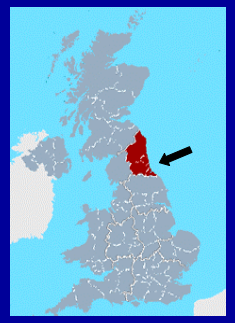
CLEMANCE
Clean
Environment
Management
Centre

BioReGen



Reusing Brownfield Sites for Energy Crops

Dr Richard Lord

wrap
Material change for a better environment

UNIVERSITY OF TEESSIDE

CLEMANCE is part funded by the European Regional Development Fund

IPC-EAPW, Montreal 5-6-07

CLEMANCE
Clean
Environment
Management
Centre

What is BioReGen?

Biomass
Remediation
(Re)**Gen**eration

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean Environment Management Centre

Project overview

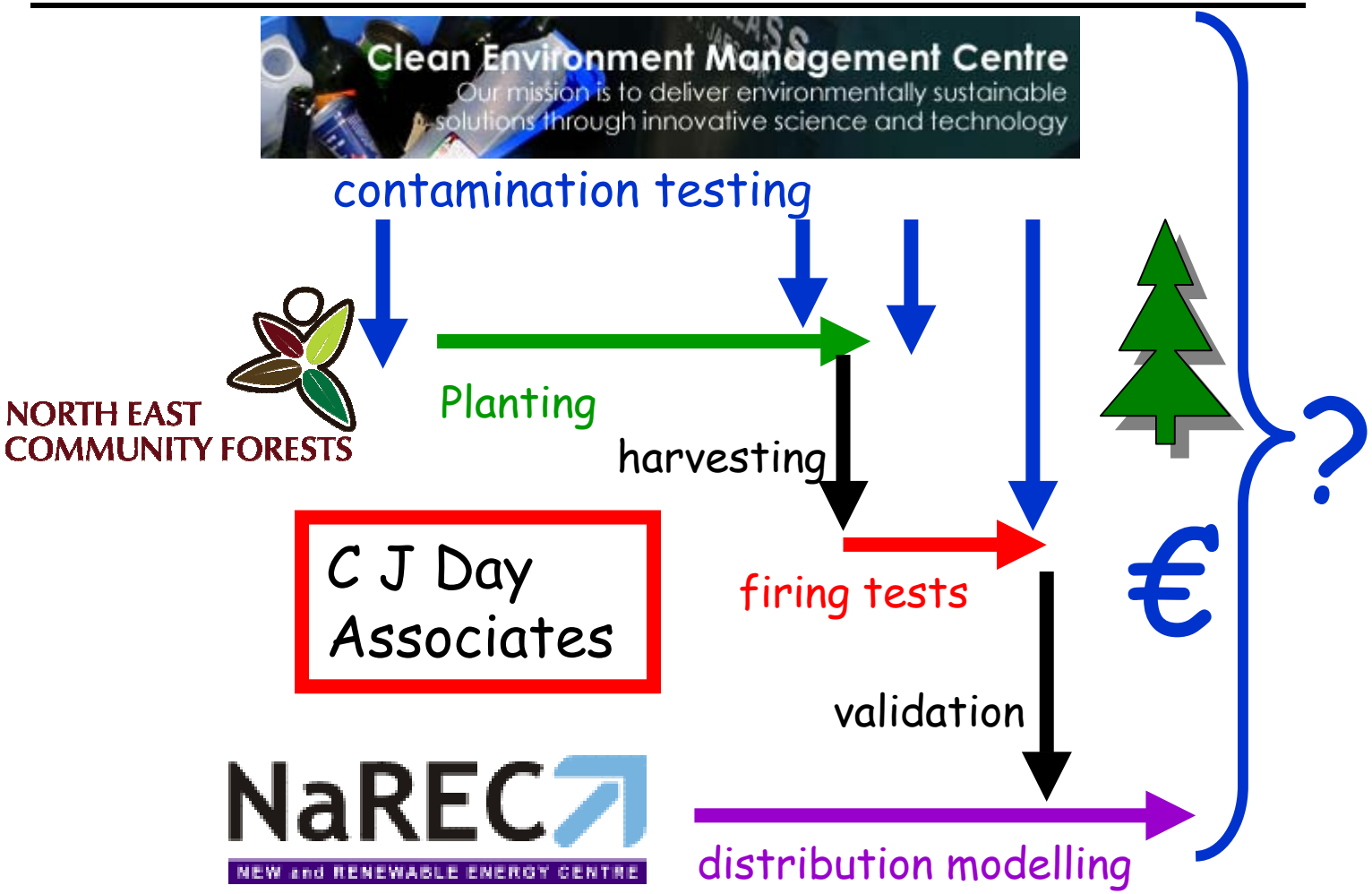
- Choose ten 1 ha brownfield sites
- Plant, maintain & harvest four energy crops
  Willow SRC, Miscanthus, Reed Canary Grass, Switchgrass

