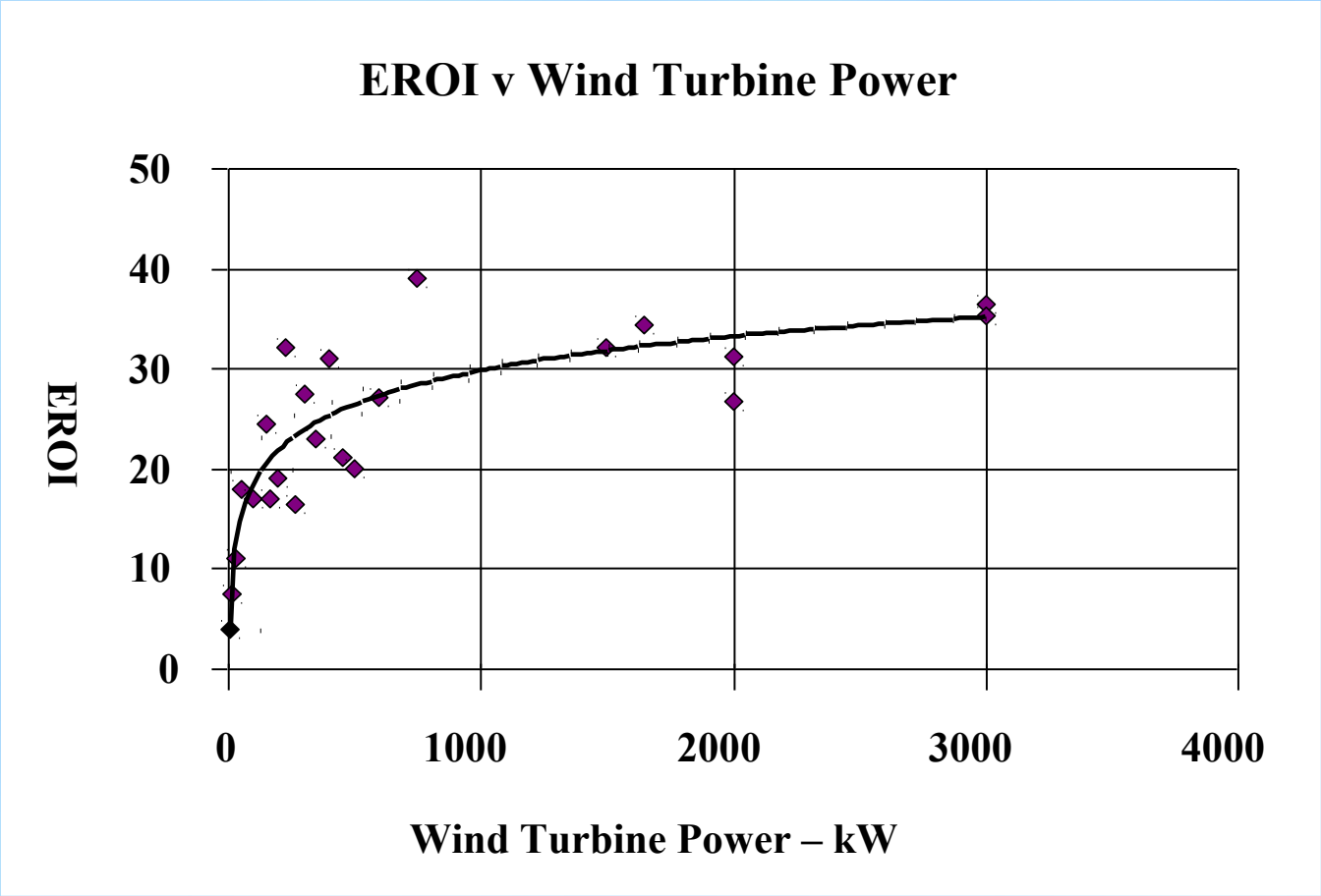
Of the renewable electricity sources:

- Hydropower and Geothermal are good but site-limited.
- Wind Turbines are much better than Solar Thermal



EROIs of Wind Turbines: Scale Effect

The EROIs of Wind Turbines show a marked scale effect
Hence we should invest only in large machines - MW class



