אוניברסיטת תל אביב
בעקבות הלא נודע

ביה"ס ללימודי הסביבה ע"ש פורטר

Offshore marine biorefinery in Israel a consolidated approach to support bioeconomy and blue growth.

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Porter School of Environmental Studies
agolberg@gmail.com

MOBI, May 2017

Ministry of National infrastructure,
Energy and Water Resources
www.energy.gov.il

Embassy
of the Federal Republic of Germany
Tel Aviv

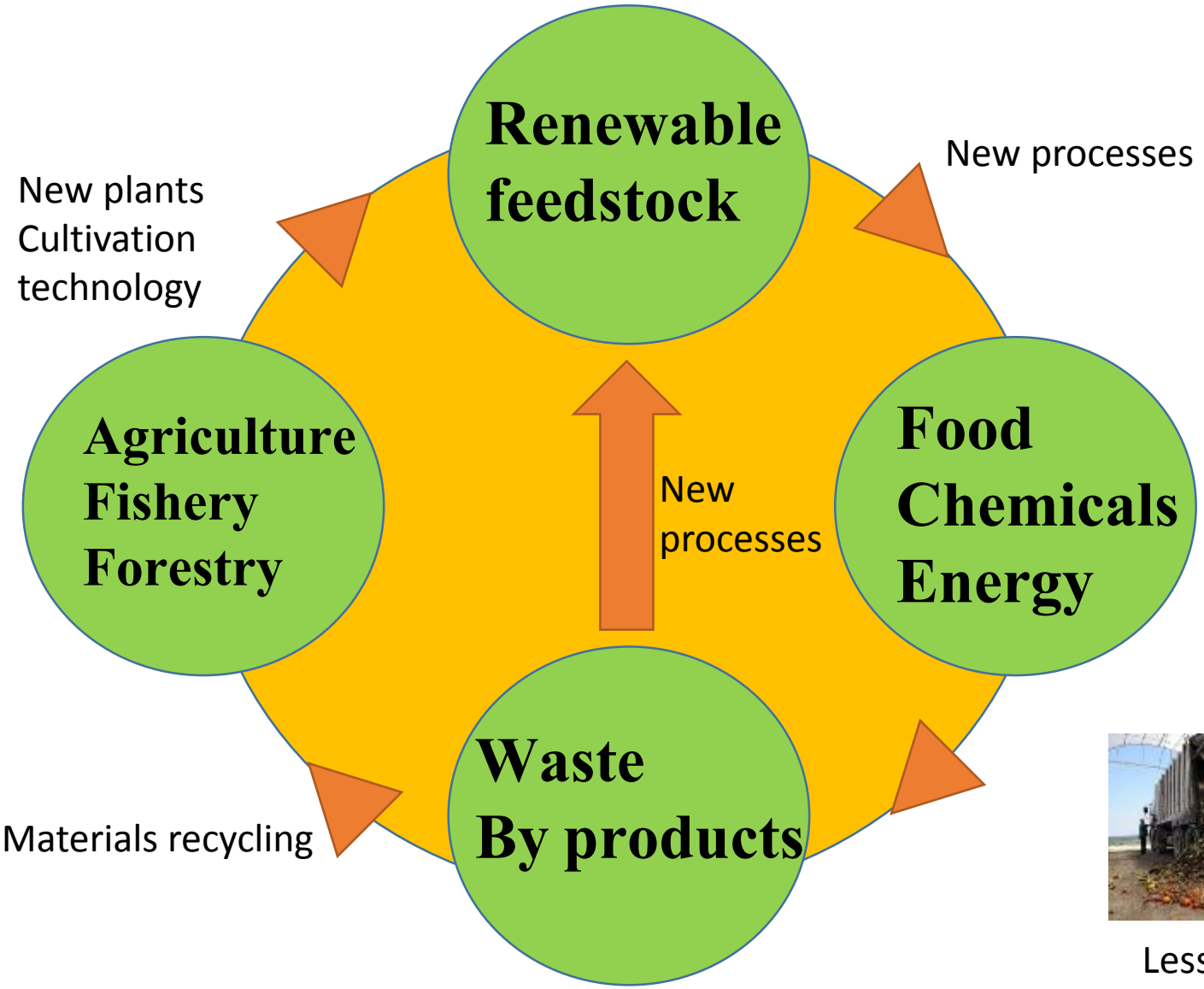
G7 leaders are calling to phase out fossil fuels by 2100

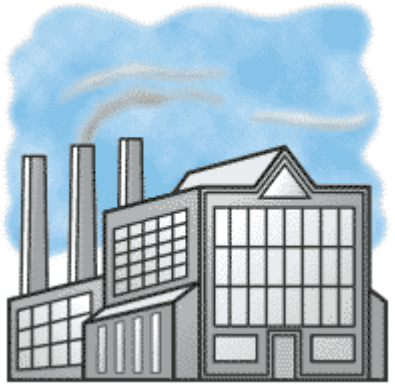
Although

> .@whitehouse continues to defend the billions it pissed away on ‘green energy’ failures bit.ly/11n5PGy Your money was wasted.

