

Bilag. Modenhedsvurdering i Energistyrelsens Teknologikatalog

Kontor/afdeling
SYS

Dato
12-08-2022

J nr.

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Boks 1 viser definitionen af læringskurvens fire kategorier, som angivet i Energistyrelsens Teknologikatalog.

Tabel 1 viser modenhedsvurdering for en række relevante teknologier for hvert omstillingselement. Den samlede modenhed ud fra læringskurven som vurderet af Energistyrelsen er angivet for hvert omstillingselement.

Boks 1. Læringskurvens fire kategorier. Kilde: Teknologikataloget, Energistyrelsen

Læringskurve, Teknologikatalogerne

Kategori 1. Teknologierne er på forsknings- og udviklingsstadiet. Omkostninger og effekt er forbundet med betydelig usikkerhed.

Kategori 2. Teknologierne er på pionerstadiet. Det er blevet påvist, at teknologierne virker gennem demonstrationsanlæg og halv-kommercielle anlæg. Omkostninger og effekt er behæftet med nogen usikkerhed, idet teknologiens udbredelse er begrænset og idet teknologien stadig er under udvikling og tilpasning.

Kategori 3. Teknologierne er kommercielle og har moderat udbredelse. Omkostninger og effekt er velkendt, men teknologierne har stadig et væsentligt udviklingspotentiale og omkostningerne forventes at falde yderligere ved opskalering.

Kategori 4. Teknologierne er kommercielle og har stor udbredelse. Omkostninger og effekt er velkendt, og teknologiske forbedringer ved større udbredelse er inkrementelle.

Tabel 1. Modenhedsvurdering for en række teknologier. Kilde: Teknologikataloget, Energistyrelsen

	Katalog: Kapitel	Modenhed	Samlet modenhed
Husholdninger			
Varmepumper og fjernvarme i husholdninger	Individual heating installation: 203 District heating substation	4	3-4
	Energy Transport: 113 District heating grid	4	
	Individual heating installation: 207 Electric heat pumps, air-to-water, brine-to-water, air-to-air and ventilation	3-4	

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Energibesparelser i husholdninger	<i>Ikke beskrevet</i>	-	-	
Produktion af olie, gas og VE-brændstoffer				
Elektrificering af raffinaderier	Industrial process heat / 301 Traditional heat pumps with certain limitations in maximum temperature and combined process heating and cooling	3 ¹	3-4	
	Industrial process heat / 302 High temperature heat pump	3		
	Industrial process heat / 304 Heat driven heat pump	3		
	Industrial process heat / 305 Mechanical Vapour Recompression (MVR)	3 ¹		
	Industrial process heat / 306 Thermal gasification	3		
	Industrial process heat / 307 Hotdisc	4		
	Industrial process heat / 308 Dielectric assisted heating	4		
	Industrial process heat / 310 Electric boilers (industrial process heating)	3		
	Industrial process heat / 312 Direct firing	4		
	Skift til bio-feedstock på raffinaderier	Renewable fuels: 85 Liquid fuels from biogas gasification and Fischer Tropsch	2	3-4
		Renewable fuels: 89 Vegetable Oil FAME	4	
Renewable fuels: 90 UCO and Animal Fat FAME		4		
Renewable fuels: 91 Hydrogenated Vegetable Oil / Renewable Diesel		4		
Renewable fuels: 92 HVO Jet Fuel		3		
Renewable fuels: 93 1 st Generation Ethanol		4		
Renewable fuels: 94 Pyrolysis Oil		2		
Renewable fuels: 95 Cellulosic Ethanol		2		
Renewable fuels: 97 Methanol from Biomass Gasification		2		
CCS på raffinaderier ²	Carbon Capture, Transport and Storage/ 401 Amine Post Combustion carbon capture technology	3	3	
	Carbon Capture, Transport and Storage/ 402 Oxy-fuel combustion technology	2		
	Carbon Capture, Transport and Storage/ 421 CO ₂ transport in pipelines	4		
	Carbon Capture, Transport and Storage/ 422 CO ₂ transport by ship	3		
	Carbon Capture, Transport and Storage/ 423 CO ₂ transport by road	4		
	Elektrificering af olie- og gasindvinding i Nordsøen	Industrial process heat / 301 Traditional heat pumps with certain limitations in maximum temperature and combined process heating and cooling	3 ¹	3-4
Industrial process heat / 302 High temperature heat pump		3		
Industrial process heat / 304 Heat driven heat pump		3		
Industrial process heat / 305 Mechanical Vapour Recompression (MVR)		3 ¹		
Industrial process heat / 306 Thermal gasification		3		
Industrial process heat / 307 Hotdisc		4		
Industrial process heat / 308 Dielectric assisted heating		4		
Industrial process heat / 310 Electric boilers (industrial process heating)		3		
Metanisering af CO ₂ fra biogasanlæg		Renewable fuels: 99 SNG from Methanation of Biogas	2	2
El og fjernvarme				