- Full scale firing tests using each fuel/site
- Assess contamination of soil & water (before & after planting), plant parts, fuel, ash, air polution control residues
- Validate model of embedded generation for biomass CHP

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean Environment Management Centre

Project partners



UNIVERSITY OF TEESSIDE

CLEMANCE
Clean Environment Management Centre

Why BioReGen?

- ***Renewables*** - Renewable energy from biomass fuel without displacing food production
- ***Diversion*** - Biodegradable waste used as compost amendments (e.g. 500t/ha), reduces CH_4 emissions
- ***Restoration*** - Reuse for energy crops restores derelict land with income from biomass fuel
- ***Bioremediation*** - In situ degradation via aerobic microbial action during plant growth
- ***Sequestration*** - Stabilization of contaminants from soil improvement, carbon & metals fixed in rhizomes
- ***Phytoremediation*** - Removal of metals, via plant uptake/folial dust, capture in ash or air-pollution control residues, recovery or safe disposal
- ***Regeneration*** – Supports local economic regeneration of post-industrial areas through renewable power generation, without energy-, waste- & resource-intensive costs of conventional remediation methods

UNIVERSITY OF TEESSIDE

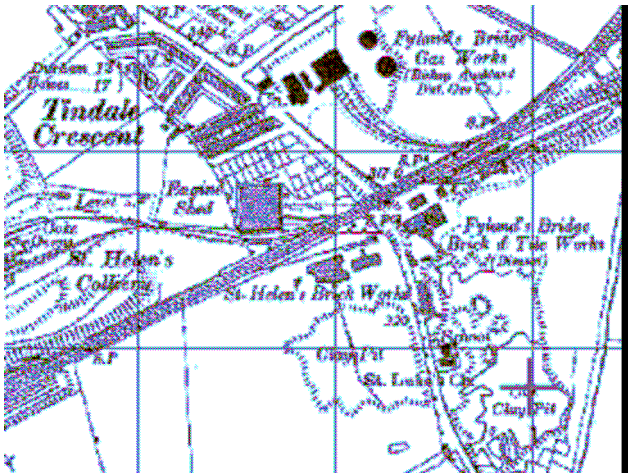
Key questions:-

- Does it grow?
  (a "killer" assumption!)

- Is the biomass fuel contaminated?
  (Is it phyto-remediation or just a contaminated land management strategy?)

CLEMANCE
Clean Environment Management Centre

Pilot site-Fyland's Bridge



- Former brick clay pit
- Coal ash, privy waste, incinerator ash infill (up to 3.5m)
- Potentially phytotoxic & contaminated (>SGVs #)

Zn 400-1000 ppm (300*),
Cu 100-500 ppm (130*),
Ni 100-200 ppm (70*),

Pb 300-2000 ppm (450#),
As 50-200 ppm (20#)

UK Soil Guideline Values with plant uptake

*ICRCL plant use trigger values (withdrawn)

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean
Environment
Management
Centre

Pilot site - August '04

- Eight 7.5 x 6 m sub-plots (unamended, unfenced!)
- Willow establishent 98% but die-back on most contaminated plot after rabbit grazing
- Miscanthus establishment 64-83%, no rabbit damage!
- Reed Canary Grass 90% but cropped by rabbits
- Switchgrass ≤ 90%, destroyed by rabbits
- Mulched 750t/ha

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean
Environment
Management
Centre

Mulching by NE Community Forest's New Deal workforce

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean Environment Management Centre

Pilot site August '05

- Rabbit fenced!
- Willow establishment now 81% & 24 % (re-growth on "dead" plot)
- Miscanthus 80-85 % survival rate
- Reed Canary Grass 85-90 %, with seed heads
- Some Switchgrass ??

