ALGER

til Biogas i Region Midtjylland

– projektidé til et 3-årigt udviklings- og demonstrationsprojekt

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Alger til Biogas i Region Midtjylland

Ansøgte projekt er et 3-årigt udviklings- og demonstrationsprojekt, der skal:

- sikre Region Midtjylland en frontposition i udvikling af energi- og miljøteknologi baseret på anvendelse af akvatisk biomasse fra salt- og ferskvand
- fremme erhvervsudvikling og innovation i regionen gennem udvikling og udveksling af teknologi, viden og behov mellem virksomheder, forskningsinstitutioner og Godkendte Teknologiske Service Institutter (GTS-institutter)
- være forankret i regionen, men danne basis for et stærkt netværk af nationale og internationale virksomheder og forskningsmiljøer indenfor anvendelse af akvatisk biomasse

Projektet ansøges af et samarbejdskonsortium mellem Danmarks Miljøundersøgelser ved Aarhus Universitet (DMU), Teknologisk Institut (TI), Havets Hus (HH), Kattegatcentret (KC), Det Jordbrugsvidenskabelige Fakultet ved Aarhus Universitet (DJF) og DONG Energy (DONG).

Baggrund

Alger har de seneste år været i søgelyset, både nationalt og internationalt, som en potentiel kilde til bæredygtig energi. Fordelene ved at anvende alger til energiformål er dels et højt biomasseudbytte, sammenlignet med terrestriske energiafgrøder, dels at produktet ikke konkurrerer med fødevareproduktion. På internationalt plan har fokus primært været på produktion af biodiesel fra mikroalger, mens enkelte projekter bl.a. i USA i 1980'erne, i Skotland (Biomara) og det danske Søsalatprojekt i stedet har fokuseret på makroalger. Makroalger – eller tang – har et højt indhold af kulhydrater, der potentielt kan udnyttes til både bioethanol, butanol, biogas og forbrænding.
I det danske søsalatprojekt er det for nyligt dokumenteret at såvel produktionspotentialet, som biogaspotentialet i den danske makroalge søsalat (*Ulva lactuca*) er betragteligt. Produktionen er estimeret til minimum 45 T tørvægt /ha/år i landbaserede anlæg, og biogas produktionen fra søsalat er på niveau med produktionen fra kvæggylle og kløvergræs (Bruhn et al, *in prep*. Bech, 2009). Produktionstallene indikerer, at det danske klima ikke er en hindring for en meget høj biomasseproduktion. Barrieren i kommercialisering af bioenergi fra alger er bl.a., at omkostningerne er relativt høje gennem hele produktionskæden: dyrkning, høst, forbehandling og energikonvertering. Omkostningerne kan dog bringes ned dels ved udvikling og implementering af ny og eksisterende teknologi gennem hele produktionskæden, dels ved at udnytte andre kommercialiserbare stoffer i alger. Produkter af høj værdi, som farvestoffer, proteiner, vitaminer, næringsstoffer eller bioaktive stoffer kan udvindes af algebiomassen før energikonvertering. Alger anvendes således i dag i en række industrivirksomheder indenfor både fødevare-, foder- og medicinalindustrien, og der er et oplagt potentiale for en følgeindustri af algeprodukter i regionen både indenfor allerede eksisterende virksomheder og i etableringen af nye. En sådan industri kunne udvikles i Grenå området, hvor adgang til hav-baserede dyrkningsanlæg kan etableres og hvor grunden er lagt til en aftage-industri bl.a. gennem den projekterede bioethanol produktion. Dyrkning af alger giver desuden miljømæssige gevinster. Algerne fungerer som "biofiltre", idet de omdanner affalds- eller spildprodukter som CO_2, gylle, spildevand eller næringsstoffer i havmiljøet til CO_2 neutral biomasse (Gao & McKinley, 1994)
Mens 2. generations bioethanol fortsat er på det før-kommercielle stadie, er biogasproduktion på baggrund af affald og plantebiomasse veldokumenteret og i hastig vækst på verdensplan. I forhold til andre teknologier for energikonvertering af akvatisk biomasse, menes biogas derfor at være den teknologi, der på kortest tid kan kommercialiseres. Biogas vil blive en væsentlig del af fremtidens miljøvenlige energisystem både til produktion af el og varme i den eksisterende energisektor og i opgraderet form som transportbrændstof. Ved at udvikle den eksisterende biogasteknologi, og udvikle/demonstrere nye teknologier til at producerer biogas fra alger, vurderes det, at produktionen kan øges med op til 50%. Udfordringerne i biogasproduktionen ligger primært i forbehandlingen, bl.a. i fjernelse af forgæringshæmmende komponenter som salt og svovl fra biomassen før forgæring. En ny vinkel på forbehandling af biomasse er introduceret med DONG's REnescience teknologi, der er udviklet med henblik

på omsætning af usorteret husholdningsaffald. Forbehandlingen består i kogning af biomassen efterfulgt af enzymatisk nedbrydning, og resulterer i en fast fraktion som kan anvendes til el- og varmeproduktion i et kraftværk og en flydende fraktion som forventes anvendelig til biogasproduktion. Teknologien er af tre årsager interessant i forhold til akvatisk biomasse. Forbehandlingen kan vise sig at være velegnet til nedbrydning af algebiomassen forud for en biogasproduktion. Brændselskvaliteten af den faste fraktion vil øges, idet salte separeres ud i den flydende fraktion, og endelig kan den flydende fraktion fra forbehandling af husholdningsaffald potentielt anvendes som næring for algedyrkning. Indenfor produktionen af alger ligger udfordringerne i at udvælge de mest optimale arter til biogasproduktion, optimere den biokemiske sammensætning af disse arter, øge produktionsraten og nedbringe energiomkostningerne i dyrkningen. Protoplast-teknologi er hér en lovende metode til selektion og effektiv opformering af udvalgte økotyper af alger - uden anvendelse af genetisk manipulation (Reddy et al. 2008).

Energi- og miljømæssige fordele ved dyrkning af alger til energi

Biogas produceret af algebiomasse er CO_2 neutral energi, der kan substituere for fossilt brændstof. Dels i produktion af el og varme, hvor biogassen kan erstatte naturgas; dels på transportområdet, hvor flydende biogas kan erstatte diesel og benzin.

Dyrkning af alger til biogas, har desuden flere gavnlige virkninger på miljøet, idet algerne under væksten lever af CO_2 og næringsstoffer, der til dels er uønskede i miljøet:

- Der bindes kulstof svarende til 1,5 -3 tons CO_2 per ton producerede alger (tørvægt)
- Tilførsel af CO_2 beriget luft kan forøge produktionen af alger per areal (Bidwell et al. 1985)
- Dyrkning af makroalger fjerner kvælstof og fosfor fra det omgivende vand. Op til 15,4 kg kvælstof pr. ha per dag (Gao & McKinley, 1994). Dyrkning af alger i havvand kan således mindske de negative effekter af næringsforurening i havmiljøet, som eksempelvis iltsvind i kystnære farvande. Alternativt kan algedyrkningen indgå som et led i spildevandsbehandlingen
- De organiske restprodukter fra biogasproduktionen kan anvendes som gødning/jordforbedring i landbruget. Det fører både kulstof og næringsstoffer tilbage til landbrugsjorden på en sådan måde, at de frigives langsomt i jorden og derfor mindsker udvaskningen af næringsstoffer til vandmiljøet
- Restprodukter fra biogasproduktion kan bidrage til at sikre næringsstofforsyningen i økologiske planteavls bedrifter, der i fremtiden ikke vil kunne importere ikke-økologisk husdyrgødning

Formål

Formålet med projektet "Alger til Biogas i Region Midtjylland" er udvikling og implementering af nye teknologier og facilitering af vidensdeling mellem virksomheder, forskningsinstitutioner og GTS-institutter. Projektet har som konkrete delmål, at:

- Opstille og forvalte et landbaseret, recirkuleret algedyrkningssystem ved Havets Hus og Kattegatcentret i Grenå
- Identificere, optimere og demonstrere produktion af de mest optimale danske arter af makroalger til produktion af biogas, herunder implementering af protoplast teknologi
- Udvikle teknologi til udnyttelse af relevante spildprodukter i Region Midtjylland som næring for algeproduktion (fx gylle, spildevand, CO_2 fra røggas)
- Udvikle og demonstrere teknologi til høst, forbehandling og karakterisering af akvatisk biomasse, herunder termisk og enzymatisk behandling med REnescience teknologien
- Udvikle og demonstrere eksisterende og ny teknologi til produktion af biogas fra akvatisk biomasse, bl.a. fjernelse af svovl før forgæring
- Opgradere biogas til flydende biogas, et bæredygtigt 2. generations transportbrændstof (denne aktivitet foregår gennem EU projektet BioWalk4Biofuels)
- Undersøge og beskrive potentialet for opførelse af fuld-skala REnescience anlæg i Region Midtjylland
- Udnytte restproduktet fra biogasproduktion og fast fraktionen fra REnescience forbehandling til brændselspiller eller økologisk jordforbedringsmiddel

- Deltage i en erhvervsklynge med omdrejningspunkt i aktiviteterne i Havets Hus og Grenå med fokus på kommercialisering af energi og højværdiprodukter fra alger
- Kortlægning af muligheder og potentialer for erhvervsudvikling bl.a. gennem afholdelse af årlige workshops, hvor erhverv, forskning og GTS-institutter udveksler viden og behov
- Formidle principperne for produktion af bæredygtig energi fra akvatisk biomasse og projektets resultater gennem Kattegatcentret (udstilling og skoletjeneste), Havets Hus (erhvervsklynge), medier og videnskabelige fora
- Opstille et realistisk scenarie for algedyrkning i stor skala i Danmark

"Alger til Biogas i Region Midtjylland" vil blive medfinansieret fra et forsknings- og demonstrationsprojekt under EU's 7 rammeprogram "BioWALK4Biofuels", med deltagelse af to af nærværende projekts partnere, DMU og TI. Projektet har 10 andre internationale partnere fra bl.a. Italien, Indien, Spanien, Jordan, Polen og Sverige (bilag 1). BioWALK4Biofuels er for øjeblikket i kontraktforhandling mellem de europæiske partnere og EU. Målet er at producere biogas fra alger, der næres ved spildevand og røggas, og derved producere et bæredygtigt 2. generation biobrændstof.
Den direkte kobling mellem ansøgte projekt og et nyt EU projekt vil sikre gennemslagskraft både nationalt og internationalt: Internationale erfaringer - *beyond state of the art* - fra algedyrkning, biogasproduktion og biogasopgradering vil både skabes i og overføres til Region Midtjylland. I BioWalk4Biofuels projektet deltager indiske partnere som internationale spidskompetencer indenfor protoplast-teknologi, og et mål er at implementere teknologien i Region Midtjylland i ansøgte projekt. Kun to af de planlagte aktiviteter i EU projektet vil ikke blive gennemført i Region Midtjylland. Det drejer sig om kryogen opgradering af biogassen til flydende biogas til miljøvenlig transport, og opskalering af algedyrkningen i bassiner i åbent vand. Viden fra disse områder i EU-projektet vil dog kunne implementeres i Region Midtjylland og dermed bidrage til udvikling i regionen.
"Alger til Biogas i Region Midtjylland" forventes at have stor betydning for erhvervsudviklingen i regionen indenfor udnyttelsen af alger og udvikling af nye anvendelsesområder og medvirke til at opbygge regionens position som førende i Danmark og Europa indenfor udnyttelse af akvatisk biomasse.

Erhvervspotentiale i "Alger til Biogas i Region Midtjylland"
I et notat udarbejdet juli 2009 af Teknologisk Institut til Region Midtjylland (TI, 2009), fremgår det entydigt, at der er et "*stærkt udgangspunk for vækst*" samt et "*signifikant erhvervspotentiale*" baseret på produktion og udnyttelse af alger til energi og andre formål i Region Midtjylland. Et bredt udvalg af regionens virksomheder kan indgå i de forskellige faser i værdikæden fra produktion til anvendelse (figur 1) – ikke mindst med henblik på en produktion af biogas. Denne udvikling understøttes yderligere af en erhvervsklynge med fokus på udnyttelse af akvatisk biomasse som er under etablering ved Havets Hus. *Etablering*: I fasen forud for opstillingen af et dyrkningssystem, vil et stort antal virksomheder kunne bidrage med implementering af måleudstyr og rådgivning omkring teknologiske løsninger. *Produktion*: 19 havbrug, 107 ferskvandsbrug og 44 virksomheder knyttet til behandling af spildevand vil potentielt kunne indgå som medudviklere og aftagere af grøn teknologi til rensning af spildevand eller som leverandører af spildprodukter som næring for algeproduktionen. Udvikling af et samarbejde med den østjyske virksomhed Marifood, som Havets Hus allerede samarbejder med, og som er landets eneste nystartede algeproducent er planlagt. *Anvendelse:* Anvendelsen af biomassen er den fase, der har størst erhvervspotentiale, og notatet har således identificeret 698 virksomheder i energibranchen i Region Midtjylland. Alene til fremstilling af gas findes 16 virksomheder, der vil kunne få gavn af den nyudviklede teknologi. Desuden forventes udvinding af højværdiprodukter af algebiomassen før den konverteres til energi, at have betydelig fremtidig kommerciel værdi. Uanset om det er stivelsesprodukter, olier, proteiner, vitaminer, fibre eller farvestoffer, man prioriterer at udvinde, ligger hér et uhyre stort erhvervspotentiale i Region Midtjylland. I notatet figurerer 196 virksomheder som potentielle aftagere af algebiomasse til fødevarer, foder, kosmetik og helsekost.

Det ansøgte algedyrkningssystem vil desuden være ideelt til målrettet udvikling og optimering af udnyttelse af specifikke algearter til specifikke erhvervsformål. Små og mellemstore virksomheder (SMV) vil oplagt kunne benytte Forsknings- og Innovations styrelsens "Videnskuponer" til udvikling af målrettet viden til gavn for den enkelte SMV i samarbejde med universiteter eller GTS-institutter.

Figur 1. Flow i produktionskæden fra dyrkningen af alger over høst, forbehandling, karakterisering og endelig energiproduktion.

Formidling af projektet

Formidlingen af "Alger til Biogas i Region Midtjylland" vil være funderet i Havets Hus og Kattegatcentret.

- Havets Hus vil årligt afholde en virksomheds workshop med gratis deltagelse for samtlige interesserede virksomheder, med henblik på udvikling og udveksling af viden og behov mellem erhverv, forskning og GTS-institutter. Havets Hus er som nævnt allerede i færd med at etablere en erhvervsklynge med fokus på udnyttelse af havets ressourcer
- Dyrkningssystemet med tilhørende demonstrations-biogasreaktor i mini-størrelse vil indgå i Kattegatcentrets Skoletjenestes tilbud om tematiserede undervisningsforløb særligt rettet mod gymnasium og HTX
- På Kattegatcentret skal produceres en udstilling, der formidler koncept, metodologi og erhvervspotentiale bag vedvarende energi fra akvatisk biomasse
- Projektets koncept, mål og resultater vil løbende blive formidlet til medier og videnskabelige tidsskrifter

Projektets aktører

Ansøgerne bag "Alger til Biogas i Region Midtjylland" er alle forankrede i Region Midtjylland og blandt de førende kræfter indenfor udnyttelse af makroalger til energi, både nationalt og internationalt.
Danmarks Miljøundersøgelser (DMU) er førende nationalt mht. dyrkning af akvatisk biomasse som kilde til vedvarende energi og som middel til miljøforbedring. DMU leder/deltager i tre nationale projekter om anvendelse af akvatisk biomasse til energi og deltager i EU projektet BioWalk4Biofuels.
Teknologisk Institut (TI) arbejder målrettet med udvikling og anvendelse af nye biomasser til energi, foder, fødevarer og miljøsektoren. TI er projektleder på det største nationale projekt (Søsalat-projektet) om anvendelse af akvatisk biomasse til energi og deltager i EU projektet BioWalk4Biofuels.
Dansk Jordbrugs Forskning (DJF). Det er Det Jordbrugsvidenskabelige Fakultets mission at fastholde, udvikle og formidle vidensgrundlaget for bæredygtigt jordbrug og produktion af fødevarer af høj kvalitet. DJF råder over moderne laboratorier og biogasforsøgsanlæg, og satser bl.a. på biogas fra akvatisk biomasse.
DONG energy (DONG) er Danmarks største producent af elektricitet og deltager løbende i Forsknings & Udviklings projekter i relation til den danske energisektor. DONG står bag de banebrydende anlæg INBICON til ethanol produktion og REnescience til produktion af gas fra affald.
Kattegatcentret (KC) er en selvejende fond og drives på non-profit basis. KC formidler bred viden om livet i havet lokalt og globalt, og har en aktiv skoletjeneste, som årligt besøges af 14.000 elever og studerende.
Havets Hus (HH) Havets Hus er et udviklingsprojekt, der har kurs mod etablering af et kombineret forsknings-, erhvervs- og oplevelsescenter i tilknytning til det nuværende Kattegatcenter i Grenå.
AkvaGroup (AG) er en førende international virksomhed med mere end 25 års erfaring indenfor design og udvikling af recirkuleringssystemer til akvakultur af primært fisk og skaldyr og senest dyrkning af alger. (AG er underleverandør – ikke ansøger til projektet).

Budget og finansieringskilder

Aktivitet/Finansiering	RM	EU	DJF	NK/KC	HH/KC	DONG	AG	**I alt**
Organisering	150							**150**
Dokumentation	1.491	2.969	500			250		**5.210**
Formidling	670				150			**820**
Etablering af algedyrkningssystem	2.261	261		1.000			500	**4.022**
I alt	**4.572**	**3.230**	**500**	**1.000**	**150**	**250**	**500**	**10.202**

Ansøgte beløb svarer til 45% af projektets totale omkostninger.
RM = Region Midtjylland, EU = projektet BioWalk4Biofuels under EU's 7. rammeprogram. NK = Norddjurs Kommune.

RM's Vækstfond ansøges om at dække 45% af projektets omkostninger, svarende til 4,572 mio DKR. Heraf udgør 1,127 mio medfinansiering til projektet BioWalk4Biofuels under EU's 7. rammeprogram (bilag 1). DMU og TI medfinansierer via BioWalk4Biofuels dyrkningssystem og dokumentation af aktiviteter. DJF medfinansierer med rådighed over forsøgsanlæg i Foulum. NK/KC stiller 500m^2 på Grenå Havn til fuld rådighed for projektet (bilag 2). HH/KC medfinansierer ved at stille skoletjenesten til rådighed med 25 årlige undervisningsforløb á 2 timer på gymnasium/HTX niveau i projektets løbetid. DONG medfinansierer med mandetimer. AG medfinansierer ved at skyde egenkapital ind i udvikling af algedyrkningssystemer (bilag 3).

Tidsplan

	Aktivitet (aktører)	**År**		
		2010	**2011**	**2012**
Organisering	Organisering af styregruppe for dyrkningssystem (DMU, TI, HH)	x		
	Udarbejdning af plan for involvering af erhvervslivet i RM (Alle)	x		
	Udarbejdning af overordnet plan for formidling (Alle)	x		
	Udbygning af nationalt og internationalt netværk (Alle)	x	x	x
Etablering				
	Projektering af dyrkningssystem (AG, DMU, TI, HH, KC)	x		
	Opstilling af dyrkningssystem (AG, DMU, TI, HH, KC)	x		
	Etablering af demonstrations reaktor til biogasproduktion (DJF, HH, KC)	x		
	Etablering af erhvervsklynge med fokus på akvatisk biomasse (HH, DMU, TI)	x		
Dokumentation				
	Identifikation af optimale algearter (DMU, TI, DFJ)	x		
	Optimering af udvalgte arters vækst og indholdsstoffer (DMU)	x	x	x
	Spildevand/gylle/CO_2 som næring i algeproduktion (DMU, DJF, DONG)		x	x
	Implementering af protoplast teknologi (DMU)		x	x
	Udvikling af teknologi til høst og forbehandling (TI, DONG)	x	x	x
	Karakterisering af biomasse (TI)	x	x	x
	Produktion af biogas (DJF)	x	x	x
	Udvikling af 2. generations biogasteknologi (fx svovlstripning) (DJF)		x	x
	Presning af piller ud fra restprodukter og evaluering af brændselkvalitet (TI)	x	x	x
	Vurdering af restprodukter som økologisk jordforbedringsmiddel (DJF)		x	x
Formidling				
	Grøn energi i udstilling og skoletjenesten i Kattegatcentret (Alle)	x	x	x
	Workshops for erhvervslivet – Havets Hus (Alle)	x	x	x
	Erhvervsorienterede kurser i algedyrkning (HH, DMU)		x	x
	Formidling af resultater via medier og artikler (Alle)	x	x	x
	Slutrapport (DMU, TI, HH, KC, DONG)			x

Bilag

1. Projektbeskrivelse BioWalk4Biofuels. Projekt under EU's 7. rammeprogram.
2. Tilsagn om rådighed over havneareal. Kattegatcentret, Grenå Havn, Norddjurs Kommune
3. Skitse af algedyrkningssystem. AkvaGroup
4. Referencer

COLLABORATIVE PROJECT
Call Identifier FP-7Energy-2009-1-RTD

Topic Energy.2009.3.2.2

Biowaste as feedstock for 2nd generation

Proposal full title:	**Biowaste and algae knowledge for the production of 2nd generation biofuels**
Proposal Acronym:	**BioWalk4biofuels**
Type of funding scheme:	Collaborative project
Work programme topics addressed:	**Theme Energy.2009.3.2.2: Biowaste as feedstock for 2nd generation**
Project Coordinator:	Dr. Silvano Simoni CIRPS – Interuniversity Research Centre for Sustainable Development – University of Rome "La Sapienza" silvano.simoni@uniroma1.it Tel. +39 06 87452030 Fax +39 06 87452050

List of participants

Participant no.	Participant organisation name	Country	Type
1 (Coordinator)	Interuniversity Research Centre for Sustainable Development (CIRPS) – University of Rome "La Sapienza"	Italy	Research Institute
2	National Interuniversity Consortium for Ocean Sciences (CoNISMa)	Italy	Research Institute
3	Ecoil	Italy	SME
4	National Environmental Research Institute (NERI), Aarhus University	Denmark	Research Institute
5	Danish Technological Institute (DTI)	Denmark	Research Institute
6	Central Salt & Marine Chemicals Research Institute (CSMCRI)	India	Research Institute
7	NGVA Europe	Spain	NGO
8	Scandinavian Gas Treatment Service (SGtS)	Sweden	SME
9	Hashemite University – Faculty of Natural Resources and Environment (HU)	Jordan	University
10	Riga Technical University (RTU)	Latvia	University
11	Aquagri Process Pvt Ltd (AP)	India	SME

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1 : Scientific and/or technical quality, relevant to the topics addressed by the call

1.1 Concept and objectives

The world energy demand is expected to rise 60% by 2030; oil consumption has increased by 20% since 1994, while the European Union import dependency reached almost 54% of its energy requirements in 2006[1]. Landfilling of biowaste is one of the major sources of methane emissions in Europe, contributing to 2% of GHG emissions in 2007 in the European Union (EU)[2]. Biodegradable waste that is landfilled should be reduced to 35% of 1995 levels by 2016 according to EC Landfill Directive (1999/31/EC). Direct and indirect greenhouse gas emissions (GHG) emissions from industry are currently about 12 $GtCO_2$-eq[3]. Council Directive 91/676/EEC[4], has underlined the need to control the reduction of water pollution caused *by nitrates from wastes to protect human health*, living resources and aquatic ecosystems. As well, attention is being focused to the treatment of biowaste, which requires a strong support from EU legislation[5] to address difficulties in their direct utilisation, cost-efficiency and pollution in its output products.
Moreover the need to focus on 'non-food' energy crops for the production of 2nd generation biofuels and develop cost-efficient solutions has been revealed and underlined in the recent report of the Food and Agriculture Association6. In fact, currently, the production of biogas is principally carried out through anaerobic fermentation of (mixed) cereal crops.
The European Council after the United Nations Climate Change Conference in Bali December 2007 set two ambitious key targets: a reduction of 20% of greenhouse gases (GHG) by 2020; and a 20% share of renewable energies in EU energy consumption by 2020. Hence, the need to further explore new sources of alternative renewable energy and ground-breaking solutions to reduce GHG emissions becomes of upmost importance. In this scenario it appears fundamental to improve the know-how about a "new" biofuel production, in particular regarding 2nd generation biofuels. In order to face this new challenge, in this project, "Biowaste and Algae Knowledge for the Production of 2nd Generation Biofuels" **the use of biowaste as a feedstock and of algae as a catalyser for producing biofuels represents an alternative way to address the mentioned issues** in a multidisciplinary approach.