Biogasomlægning fra kraftvarme til opgradering	Renewable fuels: 82 Biogas, opgrading	3	3	
CCS på el-, fjernvarme- og biogasanlæg ²	Carbon Capture, Transport and Storage/ 401 Amine Post Combustion carbon capture technology	3	3	
	Carbon Capture, Transport and Storage/ 402 Oxy-fuel combustion technology	2		
	Carbon Capture, Transport and Storage/ 421 CO ₂ transport in pipelines	4		
	Carbon Capture, Transport and Storage/ 422 CO ₂ transport by ship	3		
	Carbon Capture, Transport and Storage/ 423 CO ₂ transport by road	4		
Serviceerhverv				
Varmepumper og fjernvarme i serviceerhverv	Individual heating installation: 203 District heating substation	4	3-4	
	Energy Transport: 113 District heating grid Individual heating installation: 207 Electric heat pumps, air-to-water, brine-to-water, air-to-air and ventilation	4 3-4		
Fremstillingserhverv og byggeanlæg				
Energieffektivisering i procesenergi og intern transport	<i>Ikke beskrevet</i>	-		
Elektrificering i procesenergi og intern transport ⁴	Industrial process heat / 301 Traditional heat pumps with certain limitations in maximum temperature and combined process heating and cooling	3 ¹	2-4	
	Industrial process heat / 302 High temperature heat pump	3		
	Industrial process heat / 303 Booster heat pump systems applying turbo compressors in combination with traditional heat pumps	2		
	Industrial process heat / 304 Heat driven heat pump	3 ¹		
	Industrial process heat / 305 Mechanical Vapour Recompression (MVR)	3		
	Industrial process heat / 308 Dielectric assisted heating	4		
	Industrial process heat / 309 Infrared heating	2		
	Industrial process heat / 310 Electric boilers (industrial process heating)	3		
	Bio- og PtX-brændstoffer i intern transport ³	Renewable fuels: 85 Liquid fuels from biogas gasification and Fischer Tropsch	2	(2-4)
		Renewable fuels: 89 Vegetable Oil FAME	4	
Renewable fuels: 90 UCO and Animal Fat FAME		4		
Renewable fuels: 91 Hydrogenated Vegetable Oil / Renewable Diesel		4		
Renewable fuels: 93 1 st Generation Ethanol		4		
Renewable fuels: 94 Pyrolysis Oil		2		
Renewable fuels: 95 Cellulosic Ethanol		2		
Renewable fuels: 97 Methanol from Biomass Gasification		2		
Gas og PtX-brændsler i direkte fyrede processer	51 Natural gas engine plant	4	3-4	
	306 Thermal gasification	3		
CCS i fremstillingserhverv ²	Carbon Capture, Transport and Storage/ 401 Post Combustion	3	3	
	Carbon Capture, Transport and Storage/ 402 Oxy fuel	2		
	Carbon Capture, Transport and Storage/ 421 CO ₂ transport in pipelines	4		
	Carbon Capture, Transport and Storage/ 422 CO ₂ transport by ship	3		



