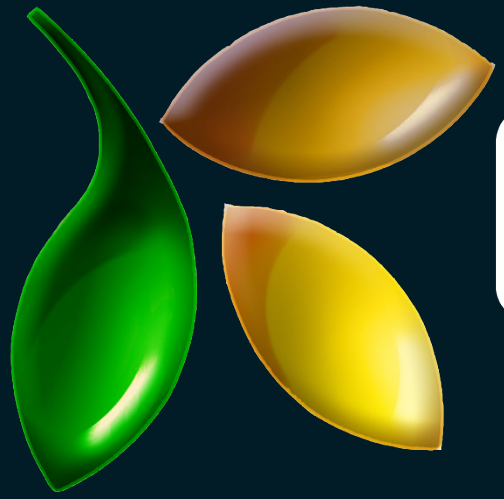

Celignis Analytical

Experiences of an SME in Spinning Out from EU Research and Participating in H2020 Projects

BBI Ireland Event

May 22nd UL

Dan Hayes

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www.celignis.com

History:

From research project to business concept to launch….

History - BC

- Masters funded by IRC (desk study).
- Helped form Carbolea Biomass Research Group at University of Limerick.
- Literature data severely lacking.
- Obtained funding to build capacity for biomass analysis within Carbolea.
- Grants from Dept. of Agriclture (€130k), EPA (€100k),and Bord na Mona (€40k) allowed PhD on biomass analysis.
- Realised lignocellulosic analysis was slow and costly, developed NIR as part of PhD.

DIBANET

- €3.7m FP7 advanced biofuels research project, coordinated by UL, involving 13 partners from EU and Latin America. 2009-2013.
- Focused on production of levulinic acid and furfural and conversion to advanced biofuels.

DIBANET - Deliverables

- Concept – turn a sugar mill into a diesel facility.
- Proposal – eliminate diesel imports in Europe by 2020!!!
- WP2 – biomass analysis:
  - UL work → develop models for European biomass, particularly Miscanthus.
  - Brazil work → develop models for sugarcane bagasse and trash (CTC, 2 years) and other Latin American feedstocks (e.g. coffe husks, coconut residues – UNICAMP).
  - Deliverable: Patent NIR models.
  - Write business plan for imaginary spin-out company (end 2012).

Business Plan: Observations

- No company dedicated to lignocellulosic analysis..
- Custom NIR models developed for specific applications and clients but not universally available.
- Question on size of market, particularly outside USA.
- Company would need to also offer analytical services for the bioenergy sector.
- Decided (2013) to give it a go!

Celignis - Timeline

- DIBANET ended April 2013.
- Company registered in July 2013.
- Personal investment ~€140k + €40k grant from Limerick county council.
- Launched company in August 2014.
- Moved into independent lab in Feb 2015.
- First H2020 project (BIOrescue) started 2016.
- Moved to new premises Nov 2018, accompanied with expansion in personnel.

Celignis Analytical

- Dedicated biomass analysis laboratory.
- Spin-out from university research and EU biofuels project (DIBANET).
- Focus on catering to the needs of the bioeconomy.
- Provision of analytical services to stakeholders and R&D on biomass valorisation.
- Launched 2014 → experience (15 yrs).

With accurate data the possibilities are limitless…. *www.celignis.com*

1. Analysis for Advanced Biofuel and biorefinery Feedstocks

- Hydrolysis process (e.g. enzymatic).
  - Cellulose content (structural glucose).
  - Hemicellulose content (constituent sugars).
  - Lignin content (acid soluble and insoluble)
  - Extractives
  - Ash.
  - One-day analysis with our NIR models.
- Thermochemical (e.g. pyrolysis).
  - Elemental analysis (C, H, N, O, S)
  - Heating value
  - Ash, anions and cations.

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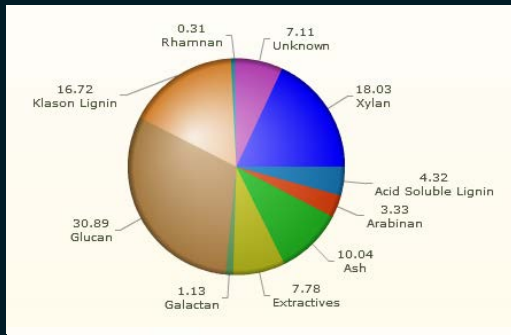