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean
Environment
Management
Centre

Pilot site Aug 06

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean
Environment
Management
Centre

Willow SRC

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean
Environment
Management
Centre

Miscanthus

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean
Environment
Management
Centre

Reed Canary Grass

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean
Environment
Management
Centre

Switchgrass?

UNIVERSITY OF TEESSIDE

Key question 1:-

- Does it grow?
  (a "killer" assumption!)

Yes, but-

- **Some species more/less tolerant to contamination**
- **Good agricultural practice must be followed, especially weed control & rabbit protection.**

CLEMANCE
Clean
Environment
Management
Centre

Fuel harvest Mar '06

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean Environment Management Centre

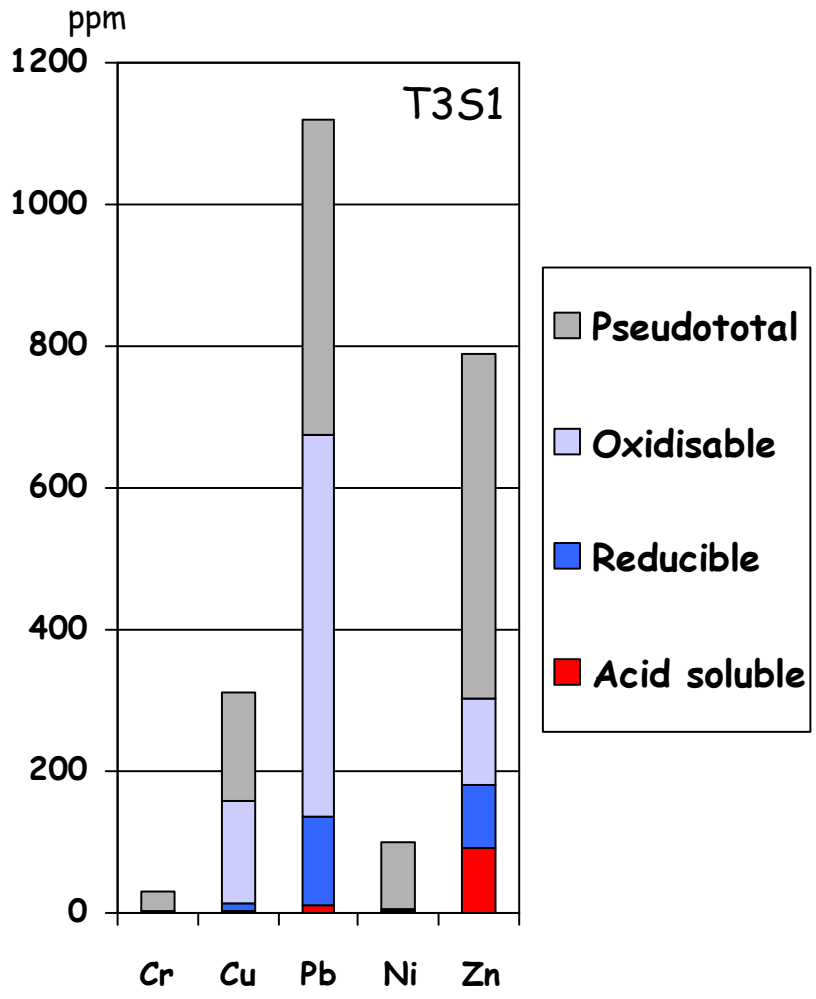
Biomass fuel analysis

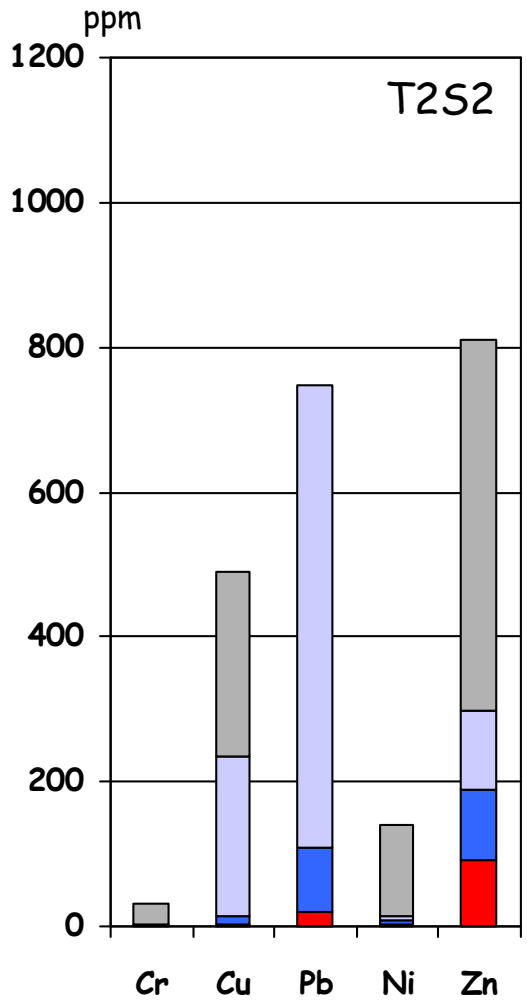
	Soil (2007) (av. 8)	Miscanthus ('05-'06)	Reed Canary Grass '05-'6	SRC '04-'05 prunings
As ppm	31	0.7	0.5	<0.5
Cr ppm	29	0.47	1.1	0.21
Cu ppm	130	3.1	6.42	8.17
Pb ppm	271	0.66	4.74	0.32
Ni ppm	51	0.52	1.24	0.32
Zn ppm	365	27	80.3	323
Cd ppm	0.9	0.13	0.31	0.09
Hg ppm	0.4	<0.02	<0.02	<0.02
Ash % dry		4.7	7.3	1.9
Na2O %		2.78	1.24	3.53
K2O %		11.77	2.34	25.42
SiO2 %		66.47	78.1	2.36
Cl % dry		0.21	0.01	0.09
F ppm		21	28	44

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean
Environment
Management
Centre

BCR Sequential extraction (soil)





UNIVERSITY OF TEESSIDE

Key question 2:-

- Is the biomass fuel contaminated?
  (Is it phyto-remediation or just a contaminated land management strategy?)

Yes and No:-

- **Phytoremediation (removal) of bioavailable Zn (±Cd, ±Cu) by SRC willow**