	Carbon Capture, Transport and Storage/ 423 CO ₂ transport by road	4	
Transport			
Elektrificering og brint i vejtransport ³	Renewable fuels: 86 Hydrogen production	3	(3)
Elektrificering og brint i søfart ³	Renewable fuels: 86 Hydrogen production	3	(3)
Bio- og PtX-brændstoffer i vejtransport ³	Renewable fuels: 85 Liquid fuels from biogas gasification and Fischer Tropsch	2	(2-4)
	Renewable fuels: 89 Vegetable Oil FAME	4	
	Renewable fuels: 90 UCO and Animal Fat FAME	4	
	Renewable fuels: 91 Hydrogenated Vegetable Oil / Renewable Diesel	4	
	Renewable fuels: 93 1 st Generation Ethanol	4	
	Renewable fuels: 94 Pyrolysis Oil	2	
	Renewable fuels: 95 Cellulosic Ethanol	2	
	Renewable fuels: 97 Methanol from Biomass Gasification	2	
	Renewable fuels: 86 Hydrogen production	3	
Bio- og PtX-brændstoffer i søfart ³	Renewable fuels: 85 Liquid fuels from biogas gasification and Fischer Tropsch	2	(2-4)
	Renewable fuels: 89 Vegetable Oil FAME	4	
	Renewable fuels: 90 UCO and Animal Fat FAME	4	
	Renewable fuels: 91 Hydrogenated Vegetable Oil / Renewable Diesel	4	
	Renewable fuels: 93 1 st Generation Ethanol	4	
	Renewable fuels: 94 Pyrolysis Oil	2	
	Renewable fuels: 95 Cellulosic Ethanol	2	
	Renewable fuels: 97 Methanol from Biomass Gasification	2	
Bio- og PtX-brændstoffer i luftfart ³	Renewable fuels: 92 HVO Jet Fuel	3	(3)
Affald			
Genanvendelse og affaldsreduktion	<i>Ikke beskrevet</i>	-	
CCS på affaldsforbrændingsanlæg	Carbon Capture, Transport and Storage/ 401 Amine Post Combustion carbon capture technology	3	3
	Carbon Capture, Transport and Storage/ 402 Oxy-fuel combustion technology	2	
	Carbon Capture, Transport and Storage/ 421 CO ₂ transport in pipelines	4	
	Carbon Capture, Transport and Storage/ 422 CO ₂ transport by ship	3	
	Carbon Capture, Transport and Storage/ 423 CO ₂ transport by road	4	
Landbrug, gartneri, skove og fiskeri			
Fodertilsætningsstoffer	<i>Ikke beskrevet</i>	-	
Håndtering af gylle og gødning	<i>Ikke beskrevet</i>	-	
Udtag af lavbundsjord	<i>Ikke beskrevet</i>	-	
Fordobling af det økologiske areal	<i>Ikke beskrevet</i>	-	
Biokul fra pyrolyse af halm	Renewable fuels / 105 Slow pyrolysis	2 ¹	2
Dyrkning af plantebaserede fødevarer og planteprotein	<i>Ikke beskrevet</i>	-	
Skovrejsning	<i>Ikke beskrevet</i>	-	
Energieffektiviseringer i procesenergi og intern transport i landbruget	<i>Ikke beskrevet</i>	-	
Elektrificering i procesenergi og intern transport i landbruget ⁴	Industrial process heat / 301 Traditional heat pumps with certain limitations in maximum temperature and combined process heating and cooling	3 ¹	3-4



	Industrial process heat / 302 High temperature heat pump	3	
	Industrial process heat / 303 Booster heat pump systems applying turbo compressors in combination with traditional heat pumps	2	
	Industrial process heat / 305 Mechanical Vapour Recompression (MVR)	3 ¹	
	Industrial process heat / 308 Dielectric assisted heating	4	
	Industrial process heat / 310 Electric boilers (industrial process heating)	3	
Bio- og PtX-brændstoffer i intern transport i landbruget ³	Renewable fuels: 85 Liquid fuels from biogas gasification and Fischer Tropsch	2	(2-4)
	Renewable fuels: 89 Vegetable Oil FAME	4	
	Renewable fuels: 90 UCO and Animal Fat FAME	4	
	Renewable fuels: 91 Hydrogenated Vegetable Oil / Renewable Diesel	4	
	Renewable fuels: 93 1 st Generation Ethanol	4	
	Renewable fuels: 94 Pyrolysis Oil	2	
	Renewable fuels: 95 Cellulosic Ethanol	2	
	Renewable fuels: 97 Methanol from Biomass Gasification	2	
	Renewable fuels: 86 Hydrogen production	3	
Andet			
Regneeksempel for DAC (baseret på 1 GW havvind)	Carbon Capture, Transport and Storage/ 403a Direct air capture	2	2
	Carbon Capture, Transport and Storage/ 421 CO ₂ transport in pipelines	4	
	Carbon Capture, Transport and Storage/ 422 CO ₂ transport by ship	3	
	Carbon Capture, Transport and Storage/ 423 CO ₂ transport by road	4	

Anm 1: Modenhed ikke angivet i Teknologikataloget, men er tilføjet af Energistyrelsen efterfølgende

Anm 2: Kapitler i Teknologikataloget ikke kategoriseret efter CO₂-kilden

Anm 3: Kun brændstofproduktion beskrevet i Teknologikatalogerne, og ikke transportformen.

Anm 4: Intern transport ikke beskrevet

Kilder

Technology catalogue for industrial process heat. Energistyrelsen 2022.

Technology catalogue for Carbon Capture, Transport and Storage. Energistyrelsen 2022.

Technology catalogue for Renewable fuels. Energistyrelsen 2022.

Technology catalogue for Individual heating installation. Energistyrelsen 2022.