TEKNOLOGISK INSTITUT

# State of the art

# Globale dronemarkeder og ny teknologi

“ – Danske drone udviklere imod internationale giganter

**Teknologisk Institut**

**Titel:**
State of the art – globale dronemarkeder og ny teknologi

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# Indholdsfortegnelse

# 1. Danske drone udviklere imod internationale giganter

Danske Sky-Watch A/S er den eneste danske drone produktionsvirksomhed, som udvikler egne droneplatforme. Virksomheden er op imod i globalt marked, som domineres af USA. Hver tredje droneplatform er amerikansk. Dernæst kommer Kina og Frankrig, og alle øvrige lande har i sammenligning meget få droneplatforme på markedet. Der er interesse for droner, og hele 63 lande i verden har mindst én droneproducent. I alt er der identificeret næsten 500 dronevirksomheder, og forholdsvis stor andel er virksomheder med mere end 500 ansatte. Det understøtter, at droneindustrien er ved at vokse sig moden, at væksten i antal civile droner, anvendelsesmuligheder mv. vil være stærkt voksende i de kommende år, og at der vil blive investeret i innovation og markedsføring for at få plads på de markeder, der efterhånden dukker op.

Teknologisk Institut har analyseret verdens mest omfattende database om droner, AUVSI databasen, som har detaljerede informationer om 3.000 droneplatforme og deres producenter og om teknologien bag deres produkter. Formålet med analysen er at kaste lys på det globale marked for civile droner og at kortlægge virksomheder og droneplatforme, hvor flyvning uden for synsvidde, stor rækkevidde og brændselsceller spiller en rolle.

Dronevirksomhederne udspringer i mange tilfælde af større militær- eller luftfartsrelaterede virksomheder som fx amerikanske Boeing. Det betyder, at der er penge til at investere i innovation, noget som de mindre iværksættervirksomheder i højere grad skal arbejde på. Danske Sky-Watch har været i gang siden 2009, og virksomheden står da heller ikke alene, idet virksomheden ejes af Dangroup ApS og Borean Innovation A/S. Desuden har Sky-Watch samarbejder om teknologi med Boeing, DTU, AAU, FLIR og Colt.[1]

Teknologianalysen viser, at flyvning uden for synsvidde (BLOS) efterhånden vinder indpas og er tilgængelig. Energikilden bag dronerne varierer meget, dels fordi der stadig eksperimenteres og udvikles, dels fordi dronerne skal kunne noget forskelligt. Brændselsceller er en ny og lovende energikilde til droner, fordi potentialet er at kunne medbringe meget energi ved lav vægt. Det har betydning for den last, som dronen kan medbringe samt rækkevidden. Blandt de 2200 civile droneplatforme er der 21 virksomheder, der arbejder med brændselsceller.

Rapporten består af to dele. Kapitel 2, 3 og 4 handler om markedet for droneplatforme, og kapitel 5 runder af med et kig på informationer om droneplatforme, som arbejder med BLOS eller brændselsceller.

## 1.1. Verdens største database om droneteknologi

Rapporten bygger på verdens største database om droneteknologi, som vedligeholdes af AUVSI, The Association for Unmanned Vehicle Systems International (http://www.auvsi.org/). Databasen indeholder detaljerede informationer om knap 3.000 droneplatforme fordelt på næsten 1.000 virksomheder verden over.

I denne analyse indgår 2.220 flyvende droneplatforme, som er tilgængelige for det civile marked. Mange af disse sælges også på det militære marked. For hver af droneplatformene er der information om, hvilke brancher og industrier dronen forventes anvendt i, hvem der

[1] http://sky-watch.com/labs/partnerships/

producerer dem samt detaljeret information om størrelse, performance, energi, payload, markedsnyt mv. Databasen opdateres løbende, og denne analyse er et snapshot af data udtrukket fra AUVSI databasen den 8. november 2017. Figur 1.1 viser et eksempel på informationen fra AUVSI – her om droneplatformen Huginn X1.

Figur 1-1: Eksempel på information fra AUVSI – her om Huginn X1 fra Sky-Watch A/S

**HUGINN X1**

by: Sky-Watch A/S (Denmark)

| | |
|---|---|
| **Domain:** | Air |
| **Market Category:** | Civil, Military |
| **Application:** | Chemical, Biological, Radiological, Nuclear (CBRN); Disaster Response; Environmental Research or Monitoring; Explosive Ordnance Disposal; Firefighting; Imaging; Inspection; Intelligence, Surveillance, Reconnaissance; Patrol, Security; Search & Rescue; Survey, Mapping; Target Acquisition |
| **Continent:** | Europe |
| **Countries:** | Denmark |
| **Production Status:** | Active |

Platform Website

©[2017] www.uasvision.com

**Description:**

The Huginn X1 is designed as a total solution, capable of handling both exterior and interior reconnaissance flights. The sonar makes Huginn X1 capable of performing automatic take-offs and landings, this enables the operator to focus on the task at hand. The high precision GPS facilitates, autonomous waypoint navigation and the sonar together with presure sensor makes Huginn X1 able to hold its height. Combined these features makes Huginn X1 the total solution for a broad range of both external and internal inspection, monitoring, surveillance and reconnaissance tasks. Huginn X1 is designed to be used with only a minimum of training and by people with little or no technical knowledge. The system is capable of vertical take-off and landing, which enables it to be launched without any launch mechnism and land where there is no landingpad. Its small size allows you to transport the Huginn X1 as hand luggage on planes or in the back of a car.
With a deployment time of less than one minute, the Huginn X1 is a perfect tool for reaching inaccessible or dangerous areas.

*Kilde: AUVSI.*

For Danmark indeholder databasen to droneplatforme fra Sky-Watch A/S: Huginn X1 og Heidrun V1, men en kontrol på Sky-Watch's hjemmeside viser, at Sky-Watch også tilbyder Cumulus V1[2], og Huginn X1 hedder nu Huginn X1 D. Det er derfor sandsynlig, at der udover de 2.220 flyvende droneplatforme er flere på markedet, som hele tiden er i bevægelse.

Bevægelserne gælder også de virksomheder, der står bag droneplatformene. Det er et levende marked, hvor virksomheder bliver lagt sammen, nogle vokser, andre går konkurs eller lukkes af andre årsager. Af de 2.220 droneplatforme er de 1,534 fra aktive virksomheder, 180 er der usikkerhed omkring, og 500 er inaktive. I de følgende analyser medregnes alle 2.220 observerede droneplatforme, idet det er teknologier og markeder, der har vores interesse. Ved lister over virksomheder markeres det, om de ifølge AUVSI er aktive, inaktive eller usikre.

[2] Cumulus-platformen var ikke en del af AUVSI databasen på udtrækstidspunktet, men er det ved seneste opdatering

Figur 1-2: Droneinformationer fra AUVSI databasen


*Kilde: AUVSI. Udover information om leverandører, markeder og brug indeholder AUVSI mange tekniske detaljer om droner. Illustration Teknologisk Institut*.

AUVSI databasen er så opdateret, som en global database kan laves. Den amerikanske hær anvender også databasen som deres reference. AUVSI tjekker løbende oplysningerne for nøjagtighed og for de enkelte droners status, og om der er kommet nye til. AUVSI udsender en e-mail to gange om måneden for at høste oplysninger om nye platforme eller opdateringer til de eksisterende eller oplysninger om virksomhederne. Oplysningerne i basen er dokumenteret gennem offentligt tilgængelige kilder såsom virksomhedernes hjemmesider, brochurer og pressemeddelelser. En til to gange om året gennemgås hele databasen, og der tilføjes løbende nye platforme og leverandører på næsten på daglig basis.[3]

Databasen er blevet anvendt i meget få andre studier. Eksempelvis af David Klein, som bestyrer databasen for AUVSI.[4]

[3] Information om AUVSI-databasen baseret på Interview med David Klein, database ansvarlig, AUVSI
[4] http://www.auvsi.org/our-impact/commercial-exemptions-numbers.

## 2. Droneplatforme til civilt brug koncentreres på få lande

En droneplatform i AUVSI-databasen er en specifik-drone som fx HUGINN X1 fra det danske firma Sky-Watch – se eksemplet fra figur 1.1. AUVSI-databasen har registreret to danske droneplatforme og 2.200 på globalt plan. Heraf er en tredjedel af droner til civilt brug fra USA. Danmark kommer med de to danske registrerede droner på en 54. plads, mens Norge viser sig på en 14. plads med 30 droneplatforme.

Danmark er lige akkurat med på dronemarkedet. De 15 førende nationer står for 79 procent af udbuddet af droner på det civile marked. AUVSI har i alt registreret 63 lande.

Figur 2-1: Droneplatforme til civilt brug

| Rang | Land | # Platforme |
|---|---|---|
| 1 | United States | 741 |
| 2 | China | 173 |
| 3 | France | 126 |
| 4 | Italy | 98 |
| 5 | Germany | 84 |
| 6 | Russian Federation | 84 |
| 7 | Israel | 83 |
| 8 | United Kingdom | 76 |
| 9 | Canada | 56 |
| 10 | Spain | 46 |
| 11 | Australia | 38 |
| 12 | Brazil | 35 |
| 13 | India | 30 |
| 14 | Norway | 30 |
| 15 | Japan | 29 |
| 54 | Denmark | 2 |

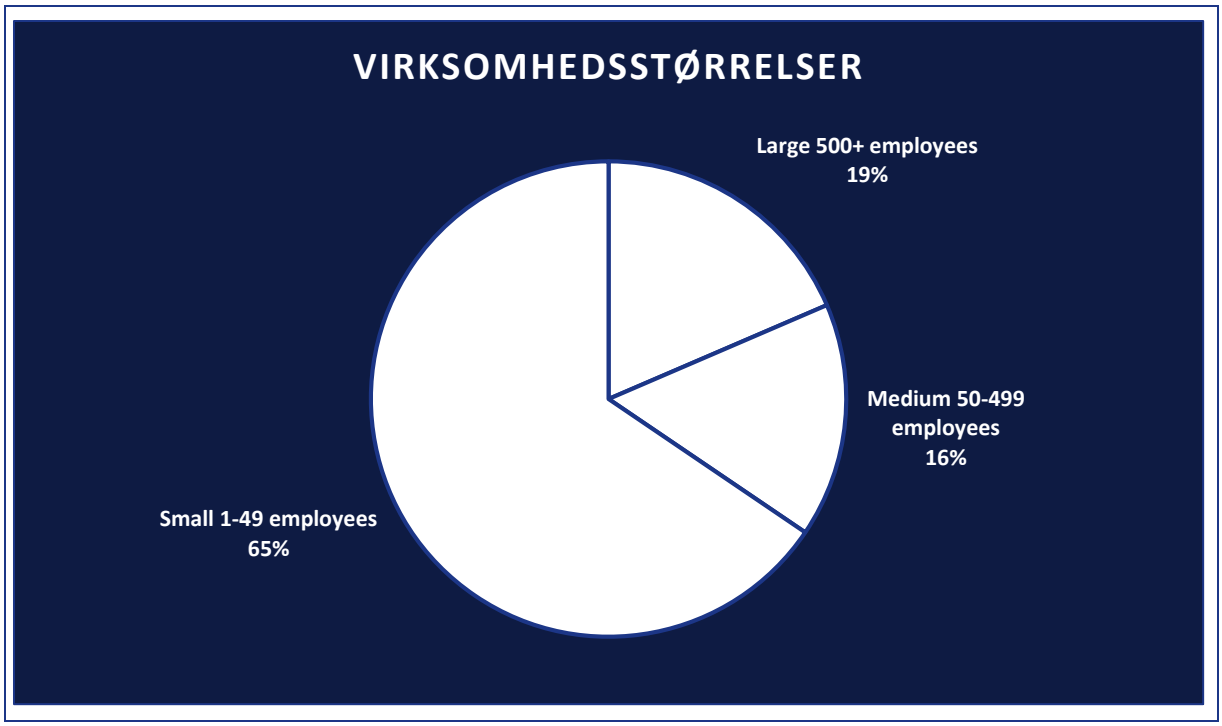
*Kilde: AUVSI databasen, november 2017 Der er i alt 63 lande på listen over lande, hvor der produceres droneplatforme til civilt brug. 99 droneplatforme kan ikke henføres til et bestemt land. I alt 2200 droneplatforme er identificeret*.

## 3. Droner er for store virksomheder

Droneplatforme er endnu ny teknologi, der rimer på teknologiudvikling, innovation, investeringer, test og forsøg. Mange af de lande, som ligger i front, har en betydelig militærindustri og måske endda udvikling af egne fly eller en flyindustri. Det er store virksomheder.

Tager man alle virksomheder i alle brancher over en kam, er det typisk 95 procent af virksomhederne eller flere, som kan betragtes som SMV virksomheder – om end med nationale variationer.[5] "Branchen" for droneplatforme adskiller sig markant. Når det gælder dronevirksomheder, er der en betydelig overvægt af store virksomheder.

Figur 3-1: Mange store virksomheder blandt droneproducenterne




*Kilde: AUVSI databasen, november 2017 Der er i alt 61 lande på listen over lande, hvor der produceres droneplatforme til civilt brug. AUVSI indeholder 795 virksomhedsnavne, hvoraf der er oplysninger om virksomhedsstørrelse for 464 virksomheder*

For de virksomheder i AUVSI databasen, hvor der er opgørelse over antal ansatte, har 65 procent af virksomhederne 49 ansatte eller færre, mens hele 19 procent af virksomhederne har mere end 500 ansatte.

Det betyder, at der er betydelige økonomiske og kompetencemæssige "muskler" ved den teknologiudvikling der finder sted til civile droner. Det understreger også, at der er en betydelig tro på, at dronemarkedet vil udvikle sig kommercielt i de kommende år. Fordelingen bygger på de 464 virksomheder, der er oplysninger for.