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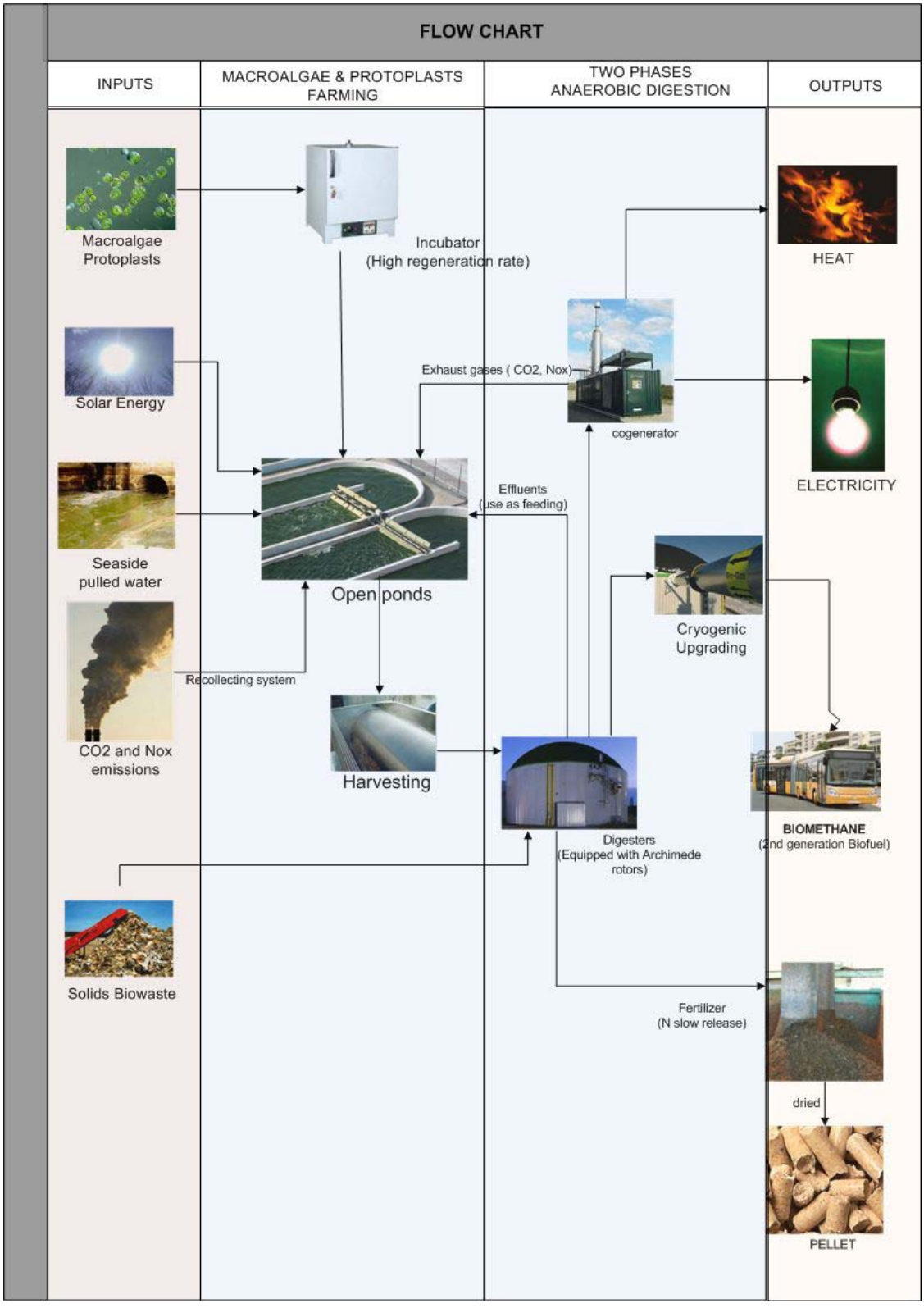
[1] Commission of the European Communities, 2008. *Commission Staff Working Document. Second Strategic Energy Review, An EU Security and Solidarity Action Plan: Europe's current and future energy position Demand – resources – investments*. {COM(2008) 744}, Unofficial Version, Brussels, Belgium.
[2] EEA – European Environment Agency, 2007. *Greenhouse gas emissions trends and projections in Europe 2007.* EEA Report, Copenhagen.
[3] IPCC – Intergovernmental Panel for Climate Change, 2007. *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge Univesity Press, Cambridge, United Kingdom and New York, NY, USA.
[4] Concerning the protection of waters against pollution caused by nitrates from agricultural sources.
[5] Tabajdi CS, 2007. *Report on sustainable agriculture and biogas: a need for review of EU Legislation (2007/2107(INI)).* Committee on Agriculture and Rural Development. European Parliament Session Document.
[6] FAO – Food and Agriculture Association, 2008. *The State of Food and Agriculture. Biofuels: prospects, risks and opportunities.* Rome, Italy.

Figure 1 - Shows the proposed process scheme flows for the production of biofuels, using biowaste as feedstock and macroalgae as our catalyser



The BioWalk4Biofuels project is a research and an demonstrative initiative which **has the aim to develop a cost-efficient solution that uses biowaste as a feedstock for the production of 2nd generation biofuels, using macroalgae as a catalyser, while minimising the environmental impact of biofuel production**. **Main** and **Specific objectives** of the project are pointed out as follows:

a) The use of macroalgae as interface between biowaste and energy production allow a direct utilisation of biowaste obtaining, at the same time, the following positive externalities or specific objectives:

a1) Treatment of high nitrogen and phosphate content biowaste (control index 21 kg N/day, control index 3 kg P/day)

a2) Creation of a CO2 sink for the carbon credit market (control index 190 kg/h insufflated)

a3) Production of biomass pellets and fertilizer from organic residues of the biodigestor (control index 300 kg/day)

---

a1) ***Treatment of high nitrogen and phosphate content biowaste***
Macroalgae need nitrogen and phosphate to grow: an adequate choice of biowaste rich on this chemical elements (e.g. poultry manure) can provide the right amount of nitrogen requested for algae growth and, at the same time, transform the negative eutrophication potential of such biowaste into a positive input. The idea is to take advantage of the eutrophication problem and CO_2 emissions that are negative externalities of human activities using them as feeding for macroalgae cultivation with the aim to optimize the life-cycle analysis (LCA) of the overall process from wheel to wheel. Considering the above reasons macroalgae could resolve the problems related to the excessive amount of nitrogen in wastewater treatment plants.

a2) ***Creation of a CO2 sink for the carbon credit market***
The amount of CO_2 requested for algae growth will be supplied through a piping system from a boiler (about 150m3/h) to open ponds. This means a reduction of CO_2 and NOx emissions in the air from the boiler*;*

a3) ***Production of biomass pellets and fertilizer from organic residues of the biodigestor.*** The use of a two phase anaerobic digestion allows to produce residues that could be dried out and pelletized or used as organic amending with 7-9% nitrogen content to slower its release.

b) Macroalgae can be directly used in biodigestors to produce energy without the need of mixing with other cereal crops

Macroalgae allow to avoid the use of food crops for energy production making biowaste a positive input in the process. Nowadays, the production of cereal crops is in the range of 30-200€/tonne, where prices are dependent on the food market. Below the related specific objectives:

b1) ***Use of macroalgae as a high-yield 'non-food' source of biomass and energy (to avoid food/fuel competition for land use) (control index 600 kg dw/day)***

b2) ***To achieve a cost-effective biomass production, independent from a food market, (Control index 150 €/tonn algae)***

---

b1) ***Use of macroalgae as a high-yield 'non-food' source of biomass and energy (to avoid food/fuel competition for land use).*** Macroalgae cultivation can be carried out in controlled open ponds (savings 5000 m^2 of land surface) . Four PVC open ponds will be placed seaside in the site plant in Sicily in order to create a close system 'contaminated' with nitrogen, phosphate, potassium (K (coming from selected biowaste) and CO_2 (collected from the boiler);

b2) ***To achieve a cost-effective biomass production, independent from the food market***, which is a product of rational biowaste (a non-valuable product) treatment, is a BioWalk4Biofuels goal.

c) Pre-cultivation of protoplasts in incubator permit to accelerate the cell regeneration, diminishing the life-cycle of macroalgae:

c1) ***Easier pre-selection and reproduction of high-carbohydrate content species (Control index 50% carbohydrate content)***

c2) **Pre-cultivation of protoplasts *obtain higher yields within shorter periods (Control index 10% increase in algae production)***

---

c1) ***Easier pre-selection and reproduction of high-carbohydrate content species;***

The selection criteria will be high growth rate and high-energy potential, defined as a high calorie content as well as carbohydrate and lipid content.

c2) **Pre-cultivation of protoplasts *obtain higher yields within shorter periods.***

Fast growing green algae like Ulva lactuca and Chaetomorpha linum. Etc will be cultivated in Danish waters at the first step, and in Italy in the demonstration plant.

d) Optimization of the two phase anaerobic digestion process

d1) **biogas production per tonnes of biomass (Control index at least $30m^3/h$)**

---

d1) **biogas production per tonnes of biomass**

The Archimedes reactor, patented, consists in a rotating cylindrical body, which keeps moving by the biogas insufflation at bottom effect that is created by the anaerobic digestion, through its partial recycle. Its structure works as a support (200 m^2/m^3) for the methanogen bacteria colonies growth and presents two meaningful advantages compared to the suspended biomass systems:

- It allows to obtain a microrganism concentration up to five times higher;
- It is not necessary to recycle the bacteria biomass, that is renewed through the natural tear from the surface of adherence.

The proposed process presents many advantages compared to the traditional systems that are only apparently less complex:

- It is a multiphase system, that allows monitoring and checking (in each phase) the chain of biological reactions required for biogas production, allowing to prevent common problems of monophasic systems;
- The retention time of solids that are not dissolved might be increased to allow bacteria present to be completely solubilized;
- As a result, a total transformation is obtained of the present organic substance, increasing the return and quality of biogas and making the solid product of the digestion more efficient, to be used as fertilizer;
- The structure, at the same time, has a 50% smaller volume than common monophasic systems

Considering the importance of transport among all anthropic activities, it appears fundamental to define what kind of fuel shall be allocated for the traffic sector: biogas is by far the most interesting alternative.

e) Biogas upgraded to high quality vehicle fuel

e1) **Optimization of cryogenic upgrading process (control index at least 97% of methane content in bio-methane produced with maximum 3% losses of the overall process)**

---

e1) **Optimization of cryogenic upgrading process**

The BioWalk4Biofuels project will use an innovative cryogenic technology optimizing the process to obtain a cost efficient LBG production;

Macroalgae could be a possible solution to obtain a suitable and cost efficient raw material that could become a volume fuel with large scale production plants.

Figure 2 - Presents the interrelationships between our concept and objectives

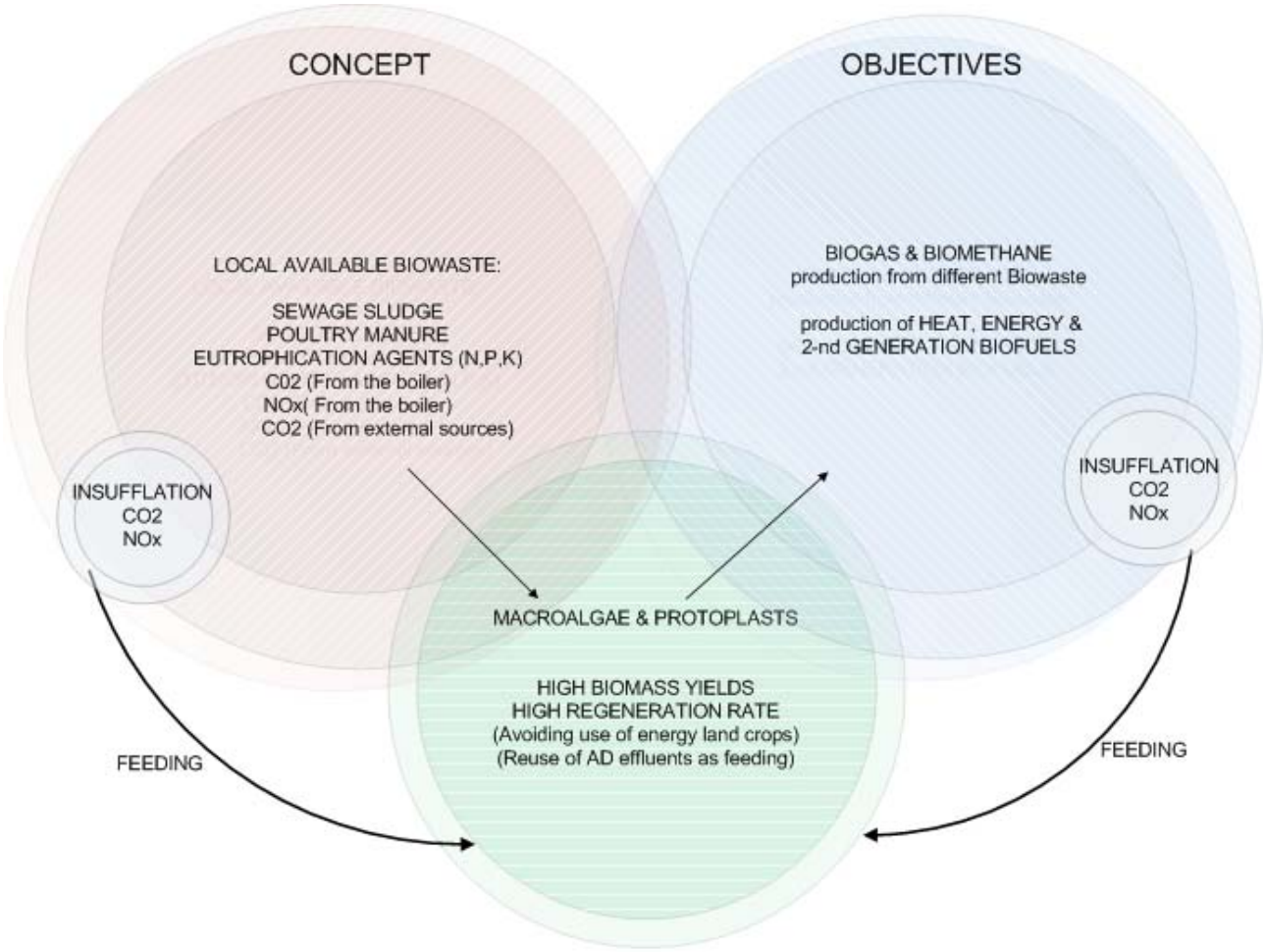
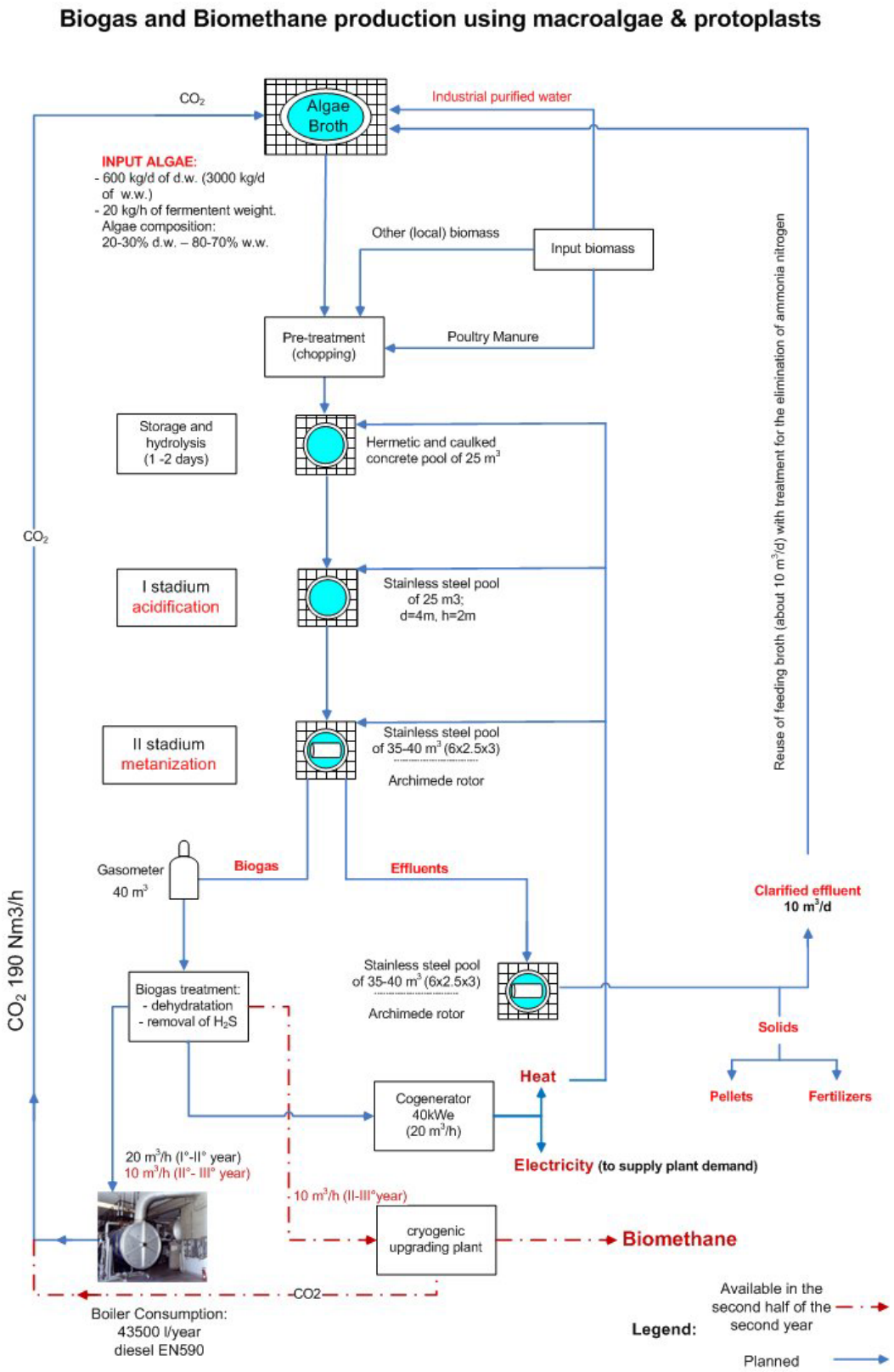


Figure 3 - Depicts clearly the production system of our initiative



1.2 Progress beyond the state-of-the-art

The focus on the use of biomass as an alternative feedstock to fossil fuels is intensifying due to its role in reducing CO_2 emissions. One of the main issues of biomass utilization is that the amount required in order to make a significant impact of CO_2 reduction will be governed by supply[14]. As a consequence, interest in alternative biomass resources has increased, i.e. commercial viability of 2nd generation biofuels.

On the other hand, biowaste management in the EU-25 continues to be an issue of discussion, where approximately 1.6 billion tonnes of waste (sludge, bio-and green waste 7%, animal waste 61%, industrial waste 7%, and crop residues 25%) are generated each year in the EU[15]. Its treatment is being addressed through landfilling, composting, incineration and anaerobic fermentation, without a common trend in the EU[16]. Therefore, proper waste management will be an important issue for EU waste policy in 2009, where a Green Paper is being prepared by the European Commission, and address energy solutions from biowaste.

As a response, current efforts for 2nd generation biofuels is focusing in gasification of lignocellulosic waste and residuals, conversion of lignine matter produced in the paper pulp industry, anaerobic digestion of organic wastes and residuals, non food crops (e.g. algae, grass, fodder beet). In the case of using lignocellulose there are presently serious doubts if gasification is sustainable. The use of biowaste as a feedstock for 2nd generation biofuels production has mainly focused in a direct conversion of biowaste into alternative energy. Treatment of municipal solid waste, sludge, animal by products (ABP, e.g. manure, slaughter-by-products, blood, lipids) and other biowaste (e.g. from households and food industries), to be used in a biodigestor, is a common approach for biogas production (Sahlstrom et al., 2008). Nevertheless, the Biogas Regions project identified that biogas production in Europe is still lagging behind in relation to the objectives set for 2010. There are an estimated 2700 composting plants and only 150 biogas plants in the EU for treatment of source separated biowaste. Current biogas production from animal manure, energy crops and organic waste is 50PJ, a small fraction of the potential[17].
The direct use of biowaste in biodigestors is problematic due to the heterogeneity of the compound and the high nitrogen content (e.g. in poultry manure). This causes problems in the fermentation process, so the introduction of other biomasses (e.g. cereal crops) or complex pre-treatments are usually required, to have a homogenous mixture in the biodigestors. A low quality biogas is produced that requires adequate treatment and does not provide an advantage in terms of eutrophication whatever the biogas utilisation due to large amounts of liquid discharge during the anaerobic process[18].

As mentioned above our project seeks a synergy between biowaste and macroalgae for a clean biogas production. With the cultivation of macroalgae it is possible to introduce

[14] Ross AB, Jones JM, Kubacki ML, Bridgeman T, 2008. *Classification of macroalgae as fuel and its themchemical behaviour.* Biosource Technology 99: 6494-6504.
[15] Amlinger F, 2006. *Biowaste management in the EU 25: Summarising the results of the questionnaire.* Ecologically Sound Use of Biowaste in the EU - Conference, Brussels 31 May – 1 June, 2006.
[16] Favoino E, 2008. *Strategies for the management of biowaste in the EU – Optimising the C Cycle.*ECN – European Composting Network Workshop: "The future for Anaerobic Digestion of Organic Waste in Europe".
[17] Idem 5
[18] Wenisch S, Monier E, 2007. *Life Cycle Assessment of different of biogas from anaerobic fermentation of separately collected biodegradable waste in France.* ADEME – French Agency for the Environment and Energy Management, France.

biowaste in their growth environment. The BioWalk4biofuels project allow to by-pass the high nitrogen content problem of biowaste using macro algae; in fact macro algae represents an optimal interface capable to transform the negative eutrophication potential of such biowaste (related to the high contents of nitrogen and phosphate compounds) in a benefit for algae increasing their growth rate.
Moreover, it is important to know that the planet's biomass is for the most part made of algae. Consequently, a serious discussion has been recently retaken[19] on the use of biomass coming from an aquatic environment: marine biomasses represent a potential source of renewable energy.

Macroalgae are fast growing marine and freshwater plants that in their natural environment grow on rocky substrates and form stable, multi-layered, perennial vegetation. They are subdivided in three groups: the red, green and brown macroalgae.
Algae are extremely efficient in converting solar energy to biomass. Their photosynthetic efficiency is much higher than that of land plants: 6-8% against 1.8-2.2%[20]. This enables algae to have higher growth rates than those of terrestrial biomass. Fast growing macroalgae sucha as *Ulva*, have demonstrated growth rates of 40% per day.[21] Algae need carbon CO_2 and nutrients for optimal growth. Increasing the concentration of CO_2 in the growth media increase the growth rates by a factor 1.5-1.8 [22].

Macroalgae present growth rates higher than those of terrestrial biomass; also photosynthetic efficiency is much higher: 6-8% against 1.8-2.2%[23]. Algae need CO_2 to grow, their cultivation requires large quantities of CO_2 to be constantly fed into their growing environment.

Macroalgae are used in the production of food, feed, chemicals, cosmetics and pharmaceutical products. They can also be used as raw material for co-firing to produce electricity, for liquid fuel production via pyrolysis (bio-oil), or for bio-methane generation through fermentation. Commercial farming of seaweeds is mainly carried out in Asian countries such as China, the Philippines, North and South Korea, Japan and Indonesia. Instead USA, Canada and European countries such us France, Germany and Netherlands are trying to establish large-scale seaweed cultivation[24]. About 200 species are cultivated worldwide, but only 10 are the most used: the brown algae *Undaria pinnatifida,* the red algae *Porphyra*, *Eucheuma*, *Kappaphycus* and *Gracilaria*, and the green algae *Monostroma* and *Enteromorpha*. The kelp *Laminaria Japonica* is the most important with 4.2 million tonnes cultivated mainly in China.

[19] During the 1970s as a response to energy shortages due to an oil embargo, the study of micro- and macro-algae as biomass for biofuels took place.
[20] FAO – Food and Agriculture Organization of the United Nations, 1997. *Renewable biological systems for alternative sustainable Energy production*. Agricultural Services Bulletin – 128 ISBN 92-5-104059-1
[21] Malta, E. J. & J. M. Verschuure 1997. Effects of environmental variables on between-years variation of Ulva growth and biomass in a eutrophic brackish lake. Journal of sea research 38: 71-84
[22] Bidwell, RGS, McLachlan J and Lloyd, NDH.1985. Tank cultivation of Irish Moss, *Chondrus crispus* Stackh. Botanica Marina 28: 87-97
[23] FAO – Food and Agriculture Organization of the United Nations, 1997. *Renewable biological systems for alternative sustainable Energy production*. Agricultural Services Bulletin – 128 ISBN 92-5-104059-1
[24] Carlsson AS, Van Beilen JB, Moller R, Clayton D, 2007. *Micro-and macro-algae utility for industrial applications*. Epobio project

Previous studies into farming of marine biomass for energy purposes has shown difficulties[25], particularly for off shore kelp farming. However, since then, the farming practices have improved significantly.

Regarding the production of bio-methane from macro algae, a research to determine the technical and economic feasibility, was conducted under the sponsorship of the U.S. Navy, the American Gas Association and Gas Research Institute, and the U.S. Department of Energy: the study, after comparing different biomass sources, concluded that marine biomass offered the highest potential. Nevertheless, the programme was cancelled in 1986, because of decrease emphasis on alternate (renewable) gas supplies and the high-perceived cost of marine biomass energy[26]. Afterwards, it was found that marine algae, such as *Gracilaria sp.* and *Macrocystis* (kelp), were excellent substrates for bio-methane generation[27]. Further studies showed that *Ulva lactuca* and *Chaetomorpha linum* have high growth rates,[40] as well as high contents of carbohydrates, that can be used for fermentation. Both are green algae, which store energy as starch as for instance does grain. In Denmark, a 3-year national project is focusing on the cultivation, harvesting and handling as well as the utilization of Ulva Lactuca is carried out in the period 2008-2010.
Marine biomass for energy has mostly focused not only in macroalgae open-sea cultivation, but also in the use of pests from lagoons (e.g. studies carried out in the Baltic Sea[28] and Orbetello Lagoon, Italy[29]). Moreover, many authors suggest that the best approach for bio-methane production from macro-algae is mixing of algal biomass with other biomass inputs, for example gas production arising from digestion of the residues of the hydrocolloid extraction[30]. In this way the co-production of methane with other products lower the production costs and make bio-methane production profitable[31]. Recent development in seaweed cultivation is the growing of algae in land-based artificial ponds into which seawater is pumped: seaweeds can grow detached and at very high densities. This necessitates the careful study of growth parameters of seaweeds involved and the development of special strains, preferably with high growth rates, adapted to the artificial conditions. Production figures have been reported in the range of 3.3 – 11.3 Kg dry weight m^{-2} yr^{--1} for non-cultured and up to 13.1 Kg dry weight m^{-2} over 7 month for cultured brown algae compared with 6.1 – 9.5 Kg fresh weight m^{-2} yr^{-1} for sugar cane, a most productive land plant. Moreover, the absence of lignin and a low content of cellulose make brown and green algae easily convertible in biological processes compared to land plants.

[25] Wise DL, 1981. *Probing the feasibility of large scale aquatic biomass energy farms*. Solar energy 26 (5): 455-457.
[26] Chynoweth DP, 2002.*Review of biomethane from marine biomass*. Department of Agricultural and Biological Engineering, University of Florida, Gainesville, Florida, USA.
[27] Chynoweth DP, Turick CE, Owens JM, Jerger DE, Peck MW, 1993. *Biochemical methane potential of biomass and waste feedstocks*. Biomass & Bioenergy 5: 95-111.
[40] Pedersen, M.F. & J. Borum (1996). *Nutrient control of algal growth in estuarine waters. Nutrient limitation and the importance of nitrogen requirements and nitrogen storage among phytoplankton and species of macroalgae*. Mar. Ecol. Prog. Ser., 142: 261-272.
[28] Filipkowska A, Lubecki L, Szymczak-Zyla M, Kowalewska G, Zbikowski R, Szefer P, 2008. *Utilisation of macroalgae from the Sopot Beach (Baltic Sea)*.
[29] Bastianoni S, Coppolo F, Tiezzi E, Colacevich A, Borghini F, Focardi S, 2008. *Biofuel potential production from the Orbetello lagoon macroalgae: A comparison with sunflower feedstock*. Biomass and Bioenergy 32: 619-628.
[30] Kerner KN, Hanssen JF, Pedersen TA, 1991. *Anaerobic digestion of waste sludges from the alginate extraction process*. Bioresource Technology 37: 17 – 24
[31] IBID 6

The use of protoplasts as feedstock for cultivation, in an incubator under controlled condition, allow to obtain an higher regeneration rate; this type of cultivation in an incubator rather result in increased productivity of cultivation and higher biomass yield. It can be possible to increase the productivity utilizing biowaste as feed associate with CO_2 insufflation.