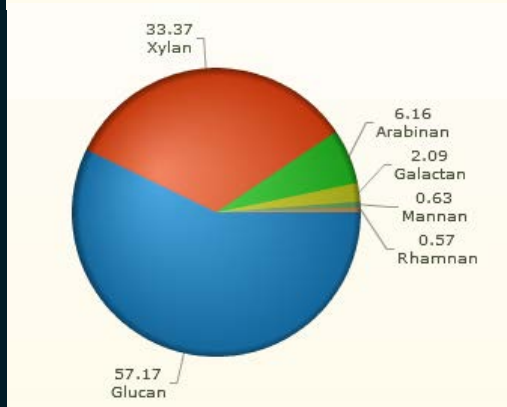

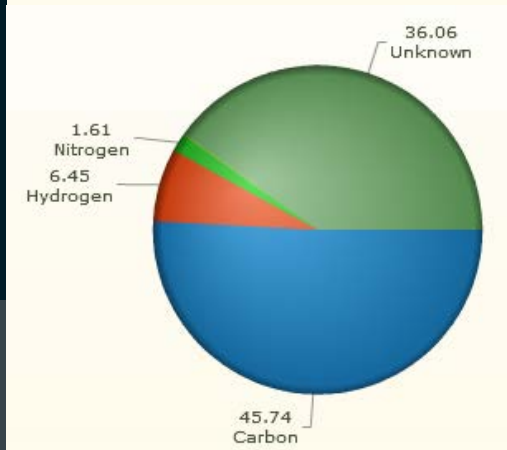

2. Process Liquids Analysis

- Analysis of liquid products of pre-treatment and conversion.
- Can determine the amounts of each sugar that are in the oligomeric form (e.g. LHW pretreatment).
- Can characterise anhydrodosugars, uronic acids, sugar alcohols, sugar degradation products (e.g furfural, HMF, levulinic acid etc.).
- Fermentation tests and analysis for products.

3. Marine Biomass analysis

- "3rd generation biofuel".
- Carbohydrates in seaweed.
- Mannitol, fucose, glucuronic acid, mannuronic acid, guluronic acid.
- Amino acids in seaweed.

4. Thermal Properties

- Proximate analysis.
- Ultimate analysis.
- Heating value.
- Chlorine content.
- Ash and ash composition.
- Ash melting temperature.
- Also look at physical properties (e.g. particle size distribution of wood chips).

Services:
5. Anaerobic Digestion

- Biogas production and Biomethane Potential (BMP). Digestions for 14-40 days with biogas analysed at several stages for its composition (methane, carbon dioxide, hydrogen sulphide, ammonia, oxygen).
- Detailed feedstock and digestate analysis.
- Expertise in biomass chemistry, our data can help understand the efficiencies of digestion of biogenic polymers (e.g. cellulose, hemicellulose, lignin).
- Experienced analysts: We are available by phone/email to discuss results and provide advice on the next steps in feedstock valorisation and process optimisation.

With accurate data the possibilities are limitless….

Services 6:
Biological Advisory for Biogas Plants

Data analysis of plant process indicators and correlating with the major and minor nutrients concentration in the plant

Suggested changes in trace elements and additives concentration

Statistical analysis of plant input and output streams and process efficiencies

Defined limits for feed input and early process indicators that can be monitored in the plant

Suggested changes in trace elements and additives concentration

Overall process improvement in terms of plant stability and energy efficiency - Around 50%

With accurate data the possibilities are limitless….

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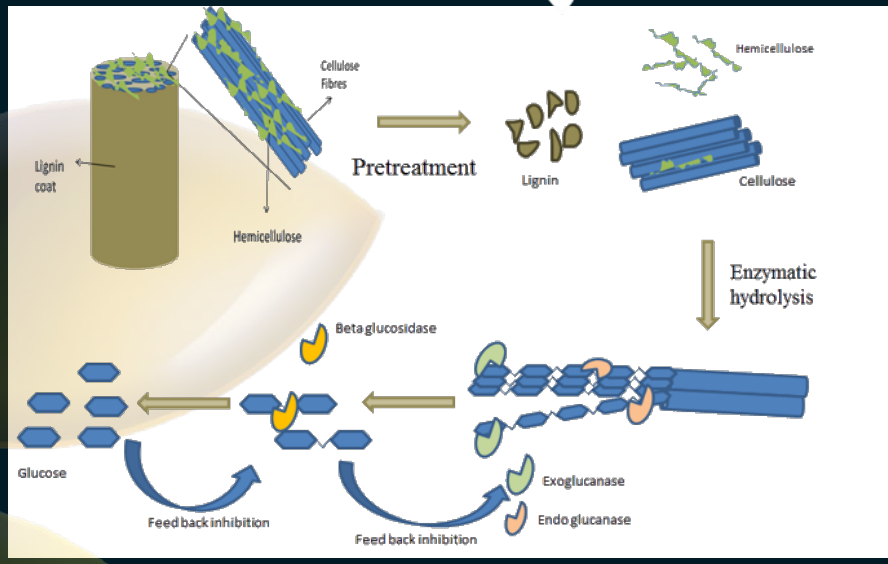
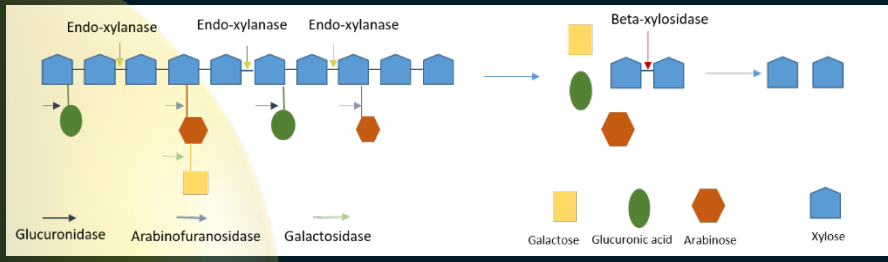
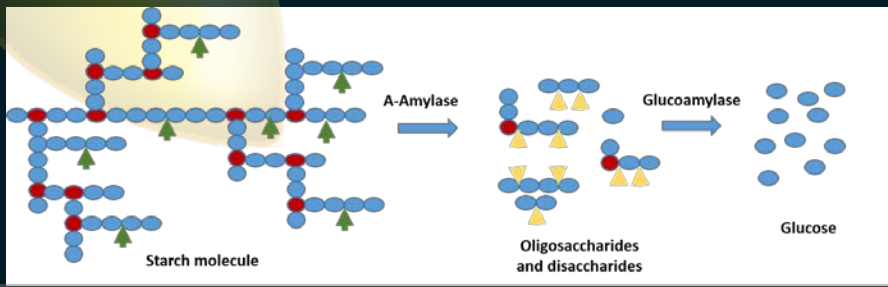
Services 7: Enzymatic Hydrolysis & Fermentation

