超臨界水氧化技術在有機廢棄物處理之原理與應用

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WRP TECHNOLOGY

Organic Wastes – **Recycling Methods**

Method	Place - process	Description	Problems
Landfilling	garbage fields, agricultural land	Slow process	GHG / water pollution
		Costly for some areas	
Biological	biogas plants, composting	Slow process	GHG / water pollution
		Costly	Large residue
Physical-chemical	incineration, gasification, pyrolysis	Fast, effective	Toxic wastes / GHG / water pollution
		Costly	
Chemical	chemical treatment with further landfilling	Fast, effective	Toxic wastes / GHG / water pollution
		Costly	

Key issues:

- Low economic efficiency
- Pollution

WRP Technology

Eco-Fiendly and **Cost Effective Technology** (WRP – waste recycling plant):

- Making OW less toxic / harmful, preventing environmental pollution;
- Producing valuable marketable products.

Thermo-chemical method:

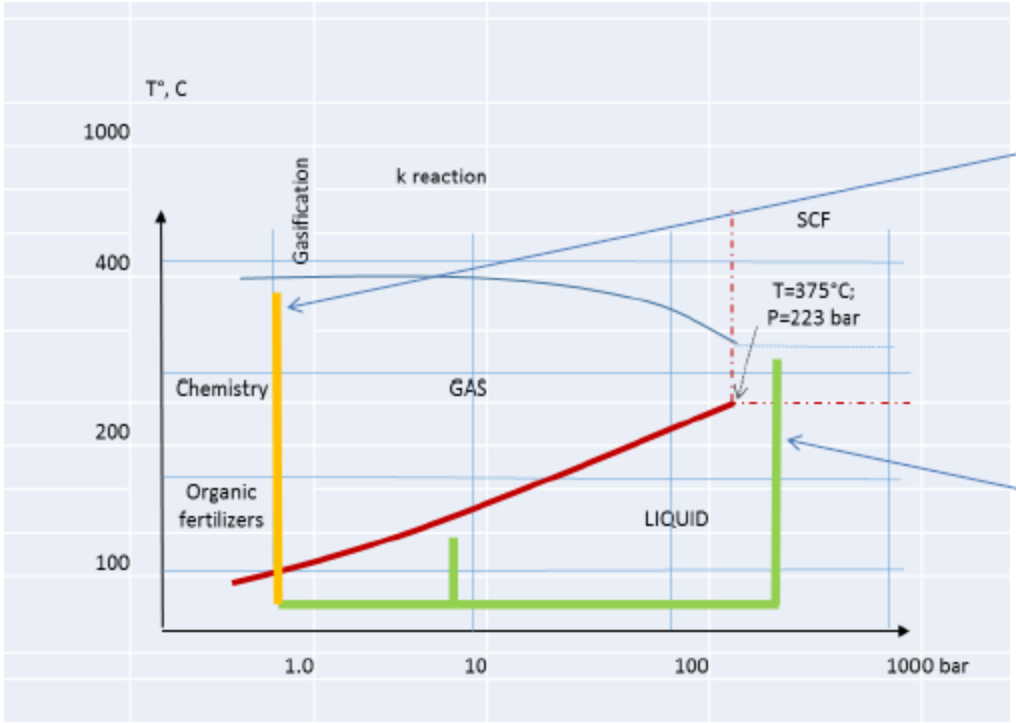
- High temperature and high pressure;
- No toxic / harmful wastes.

Type of thermo-chemical processes:

- SCWO (supercritical water oxidation);
- Thermolysis (in supercritical conditions).

WRP: waste recycling plant
OW: organic wastes

THERMAL CYCLE DIAGRAMS



Current SCWO methods
(yellow line)

Proposed Method
(green line)