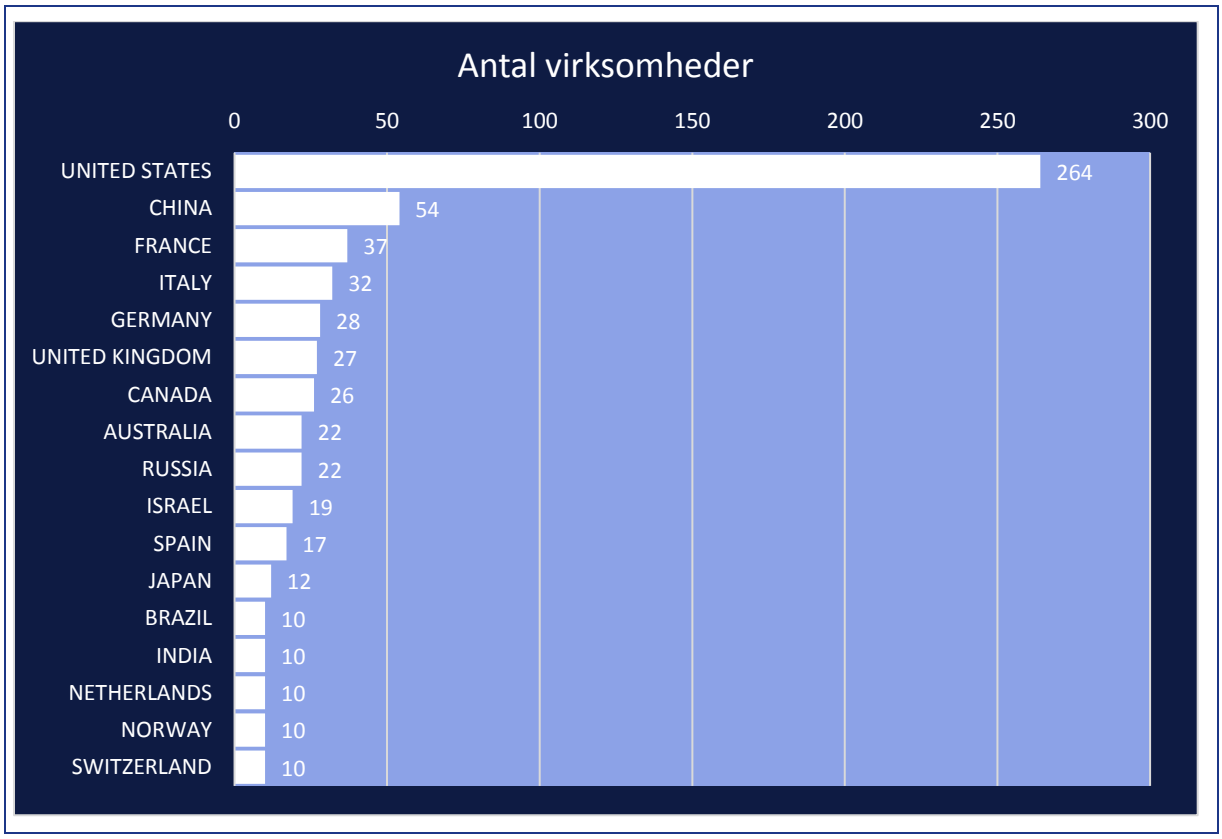
I "restgruppen" kan der naturligvis være mange små virksomheder. Netop fordi en del af virksomhederne sandsynligvis har relationer til militæret, kan der også være tale om, at

[5] http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.453.5778&rep=rep1&type=pdf

den type informationer ikke er offentligt tilgængelige for alle. Endelig kan der være virksomhedskoncerner, hvor det er umuligt at adskille og opgøre størrelsen af den del af virksomheden, som udvikler og fremstiller droner uden at have nærmere adgang til regnskabsdata for disse virksomheder. Det kan dog antages, at denne gennemgang giver et nogenlunde retvisende indtryk af aktiviteten, dog sandsynligvis med den bias, at flere små virksomheder har oplyst antal ansatte end de større virksomheder. Fordelingen kan således være mere skæv i de store virksomheders favør.

USA er førende på virksomhedsaktivitet. Hver tredje dronevirksomheder, der her er optalt, er en amerikansk virksomhed. På andenpladsen ligger Kina, hvor hver tyvende virksomhed har rødder. I Danmark har vi for tiden én droneproducent. Mange andre lande har en enkelt droneproducenter, og i alt er der registreret 61 lande med droneproducenter i AUVSI databasen.

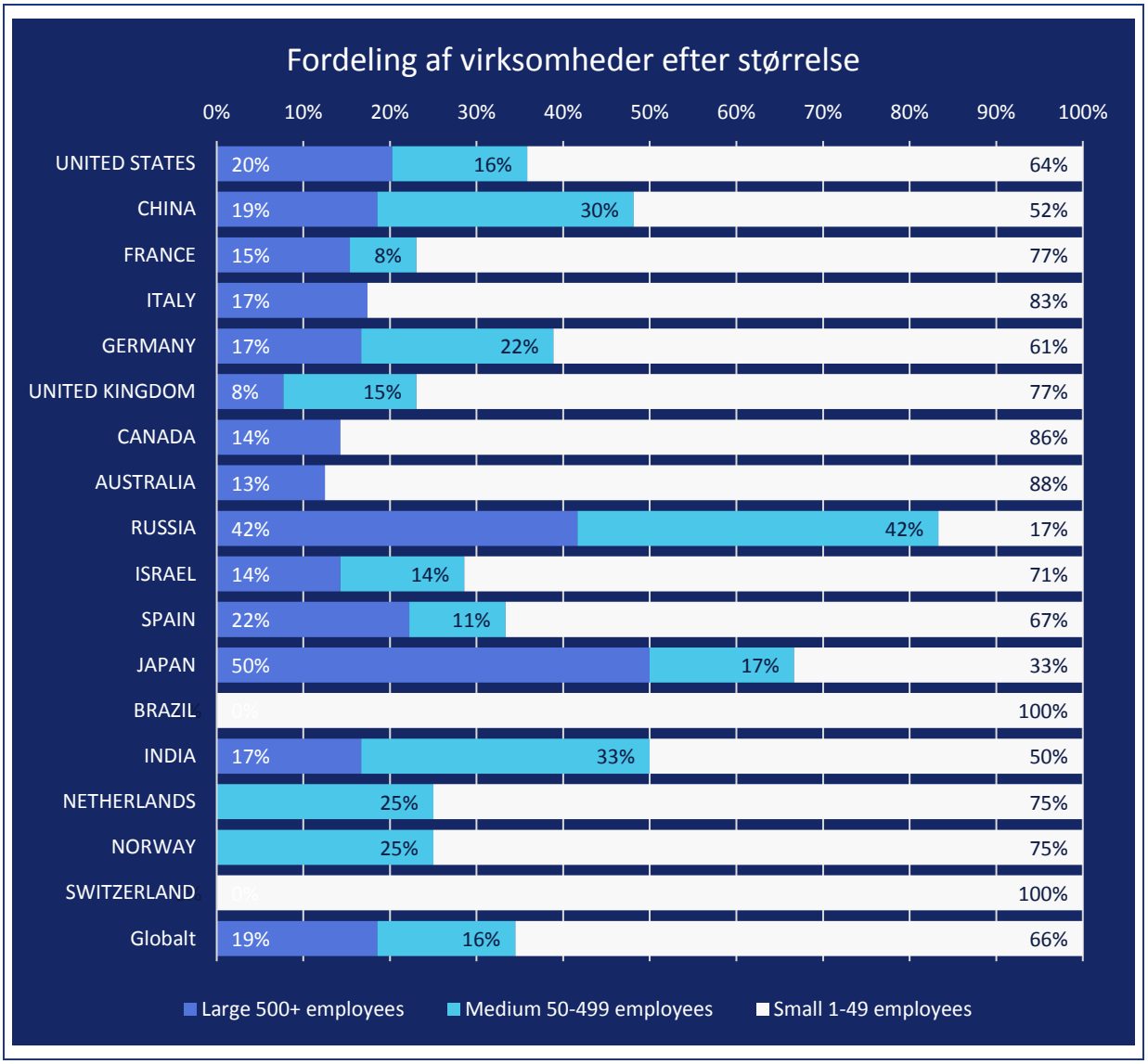
Figur 3-2: Antal dronevirksomheder i lande med 10 eller flere dronevirksomheder




*Kilde: AUVSI databasen, november 2017 Der er i alt 61 lande på listen over lande, hvor der produceres droneplatforme til civilt brug. AUVSI indeholder 795 virksomhedsnavne*.

Figur 3-3 viser virksomhederne i de lande, som har ti eller flere droneproducenter opdelt efter antal medarbejdere. Ganske få lande er tæt på en normal fordeling af små og store virksomheder. Indtrykket af, at det er store virksomheder, som engagerer sig i drone udvikling og produktion, holder her.

Figur 3-3: Virksomheder opgjort efter størrelse. Lande med 10 eller flere dronevirksomheder




*Kilde: AUVSI databasen, november 2017. Lande med ti virksomheder eller flere medtaget. Procentberegning kun for virksomheder, hvor størrelse i antal ansatte er opgjort.*

## 3.1. USA, Kina og Frankrig

De 2.220 droner, som indgår i denne analyse, kan alle anvendes til civilt brug. USA, Kina og Frankrig leverer knap halvdelen af de civile droneplatforme. USA alene hver tredje drone. Af dem er 65 procent på det kommercielle marked og kan altså købes af private, 54 procent sælges også til militæret, 8 procent henvender sig til forskningsverdenen, og 6 procent til almindelige forbrugere, fx legetøj eller små droner til fotografering.

I Figur 3-4 er droneplatformene opdelt alt efter, hvilke markeder de sælges på udover til civilt brug for de lande, som har flest droneplatforme udbudt på det kommercielle marked. I Danmark er to droneplatforme registret, og HUGINN X1 kan anvendes både på det kommercielle marked – fx af virksomheder – og af det militære marked. I Israel, Indien og den Russiske Føderation har hovedparten af dronerne også en militæranvendelse.

Figur 3-4: Droneplatforme til civilt brug – anvendelse på andre markeder

| Rang | Lande | Commercial market | Military market | Academic market | Consumer market | # Droneplatforme |
|---|---|---|---|---|---|---|
| 1 | United States | 60% | 52% | 14% | 9% | 741 |
| 2 | China | 91% | 31% | 1% | 19% | 173 |
| 3 | France | 65% | 62% | 2% | 2% | 126 |
| 4 | Italy | 79% | 36% | 2% | 0% | 98 |
| 5 | Germany | 81% | 31% | 18% | 5% | 84 |
| 6 | Russian Federation | 50% | 85% | 0% | 0% | 84 |
| 7 | Israel | 35% | 93% | 0% | 0% | 83 |
| 8 | United Kingdom | 71% | 66% | 5% | 4% | 76 |
| 9 | Canada | 84% | 36% | 14% | 7% | 56 |
| 10 | Spain | 76% | 61% | 0% | 0% | 46 |
| 11 | Australia | 53% | 47% | 11% | 0% | 38 |
| 12 | Brazil | 71% | 60% | 3% | 0% | 35 |
| 13 | India | 43% | 87% | 0% | 0% | 30 |
| 14 | Norway | 83% | 43% | 10% | 0% | 30 |
| 15 | Japan | 90% | 3% | 21% | 10% | 29 |
| 54 | Denmark | 50% | 100% | 0% | 0% | 2 |
| | Total | 65% | 54% | 8% | 6% | 2200 |

*Kilde: AUVSI databasen, november 2017. Procenterne viser, hvor stor en andel af de civile droner, som sælges fra de nationale leverandører på de fire markeder: Kommercielle, militære, forskning & udvikling samt forbrugermarkedet (primært legetøj).*

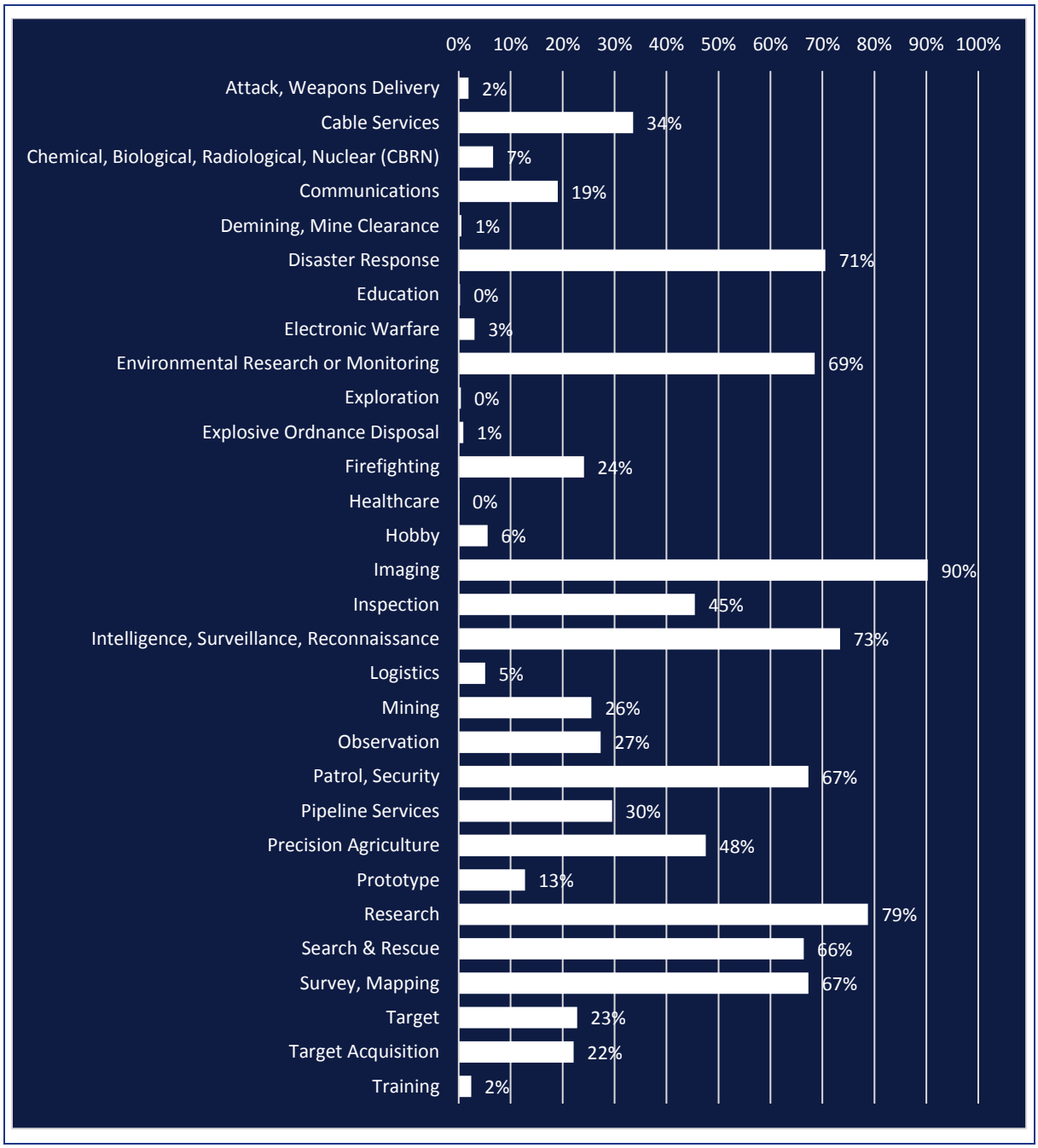
I Japan, Norge, Canada, Tyskland, Italien og Kina er der overvægt af droner på det kommercielle marked i forhold til det militære marked. Droner, som også er særligt tænkt til forskning og udvikling ("Academic market") udgør kun 8 procent på verdensmarkedet, mens droner fra Japan, Tyskland, USA og Canada når frem til forskning og udvikling i højere grad end andre. Det samme gælder droner fra New Zealand og Schweiz (som ikke er med på listen).

På forbrugermarkedet er det i sær Kina, der har et udbud af droneplatforme. Ikke med på listen er Taiwan, hvor 21 procent af de 19 droneplatforme produceret i Taiwan er til forbrugermarkedet.

# 4. Stor udbredelse af civile droner

AUVSI databasen opsamler information om, hvad dronerne kan anvendes til.

Figur 4-1: Droneplatforme til civilt brug: Hvad kan dronerne anvendes til?




*Kilde: AUVSI databasen, november 2017. Optalt på 2200 civile droner.*

I Figur 4-2 er anvendelserne optalt og fordelt på markeder.