Protoplasts are living plant or algae cells without cell walls which offer a unique uniform single cell system that facilitates several aspects of modern biotechnology. The main application of many protoplast studies is to produce somatic hybrids through protoplast fusion in order to obtain fast growing algae species. [32]

Although protoplasts isolation from macrophytic benthic marine algae was reported as early as 1970 using mechanical methods[23, 24, 25], the success in producing a large number of viable protoplasts became possible only after the development of an enzymatic method.[26]

Since then, considerable efforts have been made to isolate and culture protoplasts from a wide variety of multicellular marine macrophytic algae.[27, 28, 29, 30, 31]

Nevertheless, regeneration of protoplasts to complete thalli, especially from anatomically complex seaweeds as well as giant kelps, is a relatively recent development.[32, 33]

Uppalapati and Fujita[34] e Reddy et al.[35] further simplified the protoplast isolation method by significantly reducing the ionic strength of protoplast isolation medium. These studies revealed that the simple dissolution of cell wall lytic enzymes (2% Cellulase Onozuka R-10) in low ionic medium (1% NaCl in deionised water) provided substantially high yields of viable protoplasts in shorter durations in different green seaweeds than the one prepared with normal seawater.

---

[32] Reddy CRK, Gupta MK, Mantri VA, Jha B, 2007. *Seaweed protoplasts: status, biotechnological perspectives and needs.* Applied Phycology Journal.

[23] Tatewaki M, Nagata K, 1970. *Surviving protoplasts in vitro and their development in Bryopsis*. J Phycol 6: 401-403

[24] Enomoto K, Hirose H, 1972. *Culture studies on artificially induced aplanospores in the marine alga Boergesenia forbesii (Harvey) Feldman (Chlorophyceae, Siphonocladales)*. Phycologia 11: 119-122

[25] Kobayashi K, 1975. *Growth of extra cellular protoplast of Bryopsis maxima in an agar medium*. Bull Tokyo Gakugei Univ Ser 27: 1-5

[26] Millner PA, Callow ME, Evans LV, 1979. *Preparation of protoplasts from the green alga Enteromorpha intestinalis (L.)*. Planta (Berlin) 147: 174-177

[27] Polne-Fuller M, Biniaminov M, Gibor A, 1984. Vegitative propagation of Porphyra perforate. Proc Int Seaweed Symp 11: 308-313

[28] Evans LV, Butler DM, 1988. *Seaweed biotechnology-current status and future prospects*. In: Roger LJ, Gallon JR (eds) Biochemistry of the algae and cyanobacteria. Clarendon Press, Oxford, pp 335-350

[29] Butler DM, Evans LV, Kloareg B, 1990. *Isolation of protoplasts from marine macroalgae*. In: Akatsuka I (ed) Introduction to applied phycology. SPB Academic Publication, The Hague, The Netherlands, pp 647-666

[30] Reddy CRK, Fujita Y, 1991. *Regeneration of plantlets from Enteromorpha (Ulvales, chlorophyta) protoplasts in axenic culture*. Bot Mar 32: 483-490

[31] Reddy CRK, Fujita Y, Bajaj, 1994. *Somatic hybridisation in algae*. In: Bajaj YPS (ed) Biotechnology in agriculture and forestry 27. Somatic hybridisation in crop improvement I. Springer-Verlag, Berlin Heidelberg, pp 483-502

[32] Sawabe T, Ezura y, Yamamoto H, 1997. *Plant regeneration from protoplasts of Laminaria japonica Areschoug (Laminariales, Phaeophyceae) in a continuous-flow culture system*. Plant Cell Rep 17: 109-112

[33] Matsumura W, Yasui H, Yamamoto H, 2000. Mariculture *of Laminaria japonica (Laminariales, Phaeophyceae) using protoplast regeneration*. Phycol Res 48: 169-176

[34] Uppalapati SR, Fujita Y, 2002. *A simple method for mass isolation of protoplasts from species of Monostroma, Enteromorpha and Ulva (chlorophyta, Ulvales).* J Appl Phycol 14: 165-168

[35] Reddy CRK, Dipakkore S, Rajakrishan Kumar G, Jha B, Cheney DP, Fujita Y, 2006. *An improved enzyme preparation for rapid mass production of protoplast as seed stock for aquaculture of macrophytic marine green algae*. Aquaculture 260: 290-297

Maximum regeneration rate (>90%) of protoplasts in *Ulva* and *Enteromorpha* was observed in cultures grown at 20°C and 25°C, while at 30°C there was a lack of differentiation of fronds from the rhizoidal system which grew prominently.[36] The continued presence of osmoticum >0.4 M in culture medium hampered cell division and further growth in both *Ulva* and *Porphyra*. The list of species capable of regeneration into complete plant from protoplast is steadily increasing. Several studies have attempted to diversify the application of protoplasts for as many applications as possible. In order to provide continuous seed stock for cultivation of green seaweeds, Chen[37] and Chen and Shih[38] developed protoplast-based methods for producing stocks of seedlings (micro-thalli) with survival abilities of many years in an incubator while maintaining their potential to develop into leafy thalli of *Ulva* and *Monostroma*. Protoplasts from *Monostroma* and *Porphyra* have been successfully tested for their seeding and regeneration in laboratory conditions.[39]
Regarding the project BioWalk4biofuels , prolonged culture of protoplasts in defined conditions forms a green mat at the bottom of the entire culture plate. The achieved culture can be later transplanted in the open sea or outdoor culture ponds after growing for a while in land-based culture system (nursery with enriched seawater medium).

To address limitations found in the production of 2nd generation biofuels from biowaste or macroalgae, a hybrid use seeks to complement each other and solve their negative aspects. For this reason, the focus of the project is the management of biowaste, with a new approach: macroalgae represent an agent to treat biowaste and industry's emissions while producing biofuels.
A series of developments have been attained in the cultivation of algae, protoplasts incubation, production of biogas, research on the use of biowaste and CO_2 to increase productivity of algae, among other achievements in the last few years. **The present project creates a synergy between the advancements accomplished, bringing together a series of complementary capacities that deliver an innovative 2nd generation biofuel**.

[36] Reddy CRK, 1991. Studies *on the protoplast preparation, fusion and regeneration of fusion products from members of the Ulvaceae (Chlorophyta)*. PhD thesis, Nagasaki University, Nagasaki, Japan, 129 pp.
[37] Chen LCM, Hong MF, Craigie JS, 1998. *Protoplasts development from Porphyra linearis-an edible marine red alga*. In: Puite KJ, Dons JJM, Huizing HJ, Kool AJ, Koornneef M, Krens FA (eds) Progress in plant protoplasts research, vol 7, Kluwer Academic Publishers, Dordrecht, pp 123-124
[38] Chen YC, Shih HC, 2000. Development of protoplasts of Ulva fasciata (Chlorophyta) for algal seed stock. J Phycol 36: 608-615
[39] IDEM 35

1.3 S/T methodology and associated work plan

i) Overall strategy of the work plan

WP1 will monitor work progress and costs, facilitate communications and dissemination among partners, and will be responsible both for contact with the administrative and scientific EC Project Officers, and of fulfilment of the expected objectives on time. Quite all partners (WPs leaders) will participate to the Steering Committee to review technical progress of the project, identify need for corrective actions when necessary, to take operational decisions, etc.

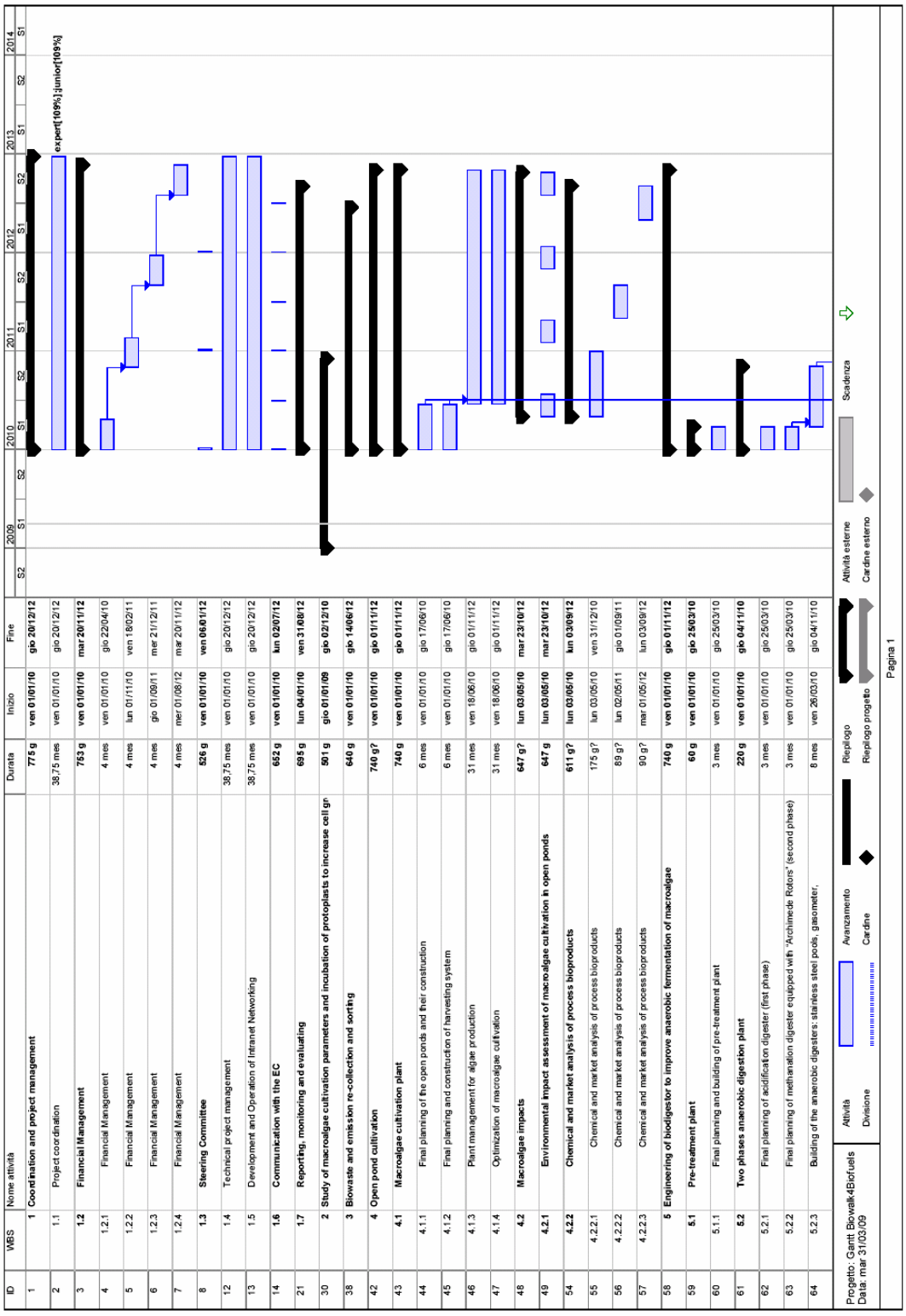
WP2 will focus on the production of a cost efficient biogas, using biowaste and the use of biowaste as a feedstock (such us poultry manure) and macroalgae (*Ulva Lactuca* and *Gracilaria edulis*) as a catalyser. The use of adequates biowaste in macroalgae cultivation allows to achieve higher yields of fermentable biomass and to provide the requested amount of feeding elements useful for algae growth like N, P, K. The **WP3** will be focused on the selection and collection of local biowaste and exhaust gases, among those available in the area of site plant, considering moreover its collection system. The attention will also be focused to study and carry out a piping system for insufflation of CO_2 produced by a boiler just active in the industrial site avoiding the emission of about 6.000 Tonn CO2 during the overall project and exhausts gases into algae ponds. The **WP4** is in fact devoted to the realisation of the ponds for macroalgae cultivation. After a preliminary planning, four open ponds will be carried out in the site plant in the harbour of Augusta, Sicily. Special care will be focused on the Life Cycle Assessment (LCA) in order to obtain detailed information on the effects of the project on the environment providing also a chemical and market analysis of process bioproducts. **WP5** deals with the planning and implementation of a two phases anaerobic digestion biogas production plant associated to an effluent treatment plant. The two phases technology permit to increase the transformation rate of the organic compounds in biogas obtaining simultaneously higher quality solid and liquid effluents avoiding the hanging problems commonly related to the single phase digesters.

The liquid fraction opportunely treated will be used as feed for algae cultivation. The following step concern the upgrading process to obtain bio-methane from biogas **WP6**. All tests are done with a unique and new production method based on cryogenic separations throughout the whole process. The function of the separations focus to the condense temperatures of expected substances and possibilities to utilize such as a commercial product. The Cryogenic process will upgrade the biogas to CBG quality as per vehicle fuel standard SS155448 ready to be used on site or injected into a gas grid for further distribution.

The implementation of a two phase anaerobic digestion plant associated to a cryogenic biogas upgrading process will allow to realize a wheel to wheel study with the aim to produced a detailed report on the LCA of the entire process **WP7**. A comparative analisys of the main European legislative tools on bio-methane together with a study concerning the use of bio-methane in term of energy sustainability in the European environment will be also carried out. As a result some legislative and technical recommendations to policy makers in order to favour and enhance the spreading of renewable energy both at national and Community level will be also developed.

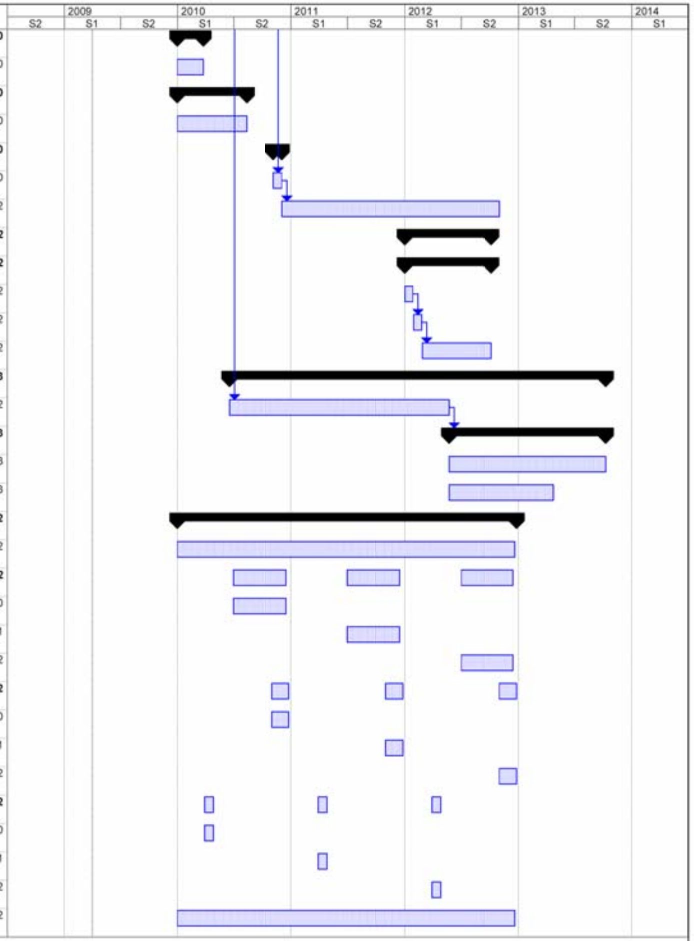
To complete the project framework, an horizontal Work Package **WP8**, Dissemination of results) will allow the diffusion to the international scientific community of results obtained in the other WP.

ii) Timing of the different WP and their components



ID	WBS	Nome attività	Durata	Inizio	Fine
1	1	**Coordination and project management**	**775 g**	**ven 01/01/10**	**gio 20/12/12**
2	1.1	Project coordination	38,75 mes	ven 01/01/10	gio 20/12/12
3	1.2	**Financial Management**	**753 g**	**ven 01/01/10**	**mar 20/11/12**
4	1.2.1	Financial Management	4 mes	ven 01/01/10	gio 22/04/10
5	1.2.2	Financial Management	4 mes	lun 01/11/10	ven 18/02/11
6	1.2.3	Financial Management	4 mes	gio 01/09/11	mer 21/12/11
7	1.2.4	Financial Management	4 mes	mer 01/08/12	mar 20/11/12
8	1.3	**Steering Committee**	**526 g**	**ven 01/01/10**	**ven 06/01/12**
12	1.4	Technical project management	38,75 mes	ven 01/01/10	gio 20/12/12
13	1.5	Development and Operation of Intranet Networking	38,75 mes	ven 01/01/10	gio 20/12/12
14	1.6	**Communication with the EC**	**652 g**	**ven 01/01/10**	**lun 02/07/12**
21	1.7	**Reporting, monitoring and evaluating**	**695 g**	**lun 04/01/10**	**ven 31/08/12**
30	2	**Study of macroalgae cultivation parameters and incubation of protoplasts to increase cell gr**	**501 g**	**gio 01/01/09**	**gio 02/12/10**
38	3	**Biowaste and emission re-collection and sorting**	**640 g**	**ven 01/01/10**	**gio 14/06/12**
42	4	**Open pond cultivation**	**740 g?**	**ven 01/01/10**	**gio 01/11/12**
43	4.1	**Macroalgae cultivation plant**	**740 g**	**ven 01/01/10**	**gio 01/11/12**
44	4.1.1	Final planning of the open ponds and their construction	6 mes	ven 01/01/10	gio 17/06/10
45	4.1.2	Final planning and construction of harvesting system	6 mes	ven 01/01/10	gio 17/06/10
46	4.1.3	Plant management for algae production	31 mes	ven 18/06/10	gio 01/11/12
47	4.1.4	Optimization of macroalgae cultivation	31 mes	ven 18/06/10	gio 01/11/12
48	4.2	**Macroalgae impacts**	**647 g?**	**lun 03/05/10**	**mar 23/10/12**
49	4.2.1	**Environmental impact assessment of macroalgae cultivation in open ponds**	**647 g**	**lun 03/05/10**	**mar 23/10/12**
54	4.2.2	**Chemical and market analysis of process bioproducts**	**611 g?**	**lun 03/05/10**	**lun 03/09/12**
55	4.2.2.1	Chemical and market analysis of process bioproducts	175 g?	lun 03/05/10	ven 31/12/10
56	4.2.2.2	Chemical and market analysis of process bioproducts	89 g?	lun 02/05/11	gio 01/09/11
57	4.2.2.3	Chemical and market analysis of process bioproducts	90 g?	mar 01/05/12	lun 03/09/12
58	5	**Engineering of biodigestor to improve anaerobic fermentation of macroalgae**	**740 g**	**ven 01/01/10**	**gio 01/11/12**
59	5.1	**Pre-treatment plant**	**60 g**	**ven 01/01/10**	**gio 25/03/10**
60	5.1.1	Final planning and building of pre-treatment plant	3 mes	ven 01/01/10	gio 25/03/10
61	5.2	**Two phases anaerobic digestion plant**	**220 g**	**ven 01/01/10**	**gio 04/11/10**
62	5.2.1	Final planning of acidification digester (first phase)	3 mes	ven 01/01/10	gio 25/03/10
63	5.2.2	Final planning of methanation digestor equipped with "Archimede Rotors" (second phase)	3 mes	ven 01/01/10	gio 25/03/10
64	5.2.3	Building of the anaerobic digesters: stainless steel pods, gasometer,	8 mes	ven 26/03/10	gio 04/11/10

ID	WBS	Nome attività	Durata	Inizio	Fine
65	**5.3**	**Effluents treatment plant**	**60 g**	**ven 01/01/10**	**gio 25/03/10**
66	5.3.1	Final planning and construction of effluents treatment plant	3 mes	ven 01/01/10	gio 25/03/10
67	**5.4**	**Biogas treatment plant and piping implementation to feed the boiler**	**160 g**	**ven 01/01/10**	**gio 12/08/10**
68	5.4.1	Final planning and construction of treatment plant (dehydratation and removal of H2S and	8 mes	ven 01/01/10	gio 12/08/10
69	**5.5**	**Production of heat and electricity**	**20 g**	**ven 05/11/10**	**gio 02/12/10**
70	5.5.1	Implementation of the cogeneration plant	1 mes	ven 05/11/10	gio 02/12/10
71	5.6	Use of heat energy produced to control open ponds and digesters temperature	25 mes	ven 03/12/10	gio 01/11/12
72	**6**	**Biogas upgrading plant**	**200 g**	**lun 02/01/12**	**ven 05/10/12**
73	**6.1**	**Analysis and evaluation of plant scale**	**200 g**	**lun 02/01/12**	**ven 05/10/12**
74	6.1.1	Final planning of the upgrading plant	1 mes	lun 02/01/12	ven 27/01/12
75	6.1.2	Plant construction	1 mes	lun 30/01/12	ven 24/02/12
76	6.1.3	Biomethane production and use as 2-nd generation biofuel	8 mes	lun 27/02/12	ven 05/10/12
77	**7**	**Monitoring and appraisal - Survey of European economic and legislative barriers**	**864 g**	**ven 18/06/10**	**mer 09/10/13**
78	7.1	Seaweeds production and utilization	25,2 mes	ven 18/06/10	mer 23/05/12
79	**7.2**	**Biomethane use as second generation biofuel**	**360 g**	**gio 24/05/12**	**mer 09/10/13**
80	7.2.1	Comparative analysis of the main european legislative tools on biomethane	18 mes	gio 24/05/12	mer 09/10/13
81	7.2.2	Analysis of possible legislative amendments to be made at italian level	12 mes	gio 24/05/12	mer 24/04/13
82	**8**	**Promotion, Marketing & Dissemination**	**779 g**	**ven 01/01/10**	**mer 26/12/12**
83	8.1	Website (development, maintenance, promotion)	38,75 mes	ven 01/01/10	gio 20/12/12
84	**8.2**	**Publications**	**642 g**	**gio 01/07/10**	**ven 14/12/12**
85	8.2.1	Publications 1	6 mes	gio 01/07/10	mer 15/12/10
86	8.2.2	Publications 2	6 mes	ven 01/07/11	gio 15/12/11
87	8.2.3	Publications 3	6 mes	lun 02/07/12	ven 14/12/12
88	**8.3**	**(conferences, workshops, exhibition, meetings)**	**563 g**	**lun 01/11/10**	**mer 26/12/12**
89	8.3.1	(conferences, workshops, exhibition, meetings) 1	2 mes	lun 01/11/10	ven 24/12/10
90	8.3.2	(conferences, workshops, exhibition, meetings) 2	2 mes	mar 01/11/11	lun 26/12/11
91	8.3.3	(conferences, workshops, exhibition, meetings) 3	2 mes	gio 01/11/12	mer 26/12/12
92	**8.4**	**Study Tours**	**543 g**	**mar 30/03/10**	**gio 26/04/12**
93	8.4.1	Study Tours 1	1 mes	mar 30/03/10	lun 26/04/10
94	8.4.2	Study Tours 2	1 mes	mer 30/03/11	mar 26/04/11
95	8.4.3	Study Tours 3	1 mes	ven 30/03/12	gio 26/04/12
96	8.5	Set-up of an High-tech Platform (videoconference, database, file sharing)	38,75 mes	ven 01/01/10	gio 20/12/12



Progetto: Gantt Biowalk4Biofuels
Data: mar 31/03/09

Attività | Divisione | Avanzamento | Cardine | Riepilogo | Riepilogo progetto | Attività esterne | Cardine esterno | Scadenza

Pagina 2

iii) Provide a detailed work description broken down into work packages

Table 1.3 a: Work package list

Work package No[33]	Work package title	Type of activity [34]	Lead partic no.[35]	Lead partic. short name	Person - months [36]	Start month [37]	End month
WP 1	Coordination and Project Management	MGT	1	CIRPS	73,6	1	36
WP 2	Study of macroalgae cultivation parameters and incubation of protoplasts to increase cell growth rate	RTD	4	NERI	111,6	1	34
WP 3	biowaste and emission re/collection and sorting	RTD	3	Ecoil	51	4	34
WP 4	Open ponds cultivation	DEM	1	CIRPS	133,4	1	34
WP 5	Planning, implementation and management of a patented two phase anaerobic digestion plant	DEM	1	CIRPS	47,6	1	34
WP 6	Bio-methane production thanks to the cryogenic upgrading technology	DEM	8	SGtS	68,4	25	32
WP 7	Monitoring and appraisal - survey of Wuropean Economic and legislative barriers	RTD	10	RTU	72,4	6	36
WP 8	Promotion, marketing & Dissemination	TRA	7	NGVA	49,7	1	36
	TOTAL				607,8		

33 Work Package number: WP 1 – WP n.

34 Please indicate one activity per work package: RTD = Research and technological development (including any activities to prepare for the dissemination and/or exploitation of project results, and coordination activities); DEM = Demonstration; TRA = Training; MGT = Management of the consortium; OTHER = Other specific activities, if applicable in this call.

35 Number of the participant leading the work in this work package.

36 The total number of person-months allocated to each work package.

37 Measured in months from the project start date (month 1).

Table 1.3 b: Deliverables List

Del. no.[38]	Deliverable name	WP no.	Nature [39]	Dissemi-nation level[40]	Delivery date[41] (proj. month)
D 1.1	Inception Report	1	R	CO	1
D 1.2	Start of intranet network	1	O	CO	1
D 1.3	Periodic activity report	1	R	CO	6-12-18-24-30-36
D 1.4	Periodic management report	1	R	CO	1-5-11-16-21-26-31-36
D 1.5	Periodic draft planning for the following year	1	R	CO	12-24
D 1.6	Final evaluation	1	R	PU	36
D 2.1	Delivery of a catalogue of high interest algae species with high growth and energy potential	2	R	PP	6
D 2.2	Delivery of a manual of optimising growth and energy potential of species selected in WP1.1.	2	R	PP	6
D 2.3	Delivery of a classification of the value of selected sources of biowaste and emissions as nutrient and carbon source of the selected macroalgae species	2	R	PP	6

38 Deliverable numbers in order of delivery dates. Please use the numbering convention <WP number>.<number of deliverable within that WP>. For example, deliverable 4.2 would be the second deliverable from work package 4.

39 Please indicate the nature of the deliverable using one of the following codes: **R** = Report, **P** = Prototype, **D** = Demonstrator, **O** = Other

40 Please indicate the dissemination level using one of the following codes: **PU** = Public; **PP** = Restricted to other programme participants (including the Commission Services); **RE** = Restricted to a group specified by the consortium (including the Commission Services); **CO** = Confidential, only for members of the consortium (including the Commission Services).