超臨界水氧化技術簡介

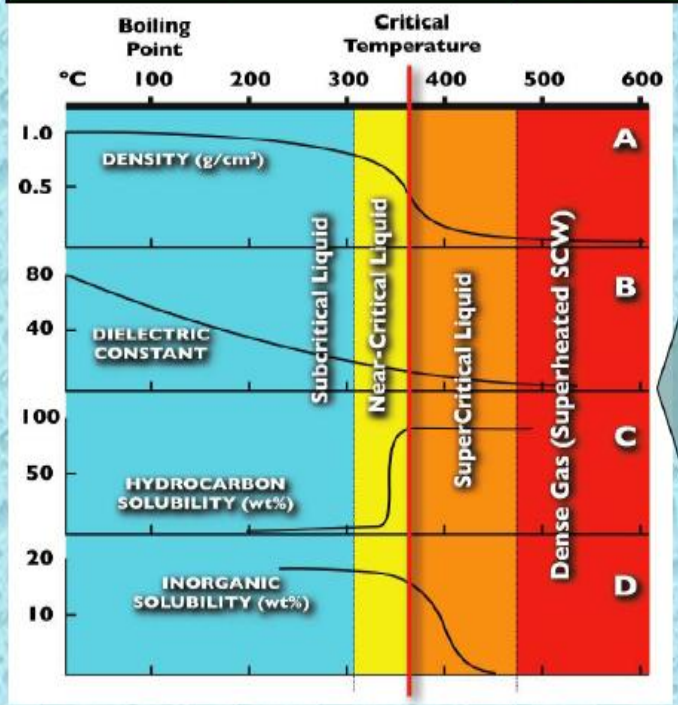
It`s very interesting & promising because:
- it`s good for Nature
- it`s good for People
- it`s economically feasible
- it`s the way to the Future

All type of wet Biomass:
- *sewage sludge*
- *toxic wastes*
- *MSW*
- *animal wastes*
- *micro-algae*

SCW – conversion to:

Clean Gas Fuel for Energy:
- **Hydrogen (H_2)**
- **Methane (CH_4 & C_2+)**
- **CO_2**
- **fertilizer (N:P:K)**
- **clean water**

CO_2+ fertilizers → used for algae growth

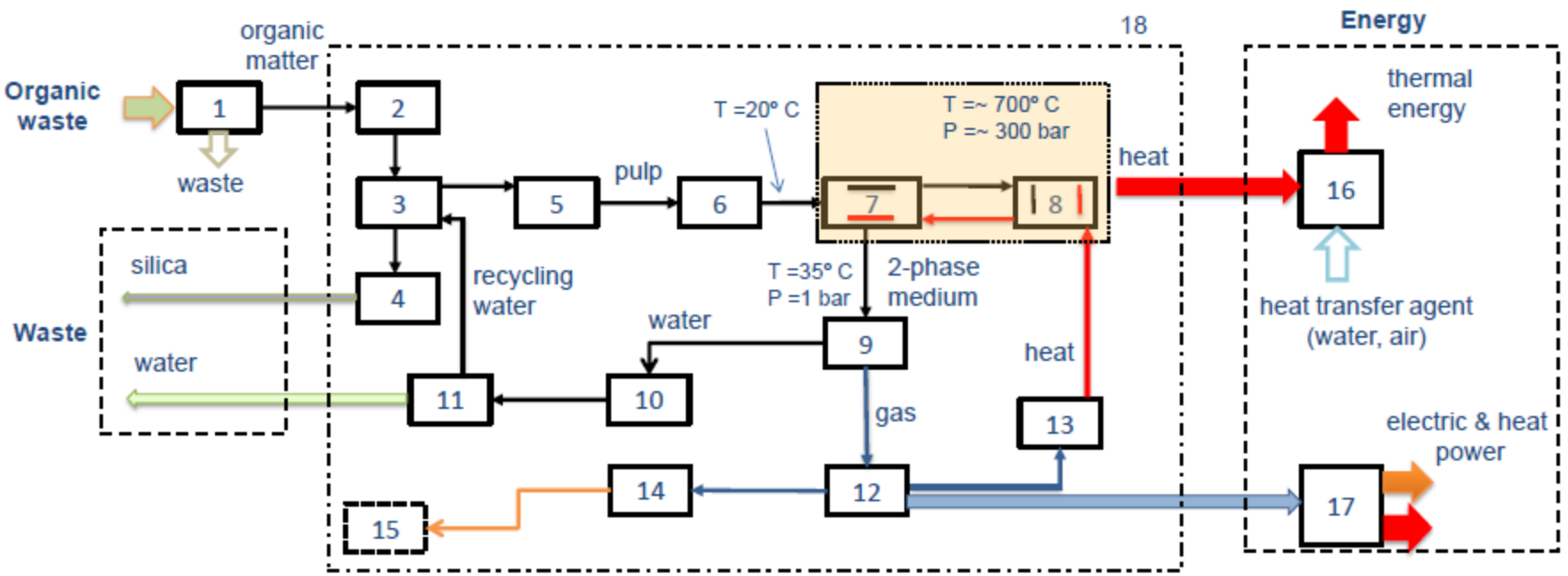


It`s the way to income generation from waste!