- Enzymatic saccharifcation of biomass and pre-treated samples.
- Analysis of activity of enzymes (cellulolytic, amylolytic)
- Fermentation tests for hydrolysates.
- Analysis of fermentation inhibitors.
- Dedicated microbiology lab in new premises.







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Services 8:
Bespoke Bioprocess Development

- Pretreatment optimisation, e.g. pre-treatment for AD
- Hemp biorefinery: Two large multi-national companies in UK cultivating hemp
- Dried distiller grains (DDGs) for 1G-2G integrated biofuel prodction. US (Ibiocat) -Ireland (Celignis) collaboration.
- Flax fibre and residues modification - Improving fibre quality and oil absorption properties with enzymatic treatment.
- Enzymatic hydrolysis and fermentation for biorefinery process streams.


FOSS
Rapid Content Analyser
XDS

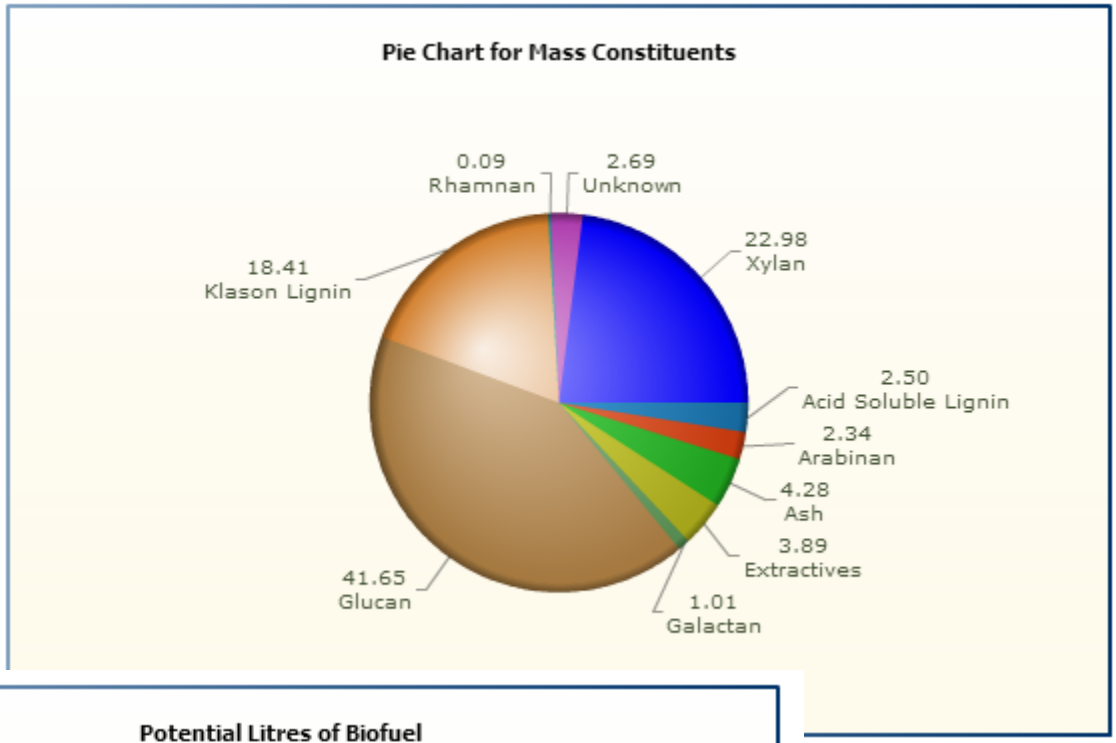

Parr
6200 CALORIMETER
SciMed


Nabertherm

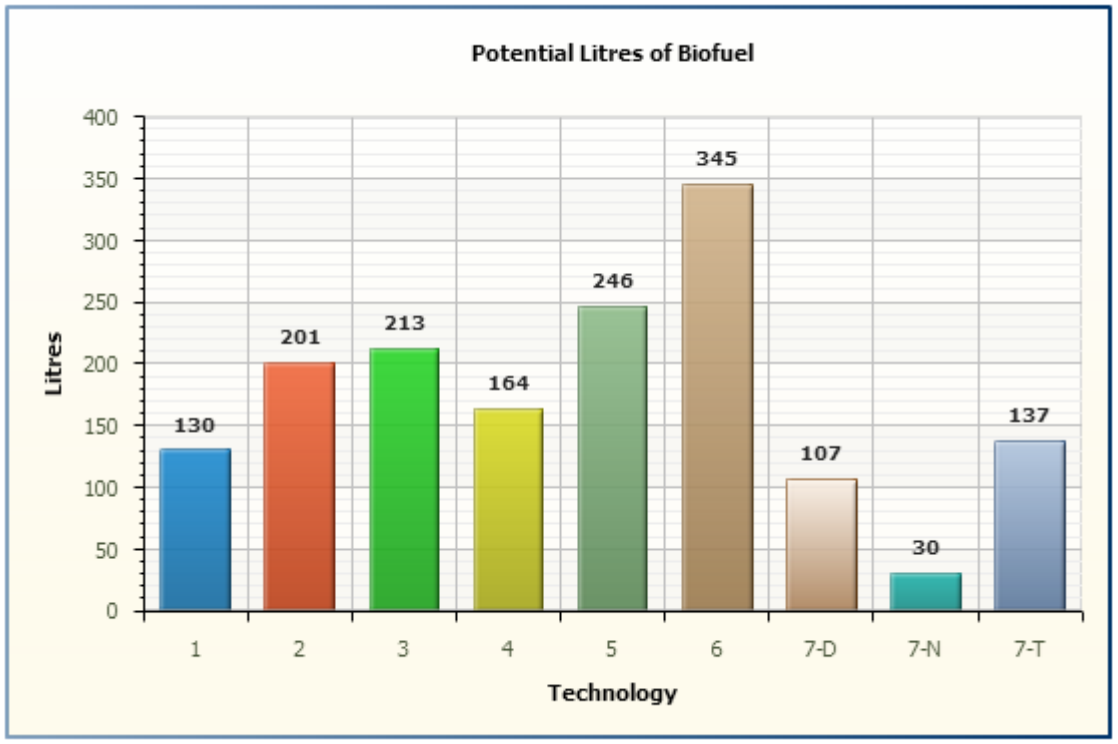

Medeco
monaghan biosciences
Arigna Fuels
University of Bristol
Quinns
Everything for the Farmer
The University Of Queensland
Australia
TU/e
Technische Universiteit Eindhoven
University of Technology
University of Agder
University of Eastern Finland
Clearpower
Renewable Energy Solutions
SLU
Swedish University of Agricultural Sciences
universität innsbruck
Universidade Federal de Viçosa