Figur 4-2: Droneplatforme til civilt brug: Hvad kan dronerne anvendes til? Opdelt på markeder

| Anvendelse | Markeder | | | | |
|---|---|---|---|---|---|
| | Commercial market | Military Market | Academic market | Consumer market | Civil market |
| Antal droneplatforme analyseret | 1.432 | 1.190 | 183 | 140 | 2.214 |
| Attack, Weapons Delivery | 1% | 3% | 0% | 0% | 2% |
| Cable Services | 51% | 24% | 23% | 26% | 34% |
| Chemical, Biological, Radiological, Nuclear (CBRN) | 7% | 8% | 8% | 0% | 7% |
| Communications | 13% | 31% | 10% | 0% | 19% |
| Demining, Mine Clearance | 0% | 1% | 0% | 0% | 1% |
| Disaster Response | 84% | 65% | 57% | 81% | 71% |
| Education | 0% | 0% | 2% | 1% | 0% |
| Electronic Warfare | 1% | 6% | 2% | 0% | 3% |
| Environmental Research or Monitoring | 87% | 57% | 77% | 89% | 69% |
| Exploration | 0% | 0% | 1% | 0% | 0% |
| Explosive Ordnance Disposal | 1% | 1% | 0% | 0% | 1% |
| Firefighting | 32% | 26% | 24% | 7% | 24% |
| Healthcare | 0% | 0% | 0% | 0% | 0% |
| Hobby | 9% | 0% | 11% | 88% | 6% |
| Imaging | 94% | 91% | 80% | 99% | 90% |
| Inspection | 62% | 31% | 41% | 86% | 45% |
| Intelligence, Surveillance, Reconnaissance | 70% | 91% | 49% | 21% | 73% |
| Logistics | 6% | 5% | 1% | 4% | 5% |
| Mining | 39% | 15% | 27% | 22% | 26% |
| Observation | 22% | 42% | 15% | 1% | 27% |
| Patrol, Security | 68% | 81% | 45% | 24% | 67% |
| Pipeline Services | 45% | 25% | 20% | 11% | 30% |
| Precision Agriculture | 73% | 29% | 50% | 87% | 48% |
| Prototype | 6% | 14% | 24% | 4% | 13% |
| Research | 92% | 70% | 98% | 93% | 79% |
| Search & Rescue | 76% | 66% | 51% | 79% | 66% |
| Survey, Mapping | 83% | 60% | 69% | 65% | 67% |
| Target | 15% | 39% | 10% | 0% | 23% |
| Target Acquisition | 15% | 38% | 9% | 0% | 22% |
| Training | 2% | 2% | 7% | 5% | 2% |

*Kilde: AUVSI databasen, november 2017. Farverne er blot en læsehjælp til tabellen, hvor grønne farver angiver høje procenter og røde farver lave procenter.*

Anvendelserne er opdelt i hele 30 kategorier og giver et godt indblik i, hvor dronernes anvendelse koncentrerer sig samt på hvilke typer af anvendelse, der bliver satset på rent markedsmæssigt.

Procenterne udtrykker, hvor stor en andel af droneplatformene, der kan anvendes på et givet marked. På det kommercielle marked og de øvrige markeder er det **Imaging**, billeder, som er det mest almindelige. På nær det akademiske marked, er det næsten alle droner, som kan anvendes til at tage billeder. Det at kunne tage billeder fra luften på en let og billig måde er det letteste og er indlysende attraktivt i en række sammenhænge. Det er også til fotografering og film, at droner i Danmark er mest udbredte. Imaging kan være med mange typer af kameraer, også infrarøde kameraer eller multi-spektrale ka-

meraer, og det øger anvendelsesområdet, og er nok en del af forklaringen på, at fx "Precision agriculture" og "Survey, mapping" også scorer højt. AUVSI kan også give en del oplysninger om, hvilke typer kameraer, der anvendes.

Med de mange typer kameraer er det sandsynligt, at der er et stærkt behov for software, som egner sig til automatiseret, digital analyse af de billeder og film, som dronerne henter. Det kan være alt fra at opdage varmeudslip, tælle alt fra elefanter til bladlus, opdage og fortolke farvevariationer i afgrøder mv. Det er jo først for alvor kommercielt interessant at flyve med et kamera, når resultaterne giver en merværdi.

I Bilag 1 i Figur 5-5 er en omfattende tabel, som viser samvariationen mellem hver af de 30 anvendelser.

Figur 4-3: Droneplatforme til civilt brug: Gruppering af anvendelser

| | Arial inspection | Disaster and security | Military targeting | Environmental research | Professional surveillance | De-mining | Military surveillance | Public service | Research and education | Drone training |
|---|---|---|---|---|---|---|---|---|---|---|
| Attack, Weapons Delivery | 0,01 | -0,10 | 0,39 | -0,09 | -0,11 | 0,02 | 0,27 | 0,09 | -0,07 | -0,36 |
| Cable Services | 0,83 | 0,13 | -0,06 | 0,13 | 0,07 | 0,00 | -0,03 | -0,01 | 0,01 | -0,02 |
| Chemical, Biological, Radiological, Nuclear (CBRN) | 0,14 | 0,05 | 0,06 | 0,02 | 0,15 | 0,27 | 0,10 | 0,13 | 0,58 | -0,03 |
| Communications | -0,12 | 0,09 | 0,19 | -0,00 | 0,15 | -0,05 | 0,71 | -0,02 | 0,06 | -0,02 |
| Demining, Mine Clearance | -0,03 | 0,00 | 0,01 | 0,01 | 0,01 | 0,86 | 0,03 | -0,03 | 0,04 | -0,01 |
| Disaster Response | 0,37 | 0,57 | 0,04 | 0,46 | -0,07 | 0,04 | -0,07 | 0,12 | 0,02 | 0,01 |
| Education | -0,07 | -0,03 | -0,05 | -0,00 | -0,16 | -0,11 | -0,03 | -0,10 | 0,79 | 0,02 |
| Electronic Warfare | 0,09 | -0,05 | 0,27 | -0,16 | -0,11 | 0,07 | 0,50 | 0,01 | 0,13 | -0,20 |
| Environmental Research or Monitoring | 0,38 | 0,31 | -0,07 | 0,78 | -0,13 | 0,00 | 0,03 | -0,03 | 0,00 | -0,02 |
| Exploration | 0,00 | 0,00 | -0,24 | -0,02 | -0,08 | 0,08 | 0,42 | 0,16 | -0,15 | 0,23 |
| Explosive Ordnance Disposal | 0,00 | 0,03 | 0,11 | -0,01 | -0,00 | 0,84 | -0,02 | -0,02 | 0,02 | -0,01 |
| Firefighting | 0,46 | 0,18 | 0,19 | 0,20 | 0,31 | -0,00 | -0,03 | 0,09 | 0,20 | 0,11 |
| Healthcare | -0,04 | 0,00 | -0,03 | -0,06 | -0,00 | 0,00 | -0,05 | 0,66 | -0,05 | 0,02 |
| Hobby | -0,08 | 0,05 | -0,05 | 0,12 | -0,78 | -0,03 | -0,06 | 0,01 | 0,07 | 0,05 |
| Imaging | 0,15 | 0,77 | 0,02 | 0,06 | -0,12 | -0,01 | 0,13 | -0,11 | -0,06 | -0,17 |
| Inspection | 0,59 | 0,25 | 0,01 | 0,06 | -0,32 | 0,09 | -0,24 | 0,12 | 0,05 | -0,10 |
| Intelligence, Surveillance, Reconnaissance | -0,04 | 0,68 | 0,16 | -0,08 | 0,51 | 0,01 | 0,13 | 0,02 | 0,03 | -0,10 |
| Logistics | 0,01 | -0,03 | 0,03 | 0,06 | 0,00 | -0,04 | 0,08 | 0,76 | 0,06 | -0,05 |
| Mining | 0,76 | 0,04 | -0,04 | 0,08 | 0,00 | -0,03 | -0,06 | -0,06 | -0,03 | -0,02 |
| Observation | -0,26 | 0,27 | 0,12 | 0,13 | 0,30 | -0,04 | 0,54 | -0,10 | 0,01 | 0,03 |
| Patrol, Security | 0,06 | 0,70 | 0,21 | 0,06 | 0,43 | 0,01 | 0,10 | 0,02 | 0,10 | -0,03 |
| Pipeline Services | 0,76 | 0,10 | -0,02 | 0,14 | 0,22 | -0,01 | 0,09 | -0,03 | 0,03 | 0,03 |
| Precision Agriculture | 0,70 | 0,21 | -0,12 | 0,34 | -0,27 | -0,04 | -0,12 | -0,02 | -0,03 | -0,02 |
| Prototype | -0,27 | -0,65 | -0,06 | 0,15 | 0,27 | -0,01 | -0,12 | 0,11 | 0,04 | -0,17 |
| Research | 0,26 | -0,14 | -0,09 | 0,89 | -0,01 | -0,02 | -0,07 | 0,00 | 0,03 | -0,04 |
| Search & Rescue | 0,30 | 0,67 | 0,08 | 0,22 | -0,02 | 0,03 | -0,17 | 0,12 | 0,05 | 0,02 |
| Survey, Mapping | 0,46 | 0,38 | 0,04 | 0,47 | -0,04 | 0,06 | -0,00 | -0,07 | -0,06 | -0,06 |
| Target | -0,06 | 0,17 | 0,93 | -0,04 | 0,09 | 0,07 | 0,12 | -0,02 | 0,00 | 0,09 |
| Target Acquisition | -0,06 | 0,18 | 0,92 | -0,04 | 0,09 | 0,07 | 0,12 | -0,01 | 0,01 | 0,02 |
| Training | -0,02 | -0,12 | 0,09 | -0,07 | -0,08 | -0,02 | 0,03 | -0,01 | -0,02 | 0,85 |

*Kilde: AUVSI databasen, november 2017. Mønsteret er undersøgt ved hjælp af den statistiske metode "factor analysis", modellen forklarer 65 procent af variationen i datasættet. Metoden er "PCA" og modellen er roteret "Varimax with Kaiser Normalization".*

De 30 anvendelser giver et ret flimrende billede, og Figur 4-3 viser en mulig gruppering med ti grupper, som er lavet på grundlag af samvariationen mellem anvendelsesområderne.

For hver drone er der opgivet en eller flere anvendelser. De anvendelser, som grupperes sammen, giver en fortælling om dronen. Hvis man reducerer til de mest almindelige grupperinger, giver det et interessant mønster for anvendelsesmulighederne for de civile droner. Hver anvendelse kan samvarieres med gruppen på en skala fra -1 til 1, altså stærk negativ eller stærk positiv sammenhæng. Tal omkring 0 betyder ingen sammenhæng. Gruppenavnene er Teknologisk Instituts fortolkning på de ti grupper.

De ti grupperinger er en måde at få overblik over materialet. *Imaging* hænger ifølge det fremkomne mønster stærkt sammen med *Intelligence, Disaster response* og *Search & rescue*. I fortolkningen af tabellen er det vigtigt at være opmærksom på, at "prisen" for at reducere de 30 anvendelsesområder til 10 mønstre er, at en del information forsvinder. Tabellen findes i en lidt større version i Bilag 1, Figur 5-4.

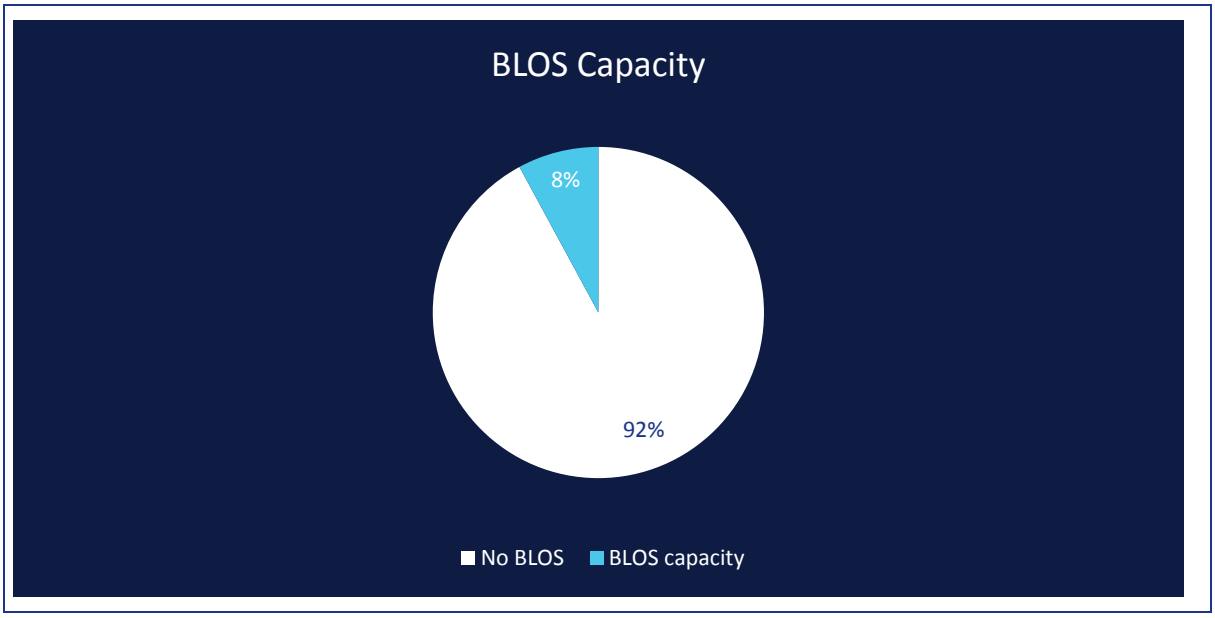
I Bilag 1, Figur 5-6, er grupperingerne anvendt til at identificere specialiseringer for de enkelte lande. Værdier over 0,5 angiver en specialisering. Værdier omkring 0 angiver, at landet ikke har en særlig specialisering på feltet. Tabellen viser, at USA fx ikke har nogen specialiseringer, fordi USA er med på alle områder. Kina er specialiseret på "Arial inspection", og Frankrig er ligesom USA med på alle områder. Det er især lande med færre producenter, der kan siges at have en specialisering og ikke er tilstede på alle typer af anvendelsesområder.

# 5. Teknologi og droner

## 5.1. Flyvning uden for synsvidde

Det har stor værdi for dronerne, at de kan flyve langt. Så langt, at man ikke kan se dem med det blotte øje. Det giver mulighed for søgninger over hav og store naturområder, og for operationer, hvor man i øvrigt har vanskeligt ved at bevæge sig. Det er teknologisk krævende at flyve uden for dronepilotens synsvidde, og blandt de civile droner er det 8 procent af dronerne, som kan det – svarende til 175 af de undersøgte platforme.