EROIs of Wind Turbines: Capacity Factor

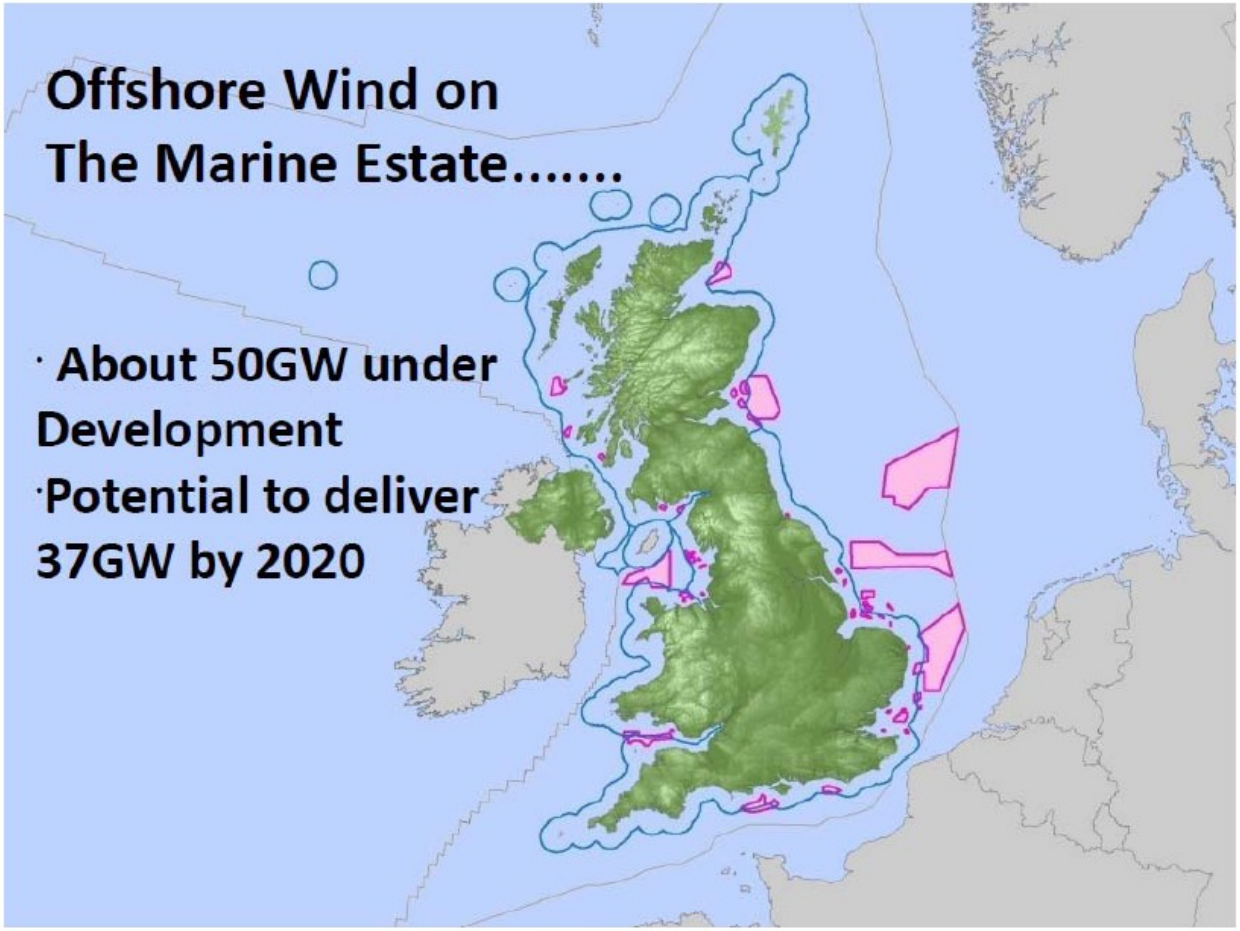
The EROI of Wind Turbines depends on Capacity Factor

Location	Capacity Factor	EROI
Inland	0.25	35.4
Near-Coast	0.29	40.8
Coastal	0.36	51
Excellent	0.50	70

Enercon, 2012

Wind Energy

- Biomass is multi-constrained, while Solar Thermal plants have poor EROIs in temperate climates
- However, wind energy (and modern PV) can produce electricity with very high EROIs
- Large wind turbines can be sited onshore or offshore, with the latter fixed or floating
- Offshore siting is particularly welcome in an increasingly crowded world
- The global wind resource has been put at 96 TW and the UK wind resource at up to 2 TW


Offshore Wind on
The Marine Estate.....
· About 50GW under Development
·Potential to deliver 37GW by 2020

….prospects of becoming a net electricity exporter – UK Plc £££££

	Installed capacity	Resource utilisation	Capital expenditure	Annual Revenue in 2050	
Scenario 1	78 GW	13%	£170B	£28B	50% UK demand
Scenario 2	169 GW	29%	£443B	£62B	Net *electricity* exporter
Scenario 3	406 GW	76%	£993B	£164B	Net *energy* producer

the electricity **equivalent of 1 billion barrels of oil** could be generated annually, matching North Sea oil and gas production

www.OffshoreValuation.org

Total practical resource for offshore renewables

Technology	Currently allocated capacity (GW)	Currently allocated capacity (TWh)	Additional practical resource (TWh)	Total practical resource (TWh)
Fixed wind	47	165	241	406
Floating wind	-	-	1,533	1,533
Tidal stream	0.6	2	114	116
Tidal range	-	-	36	36
Wave	0.6	1	39	40
Total	48.2	168	1,963	2,131

Our analysis shows that the UK's offshore resource, if developed to its maximum potential, could generate over 2,100 terawatt hours (TWh), equal to six times UK electricity consumption in 2009.