41 Measured in months from the project start date (month 1).

D 2.4	Delivery of an enzyme based methods for producing large number of viable protoplasts from different macroalgal species	2	R	PP	3
D 2.5	Delivery of a report on protoplast culture and their developmental morphology of selected algae	2	R	PP	3
D 2.6	Delivery of a report on the effect of biowaste and emission on the growth of protoplasts transplanted into open ponds	2	R	PP	3
D 3.1	Delivery of a report about the effects CO_2 insufflation on macro algae growth rate	3	R	PU	14
D 3.2	Delivery of a local biomass catalogue including a description of characteristics and localization	3	R	PP	7
D 3.3	Delivery of a complete LCA study from the input biomass to the output products of the anaerobic digestion plant	3	R	PP	12
D 4.1	Executive project of open ponds and circulating system	4	O	PP	5
D 4.2	Executive project for harvesting system	4	O	PP	5

D 4.3	Periodic reports on macroalgae cultivation trend	4	R	PU	10-15-20-25-30-35
D 4.4	Periodic reports (draft and final versions) about LCA (regarding macroalgae cultivation and the whole plant process), market analysis (total energy benefit, Stakeholder analysis green" electricity users and heating end-users) and chemical analysis	4	R	PP	8-14-20-26-32-36
D 5.1	Assessment report on operational experience on pre-treatment process using macroalgae as co-substrate	5	R	PP	12-24-32
D 5.2	assessment report on optimization of two phase anaerobic digestion process	5	R	PP	12-24-32
D 5.3	To deliver a report with a description of the guidelines for increasing the production efficiency.	5	R	PU	34
D 6.1	Delivery of an analysis of the preconditions and planned technical solution with expected production results.	6	O	PP	24
D 6.2	Delivery of a process design and integration with digester and algae process.	6	O	PP	24

D 6.3	Delivery of the production results and conclusions of CBG and LBG as the 2-nd generation vehicle fuel.	6	R	PU	34
D 7.1	Report concerning the analysis of the different methodology for seaweeds production and their utilization	7	R	PP	12-24
D 7.2	Periodic reports (draft and final version) concerning analysis of the main european legislative tools on bio-methane in terms of comparison of different sustainability	7	R	PU	24-36
D 7.3	Delivery of a report concerning the analysis of Italy current laws and possible bills	7	R	PU	34
D 8.1	Delivery of the electronic forum and newsletter	8	R	PU	2
D 8.2	Delivery of a dissemination logistic Plan	8	R	CO	6
D 8.3	Delivery of a project brochures and CD-ROMs	8	R	PU	9

Table 1.3 c: List of Milestones

Milestone number	Milestone name	Work package(s) involved	Expected date [42]	Means of verification [43]
M 1.1	Kick-off of the project	WP1	1	Start of the project
M 1.2	Inception Report	WP1	3	Production and sending of the report
M 1.3	Periodic activity report, Periodic Management report	WP1	1	Production and sending of the report
M 1.4	Steering management committee meeting & Project management committee meeting	WP1	1	Organisation of conference with all partners
M 2.1	Selection of algae species	WP2	6	Production and dissemination of the information
M 2.2	Selection of optimal environmental conditions for optimal growth and energy potential of selected species	WP2	6	Production and dissemination of the information
M 2.3	A characterisation of the key nutrients (N,P,K,C) and potentially harmful compounds in selected sources of biowaste and emissions.	WP2	3	Production of a report on key nutrients and harmful compound that affected algae growth
M 2.4	Optimised methods for isolating viable protoplasts from different macroalgaes	WP2	3	Optmization of the isolation process.

[42] Measured in months from the project start date (month 1).

[43] Show how both the participants and the Commission can check that the milestone has been attained. Refer to indicators if appropriate.

M 2.5	Delivery of optimised culture conditions and regeneration patterns of isolated protoplasts from selected macroalgae	WP2	3	Production of a guideline with optimised culture parameters
M 2.6	Growth of transplanted protoplasts in open ponds	WP2	5	Protoplasts transplant
M3.1	Planning and implementation of a piping system for transport and insufflation of CO_2 into algae broth	WP 3	8	Executive project
M 3.2	Collection of available and suitable local biowaste to introduce in the algae pond	WP 3	6	Biowaste collection
M 4.1	Planning and Construction of a closed system method for macroalgae cultivation	WP 4	5	Plant construction
M 4.2	Implementation and optmization of the feeding and harvesting system	WP 4	5	Harvesting system implementation
M 4.3	Providing a useful tool for stakeholders and decision makers in order to identify different alternatives for different local plant environments.	WP 4	15	Delivery of a complete guideline useful for choosing different biomass alternatives
M 5.1	Planning, implementation and optimization of the pre-treatment plant	WP 5	5	Executive project
M 5.2	Planning, construction and optimization of the Two Phase anaerobic digestion plant	WP 5	5	Executive project

M 5.3	Planning, implementation and optimization of effluents and Biogas treatment plants	WP 5	5	Executive project
M 6.1	Design and manufacturing and installation of the cryogenic upgrading plant	WP 6	20	Executive project
M 6.2	Implementation of a latest plant remote control via internet	WP 6	24	Upgrading plant implementation
M 7.1	Wider and clear picture of the European concerning the Seaweeds production and utilization for biomethane.	WP 7	24	Delivery of a detailed report
M 8.1	Kick-off meeting	WP 8	2	First Conference
M 8.2	Planning and implementation of the internet project website	WP 8	3	Website implementation
M 8.3	Plan for using and disseminating the knowledge at EU and Extra-UE level	WP 8	6	Dissemination plan drawing up
M 8.4	Reports and Brochures presentation and discussion to the final conference	WP 8	36	Final conference

Work package description

Work package number	1	**Start date or starting event:**		1		
Work package title	Coordination and Project Management					
Activity type[44]	MGT					
Participant number	**1**	**2**	**3**	**4**	**5**	**6**
Participant short name	CIRPS	CoNISMa	Ecoil	NERI	DTI	CSMCRI
Person-months per participant	70,6	0,4	0,4	0,4	0,2	0,4
Participant number	**7**	**8**	**9**	**10**	**11**	
Participant short name	NGVA	SGtS	HU	RTU	AP	
Person-months per participant	0,4	0,4	0	0,4	0	

Objectives

- To provide project effective management and coordination in order to achieve the expected objectives on time and guarantee a high-quality level of the whole project
- To ensure the technical and administrative coordination at project level and on site
- To ensure that the Demonstration / Research & Technological Development / Training / Evaluation and Dissemination activities are implemented in a complementary way
- To ensure interaction with the European Commission
- To ensure interaction and information sharing among all partners

[44] Please indicate one activity per work package: RTD = Research and technological development (including any activities to prepare for the dissemination and/or exploitation of project results, and coordination activities); DEM = Demonstration; TRA = Training; MGT = Management of the consortium; OTHER = Other specific activities, if applicable in this call.

Description of work (WP leader CIRPS)

CIRPS is in charge of project coordination and all its related tasks in cooperation with the WPs leaders according to the timetable proposed.

Task 1.1: Project Coordination

CIRPS will be responsible for the administration of the entire project and will supervise the contractual and administrative management by partners. It will also ensure that all the procedures (reporting - auditing - etc) established by the European Commission will be executed on time and that the results will be promptly sent to the Commission. CIRPS will be in charge of the Inception Report, half-yearly, mid-term and final administrative reports, project audits and any other project contractual and administrative document required during the programme implementation.

Task 1.2: Financial Management

The project financial manager of CIRPS and all the partners' financial managers will set up a close relationship in order to create a transparent system for collecting and transferring invoices, payment claims etc. CIRPS will manage all the relevant administrative project documentation to comply with EC regulations.
The financial manager will open a special bank account with Banca di Roma for the project. All EC-payments will be made upon this account; all transfers to the project partners will be made from this special account. CIRPS will carry out the checking of the accounts and handle the certification of expenses, the reception of European funds, transfer to the partner, the annual and final reports and the financial control. The financial management responsibility includes the liability towards the EC for all finance related matters, supervising the partners' financial tasks, making financial claims, monitoring and book-keeping of the EC funding, supervising the cost statements as well as the mid-term and final financial evaluation, and ordering the financial project audits of the project by an outside service provider.

Task 1.3: Steering Committee

The Project Management committee (PMC) is chaired by the project manager and comprises the coordinator, the task leader and the site leader. After having informed the others, each partner with a place on the PMC shall have the right to replace its representative. Each representative shall have a deputy. The PMC meets regularly at least ones per year in principle or at any other time when necessary at the request of the project manager or another partner. The main tasks of the PMC are:

- to rewiev the technical progress of the project
- to identify need for corrective actions where necessary
- to take operational decisions and ensure concerns are resolved
- to report to the steering group any important issues and propose appropriate solutions to likely problems

The PMC meetings will be organised and prepared by the project co-ordinator, in liaison with the project manager. In advance of meetings the PMC will receive a progress report so that problems can be anticipated and potential project risks identified and solution offered.

Task 1.4: Technical project management

The technical management will ensure the smooth running of the programme. This task will include the activities described below, to be carried out throughout the project duration:

- Monitoring the ongoing activities within each specific WP managed by partners

- Achieving the project objectives on time

- Implementing the coordination and information sharing between the project partners

- Promoting and coordinating the consortium meetings (CIRPS and NGVA).

The task will also include the promotion and monitoring of the specific work plan adopted by partners, the coordination of deliverables, the quality control and production of the six-monthly management reports to be sent to the EC.

Task 1.5: Development and operation of Intranet Networking

CIRPS will establish appropriated communication lines which will reflect the project management structure in order to ensure a clear delegation in terms of tasks and responsibilities.

CIRPS will promote and coordinate project meetings in order to support all the partners, to inform them about the state of the art of the tasks and to plan together the project follow-ups. Face-to-face meetings and informal contacts will also be developed. Periodical mailings will keep partners informed about all important issues and dates foreseen during the next period, as well as the outcomes produced by the project. An intranet network will be developed within the project website to facilitate discussions, information exchange and help partners to work together within each work package.

CIRSP will also guarantee the spread-out among partners of all the relevant documents and outputs and promote the communication within the consortium by electronic mail, telephone, fax, and ordinary mail.

Task 1.6: Communication with the EC

The reporting and interfacing with the European Commission will be CIRPS responsibility, controlled by the Project Manager and with the support of the Project Office. The Project Manager will be the contact point for the EC and for the strategic issues outside the project. This task will ensure the appropriate follow-up of the specific obligations deriving from the EC contract, in terms of reporting (financial and results), communication and general management procedures. It will inform the EC of the achievements and deviations from plans, if any. In case of major difficulty, dialogue with the EC will take place in order to find the appropriate solution. The establishment of routines will ensure the communication between and among the project partners, the associated experts, the EC and other partners.

Task 1.7: Reporting, monitoring and evaluating

CIRPS will select a Technical Committee, consisting of experts and Professors from the University of Rome that will periodically monitor together with the Management Unit, the execution of all the project actions and will evaluate the ongoing results and the final outputs.

In addition, the Management Unit will also periodically monitor the administrative and financial issues within the consortium and will evaluate solutions to be adopted together with the EC in order to face hiccups if any will occur during the project development.

Deliverables

D 1.1 Inception Report (month 1)

D 1.2 Start of intranet network (month 1)

D 1.3 Periodic activity report (months 6-12-18-24-30-36)

D 1.4 Periodic management report (months 1-5-11-16-21-26-31-36)

D 1.5 Periodic draft planning for the following year (months 12-24)

D 1.6 Final evaluation (month 36)

Milestones and expected result

M 1.1: Kick-off of the project (month 1)
M 1.2: Inception report (month 3)
M 1.3: Periodic activity report, periodic management report (month 1)
M 1.4: Steering management committee meeting & Project management committee meetings (month 1)

Work package number	2	**Start date or starting event:**			1	
Work package title	Study of macroalgae cultivation parameters and incubation of protoplasts to increase cell growth rate					
Activity type	RTD					
Participant number	**2**	**4**	**5**	**6**	**9**	**11**
Participant short name	CoNISMa	NERI	DTI	CSMCRI	HU	AP
Person-months per participant	18,3	29,4	12,6	27,3	8,0	16,0

Objectives

- Select optimal macroalgae species according to growth rate and high energy content
- Carry out Research in optimising the growth and energy potential of the selected species
- Isolate and regenerate protoplasts from the selected species
- Optimise cell growth rate of the protoplasts
- Achieve maximal biomass yield from the selected species

Description of work

NERI and CSMCRI are in charge of work package coordination and all its related tasks in cooperation with the task leaders according to the timetable proposed.

Task 2.1: Species selection

Subtask 2.1.1 – Select of optimal macroalgae species for growth and high energy content (CoNISMa, NERI, DTI, HU)

NERI will be responsible for the selection of optimal macroalgae species from EU waters. The selection will be based on a literature study of potentially interesting macroalgae species from EU waters. The selection criteria will be high growth rate and high-energy potential, defined as a high calorie content as well as carbohydrate and lipid content. NERI will cultivate fast growing green algae like Ulva lactuca and Chaetomorpha linum in Danish waters. NERI has proven expertise [45] in cultivating Ulva lactuca as well as thecarragenophyte Chondrus crispus.[46]

[45] (Thomsen, A B, Bruhn, A, Jensen, P D, Nielsen, H B, Dahl, J and Rasmussen, M B. Characterisation of the green macroalgae *Ulva lactuca* as a source of biomass for biofuel.In prep).

[46] (Rasmussen, M B and Bruhn, A. 2008. Investigation of the potential for commercial cultivation of *Chondrus crispus*. Report. Danish Food Industry Agency, Ministry of Food, Agriculture and Fisheries, Denmark.
Bruhn, A, Olesen, B, Worm, T and Rasmussen, M B. 2008. Cultivation of *Chondrus crispus* in Danish waters. Report. Danish Food Industry Agency, Ministry of Food, Agriculture and Fisheries, Denmark).

CSMCRI will cultivate fast growing red algae like Gracilaria edulis and G. verrucosa and green algae Enteromorpha in Indian waters. CSMCRI has long standing and proven expertise in the field cultivation of different agarophytes, carrageenophytes and some green algae like Ulva and Enteromorpha in coastal waters along the Indian coast. The initial cultivation studies will be carried out in coastal waters at first instance and later will explore the offshore waters in collaboration with interested partners of this project.

DTI will characterise the basic energy potential of the cultivated species.

Subtask 2.1.2 – Analysis of the growth and energy potential of potentially suitable algae, with focus on response to salinity, solar radiation and CO_2 (CoNISMa, NERI, DTI, HU)

NERI and CSMCRI will be responsible for collecting macroalgae of the selected species from task 2.1 from EU waters and Indian waters.

NERI will undertake cultivation of the selelcted macroalgae in small/laboratory scale in order to optimise growth rate as well as energy content. The parameters tested will be nutrients, temperature, irradiance, salinity, CO_2 addition, pH and water exchange. Furthermore, the growth optimisation of selected species will be carried out in a larger pilote scale cultivation system constructed in Denmark. Parallel pilot scale cultivation of *Gracilaria edulis*, *G. verrucosa* and *Enteromorpha* will be carried out in coastal Indian waters to under stand seasonal variation in biomass and to optimise harvesting periods for respective crop plants. The vegetative propagation methods will be adopted for the former ones and spore based methods for the latter one. This phase is of great importance since it will facilitate test of harvest systems as well as it will produce sufficient biomass for the further analysis by the DTI. Of likewise great importance is the selection and cultivation of macroalgae species covering a range of climatic conditions in Denmark, India and Italy, delivering a suggestion of macroalgae species optimal for cultivation in a range of international waters from temperate to tropical conditions.

NERI and DTI will characterise the energy potential of the selected species, in order to determine the effect of the various cultivation conditions. The experimental phase will take into consideration the effect of biowaste and emissions on macroalge cultivation undertaken in WP 2.1.3 and WP3.

The results obtained in the pilot scale cultivation phase will be extended to large scale in the sea in WP4. The results obtained in this experimental phase will be tested in the open ponds in WP4.

Subtask 2.1.3 – Effect of biowaste and emissions on macroalgae cultivation (CoNISMa, NERI, DTI, HU)

The nutrient and carbon content of various sources of biowaste and emissions will be characterised and tested as sources of nutrients for the selected macroalgae species in laboratory scale experiments. Also the potentially negative effects on growth and biochemical composition of the macroalgae will be characterised. The sources of biowaste to be tested will be selected according to the available sources at the site of the actual plant. Additional types of biowaste with a potential may be included.

DTI will characterize the different types of biowaste regarding key nutrients (N,P,K,C) as sources of algae growth.

NERI will be responsible for carrying out the growth experiments with selected algae in Danish waters. Parameters for effect on growth will be growth rate and energy

content of the selected algae species.

Task 2.2: Protoplasts selection and cultivation

Subtask 2.2.1 – Development of enzyme based methods for producing large number of viable protoplasts from different macroalgal species (CoNISMa, CSMRCRI, AP)

CSMCRI will be responsible for developing methods for isolating viable protoplasts from diverse macroalgal species from Indian waters (tropical) using a consortium of different cell wall degrading enzymes procured commercially. The species responding to enzymatic digestion of seaweed cell walls will be selected for further optimising isolation conditions so as to achieve higher yields of viable protoplasts. The optimised parameters include enzyme types and their concentrations, enzyme pH, incubation period and time, type and concentration of osmoticum etc.

Subtask 2.2.2 – Protoplast culture and their developmental morphology of select algae in the laboratory cultures (CoNISMa, CSMCRI, AP)

CSMCRI will be responsible for developing sustainable methods for achieving high regeneration rate of isolated protoplasts from select species that are amenable for protoplast isolation techniques. The parameters studied include variety of culture media, light, temperature and osmotic conditions. The findings obtained during regeneration system will be gainfully used for seeding the cultivation substratum in the laboratory conditions and then grown in nursery under defined and controlled conditions for ensuring firm attachment and protection. The cultivation nets with relatively big germlings will be transplanted in the sea or ponds for further growth.

Deliverables

D 2.1 Delivery of a catalogue of high interest algae species with high growth and energy potential (month 6)

D 2.2 Delivery of a manual of optimising growth and energy potential of species selected in WP2.1.1 (month 6)

D 2.3 Delivery of a classification of the value of selected sources of biowaste and emissions as nutrient and carbon source of the selected macroalgae species (6 month)

D 2.4 Delivery of an enzyme based methods for producing large number of viable protoplasts from different macroalgal species (month 3)

D 2.5 Delivery of a report on protoplast culture and their developmental morphology of selected algae (month 3)

D 2.6 Delivery of a report on the effect of biowaste and emission on the growth of protoplasts transplanted into open ponds (month 3)

Milestones and expected result
M 2.1 Selection of algae species (month 6)
M 2.2 Selection of optimal environmental conditions for optimal growth and energy potential of selected species (month 6)
M 2.3 A characterisation of the key nutrients (N, P, K, C) and potentially harmful compounds in selected sources of biowaste and emissions (month 3)
M 2.4 Optimised methods for isolating viable protoplasts from different macroalgae (month 3)
M 2.5 Delivery of optimised culture conditions and regeneration patterns of isolated protoplasts from selected macroalgae (month 3)
M 2.6 Growth of transplanted protoplasts in open ponds (month 5)

Work package number	3	**Start date or starting event:**	1
Work package title	Biowaste and emission recollection and sorting		
Activity type	RTD and DEM		
Participant number	**1**	**3**	**4**
Participant short name	CIRPS	Ecoil	NERI
Person-months per participant	11,5	30,5	9

Objectives

- Study and carry out a piping system for CO_2 transport from boiler and upgrading plant
- Selection of adequate biowaste to be used for algae growth, based on its availability and collection system

Description of work

Nitrogen and CO_2 are fundamental elements for algae growth. In particular, the requested amount of nitrogen can be supplied introducing selected biowaste in the algae broth. This work package deals with these aspects of macroalgae cultivation, along with logistical aspects regarding the site plant.

Task 3.1 : Evaluation of adequate systems for CO2 collection and transport

Subtask 3.1.1 – Implementation of the system for transport and insufflation of CO_2 (CIRPS, Ecoil, NERI)

Algae need CO_2 to grow, so algae broth havebroths have to be constantly fed with large quantities of CO_2. The goal of this task is to provide the necessary CO_2 for algae growth. In order to assure CO_2 insufflation into the algae pond, the elaboration of an adequate piping system will be studied for studied and carried out for CO_2 transportation from the boiler and the upgrading plant to the open ponds; with a resulting in substantial reduction of CO_2 emissions.

Task 3.2: Evaluation and collection of available biowaste

Biowaste can be used directly in macroalgae cultivation to achieve higher yields of fermentable biomass. The goal of this task is to select the suitable biowaste among those available in the area of site plant. An adequate choice of biowaste (e.g. poultry manure), in fact, can provide the right amount of nitrogen requested for algae growth and, at the same time, transform the negative eutrophication potential of such biowaste into a positive input. For this choice, the attention will also be focused on the possible collection system of the biowaste. An other aspect will be developed in this task: it will be selected whether to use the output of the second Archimede rotor for producing pellets or as fertilizer on the base of LCA studies.

Deliverables

D 3.1 Delivery of a report about the effects of CO_2 insufflation on macro algae growth rate (month 14)

D 3.2 Delivery of a local biomass catalogue including a description of its characteristics and localization (month 7)

D 3.3 Delivery of a complete LCA study from the input biomass to the output products of the anaerobic digestion plant (month 12)

Milestones and expected result

M 3.1 Planning and implementation of a piping system for transport and insufflation of CO_2 into algae broth (month 8)

M 3.2 Collection of available and suitable local biowaste to introduce in the algae pond (month 6)

Work package number	4		**Start date or starting event:**		1		
Work package title	Open pond cultivation and optimisation						
Activity type	RTD						
Participant number	**1**	**2**	**3**	**4**	**5**	**6**	**9**
Participant short name	CIRPS	CoNISMa	Ecoil	NERI	DTI	CSMCRI	HU
Person-months per participant	15,6	7,20	17,4	21,0	25,2	31,5	9,0
Participant number	**10**	**11**					
Participant short name	RTU	AP					
Person-months per participant	20,0	9,0					

Objectives

- Study, evaluation and implementation of a closed system for macroalgae cultivation
- Implementation of an efficient harvesting method
- Optimisation of macroalgae cultivation parameters to increase biomass yield
- Economical, technical and environmental assessments of the products including in particularly:
  - a development of an LCA (Life Cycle Analysis) of the whole plant process (quantification of activities and flows associated with the system, quantification of the emissions, resource use and other environmental or social interventions associated with the activities that are part of the product system, evaluation of the environmental impacts of the whole system, quantification and evolution of the energy balance of the whole process),
  - A development of an analysis regarding final products and by-products, including: exact calculations of achieved electrical and heat energy per time period, in order to understand the possible product market; find the best, most efficient way for usage of heat and electricity, in order to get the most profitable result in connection with environmental aspects; assess the quality of the fertilizer, in order to understand the possible product market; assess the quality of clarified effluent, in order to understand the possible usage.
  - Providing a basing tool for stakeholders.

Description of work

This work package deals with the implementation of the plant for macroalgae

cultivation and the study of economical, technical and environmental assessments of process bioproducts.

PVC open ponds will be carried out in the site plant in Augusta (Sicily) and simultaneously, an optimised harvesting system will be studied.

Task 4.1: Macroalgae cultivation plant

Sub Task 4.1.1 – Final planning of the open ponds and their construction (CIRPS, Ecoil, NERI, DTI, CSMCRI)

Before establishing macroalgae cultivation the final and executive plan of the open ponds will be developed. Later, four PVC open ponds will be carried out in the site plant in Augusta (Sicily). A jet air will be connected with each pond, in order to provide water and CO_2 to the algae broth. Moreover, eutrophicational agents (coming from the biodigestors) will be introduced in the open ponds, after an appropriate treatment, achieving a closed cycle. The cultivation in open ponds assures a strict control of parameters such as pH, nitrogen compounds, phosphates, etc.

Sub Task 4.1.2 – Final planning and implementation of harvesting system (CIRPS, Ecoil, NERI, DTI, CSMCRI, HU)

The aim of this task is to plan and implement the harvesting method, after a selection among different systems. A possible solution is the siphon-based harvest system in which the gravity does the job; an other possibility is the use of a rotating drum screen for the treatment of waters with high concentration of suspended solids. Obviously the choice of the harvesting system has to consider specific factors regarding the characteristics of the open ponds and their place in the site plant.

Sub Task 4.1.3 – Plant management for algae production (CIRPS, Ecoil, DTI)

A strict control of operation plant is fundamental. The main aspects on which the attention will be focused are: external biomass inputs, open ponds and piping integrity, correct functioning of incubator, boiler, biodigestors, and Archimede rotors. This will be obtained with periodic review of the entire plant.

Sub Task 4.1.4 – Optimization of macroalgae cultivation (CoNISMa, NERI, DTI, CSMCRI, HU, AP)

During macroalgae cultivation a constant control of parameters will be carried out. This allows optimising the cultivation in order to increase the regeneration rate of protoplasts and the macroalgae biomass yield.

Subtask 4.1.5 – Study of the effects of biowaste and emissions after the transplant in the open ponds (CoNISMa ,DTI, CSMCRI, AP)

The nutrient and carbon content of various sources of biowaste and emissions will be characterised and tested as sources of nutrients for growing select macroalgae species raised from protoplasts in laboratory scale experiments. The data generated in the laboratory experiments will be scaled up and used for field cultivation in the sea for achieving higher growth

potentials. The sources of biowaste and emissions to be tested will be selected according to the available sources at the site of the actual plant. Additional types of biowaste with a potential may be included.

Task 4.2: Macroalgae impacts

Sub Task 4.2.1 – LCA of macroalgae cultivation in open ponds (NGVA, RTU)
The person responsible for this task will produce an EIA that will help to understand the effects of the project on the environment. The assessment will contain a description of the project, the several options that were considered, a description of the local environment, an accurate description of the significant effects on the environment and the possible mitigation measures.
In particularly the task leader will be responsible for:

- the whole impact assessment of macroalgae cultivation in open ponds by LCA (based on ISO14044) in order to assess the environmental, energetic and economic performances of the algae-based biogas plant. Analysis will be provided including the use of LCA software SIMAPRO 7.0,
- providing the final conclusions of the study in order to identify advantages and disadvantages of process, and to identify critical factors,
- the development of a literature review of LCAs of biogas for CHP.

Sub Task 4.2.2 – Chemical and market analysis of process bioproducts (DTI, NGVA, HU, RTU)
The task leader will be responsible for:

- the calculation of the total energy benefit, taking into account all the possible looses,
- providing a stakeholder analysis on the base of specific characteristics and specific energy requirements,
- market analysis concerning "green" electricity users and heating end-users on the base of the most efficient usage for the generated energy,
- market analysis concerning the end use of fertilizer as bioproduct,
- chemical and quality test of bioproducts.