Figur 5-1: BLOS – et skridt ind i fremtiden



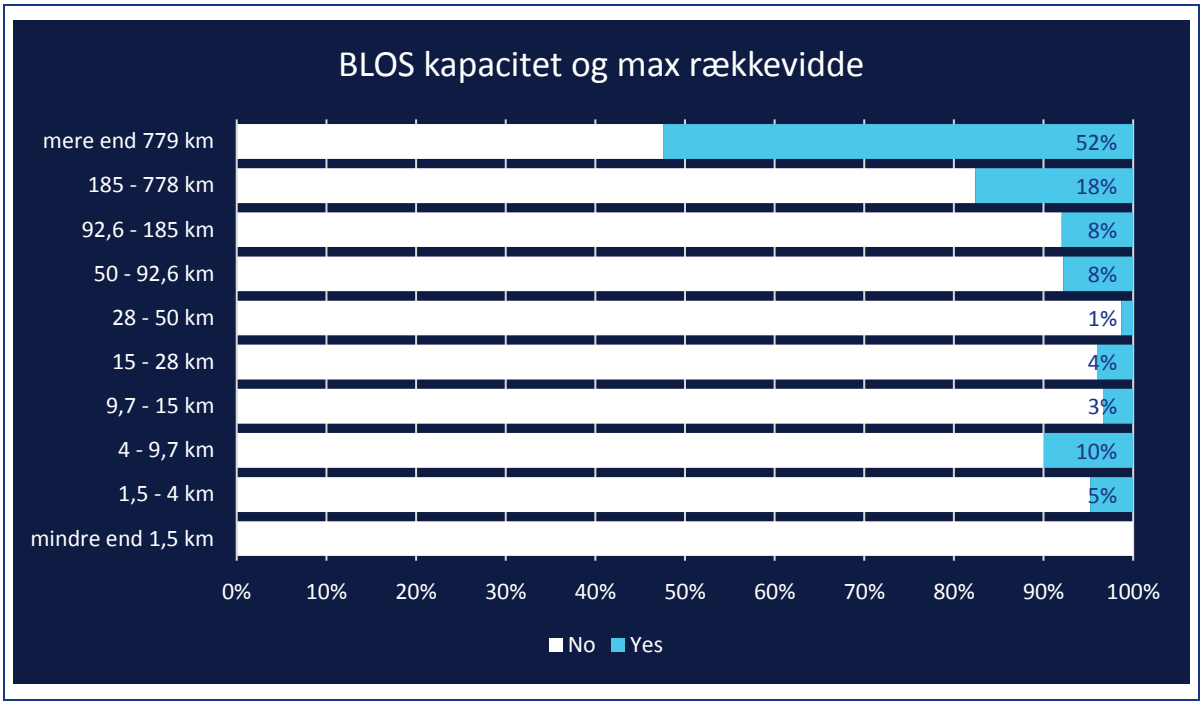

*Kilde: AUVSI databasen, november 2017. BLOS – Beyond line of sight – droner, som flyver uden for synsvidde.*

Det er dog primært højtflyvende droner, som har BLOS kapacitet, som kan flyve over enorme afstand i lang tid. Et eksempel er The SkyOrbiter:

> *"The SkyOrbiter HA55 is a high-altitude flexible, non-polluting and cost-effective platform designed as an alternative to satellites and terrestrial systems. The HA55 operates at a high altitude of 22km and its main function is to intermediate communication between satellites and ground bases. Furthermore, its position above earth allows it to undertake surveillance and remote sensing missions. The HA55 can be used either as a stand-alone platform, providing access to users in a coverage area of a central ground station, or interconnected with other SkyOrbiters using the Constellation Manager ® as the coordination system."*

Blandt droner med en rækkevidde på under 500 kilometer har 62 droner BLOS kapacitet og en gennemsnitlig max rækkevidde på 109 kilometer, mens droner uden BLOS kapacitet har en gennemsnitlig max rækkevidde på 62 kilometer.

Figur 5-2: BLOS og max rækkevidde– et skridt ind i fremtiden

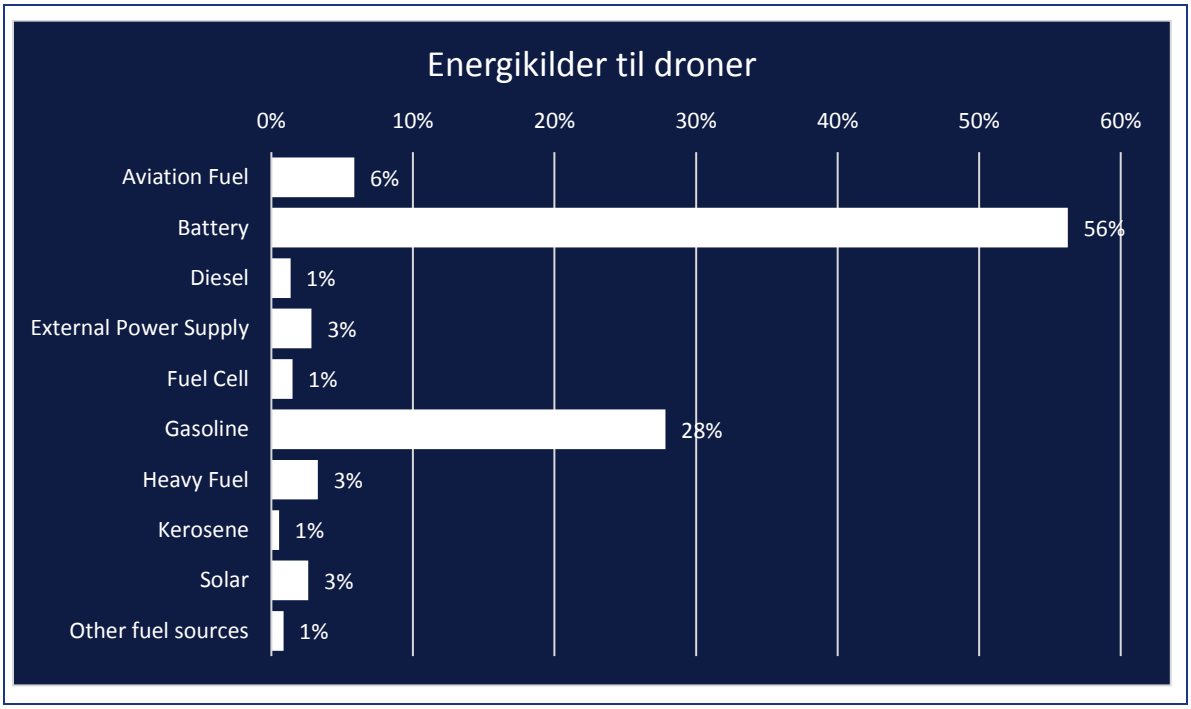



*Kilde: AUVSI databasen, november 2017. BLOS – Beyond line of sight – droner, som flyver uden for synsvidde. Tabellen viser andele af droneplatformene, som tilbyder BLOS afhængig af platformens maksimale flyveafstand. 960 platforme har ikke opgivet max flyveafstand. Afstandskategorierne er maskinelt beregnet, således at der indgår omkring 10 procent af droneplatformene i hver kategori. Eksempelvis har 9,9 procent en maksimal rækkevidde på 185 – 778 kilometer og 10 procent har en maksimal rækkevidde på over 779 kilometer. Blandt de, der kan flyve mere end 779 kilometer har over halvdelen BLOS kapacitet.*

## 5.2. Energikilder – fokus på brændselsceller

Den mest almindelige energikilde for droner er batterier. Lige over halvdelen af alle droneplatformene har batterier. En ud af tyve anvender flybrændstof, og mere end hver fjerde bruger benzin. Brændselsceller anvendes kun af 1 procent af dronerne.

Figur 5-3: Droneenergikilder – batterier i mere end halvdelen




*Kilde: AUVSI databasen, november 2017.*

Nedenfor følger en kort liste over droneproducenter, som har droneplatforme platforme, der angives at anvende brændselsceller. Nogle droneproducenter har mere end en platform. Databasen indeholder oplysninger, som producenterne selv har opgivet. Det er derfor sandsynligt, at droneplatformene ikke er standard- eller hyldevarer, men at de kan udvikles til at bruge brændselsceller.

Listen er derfor som minimum udtryk for de droneproducenter, der har angivet konkret interesse i at levere droner med brændselsceller – og ikke nødvendigvis udtryk for, at dronerne står klar til levering ved bestilling. Droneplatformens navn står i [klammer].

I Bilag 2 er medtaget producenternes udvidede beskrivelse af droneplatformen:

- H3 Dynamics, CleanTech Two, 3 Clean Tech Loop, 06-03. SINGAPORE. [HYWINGS]
- TOP Engineering Group Co., Ltd. (Thailand), 233/187 Soi 11 Mu 5 Nantawan-Srinakarin Village, Srinakarin Road, T. Bangmuang, Amphur Muang. THAILAND. [FALCON-V (3 meter version)]
- TOP Engineering Group Co., Ltd. (Thailand), 233/187 Soi 11 Mu 5 Nantawan-Srinakarin Village, Srinakarin Road, T. Bangmuang, Amphur Muang. THAILAND. [FALCON-V (4.5 meter version)]

- Shenzhen MicroMultiCopter Aero Technology Co., Ltd., 14B1, Dongjiang Bldg, Baomin 1st RD, Bao'on District. CHINA. [HyDrone 1800]
- VTOL Technologies, .. [Urban Eagle]
- Israel Aerospace Industries (Israel), Ben Gurion International Airport.ISRAEL. [Panther]
- Alcore Technologies, Rue-Saint-Simon.FRANCE. [Azimut 2]
- Alcore Technologies, Rue-Saint-Simon.FRANCE. [Biodrone]
- Israel Aerospace Industries (Israel), Ben Gurion International Airport.ISRAEL. [Bird Eye 650]
- BlueBird Aero Systems (Israel), 8 Hamatechet ST.ISRAEL. [Boomerang]
- BlueBird Aero Systems (Israel), 8 Hamatechet ST.ISRAEL. [WanderB]
- Unique (Yin Chuan) Aero-Tech Corporation (China), unknown.CHINA. [UATC Tilt-Rotor UAV]
- Israel Aerospace Industries (Israel), Ben Gurion International Airport.ISRAEL. [Mini-Panther]
- Silent Falcon UAS Technologies (United States), 11030 Cochiti RD SE.UNITED STATES. [Silent Falcon]
- EnergyOr Technologies, Inc., 180 Authier ST.CANADA. [H2 Demonstrator UAV]
- Airborne Concept SAS (France), Aéroport de Toulouse Francazal, (Ex. Base aérienne 101). FRANCE. [DROP 'N DRONE (old version)]
- Airborne Concept SAS (France), Aéroport de Toulouse Francazal, (Ex. Base aérienne 101). FRANCE. [DROP 'N DRONE V3]
- Nautilus (Italy), Via Torino 16.ITALY. [ELETTRA]
- Skyline SRLS (Italy), Via Vincenzo Sivilli, 19.ITALY. [SEAGULL / SK-Hydrogen]
- Politecnico di Torino (Italy), Corso Duca degli Abruzzi, 24.ITALY. [Heliplat]
- Horizon Energy Systems, Horizon Unmanned Systems Pte. Ltd., 6 Penjuru Close #03-01. SINGAPORE. [HYCOPTER]
- RaptorUAS (United Kingdom), UNKNOWN.UNITED KINGDOM. [Raptor E1]
- RaptorUAS (United Kingdom), UNKNOWN.UNITED KINGDOM. [Raptor LE E2]
- AeroVironment, 181 W Huntington DR Ste 202.UNITED STATES. [Centelios]
- AeroVironment, 181 W Huntington DR Ste 202.UNITED STATES. [Helios]
- U.S. Naval Research Laboratory, 4555 Overlook Ave. S.W..UNITED STATES. [Ion Tiger]
- U.S. Naval Research Laboratory, 4555 Overlook Ave. S.W..UNITED STATES. [Spider-Lion]
- Lockheed Martin Corporation, 6801 Rockledge Dr.UNITED STATES. [Stalker XE (eXtreme Endurance)]
- Acuity Technologies, 3475 Edison Way, Bldg. P. UNITED STATES. [AT-10 Responder]
- FlightWave Aerospace Systems Inc. (United States), 1032 3rd ST.UNITED STATES. [Jupiter-H2]