Bioeconomy as an alternative

New plants
Cultivation
technology

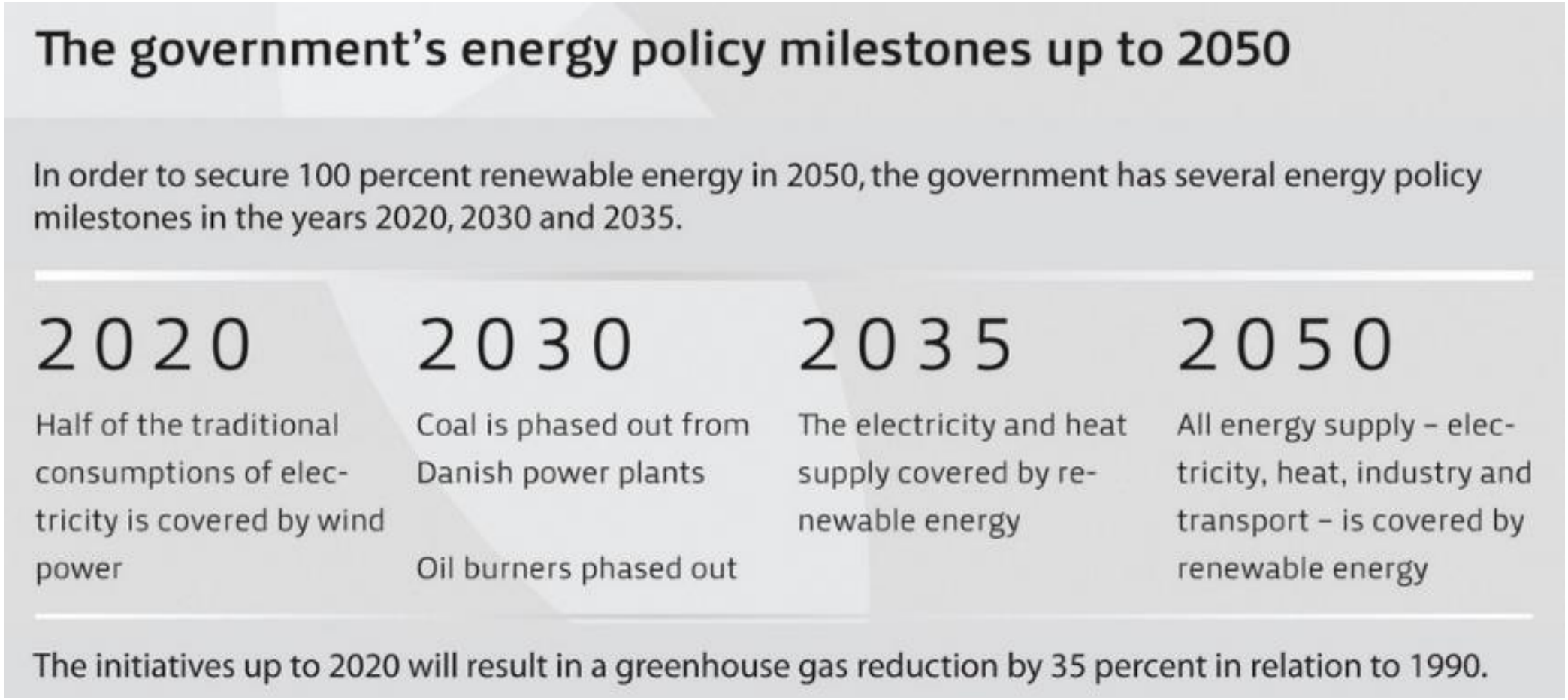




Less fossil fuels

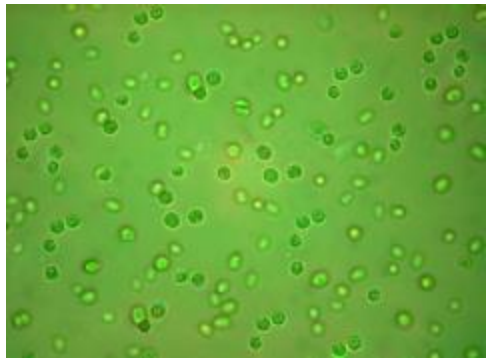
Less waste

Example of Denmark Road Map



1st anniversary of the Bio-based Industries Joint Undertaking: on the way to making Europe greener

Bio-Chemicals Feedstocks

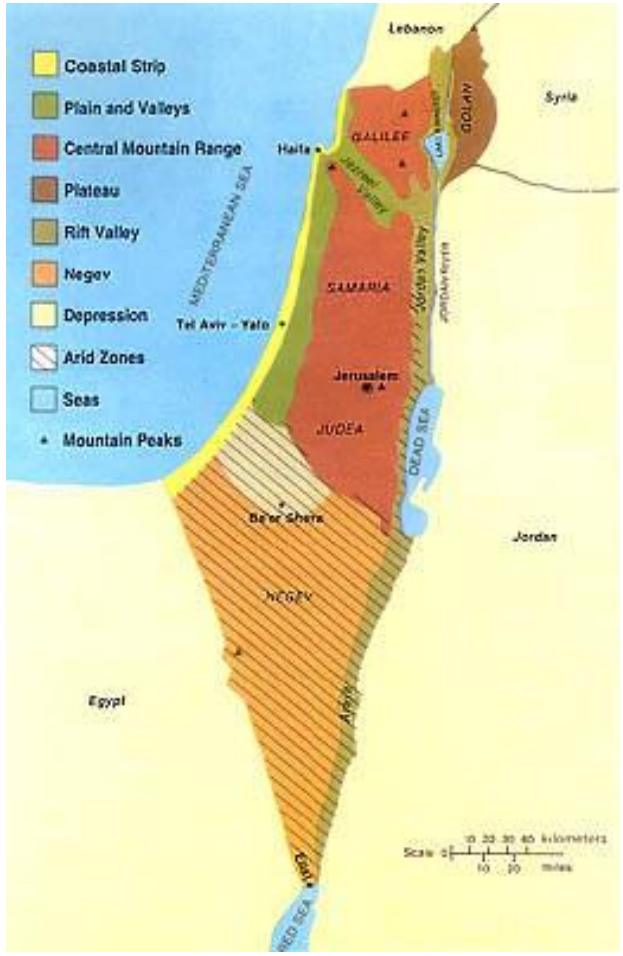


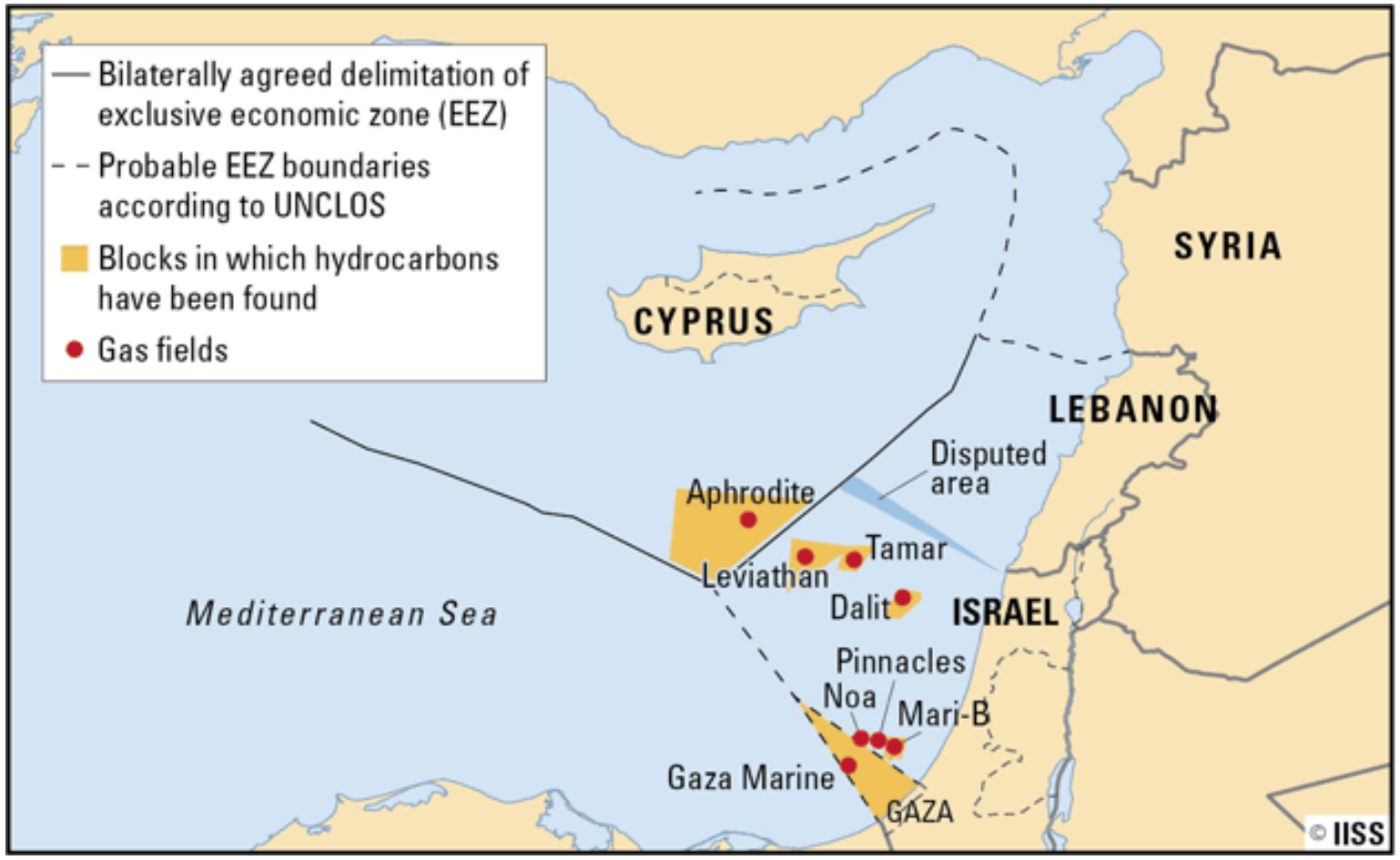
Micro Algae
(3-5micron)