Deliverables

D 4.1 Executive project of open ponds and circulating system (month 5)

D 4.2 Executive project for harvesting system (month 5)

D 4.3 Periodic reports on macroalgae cultivation trend (months 10-15-20–25–30-35)

D 4.4 Periodic reports (draft and final versions) about LCA (regarding macroalgae cultivation and the whole plant process), market analysis (total energy benefit, Stakeholder analysis, green electricity users and heating end-users) and chemical analysis (months 8–14–20–26–32-36)

Milestones and expected result

M 4.1 Planning and Construction of a closed system method for macroalgae cultivation (month 5)
M 4.2 Implementation of the Feeding and harvesting system (month 5)
M 4.3 Providing a useful tool for stakeholders and decision makers in order to identify

different alternatives for different local plant environments (month 15)

Work package number	5	**Start date or starting event:**		1		
Work package title	Planning, implementation and management of a patented two phase anaerobic digestion plant					
Activity type	RTD and DEM					
Participant number	**1**	**2**	**3**	**4**	**5**	**6**	**9**
Participant short name	CIRPS	CoNISMa	Ecoil	NERI	DTI	CSM CRI	HU
Person-months per participant	15,6	15,4	6,0	3,0	4,8	6,0	2,8

Objectives

This work package has the overall aim to optimize biogas production

- To establish optimised plant scale, implementation, spatial and logistic organization
- To obtain an homogenized input biomass and optimised feedstock management
- To develop process guideline for a more efficient biogas plant implementation and management
- To realize a pre-treatment aerobic plant producing an homogenized input
- To realize a two phase anaerobic digestion plant improving biogas yield
- To treat the bio-products in order to ensure hygienic and quality.

Description of work

This work package deals with all the aspects inherent to biogas production from the planning of biogas plant to the residual material handling.

Task 5.1: Pre-treatment plant

Sub Task 5.1.1 – Final planning and building of pre-treatment plant (CIRPS, NERI, DTI and HU)

A detailed comparison of data and technical information with local authorities and enterprises will allow submitting the final design of the plane.

The input Biomasses (macroalgae, poultry manure and other) are pumped into a hydro cyclone for the removal of sand, afterwards they go through a system of crumbling that allows them to create a very fine mush.

The obtained product will be stored in a feeding tank from which it will be subsequently taken out with a continuous pump and fed to a complete stirring hydrolysis and acidification reactor.

The aerobic pre-treatment allows degrading the biggest molecular compounds into

easier digestible one optimizing the overall process.

Task 5.2: Two phases anaerobic digestion plant

Sub Task 5.2.1 – Final planning of acidification digester (first phase) (CIRPS, NERI, DTI and HU)

The acidification phase (in a complete mixing anaerobic digester) will be carry out at 38° C. The use of a thermophile process to accelerate the macromolecule demolition.
After this first phase, the effluent is clarified: the solid part is going to be recycled in order to complete the hydrolysis, while the liquid part will go through the second phase for the methanation.
The system will be fitted with instruments for the automatic control of mechanical operations and of the acidification reaction trend. It will be provided with safety systems in compliance with local legislation.

Sub Task 5.2.2 – Final planning of methanation digester equipped with "Archimede Rotors" (second phase)

The methanogenic reactor uses biomass rotors "Archimedes" in order to maintain a high concentration of bacteric methanogen flora and to optimize the stripping of biogas.
The Archimede Rotor (Deatec patented system) is composed by a cylindrical rotating body: its rotation is guaranteed by the bottom insufflations of partial recirculating biogas produced during anaerobic digestion phase.
The control of the reaction flow (measurement of the potential redox and the content of solid volatile residues) will eventually determine the need of an additional stage of refinery.

The two phase process presents such advantages. It allows:

- To monitoring and control the biological pathways reactions in each phase, avoiding the hanging problems commonly related to the single phase digesters.
- The possibility to increase the retention time of the biomass and the solubilisation of un-dissolved solids operated by bacteria.

As result it will be possible to increase the transformation rate of the organic compounds in biogas, obtaining simultaneously higher quality solid and liquid effluents.
The digester will be connected with a gasometer to ensure a constant inflow and a biogas reserve for the system. The system will be fitted too with instruments for the automatic control of mechanical operations and of the methanation reaction trend. It will be provided with safety systems in compliance with local legislation.

Sub Task 5.2.3 – Building of the anaerobic digesters: stainless steel pools, gasometer, Archimede rotors

The acidification digester will consist of a stainless steel pool of 25 m^3 with a diameter and height respectively of 4 and 2 meters. Regarding the second digester, it will consist of a stainless steel pool of about 35 – 40 m^3 (6x2.5x3); the Archimede rotor will be positioned inside the pool. The outputs of second phase digestion are: biogas and effluents. The first will be collected in a gasometer of about 10 m^3, while the second will flow in the treatment plant (WP 5.4).

Task 5.3: Effluents treatment plant

Sub Task 5.3.1 – Final planning and construction of effluents treatment plant

The effluent treatment plant will use the patent Archimede system in order to obtain a separate production of solid and liquid effluents. It will be used to vary the concentration of nitrate compounds in the liquid fraction (used as feed for algae cultivation) and creating so a closed system.

The solid effluents will be dried and pelletized and an assessment report on quality and hygienic (sub task 5.2.1) will be produced. A detailed collection of data from local authorities associated with simultaneously study on the EC regulation and Italian acknowledgment at regional and national level will permit us to redistribute the eco-fertilizer to the local farmers (WP 7.1).

Task 5.4: Biogas treatment plant and piping implementation to feed the boiler

Sub Task 5.4.1 – Final planning and construction of treatment plant (dehiydratation and removal of H2S and dusts systems)

A detailed study about the characteristics of the gas produced will be necessary in order to plan the implementation of a suitable gas treatment plant.

The removal of H_2S will be carry out thanks to a scrubber technology (using caustic soda associated to a pH control system) followed by the removal of a the excess of CO2 thanks to a cooling method. This task will be planned taking in consideration to the proposed cryogenic upgrading process (WP6).

Task 5.5: Production of heat and electricity

Sub Task 5.5.1 – Implementation of the cogeneration plant

The CHP system will come after the cleaning and dehydration of gas. It will be composed of a gas engine, an electricity generator, and a system to feed back the energy produced into the grid. Through a heat exchanger it will be possible to recover thermal energy, that will be useful, to a very limited extent, to maintain the digester and open ponds temperature. The combustion flue gases (rich in carbon dioxide) will be conveyed to the lagoon diffusion system.

Task 5.6: Use of heat energy produced to control open ponds and digesters temperature

In order to control the open ponds temperature a pipeline system will be planned and implemented. The system will be supply thanks to exhaust gases produced by the cogenerator. A relevant amount of that gases will be collected and insufflates directly in the open ponds to maintain unaltered the temperature culture parameters especially during winter season while the rest will be use to supply heat to digesters.

Deliverables

D 5.1 assessment report on operational experience on pre-treatment process using

macroalgae as co-substrate (month 12-24-32)
D 5.2 assessment report on optimization of two phase anaerobic digestion process (month 12-24-32)
D 5.3 To deliver a report with a description of the guidelines for increasing the production efficiency (month 34)

Milestones and expected result
M 5.1 Planning, implementation and optimization of the pre-treatment plant (month 5)
M 5.2 Planning, construction and optimization of the Two Phase anaerobic digestion plant (month 5)
M 5.3 Planning, implementation and optimization of effluents and Biogas treatment plants (month 5)

Work package number	6	**Start date or starting event:**		20			
Work package title	Bio-methane production thanks to the cryogenic upgrading technology						
Activity type	RTD						
Participant number	**1**	**5**	**8**				
Participant short name	CIRPS	DTI	SGtS				
Person-months per participant	5,0	6,4	26				

Objectives

- To demonstrate new cryogenic gas treatment technology beyond state of the art.
- To separate biogas into suitable streams and create produce a high quality methane fuel CBG (Compressed BioGas) suitable for vehicles
- To carry out Research utilising other components in the biogas besides methane where nutrients, minerals and carbon dioxide is reused to produce more algae.
- To optimise the energy efficiency, energy input / energy output
- To eliminate the need of chemicals used
- To minimise the methane losses without the usage of external combustion
- To evaluate the produced CBG quality with focus to produce LBG (Liquid BioGas) this is the main sustainable 2-nd generation vehicle fuel.
- Lower the GHG effect further then present production methods.
- Lower the production cost by introducing remote control via internet and unmanned operation

Description of work

SGtS is in charge of work package and all its related tasks in cooperation with the task leader according to the timetable proposed. CSMRCRI is responsible for coordinating activities and operation on site.

Task 6.1: Analysis and evaluation of plant scale

Subtask 6.1.1 – Final planning of the upgrading plant

SGtS will be responsible for the design, manufacturing, installation and operation of a cryogenic biogas upgrading plant. The design will be done with focus on integration with macro algae production where methane is extracted and the remains of the biogas are returned to the algae production to produce new biomass.

The design and construction of production method will comply with future requirement and also appropriate for large scale production which makes CBG & LBG into a volume fuel.

Subtask 6.1.2 – Plant construction
SGtS will make the complete design and construct the process for modern operation to optimise the production costs. This involve the latest remote control via internet and tests of unmanned operation.
The cryogenic technology eliminates the need of chemicals and is a strict separation process where substances in the biogas are removed as condensate. The separation process is hereby insensitive to unexpected contents in the biogas as a result of digestion of new algae types. It gives the project a freedom to test not only algae but also co-digestion of other substrates.

Subtask 6.1.3 – Bio-methane production and use as 2nd generation biofuel
The use of biogas as vehicle fuel can reduce light and duty vehicles emissions of carbon dioxide by 20-25% over petrol vehicles. The main goal of this task is to feed a local vehicle fleet, opportunely modified, using upgraded bio-methane as second generation biofuel.

Deliverables
D 6.1 Delivery of an analysis of the preconditions and planned technical solution with expected production results (month 24)
D 6.2a Delivery of a process design and integration with digester and algae process (month 24)
D 6.2b Delivery of the production results and conclusions of CBG and LBG as the 2nd generation vehicle fuel (month 34)

Milestones and expected result
M 6.1 Design and manufacturing and installation of the cryogenic upgrading plant (month 20)
M 6.2 Implementation of a latest plant remote control via internet (month 24)

Work package number	7		**Start date or starting event:**			6	
Work package title	Monitoring and appraisal – Survey of European economic and legislative barriers						
Activity type	RTD						
Participant number	**1**	**2**	**5**	**6**	**7**	**8**	**10**
Participant short name	CIRPS	CoNISMa	DTI	CSMCRI	NGVA	SGtS	RTU
Person-months per participant	8,4	15,1	5,2	6,3	10,5	15	11,2

Objectives

- Providing a picture concerning the main actual methods for seaweeds production
- Providing the seaweeds production – end uses mass balance
- Economical analysis in connection to the seaweeds market

Description of work

Task 7.1: Seaweeds production and utilization (CoNISMa, DTI and RTU)

- RTU will provide the development of a literature review concerning macroalgae production methodology and their final utilization
- RTU provide a study concerning the evaluation of different seaweeds production systems and their final utilization

Task 7.2: Bio-methane use as second generation biofuel

Sub Task 7.2.1 – Comparative analysis of the main european legislative tools on bio-methane (CIRPS, NGVA, SGtS and RTU)

The comparative analysis of the European legislation on biofuel production will give a documentary basis providing a bibliography research on the main barriers from a legislative and economic point of view to the further development of renewable energies in the EU.
RTU will provide a final report comparing the main european legislative tools on bio-methane simultaneously to a study concerning the use of biomethan in term of energy sustainability in the European environment.

Sub Task 7.2.2 – Analysis of possible legislative amendments to be made at italian level

This task will consider the outputs emerged from the previous task and will produce some legislative and technical recommendations to policy makers in order to favour and enhance the spreading of renewable energy both at national and Community

level. It Will also carry out a detailed study on the characteristics of biogas and bio-methane produce in order to promote their use as second generation transport fuels. These two tasks will involve a written report containing the conclusions.

Deliverables

D 7.1 Delivery a report concerning the analysis of the different methodology for seaweeds production and their utilization (months 12–24)

D 7.2 Periodic reports (draft and final version) concerning analysis of the main European legislative tools on bio-methane in terms of comparison of different sustainability (months 24-36)

D 7.3 Delivery of a report concerning the analysis of Italy current laws and possible bills (month 34)

Milestones and expected result

M 7.1 Wider and clear picture of the European concerning the Seaweeds production and utilization for bio-methane (month 24)

Work package number	8	**Start date or starting event:**			1
Work package title	Promotion, marketing and dissemination				
Activity type	RTD				
Participant number	**1**	**2**	**7**	**9**	**10**
Participant short name	CIRPS	CoNISMA	NGVA	HU	RTU
Person-months per participant	7,0	13,3	17,9	6,0	5,5

Objectives

- To give visibility to the initiative and collect updated information about project development
- To disseminate the results of the project among

Description of work

Task 8.1: Website (development, maintenance and promotion)

CIRPS will develop and host a dedicated project website. The consortium, with the support of a graphic, will also create a logo to be used for all the project documentation. The website will contain all the information about the development and implementation of the project: documents, reports, videoconferences, news, projects and all other relevant events related to renewable energy and national, European and international initiatives dealing with environmental issues.
Moreover, on this website all the technical documentation will be currently updated by all the members. The website will also contain an intranet section which will be accessible only from the partners of the consortium. In the intranet, CIRPS will also create a forum to facilitate the information sharing between the partners.

Task 8.2: Publications

Publications, in the form of brochures, newsletters and CD-ROM, will be the preferential ways to disseminate he project results. Some videos will be produced and a documentary is planned to be developed to illustrate the main phases of the project and the innovative technologies applied. This documentary will be presented during the final conference and will be uploaded on the website.

Task 8.3: Events (conferences, workshops, exhibitions and meetings)

Another way of dissemination of the knowledge produced in the project will be the organisation of events like conferences and workshops to make public the advancement of the work and the different stages, and eventually the final conclusions.

Task 8.4: Study tours

Several journeys will be organised in order to give stakeholders and partners the possibility to visit
the area of the project implementation. These visits will also be an important occasion to strenghten the partnership and improve the communication and information sharing among partners. Moreover, these events will allow the establishment of useful contacts between the private companies involved in the project, the research institutes and public authorities to plan further activities.

Task 8.5: Set-up of a High-tech platform (videoconferences, database and filesharing)

Since the beginning of the project we will set up a system of communication trough a virtual database and file sharing among the partners in order to have full access to the information from all sides. In function of the necessities of each project development phase and task, we will also organize videoconferences to present and discuss the progression of the work.

Deliverables (brief description) and month of delivery

D 8.1 Delivery of the electronic forum and newsletter(Month 2)
D 8.2 Delivery of a dissemination logistic Plan (Month 6)
D 8.3 Delivery of a project brochures and CD-ROMs (Month 9)

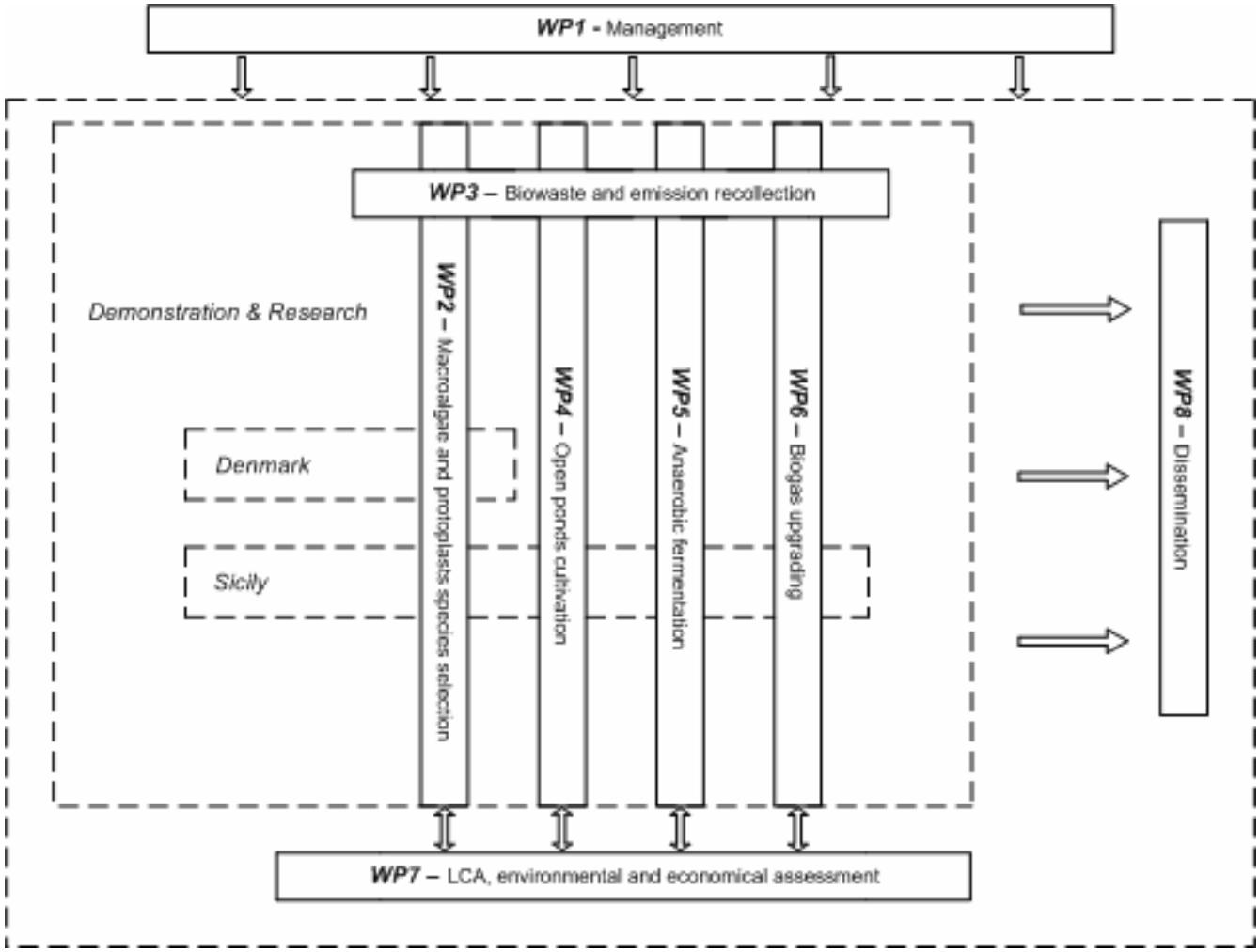
Milestones and expected result

M 8.1 Kick-off meeting (Month 2)
M 8.2 Planning and implementation of the internet project website (Month 3)
M 8.3 Plan for using and disseminating the knowledge at EU and Extra-UE level (Month 6-12-18-24-36)
M 8.4 Reports and Brochures presentation and discussion to the final conference (Month 36)

Summary of staff effort

Partic. no.	Partic. short name	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	Total person months
1	**CIRPS**	70,6	0,0	11,5	15,6	15,6	5,0	8,4	7,0	**133,7**
2	**CoNISMA**	0,4	18,3	0,0	7,2	15,4	0,0	15,1	13,3	**70**
3	**Ecoil**	0,4	0,0	30,5	17,4	6,0	0,0	0,0	0,0	**54**
4	**NERI**	0,4	29,4	9,0	21,0	3,0	0,0	0,0	0,0	**63**
5	**DTI**	0,2	12,6	0,0	25,2	4,8	6,4	5,2	0,0	**54**
6	**CSMCRI**	0,4	27,3	0,0	31,5	6,0	0,0	6,3	0,0	**44**
7	**NGVA**	0,4	0,0	0,0	0,0	0,0	0,0	10,5	17,9	**29**
8	**SGtS**	0,4	0,0	0,0	0,0	0,0	57,0	15,0	0,0	**72**
9	**HU**	0,0	8,0	0,0	9,0	2,8	0,0	0,0	6,0	**26**
10	**RTU**	0,4	0,0	0,0	20,0	0,0	0,0	11,2	5,5	**37**
11	**AP**	0,0	16,0	0,0	9,0	0,0	0,0	0,0	0,0	**25**
Total		**73,6**	**111,6**	**51**	**133,4**	**47,6**	**68,4**	**72,4**	**49,7**	**607,8**

iv) Provide a graphical presentation of the components showing their interdependencies



v) Describe any significant risk, and associated contingency plans.

A large, innovative, demonstration project like Biowalk4Biofuels, considering the number of variables involved in it, has some possible risks that could influence the expected results. An early identification of emerging risks and the development of preventive actions and contingency plans are crucial to the success of the project. Due to the complexity of the initiative, risk management has to be done in a rigid way following a structured approach throughout the lifetime of the project. Risk management will be carried on by the Project Boards. The overall objective is to identify possible risks at an early stage to be in a position to take counteractions and therefore ensure that the planned application will be brought back on track ensuring a successful completion of the project. The following main risks have been identified.

There are a number of potential risks associated with the development and implementation of the **demonstration plant**:

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1) Possible damages of the PVC open ponds due to act of vandalism or accidental events (it does not represent a high risk due to the fact that the algae used in the plant are aboriginal, so they cannot be considered dangerous in that ecosystem). Due to the kind of material chosen for the open ponds this kind of damages would be repaired soon without complex operations. Daily checks on multiple shifts will be scheduled to assure an immediate intervention in case of damages.
2) Bottom erosion episodes due to the modification of the existing current fields under the open ponds, which distance from the bottom could vary from 1.5 to 3 meters. This kind of risk is however considered very low due to the localization of the demonstration plant: in fact it is set in a area protected by the wind and swell, far away from the Augusta Bay entrance, in a secluded area of the Bay;
3) Excessive approaching of the ships to the open ponds due to mistaken manoeuvre with possible damages of the PVC open ponds;
4) Damages of the PVC open ponds due to tidal wave. This kind of risk is considered to be very low due to the complete knowledge of the tides in that area and to what has already been mentioned above;
5) Exceeding of algae growing in open ponds (in this case we can just decrease the quantity of CO2 insufflated)
6) Malfunctioning of the protoplast incubator or of the CO_2 pipeline (it would provoke a decrease in the algae growing)
7) Delay in the delivery of the manure (the delay could reduce for few days the biogas productions)
8) Any project of this complexity and size envisages that financial risks might occur during the lifetime of the project. Although the resources for the project have been assessed as accurately as possible it will be necessary to closely monitor the progress of the project and to control the resources spent. It will be a task of the project management to refine the project planning at least each year of the project lifetime and to reallocate resources whenever necessary.

2 Implementation

2.1 Management structure and procedures

BioWalk4biofuels is a large and strategically very important project for the consortium. The partners consider project management as a key task to achieve the project objectives in the most effective way. The project management task is therefore adequately resourced and aimed at accomplishing three key objectives:

- To monitor the project development, ensure the interaction with the European Commission and coordinate the actions to be undertaken along the project development in order to fulfil the work programme activities, objectives and schedules;
- To ensure the interaction at the European level with related projects in the field in order to contribute to and maximise the coordination and integration of research, development and demonstration relevant activities;
- To promote the dissemination, exploitation and marketing of the project end-results in order to maximise their impact in the European energy system.

The project has adopted a management structure that takes account of the complexity of a project of this size and ambition. Both the project management structure and the breakdown of the work will allow:

- Efficient and effective project management on all project levels
- Timely information on project progress and resources
- Clear delegation of tasks and responsibilities
- Necessary control and coordination between tasks
- Assessment of emerging risk and development of contingencies at an early stage
- Clear communication lines within the consortium and with the European Commission
- Efficient dissemination of results and transfer of knowledge at international level.

The project will be coordinated in the technical and administrative aspects by CIRPS which assumes responsibility for the project management in all aspects as stated by the European Commission contracting rules. CIRPS project management team will comprise a Project Manager and a Project Coordinator.

The Project Manager will be responsible for:

- Overall coordination and direction of the project
- Co-ordination of the overall transnational activities
- Monitoring the European funding
- Rights and duties of all partners involved, as described in the joint Consortium Agreement.

The day to day running of the project will be in the hands of a Project Coordinator who is mainly responsible for the day to day communication, activity monitoring and decision-making, plus liaison where required between partners and other related EC projects. The coordinator is supported in this action by the Project Office. The Project Office will be

composed of a staff of three officers: a communication responsible person, a translator and a financial expert. All scientific and technological activities of BioWalk4biofuels are directed towards the overall goal of BioWalk4biofuels , and they are all defined as necessary contributors for achieving this goal. Experience with previous international projects has shown that a management structure split into defined levels provides more effective decision-making structures and also facilitates clear internal lines of communication. On the other hand, a broad and hierarchically structured organisation can often be costly and too inflexible for innovative research and development processes. These aspects have led to an organisation which is flat and slim (only 3 levels) and works with distributed responsibilities, in both vertical and horizontal directions, as shown in Figure 4.