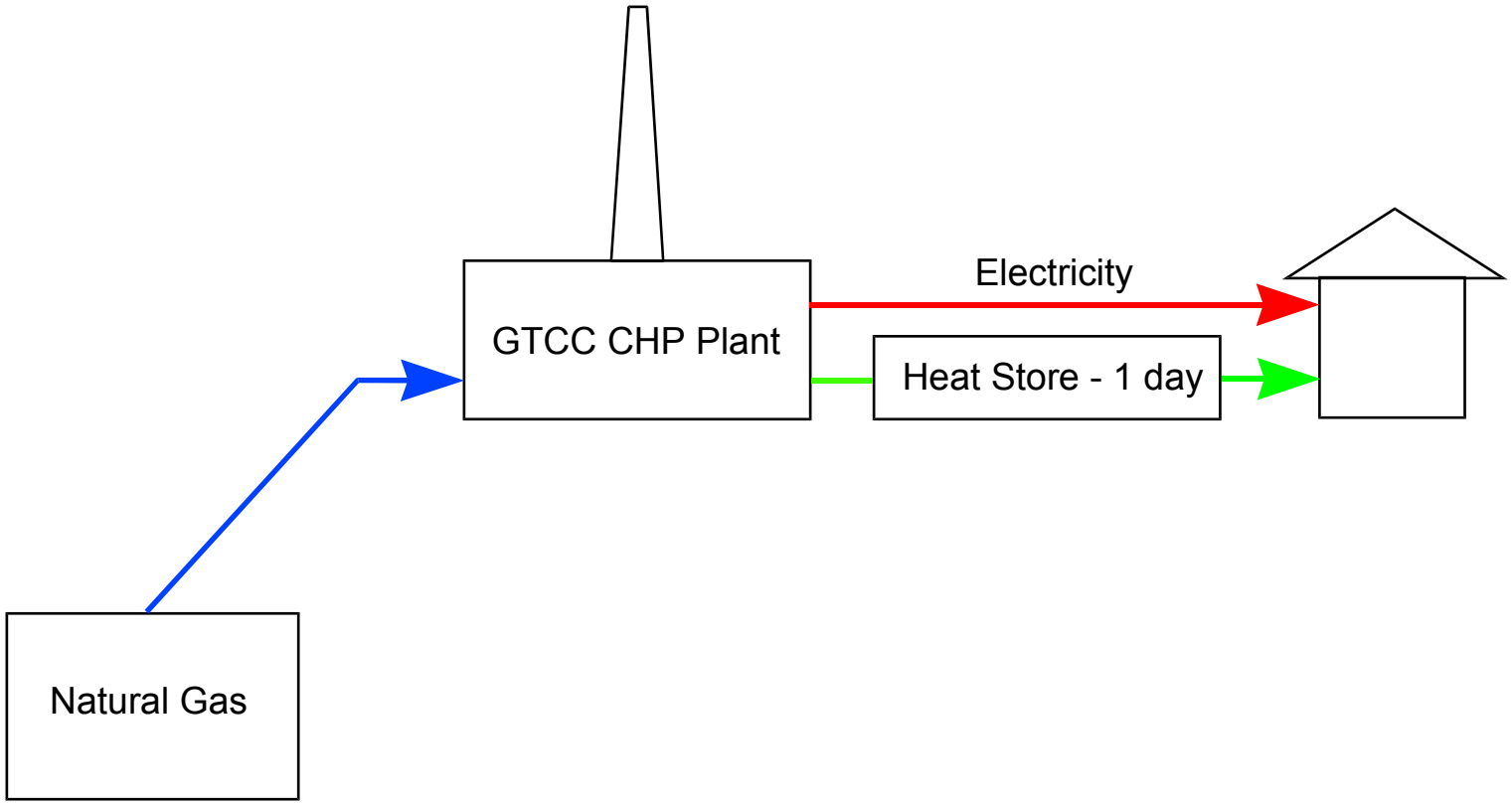
The Offshore Valuation, 2010, p 13

100% Energy from Wind

- to carbon-free sustainability in four steps

