Functionalized Ordered Mesoporous Composites as Potential Ammonia Storage Material

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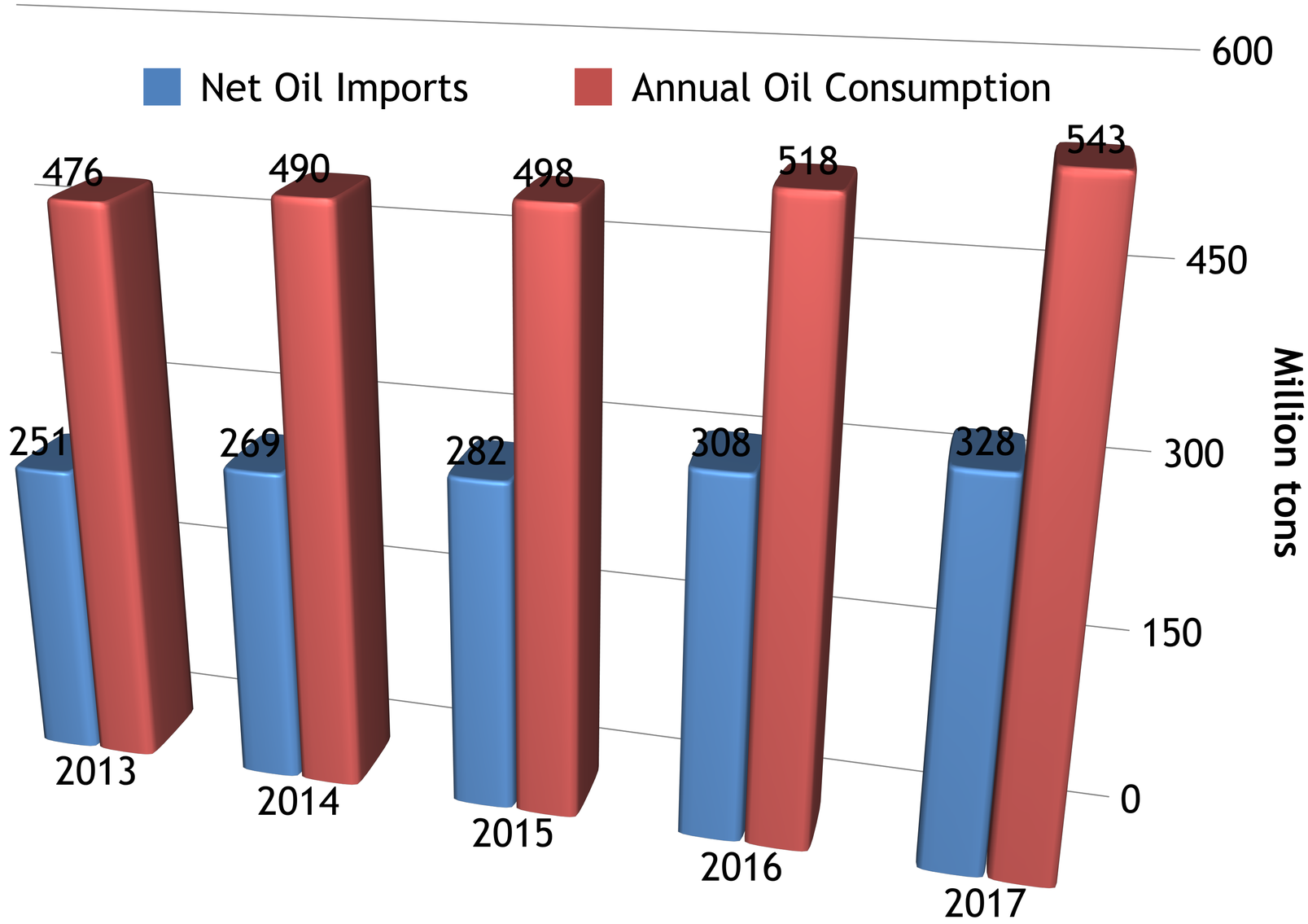
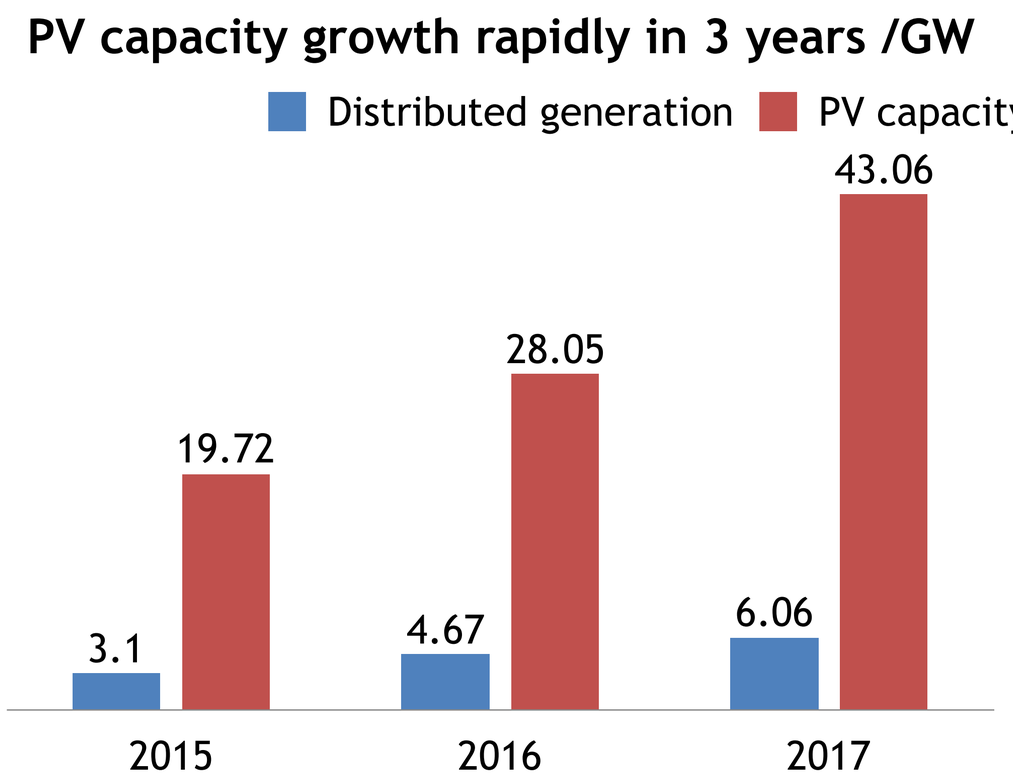
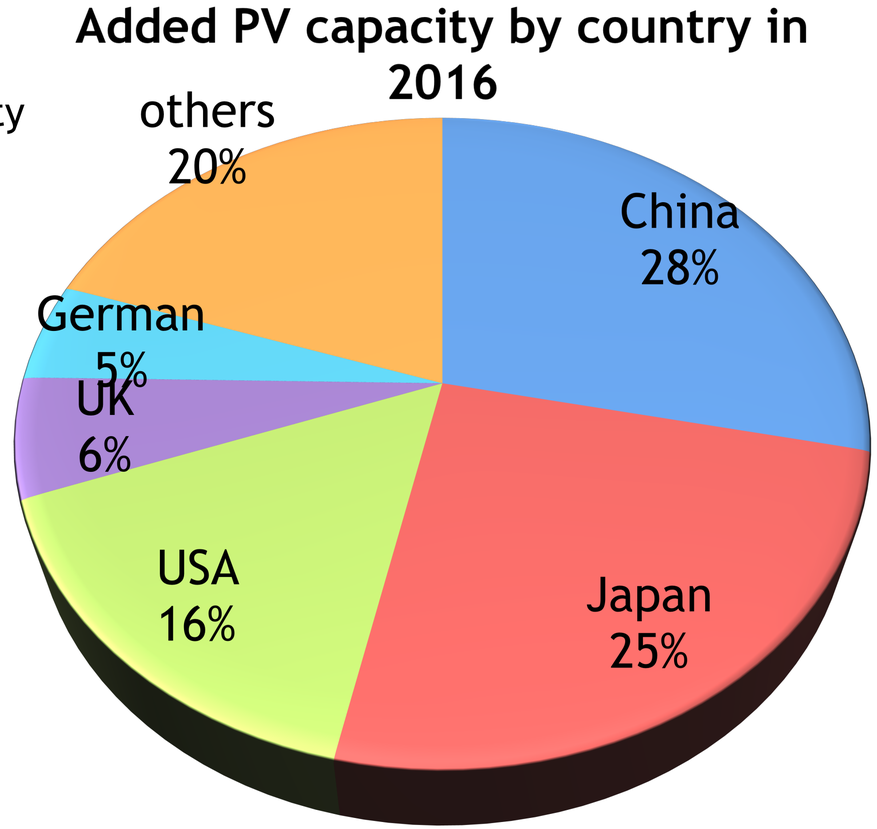
China’s demand for oil energy is unsustainable