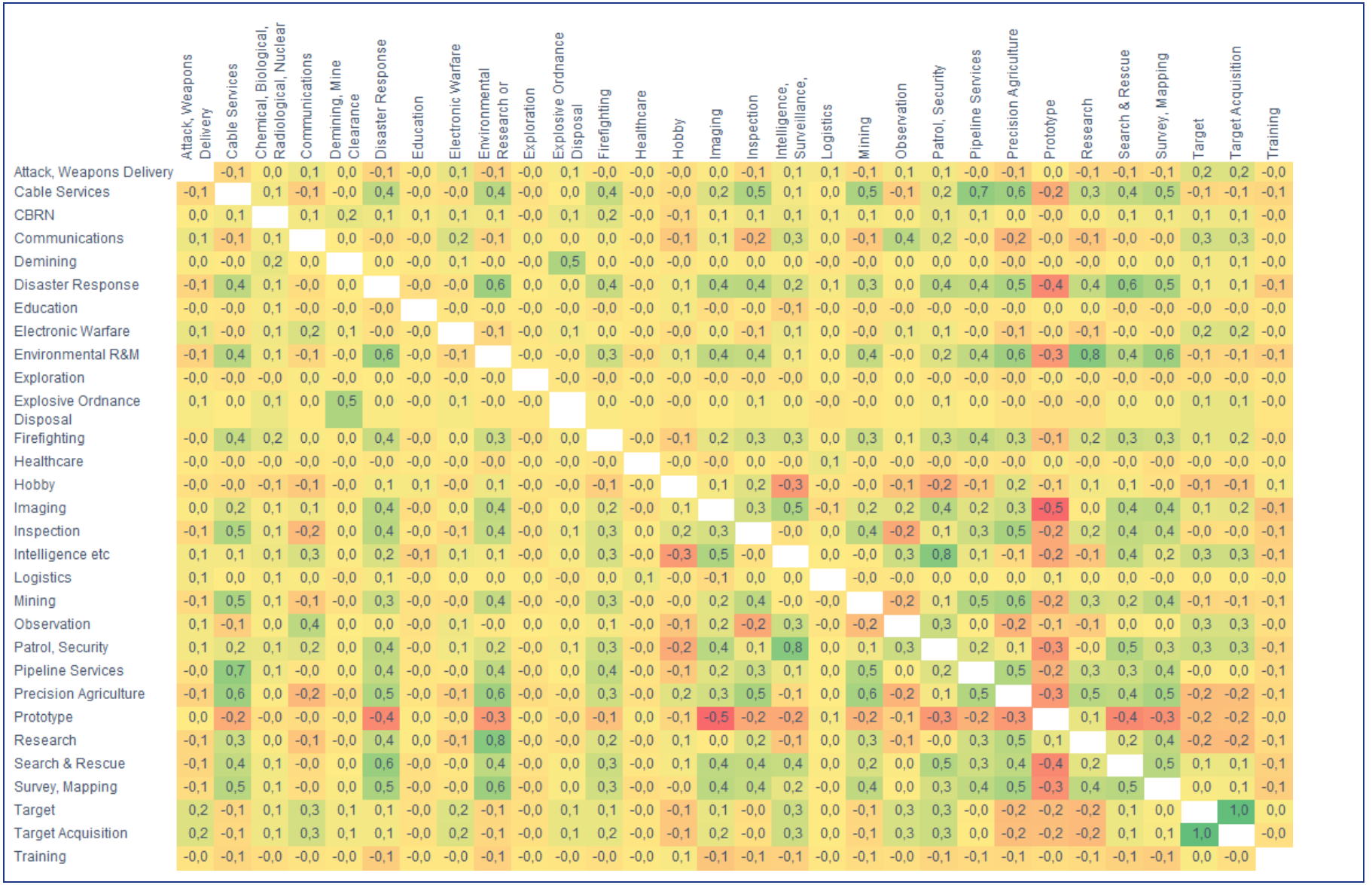
# Bilag 1

Figur 5-4: Droneplatforme til civilt brug: Gruppering af anvendelser

| | Arial inspection | Disaster and security | Military targeting | Environmental research | Professional surveillance | De-mining | Military surveillance | Public service | Research and education | Drone training |
|---|---|---|---|---|---|---|---|---|---|---|
| Attack, Weapons Delivery | 0,01 | -0,10 | 0,39 | -0,09 | -0,11 | 0,02 | 0,27 | 0,09 | -0,07 | -0,36 |
| Cable Services | 0,83 | 0,13 | -0,06 | 0,13 | 0,07 | 0,00 | -0,03 | -0,01 | 0,01 | -0,02 |
| Chemical, Biological, Radiological, Nuclear (CBRN) | 0,14 | 0,05 | 0,06 | 0,02 | 0,15 | 0,27 | 0,10 | 0,13 | 0,58 | -0,03 |
| Communications | -0,12 | 0,09 | 0,19 | -0,00 | 0,15 | -0,05 | 0,71 | -0,02 | 0,06 | -0,02 |
| Demining, Mine Clearance | -0,03 | 0,00 | 0,01 | 0,01 | 0,01 | 0,86 | 0,03 | -0,03 | 0,04 | -0,01 |
| Disaster Response | 0,37 | 0,57 | 0,04 | 0,46 | -0,07 | 0,04 | -0,07 | 0,12 | 0,02 | 0,01 |
| Education | -0,07 | -0,03 | -0,05 | -0,00 | -0,16 | -0,11 | -0,03 | -0,10 | 0,79 | 0,02 |
| Electronic Warfare | 0,09 | -0,05 | 0,27 | -0,16 | -0,11 | 0,07 | 0,50 | 0,01 | 0,13 | -0,20 |
| Environmental Research or Monitoring | 0,38 | 0,31 | -0,07 | 0,78 | -0,13 | 0,00 | 0,03 | -0,03 | 0,00 | -0,02 |
| Exploration | 0,00 | 0,00 | -0,24 | -0,02 | -0,08 | 0,08 | 0,42 | 0,16 | -0,15 | 0,23 |
| Explosive Ordnance Disposal | 0,00 | 0,03 | 0,11 | -0,01 | -0,00 | 0,84 | -0,02 | -0,02 | 0,02 | -0,01 |
| Firefighting | 0,46 | 0,18 | 0,19 | 0,20 | 0,31 | -0,00 | -0,03 | 0,09 | 0,20 | 0,11 |
| Healthcare | -0,04 | 0,00 | -0,03 | -0,06 | -0,00 | 0,00 | -0,05 | 0,66 | -0,05 | 0,02 |
| Hobby | -0,08 | 0,05 | -0,05 | 0,12 | -0,78 | -0,03 | -0,06 | 0,01 | 0,07 | 0,05 |
| Imaging | 0,15 | 0,77 | 0,02 | 0,06 | -0,12 | -0,01 | 0,13 | -0,11 | -0,06 | -0,17 |
| Inspection | 0,59 | 0,25 | 0,01 | 0,06 | -0,32 | 0,09 | -0,24 | 0,12 | 0,05 | -0,10 |
| Intelligence, Surveillance, Reconnaissance | -0,04 | 0,68 | 0,16 | -0,08 | 0,51 | 0,01 | 0,13 | 0,02 | 0,03 | -0,10 |
| Logistics | 0,01 | -0,03 | 0,03 | 0,06 | 0,00 | -0,04 | 0,08 | 0,76 | 0,06 | -0,05 |
| Mining | 0,76 | 0,04 | -0,04 | 0,08 | 0,00 | -0,03 | -0,06 | -0,06 | -0,03 | -0,02 |
| Observation | -0,26 | 0,27 | 0,12 | 0,13 | 0,30 | -0,04 | 0,54 | -0,10 | 0,01 | 0,03 |
| Patrol, Security | 0,06 | 0,70 | 0,21 | 0,06 | 0,43 | 0,01 | 0,10 | 0,02 | 0,10 | -0,03 |
| Pipeline Services | 0,76 | 0,10 | -0,02 | 0,14 | 0,22 | -0,01 | 0,09 | -0,03 | 0,03 | 0,03 |
| Precision Agriculture | 0,70 | 0,21 | -0,12 | 0,34 | -0,27 | -0,04 | -0,12 | -0,02 | -0,03 | -0,02 |
| Prototype | -0,27 | -0,65 | -0,06 | 0,15 | 0,27 | -0,01 | -0,12 | 0,11 | 0,04 | -0,17 |
| Research | 0,26 | -0,14 | -0,09 | 0,89 | -0,01 | -0,02 | -0,07 | 0,00 | 0,03 | -0,04 |
| Search & Rescue | 0,30 | 0,67 | 0,08 | 0,22 | -0,02 | 0,03 | -0,17 | 0,12 | 0,05 | 0,02 |
| Survey, Mapping | 0,46 | 0,38 | 0,04 | 0,47 | -0,04 | 0,06 | -0,00 | -0,07 | -0,06 | -0,06 |
| Target | -0,06 | 0,17 | 0,93 | -0,04 | 0,09 | 0,07 | 0,12 | -0,02 | 0,00 | 0,09 |
| Target Acquisition | -0,06 | 0,18 | 0,92 | -0,04 | 0,09 | 0,07 | 0,12 | -0,01 | 0,01 | 0,02 |
| Training | -0,02 | -0,12 | 0,09 | -0,07 | -0,08 | -0,02 | 0,03 | -0,01 | -0,02 | 0,85 |

*Kilde: AUVSI databasen, november 2017. Mønsteret er undersøgt ved hjælp af den statistiske metode "factor analysis", modellen forklarer 65 procent af variationen i datasættet. Metoden er "PCA" og modellen er roteret Varimax with Kaiser Normalization*

Figur 5-5: Samvariation af anvendelser



| | Attack, Weapons Delivery | Cable Services | Chemical, Biological, Radiological, Nuclear | Communications | Demining, Mine Clearance | Disaster Response | Education | Electronic Warfare | Environmental Research or | Exploration | Explosive Ordnance Disposal | Firefighting | Healthcare | Hobby | Imaging | Inspection | Intelligence, Surveillance, | Logistics | Mining | Observation | Patrol, Security | Pipeline Services | Precision Agriculture | Prototype | Research | Search & Rescue | Survey, Mapping | Target | Target Acquisition | Training |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Attack, Weapons Delivery | | -0,1 | 0,0 | 0,1 | 0,0 | -0,1 | -0,0 | 0,1 | -0,1 | -0,0 | 0,1 | -0,0 | -0,0 | -0,0 | 0,0 | -0,1 | 0,1 | 0,1 | -0,1 | 0,1 | 0,1 | -0,0 | -0,1 | 0,0 | -0,1 | -0,1 | -0,1 | 0,2 | 0,2 | -0,0 |
| Cable Services | -0,1 | | 0,1 | -0,1 | -0,0 | 0,4 | -0,0 | -0,0 | 0,4 | -0,0 | 0,0 | 0,4 | -0,0 | -0,0 | 0,2 | 0,5 | 0,1 | 0,0 | 0,5 | -0,1 | 0,2 | 0,7 | 0,6 | -0,2 | 0,3 | 0,4 | 0,5 | -0,1 | -0,1 | -0,1 |
| CBRN | 0,0 | 0,1 | | 0,1 | 0,2 | 0,1 | 0,1 | 0,1 | 0,1 | -0,0 | 0,1 | 0,2 | -0,0 | -0,1 | 0,1 | 0,1 | 0,1 | 0,1 | 0,1 | 0,0 | 0,1 | 0,1 | 0,0 | -0,0 | 0,0 | 0,1 | 0,1 | 0,1 | 0,1 | -0,0 |
| Communications | 0,1 | -0,1 | 0,1 | | 0,0 | -0,0 | -0,0 | 0,2 | -0,1 | 0,0 | 0,0 | 0,0 | -0,0 | -0,1 | 0,1 | -0,2 | 0,3 | 0,0 | -0,1 | 0,4 | 0,2 | -0,0 | -0,2 | -0,0 | -0,1 | -0,0 | -0,0 | 0,3 | 0,3 | -0,0 |
| Demining | 0,0 | -0,0 | 0,2 | 0,0 | | 0,0 | -0,0 | 0,1 | -0,0 | -0,0 | 0,5 | 0,0 | -0,0 | -0,0 | 0,0 | 0,0 | 0,0 | -0,0 | -0,0 | 0,0 | 0,0 | 0,0 | -0,0 | -0,0 | -0,0 | 0,0 | 0,0 | 0,1 | 0,1 | -0,0 |
| Disaster Response | -0,1 | 0,4 | 0,1 | -0,0 | 0,0 | | -0,0 | -0,0 | 0,6 | 0,0 | 0,0 | 0,4 | -0,0 | 0,1 | 0,4 | 0,4 | 0,2 | 0,1 | 0,3 | 0,0 | 0,4 | 0,4 | 0,5 | -0,4 | 0,4 | 0,6 | 0,5 | 0,1 | 0,1 | -0,1 |
| Education | -0,0 | -0,0 | 0,1 | -0,0 | -0,0 | -0,0 | | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | 0,1 | -0,0 | -0,0 | -0,1 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | 0,0 | 0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 |
| Electronic Warfare | 0,1 | -0,0 | 0,1 | 0,2 | 0,1 | -0,0 | -0,0 | | -0,1 | -0,0 | 0,1 | 0,0 | -0,0 | -0,0 | 0,0 | -0,1 | 0,1 | 0,0 | -0,0 | 0,1 | 0,1 | -0,0 | -0,1 | -0,0 | -0,1 | -0,0 | -0,0 | 0,2 | 0,2 | -0,0 |
| Environmental R&M | -0,1 | 0,4 | 0,1 | -0,1 | -0,0 | 0,6 | -0,0 | -0,1 | | -0,0 | -0,0 | 0,3 | -0,0 | 0,1 | 0,4 | 0,4 | 0,1 | 0,0 | 0,4 | -0,0 | 0,2 | 0,4 | 0,6 | -0,3 | 0,8 | 0,4 | 0,6 | -0,1 | -0,1 | -0,1 |
| Exploration | -0,0 | -0,0 | -0,0 | 0,0 | -0,0 | 0,0 | -0,0 | -0,0 | -0,0 | | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | 0,0 | -0,0 | 0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 |
| Explosive Ordnance Disposal | 0,1 | 0,0 | 0,1 | 0,0 | 0,5 | 0,0 | -0,0 | 0,1 | -0,0 | -0,0 | | 0,0 | -0,0 | -0,0 | 0,0 | 0,1 | 0,0 | -0,0 | -0,0 | 0,0 | 0,1 | 0,0 | -0,0 | -0,0 | -0,0 | 0,0 | 0,0 | 0,1 | 0,1 | -0,0 |
| Firefighting | -0,0 | 0,4 | 0,2 | 0,0 | 0,0 | 0,4 | -0,0 | 0,0 | 0,3 | -0,0 | 0,0 | | -0,0 | -0,1 | 0,2 | 0,3 | 0,3 | 0,0 | 0,3 | 0,1 | 0,3 | 0,4 | 0,3 | -0,1 | 0,2 | 0,3 | 0,3 | 0,1 | 0,2 | -0,0 |
| Healthcare | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | | -0,0 | -0,0 | 0,0 | -0,0 | 0,1 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | 0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 | -0,0 |
| Hobby | -0,0 | -0,0 | -0,1 | -0,1 | -0,0 | 0,1 | 0,1 | -0,0 | 0,1 | -0,0 | -0,0 | -0,1 | -0,0 | | 0,1 | 0,2 | -0,3 | -0,0 | -0,0 | -0,1 | -0,2 | -0,1 | 0,2 | -0,1 | 0,1 | 0,1 | -0,0 | -0,1 | -0,1 | 0,1 |
| Imaging | 0,0 | 0,2 | 0,1 | 0,1 | 0,0 | 0,4 | -0,0 | 0,0 | 0,4 | -0,0 | 0,0 | 0,2 | -0,0 | 0,1 | | 0,3 | 0,5 | -0,1 | 0,2 | 0,2 | 0,4 | 0,2 | 0,3 | -0,5 | 0,0 | 0,4 | 0,4 | 0,1 | 0,2 | -0,1 |
| Inspection | -0,1 | 0,5 | 0,1 | -0,2 | 0,0 | 0,4 | -0,0 | -0,1 | 0,4 | -0,0 | 0,1 | 0,3 | 0,0 | 0,2 | 0,3 | | -0,0 | 0,0 | 0,4 | -0,2 | 0,1 | 0,3 | 0,5 | -0,2 | 0,2 | 0,4 | 0,4 | -0,0 | -0,0 | -0,1 |
| Intelligence etc | 0,1 | 0,1 | 0,1 | 0,3 | 0,0 | 0,2 | -0,1 | 0,1 | 0,1 | -0,0 | 0,0 | 0,3 | -0,0 | -0,3 | 0,5 | -0,0 | | 0,0 | -0,0 | 0,3 | 0,8 | 0,1 | -0,1 | -0,2 | -0,1 | 0,4 | 0,2 | 0,3 | 0,3 | -0,1 |
| Logistics | 0,1 | 0,0 | 0,1 | 0,0 | -0,0 | 0,1 | -0,0 | 0,0 | 0,0 | 0,0 | -0,0 | 0,0 | 0,1 | -0,0 | -0,1 | 0,0 | 0,0 | | -0,0 | -0,0 | 0,0 | 0,0 | 0,0 | 0,1 | 0,0 | 0,0 | -0,0 | 0,0 | 0,0 | -0,0 |
| Mining | -0,1 | 0,5 | 0,1 | -0,1 | -0,0 | 0,3 | -0,0 | -0,0 | 0,4 | -0,0 | -0,0 | 0,3 | -0,0 | -0,0 | 0,2 | 0,4 | -0,0 | -0,0 | | -0,2 | 0,1 | 0,5 | 0,6 | -0,2 | 0,3 | 0,2 | 0,4 | -0,1 | -0,1 | -0,1 |
| Observation | 0,1 | -0,1 | 0,0 | 0,4 | 0,0 | 0,0 | -0,0 | 0,1 | -0,0 | 0,0 | 0,0 | 0,1 | -0,0 | -0,1 | 0,2 | -0,2 | 0,3 | -0,0 | -0,2 | | 0,3 | 0,0 | -0,2 | -0,1 | -0,1 | 0,0 | 0,0 | 0,3 | 0,3 | -0,0 |
| Patrol, Security | 0,1 | 0,2 | 0,1 | 0,2 | 0,0 | 0,4 | -0,0 | 0,1 | 0,2 | -0,0 | 0,1 | 0,3 | -0,0 | -0,2 | 0,4 | 0,1 | 0,8 | 0,0 | 0,1 | 0,3 | | 0,2 | 0,1 | -0,3 | -0,0 | 0,5 | 0,3 | 0,3 | 0,3 | -0,1 |
| Pipeline Services | -0,0 | 0,7 | 0,1 | -0,0 | 0,0 | 0,4 | -0,0 | -0,0 | 0,4 | -0,0 | 0,0 | 0,4 | -0,0 | -0,1 | 0,2 | 0,3 | 0,1 | 0,0 | 0,5 | 0,0 | 0,2 | | 0,5 | -0,2 | 0,3 | 0,3 | 0,4 | -0,0 | 0,0 | -0,1 |
| Precision Agriculture | -0,1 | 0,6 | 0,0 | -0,2 | -0,0 | 0,5 | -0,0 | -0,1 | 0,6 | -0,0 | -0,0 | 0,3 | -0,0 | 0,2 | 0,3 | 0,5 | -0,1 | 0,0 | 0,6 | -0,2 | 0,1 | 0,5 | | -0,3 | 0,5 | 0,4 | 0,5 | -0,2 | -0,2 | -0,1 |
| Prototype | 0,0 | -0,2 | -0,0 | -0,0 | -0,0 | -0,4 | 0,0 | -0,0 | -0,3 | -0,0 | -0,0 | -0,1 | 0,0 | -0,1 | -0,5 | -0,2 | -0,2 | 0,1 | -0,2 | -0,1 | -0,3 | -0,2 | -0,3 | | 0,1 | -0,4 | -0,3 | -0,2 | -0,2 | -0,0 |
| Research | -0,1 | 0,3 | 0,0 | -0,1 | -0,0 | 0,4 | 0,0 | -0,1 | 0,8 | -0,0 | -0,0 | 0,2 | -0,0 | 0,1 | 0,0 | 0,2 | -0,1 | 0,0 | 0,3 | -0,1 | -0,0 | 0,3 | 0,5 | 0,1 | | 0,2 | 0,4 | -0,2 | -0,2 | -0,1 |
| Search & Rescue | -0,1 | 0,4 | 0,1 | -0,0 | 0,0 | 0,6 | -0,0 | -0,0 | 0,4 | -0,0 | 0,0 | 0,3 | -0,0 | 0,1 | 0,4 | 0,4 | 0,4 | 0,0 | 0,2 | 0,0 | 0,5 | 0,3 | 0,4 | -0,4 | 0,2 | | 0,5 | 0,1 | 0,1 | -0,1 |
| Survey, Mapping | -0,1 | 0,5 | 0,1 | -0,0 | 0,0 | 0,5 | -0,0 | -0,0 | 0,6 | -0,0 | 0,0 | 0,3 | -0,0 | -0,0 | 0,4 | 0,4 | 0,2 | -0,0 | 0,4 | 0,0 | 0,3 | 0,4 | 0,5 | -0,3 | 0,4 | 0,5 | | 0,0 | 0,1 | -0,1 |
| Target | 0,2 | -0,1 | 0,1 | 0,3 | 0,1 | 0,1 | -0,0 | 0,2 | -0,1 | -0,0 | 0,1 | 0,1 | -0,0 | -0,1 | 0,1 | -0,0 | 0,3 | 0,0 | -0,1 | 0,3 | 0,3 | -0,0 | -0,2 | -0,2 | -0,2 | 0,1 | 0,0 | | 1,0 | 0,0 |
| Target Acquisition | 0,2 | -0,1 | 0,1 | 0,3 | 0,1 | 0,1 | -0,0 | 0,2 | -0,1 | -0,0 | 0,1 | 0,2 | -0,0 | -0,1 | 0,2 | -0,0 | 0,3 | 0,0 | -0,1 | 0,3 | 0,3 | 0,0 | -0,2 | -0,2 | -0,2 | 0,1 | 0,1 | 1,0 | | -0,0 |
| Training | -0,0 | -0,1 | -0,0 | -0,0 | -0,0 | -0,1 | -0,0 | -0,0 | -0,1 | -0,0 | -0,0 | -0,0 | -0,0 | 0,1 | -0,1 | -0,1 | -0,1 | -0,0 | -0,1 | -0,0 | -0,1 | -0,1 | -0,1 | -0,0 | -0,1 | -0,1 | -0,1 | 0,0 | -0,0 | |