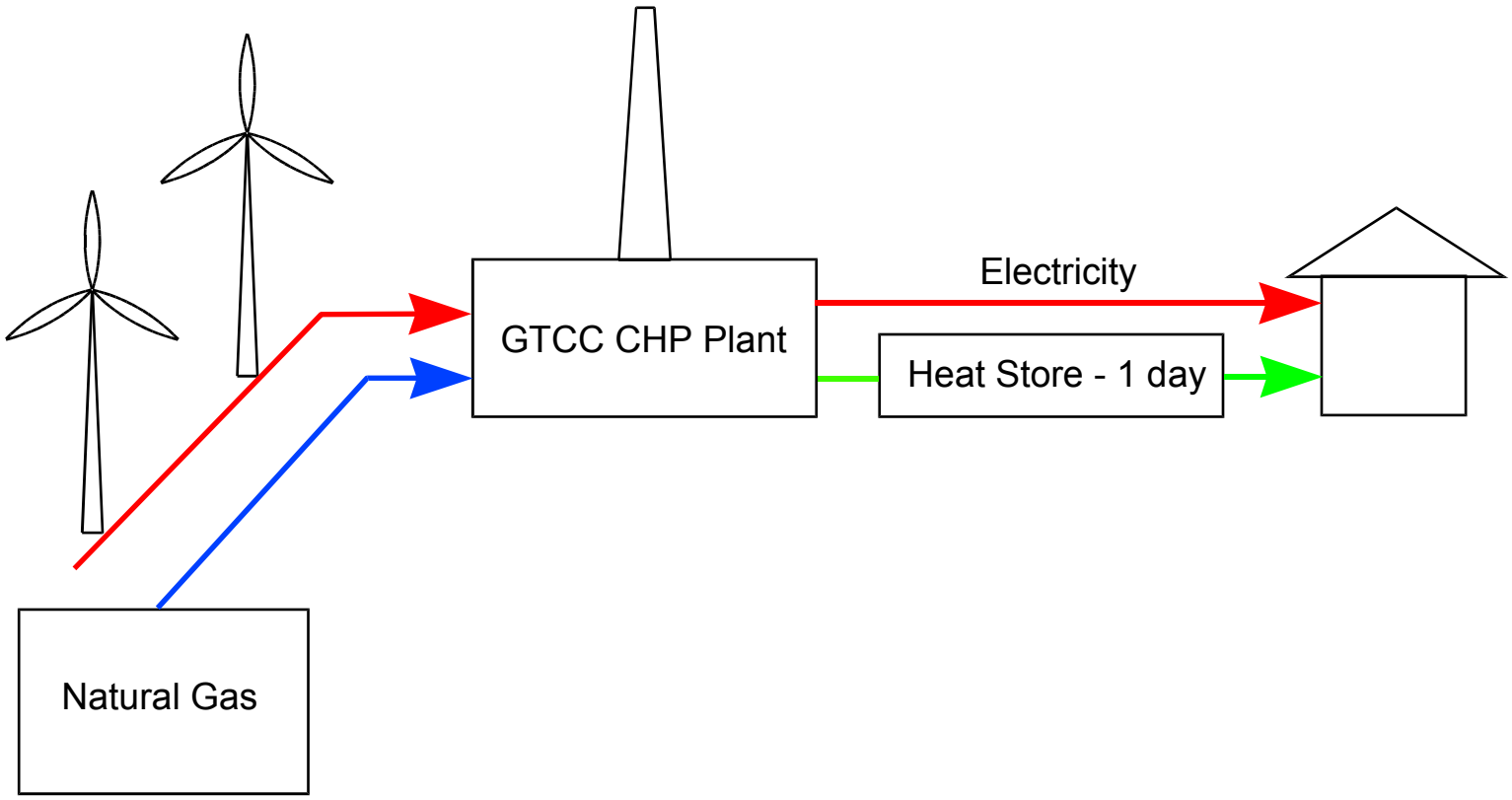
- 0% Electricity from Wind
- 50% Electricity from Wind
- 100% Electricity from Wind
- 100% Electricity, Transport and Heat from Wind