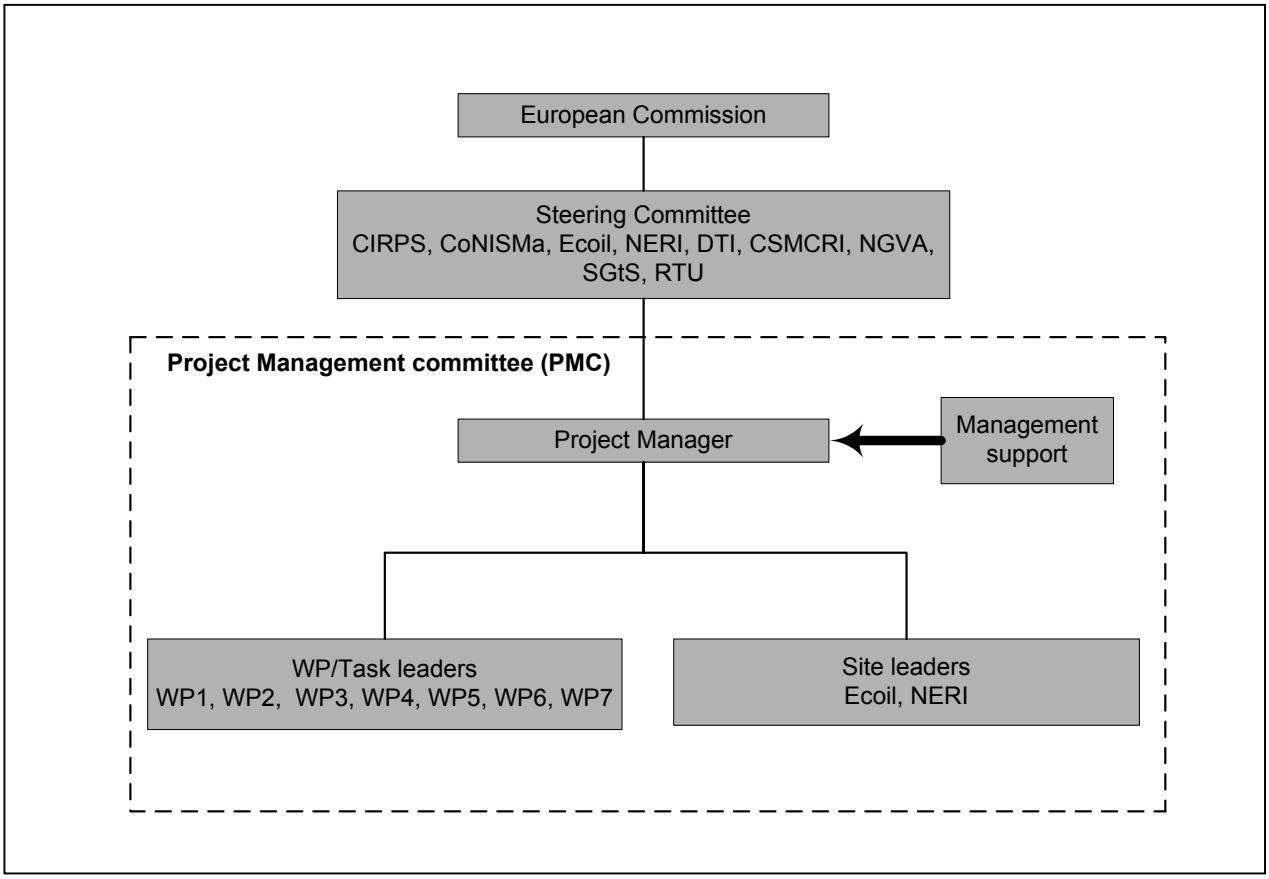


Figure 4 Project management structure

The following roles in the management structure were distinguished:

- Project Management Committee
- Project Manager and Coordinator
- WP-leaders

The monitoring, control and steering of the project is executed by the Project Management Committee (PMC). The supervision is to be considered both in a strategic sense and an operational level.

The Project Management Committee (PMC)

The Project Management Committee (PMC) is chaired by the Project Manager and comprises the coordinator, the Work Packages leaders and the project Office staff. After having informed the others, each partner with a place on the PMC shall have the right to replace its representative.
Each representative shall have a deputy. The PMC meets regularly at least twice per year in principle or at any other time when necessary at the request of the Project Manager or another partner. The other partners shall be entitled to participate in and cooperate with the PMC. The major tasks of the PMC shall be:

- Taking overall responsibility for the project, ensuring its continuity and consistency and adequate allocation of its resources
- Mentoring and monitoring the progress of the project at the strategic level from its start-up phase to its completion
- Approving reports and deliverables
- Defining and handling the involvement of additional partners in line with the overall project plan and when certain needs arise
- If necessary, e.g. due to a technological break through, adjusting the content and direction of research in the project
- Handling any conflict resolution within the project which could not be solved at a lower level
- Handling any contractual and financial matters
- Reviewing the technical progress of the project
- Identifying need for corrective actions where necessary
- Taking operational decisions and ensuring difficult situations are solved.

The PMC meetings will be organised and prepared by the Project Coordinator, in liaison with the Project Manager. In advance of meetings the PMC will receive a progress report so that problems can be anticipated and potential project risks identified and solutions offered.

Project Coordinator

The project coordination will be provided by CIRPS as the coordinating contractor. CIRPS will therefore be the only contact point for the European Commission and will ensure the day-to-day management, financial, administrative and contractual activities, as well as the preparation of regular reports on work progress, the project review and the final report. The Project Coordinator will be supported by a Project Secretariat. The responsibilities of the Project Coordinator involve the following:

- conducting of formal negotiations between the consortium and the Commission as well as between partners;
- relationship and correspondence with the Commission and third parties not involved in the Project;
- appropriate establishment of communication channels among the project partners;
- coordination of the development and implementation of the work plan and periodical review of the project progress against the work plan;

- preparing the Project Management Committee and smaller team meetings and follow-up of its decisions;
- supervision of progress relative to the time table of the project;
- collection of the partners documents and cost and other statements and forwarding thereof to the Commission;
- transmission of any documents connected with the project between the partners and the Commission, and vice versa.

Work Package leaders

The WP leader supervises the activities within the corresponding work package. He/she can interact as necessary with the Project Management Committee, regarding technical questions. In particular he/she is responsible for the active project planning and progress monitoring within his/her WP in conjunction with the Coordinator. For both planning and monitoring he/she can, if necessary, request the assistance of the partners involved in tasks inside his/her Work Package. The WP leader shall ensure that partners deliver their input in time and with good quality to the deliverables of his/her WP and furthermore prepares for the technical audits by sending all relevant information on technical progress and results.

Site leaders

The site leaders from Augusta (Sicily) and Denmark shall supervise all contributions to the Work packages from their respective partners. They are responsible for supervision of local progress in the technical WPs, editing of site's contribution to yearly reports. The Site Manager is responsible for contributions to project deliverables to which his/her site has to contribute to.

2.2 Individual participants

- **Interuniversity Research Centre for Sustainable Development (CIRPS)**

CIRPS, the Inter-university Research Centre for Sustainable Development at the University of Rome
"La Sapienza" (Italy) is focused on promoting and conducting activities related to sustainable economic and social development at the international level in cooperation with Italian and foreign Institutions and international Organisations.
CIRPS promotes, coordinates and manages a number of interdisciplinary activities carried out by the member Universities in collaboration with other private and public partners, both Italian and foreign. Therefore, CIRPS activities emphasise the added value given by the combination of academic experiences with worldwide private experts. In Rome CIRPS handles a number of training and educational initiatives (Ph.D., Master, Diploma and continuous High-Education Courses) for Italian and foreign graduate and post-graduate students in fields mainly related to international cooperation and sustainable development. CIRPS staff is composed of 60 employees. To date the Universities of Lecce, Macerata, Palermo, Perugia, Sassari and Turin officially join CIRPS, with the relevant additional act modifying the Convention. CIRPS head office is at Palazzo Doria Pamphilj in Valmontone (40 km from Rome). More specifically, CIRPS:

a. promotes, coordinates and/or directly carries out activities conducted by the Universities having signed the agreement, also in collaboration with Organisations and similar Centres, Universities, National and International Institutions, namely from Developing Countries, EU and UN (UNESCO, UNICEF, UNITAR, UNDP, etc.);
b. promotes training initiatives in the field of International Cooperation and Sustainable Development: Master (I and II level), High Education Courses, Distance Learning;
c. participates in and promotes national and international projects;
d. assists Governmental and Non-Governmental Organisations in choosing and analysing the feasibility of cooperation programmes, and also in implementing and detecting the possible contributions that could be given by CIRPS Operational Units and Sections, and, generally speaking, its associated Universities;
e. fosters initiatives for scientific books and interdisciplinary collaboration (e.g. Forums, Workshops, etc.) and attracts the attention of Degree Courses, Faculties, Institutes and Departments, and Research Doctorates of Italian Universities towards sustainable development oriented education;
f. promotes and enhances the organised coordination of the university world with the non academic world of development cooperation, also providing advice to the parties having an interest in the single programmes as well as assistance in the feasibility analysis and exante and/or ex-post evaluations of the same programmes;
g. encourages the dissemination of information on cooperation activities, through the establishment of Data Banks, Documentation Centres and publication of periodic newsletters;
h. promotes coordinated exchanges of university personnel at the international level;
i. organises training courses for students who wish to work in the field of International Development Cooperation;

j. promotes, coordinates and directly carries out research and interdisciplinary collaboration activities at the international level directed towards Developing Countries and also all the

55

other Countries dealing with and interested in development cooperation.

Scientific team

Prof. Vincenzo NASO, Director of the Interuniversity Research Centre for Sustainable Development (CIRPS), and President of ISES ITALIA, the Italian section of the International Solar Energy Society.

Full professor of Energy Systems at the Department of Mechanical and Aeronautical Engineering of the University of Rome "La Sapienza" (Italy). Long experience in international cooperation and EU projects. Responsible for the renewable energy sector since the latest seventies. Main fields of research and technical expertise:

- ✓ Energy Conversion Systems:
  - *Conventional:* Reciprocating internal combustion engines; Hot air (Stirling) external combustion engines; Turbomachines; Refrigerating and cryogenic machines; Compressors and pumps
  - *Advanced*: CHP; Heat pumps; Advanced technologies in Energy Conversion Systems
- ✓ New and Renewable Energy Conversion Systems:
  - Hydrogen production from renewable energy sources
  - Solar thermal at low and medium temperature
  - Biomass
- ✓ Energy Saving in Industry, Transport and other End Uses
- ✓ Clean Technologies for Sustainable Development.

Dr. Silvano SIMONI is an expert in the renewable energy field at the University of Rome "La Sapienza". He is research coordinator of the Unit B*iofuels and engineering in the innovation of new energy plants* and is involved in Biofuel promotion. He believes that biofuels could be one of the most important tools to achieve energy sustainability. Dr. Simoni has extensive experience in International project collaboration, multi-cultural background and speaks English, Italian and Portuguese. He organises events aimed at the transfer of know-how and market penetration of Biofuel technologies.

He is working on biofuels in several Italian Regions to foster the application of Precision Farming and biomass cultivation for biofuel production. He has submitted several project proposals within the EU and Brazil to carry out a study research on biomass cultivation for biofuel production using precision farming technologies, Geographic Information Systems (GIS) and adequate machines/hardware. These innovative technologies for cultivation allow biofuel production by using cheaper and more sustainable and environmentally friendly techniques, rationalising available resources and minimising the environmental impact of rural productions. Finally, Dr. Simoni coordinates projects related to cogeneration, biofuels and oil production, photovoltaic energy, anaerobic digestion in partnership with Italian SMEs, Universities and Governmental Institutions.

- ➢ **National Interuniversity Consortium for Marine Science (CoNISMa)**

CoNISMa was established in February 1994. It is a research organisation composed by 31 Italian Universities with a recognized legal status and controlled by the Ministry of Universities and Research. At the moment it consists of about 600 among teachers, researchers and university technicians afferent to it.
Its purposes are:

- ✓ to promote and co-ordinate researches and other scientific and applicable activities in the field of Marine sciences, favouring the co-operation not only among the associated Universities, but also with other Universities, with public and private research Bodies, local and territorial Authorities, production structures.
- ✓ to promote and coordinate, also granting Scholarships, the preparation of experts in different research fields;
- ✓ to begin the transfer of national and international results in the field of Marine sciences, in order to apply these to the public and private sector;
- ✓ to promote and support national and international projects as well as to carry out studies for State Administrations, public and private Bodies, local and territorial Bodies, national and international Agencies.

The Consortium organises, every two years, in agreement with the Scientific Societies AIOL (Italian Association of Oceanology and Lymnology), SIBM (Italian Society of Marine Biology) and SItE (Italian Society of Ecology), the National Marine Science Meeting. The Consortium's publishing activity consists in books publication and also in the publication of a quarterly newsletter. It has conventions with European and Latin American Universities. It has established associated companies with research Bodies and local Bodies. The Consortium acts besides through the Statute, also on the basis of specific Operating Regulations of Bodies, Services, Personnel, Administrative and Accounting and of Missions. The Consortium Board is constituted by a decree of the Ministry of the Universities and Research in Science and Technology; it is formed by a representative for each associated University and by a representative of the Ministry of the Universities and Research in Science and Technology, by a representative of the Ministry of the Environment and by a representative of the Ministry for the Agricultural Policies. Thematic areas for the Consortium are: Coast Littoral Environment, Ocean Environment, Brackish Environment, Polar Environments, Marine Technologies, Marine Biotechnologies, Protected Marine Areas, Fishing, Aquaculture and Mariculture.

Scientific team
Prof. Francesco Cinelli Full Professor of Ecology at the University of Pisa from 1982. At present he is also President of the Course of "Science and Technology for the Environment" of the same University. From 1984 to 1990 he has been Director of the Interuniversity Centre of Marine Biology "G. Bacci" of Livorno and, from 1992 to 1994 he has been Director of the Department of Environmental and Territorial Science (D.E.T.S.) at the University of Pisa. He was Coordinator of the algology Group of the Italian Botanic Society from 1978 to 1982 and he is member of a number of scientific national and international Societies. In 1999 he organized the 2nd European Seaweeds Symposium. In 1983 he received the "Tridente d'Oro" award for the Scientific Diving Activity and he is member of the Academy of Underwater Science and Technology of Ustica (Italy).

- **ECOIL srl**

Registered office : via Nicolò Tartaglia 15 – 00198 ROMA
Capital: € 100.000,00 in cash
Date of establishment: 13 aprile 2005

Shareholder:
Daniele, Emanuele, Chiara, Cristiana e Marta Jacorossi

Management:
Management Board: PhD. Elio Di Lella (Chairman) Dr. John Mocali, Dr. Marta Jacorossi - in-Office until closure of the budget dec,31 2009.

Auditor, one authorized to examine accounts: dott. Giovanni Pacini

The social object: *(deletion)*
Art.3.1 – Construction, acquisition in property and exercise of plants for the production and storage of fuel and fuels of plant origin, for the production of electricity from renewable sources …. *omissis*… acquisition in property, also in Leasing, financing, alienation, the sale, barter, the location, the concession in enjoyment and the management and exploitation any kind of property civil and industrial, land and buildings of any kind and necessary to the conduct of social activity

Activities carried out up to 2007:

- Acquisition in ownership of immovable property of 300 m^2 in Genoa, located to the company Maxcom Bunker spa
- Real estate purchase in Rome, restructured and sold in July 2008
- Presentation of the project for an integrated plant for the production of 200.000 t/y ofi biodiesel, to be achieved within the framework of the initiatives for the qualification and Reindustrialisation of petrochemical site of Priolo (Siracuse), approved by the Joint Committee State-region the 3-26-2007. ITER authorisation began on 5-25-2007.

News in brief financial year 2008:

1. *November:* Start marketing of biodiesel blend B25
2. *September:* participation in quality of subcontractor to the project MARE Micro Algae renewable Energy, which involves Enea, CNR and four Italian universities, for the construction of a demonstration plants for production of biodiesel from algae
3. *July*: vendita dell'immobile in Roma, acquistato nel 2007 e ristrutturato da Ecoil
4. *June*: Convention with the Department of agricultural and agro, University of Catania, for the research of euforbiacee breeder, suitable for the production of biodiesel and to the growth in soils in collapse without the need for irrigation
5. *maggio:* Started marketing of biodiesel

Budgetary data to dec,31 2007:

- assets: 3,1 M€
- turnover: 0,4 M€

The turnover over the financial year 2008 has exceeded 5,3 M€

There is a capital increase not just obtained authorisation to construction plant of biodiesel.

- **The National Environmental Research Institute (NERI), Aarhus University, Denmark**

  - undertakes scientific consultancy work, monitoring of nature and the environment as well as applied and strategic research.
  - establishes a scientific foundation for policy decisions regarding nature, environment and climate in Denmark as well as in the EU.
  - participates in a large number of national and international research programmes.
  - participates in scientific working groups, commissions, etc. under such bodies as the EU and UN.
  - is the National Focal Point for the European Environment Agency, and participates in environmental assistance tasks in Africa, Asia and Eastern Europe.
  - is a non-profit institution and is part of Aarhus University, Denmark, which has 35.000 students, 8.500 members of staff and a turnover of 4.8 mia DKR per year.

Previous experience relevant to the attributed tasks

NERI has extensive experience in optimising and analysing the growth of several species of macro algae for energy purposes. NERI has been cultivating macroalgae under varying environmental conditions regarding nutrients and CO2 in nature as well under laboratory conditions. NERI has a team of skilled laboratory technicians, who has worked for several year in the field of cultivating micro- and macroalgae in the laboratory as well as in larger scale. The NERI lab is fully upgraded in undertaking the full set of analysis relevant for international standard scientific work in this field.

NERI is coordinating and participating in the following projects concerning algae cultivation and energy production from marine biomass

- Energy production from marine biomass (Ulva lactuca) - ongoing
- Bioethanol from algae - ongoing
- Macroalgae biomass as a primary source for the production of biofuel - ongoing
- Commercial cultivation of Chondrus crispus in Danish waters
- Investigation of the potential for commerciel cultivation of Chondrus crispus

Scientific team

Senior Adviser Michael Bo Rasmussen (MBR)

MBR has worked with cultivation of algae and conversion of algae to bioenergy for 5 years and has worked with mapping of vegetation conditions in Danish waters for 25 years. MBR been primarily responsible for marine vegetation studies related to environmental authorities monitoring in Denmark.

Scientist Annette Bruhn (AB)

Phd in the nitrogen metabolism of microalgae, including solid experience in the cultivation of microalgae. AB has worked intensively with the cultivation of macroalgae (project leader) since primo 2008.

- **Danish Technological Institute (DTI)**

DTI is an independent not-for-profit organisation, approved as a technological service institute by the Danish Ministry of Science, Technology and Innovation.

DTI has proven experience with quality, pre-treatment and handling of solid biofuels for energy purposes in relation to CEN standards for biomass/biofuel as well as anaerobic digestion and biogas production from animal manure and other biowaste products. DTI has participated in and coordinated several EU- and other international projects over the last decade.

Previous experience relevant to the attributed tasks
Through national projects DTI has gained/is gaining profound know-how and experience in the field of micro and macro algae growth and characterization (complete fuel analysis). Harvesting and conditioning know-how includes rinsing (to reduce the salinity), drying, grinding and pelletizing or compressing to increase the density. Also fuel production from the algae biomass – and its utilization – is part of the experiences from those projects.

Besides the Algae know-how, Mr Hinge (see "Short profile of staff members") has a profound knowledge on anaerobic digestion and biogas production from biowaste, among other things being Coordinator of the FP6-project AGROBIOGAS from June 2006 until December 2007. Besides that, he has been the project leader on the projecting and establishing of several biogas plants – including gas utilization in co-generation units.

Scientific team
Peter Daugbjerg Jensen is a PhD in solid biofuels from the Royal Danish Veterinarian and Agricultural University and is at present Head of Section for Biomass and Residues at DTI's center for Renewable Energy and Transport. Also he is the Danish representative in CEN/TC 335, WG4: Solid Biofuels. Mr. Daugbjergs main research is now carried out in the field of marine biomass – especially algae – for bioenergy production.

Jørgen Hinge is a Cand. scient. in biology from the University of Aarhus, Denmark. He has been working with bioenergy since 1988 in the fields of: Anarobic digestion and biogas production, biogas cleaning and utilization, straw production and combustion, biomass handling and logistic, utilization of residues from bioenergy production.

Karin Svane Bech is a Cand. scient. in Biology and has among other things worked with micro and macro algae. She was a member of the "Galathea" Scientific Expedition, working on the research project "*The marine Carbon-cycle from North to South along the Galathea route*".

- **Central Salt and Chemicals Research Institute (CSMCRI)**

The Central Salt and Marine Chemicals Research Institute (CSMCRI), Bhavnagar is a National Laboratory under Council of Scientific and Industrial Research (CSIR), New

Delhi, an autonomous body of Ministry of Science and Technology, Govt of India, New Delhi. CSMCRI, Bhavnagar has an active group pursuing various aspects of seaweed biology and cultivation. The Institute also has a field station at Tamil Nadu on southeast coast of India exclusively working on development of field cultivation methods for sustainable production of phycocolloid yielding seaweeds such as agarophytes and carrageenophytes. The cultivation technology developed for large scale farming of *Kappaphycus* has been transferred for commercial scale production. Our laboratory got relevant infrastructure facilities like culture laboratory, microscopes, growth chambers, bio-clean bench, platform shakers etc for carrying out seaweed protoplast research. We have already succeeded in seeding of protoplasts from *Monostroma* and *Porphyra* on cultivation substratum in the laboratory conditions. Besides these, we have proven expertise in the area of biodiversity, molecular biology, biotechnology and bio-prospecting of seaweeds.

For each participant in the proposed project, provide a brief description of the legal entity, the main tasks they have been attributed, and the previous experience relevant to those tasks. Provide also a short profile of the staff members who will be undertaking the work.

Previous experience relevant to the attributed tasks

Sustainable production of biomass for energy is one of the key steps for the success of this project. The advantage of using protoplasts over spores as seed stock is that they can be produced at will by employing appropriate cell wall degrading enzymes. Otherwise, the conditions that induce sporulation from respective algae have to be investigated which is time consuming and cumbersome. It is evident from our findings that the culture of protoplasts from green seaweeds (*Ulva* and *Enteromorpha*) at higher temperature (>30°C) induces prolific rhizoidal growth than apical shoots. Prolonged culture of protoplasts in such conditions forms a green mat at the bottom of the entire culture plate. The rhizoidal growth can be fragmented and used as inoculum for seeding of polypropylene ropes (3 mm dia) which can be later transplanted in the open sea or outdoor culture ponds after growing for a while in land-based culture system (nursery) with enriched seawater medium under defined culture conditions.

The collaborators (Drs C R K Reddy and Bhavanath Jha) have proven expertise in the area of protoplast isolation and regeneration from different marine macroalgae. We have also demonstrated the use of protoplasts as seed stock for seeding the culture substratum in the laboratory cultures for *Monostroma* and *Porphyra*. In addition to the protoplasts, we have demonstrated large scale cultivation of economically important red algae in the sea using raft method. The same method could also be employed for generating biomass for green seaweeds as well.

Scientific team

C R K Reddy is the Senior scientist and Group Leader for Seaweed biology and cultivation programmes, Marine Algae and Marine Environment Discipline, Central Salt and Marine Chemicals Research Institute, Bhavnagar 364 002, India. Biography: Born in September 11, 1958.

Obtained Ph.D in Marine Sciences from Graduate School of Marine Science and Engineering, Nagasaki University, Japan in 1992 and subsequently, spent one year as Teaching Assistant at the Faculty of Fisheries of the same University. During his Ph.D years, worked with Prof. Yuji Fujita on seaweed protoplasts fusion for development of

genetically new and improved varieties of Chlorophyta members. Last one decade, actively pursuing seaweed tissue culture and seaweed protoplast research to select and propagate genetically improved germplasm of economically important seaweeds for commercial cultivation in India. Recent tissue culture work on *Kappaphycus alvarezii* helped to discover somatic embryogenesis-like development and abundant production of micropropagules clonally from pigmented filamentous callus. Published several original articles and review papers in different reputed scientific journals and books. Also received several recognitions at regional and national level for my contributions to seaweed biotechnology research in India. Presented papers in several international conferences held in different countries. Filed two US patents on cultivation and utilization of *K. alvarezii*.

Bhavanath Jha after obtaining M. Phil. & Ph.D. from Jawaharlal Nehru University, New Delhi and Post-Doc. from University of Cambridge, U.K. served as University teacher (Lecturer, Reader & University Professor) for 18 years before joining CSMCRI, Bhavnagar as Deputy Director and Head, Discipline of Marine Biotechnology & Ecology in February, 2002. He was visiting Scientist at J.W. Goethe, University Frankfurt for one year (1990-91) and for 5 years at Helmholtz Zentrum München**,** German Research Center for Environmental Health (GmbH). He was responsible for initiating the molecular biology & biotechnology research at CSMCRI, Bhavnagar and is actively engaged in the area of molecular diversity and stress genomics to understand the adaptation mechanism of plants in saline habitat. Published several original articles and review papers in different reputed scientific journals and books.

- **NGVA Europe**

NGVA Europe is the European Association that puts together experiences and voices.
We want to be the single and strong voice of the European NGV´s industry to talk with European Union politicians. We are developing proposals for new regulations that recognize the public interest of this alternative energy. We want to offer all the possibilities of cross
information among countries, companies and customers. We think that an Association like ours is only justified if we produce deliverables: experiences, political actions of support, regulations' proposals, useful data.

Previous experience relevant to the attributed tasks
Manuel Lage, General Manager of the NGVA Europe association was director of the CNG area within Iveco trucks, has a long experience in both national and international projects carried out with several partners. Some of the projects in which he has participated are:

- European project of Fuel Cell buses developed in the period 2001-2004
- Spanish Profit Project AERGAS, for the development of airport equipment running on CNG
- Study of the possibilities and energy potential of the Madrid landfill "Valdemingómez" to produce biogas to be later used as the fuel for the garbage collection truck fleet, already running on CNG.

M. Lage has a strong engineering background and experience on engines, fuels and alternative tractions.

Scientific team
Manuel Lage, Dr. Eng. General Manager is a Senior industry manager with more than 30 years experience in the truck industry, having been responsible for Engine Engineering, Truck Development, Strategy and Product Planning, Sales & Marketing and Business Development. Former responsible for IVECO Natural Gas Vehicle Development. Presently responsible of Institutional Relations of IVECO and Fiat Group in Spain.
Main responsibilities:

- Chief Executive Officer of the Association
- To carry out the lobbying actions, mainly at European level, in line with the priorities established by the Working Committees, and confirmed by the Board and by the General Meeting
- To establish a yearly road map in which any of the actions defined by the Working Committees have to be included and assigned responsibilities and timing
- To guarantee the correct development of the Association activities, on a day to day basis, and also via special events
- To represent the Association in different European and International fora

Matthias Maedge, M.A., Marketing & Communications Manager
Student employee of Patrick Meinhardt, member of the German parliament, shadow secretary of education, Liberal Democrat (FDP). Responsible for: Writing press releases for regional / nationwide issues and preparing surveys pertaining to the implementation of the Bologna Process.

- **Scandinavian GtS AB (SGtS)**

Scandinavian GtS AB (SGtS) is a project development company with focus on upgrade of biogas to vehicle fuel CBG & LBG. The total organization is 47 people split into 3 companies with common ownerships. The company has the most advanced gas technology and beyond state of the art.
SGtS have a unique competence of both long term biogas treatment combined with cryogenic process knowledge for ultra low temperatures.
Present main focus for SGtS is to develop competitive production methods for production of 2.nd generation vehicle fuel such as CBG and LBG.

Previous experience relevant to the attributed tasks
SGtS have among most experienced staff world wide within biogas treament from all available technologies with individual staff references which goes back more then 15 years and who also designed and constructed the first plants in Europe. The individual gas competence for the staff goes as far back as 25 years.
Most of the experiences are from various countires in Europe and in USA have we had the role as advisor for our Environmental Minister to help the State of California in their ambition to develop the biogas utilisation.

Scientific team
Hans Kättström CEO for SGtS and over 15 years in depth experince of various biogas treatment methodes and by goverment authoriesed gas inspector

Lars Brolin Project Manager and 20 years experience of biogas production

Jörgen Ejlertsson R&D Manager in biogas processes and assistant Professor at Linköping University

Annika Andersson PhD Water and environment

Mathieu de Bas M of S & MBA, expert in gas process and MD of GtS

Jaques de Kuiper expert in automation for gas process

Jeroen de Pater expert in Cryogenic gas treament and Chemical engineer

Addtional staff will be use within design, project management, adminstration and evaluation.