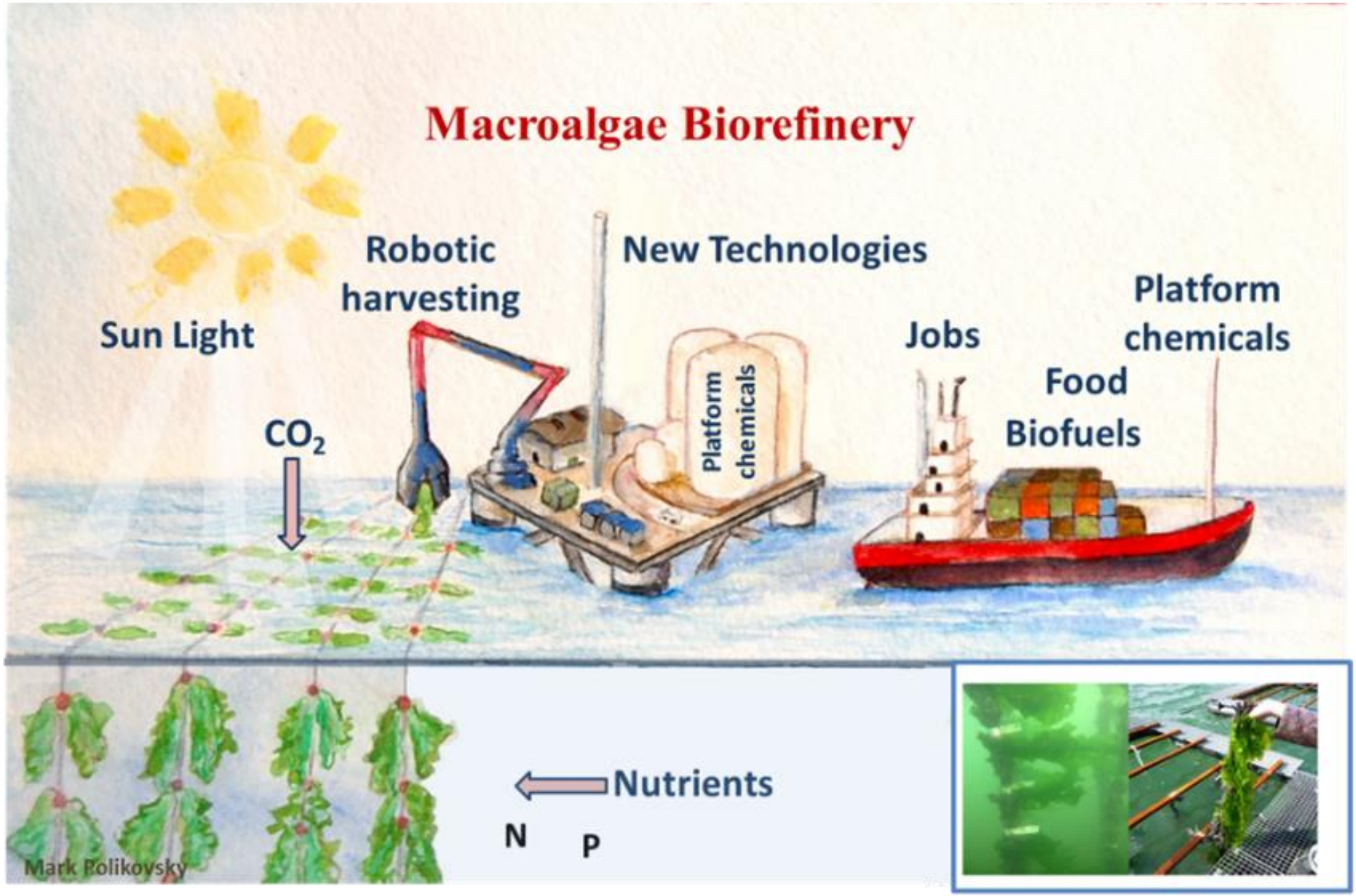
Arable Plants

Macro Algae

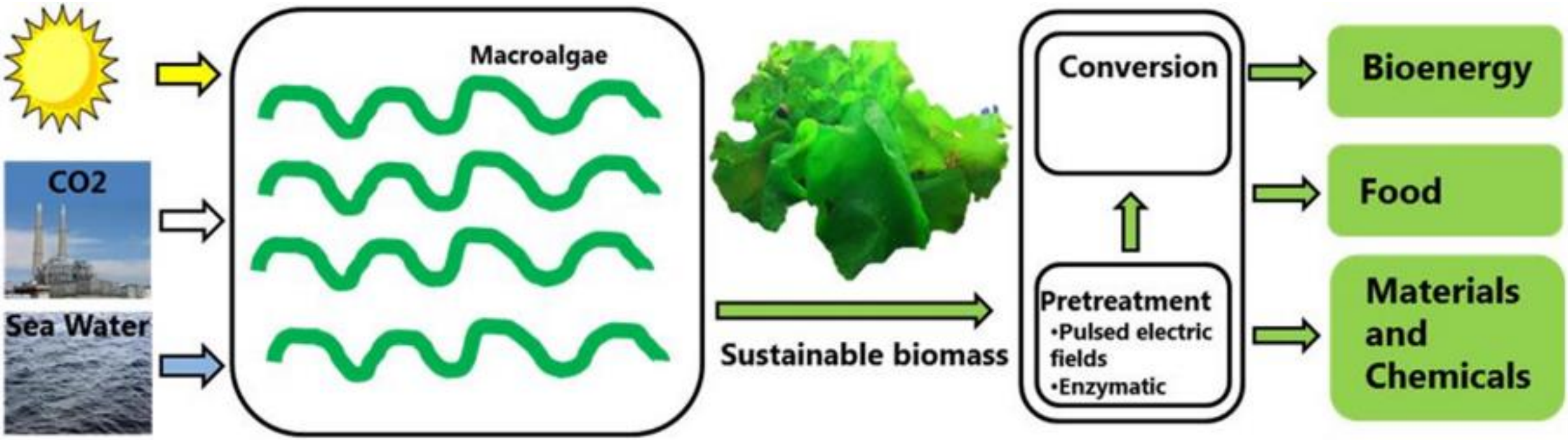
Where do we have area to grow biomass in Israel?






Macroalgae Biorefinery
Sun Light
Robotic harvesting
New Technologies
Platform chemicals
Jobs
Platform chemicals
Food
Biofuels
CO_2
Nutrients
N
P
Mark Polikovsky