How does it work?

It`s the main physical reasons for:
- the dissolution of biomass in the water
- the conversion of biomass into gas
- mixing the gas with water vapor
- the salt precipitation in the residue

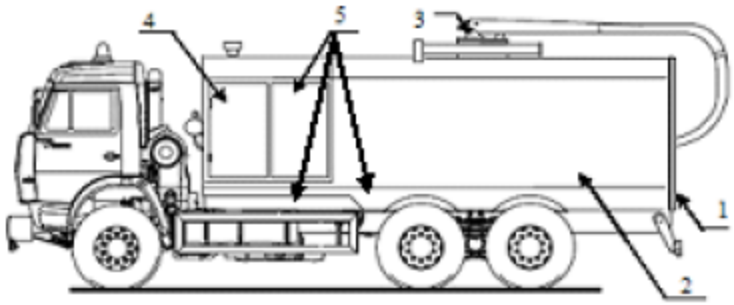
Waste to Energy - **Process Diagram**



Hardware specification:
1-filter (separator); 2-shredder; 3-hydro-separator; 4-screw; 5-macerator; 6-pump; 7-heat-exchanger; 8-superheater; 9-gas separator; 10-pressure regulator; 11-controller (supply of recycled water); 12-gas-cylinders ramp; 13-burner; 14-internal power unit; 15-system automation; 16-heat exchanger; 17-external power unit (CHP); 18 Autonomous technological WRP complex.

Mobile Solution

Parameter	Description
Production capacity	25 - 2,500 ton per day
Depth of recycling	100%
Methods	decontamination, gasification
Processing time	30 min.
Payback	1.5 – 2.5 y.
Dimensions	20 – 40 ft. container, modular, mobile
Environment	no GHG or toxins released



Mobile TC system:

1. Waste collector.
2. Reservoir for technical water.
3. Waste feeding system.
4. Thermo-chemical reactor (TK).
5. Hydro, air, electric and control systems.

PROJECT STATUS

Gasification – **Lab Testing**

Temperature control

Recycling of sewage sludge (98% wet)

Production of the mix of flammable gases

Processing time – 7 min.

Production capacity – 20 litres / hr.

Site: Noginsk (sewage sludge), Russia, June 2016.

SCWO machine demonstration video (1/2)

- Temperature: 600-650 °C
- Pressure: 250-270 bar (about 247-266 atm)
- Production capacity: 20L/hr
- Processing time: 7 min
- 1 m^3/hr sewage sludge (90% humidity)
- 49 m^3 gas mixture => 1500 MJ => 400 kWh th.

(1 MJ= 0.28 kWh = 0.009 therm; 1 kWh = 0.034 therm)

SCWO machine demonstration video (2/2)

- **Input: sewage sludge**
  - 1 kg organic matter (dry weight)

- **Output (by weight):**
  - 51%: O_2
  - 49%: organic matter (w/o O_2)
    - Methane (40-60%), ethane (20-30%), propane (10-15%), and H2 (5-15%)
    - Solid residue ???

Gasification – **Lab Testing**

With Proffessor FU, Chao-Ming, Dr. Sci.
Director, Taipei-Moscow Economic and Cultural Coordination Commission

With Clients from Dmitrov Administration, Moscow region
Waste water treatment Plant

R&D Partners

- Russian Academy of Engineering (www.rae-info.ru)
- Industrial enterprise of JSC «TVEL» (www.twel.ru - «ROSATOM»)
- Tech Experts from FSC IPPE (www.ippe.ru - «ROSATOM»)
- N.D.Zelinsky Institute of Organic Chemistry RAS (www.zioc.ru)
- NRC «Kurchatov Institute» (www.eng.nrcki.ru)
- JSC «Giprogasoochistka» (www.ggo.ru)
- HSU MIPT (www.mipt.ru), MEPHI (www.mephi.ru)
- BMSTU (www.bmstu.ru)
- Lomonosov MSU (www.msu.ru), Gubkin RSU (www.en.gubkin.ru)

BUSINESS OPPORTUNITY

Target Markets

Annual Global Markets: Waste-to-Energy - **$30 b.** (*)