TRICEL
Generations of Innovation
Brunel University London
Biopolis
Tailor-made Biotechnology
NOVA Q
Loughborough University
bp
woodco
ENSYN
CORNING
SWEETWATER ENERGY
LEAF RESOURCES LIMITED
Sustainable products from plant biomass
Fiberight
TEXCHEM
Texchem Resources Bhd
SUZANO
PAPEL E CELULOSE
AMERICAN BIOCARBON
ARBIOM
sappi | biotech
kemira
ADM
avantium
FOET
biorefining
Ørsted
chempolis
Sustainable Results
Future Blends
TATE & LYLE SUGARS
ASR GROUP
NOVAPANGAEA
Technologies
indigo
IOWA STATE UNIVERSITY
Sentio
BioSciences
ASHLEIGH
ENVIRONMENTAL
SCION
forests · products · innovation
Aston University
Birmingham
EBRI
European Bioenergy Research Institute
cirisenergy
Imperial College London
DTU
Technical University of Denmark
microlife solutions
Prifysgol Aberystwyth University
ROYAL
ADHESIVES & SEALANTS
NMIM
NATIONAL METROLOGY INSTITUTE OF MALAYSIA
Biorefining & Bioenergy
AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE
plaxica
NUI Galway
BHSL Hydro
Creating Value from Waste
UND
NORTH DAKOTA
Premium
A Goodhope Company
irstea
Biotricity
POWER FROM NATURE

Individual Suga

	Glucan	Xylan	Arabinan	Gala
			Wet-Chemical Data (% Dry	
AV.	41.65	22.98	2.34	1.
Rep 1	41.70	22.99	2.31	1.
Rep 2	41.61	22.97	2.36	1.
SD	0.06	0.02	0.04	0.
			Near-Infrared Predicted Values ('	
Pre.	41.97	23.39	2.27	0.
Dev.	1.28	0.70	0.24	0.