Marine Biorefinery Initiative



Local and International Collaborations

Agilent Technologies

Israel Electric

KIT
Karlsruhe Institute of Technology

jbei
Joint BioEnergy Institute

The Hebrew University of Jerusalem
Est. 1925

Los Alamos
NATIONAL LABORATORY
EST. 1943

אוניברסיטת בר-אילן
Bar-Ilan University

Israel Oceanographic & Limnological Research

מכון ויצמן למדע
WEIZMANN INSTITUTE OF SCIENCE

Coordinated research – Global examples

Norway

Netherlands

Ireland

China

Denmark

AlgaePARC research program - Wageningen

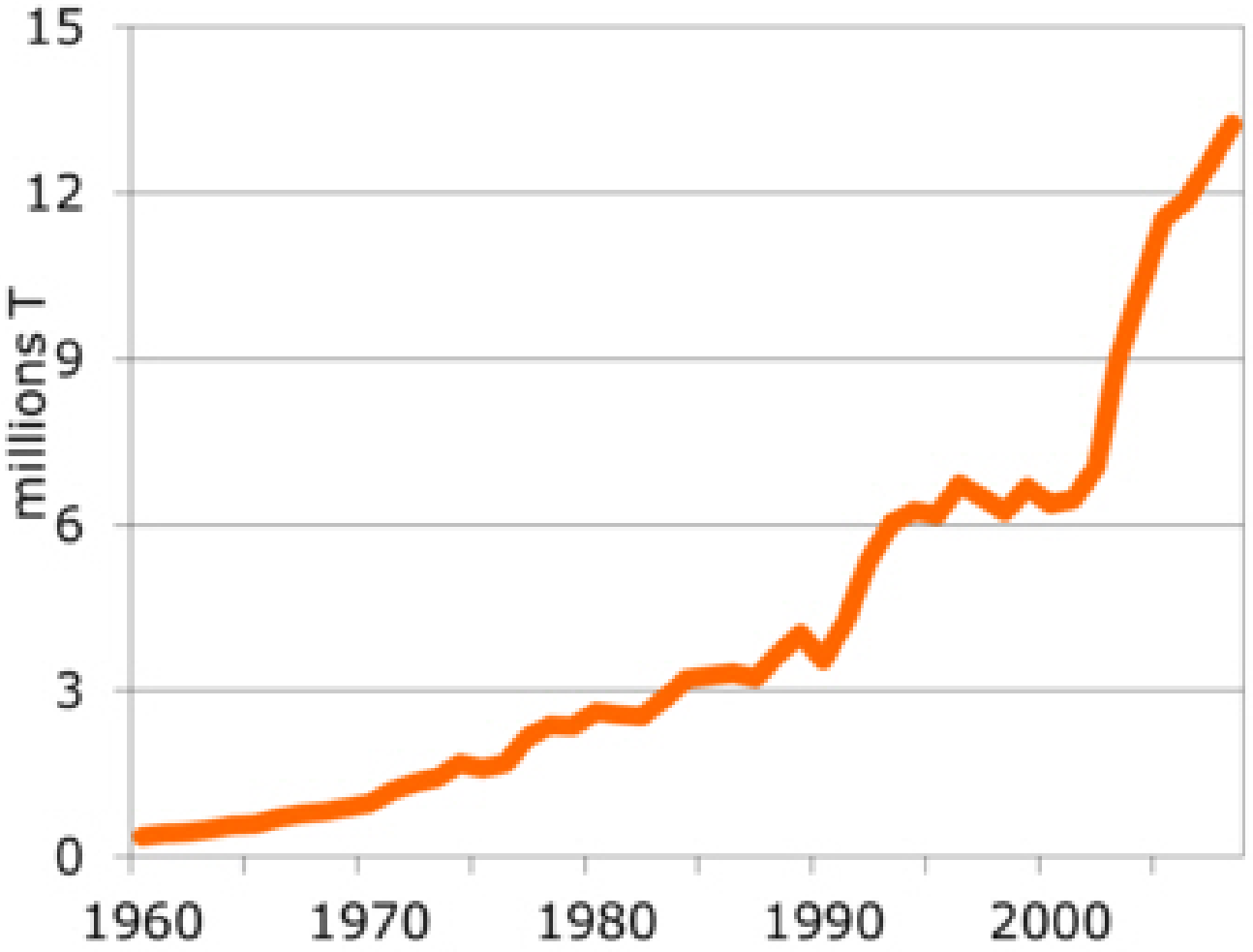
MacroBioCrude £2.3M

Horizon2020
2015-

PHYCOMORPH
Advancing Knowledge On Seaweed Growth And Development

MACROFUELS

MACRO CASCADE

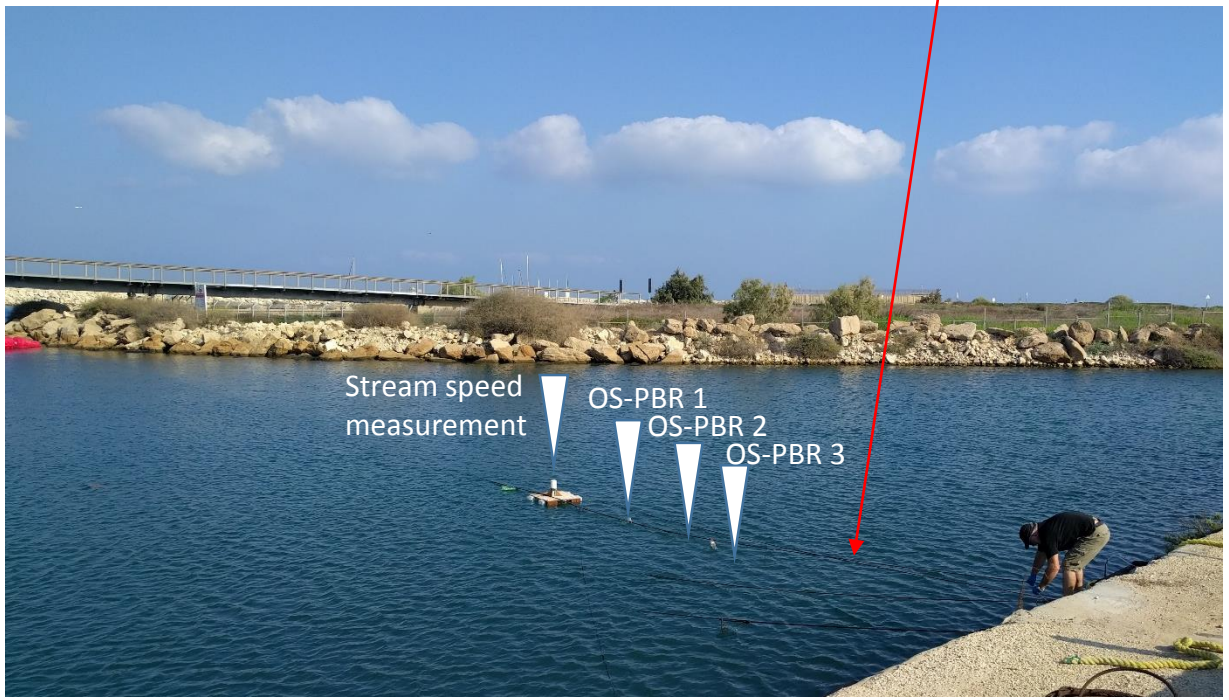


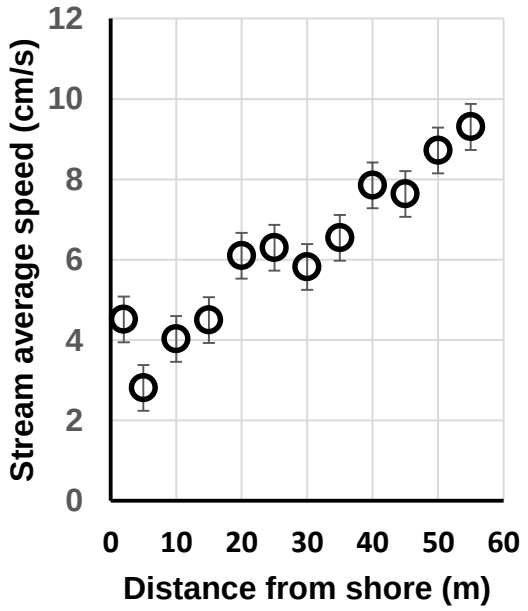
World Seaweed Production: CEVA

5 orders of magnitude less than arable biomass

Offshore macroalgae cultivation