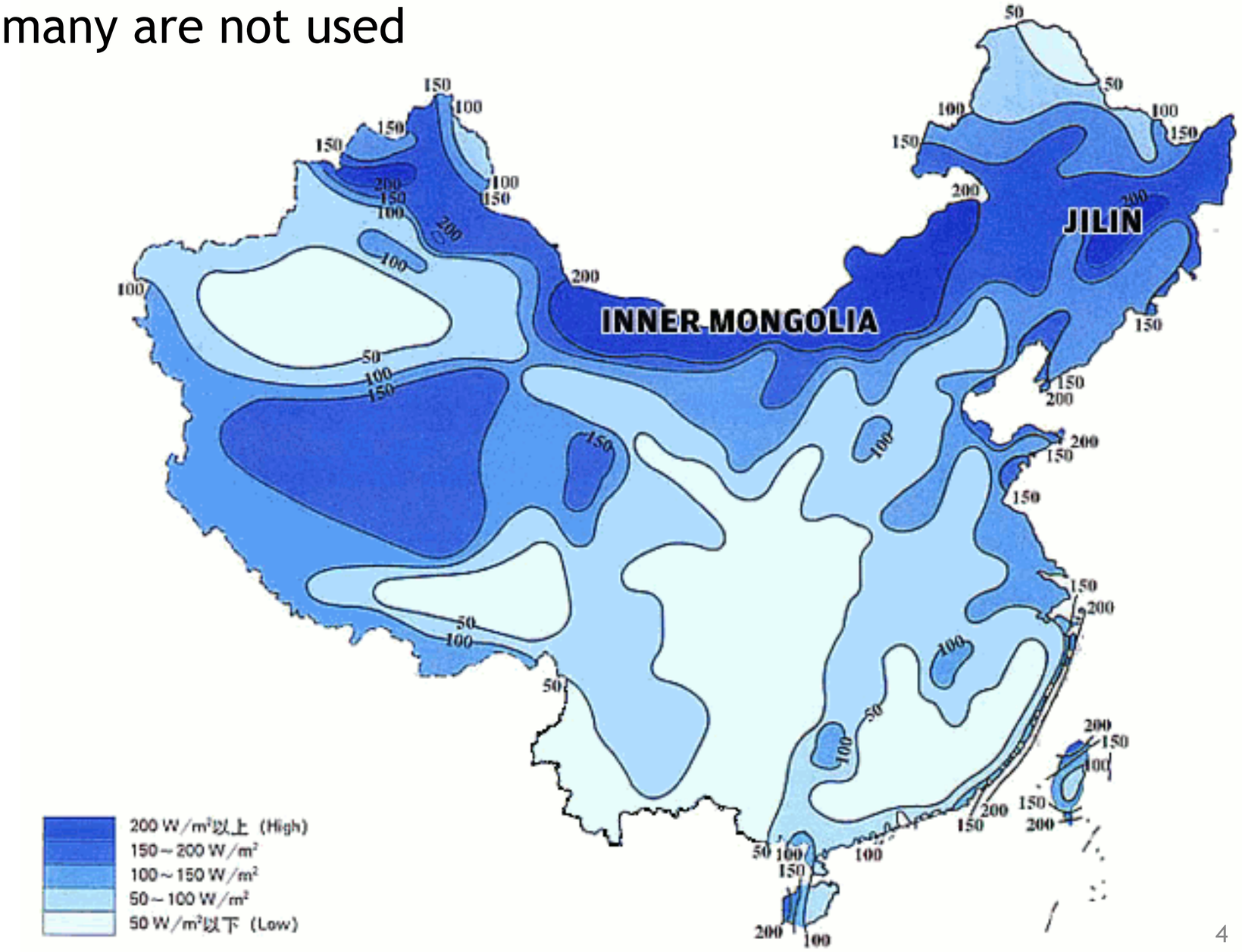


China has become one of important renewable energy markets in the world

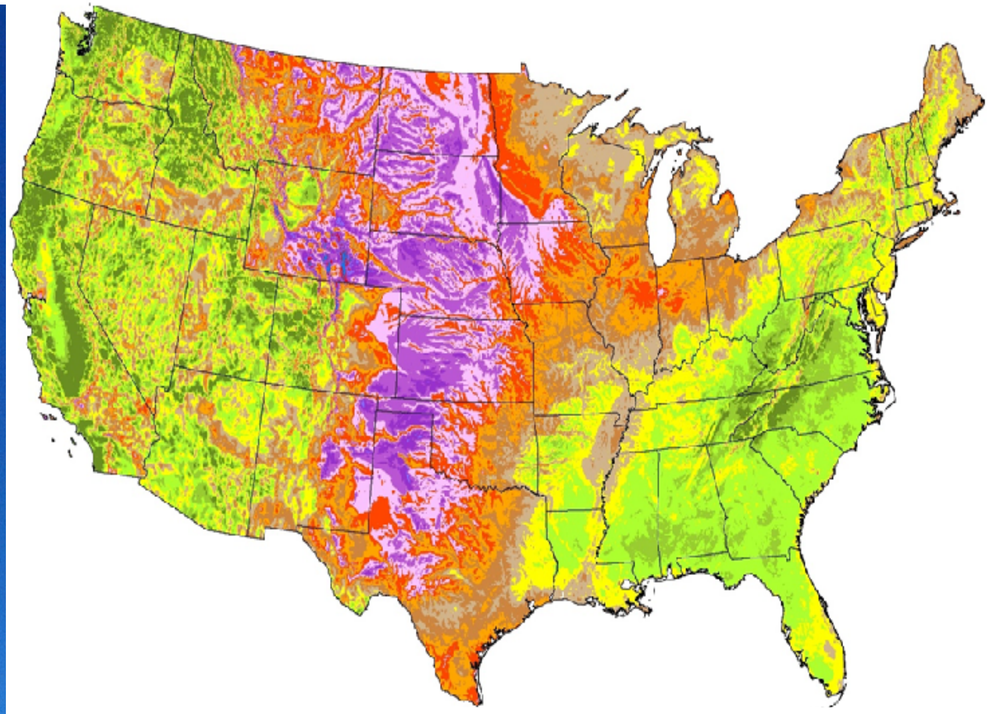


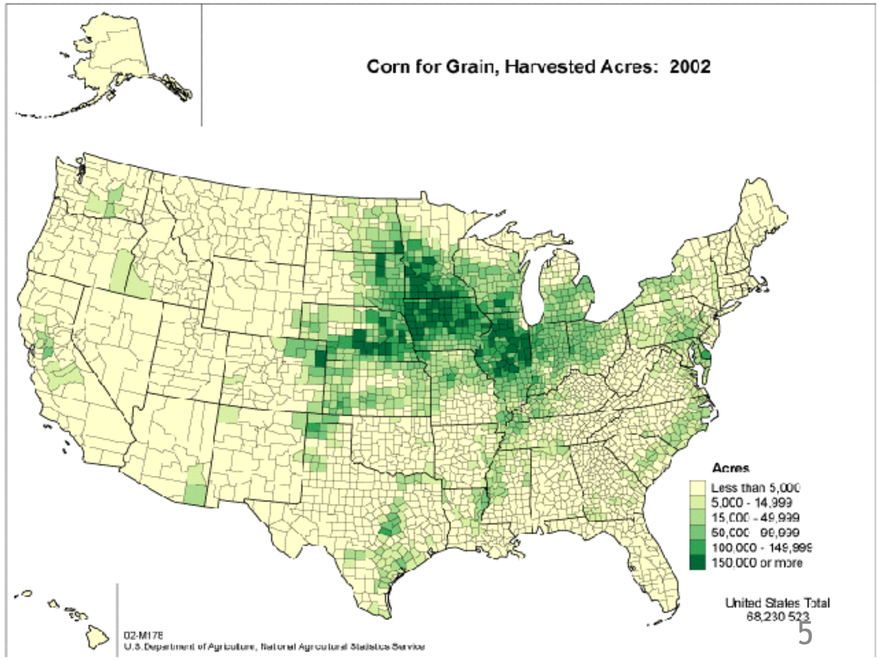


China contains large quantity of wind resources