View	Pie Chart Sugars Chart Yields Chart	Miscanthus leaf #2	
View	Pie Chart Sugars Chart Yields Chart	Sugarcane bagasse #2	
View	Pie Chart Sugars Chart Yields Chart	Compost #2	
View	Pie Chart Sugars Chart Yields Chart	Compost #3	
View	Pie Chart Sugars Chart	Bark #1	



5.2	9.5	9.9
2.5	4.3	3.9
4.2	22.3	5.3
2.2	25.8	2.4
0.9	3.1	5.2

"One-day analys *v.celignis.com*

The Celignis Database

Yields

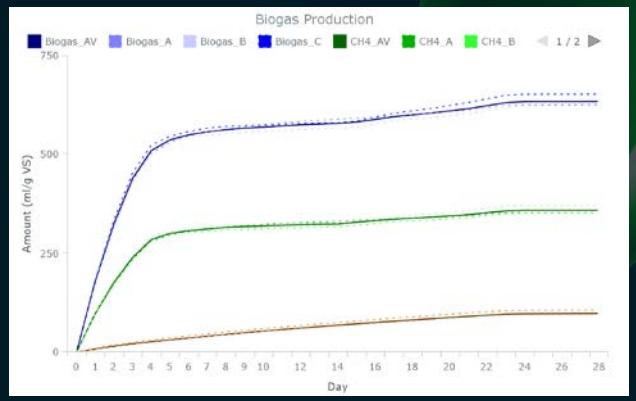
Biogas Potential (l/kg Fresh Weight)	BMP (l/kg Fresh Weight)
286	**177**
282	174
281	174
294	182
7	5

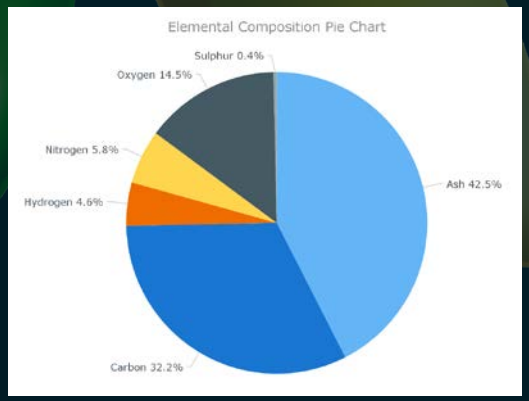
stics

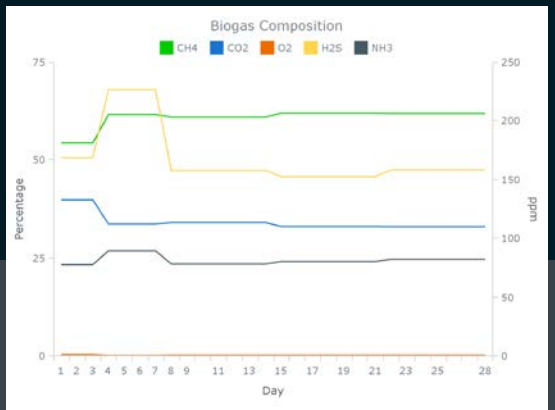
	Day
	28
	4
	4
	11
	9

The Celignis Database

- Our online reporting system provides a level of detail never seen before in the analysis of AD feedstocks.
- Biogas production data daily.
- We provide an array of information in tabular and graphical forms regarding feedstock, digestate, and biogas composition as well as statistics on the efficiency of digestion.
- Detailed pdf and Excel reports can be downloaded from the Database during digestion and after completion of analysis.







With accurate data the possibilities are limitless….

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Precision and Accuracy Are Key

- www.celignis.com/precision.php

	Glucan	Xylan	Total Sugars	Klason Lignin	Acid Soluble Lignin	Ethanol Extractives
SD	0.16%	0.04%	0.20%	0.25%	0.03%	0.25%

	Carbon	Nitrogen	Ash	Higher Heating Value	Lower Heating Value	Volatile Matter
SD	0.16%	0.02%	0.15%	0.079	0.079	0.24%

Horizon 2020 Projects

- Celignis was a spin-out from an EU research project.
- Business – but run by scientists with a passion for advancing the bioeconomy.
- Carefully selected H2020 projects provide an opportunity to couple scientific advances with real commercial progress.