With Alvaro Israel, Alex Liberzon Yoav Lehahn and Ilan HaKohen

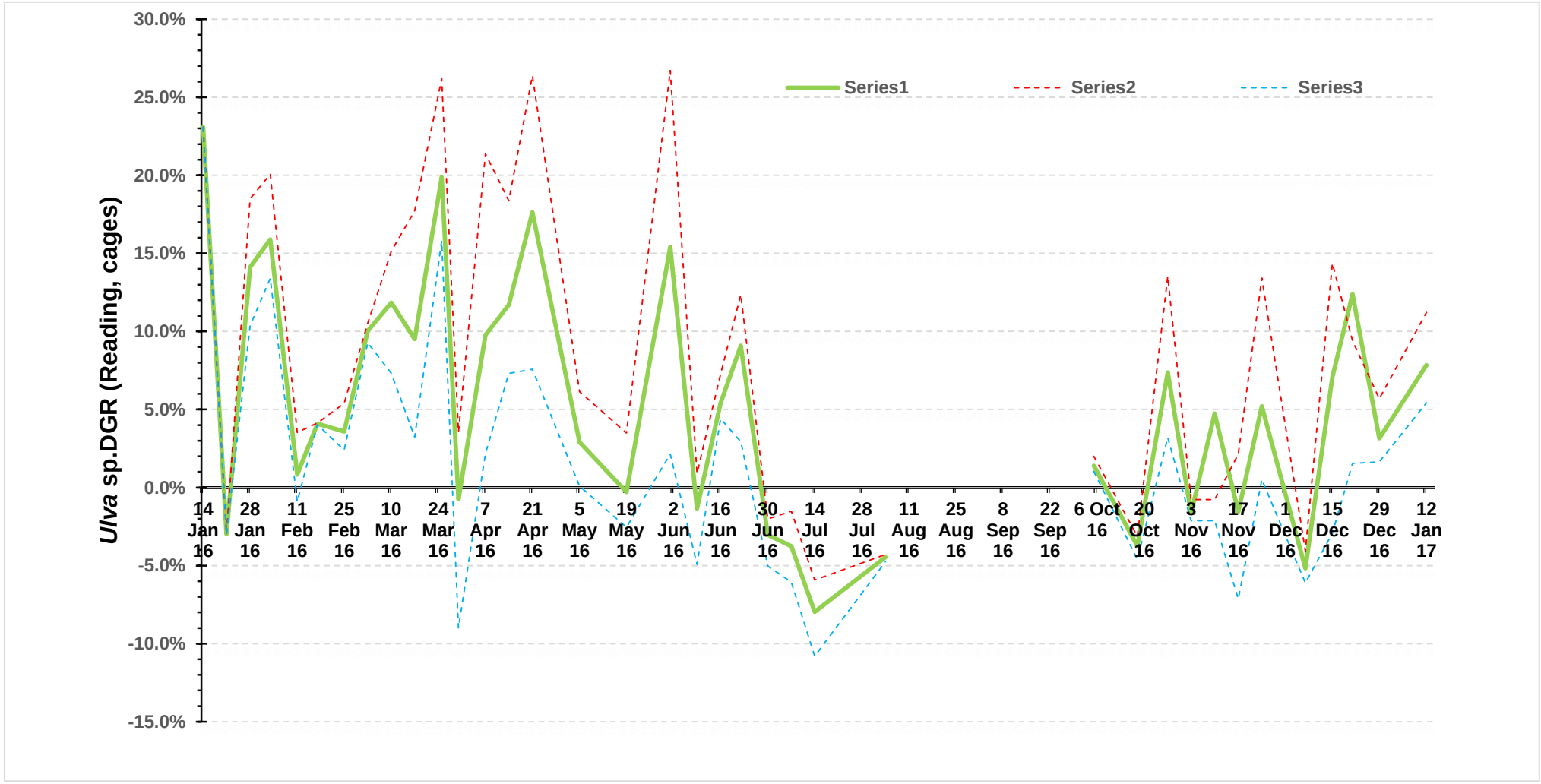




unpublished

Alex Chemodanov at IEC Reading site

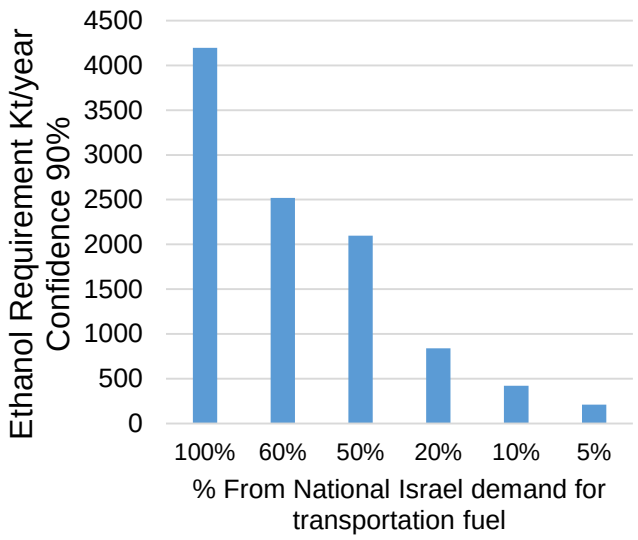
Ulva sp daily growth rates, 2016-2017

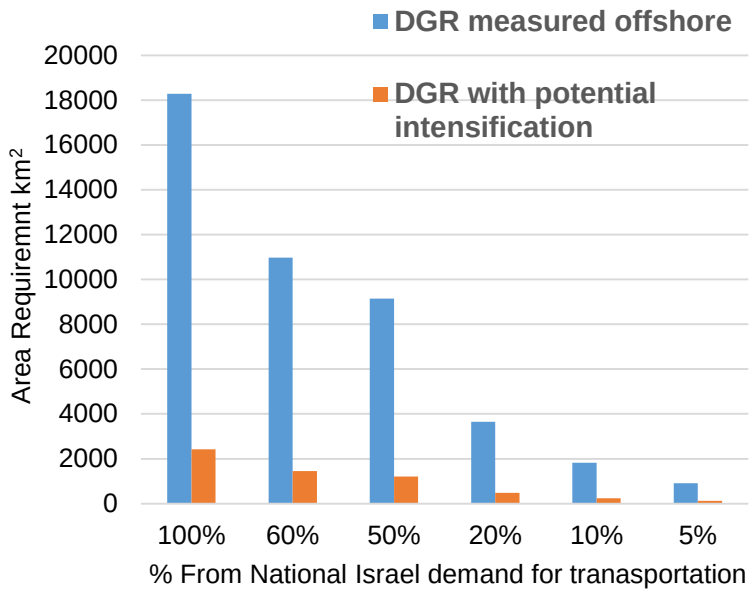


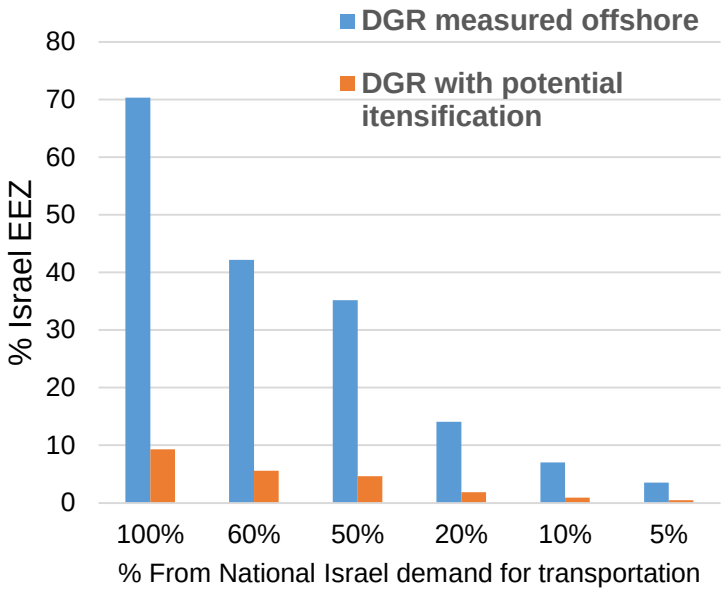
unpublished

Biofuel Crops	NPP (gr C m^{-2} $year^{-1}$)
Switchgrass	622
	624
Miscanthus	1546
	1489
Rice	631
Corn	408
	713
Wheat	378
	320
Sugar cane	1721
Food crops	613
Middle East (C4, Perennial, Leguminous and Woody)	290
Macroalgae	
Laminaria-Ascophyllum (Nova Scotia)	1900
Macrocystis (Kerguelenn archipelago)	2000
Laminaria (South-West England)	1225
Macrocystis (California)	400-820
Codium fragile (Long Island)	696-4700
Ulva sp. (Ria Formosa Lagoon (estimation))	190
Ulva compressa (Minicoy Atoll)	1460
Ulva rigida (Venice lagoon)	358
	646
Ulva sp. Reading Tel Aviv (measured). Grown in a single layer photobioreactor	838