But many are not used

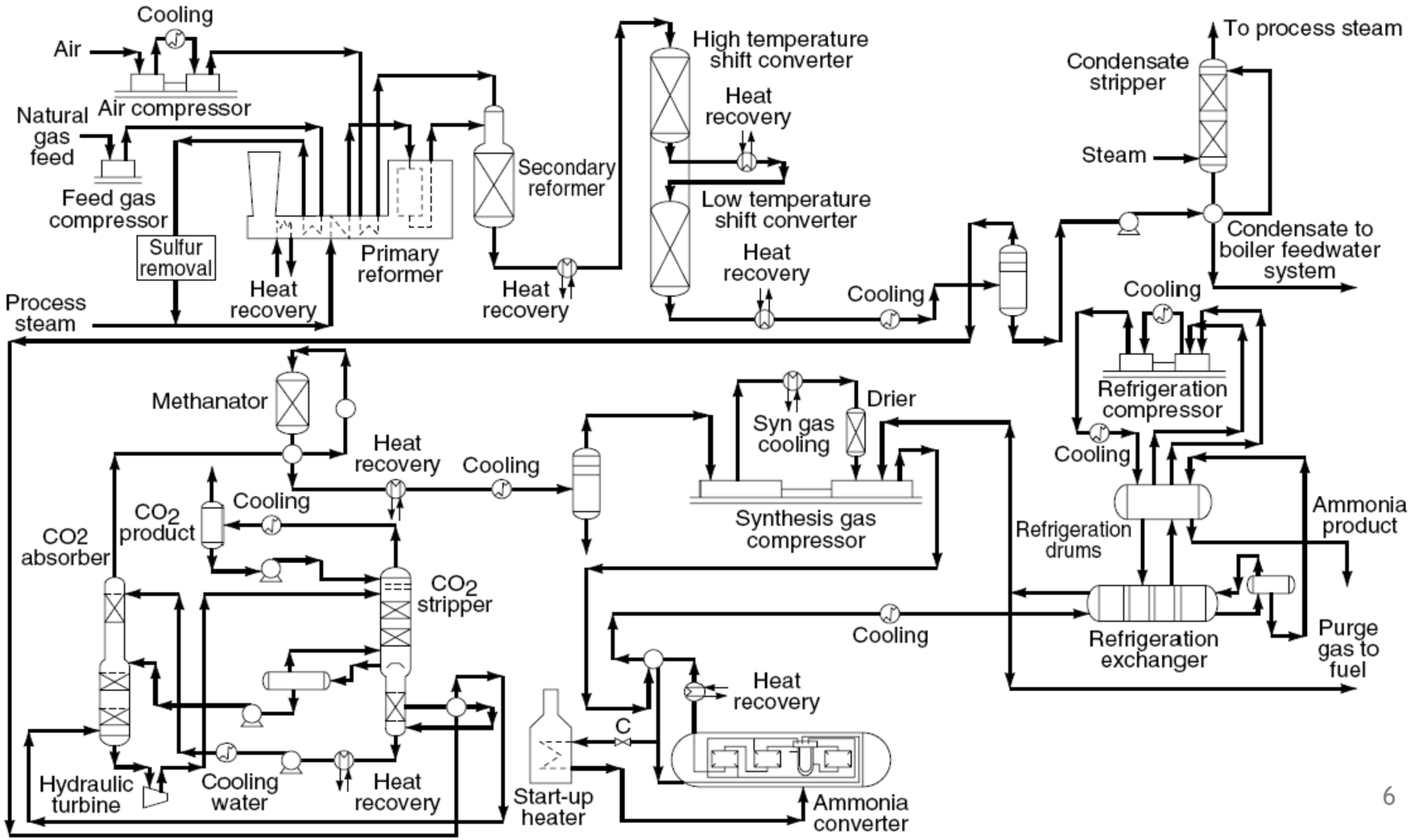


United States: Wind resource overlaps the area that need fertilizer

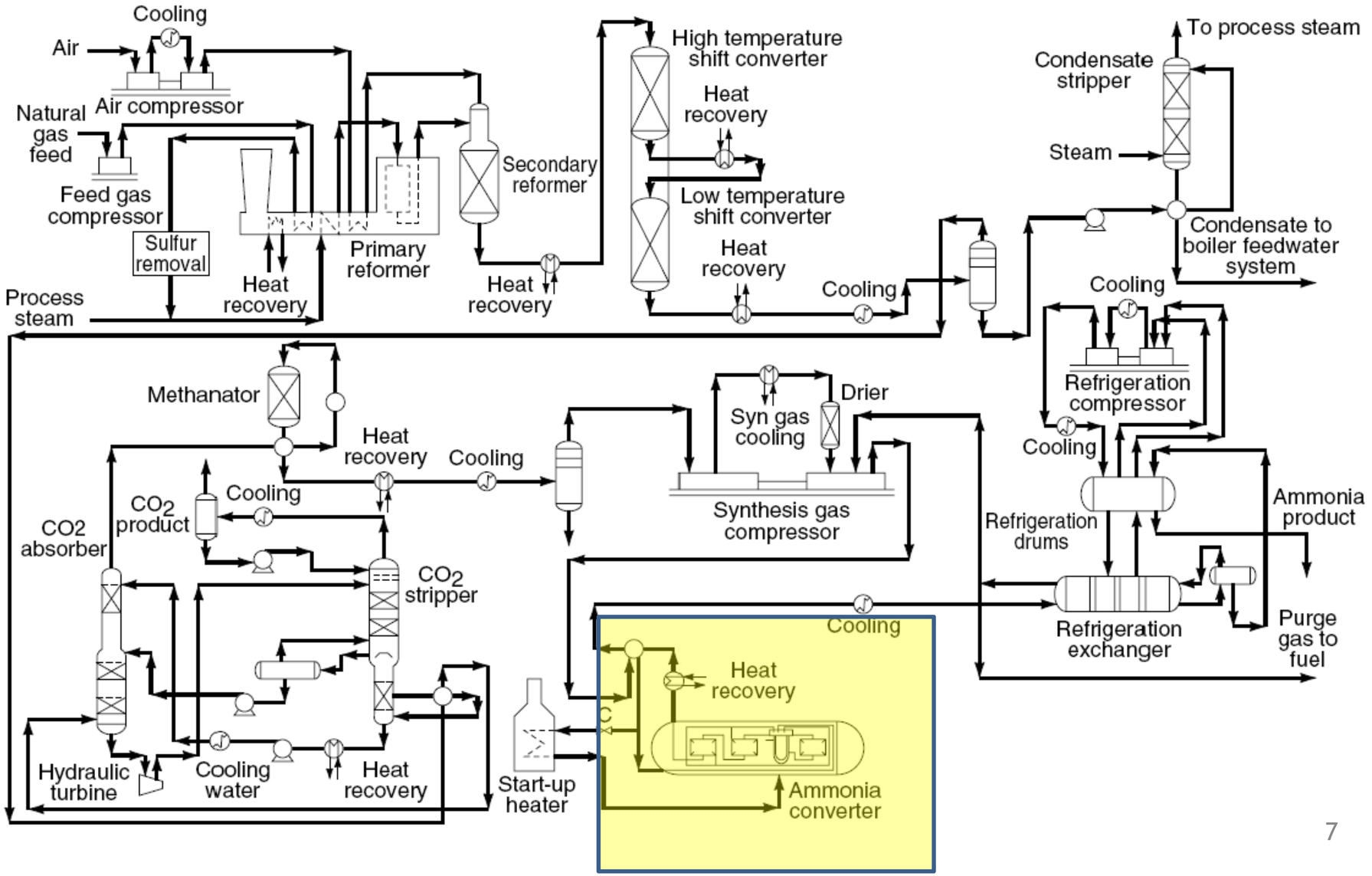




Traditional ammonia production causes larger carbon emission