BIO RESCUE

UNRAVEL

BIO-BASED INDUSTRIES
Public-Private Partnership

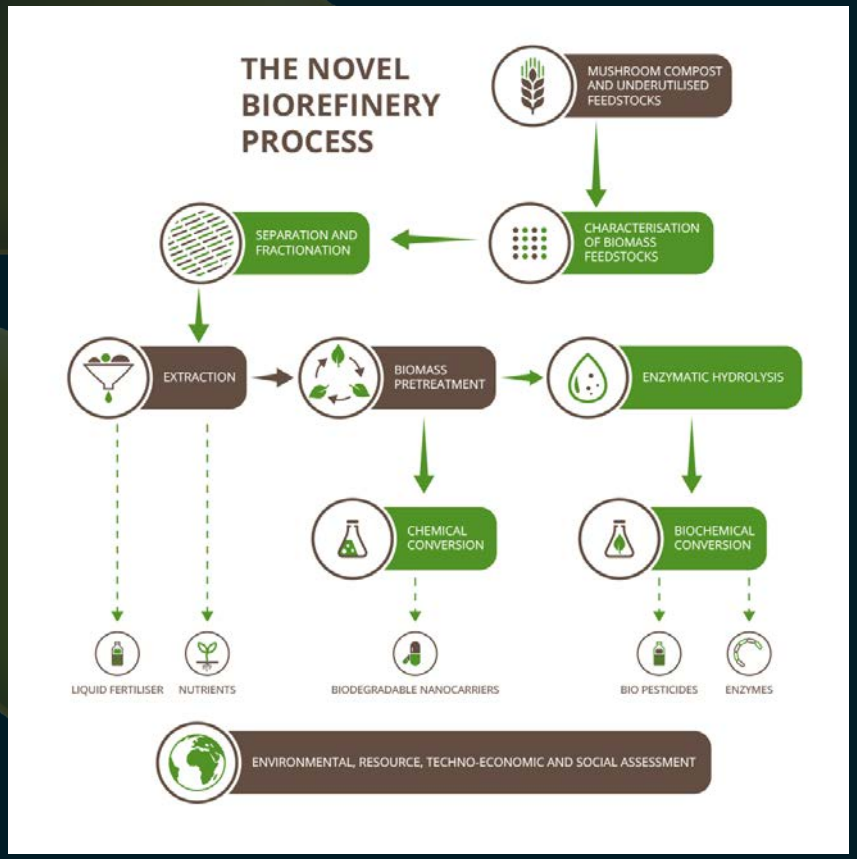
enabling

With accurate data the possibilities are limitless….

BIO RESCUE

Celignis Analytical

- BBI RIA started Set 2016.
- Valorisation of spent mushroom compost.
- Challenging composition!
- Celignis → development of NIR models for composition of feedstock and process outputs.
- Also developing advanced intelligent algorithms for prediction of composition.
- 1st H2020 project led to increased invites….