- **Varied ash composition, contamination and fuel quality – So may be manageable by blending.**

CLEMANCE
Clean Environment Management Centre

BioReGen sites

Site	Previous use	Planted?
Bishop Auckland*	Coal ash landfill	2004
Seal Sands*	Oil scum landfarm	2004
Nature's World*	Control site (but had WML)	2004
Redcar (x2)*	Fe & steel works	2006
Long Newton*	Rural control site	2004 & 5
Haverton Hill*#	Shipyard	2005 & 7
Tees Barrage #	Rail, Fe etc (capped)	2007
Binchester #	Cokeworks/coal yard	2007
Rainton Bridge #	Former STW	2007
Warden Law #	Capped landfill	2007

***Pilot sites # Demonstration sites (c. 1 ha)**

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean
Environment
Management
Centre

Pilot sites 2004-6

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean
Environment
Management
Centre

PAS100 - Compost or "waste"?

BioReGen Trailblazer Project:-

wrap

Material change for a better environment

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean
Environment
Management
Centre

Brownfield site preparation?

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean
Environment
Management
Centre

Sewage sludge & PAS100 compost mix?

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean
Environment
Management
Centre

Demonstration sites – before..

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean
Environment
Management
Centre

Brownfield style site work

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean
Environment
Management
Centre

Agricultural style site work

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean
Environment
Management
Centre

Demonstration sites – now..

UNIVERSITY OF TEESSIDE

CLEMANCE
Clean
Environment
Management
Centre

BioReGen website

UNIVERSITY OF TEESSIDE