90 % of traditional production can be cut off



Ammonia can be produced locally via renewable energy

Wind power

Solar energy

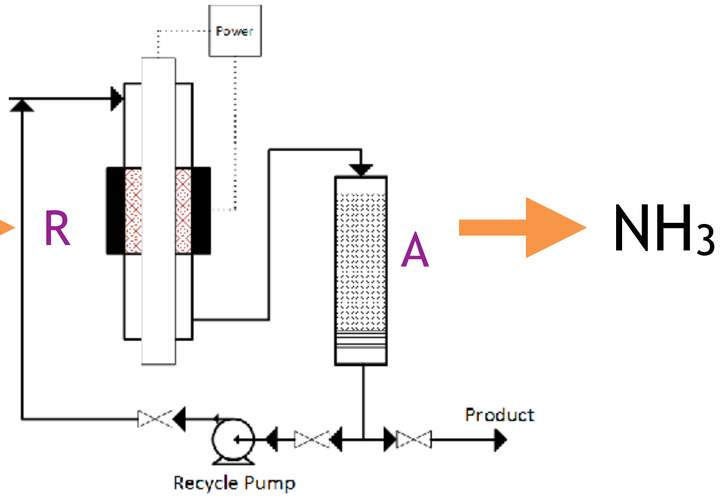
Power

H_2

ASU

N_2

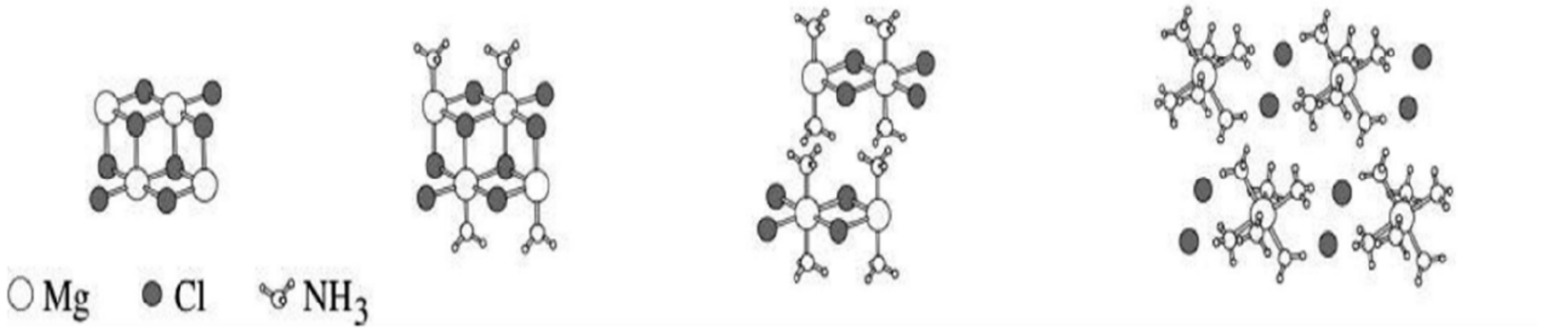
O_2