0% Electricity from Wind



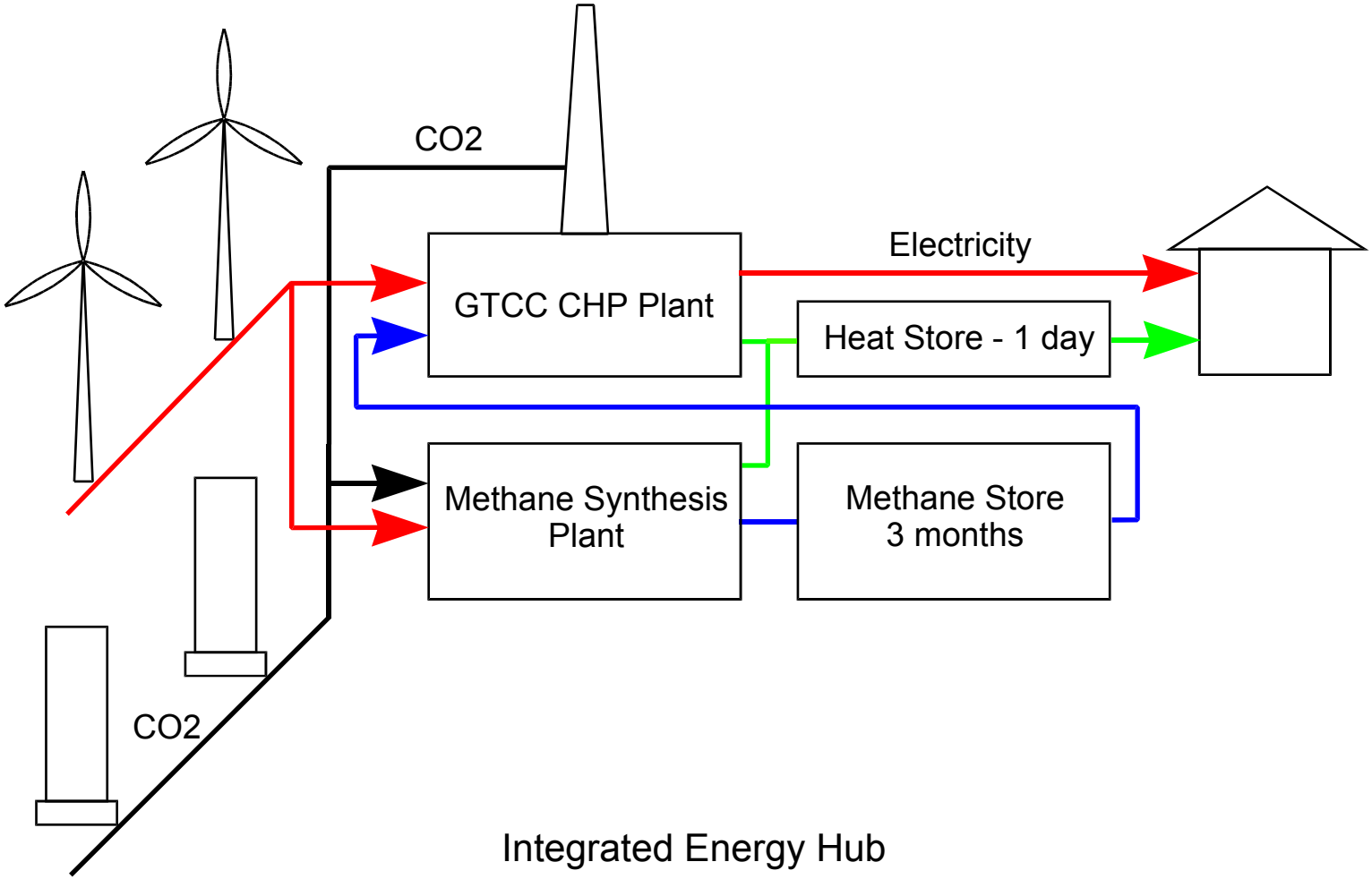
Integrated Energy Hub

50% Electricity from Wind



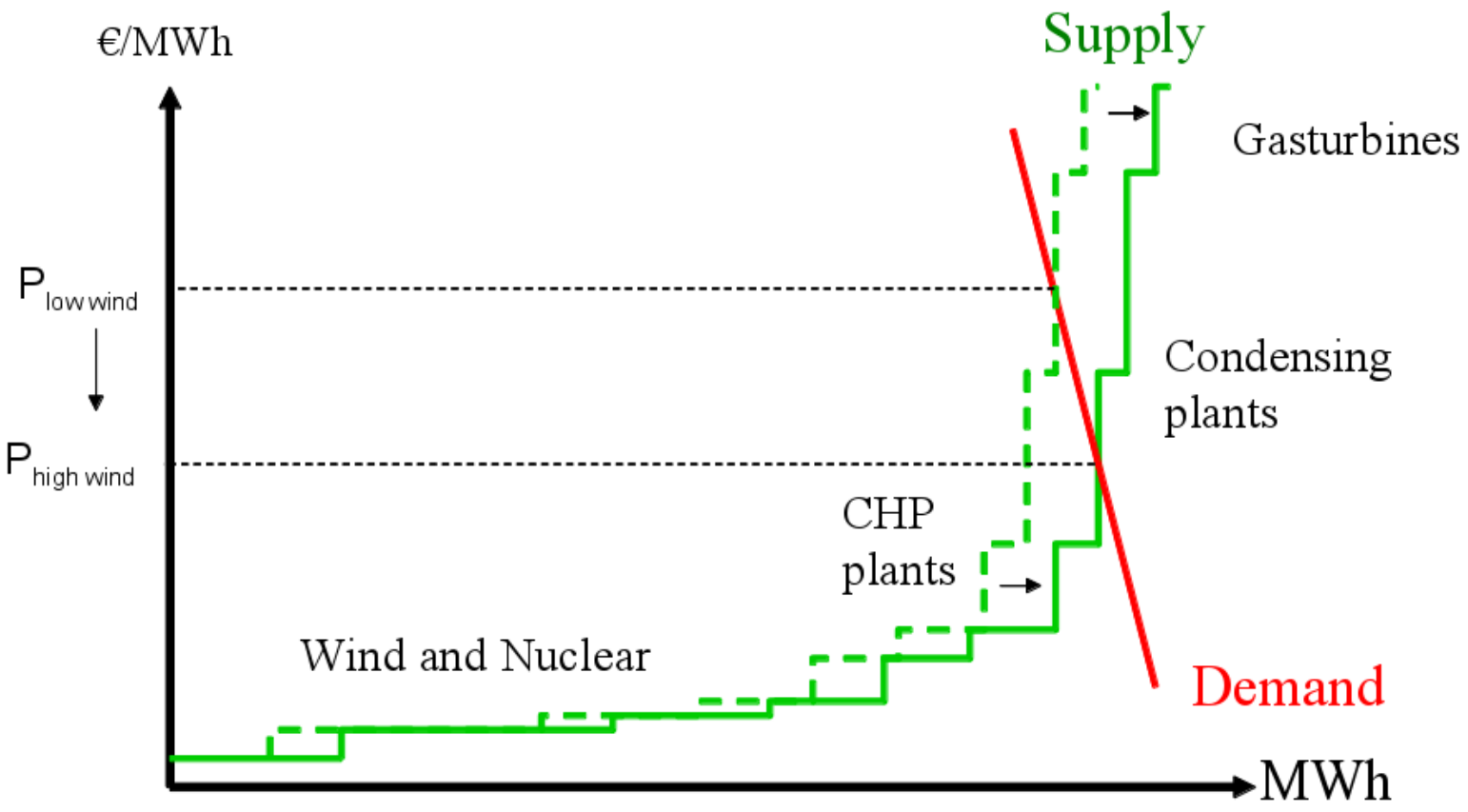
Integrated Energy Hub

100% Electricity from Wind



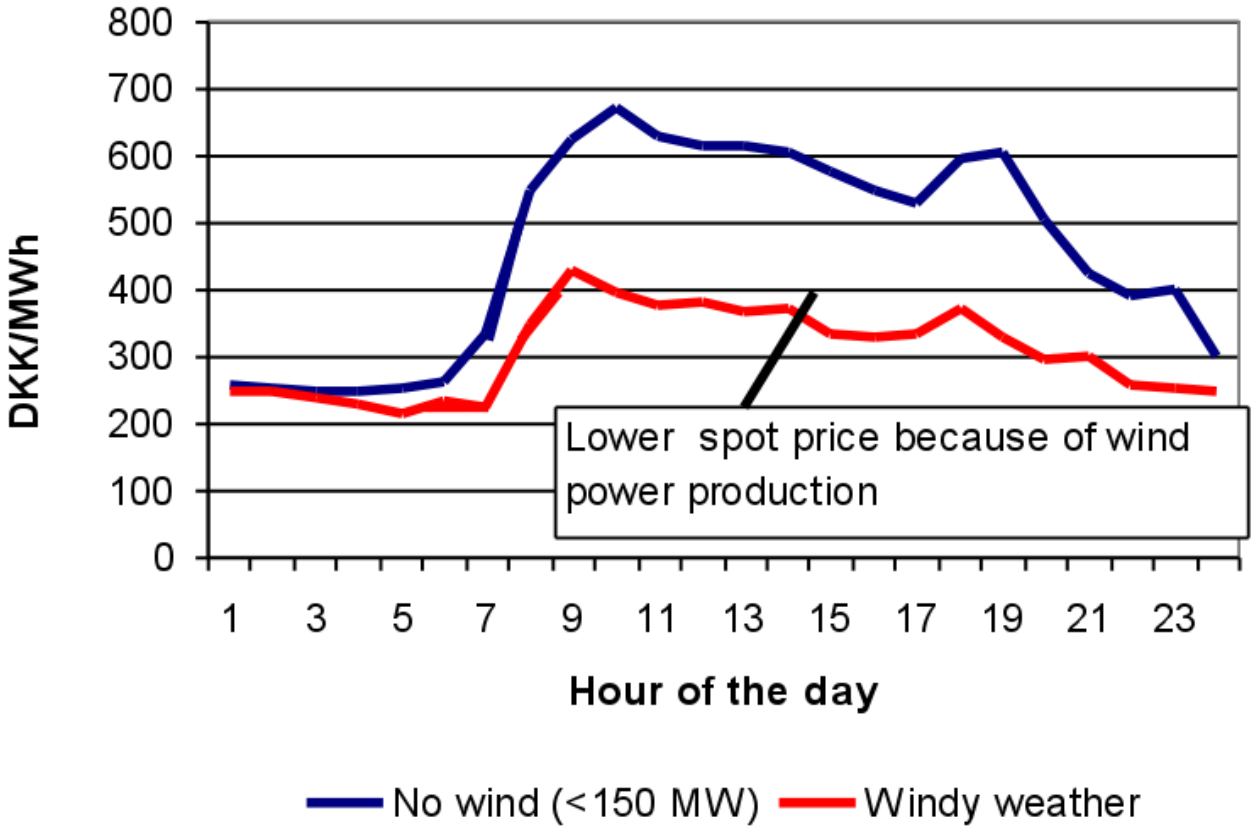
Integrated Energy Hub

Wind affects the the price setting



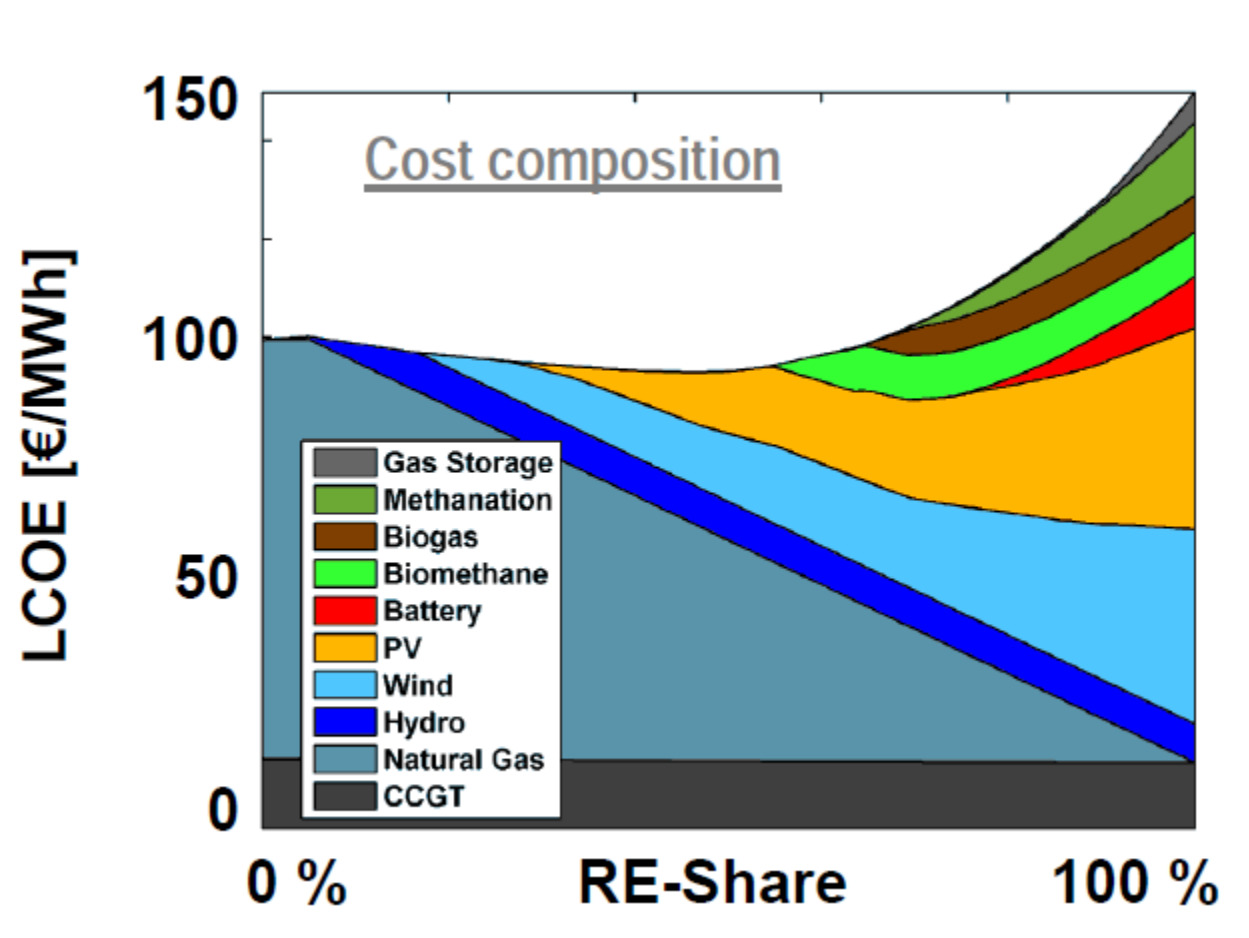