*Kilde: AUVSI databasen, november 2017. Persons R.*

Figur 5-6: Samvariation af anvendelser. Grønne felter illustrerer en specialisering

| Platform Country | Arial inspection | Disaster and security | Military targeting | Environmental research | Professional surveillance | De-mining | Military surveillance | Public service | Research and education | Drone training |
|---|---|---|---|---|---|---|---|---|---|---|
| ARGENTINA | -0,55 | 0,26 | 0,52 | 0,66 | 0,44 | -0,21 | 0,39 | -0,23 | -0,14 | 0,10 |
| AUSTRALIA | -0,04 | -0,38 | -0,12 | 0,23 | 0,28 | -0,08 | -0,22 | -0,01 | -0,10 | -0,07 |
| AUSTRIA | 0,63 | 0,07 | -0,11 | 0,51 | 0,25 | -0,07 | 0,21 | 0,71 | 0,19 | -0,24 |
| BELARUS | 0,30 | 0,16 | 0,35 | -0,04 | 0,03 | -0,34 | 0,48 | -0,38 | 1,67 | 0,07 |
| BELGIUM | 0,36 | -0,48 | -0,31 | -0,24 | -1,58 | -0,03 | -0,28 | -0,24 | -0,23 | -0,20 |
| BRAZIL | -0,03 | 0,38 | -0,10 | 0,10 | 0,24 | -0,11 | 0,09 | -0,05 | -0,18 | -0,02 |
| BULGARIA | -0,81 | 0,61 | 0,97 | -0,98 | 0,33 | -0,03 | -0,75 | -0,03 | 0,33 | 0,20 |
| CANADA | 0,26 | -0,23 | -0,27 | 0,03 | -0,21 | 0,23 | -0,18 | 0,26 | 0,49 | 0,38 |
| CHILE | -0,20 | 0,55 | -0,53 | 0,65 | -0,04 | -0,08 | -0,37 | -0,23 | -0,31 | -0,16 |
| CHINA | 0,55 | 0,27 | -0,10 | 0,24 | -0,48 | -0,11 | -0,08 | 0,06 | -0,11 | -0,24 |
| COLOMBIA | 0,40 | -0,14 | -0,21 | 1,10 | 0,82 | -0,23 | 0,11 | 0,23 | 0,20 | -0,59 |
| CROATIA | -0,90 | -1,37 | -0,55 | -0,09 | 0,79 | -0,20 | 0,71 | -0,24 | -0,06 | -0,81 |
| CZECH REPUBLIC | 0,31 | 0,19 | 0,02 | 0,58 | -0,04 | -0,09 | -0,19 | -0,30 | -0,33 | 0,00 |
| DENMARK | -0,48 | 0,53 | 1,70 | 0,78 | 0,41 | 3,02 | -1,11 | 0,04 | 0,62 | 0,32 |
| ECUADOR | -1,36 | 0,79 | 1,45 | 1,46 | 0,27 | -0,26 | 0,99 | -0,39 | -0,33 | 0,32 |
| ESTONIA | 0,65 | 0,50 | 1,26 | 0,10 | 0,42 | -0,05 | -0,50 | -0,03 | 0,43 | 0,23 |
| FINLAND | -0,45 | 0,59 | -0,10 | -0,99 | 0,18 | -0,03 | -0,31 | 0,76 | 0,43 | 0,04 |
| FRANCE | 0,09 | -0,02 | 0,00 | -0,12 | 0,07 | -0,03 | -0,09 | -0,16 | -0,05 | -0,14 |
| GERMANY | 0,28 | -0,09 | -0,18 | 0,09 | -0,01 | 0,27 | -0,22 | -0,04 | -0,02 | -0,14 |
| GREECE | -1,12 | 0,96 | -0,08 | -0,62 | 0,51 | -0,14 | -0,07 | -0,35 | -0,23 | 0,05 |
| HUNGARY | -0,30 | 0,40 | 0,17 | -0,37 | 0,03 | -0,13 | -0,70 | -0,12 | -0,17 | -0,05 |
| INDIA | -0,20 | 0,47 | 0,42 | -0,54 | 0,19 | -0,15 | -0,30 | -0,08 | -0,18 | -0,02 |
| INDONESIA | 0,32 | -0,23 | -0,21 | 0,02 | 0,08 | -0,05 | -0,32 | -0,27 | -0,28 | -0,18 |
| IRAN | 0,14 | -0,81 | 2,93 | 0,63 | -0,58 | -0,39 | 2,02 | -0,06 | -1,08 | -2,31 |
| IRELAND | 0,73 | 0,74 | -0,37 | -0,59 | 0,35 | -0,11 | -0,89 | 0,15 | 0,12 | -0,05 |
| ISRAEL | -0,40 | 0,57 | 0,64 | -0,59 | 0,37 | -0,22 | 0,60 | -0,15 | -0,07 | 0,19 |
| ITALY | 0,32 | 0,15 | -0,12 | 0,06 | 0,14 | 0,26 | -0,23 | -0,12 | -0,06 | -0,12 |
| JAPAN | 0,79 | 0,03 | -0,50 | -0,15 | -0,55 | 0,08 | -0,27 | 1,24 | 0,21 | -0,16 |
| JORDAN | -0,72 | 0,43 | 2,02 | -0,89 | -0,23 | -0,20 | -0,46 | -0,02 | -0,52 | -0,70 |
| LATVIA | -0,14 | 0,36 | 0,10 | 0,47 | -2,09 | -0,06 | -0,51 | 0,04 | -0,06 | -0,06 |
| LUXEMBOURG | 1,60 | 0,47 | -0,54 | 0,25 | 0,92 | -0,22 | 0,27 | -0,26 | -0,01 | 0,15 |
| MALAYSIA | 0,64 | 0,42 | 1,00 | -0,67 | -0,10 | -0,16 | 0,40 | -0,05 | 0,12 | -0,26 |
| MEXICO | -0,54 | -0,38 | -0,54 | -0,41 | 0,30 | -0,11 | 0,11 | -0,21 | -0,11 | -0,22 |
| NAMIBIA | -0,62 | -0,46 | -0,51 | 0,40 | -0,11 | -0,06 | -0,25 | -0,42 | -0,30 | -0,26 |
| NETHERLANDS | 0,38 | 0,03 | -0,31 | -0,09 | 0,08 | 0,05 | 0,07 | 0,09 | 0,54 | -0,02 |
| NEW ZEALAND | 0,59 | 0,09 | -0,35 | 0,18 | -0,59 | -0,05 | -0,34 | -0,27 | -0,40 | -0,21 |
| NIGERIA | -0,47 | 0,49 | 1,56 | 0,88 | 0,20 | -0,22 | 0,36 | -0,27 | -0,35 | 0,17 |
| NORWAY | -0,50 | -1,29 | -0,20 | 0,36 | 0,40 | -0,09 | -0,11 | -0,18 | 0,57 | 0,10 |
| PAKISTAN | -0,91 | 0,64 | -0,26 | -0,40 | 0,30 | -0,07 | -0,21 | -0,20 | -0,10 | 0,74 |
| PERU | -1,44 | 0,26 | -0,58 | 0,92 | 1,31 | -0,07 | -0,34 | 0,01 | -0,12 | -0,58 |
| PHILIPPINES | 0,19 | 0,68 | -0,68 | 0,36 | 0,32 | -0,08 | -0,24 | -0,16 | -0,24 | -0,15 |
| POLAND | -0,22 | 0,50 | 0,71 | -0,40 | 0,09 | -0,13 | 0,00 | 0,22 | -0,15 | -0,41 |
| PORTUGAL | 0,21 | 0,16 | 0,73 | 0,50 | 0,53 | -0,21 | 0,50 | -0,23 | 0,01 | 0,22 |
| ROMANIA | -0,41 | -0,01 | 0,37 | 0,39 | 0,57 | -0,18 | -0,34 | -0,24 | -0,13 | 1,21 |
| RUSSIA | -0,18 | 0,44 | -0,39 | -0,06 | 0,28 | -0,08 | 0,53 | 0,15 | -0,07 | 0,05 |
| SERBIA | 1,67 | -1,04 | 2,44 | -0,06 | -2,05 | 13,05 | 3,81 | -0,27 | -1,04 | -3,24 |
| SINGAPORE | 0,22 | 0,68 | -0,19 | -0,39 | 0,49 | -0,05 | -0,46 | -0,10 | -0,01 | -0,12 |
| SLOVENIA | 0,43 | 0,02 | 0,25 | 0,60 | -0,16 | 0,70 | -0,44 | -0,26 | -0,29 | 0,10 |
| SOUTH AFRICA | -0,09 | 0,30 | 0,38 | -0,31 | -0,13 | -0,17 | 0,32 | 0,17 | -0,22 | -0,18 |
| SOUTH KOREA | 0,27 | 0,09 | 0,20 | -0,17 | -0,17 | -0,09 | -0,39 | -0,28 | -0,37 | -0,09 |
| SPAIN | 0,36 | 0,16 | 0,01 | 0,18 | 0,31 | -0,13 | -0,01 | 0,05 | -0,01 | 0,09 |
| SWEDEN | 0,91 | -0,60 | 0,37 | -0,03 | -0,28 | 1,78 | 0,42 | -0,14 | 0,41 | -0,20 |
| SWITZERLAND | 0,07 | -0,03 | 0,14 | 0,35 | -0,14 | 0,06 | 0,34 | 0,18 | 0,13 | 0,10 |
| TAIWAN | -0,14 | 0,32 | -0,37 | 0,15 | -0,63 | -0,08 | -0,11 | 0,10 | 0,02 | 0,01 |
| THAILAND | 0,23 | 0,08 | -0,23 | 0,29 | -0,13 | 0,09 | 0,15 | 0,77 | 0,72 | -0,09 |
| TURKEY | -0,59 | 0,56 | 0,55 | -0,46 | 0,28 | -0,18 | -0,14 | 0,16 | -0,22 | -0,08 |
| UKRAINE | -0,35 | -0,02 | 0,27 | -0,18 | 0,42 | -0,15 | -0,14 | -0,02 | -0,16 | 0,41 |
| UNITED ARAB EMIRATES | -0,91 | 0,70 | 0,76 | -0,93 | 0,11 | -0,27 | 1,07 | -0,26 | -0,30 | -0,09 |
| UNITED KINGDOM | -0,11 | 0,09 | -0,21 | -0,01 | 0,16 | -0,03 | 0,13 | 0,13 | 0,19 | -0,11 |
| UNITED STATES | -0,12 | -0,19 | 0,01 | 0,01 | -0,07 | -0,01 | 0,00 | -0,06 | -0,01 | 0,09 |
| VIETNAM | -1,23 | 0,92 | -0,65 | 0,77 | 0,35 | -0,05 | -0,38 | -0,13 | -0,19 | -0,10 |
| Total | -0,00 | -0,00 | 0,00 | 0,00 | -0,00 | -0,00 | 0,00 | -0,00 | -0,00 | -0,00 |

*Kilde: AUVSI databasen, november 2017. Persons R.*

## Bilag 2: Droner med brændselsceller

I dette bilag oplister vi droneproducenter, som har droneplatfome, der angives at anvende brændselsceller. Nogle droneproducenter har mere end en platform. AUVSI databasen indeholder oplysninger, som producenterne selv har opgivet. Det er derfor sandsynligt at droneplatformene ikke er standard- eller hyldevarer, men kan udvikles til at bruge brændselsceller. Beskrivelserne er derfor som minimum udtryk for, hvilke droneproducenter, der har angivet konkret interesse i at levere droner med brændselsceller – og ikke nødvendigvis udtryk for, at dronerne står klar til levering ved bestilling.

## Acuity Technologies

http://www.acuitytx.com/

**AT-10 Responder**

Acuity Technologies concentrates on extending the endurance and payload capabilities of smaller unmanned air systems and providing solutions for demanding missions. The AT-10 is a tactical size hybrid propulsion VTOL UAS with a nose camera mount and a large payload bay. Propulsion is provided by twin electric motors and batteries installed in the wings. The inner section of each wing rotates for the transition between vertical and forward flight. For flights of two hours or less, additional batteries in the upper fuselage provide allelectric propulsion. For longer endurance a heavy fuel generator, fuel cell, or other energy conversion system may be included in the aft fuselage. Analysis shows that this configuration is lighter and more efficient than using internal combustion engine(s) for both VTOL and forward cruise, and this advantage will increase as electric power technology evolves. In addition, the electric power system can provide over 1000 Watts of power for payloads. Unlike many runway-independent UAS, the AT-10 requires no catapult or arresting gear. Acuity is seeking R&D / EMD funding to develop the AT-10 into an operational VTOL UAS based on fuel/electric hybrid propulsion.