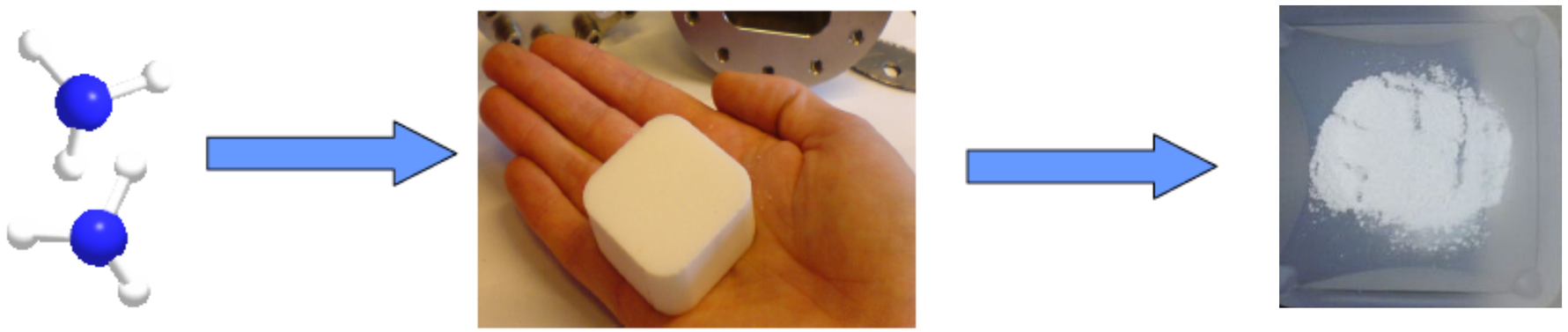


NH_3

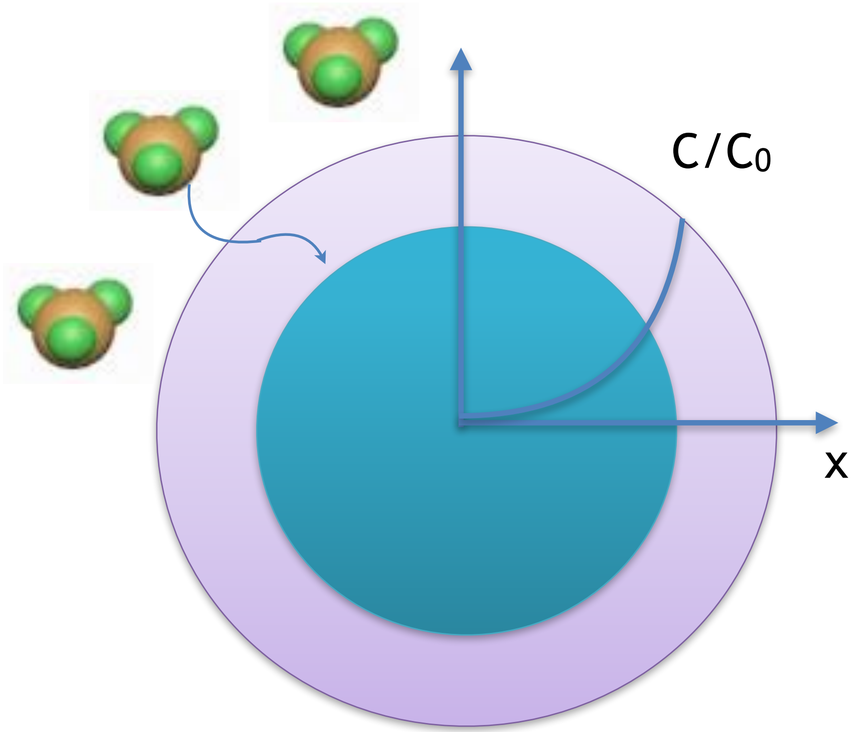
Structure changes on metal halide at higher temperature

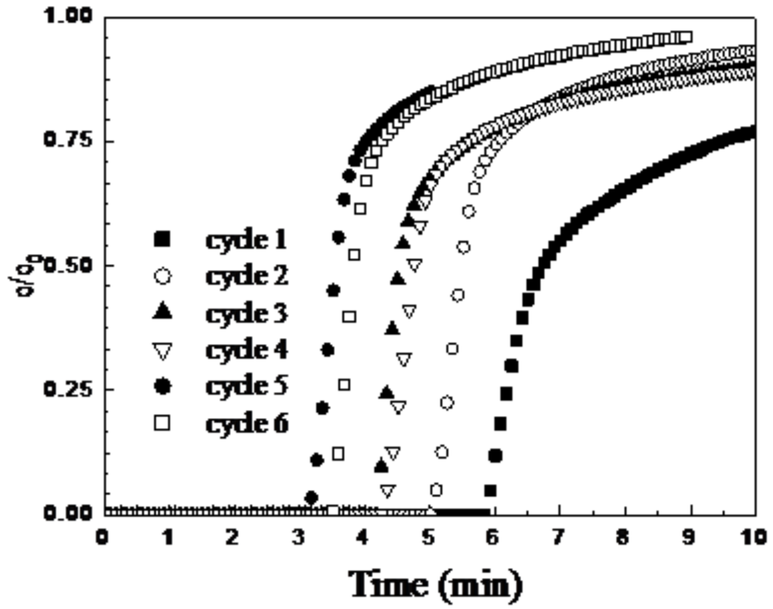
$MgCl_2$ $Mg(NH_3)Cl_2$ $Mg(NH_3)_2Cl_2$ $Mg(NH_3)_6Cl_2$