Moesgaard, EWEC 2007

The difference between the two curves is atrributed to wind power production



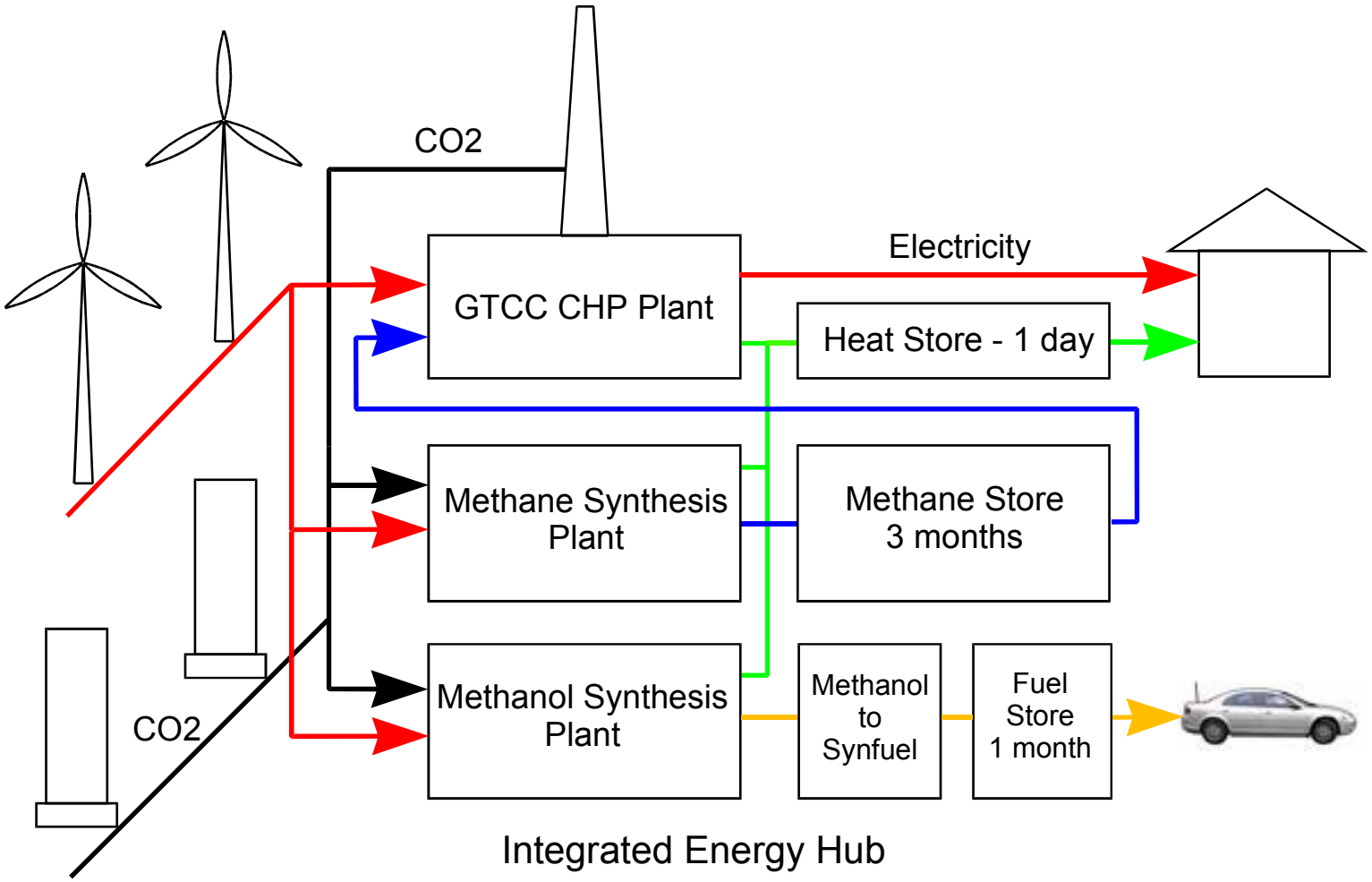
Moesgaard, EWEC 2007

System Studies for 100% electricity



Hlusiak and Breyer, IRES 2012

100% Energy from Wind



Most Energy from Wind

- The annual world electric energy is ~ 2 TWy
- The annual world transport fuel is ~ 3 TWy
- The annual world heat energy is ~ 5 TWy
- The Renewable Synthetic Fuel effy is ~ 0.5

Most Energy from Wind

- 100% final energy is ~ 10 TW, but by using the co-generated heat, the electricity input could be ~ 10 TW
- Compared with the world average wind resource of 96 TW, this is only about one-tenth
- For a Capacity Factor of 0.35, the required wind capacity is ~ 3 x the average electricity input - i.e. ~ 30 TW
- Such a 100% energy solution would be indigenous, secure, renewable and carbon-free - hence sustainable
- Investing in such a solution would increase indigenous employment and reduce overseas expenditure

Thank you for your attention

Gordon Taylor

G T Systems

Several energy presentations are at:
www.energypolicy.co.uk