Sterilization - **$ 2 b.**

Market	Market size, m. ton / year (min)	Total Global Market WRP systems (80,000 ton/y each)
The CIS countries	90	1,300
USA	440	6,700
Europe	650	10,000
Asia	900	14,000

* https://www.irena.org/DocumentDownloads/Publications/RE_Technologies_Cost_Analysis-BIOMASS.pdf

Competitive Landscape

Waste recycling methods - **Economics**

Type of technology	CAPEX, USD/kW, installed capacity	Fixed O&M (% of installed cost)	Variable O&M (USD/MWh)	Levelised cost of electricity generation over system lifetime (LCOE)
Stokers / BFB / CFC boilers	2,000 - 4,500	3.2 – 4.2	3.8 – 4.7	0.07 - 0.21
Gasifier	2,200 - 5,800	3.0 – 6.0	3.7	0.07 - 0.24
Anaerobic Digester	2,700 - 6,400	2.1 – 7.0	3.7	0.06 - 0.14
Landfill gas	2,100 - 2,700	11 – 20	4.2	0.09 - 0.12
WRP technology	1,700 - 2,500	3.0 – 4.5	2.5	**0.04 - 0.05**

source: https://www.irena.org/DocumentDownloads/Publications/RE_Technologies_Cost_Analysis-BIOMASS.pdf - Figure 6.2

Project Milestones

Stage	Technology readiness level (TRL)*	Timeline	Required Investments
Experimental prototype	TRL 4: Technology validated in lab	completed	-
Industrial prototype	TRL 7: System prototype demonstration in operational environment	9-12 mo.	$1.2 m.
Actual system	TRL 9: Actual system proven in operational environment (competitive manufacturing)	9-12 mo.	- - **

* Technology readiness level - https://en.wikipedia.org/wiki/Technology_readiness_level

** To be defined with strategic partner

Financials (5 y.)

Production capacity **- 80,000 m3/year**

- IRR - 80%
- NPV - $20 m.
- Required Investment - $3.0 m.

For customers:

- Payback - 2.1 y.

$ million	1 year				2 year				3 year	4 year	5 year
	I	II	III	IV	I	II	III	IV			
Revenue											
Number of units sold					1	2	3	4	18	30	45
Revenue					$ 1.80	$ 3.60	$ 5.40	$ 7.20	$ 32.40	$ 54.00	$ 81.00
COGS	$ 1.00	$ 0.30			$ 0.99	$ 1.98	$ 2.97	$ 3.96	$ 17.82	$ 29.70	$ 44.55
Gross profit	$ (1.00)	$ (0.30)	$ -	$ -	$ 0.81	$ 1.62	$ 2.43	$ 3.24	$ 14.58	$ 24.30	$ 36.45
Expenses											
Operational expenses	$ 0.10	$ 0.10	$ 0.10	$ 0.10	$ 0.30	$ 0.30	$ 0.30	$ 0.30	$ 3.00	$ 5.50	$ 7.50
Payroll	$ 0.15	$ 0.15	$ 0.15	$ 0.15	$ 0.25	$ 0.25	$ 0.25	$ 0.25	$ 2.00	$ 2.70	$ 3.00
R&D	$ 0.08	$ 0.08	$ 0.08	$ 0.08	$ 0.15	$ 0.15	$ 0.15	$ 0.15	$ 1.20	$ 2.00	$ 2.50
Overhead expense	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.15	$ 0.15	$ 0.15	$ 0.15	$ 1.00	$ 1.50	$ 2.00
Expenses total	$ 0.38	$ 0.38	$ 0.38	$ 0.38	$ 0.85	$ 0.85	$ 0.85	$ 0.85	$ 7.20	$ 11.70	$ 15.00
EBITDA	$ (1.38)	$ (0.68)	$ (0.38)	$ (0.38)	$ (0.04)	$ 0.77	$ 1.58	$ 2.39	$ 7.38	$ 12.60	$ 21.45
Cash flow	$ (1.38)	$ (2.06)	$ (2.44)	$ (2.82)	$ (2.86)	$ (2.09)	$ (0.51)	$ 1.88	$ 9.26	$ 21.86	$ 43.31