Ulva to bioethanol in Israel



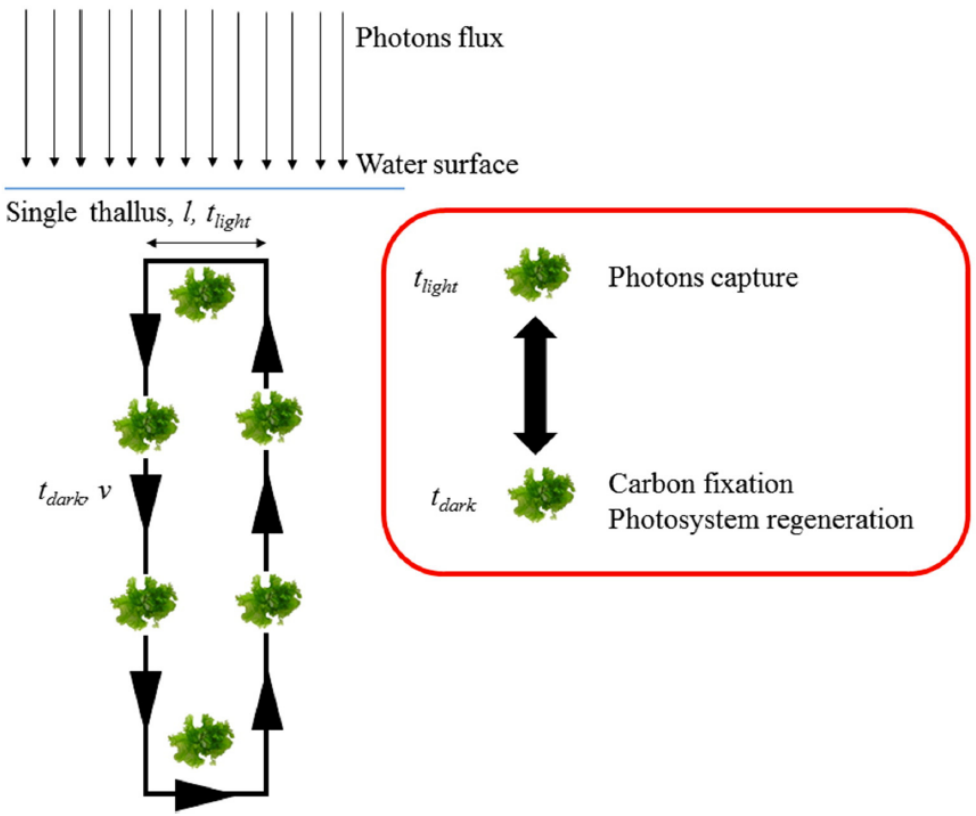




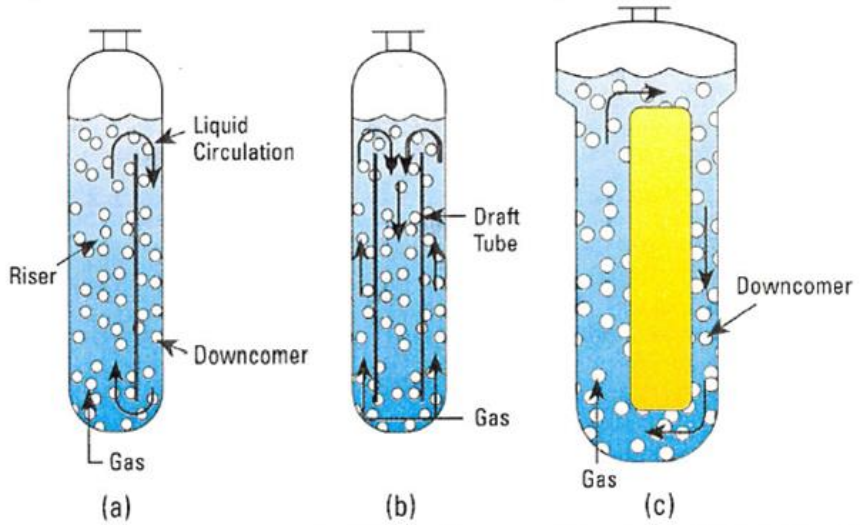
Average DGR at the sea is 4.7% and in the lab 33%

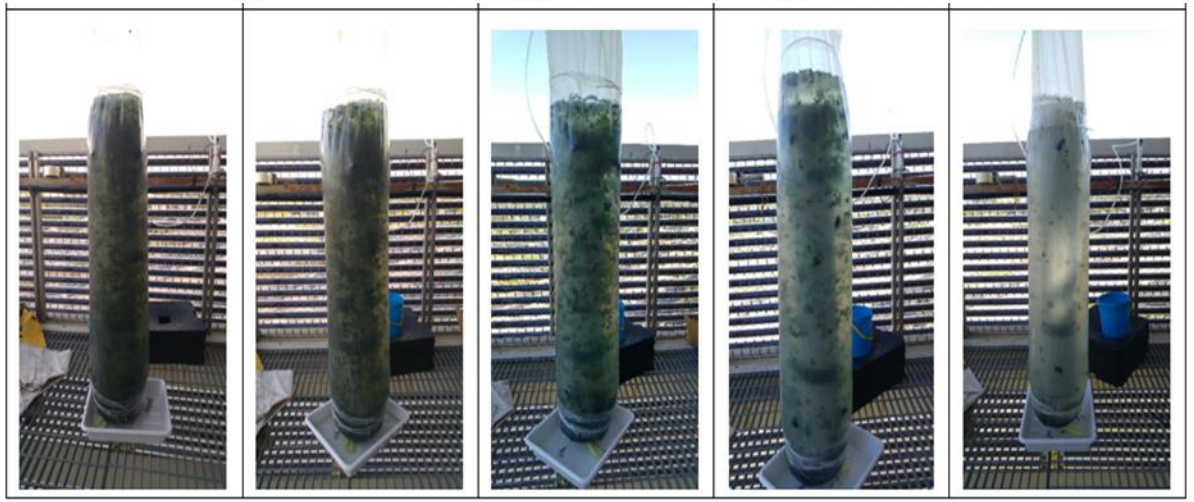
unpublished

How to intensify the growth per area?