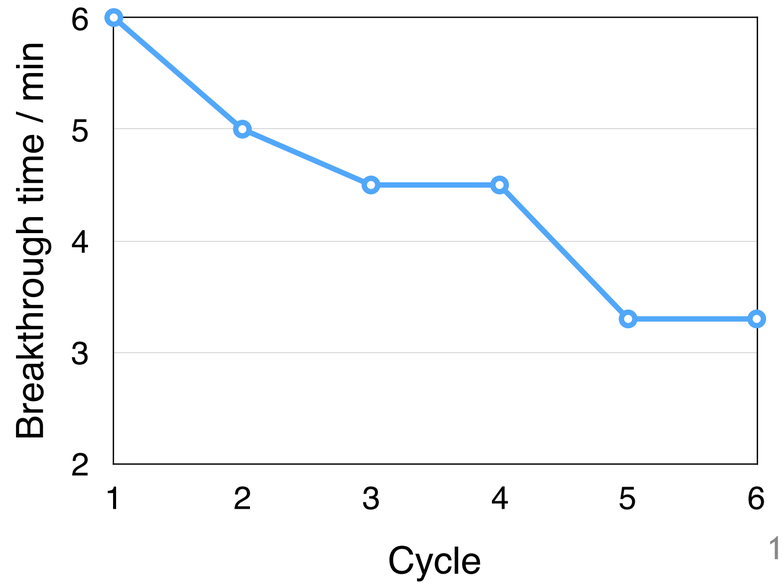




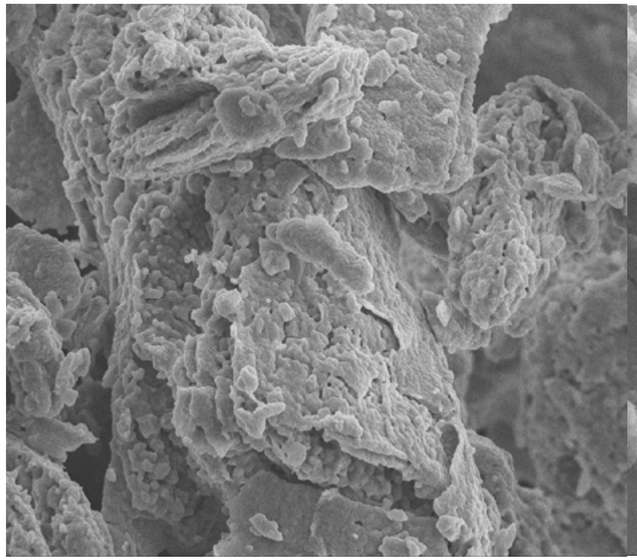
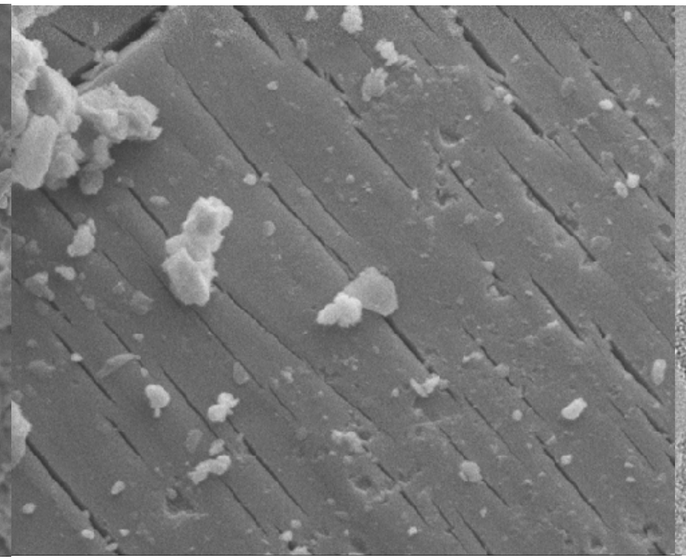
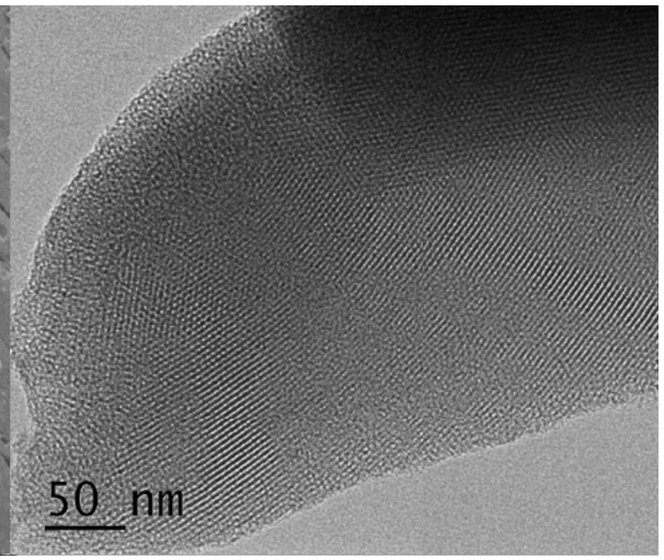
NH_3 penetration into $MgCl_2$ depends on time





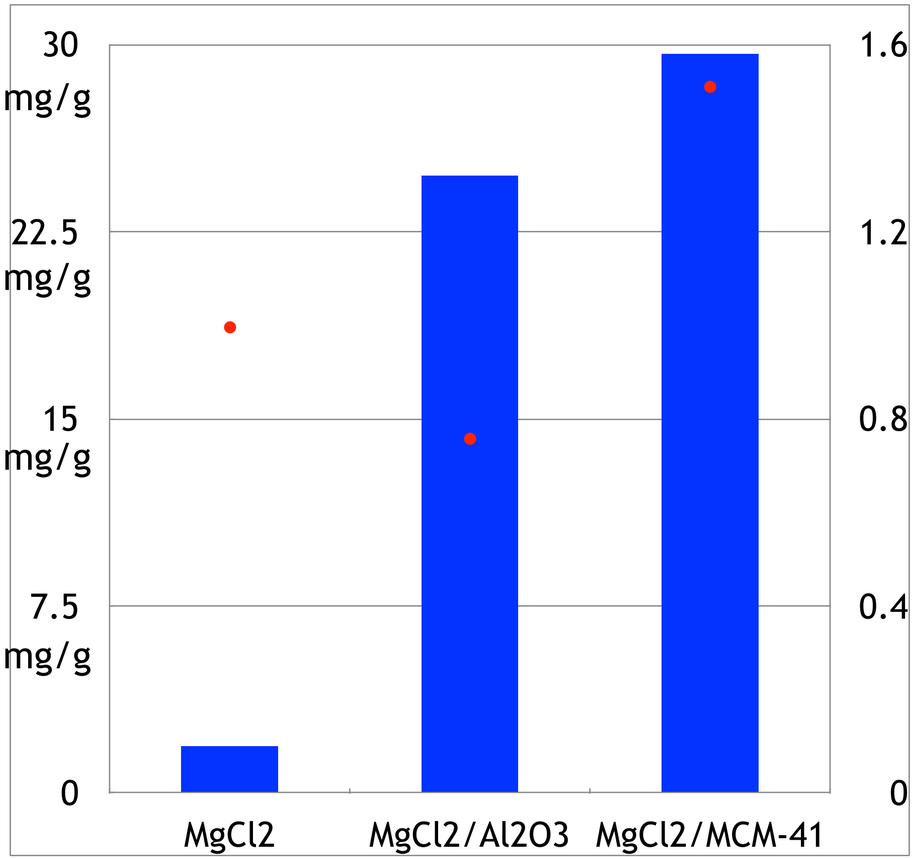


Sorbent performance gets evolved with ordered mesoporous material

$MgCl_2$	Alumina	Ordered Mesoporous Silica (MCM-41)
		
$0.5m^2/g$	$243m^2/g$	$1100m^2/g$

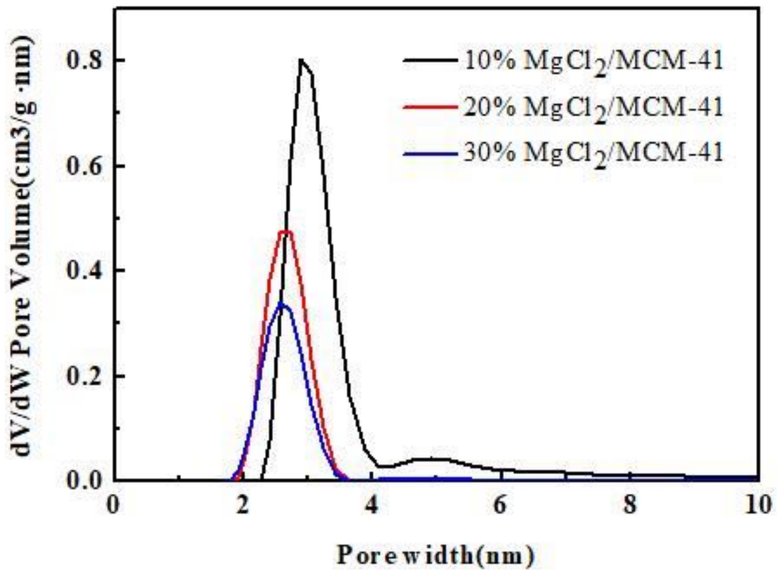
Ordered mesoporous material exhibits superiority at high temperature