- **Hashemite University**

In consequence of the deterioration of natural resources, environmental pollution and realizing the importance of sustainable development, the Hashemite University established the faculty of Natural Resources and Environment in order to undertake research, studies and suggest solutions to local environmental problems such as degradation of arid lands, wastewater treatment, renewable energy, and air pollution control.

The Faculty of Natural Resources and Environment is establishing a well equipped teaching and research laboratories, fitted with advanced equipment capable of carrying out sensitive chemical, physical, microbiological, hydrogeological, geophysical and air pollution analysis. The university is located in the highly industrialized area and this center could assist in solving pollution problems in the region and creating renewable energy.

Previous experience relevant to the attributed tasks

Many staff members have joint research projects with local and international foundations and institutes, such as the reuse of wastewater in agriculture and applying bio-solids to rangeland in collaboration with USAID, regional badia development program supported by UNDP, assessment of air pollution in the region founded by EU in addition to other researches emphasized on bio-gas production from landfills, soil and groundwater pollution, solid waste management, industrial air pollution and landfills rehabilitation. The faculty conducts also regular geophysical studies of dam construction and ground water exploration in the area and its pollution in the landfills.

Scientific team

Eid Al-Tarazi Dean of Faculty of Natural Resources and Environment, Hashemite University, Zarqa Jordan. Courses taught and research interests: Environmental applied Geophysics, landfills evaluation, environmental pollution, environmental assessment of Wastewater Reuse in Agriculture and Environmental Impact Assessment.

Radhi K. Al-Rashidi Dean Deputy and head of Land Management and Environment Department, Faculty of Natural Resources and Environment, Hashemite University, Zarqa Jordan. Courses taught and research interests: Advanced Soil Microbiology and Biochemistry, Soil, plant and Water Relationships, Soil Ecology, Microbial Transformation of Elements in Soil; Soil and Water Pollution; Sustainability of Environmental Assessment of Wastewater Reuse in Agriculture. Bio-Gas and Bio-Fuel energy, Environmental Impact Assessment.

Abu-Dieyeh Mohammed Assistant professor, Dept. of Biology and Biotechnology. Courses taught and research interests: Applied Plant Ecology, Weed Biology and Biocontrol, Aerobiology, Biotic interactions, Plant allelopathy and their effects on plants, algae and fungi.

- **Riga Technical University (RTU)**

Riga Technical University – RTU is the oldest and largest higher education institution in Latvia to offer advanced study programs in Engineering, Technology and Architecture. Institute of Energy Systems and Environment (Riga Technical University) is active in energy and environmental research, renewable energy resources (biomass, biogas, solar), energy efficiency and rational use of energy.
Special attention in institute is paid to climate change policy, GHG reduction technologies and sustainable energy development. The Institute offers bachelor, master, and PhD study programs, conducts scientific researches on a local and international level in cooperation with major foreign scientific institutions, participates in scientific conferences and other events with presentations and lectures, and takes active part in development of local energy and environment policy.
In the last years in the light of the of the more constant needed to increase the potential of the renewable energies the Institute of Energy Systems and Environment made a big effort for the development of its own laboratory and for the creation of a research group about Life Cycle Assessment.
At the moment Riga Technical University is one of regional leaders, involved in all project work packages and being responsible for successful implementation and communication of project results in Latvia.

Previous experience relevant to the attributed tasks
The keywords of Institute of Energy Systems and Environment activities are energy, environment and economy. In the area of environment-related studies, where IESE is interested in the way the Latvian energy economy influences our economy, climate and environment. The IESE has contacts with Latvian Ministry of Economy, Ministry of Environmental Protection, Ministry of Regional Development, Power Board LATVENERGO, local municipalities and Latvian industries. IESE is a partner of Nordic energy research projects BioHydrogen (Biohydrogen production life cycle). The Institute participated in NERP project REBUS (Solar energy systems), EMINENT (early stage technologies assessment project) and many other projects.
In this last years IESE, in order to develop its own Life Cycle Assessment working group, made a big effort to favorite specific PhD study programs and scientific researches on this sector with really fruitfully and interesting results.

Scientific team
Mrs. Dagnija Blumberga, Doctor Habilitus Sc.Ing. (RTU since 1976) has a professional experience of more than thirty years in energy engineering and environment. She started her professional carrier as a Senior Lecturer at the Riga Technical University (RTU) and then becoming a Professor, director of Institute of Energy Systems and Environment. Mrs. Blumberga founded the engineering and consultancy company Ekodoma for energy and environmental issues in 1991, where energy efficiency has been the main company mission since the beginning. Mrs. Blumberga started the consultancy bureau together with Mr. Veidenbergs with 2 employees and developed the organization to a well known company with 16 employees. From 2004 Dagnija Blumberga is head of the Council of Environmental Research and Education in Latvia. As senior expert at Riga Technical University and Ekodoma she has been involved in energy savings, energy efficiency and environmental projects focusing as well as on political and administrative aspects. Among

the clients of Ekodoma are most of the Latvian biggest municipalities, energy consuming companies and industries in Latvia. Mrs. Blumberga in the last years has focused her attention on the development of Environmental and Energy Engineering programs at university level, Cleaner production and Environmental Impact Assessment. Mrs. Blumberga is one of the greater Latvian experts in the energy sector, in particular concerning calculation of electricity and heat tariff. She is involved in working out of different legislative climate change documents, for example, National JI policy, National JI Action plan, National Allocation Plan etc. Mrs. Blumberga has more than 180 publications and 8 monographs

Mr. I.Veidenberg, Doctor Habilitus Sc.Ing. (RTU since 1976)has a professional experience of more than forty years in energy engineering and environment. He started her professional carrier as a researcher at the Institute of Energetic of Latvia Academy of Sciences and then continued his researching and pedagogical work in Riga Technical University.as Senior Lecturer, Assistant Professor and finally Professor. Mr. Veidenbergs together with Mrs. Blumberga founded the engineering and consultancy company Ekodoma for energy and environmental issues in 1991, where energy efficiency has been the main company mission since the beginning. As senior expert at Riga Technical University and Ekodoma he has been involved in cogeneration, energy efficiency and environmental projects focusing as well as on technical, political and administrative aspects. Mr. Veidenbergs is one of the greater Latvian experts in the energy sector, in particular concerning on engineering aspects of cogeneration plants.
Mr. Veidenbergs has more than 120 publications and 4 monographs.

Mrs. Marika Rošā, Associate professor, Researcher (RTU since 2002) has a professional experience of more than 10 years in the energy and environmental field. As researcher in Riga Technical University, Institute of Energy systems and Environment she has been involved in several energy and environmental research projects in particular focusing on emission trading and climate technologies.

Mr. Claudio Rochas, Docent, Researcher (RTU since 2003) has a professional experience of almost 10 years in the energy and environmental field. As researcher in Riga Technical University, Institute of Energy systems and Environment he has been involved in several energy and environmental research projects in particular focusing on solar energy, cogeneration and dispersed energy solutions.

Mr. Francesco Romagnoli, Lecturer, Researcher (RTU since 2008) has experience of almost 6 years in the environmental and geotechnical field. As researcher in Riga Technical University, Institute of Energy systems and Environment he has been involved in several energy and environmental research projects in particular focusing on renewable energy.

Ms. Ilze Dzene, Lecturer, Researcher (RTU since 2005) has experience of almost 5 years in the energy and environmental field. As researcher in Riga Technical University, Institute of Energy systems and Environment she has been involved in several energy and environmental research projects in particular focusing on energy planning and promotion of renewable energy on regional level.

Ms. Iluta Piļicka Dzene, bachelor student is a 3rd year bachelor student and she has been involved as project assistant in different energy and environmental research projects.

- **AquAgri Processing Pvt Ltd**

The key promoter of AquAgri Processing Pvt. Ltd. (a company incorporated in India) till March 2008 was working as an Executive Director with PepsiCo India. In his role he was responsible for exports, agriculture, CSR and sustainability for the organization. Under his leadership, PepsiCo embarked on algal cultivation with a primary focus on Kappaphycus Alvarezii (cottonii). PepsiCo has worked with Self-Help Groups to engage them in algal cultivation in the open sea by providing them, or ensuring availability of required infrastructure, planting material and technical knowhow. A dedicated team of experts working at the field level have supported the cultivation and provided a buy-back contract for the output to ensure livelihood sustainability.
International practice is that sea plants after cultivation are dried by the growers and then processed for hydrocolloid extraction. This process is both energy and water intensive. PepsiCo working in partnership with CSMCRI and based on their technology has adapted a wet processing process, which leads to the production of bio nutrients along with the hydrocolloids.
Since PepsiCo's interest in this activity was limited to creating a sustainable livelihood model as part of their CSR and Community Outreach Program and they had no business interest, the same was acquired by AquAgri Processing in July 2008. Though the company is only nine months old, by virtue of absorbing the entire PepsiCo team working on this project, in fact has a business continuity of close to 10 years.
Taking off from where PepsiCo left, AquAgri Processing has been working has been working with various technology providers and is close to implementing a manufacturing plant which would reduce water consumption to 10% of the conventional manufacturing process and will have zero discharge outside the factory premises. The process relies heavily on solar energy and is planning to bridge the gap of solar availability by use of renewable biofuel's. In this quest apart from using waste wood, have also been working with Madras University on bio-methanation of drift seaweeds.
As a participant in the project "Biowaste and Algal knowledge for Biofuels" we can undertake algal cultivation both for macro and micro species. The algal cultivation can be undertaken both in open sea conditions as well as can be attempted as co-cultivation in ponds with mariculture units, which exist in large numbers in our area of operation.

Previous experience relevant to the attributed tasks
The team has the experience of algal cultivation of close to 10 years and have demonstrated capabilities of mobilizing local communities to under take cultivation on a sustainable livelihood format. Apart from this, the key promoter has worked with NGO partners in his assignment with PepsiCo to implement source segregation of household waste. We have immediate access to 3 Mt and 2Mt of waste per day at two locations in Tamil Nadu, India. This is waste is currently being converted to vermicompost, but the NGO partners are keen to implement the bio methanation project. We believe that the implementation could be affected with an investment cost of under 100,000 Euros (for the location that generates 3Mt per day of watse) and can be leveraged for generating a lot of valuable empirical data.

Towards this end we are also working with Wipro EcoEnergy (part of one of India's largest IT companies). A copy envisaging their interest in partnering in this project is enclosed for your ready reference. Further, in our proposed processing facility coming up in Mandapam, Tamil Nadu India, we would be planning to pilot an anaerobic metanation plant based on drift seaweeds, which currently just pollute the coast and the beaches. We estimate that a small plant can be implemented at a cost of approximately 25,000 Euros.

Scientific team

Mr Abhiram Seth Executive Director of PepsiCo India, leading their agriculture, exports and sustainability initiative apart from heading the corporate affairs and corporate communications function. He is an Economics graduate with Masters in Management Studies having an industry experience of over 34 years. For the last 15 years, he has been deeply involved in agriculture, working on contract farming and involved in the policy formulation of this domain in partnership with the APEX industry Chambers.

Dr M Shanmugam (PHD Chemistry; Title of his thesis- "Studies on the Biomedically and Industrially important metabolites of Indian Marin Algae"). He has over 15 years of experience in the field of basic seaweed research and cultivation and has published papers and has presented at national seminars in the field of biomedical and industrial colloids of seaweeds.

Dr A Muruganantham – Having 13 years in experience in seaweed research specialzing in marine biology, his thesis is titled, "Heparin from Seaweeds: A research in Grateloupia filicina". He has also published papers in National and International reputed journals apart from presenting at National Seminars.

C Periyasamy (M. Phil (Botany)) – Having 9 years of experience in the field of seaweed cultivation, his thesis is titled " Impact of UV in the growth and cultivation of Kappaphycus Alvarezii and Gelidiella acerosa".

2.3 Consortium as whole

Since the first planning of the project, the complexity of the proposal highlighted the need to constitute a well-integrated managed consortium to achieve the BioWalk4biofuels ' objectives. In order to obtain the best interrelation and cooperation between all the involved partners the selection process was carried out on the base of their previous experiences and expertise they could provide to create complementarities in the elaboration and further implementation of the project.
Once the list of participant was defined, considerable importance was given to the communication and coordination aspects. The proposal is the result of an hard work among all the partners to develop and improve the overall design of the research.
It is important to underline that most of the partners involved in the proposal had already worked in national and international projects regarding the field of application of the present project. Furthermore, all partners are assigned tasks that totally fit their field of interest: this will allow their active involvement in achieving the proposal objectives.
The complementarity will be ensured by the participants' field of specialisation. Thanks to the multidisciplinary nature of the proposed approach, the technical quality of each partner in dealing with the project issues was accurately examined. As demonstrated by the institutions and individuals CVs provided in the part 2.2, the partnership is constituted by experts in biological, chemical, physical, environmental, social and economic issues.
The involvement of partners from different countries and regions is certainly an added value to the project and offers the possibility to spread its results in a wide range of contexts, going beyond the dissemination activities already included in the BioWalk4biofuels dissemination plan. Moreover, the participation of the one Eastern European partner will promote and strengthen the integration process actively pursued by EU strategies.
The participation of Indian partners will further enhance the already existing links between Europe and India and will strengthen the relationships both at national and Community level. This cooperation will also allow to exchange skills and best practices improving the know how of both European and Indian actors in the field of biofuels production.
A further aspect to be highlighted is that the composition of BioWalk4biofuels is well balanced in relation to the objectives of the project. Macroalgae and protoplasts species selection, first step of the project, will be carried out (WP1), with a research activity in Denmark, by partners with high experience in these fields. Danish partners have a strong experience with macroalgae cultivation under varying environmental conditions regarding nutrients and CO_2 in nature, as well under laboratory conditions, whilst the Indian partners has a proven expertise in the area of protoplast isolation and regeneration from different marine macroalgae. He will be supported later, in protoplasts incubation and algae cultivation (WP3), by the indian SME AquAgri Processing, with an experience in this field of close to 10 years. Macroalgae cultivation will be then conducted by all partners with appropriate experience: Danish and Indian partners above mentioned, CoNISMa, HU. Regarding the implementation and management of the plant for biogas production, CIRPS and Deatec (the unique subcontractor of the project), will undertake the technical

activities to be conducted in Italy, on an Ecoil property, a SME with proven experience in production, storage and transport of biofuels involved in WP2 regarding the implementation of the system for insufflation of exhaust gases in open ponds. An innovative Deatec patent (Archimede rotor) will be used at this stage.
Finally to achieve bio-methane from the biogas produced in the plant, an upgrading process is required: it will be carried out by SGtS, a scandinavian company, that has the most advanced gas technology and a unique competence in long term biogas treatment and in cryogenic process knowledge for ultra low temperatures.

i) SUB-CONTRACTING NEEDS (WP5)

DEATEC SUBCONTRACTING

The subcontracting consists of specialist competence in building the anaerobic digestion plant customized for biowalk4biofuels project.
In particular it is worthy of mention that in 2001 DEATEC patented process "ARCHIMEDE" was rewarded the Prize "Innovazione Amica dell'Ambiente" (environmentally-friendly innovation), held by the Politecnico of Milan and Legambiente.
The "ARCHIMEDE" system is a considerable improvement as compared to the state of the art of the processes employed, in fact it permits to save energy because of its lower energy consumption if compared to the rotating biological contactors (RBCs).
The most advanced design innovation of the Archimede fixed biomass contactors is the rotation driven by limited volumes of air; air is blown in beneath the contactor frame, which is made of small open channels suitably placed around the central shaft. The induced turbulence is also effective for keeping the substrate coming off the support in suspension.
The first basic advantage of this design innovation is the increased oxygenation and carboxylation obtained respectively in aerobic and anaerobic treatments.
The Archimede is more suitable than RBC system because of the possibility to supply air in the whole frame which leads to large operative flexibility in relation to load variations. This advantage will be essential during the project because of RTDs activity about macroalgae parameters cultivation optimization so we expect to obtain load variations Inputs during the first year.
The second advantage in using Archimede contactors is the reduced shaft dimensions and, consequently, the weight of the shafts, this is essential in the development of the project because of the reduced authorized land available (about 550 m^2). Archimede contactors allow to overcome the main drawback of mechanical driven RBC's, that is mechanical failures, because torsional stress is in practice eliminated.
The subcontractor proposed process is based on a two-phase digestion plant which concern in physically separating the two distinctly different groups of bacteria into two separate but much smaller tanks, and maximizing their growth by maintaining optimum conditions in each tank for that particular group of bacteria. In practise this subcontractor will supply us with an innovative plant giving us the opportunity to optimize the two-phase digestion process in a smaller and more efficient plant.

UNIMED SUBCONTRACTING (WP8)

The subcontracting consists of specialist competence in dissemination activities focussed on the Euro Mediterranean Region for biowalk4biofuels project.

UNIMED participates actively to several EU funded Programme (FP7, TEMPUS MEDA, Cultural Heritage, INTERREG, ENPI, among others) as coordinator or partner of multilateral projects, usually involving a wide range of partners, including universities of its Network.

The dissemination activities foresee the organization and set up of one "BIOWALK4BIOFUELS Euro-Mediterranean conference", to be held in Rome.
The conference will serve to put together the project's consortium with public authorities, other interested universities, enterprises and representatives of the business community, association of categories, chambers of commerce of the Mediterranean Countries, international organizations focussed on Biofuel development and utilization in the Euro Mediterranean region.

UNIMED, with its experience in organizing international events and its network of 84 universities from all the Euro Mediterranean region, can guarantee the successful carrying out of the conference and the involvement of a wide number of stakeholders in the dissemination of the project's results.

By this, the activities and results of biowalk4biofuels project will be diffused and communicated not only through the network in a static way, but the stakeholders will act as "bridges" towards the territory of their countries, producing a multiplier effect, which will attract all stakeholders in those countries interested in the topics and the findings of the project.

2.4 Resources to be committed

Biowalk4Biofuels is a project that aims to develop a demonstrative plant in Italy, where, to work and do some important tests is the core of the partnership interest. Therefore, an important part of the budget (28,97%) is devoted to the development of the overall plant. This cost is 1.150.000 € and each partner will contribute to buy the necessary equipment; it is composed principally of:

1. four PVC open ponds of about 1000 m^2 each one
2. protoplasts incubator
3. pipelines and jet-air for CO_2 insufflation
4. throttles for algae broth mixing
5. rotating drum screen
6. cogenerator of 100 KW_e
7. two phase anaerobic digestion plant
8. rack and pipelines for water and gas transport
9. manure poultry transport
10. cryogenic upgrading biogas plant

Since Biowalk4Biofuels collects innovative technologies (patents will be employed) a deep research shall be carried out to assure the best joint of the single mechanisms and to optimize the energy balance and LCA of the overall process. So, the major costs will be afforded for research and technological development (RTD) for the execution of the experiments and will require 49,6% of the budget (as shown in the table below).

	Participant No.	Equipment/Expenditure
CIRPS	1	100.000
CoNISMa	2	160.000
Ecoil	3	150.000
NERI	4	150.000
DTI	5	150.000
CSMCRI	6	200.000
NGVA	7	
SGtS	8	150.000
HU	9	
RTU	10	40.000
AP	11	50.000
	Total eligible costs:	1.150.000
	Requested EC contribution:	575.000

The overall Biowalk4Biofuels budget is **€ 3.970.000** and EC contribution is **2.902.500€**. Other activities such as dissemination and exploitation of results, transfer of knowledge actions, conferences and study tours have been calculated with an EC financial contribution of 100% of the total eligible costs and represent approximately 15,11% of the total.
Instead management activities (6,3% of total budget), including personnel, travel and subsistence expenses, related to the consortium meetings, and audit certificates on the financial statements will receive an EC financial contribution of a maximum of 100% of the total eligible costs.

RTD-Materials : The range for materials budget is between to 50.000 and 100.000€

Subcontracting - Two subcontractors belong to the project: a SME, Deatec (WP5) and an association of 84 universities of the countries of the Mediterranean basin, Unimed (WP8). These unique and essential contributions are estimated at € 370.000.

3 Impact

3.1 Expected impacts listed in the work programme

Pollution, climate change, dependency on oil and sustainable development are a global scale challenge to be pursued by coordinating efforts and involving the widest possible range of countries. The Seventh Framework Programme represents the EU financial tool to face this challenge. As stated in the Energy Work Programme, at present Europe's energy economy is on an unsustainable path. The overall objective of the programme is to change this situation. The BioWALK4Biofuels Project wants to give this challenge its contribution, by testing a new innovative system for biofuel production. The priority of the Programme is accelerating the development of energy technologies towards cost-effectiveness for a more sustainable energy economy for Europe (and worldwide) and ensuring that the European industry can successfully compete on the global scene.

Biomass can be a sustainable, competitive and secure energy source, but it is fundamental to find out systems of production which respect the environmental ecosystem and the social context where the production is established.

According to the Biomass Working Plan worked out by the European Commission (SEC(2005) 1573), the constant growth in the transport sector has not yet permitted the stabilisation of greenhouse gas emissions. Biofuels are still an expensive way to reduce greenhouse gas emissions, but within transport they are one possible solution to the greenhouse problem. The strategy for research in the Energy Work Programme within the Seventh Framework Programme is expected to:

- Improve energy efficiency throughout the energy system
- Accelerate the penetration of renewable energy sources
- Decarbonize power generation and, in the longer term, substantially decarbonize transport
- Reduce greenhouse gas emissions
- Diversify Europe's energy mix
- Enhance the competitiveness of European industry, also through a better involvement of SMEs.

The *BioWALK4Biofuels* Project is expected to have a positive impact in contributing to the achievement of these overall objectives. In fact, the proposal aims at developing a very efficient system for biomass production for biofuel use. The aim is to develop a 2^{nd} generation biofuel from a biomass source with a very high energy potential and with other positive environmental impacts, in terms of biowaste treatment and CO_2 capture.
The BioWALK4Biofuels Project attempts at producing a cost-efficient 2^{nd} generation biofuel using biowaste as a feedstock. The use of macroalgae has been selected to facilitate the use of biowaste directly and enhance macroalgae growth for biogas production through anaerobic fermentation. The project will contribute to the careful selection of algal species with optimal growth and energy potential that will ensure a higher output yield of algae biomass per hectare per year.

To reduce land requirements sea-cultivation is being addressed and open pond systems are proposed to diminish the water pumping requirements and facilitate the processes of feeding and harvesting

The proposed multilateral international approach facilitates the creation synergies between the different partners. The partners involved in the project come with diverse backgrounds of specialisation were one of the main strengths of the consortium is to bring together such levels of expertise together. A European approach allows for the creation of collaboration between different nations and levels of development. As well, it will strengthen know-how, technology transfer, accelerate homogeneity and catalyse a faster deployment of the pursued objectives.

Some key assumptions have been made that helped elaborate the concept; most are already being addressed and are not expected to tamper the expected impacts of the projects. Nonetheless, they are kept in mind for avoidance of unexpected misfortunes.
Key assumptions taken include:

- Low-cost of PVC open sea ponds for algae cultivation
- Simple and low-energy intensive feeding and harvesting methods of algae
- Potential of protoplasts incubation to increase the macroalgae output yield
- Ease of biowaste and CO_2 use to enhance macroalgae growth

3.2 Dissemination and/or exploitation of project results, and management of intellectual property

WP8 will be responsible for all the issues related to the exploitation and diffusion of the project results. Dissemination concerns all activities, promoting project issues and outputs towards other potential users of the findings. The aim of these activities is to spread the main results of the project and foster a wide debate at European and international level on renewable energies and the process underlying the project. It is essential to inform policy-makers about the positive impacts of such energy sources.
The dissemination activities will target stakeholders, public authorities (both at national and Community level), manufacturers, private companies and concerned end-users to validate and supplement the outputs and findings of the project. This will help to build a consensus with stakeholders on innovative technologies used and the possibilities to transfer them to different regional and sectorial contexts to make the project results more efficient and pragmatic.
Different forms of dissemination will be implemented:

- Publications
  - Pamphlets: a short project presentation, a project leaflet, specific publications related to target implementations, a final project leaflet
  - Proposed publications to scientific or general papers in the domain
  - Production of a CD-ROM and a documentary film to be presented during the final conference

- Website: development, management and promotion of a website containing information, documents, videoconferences, links to other related issues and institutions and to EU and UN publications about environmental and energy issues. The web portal will include reference to:
  - Introduction of the portal in internet
  - Press release to specialised journal
  - Information distribution at the occasion of conferences, trade show, scientific days, etc.

  The Project website will include pages detailing the objectives of the consortium. Links will be made to the consortium website from appropriate websites of each participating organisation and, if possible, from those of other interested organisation.
  Public awareness of the project will be raised at national level through public consultation and public relations mechanisms including newsletters placed in journals of relevant societies. Information generated from the project, such as information and analyses of research programmes in the area, will be made available through the projects external websites. Information for use in future cooperation activities will also be made available on the website and presented to attendees of the final project dissemination meeting. The consortium will identify a solution for the maintenance of the portal after the end of the project.

- Visits: technical visits for the stakeholders to visit the project sites and foster further meetings among partners and concerned institutions or persons

- Events:
  - Workshops: two-partially open working sessions for stakeholders and partners to improve knowledge about the project among interested actors in the field
  - Conference: one final conference to be held in Rome.

It will be possible to use some media contacts partners already have to take part in some television and radio broadcasts both at local and national level. Moreover, participation in external events to present BioWalk4biofuels Project will be encouraged.
Specific attention is paid to raising public participation and awareness about the energy issue. During the implementation of dissemination activities, a series of communication initiatives will be undertaken to raise awareness among citizens about energy problems, energy saving and environmentally-friendly ways of life. In fact, in order to increase the impact of scientific research, it is very important to favour a democratic debate with a more engaged and informed public. In this way, the project will create the best conditions for citizens participation in the collective choices and scientific debates.

Plan for management of intellectual property rights
The consortium agreement will grant a correct and scheduled performance of the project's issues concerning IPR, foreground knowledge, and access rights. This relates to enabling of public access to data, ethical, legal and social issues during the development and implementation of all necessary legal procedures to access, elaborate and disseminate data. The management of such issues will provide guidance to researches and groups needing help in order to tackle patent applications, patent analysis and general IPR issues.
The generated knowledge of commercial interest must be safeguarded and protected for the exploitation by the owner. A partner in a WP has no right to demand access to another WP's knowledge unless this is needed for the performance of the Collaborative Project. Each partner will treat information from other partners as confidential and not disclose it to third parties unless the information is already publicly available. Knowledge is owned by the partners who carried out the work generating the knowledge, or on whose behalf such work was carried out. If a partner wishes to assign any knowledge to third party he should inform the other partners and request their consent which should not unreasonably be withheld.