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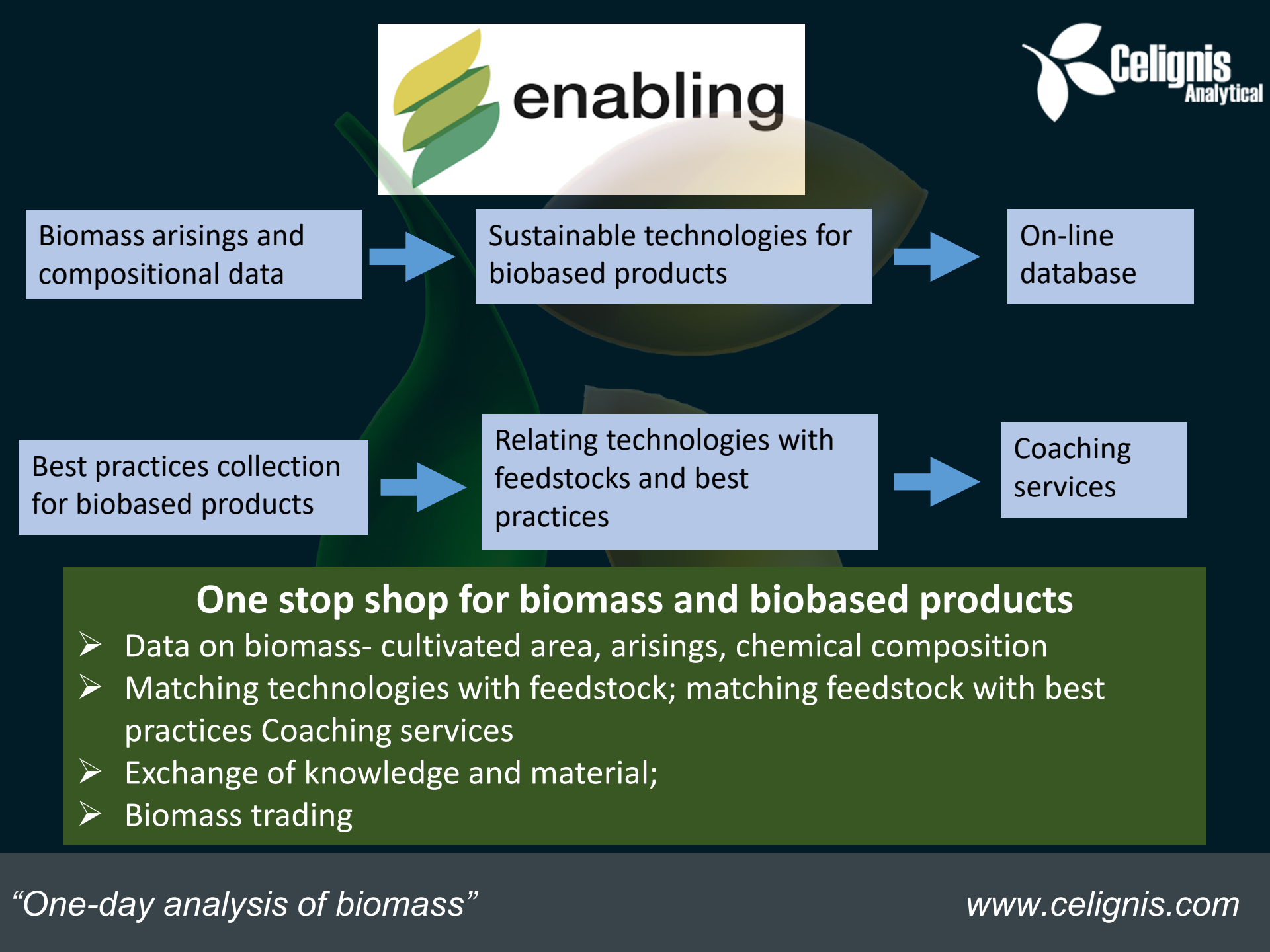
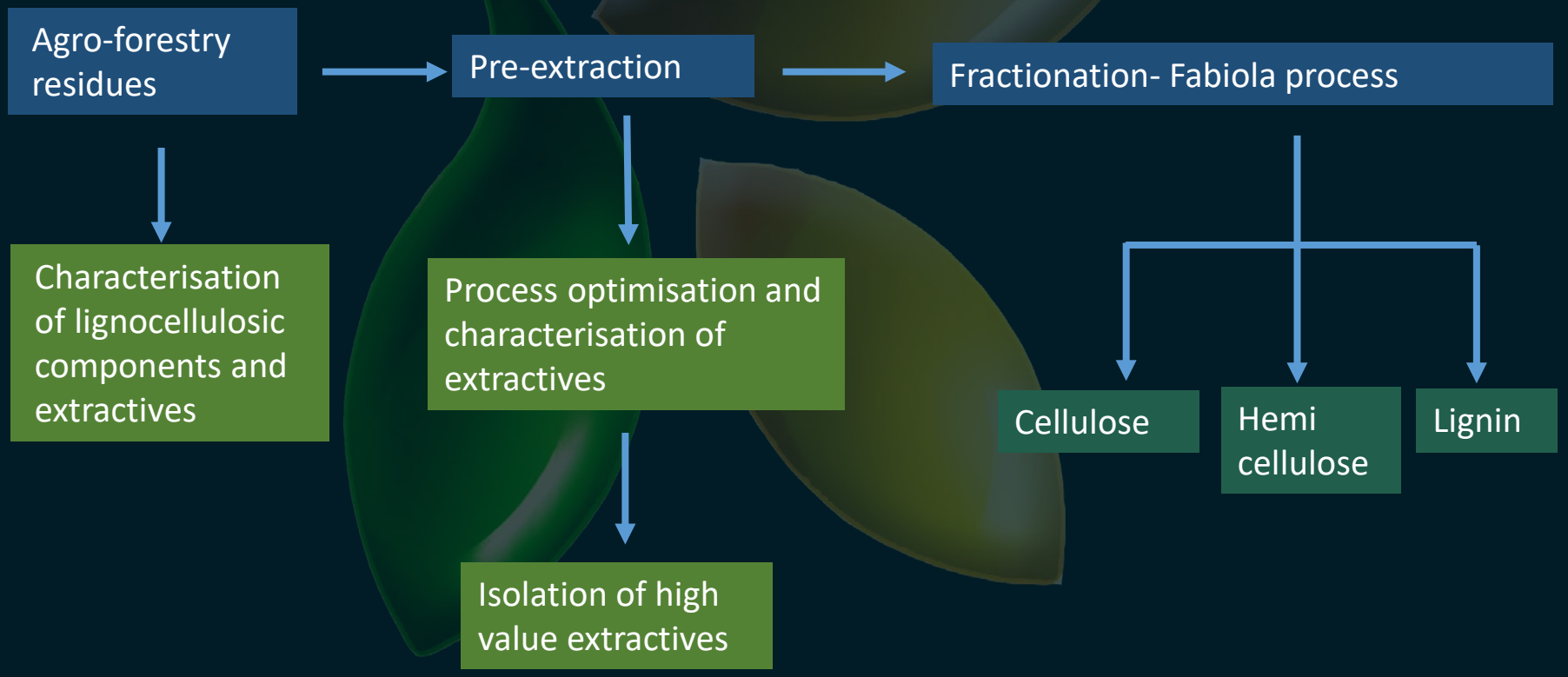

enabling
Celignis Analytical
Biomass arisings and compositional data
Sustainable technologies for biobased products
On-line database
Best practices collection for biobased products
Relating technologies with feedstocks and best practices
Coaching services
One stop shop for biomass and biobased products
Data on biomass- cultivated area, arisings, chemical composition
Matching technologies with feedstock; matching feedstock with best practices Coaching services
Exchange of knowledge and material;
Biomass trading
"One-day analysis of biomass"
www.celignis.com

10 partners – ECN, Celignis, Fraunhofer, EURIDA, Soprema, METGEN, SAPPI, CNRS, SAPPI, Max-Plank