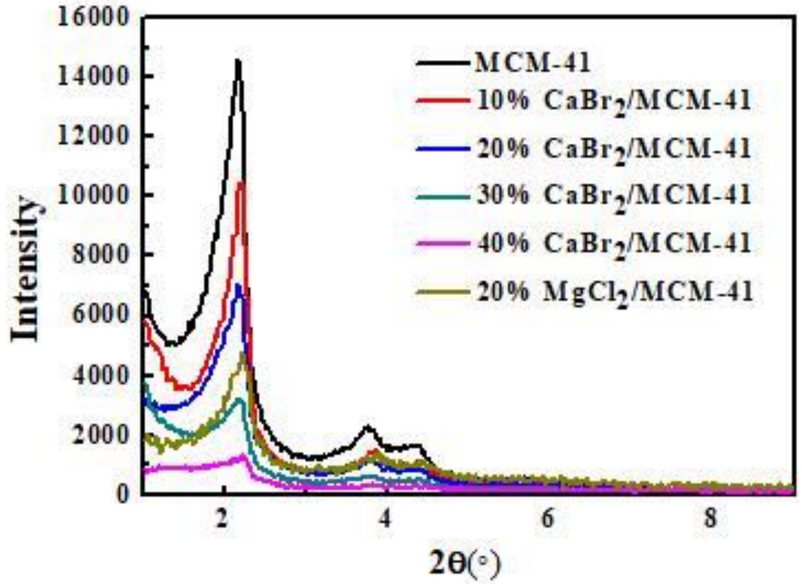
	$MgCl_2$	$MgCl_2$/ Al_2O_3	$MgCl_2$/ MCM-41
Surface area (m^2/ g)	0.5	155	992
Pore Volume (cm^3/g)	-	0.3242	0.847
Average pore size (nm)	-	8.64	2.95



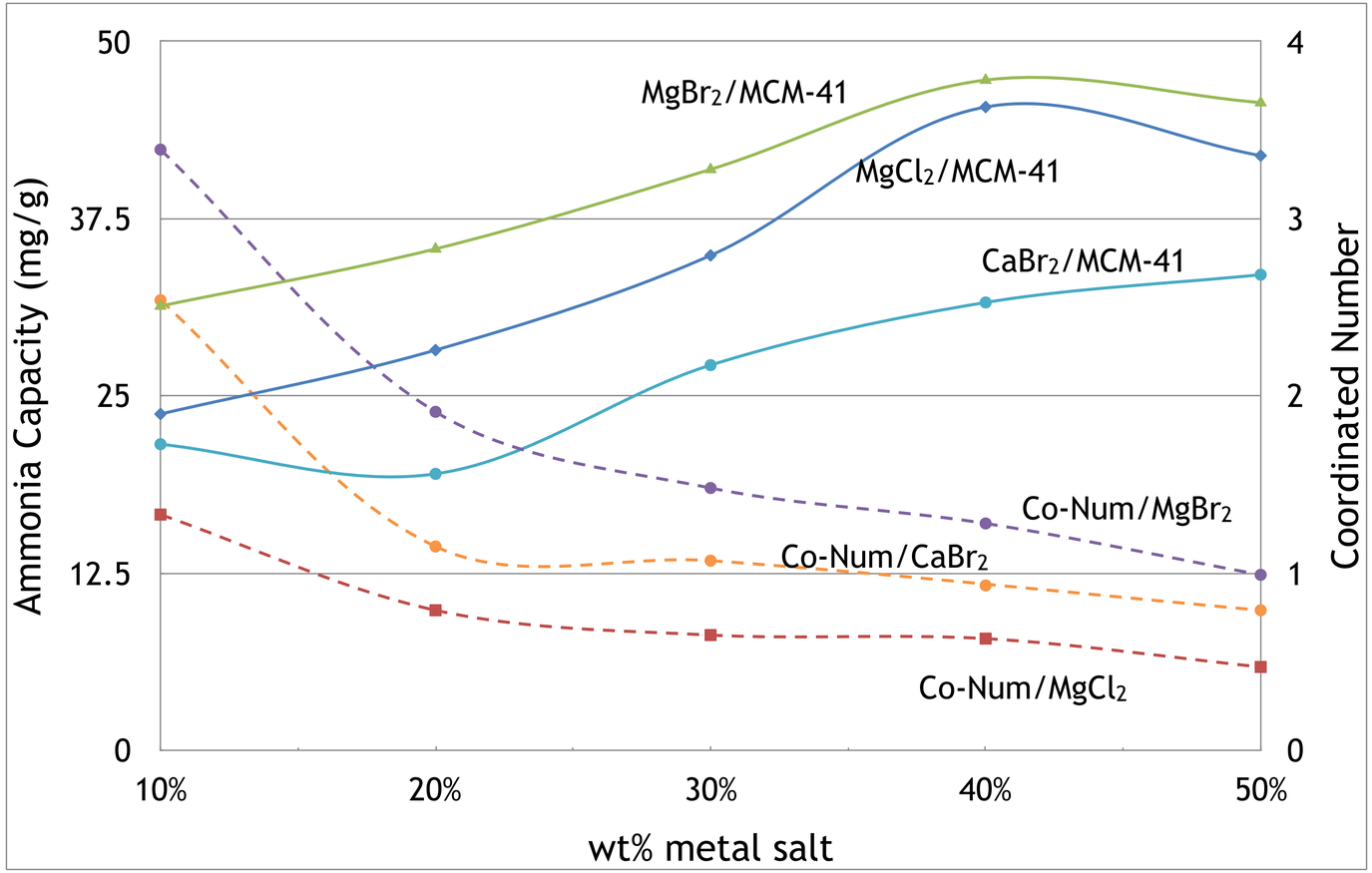
Various concentration of metal salts are impregnated to the ordered mesoporous framework

$MgCl_2$/MCM-41	10%	16%	30%	40%	50%
Surface area m^2/g	992	853	529	398	116
Pore volume cm^3/g	0.847	0.714	0.431	0.328	0.212