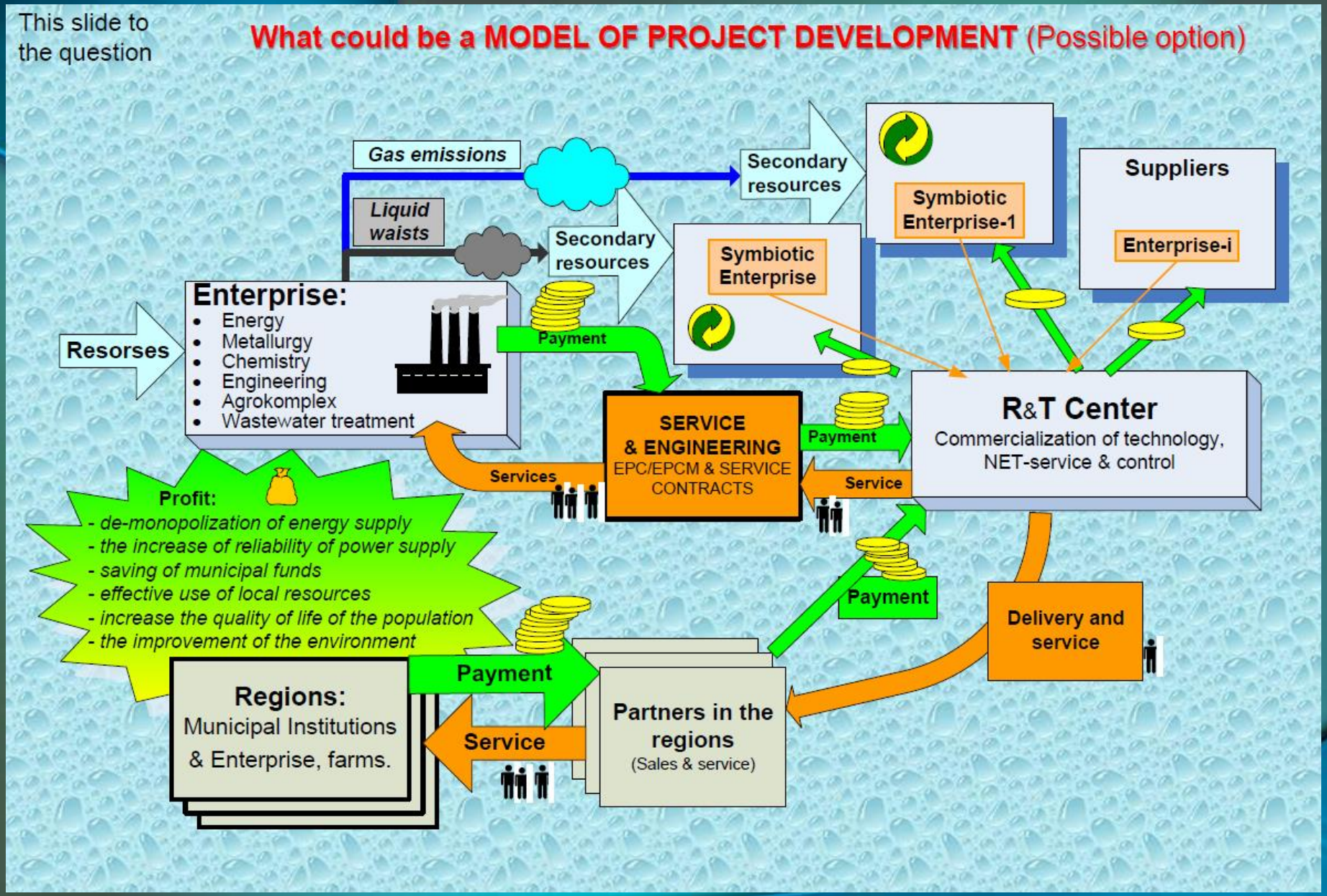
Decontamination - **Pilot Plant Testing**

- Decontamination of swine manure (150 C)
- Processing time – 15 min.
- Production of sterile organic fertilizers
- Production capacity - 50 m3/d