UNRAVEL

Celignis Analytical



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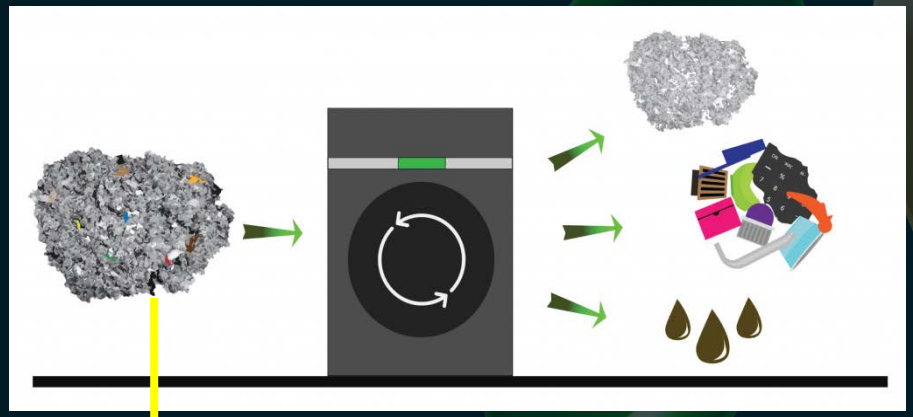
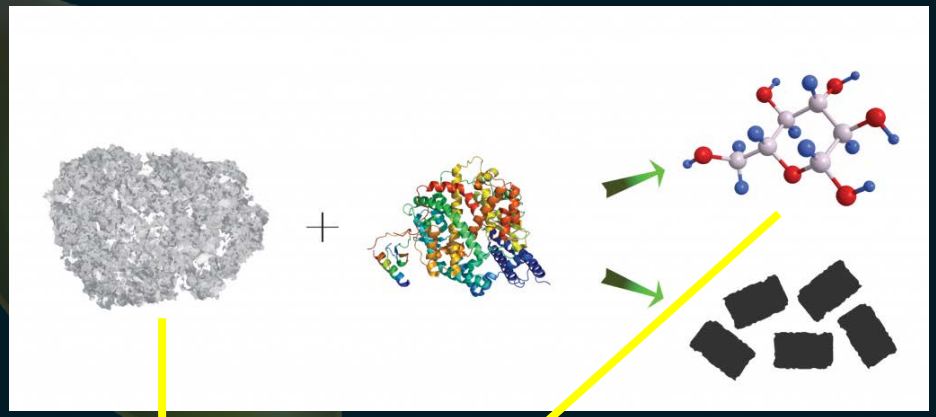
VAMOS

The Fiberight process recovers discreet cellulosic material from inconsistent streams and converts it to products like lactic acid

Celignis analyses the biomass, intermediate streams and products and develop predictive NIR models. At-line NIR unit will be placed on site at the demonstration facility for real-time analysis of compositional variation in the feedstock and its effect on process and final product.



Chemical composition- NIR



Chemical composition- NIR

"One-day analysis of biomass"

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BBI/H2020 Projects: The Good

- Expansion of network to include leading stakeholders across Europe → prove yourself (e.g. BIOrescue → ENABLING).
- Opportunities for funded IP development:
  - New algorithms (BIOrescue).
  - New extraction processes and means of recovering high value constituents (UNRAVEL).
  - Bio-marketplace platform (ENABLING).
  - Demonstrated process analytics (VAMOS).
- Allow recruitment of talented persons to expand company's offerings and potential.

With accurate data the possibilities are limitless….

Celignis Analytical

Lignocellulose, NIR

enabling

UNRAVEL

BIO RESCUE

Bioprocessing
Microbiology
Anaerobic digestion
Fermentation

Paper and pulp, leather industry

SEAI, IRC, INNOSUP applications

Bespoke bioprocess development

AD analysis packages + consultation

Programming, chemometrics, LIMS

Progress to 17025, Process analysis APIs

VAMOS (BBI 2018)

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BBI/H2020 Projects: The Not so Good

- Proposals are hard work (months). Successful proposals are not “lucky”.
  - Treat it like an exam, answer the questions provided.
  - Pre-empt the evaluators (play devils advocate).
  - Register as an expert evaluator.
- Cashflow!!! Pre-financing is a misnomer.
  - Eligible costs can cover equipment depreciation.
  - Front-load costs in proposal to 1st 18 months (UNRAVEL).
- Recruitment – issues in finding and securing contracts in current climate (SFI, IRC, Marie Curie (?)).
- Deliverables and bureaucracy, (too?) frequent meetings.
  - Coincide meetings with networking events (e.g. Celignis even in Dublin next week).

With accurate data the possibilities are limitless….

Spinning Out: Tips/Lessons

1. Do You Really Have Something? In research you can become lost in your own activities and inner circle. Do your homework!!
2. Only Spin-Out When You are Ready - 100% funding at universities vs co-financing for SMEs (EI commercialisation fund (100%) vs HPSU (50% + equity). Maintain links with universities afterwards (e.g. IRC).
3. Use Public Funds Strategically – LEO funding (50%, after spend). EI → feasibility grants and innovation vouchers to any company. HPSU to clients (post LEO). R&D tax credits.
4. EU Funding – Attractiveness depends on level of financing and pre-financing (e.g. INTERREG). Check out INNOSUP!

With accurate data the possibilities are limitless….

Website: www.celignis.com
20 webpages detailing our pitches for the BBI 2019 topics

Celignis Analytical

Thank You!

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