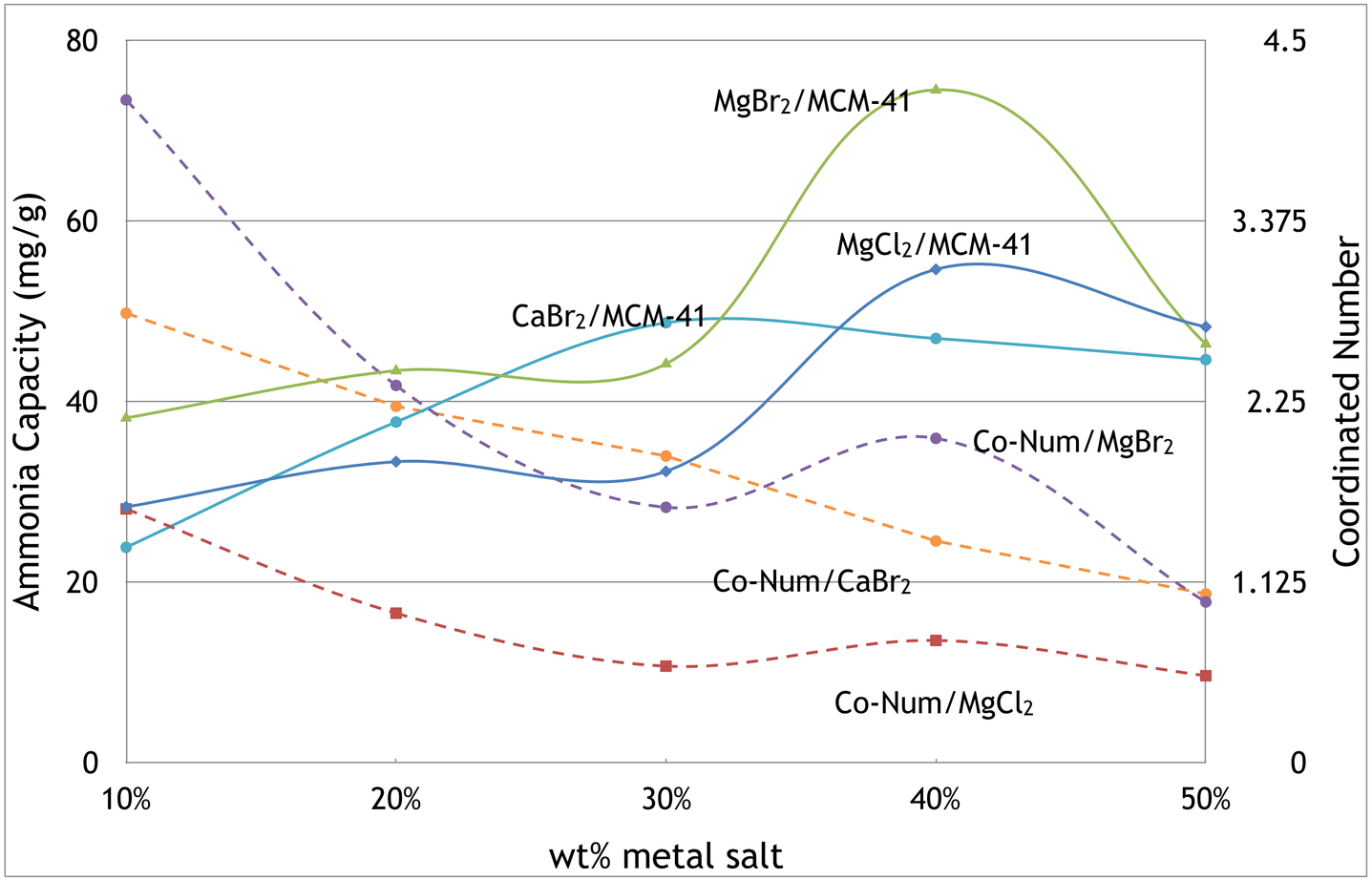




Sorbent performances at 300°C, 4bar



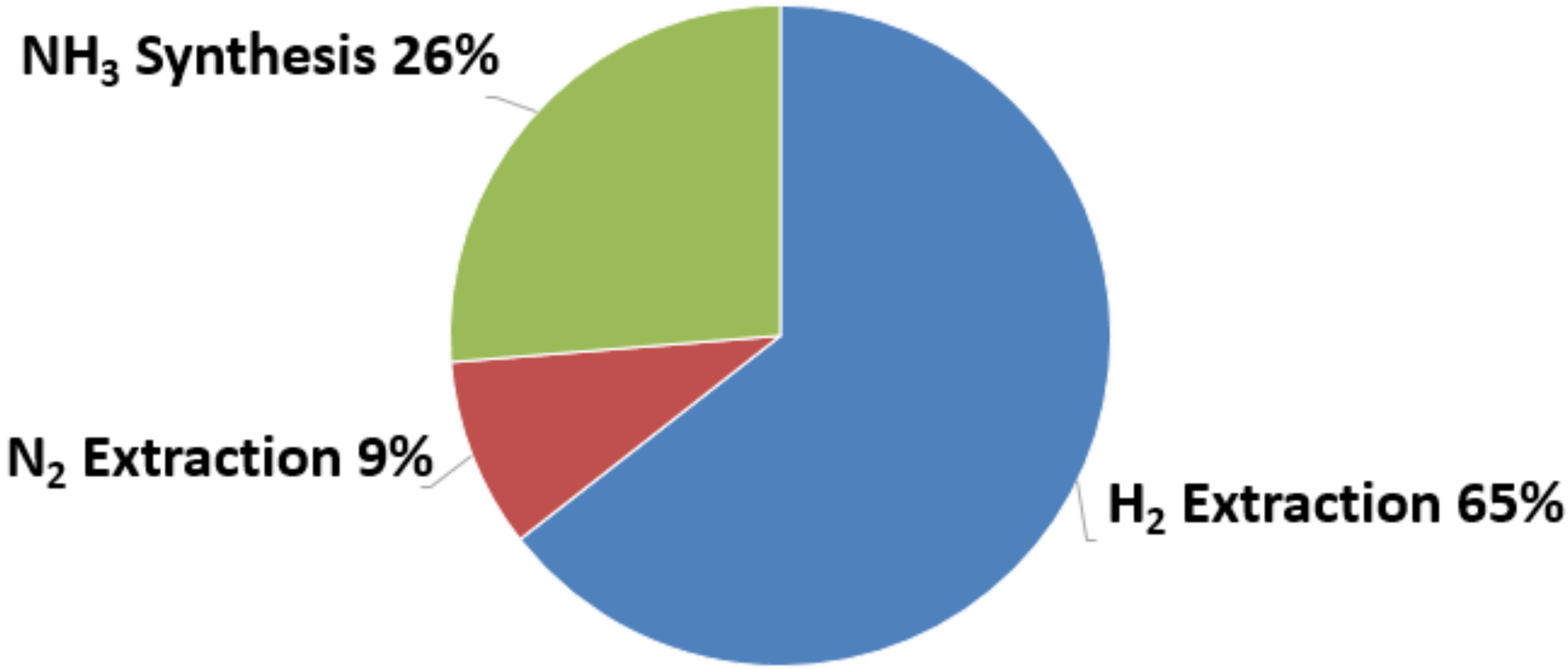
Sorbent performances at 200°C, 4bar



With absorbent coupled ammonia synthesis pressure can be reduced to 2.45MPa

	T	$V_{cat.}$	kmol NH_3/ hr	Pressure
R+A	492°C	2.5cm^3	0.00177	2.45MPa
R	492°C	2.5cm^3	0.00177	30MPa

Hydrogen extraction posses most energy consumption



For a Distributed Ammonia Production

1. Functionalized ordered mesoporous silica can be used as NH_3 storage material at high temperature.

2. With ordered mesoporous material coupled, ammonia synthesis pressure can be reduced to 2.45 MPa (lower consumption).

3. H_2 extraction calls for further development.

Thank you for your attention

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