Golberg and Liberzon Algal Research, 2015

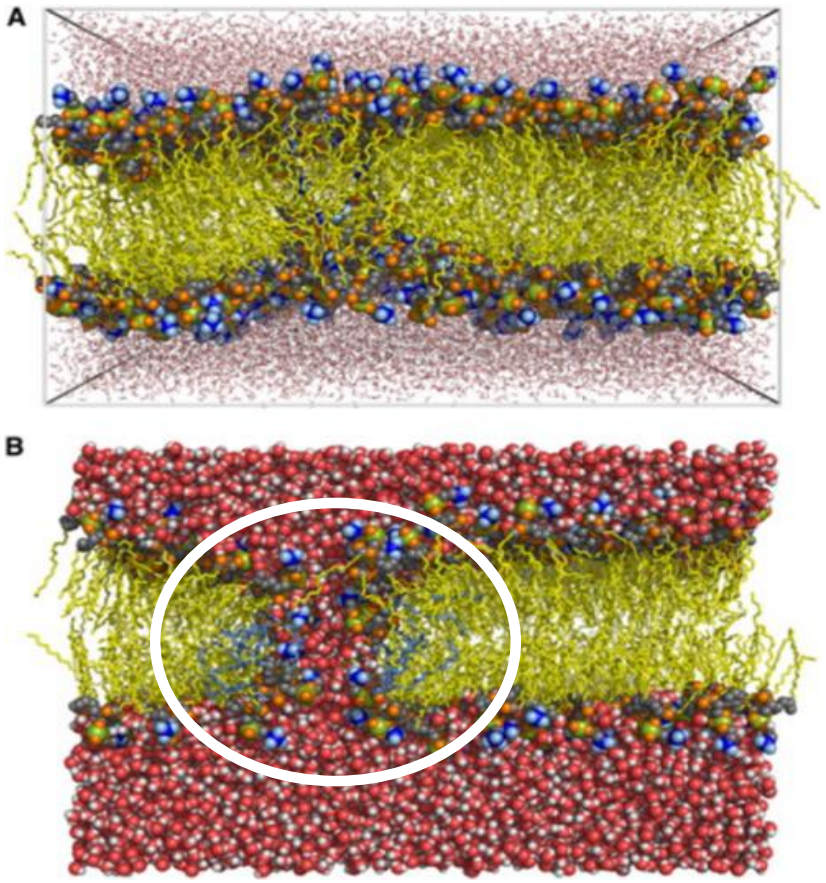




Arie Faterson, Maxim Kuzminov, Hadar Troygot

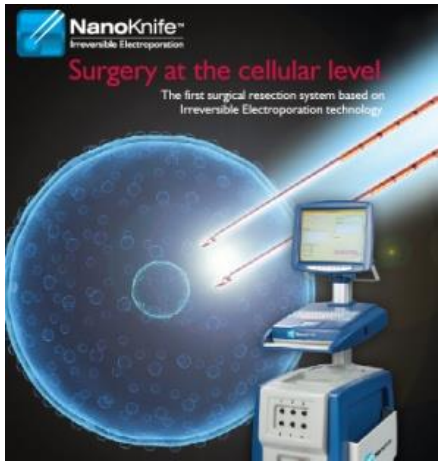
Electroporation for Processing

Cell membrane before electroporation



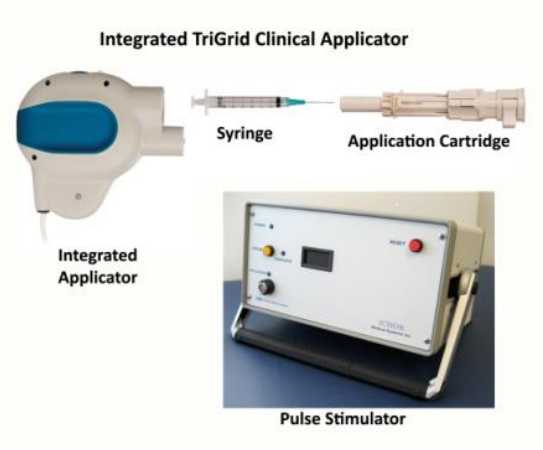
Pore at the cell membrane after electroporation