Imaging; Intelligence, Surveillance, Reconnaissance; Prototype

**http://www.acuitytx.com/pdf/Acuity%20Technologies%20AT-10%20Brief.pdf**

## AeroVironment

http://www.avinc.com/

### Helios

The Helios Prototype is a remotely piloted flying wing aircraft developed under NASA's Environmental Research Aircraft and Sensor Technology (ERAST) project. The two primary goals of the Helios Prototype development are to demonstrate sustained flight at an altitude near 100,000 feet and flying non-stop for at least 24 hours, including at least 14 hours above 50,000 feet.In 2001, the Helios Prototype achieved the first of the two goals by reaching an unofficial world-record altitude of 96,863 feet and sustaining flight above 96,000 feet for more than 40 minutes during a test flight near Hawaii. The aircraft is undergoing modifications and upgrades to enable it to accomplish the flight endurance milestone, presently planned for late summer, 2003.The operational and technical ability to reach these two goals is critical for NASA's ERAST project. Through ERAST, many new propulsion, materials, control, instrumentation, and sensor technologies are being pioneered which could enable the development of a fleet of high-flying uninhabited aircraft that could conduct a wide variety of Earth and atmospheric science missions. Flying autonomously with mission-oriented payloads and instrumentation, these ultra-high flyers could carry out storm tracking studies, atmospheric sampling, spectral imaging for agricultural and natural resources monitoring, pipeline monitoring, and also serve as relay platforms for telecommunications systems.Developed by AeroVironment, Inc., of Monrovia, CA, with the assistance of NASA's Dryden Flight Research Center, the Helios Prototype is one of several remotely piloted aircraft that have been involved in NASA's ERAST project. It is an enlarged version of the Centurion flying wing, flown at Dryden in late 1998 to verify the handling qualities and performance of a lightweight all-wing aircraft of more than 200-foot wingspan. It was renamed the Helios Prototype to reflect its role as a forerunner of the eventual Helios production aircraft, which will be designed to fly continuously for up to six months at a time on

Communications; Environmental Research or Monitoring; Prototype; Research; Survey, Mapping

**http://www.nasa.gov/centers/dryden/news/FactSheets/FS-068-DFRC.html**

NASA Dryden Flight Research Center (United States)

### Centelios

Although Centurion represents the state of the art in solar-powered flight at present, it is just another rung on the ladder towards achieving semi-perpetual flight for extended-duration science studies, an ultimate goal of the ERAST program and of AeroVironment's solar aircraft developments. The next steps will be "Centelios" and "Helios," the planned follow-on vehicles to Centurion.The Centelios, a transitional aircraft like the Pathfinder-Plus, will be a hybrid between the Centurion and the Helios. The Centelios will be an upgrade of the Centurion, but with a rechargeable fuel-cell energy storage system installed to provide electrical power for night flying. A sixth wing section, increasing wingspan to about 250 feet, will be required to carry the additional weight of the fuel cell system. The Centelios will be designed to remain aloft above 60,000 feet altitude for at least four days and nights, meeting an ERAST Level I milestone

Prototype; Research

**http://www.nasa.gov/centers/dryden/news/FactSheets/FS-056-DFRC_prt.htm**

NASA

## Airborne Concept SAS (France)

http://www.airborne-concept.com/

**DROP 'N DRONE (old version)**

The DROP 'N DRONE is an air droppable drone capable of being integrated with a fuel cell for long endurance missions.

Communications; Disaster Response; Environmental Research or Monitoring; Imaging; Intelligence, Surveillance, Reconnaissance; Patrol, Security; Search & Rescue; Survey, Mapping;

**http://www.airborne-concept.com/drop-n-drone/**

**DROP 'N DRONE V3**

Airborne Concept's Drop'n Drone has the unique ability to be deployed directly from an aircraft in flight (plane or helicopter). This is of great importance in hostile or disaster zones. Hooked to a parachute, the container holds the Drop'n Drone with its wing in line with the fuselage. After opening, they rotate automatically and the drone is released. The Drop'n Drone is then ready to accomplish its mission with total discretion, autonomously and with an unmatched endurance. Multiple units can be easily deployed to perform complimentary tasks. For example, in humanitarian disaster zones, first responders or NGOs could deploy multiple Drop'n Drones each with a particular task to perform: instant mapping though photogrammetry; finding injured or trapped persons with an infra-red sensor; and providing vital communications network with a GSM repeater.

Communications; Disaster Response; Imaging; Intelligence, Surveillance, Reconnaissance; Patrol, Security; Search & Rescue; Survey, Mapping; Target Acquisition

**http://www.airborne-concept.com/en/drop-n-drone/**

## Alcore Technologies

http://www.alcoretech.com/

**Azimut 2**

Lightwight and close range UAV for parachutist groups, task forces, customs and paramilitary operations and scientific research.

Disaster Response; Environmental Research or Monitoring; Imaging; Intelligence, Surveillance, Reconnaissance; Patrol, Security; Precision Agriculture; Search & Rescue; Survey, Mapping

**http://www.alcoretech.com/en/?vehicle=azimut2**

**Biodrone**

Biodrone is a light weight UAV system capable of close range surveillance and aero-sonde.

Disaster Response; Environmental Research or Monitoring; Firefighting; Imaging; Intelligence, Surveillance, Reconnaissance; Patrol, Security; Precision Agriculture; Search & Rescue; Survey, Mapping

**http://www.alcoretech.com/?vehicle=biodrone**

## BlueBird Aero Systems (Israel)

http://www.bluebird-uav.com/

### Boomerang

The Boomerang® is the world's first operational long-endurance mini UAV to be powered on cutting-edge Fuel-Cell technology. Due to its long endurance capability (more than 10 hours), and its extended control range (80Km), and with its dual day and IR sensor payload, the boomerang is a perfect solution for long ISR (Intelligence, Surveillance and Reconnaissance). The Boomerang is integrated with Bluebird's combat proven avionics and innovative technology, to provide all weather stealthy and reliable operation, and triple day/IR/laser Sensor.When carrying the photogrammetric payload and performing an autonomous mapping mission, the Boomerang system can be used to deliver up to 750 square kilometers of orthophoto in a single sortie.The Boomerang is the perfect solution for lower cost, long endurance area domination, in any tactical circumstances.Operational missions• Rapid "over-the-hill", covert ISTAR (Intelligence, Surveillance, Target Acquisition and Reconnaissance) in open area as well as urban warfare scenarios.• "First responder"• Border protection• Force / convoy protection• Security operations• Law enforcement• Search and rescue• Disaster control and management operations • Commercial applications• Mapping on Demand photogrammetric solutions

Cable Services; Disaster Response; Environmental Research or Monitoring; Firefighting; Imaging; Intelligence, Surveillance, Reconnaissance; Observation; Patrol, Security; Pipeline Services; Precision Agriculture; Search & Rescue; Survey, Mapping; Target Acquisition

### WanderB

WanderB® FC (Fuel Cell) SUAS is a revolutionary, advanced, extended performance electric Small-UAS, powered by a PEM (Proton Exchange Membrane) fuel cell and based on BlueBird's Field-proven, battery powered WanderB SUAS and on its Fuel Cell powered SUAS – Boomerang SUAS which was the world's first operational long-endurance small UAV to be powered on cutting-edge Fuel-Cell technology.WanderB FC is optimized to provide covert, "over-the-hill" or extended range real-time visual intelligence. WanderB is unique in its ability to fly even in strong winds and on cloudy or rainy days, assuring high operational availability for up to 10 hours and a communication range of over 50km (can be extended up to 80km).Fully autonomous, from its point of launch to its accurate parachute and airbag recovery, the system delivers autonomous ease of use and high reliability, providing a very versatile and stable ISR platform. Combining a stabilized CCD or/and IR payload with proprietary ground exploitation software – the WanderB allows for GPS-marked imagery to be relayed in real time to the ground station. This capability delivers enhanced situational awareness, contributing substantially to the success of the mission.The WanderB FC system presents an ultimate solution for supporting real time video or tactical mapping on demand for long endurance open area as well as urban scenarios for military, peace keeping, low intensity conflict, HLS, security, disaster management and commercial applications.Operational missions• Rapid "over-the-hill", covert ISTAR (Intelligence, Surveillance, Target Acquisition and Reconnaissance) in open area as well as urban warfare scenarios.• "First responder".• Border protection.• Force / convoy protection.• Security operations• Law enforcement.• Search and rescue.• Disaster control and management operations.• Commercial applications.• Mapping on Demand photogrammetric solutions.

Cable Services; Disaster Response; Environmental Research or Monitoring; Firefighting; Imaging; Intelligence, Surveillance, Reconnaissance; Mining; Observation; Patrol, Security; Pipeline Services; Precision Agriculture; Search & Rescue; Survey, Mapping; Target Acquisition

**http://www.bluebird-uav.com/WanderB.html**

## EnergyOr Technologies, Inc.

http://www.energyor.com/

**H2 Demonstrator UAV**

Designed and Built to Provide UAV Manufacturers an Advanced Development Platform for Long Endurance Electric UAVs Powered by Fuel Cells.

Disaster Response; Environmental Research or Monitoring; Imaging; Inspection; Intelligence, Surveillance, Reconnaissance; Mining; Observation; Patrol, Security; Precision Agriculture; Research; Survey, Mapping

**http://www.energyor.com/products/detail/h2-endurance-uav**

## FlightWave Aerospace Systems Inc. (United States)

http://www.flightwave.aero

**Jupiter-H2**

The Jupiter-H2 UAS sets a new standard in clean, safe, and powerful aerial platforms. The power generated onboard the Jupiter-H2 allows the UAS to fly longer while carrying more total payload weight. The universal payload system was designed so any sensor , camera, or gimbal could be mounted. The fuel cell provides abundant power, the extra power generated onboard can be used to power sensors and subsystems. Allowing payloads to shed weight and leave their batteries behind. Plug payloads directly into the universal mounting system. Payloads are not

Cable Services; Disaster Response; Environmental Research or Monitoring; Imaging; Inspection; Intelligence, Surveillance, Reconnaissance; Patrol, Security; Pipeline Services; Precision Agriculture; Search & Rescue; Survey, Mapping

**www.flightwave.aero/introducing-the-jupiter-h2/**

## H3 Dynamics

http://www.h3dynamics.com/

**HYWINGS**

HYWINGS is an easy to operate 7kg hydrogen fuel cell powered UAV demonstrator.The key features and functions of HYWINGS include:- Hand-launch: no special launch or recovery infrastructure required- Hydrogen powered UAV including choice of 3 basic sensor options- Assessment of HES fuel cell technology in real flying conditions- Can fly up to 10 hours, and cover a distance of up to 500km

Cable Services; Disaster Response; Environmental Research or Monitoring; Firefighting; Imaging; Inspection; Intelligence, Surveillance, Reconnaissance; Mining; Observation; Patrol, Security; Pipeline Services; Precision Agriculture; Search & Rescue; Survey, Mapping

**http://www.h3dynamics.com/products/hywings/**

HES Energy Systems (Singapore)

## Horizon Energy Systems

http://www.hus.sg/

**HYCOPTER**

HYCOPTER is the world's first hydrogen fuel cell powered multi-rotor UAV. HYCOPTER is being readied for a record flight endurance of 4 hours, or 8 to 10 times the average flight duration of equivalent systems today. Unlike any other rotorcraft, HYCOPTER makes use of its frame structure to store energy in the form of hydrogen instead of air, eliminating energy storage weight. With less lift power required, HYCOPTER's ultra-light fuel cell turns the hydrogen in its frame into electricity to power its rotors. With HUS' breakthrough technology, today's 20-30 minute multi-rotor missions shift to a new paradigm with flights lasting several hours at a time. Aerial survey jobs will become materially cheaper/faster and drone delivery over longer

Cable Services; Disaster Response; Environmental Research or Monitoring; Imaging; Inspection; Intelligence, Surveillance, Reconnaissance; Mining; Observation; Patrol, Security; Pipeline Services; Precision Agriculture; Prototype; Search & Rescue; Survey, Mapping

**http://www.hus.sg/**

H3 Dynamics (Singapore)

## Israel Aerospace Industries (Israel)

http://www.iai.co.il/

**Mini-Panther**

The Mini Panther is a uniquely designed Fixed Wing AVTOL UAV System with a tilt rotor capability that provides a remarkable solution to a wide variety of tasks when pin-point automatic take off and landing is a requirement. The system can be utilized in military, civilian and homeland security (HLS) operations providing high level of operational flexibility and a small logistical

Communications; Disaster Response; Environmental Research or Monitoring; Imaging; Intelligence, Surveillance, Reconnaissance; Observation; Patrol, Security; Search & Rescue;

**Panther**

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Communications; Disaster Response; Firefighting; Imaging; Intelligence, Surveillance, Reconnaissance; Observation; Patrol, Security; Search & Rescue; Survey, Mapping; Target

**http://www.iai.co.il/2013/36944-41636-en/VTOL_Family.aspx**

**Bird Eye 650**

Bird Eye is a family of small UAS developed by IAI. Only the Bird Eye 400 and 650 are currently marketed but the 100, 500, and 600 were also developed.The Bird-Eye 650 system is an advanced solution for low echelon forces to obtain real time intelligence, independent of higher echelon sources. It is based on the operational experience and knowledge accumulated with the Bird-Eye 400.The system is equipped in 2 backpacks and consists of:- 3 UAV platforms- EO&IR payloads- Portable ground control system (PGCS)- Data link- Power source and repair kit- It is man-portable with fast field deployment by a team of two.

Imaging; Intelligence, Surveillance, Reconnaissance; Observation; Patrol, Security; Search & Rescue; Survey, Mapping; Target Acquisition

**http://www.iai.co.il/2013/36943-39739-en/Bird_Eye_Family.aspx**

## Lockheed Martin Corporation

http://www.lockheedmartin.com

**Stalker XE (eXtreme Endurance)**

Lockheed Martin has developed a ruggedized version of its Stalker Unmanned Air System (UAS), called the Stalker eXtreme Endurance (XE) UAS. The Stalker XE system quadruples Stalker's flight endurance to eight-plus hours without impacting the mobility of the unmanned system or the flexibility of its payload capabilities. "Missions requiring real time eyes-on a situation for extended periods of time, like border patrol, pipeline surveillance and special operations can now be conducted by a small UAS versus a larger, more costly system," said Tom Koonce, Lockheed Martin's Stalker program manager. 'The convenience and lower cost of a small UAS combined with extended endurance is a true game-changer." The Stalker XE system is powered by Ultra Electronics' pioneering hybrid energy source using a propane fuel cell with a small, conventional lithium polymer battery to handle power peaks. This long-endurance fuel cell technology was developed through an innovative Defense Advanced Research Projects Agency (DARPA) sponsored effort led by Lockheed Martin and Adaptive Materials Incorporated (now a division of Ultra Electronics Holdings, plc). The DARPA project culminated with a rigorous flight test program including numerous back-to-back, long endurance intelligence, surveillance and reconnaissance high altitude and high wind flights proving that the Stalker UAS met or exceeded all technical and performance milestones. The complete Stalker XE system includes two aircraft, fuel cells, command and control ground station, support equipment, and small propane fuel storage tank. The standard air vehicle sensor is a modular dual daylight and night-time imager that allows persistent surveillance during the visual/thermal transition from day to night.