4 Ethical Issues

The BioWalk4biofuels Project does not engage or carry out any activities that encompass an ethical issue in the medical, genetic, biotechnological or animal welfare fields. The activities and research defined are not subject to animal or human testing. No genetic manipulation will take place. Moreover, the project does not have direct military use and has no risk in being a potential for terrorist use.

In the need of carrying out a market assessment and defining consumers' opinion on the use of biogas for their vehicles, data collected will not compromise personal privacy and guarantee anonymity. No behavioural studies or collection of personal data are to take place or relevant for the project.

With regards to the research in Developing Countries, the project does include the study and research of plant resources (macroalgae) from India. Nonetheless, there is no intervention to be carried out, research with macroalgae is already an ongoing activity carried by CSMCRI and AP, were no invasive actions are to take place. Rather an exchange of knowledge and capacities is to strengthen the synergism of the project.

Furthermore, ideally replication in India may derive from achievements attained, but the project boundaries are set to the demonstrative plant in Sicily. Extending actions to India are subsequent to results obtained from the project, which will provide an alternative energy source.

The project will pay special attention to European legislation and ensure that legislative compliance is met. If any ethical concern shall arise, the relevant experts will report to the Project Manager in order to derive in an Action Plan that addresses the expressed concerns.

ETHICAL ISSUES TABLE

	Research on Human Embryo/Foetus	YES	Page
*	Does the proposed research involve human Embryos?		
*	Does the proposed research involve human Foetal Tissues/ Cells?		
*	Does the proposed research involve human Embryonic Stem Cells (hESCs)?		
*	Does the proposed research on human Embryonic Stem Cells involve cells in culture?		
*	Does the proposed research on Human Embryonic Stem Cells involve the derivation of cells from Embryos?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	●	

	Research on Humans	YES	Page
*	Does the proposed research involve children?		
*	Does the proposed research involve patients?		
*	Does the proposed research involve persons not able to give consent?		
*	Does the proposed research involve adult healthy volunteers?		
	Does the proposed research involve Human genetic material?		
	Does the proposed research involve Human biological samples?		
	Does the proposed research involve Human data collection?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	●	

	Privacy	YES	Page
	Does the proposed research involve processing of genetic information or personal data (e.g. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?		
	Does the proposed research involve tracking the location or observation of people?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	●	

	Research on Animals	YES	Page
	Does the proposed research involve research on animals?		
	Are those animals transgenic small laboratory animals?		
	Are those animals transgenic farm animals?		
*	Are those animals non-human primates?		
	Are those animals cloned farm animals?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	●	

	Research Involving Developing Countries	YES	Page
	Does the proposed research involve the use of local resources (genetic, animal, plant, etc)?		
	Is the proposed research of benefit to local communities (e.g. capacity building, access to healthcare, education, etc)?		

I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	●

Dual Use	YES	Page
Research having direct military use		
Research having the potential for terrorist abuse		
I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	●	

The following special issues should be taken into account:
Informed consent: When describing issues relating to informed consent, it will be necessary to illustrate an appropriate level of ethical sensitivity, and consider issues of insurance, incidental findings and the consequences of leaving the study.
Data protection issues: Avoid the unnecessary collection and use of personal data. Identify the source of the data, describing whether it is collected as part of the research or is previously collected data being used. Consider issues of informed consent for any data being used. Describe how personal identify of the data is protected.
Use of animals: Where animals are used in research the application of the 3Rs (Replace, Reduce, Refine) must be convincingly addressed. Numbers of animals should be specified. Describe what happens to the animals after the research experiments.
Human embryonic stem cells: Research proposals that will involve human embryonic stem cells (hESC) will have to address all the following specific points:
· the applicants should demonstrate that the project serves important research aims to advance scientific knowledge in basic research or to increase medical knowledge for the development of diagnostic, preventive or therapeutic methods to be applied to humans.
· the necessity to use hESC in order to achieve the scientific objectives set forth in the proposal. In particular, applicants must document that appropriate validated alternatives (in particular, stem cells from other sources or origins) are not suitable and/or available to achieve the expected goals of the proposal. This latter provision does not apply to research comparing hESC with other human stem cells.
· the applicants should take into account the legislation, regulations, ethical rules and/or codes of conduct in place in the country(ies) where the research using hESC is to take place, including the procedures for obtaining informed consent;
· the applicants should ensure that for all hESC lines to be used in the project were derived from embryo's

- of which the donor(s)' express, written and informed consent was provided freely, in accordance with national legislation prior to the procurement of the cells.
- that result from medically-assisted in vitro fertilisation designed to induce pregnancy, and were no longer to be used for that purpose.
- of which the measures to protect personal data and privacy of donor(s), including genetic data, are in place during the procurement and for any use thereafter. Researchers must accordingly present all data in such a way as to ensure donor anonymity;
- of which the conditions of donation are adequate, and namely that no pressure was put on the donor(s) at any stage, that no financial inducement was offered to

donation for research at any stage and that the infertility treatment and research activities were kept appropriately separate;

Identify the countries where research will be undertaken and which ethical committees and regulatory organisations will need to be approached during the life of the project.
Include the Ethical issues table below. If you indicate YES to any issue, please identify the pages in the proposal where this ethical issue is described. Answering 'YES' to some of these boxes does not automatically lead to an ethical review. It enables the independent experts to decide if an ethical review is required. If you are sure that none of the issues apply to your proposal, simply tick the YES box in the last row.

5 Gender Issues

With regards to gender issues there are no specific gender concerns that can arise from the production of biogas from algae and biowaste.

It is not thought that there is any direct gender issue regarding the use of biofuels as source of energy.
However, the project partners are aware of certain gender issues in the sphere in which the project itself is conducted. These include:

- Proportion of women involved in research and management of the project;
- Number of women working in the biofuel industry, at the operational level;
- Proportion of women who might undertake training activities provided by the project;

5.1 Taking special action to bring more women into the project management and implementation

In terms of the project Partners a significant proportion of each organisation personnel are women. The project team will ask all partners to review involvement of staff in the project and to identify the gender balance of project input. Where there appears to be a gender bias the partner concerned will be asked to report to the Consortium on the availability of alternative staff and the mechanisms which can be implemented to overcome bias. It is not known how many women work in the current biofuel industry. However, through the training element of WP7 particular efforts will be made to positively encourage women participation so that these decision makers are best equipped in the market place for what is expected to be an area of new job growth and opportunities. Gender equality will be encouraged through impartial distribution of responsibilities, and involvement of women in training and dissemination that will improve women's opportunities.

5.2 Linking with networks of women scientists in the field of the project

The project will be pro-active in the provision of training activities, it will specifically target women to attend. Women scientist networks will be specifically informed and invited to participate in training and special events.

5.3 Conduct of surveys and analysis

All surveys undertaken will, where practical, disaggregate by gender (and by other social characteristics) to ensure that project outcomes reflect the views of all sectors of the community.

CONSORTIUM AGREEMENT

THIS CONSORTIUM AGREEMENT is based upon REGULATION (EC) No 1906/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 December 2006 laying down the rules for the participation of undertakings, research centres and universities in actions under the Seventh Framework Programme and for the dissemination of research results (2007-2013) hereinafter referred to as Rules for Participation and the European Commission Grant Agreement, adopted on 10 April 2007, hereinafter referred to as the Grant Agreement or EC-GA and Annex II adopted on 10 April 2007, hereinafter referred to as Annex II of the EC-GA, and is made on **2009-03-30**, hereinafter referred to as "Effective Date"

BEETWEEN

1. Interuniversity Research Centre for Sustainable Development (CIRPS), University of Rome "La Sapienza" – Research Centre, ITALY (Coordinator)
2. National Interuniversity Consortium for Ocean Sciences (CoNISMa) – Research Centre, ITALY
3. ECOIL – SME, ITALY
4. National Environmental Research Institute (NERI) – Research Centre, DENMARK
5. Danish Technological Institute (DTI) – Research Centre, DENMARK
6. Central Salt & Marine Chemicals Research Institute (CSMCRI) – Research Centre, INDIA
7. NGVA Europe – NGO, SPAIN
8. Scandinavian Gas Treatment Service (SGtS) – SME, SWEDEN
9. Hashemite University – Faculty of Natural Resources and Environment (HU) – University, JORDAN
10. Riga Technical University (RTU) – University, LATVIA
11. Aquagri Process Pvt Ltd (AP) – SME, INDIA

hereinafter, jointly or individually, referred to as "Parties" or "Party" relating to the Project entitled ***Biowaste and algae knowledge for the production of 2nd generation biofuels***, in short ***BIOWALK4BIOFUELS***, hereinafter referred to as "Project"

WHEREAS:

The Parties, having considerable experience in the field concerned, have submitted a proposal for the Project to the European Commission as part of the Seventh Framework Programme of the European Community for Research, Technological Development and

Demonstration Activities under the funding scheme of “Collaborative Project”. The Parties wish to specify or supplement binding commitments among themselves in addition to the provisions of the EC-GA.

NOW, THEREFORE, IT IS HEREBY AGREED AS FOLLOWS:

1. Purpose

The Parties shall carry out cooperative research and development activities in the framework of the Project. The purpose of this Consortium Agreement is to specify with respect to the Project the relationship among the Parties, in particular concerning the organisation of the work between the Parties, the management of the Project and the rights and obligations of the Parties concerning inter alia liability, Access Rights and dispute resolution.

2. Entry into force, duration and termination

2.1 Entry into force

An entity becomes a Party to this Consortium Agreement upon signature of this Consortium Agreement by a duly authorised representative. This Consortium Agreement shall have effect from the Effective Date identified at the beginning of this Consortium Agreement.

A new Party enters the Consortium upon signature of the accession document by the new Party and the Coordinator. Such accession shall have effect from the date identified in the accession document.

2.2 Duration and termination

This Consortium Agreement shall continue in full force and effect until complete fulfilment of all obligations undertaken by the Parties under the EC-GA and under this Consortium Agreement. However, this Consortium Agreement or the participation of one or more Parties to it may be terminated in accordance with the terms of this Consortium Agreement and Annex II of the (EC-GA Article II.37. and II.38.).If the Commission does not award the EC-GA or terminates the EC-GA or a Party's participation in the EC-GA, this Consortium Agreement shall automatically terminate in respect of the affected Party/ies, subject to the provisions surviving the expiration or termination as follows.

2.3 Survival of rights and obligations

The provisions relating to Access Rights and Confidentiality, for the time period mentioned therein, as well as for Liability, Applicable law and Settlement of disputes shall survive the expiration or termination of this Consortium Agreement. Termination shall not affect any rights or obligations of a Party leaving the Consortium incurred prior to the date of termination, unless otherwise agreed between the Governing Board and the leaving Party. This includes the obligation to provide all input, deliverables and documents for the period of its participation.

3. Responsibilities of Parties

3.1 General principles

Each Party undertakes to take part in the efficient implementation of the Project, and to cooperate, perform and fulfil, promptly and on time, all of its obligations under the EC-GA and this Consortium Agreement as may be reasonably required from it and in a manner of good faith.

Each Party undertakes to notify promptly, in accordance with the governance structure of the Project, any significant information, fact, problem or delay likely to affect the Project. Each Party shall promptly provide all information reasonably required by a Consortium Body or by the Coordinator to carry out its tasks. Each Party shall take reasonable measures to ensure the accuracy of any information or materials it supplies to the other Parties.

3.2 Breach

In the event a responsible Consortium Body identifies a breach by a Party of its obligations under this Consortium Agreement or the EC-GA (e.g.: a partner producing poor quality work), the Coordinator will give written notice to such Party requiring that such breach be remedied within 30 calendar days. If such breach is substantial and is not remedied within that period or is not capable of remedy, the Governing Board may decide to declare the Party to be a Defaulting Party and to decide on the consequences thereof which may include termination of its participation.

3.3 Involvement of third parties

A Party that enters into a subcontract or otherwise involves third parties (including but not limited to Affiliated Entities) in the Project remains solely responsible for carrying out its relevant part of the Project and for such third party's compliance with the provisions of this Consortium Agreement and of the EC-GA. It has to ensure that the involvement of third parties does not affect the rights and obligations of the other Parties under this Consortium Agreement and the EC-GA.

4. Liability towards each other

4.1 No warranties

In respect of any information or materials (incl. Foreground and Background) supplied by one Party to another under the Project, no warranty or representation of any kind is made, given or implied as to the sufficiency or fitness for purpose nor as to the absence of any infringement of any proprietary rights of third parties.

Therefore,

- the recipient Party shall in all cases be entirely and solely liable for the use to which it puts such information and materials, and

- no Party granting Access Rights shall be liable in case of infringement of proprietary rights of a third party resulting from any other Party (or its Affiliates) exercising its Access Rights.

4.2 Limitations of contractual liability

No Party shall be responsible to any other Party for any indirect or consequential loss or similar damage such as, but not limited to, loss of profit, loss of revenue or loss of contracts, provided such damage was not caused by a wilful act or by a breach of confidentiality.

A Party's aggregate liability towards the other Parties collectively shall be limited to once the Party's share of the total costs of the Project as identified in Annex I of the EC-GA provided such damage was not caused by a wilful act or gross negligence.

The terms of this Consortium Agreement shall not be construed to amend or limit any Party's

non-contractual liability.

4.3 Damage caused to third parties

Each Party shall be solely liable for any loss, damage or injury to third parties resulting from the performance of the said Party's obligations by it or on its behalf under this Consortium Agreement or from its use of Foreground or Background.

4.4 Force Majeure

No Party shall be considered to be in breach of this Consortium Agreement if such breach is caused by Force Majeure. Each Party will notify the competent Consortium Bodies of any Force Majeure as soon as possible. If the consequences of Force Majeure for the Project are not overcome within 6 weeks after such notification, the transfer of tasks - if any - shall be decided by the competent Consortium Bodies.

5. Governance structure

5.1 General structure

The organisational structure of the Consortium shall comprise the following Consortium Bodies:

1. The **Governing Board** is the ultimate decision-making body of the Consortium.
2. The **Executive Board** is responsible for strategic management of the Project, including strategic direction, funding, and technical aspects and is the supervisory body for the execution of the Project and shall report to and be accountable to the Governing Board. It reviews all publications and reports created in the Project and advises the

Governing Board and the Executive Board on dissemination of Foreground. It oversees ***BIOWALK4BIOFUELS*** material to be presented at workshops or conferences.

3. The **Participants' Forum** is composed of all participants in the Project.
4. The **Coordinator** is the legal entity acting as the intermediary between the Parties and the European Commission. The Coordinator shall, in addition to its responsibilities as a Party, perform the tasks assigned to it.
5. The **Deputy Coordinator** assists the Coordinator in his tasks.

5.2 Members

The Governing Board is composed by the Project Coordinator and other two experts belonging to the Parties; the two experts will be appointed in the first Project Meeting.

The Executive Board is composed by the Project Coordinator and other four experts belonging to the Parties; the four experts will be appointed in the first Project Meeting.

The Deputy Coordinator will be directly designated by the Project Coordinator.

5.3 Representation

Any member of a Consortium Body:

a) should be present or represented at any meeting of such Consortium Body;

b) may appoint a substitute or a proxy to attend and vote at any meeting;

c) shall participate in a cooperative manner in the meetings.

Meetings of each Consortium Body can also be held by teleconference, videoconference or other telecommunication means.

5.4 Minutes of meetings

The chairperson of a Consortium Body shall produce written Minutes of each meeting which shall be the formal record of all decisions taken. He/she shall send the draft to all of its members within 15 calendar days of the meeting.

The Minutes shall be considered as accepted if, within 15 calendar days from sending, no member has objected in writing to the chairperson with respect to the accuracy of the draft of the Minutes.

5.5 Meetings and decisions

Ordinary meetings of the Governing Board shall be held three times a year and extraordinary meetings can be held at any time on the written request of the Executive Board or 1/3 of the members of the Governing Board. The Governing Board will choose a Chair from among the participant representatives.

The Governing Board shall be responsible for overseeing the Project and verifying that the Coordinator, Deputy Coordinator and the Executive Board are meeting their obligations.

The Governing Board may make decisions on the following issues:

- Content, finances; Changes to the Consortium Plan (including the Consortium Budget);
- Changes to the technical work plan and deliverables;

The Executive Board shall meet every month and an extraordinary meeting may be held at any time on written request of any member of the Executive Board. The Coordinator shall chair all meetings of the Executive Board, unless decided otherwise. Minutes of Executive Board meetings, once accepted, shall be sent by the Coordinator to the Governing Board for information.

The Executive Board shall monitor the effective and efficient implementation of the Project, prepare the meetings, propose decisions and prepare the agenda of the Governing Board.

It shall seek a consensus among the Parties.

The Executive Board shall be responsible for the proper execution and implementation of the decisions of the Governing Board. It shall monitor the efficient implementation of the project. In addition, the Executive Board shall take account of the views of the Participants' Forum, collect information at least every 6 months on the progress of the Project, examine that information to assess the compliance of the Project with the Consortium Plan and, if necessary, propose modifications of the Consortium Plan to the Governing Board.

6. Financial provisions

6.1 General Principles

The Community financial contribution to the Project shall be distributed by the Coordinator according to:

- the Consortium Budget as included in the Consortium Plan

- the approval of reports by the European Commission, and

- the provisions of payment in Article 7.3.

A Party shall be funded only for its tasks carried out in accordance with the Consortium Plan.

In accordance with its own usual accounting and management principles and practices, each Party shall be solely responsible for justifying its costs with respect to the Project towards the European Commission. Neither the Coordinator nor any of the other Parties shall be in any way liable or responsible for such justification of costs towards the European Commission.

A Party which spends less than its allocated share of the Consortium Budget will be funded in accordance with its actual duly justified eligible costs only. A Party that spends more than its allocated share of the Consortium Budget will be funded only in respect of duly justified eligible costs up to an amount not exceeding that share.

A Party leaving the Consortium shall refund all payments it has received except the amount of contribution accepted by the European Commission or another contributor. Furthermore a

Defaulting Party shall bear any additional costs occurring to the other Parties in order to perform its and their tasks.

6.2 Budgeting

The Consortium Budget shall be valued in accordance with the usual accounting and management principles and practices of the respective Parties.

6.3 Payments

Payments to Parties are the exclusive tasks of the Coordinator. In particular, the Coordinator shall:

- notify the Party concerned promptly of the date and composition of the amount transferred to its bank account, giving the relevant references;
- perform diligently its tasks in the proper administration of any funds and in maintaining financial accounts;
- undertake to keep the Community financial contribution to the Project separated from its normal business accounts, its own assets and property, except if the Coordinator is a PublicBody or is not entitled to do so due to statutory legislation.

The payment schedule, which contains the transfer of pre-financing and interim payments to Parties, will be handled according to the following :

- budgeted costs for future work included in the Consortium Plan will be paid to Parties in separate instalments in conformity with the decisions of the Governing Board or the Executive Board.
- costs accepted by the Commission will be paid to the Party concerned, taking into account the amounts already paid for such reporting period.

The Coordinator is entitled to withhold any payments due to a Party identified by a responsible Consortium Body to be in breach of its obligations under this Consortium Agreement or the EC-GA" or to a Beneficiary which has not yet signed this Consortium Agreement. The Coordinator is entitled to recover any payments already paid to a Defaulting Party.

7. Signatures

AS WITNESS:

The Parties have caused this Consortium Agreement to be duly signed by the undersigned authorised representatives in separate signature pages the day and year first above written (effective date).

BIOWALK4BIOFUELS CONSORTIUM AGREEMENT

Partner n°1 – Coordinator

Interuniversity Research Centre for Sustainable Development (CIRPS), University of Rome "La Sapienza" - ITALY

Name(s) SILVANO SIRONI

Title(s) PH.D

Signature(s) and stamp

BIOWALK4BIOFUELS CONSORTIUM AGREEMENT

Partner n°2

National Interuniversity Consortium for Ocean Sciences (CoNISMa) – ITALY

Name(s) CESARE CORSELLI

Title(s) PRESIDENT

Signature(s) and stamp

CoNISMa · Consorzio Nazionale Interuniversitario per le Scienze del Mare · ROMA

IL PRESIDENTE DEL CoNISMa
Prof. Cesare Corselli

BIOWALK4BIOFUELS CONSORTIUM AGREEMENT

Partner n°3

ECOIL - ITALY

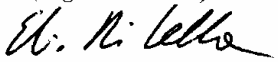
Name(s) Elio DI LELLA

Title(s) CHAIRMAN

Signature(s) and stamp ECOIL

Il Presidente

(ing. Elio Di Lella)



BIOWALK4BIOFUELS CONSORTIUM AGREEMENT

Partner n°4

National Environmental Research Institute (NERI) – DENMARK

Name(s) Bo RIEMANN

Title(s) Director of Research Department

Signature(s) and stamp

National Environmental
Research Institute
University of Aarhus
25 Vejlsøvej, P.O.Box 314
DK-8600 Silkeborg, Denmark

BIOWALK4BIOFUELS CONSORTIUM AGREEMENT

Partner n°5

Danish Technological Institute (DTI) – DENMARK

Name(s) LEIF KIRK THOGERSEN

Title(s) DIRECTOR

Signature(s) and stamp

Teknologisk Institut
Industri og Energi
Teknologiparken
Kongsvang Allé 29, 8000 Århus C
Tlf. 7220 1000

BIOWALK4BIOFUELS CONSORTIUM AGREEMENT

Partner n°6

Central Salt & Marine Chemicals Research Institute (CSMCRI) – INDIA

Name(s) Dr. Pushpito K. Ghosh

Title(s) Director

Signature(s) and stamp

Dr. Pushpito K. Ghosh
Director
Central Salt & Marine
Chemicals Research Institute
Bhavnagar--364 002, Gujarat, India

BIOWALK4BIOFUELS CONSORTIUM AGREEMENT

Partner n°7

NGVA Europe - SPAIN

Name(s) Manuel Lage Marco

Title(s) General Manager NGVA Europe

Signature(s) and stamp

BIOWALK4BIOFUELS CONSORTIUM AGREEMENT

Partner n°8

Scandinavian Gas Treatment Service (SGtS) – SWEDEN

Name(s) Hans Kattström

Title(s) CEO

Signature(s) and stamp

BIOWALK4BIOFUELS CONSORTIUM AGREEMENT

Partner n°9

Hashemite University – Faculty of Natural Resources and Environment (HU) – JORDAN

Name(s) Prof. Sulaiman Arabiat

Title(s) President

Signature(s) and stamp

BIOWALK4BIOFUELS CONSORTIUM AGREEMENT

Partner n°10

Riga Technical University (RTU) – LATVIA

Name(s) DAGNIJA BLUMBERGA

Title(s) DIRECTOR OF THE ENERGY SYSTEMS AND ENVIRONMENT INSTITUTE

Signature(s) and stamp

30. 03. 2009

RIGAS TEHNISKĀ UNIVERSITĀTE • ENERGĒTIKAS UN ELEKTROTEHNIKAS FAKULTĀTE •
VIDES AIZSARDZĪBAS UN SILTUMA SISTĒMU INSTITŪTS

BIOWALK4BIOFUELS CONSORTIUM AGREEMENT

Partner n°11

Aquagri Processing Pvt Ltd (AP) – INDIA

Name(s)

Abhiram Seth

Title(s)

Managing Director

Signature(s) and stamp

2009-03-30

AQUAGRI PROCESSING PVT. LTD. 18, Anand Lok New Delhi-49

KATTEGATCENTRETGRENAA
– mere under overfladen

23. oktober 2009

Vedrørende "Tilsagn om rådighed over havneareal".

I forbindelse med projektet "Alger til Bioenergi i Region Midtjylland" er det aftalt, at Kattegatcentret, ud over deltagelse i den aktive formidling og generel overvågning, også stiller et areal på havnen (500 m^2) til rådighed for opstilling af algedyrkningssystem.

Kattegatcentret
Jørgen L. Møller
Direktør

Færgevej 4
DK-8500 Grenaa
Telefon (+45) 8632 5200
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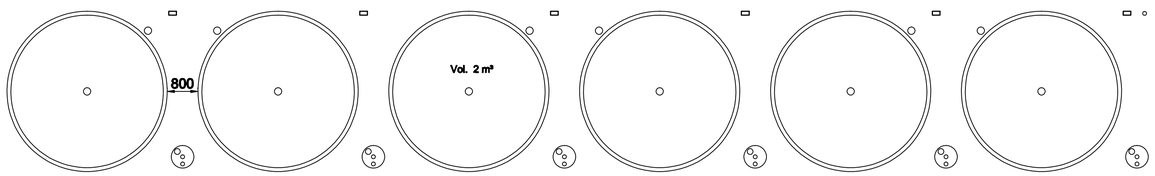
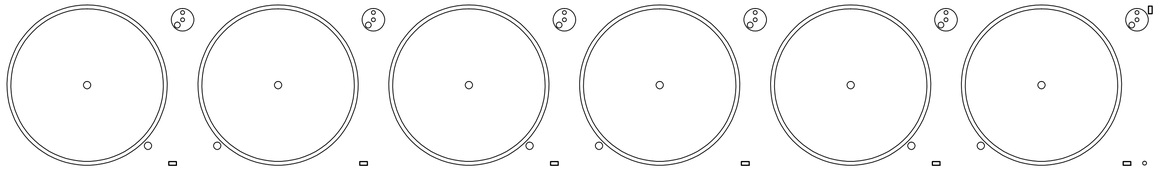
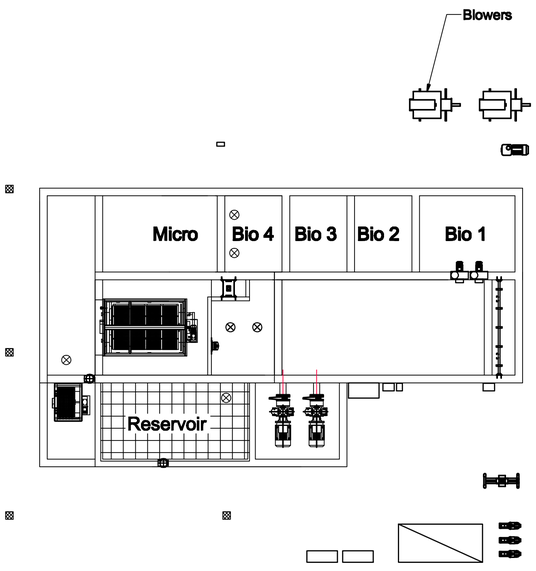


Dyrkningsfacilitet til alger





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www.akvagroup.com Teknikarvej 14, DK-7000 Fredericia Phone +45 75513211, Fax +45 75514211		Projection conv.: ISO-E					
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Alger til biogas i region Midtjylland Dyrkningsfacilitet til alger Preliminary Plan drawing		Original format: A1					
		Scale: x:xx					
		Drawing Number 09.75.001.A					

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Referencer

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