Applications in Medicine and Industry



Irreversible electroporation

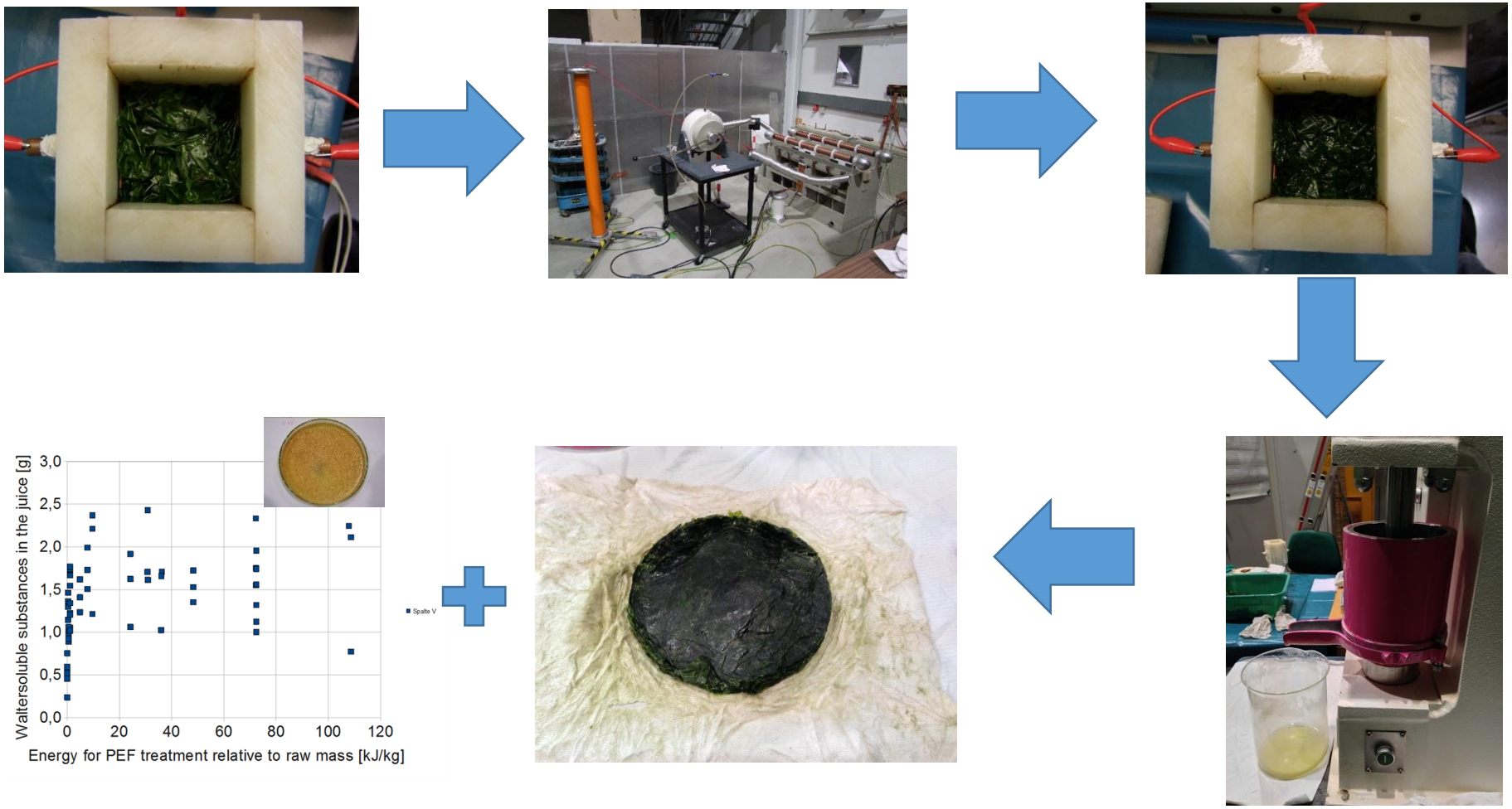
Electrochemotherapy



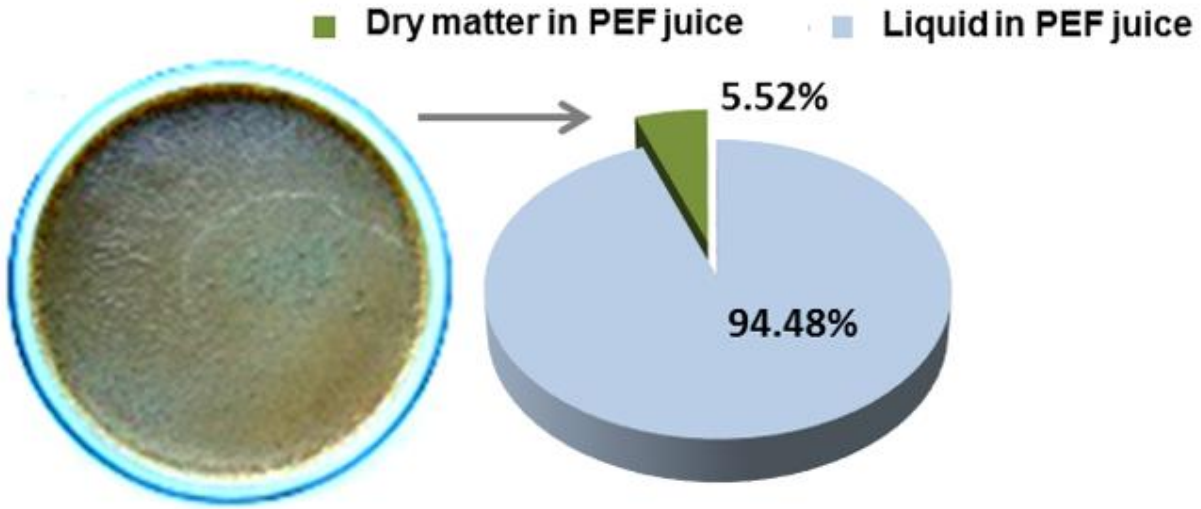
DNA vaccination

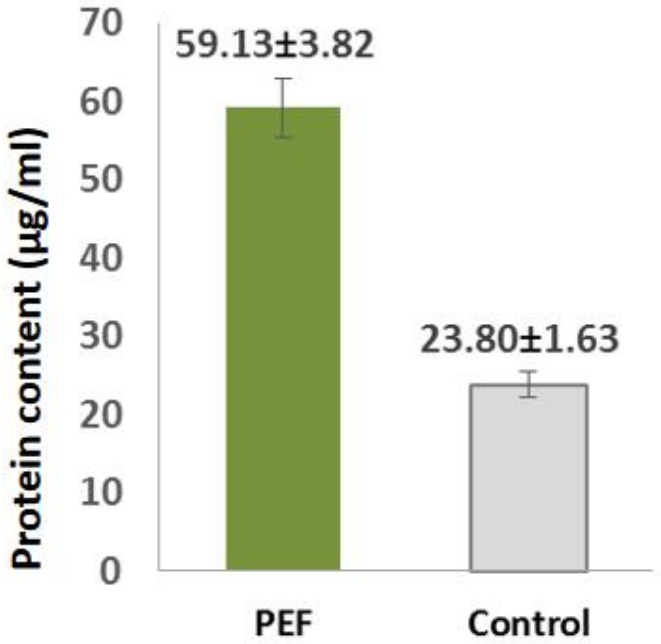
Sugar extraction

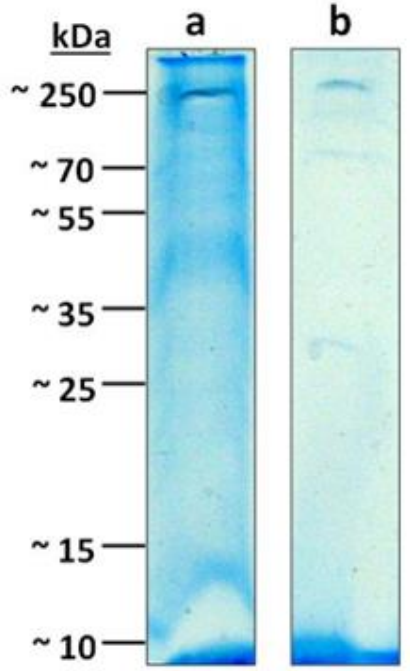
Pulsed Electric Fields System for Processing



Arthur Robin, François Fernand, Mark Polikovsky (TAU), Martin Sack (KIT)



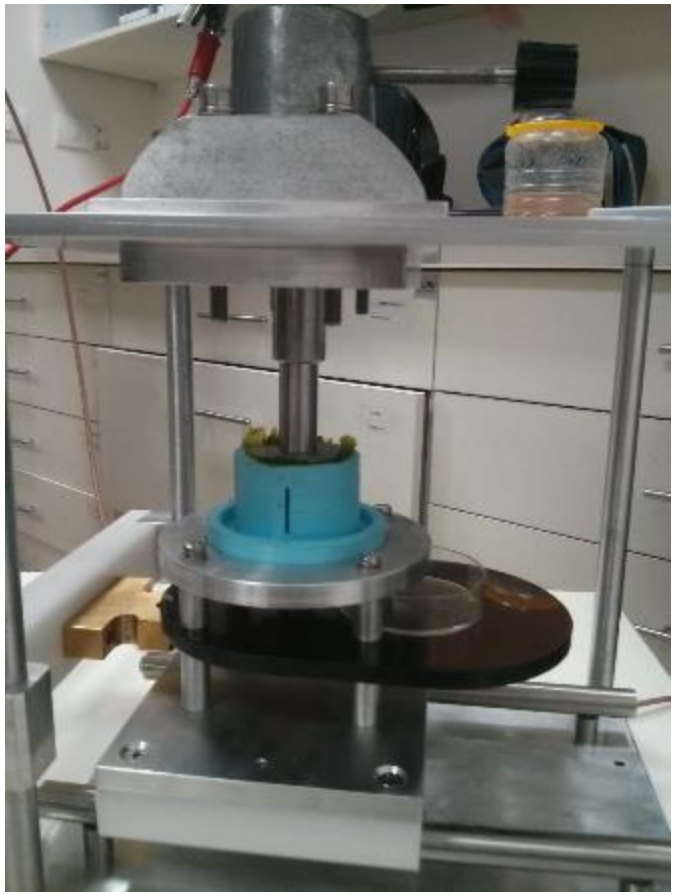


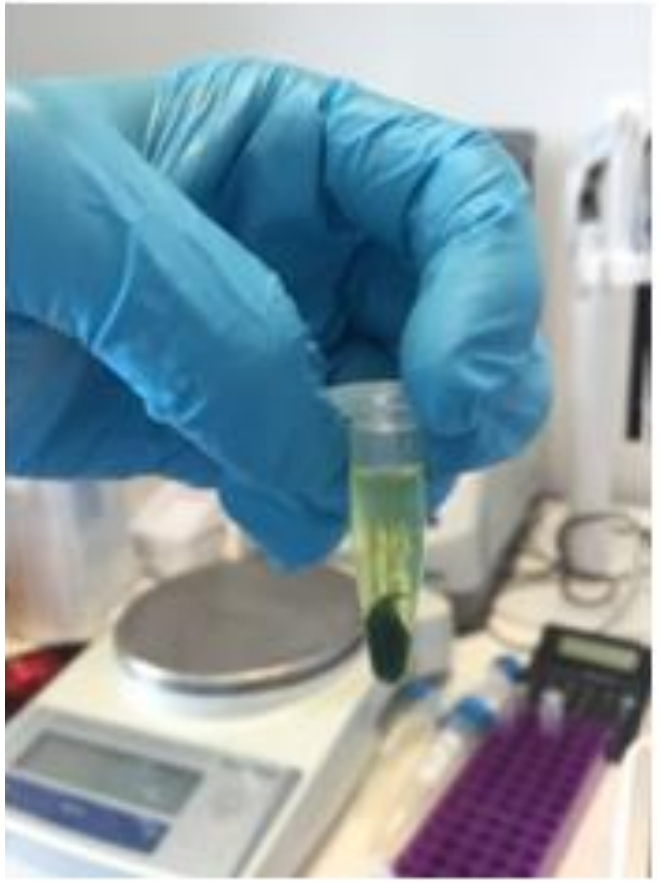


3500 V/cm, 5µs , 75 pulses at 1 Hz

Polikovsky et al IFSET 2016

Protein Extraction from Green Macroalgae

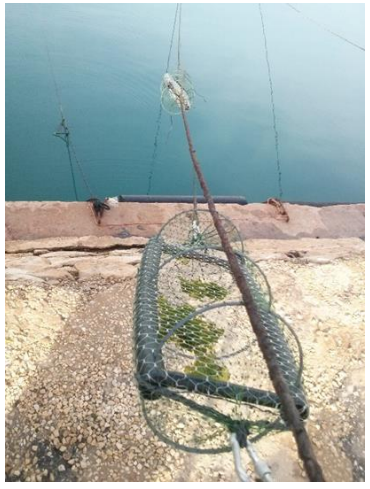


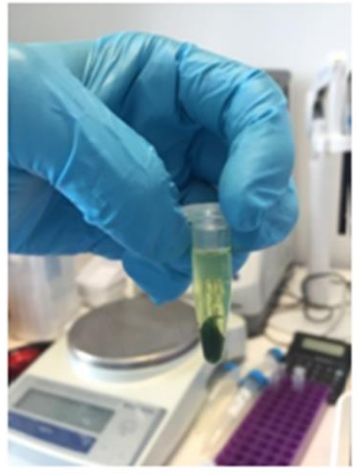


With Alvaro Israel and Yoav Livney

Jincheng Luo, Arthur Robin

The Question is How to Scale Up ?





Benefits and Implications
A balance and understanding are needed

Marine Biorefinery steering team from 2016

- Representatives from academia, public companies and 4 governmental offices (Energy, Environment, Agriculture and Prime Minister Office).
- Promoting the proof of concept study for economic production of biomass offshore as a raw material for food, chemical and biofuel industries
- Promoting the areas allocation for future offshore biomass production
- Promoting the establishment of a joint algae processing facility

Everybody is welcome to join and give an input

Current Challenges

- Long term infrastructure planning
- Offshore areas legal status
- High risk for the private sector
- Lack of basic biology and ecology knowledge and low cost technologies
- Personnel training

But very large potential to create a new industrial and knowledge infrastructure in Israel.

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Francois Fernand (TAU)
Mark Polikovsky (TAU)
Arthur Robin (TAU)
Alvaro Israel (IOLR)
Hadar Troygot (TAU)

Ministry of Infrastructure Energy and Water Resources

Ministry of Health

Innovation Authority

TAU Center for Innovation in Transportation