Disaster Response; Environmental Research or Monitoring; Firefighting; Imaging; Intelligence, Surveillance, Reconnaissance; Observation; Patrol, Security; Pipeline Services; Search & Rescue; Survey, Mapping; Target Acquisition

**http://www.lockheedmartin.com/us/products/stalker-uas.html**

Lockheed Martin Aeronautics Company, Advanced Development Programs (ADP) "Skunk Works" (United States)

## Nautilus (Italy)

http://www.nautiluspace.com/uk/dirigibili.htm

**ELETTRA**

By being an unmanned platform, able to stand with adverse weather conditions and to operate with low cost, makes ELETTRA Twin Flyers a very versatile product suitable for border and maritime surveillance missions. To cope with this activity the platform is provided with the appropriate sensors (electro-optics, radars and hyperspectrals) according to the mission's requirements. Another possibly application for the platform is the communication's coverage extension whenever it is not feasibly to rely upon a fixed installation (catastrophic events, peace-keeping, military operations). In this case the platform is provided with the appropriate communication's means, such as a radio base station and radio links. Furthermore, both the applications above can be performed concurrently by the platform. ELETTRA Twin Flyers System includes the unmanned airship, the Control Station and the Mission Station. The airship and ground stations are connected by means of redundant radio communications with secure capabilities; intercom system with wireless extension integrated with a multiservices network give the fully interoperability between the operators including also the operative staff on the field. The Control Station is provided with a easy-to-use man machine interface to allow the management of the airship made by low skilled staff. The intrinsic safety strictly related to the airship mechanical structure has been integrated and enhanced by means of automatic flight system and redundancy of the critical parts. The Mission Station is different according to the nature of the mission the airship is undertaking and, therefore, to the relevant equipping. Anyhow, the station encompasses data fusion tools and is provided with a simplified GUI (Graphical User Interface) in order to help the operator in the analysis of the received data and in

Communications; Disaster Response; Environmental Research or Monitoring; Imaging; Intelligence, Surveillance, Reconnaissance; Observation; Patrol, Security

**http://www.nautiluspace.com/pdf/2004_11_30.pdf**

## Onera

http://www.onera.fr

### Mirador

Mirador is a design project conducted by the Royal Military Academy of Belgium in collaboration with Onera. MIRADOR states for MicRo Aerial Demonstrator Onera Rma. A very low aspect ratio wing can fly safely at a wide range of angles, and is easier to trim. The range of angles of attack is wider and gusts have less influence. This is the reason why we designed a vehicle with an aspect ratio less than unity. More information on the technical details for this project can be found using the URL associated with this platform.

Prototype; Research

## Politecnico di Torino (Italy)

http://www.polito.it

**Heliplat**

Research is being carried out (as part of several EC funded projects) with the aim of designing Very-Long Endurance Solar Powered Autonomous Stratospheric UAV (VESPAS-UAV) and manufacturing a solar powered prototype. This It could play the role of a pseudo satellite, with the advantage of allowing a more detailed land vision due to the relative closeness to the land and at a much lower cost than a real satellite. 300km diameter area could be monitored by each of these platforms. The full scale HELIPLAT UAV and SHAMPO UAV were designed using the most advanced tools to obtain an endurance of 4-6 months and to be operable in almost all typical environmental conditions (jet stream up to 180km/h) at stratospheric altitude (17-20 km). During the day it will fly with 8 brushless electric motors in which power is generated by thin high-efficiency solar cells that cover the aircraft?s wing and horizontal tail. At night it will be powered by a fuel cell system fed by gaseous hydrogen and oxygen stored in pressurized tanks. A payload of up to 150kg, with available power of up to 1500W, could be installed on board for several kinds of global monitoring of environmental and security applications (GMES). A scaled size prototype (wing span 24 m , length 7 m) has been built in order to show the technological feasibility of the project. The Small Electric Solar Unmanned Airplane (SESA) flying model was built to carry out several experimental flight tests with a small solar powered UAV and to demonstrate some critical technologies and applications. The brushless electric motor was powered by high efficiency (21%) mono-crystalline silicon arrays and LiPo batteries. The structure was made entirely of fibreglass reinforced plastic, except for the wing box, for which carbon-fibre composite materials were also used. A wing with span of 7m was manufactured and 2 m2 of solar cells were bonded over the wing skin, in this way obtaining a far higher endurance of up to 8-10 hours in June and July in a level flight. With a total gross weight of 35 kg, the payload capabilities are of the order of 5 kg. The experimental tests validated several critical technologies for high altitude very long endurance flight: high efficiency solar cells, an electric brushless motor, controllers, video and thermo camera image transmission, telemetry system, autopilot.

Communications; Environmental Research or Monitoring; Firefighting; Imaging; Intelligence, Surveillance, Reconnaissance; Observation; Patrol, Security; Prototype; Research; Survey, Mapping

## RaptorUAS (United Kingdom)

http://www.raptoruas.com/

**Raptor E1**

Raptor E1 was designed to combine the best possible performance in a rugged platform, delivering exceptional flight handling characteristics for reduced ground crew fatigue. The fuselage design delivers an unprecedented large volume for UAS in its scale enabling integration of a variety of payloads. Precision agriculture, habitat research, conservation and high precision land surveys are among the missions Raptor E1 is most suited for.

Cable Services; Disaster Response; Environmental Research or Monitoring; Imaging; Intelligence, Surveillance, Reconnaissance; Mining; Patrol, Security; Pipeline Services; Precision Agriculture; Search & Rescue; Survey, Mapping

**http://www.raptoruas.com/e1.html**

**Raptor LE E2**

Raptor LE E2 delivers the ultimate long endurance platform. Atmospheric research, wildlife conservation, early warning fire detection are among the missions the platform is most suited for. Following in the success of the innovative construction of Raptor E2 it delivers an equally rugged platform for long endurance missions.

Disaster Response; Environmental Research or Monitoring; Firefighting; Imaging; Intelligence, Surveillance, Reconnaissance; Patrol, Security; Pipeline Services; Precision Agriculture; Search & Rescue; Survey, Mapping

**http://www.raptoruas.com/e2.html**

## Shenzhen MicroMultiCopter Aero Technology Co., Ltd.

http://en.mmcuav.com/

**HyDrone 1800**

The HyDrone 1800 is an industrial UAV fueled by hydrogen that keeps it aloft for over 4 hours with a range of over 100 km.

Cable Services; Disaster Response; Environmental Research or Monitoring; Imaging; Inspection; Intelligence, Surveillance, Reconnaissance; Observation; Patrol, Security; Pipeline Services; Precision Agriculture; Search & Rescue; Survey, Mapping

**http://en.mmcuav.com/ProductsSt/159.html**

## Silent Falcon UAS Technologies (United States)

http://www.SilentFalconUAS.com

**Silent Falcon**

The patent pending Silent Falcon™ is a solar/electric, all composite, modular small Unmanned Aircraft System (sUAS) designed for both military and public safety applications. With Silent Falcon's™ solar electric propulsion system, rugged composite structure, and three interchangeable wing configurations, it is the first sUAS capable of meeting the long endurance mission profiles required by commercial, civil, public safety and military operators.

Cable Services; Disaster Response; Environmental Research or Monitoring; Imaging; Inspection; Intelligence, Surveillance, Reconnaissance; Mining; Observation; Patrol, Security; Pipeline Services; Precision Agriculture; Search & Rescue; Survey, Mapping

**http://www.silentfalconuas.com/Silent-Falcon.html**

Ascent Solar (United States)Bye Aerospace Inc (United States)

## Skyline SRLS (Italy)

http://www.skylinesrls.com/

**SEAGULL / SK-Hydrogen**

The SK-Hydrogen is a vertical takeoff and landing aircraft designed to investigate and identify any contaminants in the air. The take-off weight is less than 20 kg, the aircraft is powered by hydrogen fuel cells and has an autonomy in flight equal to more than 5 hours.

Chemical, Biological, Radiological, Nuclear (CBRN); Disaster Response; Environmental Research or Monitoring; Prototype; Research

**http://www.skylinesrls.com/seagull**

## TOP Engineering Group Co., Ltd. (Thailand)

http://www.top-enggroup.com/

**FALCON-V (4.5 meter version)**

The Falcon-V is a hybrid between a quad-copter and an airplane, new technology of TOP Engineering Group allows for precision vertical take off and landing VTOL while retaining our proven long-duration and large payload capacities. It is a unmanned aerial platform designed for front-line day/night intelligence, surveillance and reconnaissance (ISR). Fully autonomous flight control is gained through the autopilot command center software which Fully autonomous flights from launch to land are easily operated by a two man crew.

Cable Services; Chemical, Biological, Radiological, Nuclear (CBRN); Communications; Disaster Response; Environmental Research or Monitoring; Firefighting; Imaging; Inspection; Intelligence, Surveillance, Reconnaissance; Logistics; Patrol, Security; Pipeline Services; Precision Agriculture; Research; Search & Rescue; Survey, Mapping

**http://www.top-enggroup.com/product.htm**

**FALCON-V (3 meter version)**

The Falcon-V is a hybrid between a quad-copter and an airplane, new technology of TOP Engineering Group allows for precision vertical take off and landing VTOL while retaining our proven long-duration and large payload capacities. It is a unmanned aerial platform designed for front-line day/night intelligence, surveillance and reconnaissance (ISR). Fully autonomous flight control is gained through the autopilot command center software which Fully autonomous flights from launch to land are easily operated by a two man crew.

Cable Services; Chemical, Biological, Radiological, Nuclear (CBRN); Communications; Disaster Response; Environmental Research or Monitoring; Firefighting; Imaging; Inspection; Intelligence, Surveillance, Reconnaissance; Logistics; Patrol, Security; Pipeline Services; Precision Agriculture; Research; Search & Rescue; Survey, Mapping

**http://www.top-enggroup.com/product.htm**

## U.S. Naval Research Laboratory

http://www.nrl.navy.mil/

**Ion Tiger**

The U.S. Navy is converging two separate research efforts — unmanned air vehicles (UAVs) and fuel cell systems — to significantly improve battlefield surveillance capability. The Ion Tiger is a hydrogen-powered fuel cell UAV in development at the Naval Research Laboratory, the corporate laboratory of the Office of Naval Research (ONR). Previously flown with battery power, it has demonstrated sound aerodynamics, high functionality, and low-heat and noise signatures. Test flights of Ion Tiger have exceeded 24 hours with a 6 lb payload. Tests demonstrated how an enduring surveillance solution can operate at a low cost with less possibility of detection. The trials exceeded previous flight duration seven-fold from previous designs. Across the board, the military is seeking quieter and more efficient sources of energy. ONR is leading the Navy with support for alternative fuel research, and has been a leader and key supporter of fuel cell research for 20 years. By leveraging other ONR research, and cooperating with partner agencies, ONR and its partners anticipate success in this mission.

Disaster Response; Environmental Research or Monitoring; Imaging; Intelligence, Surveillance, Reconnaissance; Observation; Patrol, Security; Prototype; Research; Search & Rescue; Survey, Mapping

**http://www.onr.navy.mil/Media-Center/Fact-Sheets/Ion-Tiger.aspx**

**Spider-Lion**

The Naval Research Laboratory, in collaboration with industrial partners, demonstrated an unmanned aerial system (UAS) flight solely powered by fuel cell technology. The flight of the 5.6-pound 'Spider-Lion" lasted 3 hours, 19 minutes and consumed 15-grams of compressed hydrogen gas. The project is a joint venture between NRL's Chemistry and Tactical Electronic Warfare Divisions and Protonex Technology Corporation. The flight was conducted with L3-BAI Aerosystems at their Ragged Island facility on Maryland's Eastern Shore under weather conditions of 65oF, moderate winds, and light rain at takeoff. The 100-watt fuel cell system was designed and constructed at NRL largely using commercially available hardware and a fuel cell stack and components developed by Protonex. The "Spider-Lion" UAS was developed by NRL as a high-impact research platform for testing fuel cell technology. Research and development continues aimed at developing a fuel cell system capable of powering small military platforms currently in the field or in advanced development stages requiring extended operation that is not achievable using current battery technology.

Prototype; Research

**http://www.nrl.navy.mil/media/news-releases/2005/nrl-demonstrates-fuel-cellpowered-unmanned-aerial-system**

## Unique (Yin Chuan) Aero-Tech Corporation (China)

### UATC Tilt-Rotor UAV

UATC's tilt-rotor UAV has been developed for long endurance operations using a hydrogen fuel cell propulsion system.

Disaster Response; Environmental Research or Monitoring; Imaging; Inspection; Intelligence, Surveillance, Reconnaissance; Patrol, Security; Search & Rescue; Survey, Mapping

## UnKnown Aerospace Ltd.

### Cygnet

Cygnet is a development UAV from UnKnown Aerospace. The system combines autonomy in the aircraft with autonomy in the ground system to create a flexible combined cargo and payload capability. The system includes several novel elements including self-balancing cargo attachment, reduced ground processing time leading to more time in the air, reduced structural requirement for cargo modules and modular design for different flight profiles, including medium and high altitude reconnaissance payloads, and low altitude cargo. Including missions from space launch to aerial mapping through to humanitarian aid. Capabilities include:- cargo and logistics UAV platform- capable of automated cargo ground handling- unmanned or manned, prop or jet full-size variants- automatic CofG control to ensure flight safety- free flight UAV/Remotely operated- unique logistics capabilities (patented)

Communications; Disaster Response; Environmental Research or Monitoring; Imaging; Intelligence, Surveillance, Reconnaissance; Logistics; Search & Rescue; Survey, Mapping

**http://ukaec.com/cygnet.htm**

## VTOL Technologies

http://www.vtol-technologies.com/

### VTOL UAV

This platform is a VTOL UAV powered by a hydrogen fuel cell that was developed by Iranian inventor Ja'far Aqazadeh. Detailed information regarding specifications, intended applications, etc. are currently unavailable.

Prototype; Research

**Urban Eagle**

Urban Eagle is a multi-purpose VTOL UAV for urban, maritime and mountainous environments. This unique new design from Britain's VTOL Technologies takes this idea a step further, adding four movable rotors to a single "flying-wing" to create an aircraft that claims to deliver a higher payload capacity for its size and up to four times the endurance of current vertical take-off and landing (VTOL) UAV designs.The company describes the concept as a "superb piece of minimal ?systems-engineering? based design, eliminating redundant aircraft features that add weight, overcomplicate flight control, increase drag and reduce endurance." The idea is that less can go wrong with this simplified platform, primarily because the fixed wing requires no control surface actuators. In the event that something does come unstuck, namely the loss of power to one or more of the motors, the UAV can still operate at close to cruising speed with three or even just two rotors operational. The design also boasts resistance to wind gusts, fast stall recovery and in the event of a total loss of power, the shallow glide angle offered by the flying wing design means there's a greater chance of fixing the issue in the air or bringing the craft to ground safely compared to other fixed rotor VTOL designs.

Chemical, Biological, Radiological, Nuclear (CBRN); Disaster Response; Imaging; Intelligence, Surveillance, Reconnaissance; Observation; Patrol, Security; Prototype

**http://www.vtol-technologies.com/**