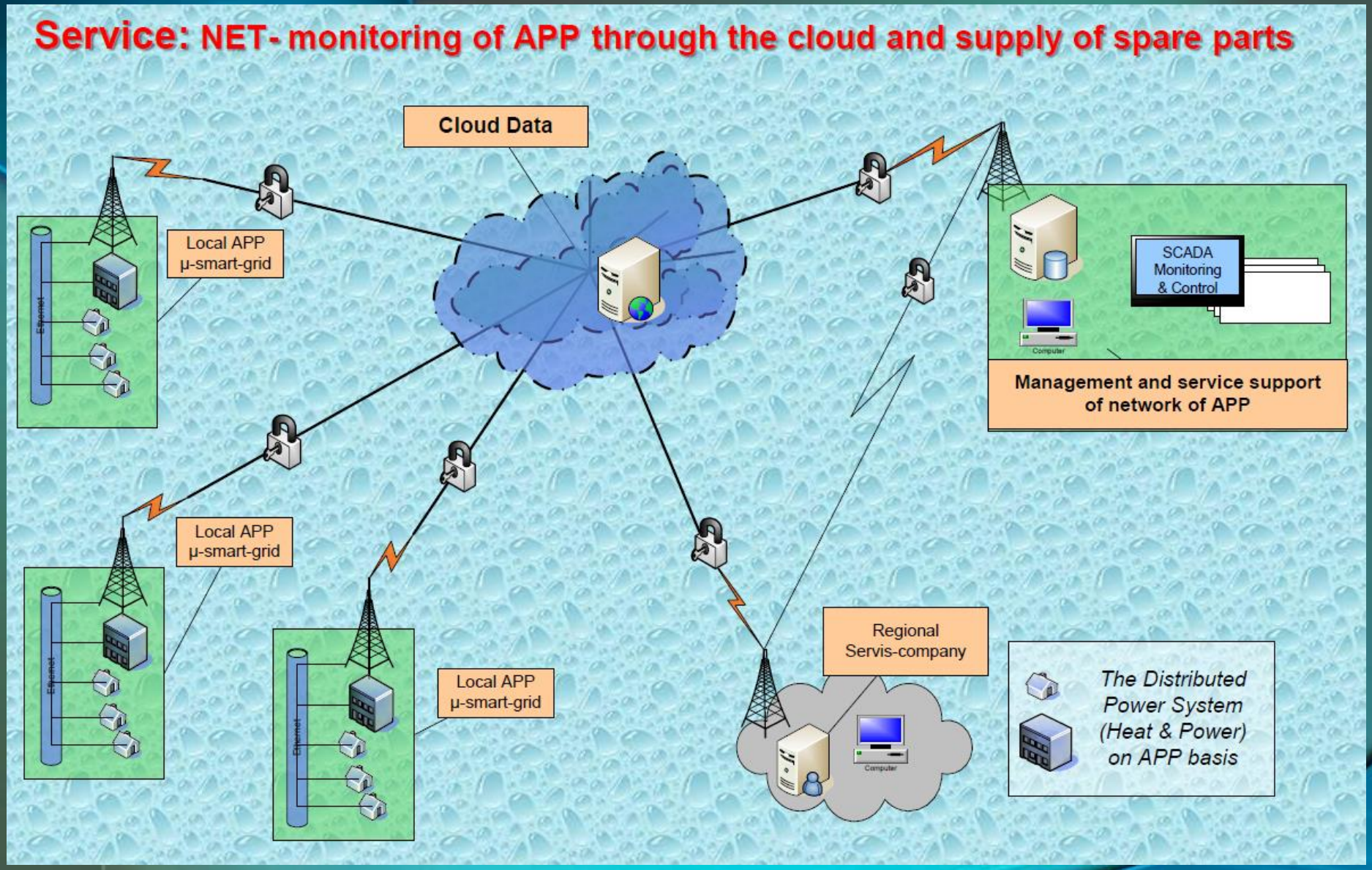
Site: Pig farm, Izhevsk region, Udmurdia, Russia.

This slide to the question

What could be a MODEL OF PROJECT DEVELOPMENT (Possible option)



Service: NET- monitoring of APP through the cloud and supply of spare parts



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台俄SCWO技術設備合作洽談

(2017.8.4 台北莫斯科經濟文化協調委員會代表處會議室)

Prof. Sergey Paskin (left), Dr. Alexander Okunev (middle), and Prof. Jung-Jeng Su (right)

Taiwan-Russian SCWO technology business outline

1. Small scale demonstration SCWO machine (25 t/d): by December, 2017
2. Large scale demonstration SCWO machine (500 t/d): by April, 2018
3. High pressure pump request from Taiwan: ~300 bar (30MPa) pressure pump
4. Automation of SCWO machine operation: PLC/IoT work frame
5. Investment request from Taiwan
6. Target feedstock for SCWO machine in Taiwan: biological sludge from wastewater treatment plants, organic solvent, pig hair, chicken feather, and so on.
7. SCWO machine is planning to be made in Taiwan and exported to Russia and the other countries.

敬請指教