Adaptive Agricultural Reuse SmartCode Module

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Because we don't think about future generations, they will never forget us.

Henrik Tikkanen

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ADAPTIVE AGRICULTURAL REUSE OF MARGINAL AGRICULTURAL AND PASTURE LANDS THROUGH CARBON SEQUESTRATION AND CELULOSIC BIOFUELS PRODUCTION

Two Reuse Programs

The first program consists of growing trees for carbon sequestration; the second, cultivating dedicated, non-food energy crops in marginal agriculture, pasture, and abandoned lands instead of prime arable land. Both provide benefits to the soil, the economy, the environment, and the city or town.

These programs may be administered by municipalities, counties, townships, state, or other governmental agencies, and/or by private and non-profit organizations. The planting and maintenance of tree stands for carbon sequestration, and the cultivation and harvesting of cellulosic biofuels, may occur on public or private land.

Carbon Sequestration through Reforestation and Afforestation

Carbon sequestration through reforestation and afforestation (developing new forests) consists of the long-term absorption and storage of carbon dioxide or other forms of carbon through tree planting. Besides mitigating climate change effects, planting or replanting of trees on marginal crop and pasture lands can create greenbelts around and between urban areas, and transfers CO2 from the atmosphere to the new biomass. Applications may include linear tree stands at urban edges, tree farms and/or productive fruit and nut orchards that sequester carbon during the healthy life of the tree.

Cellulosic Biofuels Grown on Marginal Crop and Pasture Lands

Cellulosic Biofuels are non-food crops or inedible waste energy fuels produced from wood, grasses, or the non-edible parts of plants. Food prices and land use are not likely to be negatively affected by the growing of new sources of cellulosic biofuels and biomass on marginal crop and pasture lands, nor by converting the crop into fuel through bioenergy technologies. Examples range from sustainably farmed switchgrass, a native perennial grass capable of producing high yields on otherwise non-forested, fallow land, to willow, planted and sustainably managed on marginal land without irrigation or fertilizer.

ARTICLE 3. NEW COMMUNITY SCALE PLANS

The text on the righthand page is available to activate Table AAR-1 as regulatory.

CIVIC ZONES

Some examples of Carbon Sequestration Areas used as Civic Space are groves, forests, orchards, and meadows where hiking and birdwatching is permitted, or forested/planted greenways that include bikeways. A comprehensive approach to community planning should include attention to multi-function spaces.

Biofuel production and Carbon Sequestration Areas may certainly occur outside planned Community Units, preferably as part of a Transfer of Development Rights (TDR) program. See Section 2.4.3 of the base code. However, if these areas are not within walking distance of the residents of the Community Unit, they cannot be counted as part of the SmartCode's Civic Space allocation for that pedestrian shed.

The Consolidated Agrarian Settlement (CAS) and Clustered Land Development (CLD) Community Units are especially appropriate for DACS and Cellulosic Biofuels programs as described on the following pages, because of their rural character. See Section 3.3. of the base code for Community Unit types.

(The Consolidated Agrarian Settlement is introduced in Version 10 of the SmartCode.)

ARTICLE 3. NEW COMMUNITY SCALE PLANS

3.X Specific to zones T1, T2

a. Cellulosic biofuel farming of wood, grasses, or non-food plants shall meet or exceed the latest 2010 draft of the Council on Sustainable Biomass Production (CSBP) Standards for dedicated energy products.

3.X CIVIC ZONES

3.X.X. **Civic Space (CS) Specific to Zones T1, T2, T3**

x. Carbon Sequestration Areas within the Community Unit that are also available for public recreation shall be permitted by Warrant within the appropriate Civic Space for the Transect Zone, as provided on Table AAR-1 Biofuels & Carbon Sequestration and Table 13 Civic Space.

ARTICLE 5. BUILDING & LOT SCALE PLANS

5.X BUILDING FUNCTION

5.X Specific to zones T1, T2

x. Cellulosic biofuel farming of wood, grasses, or non-food plants shall meet or exceed the latest 2010 draft of the Council on Sustainable Biomass Production (CSBP) Standards for dedicated energy products.

x. Biofuel production shall be permitted by Warrant as provided on Table AAR-1 Biofuels & Carbon Sequestration and Table 12 Specific Function and Use.

5.X.X **Specific To Zones T1, T2, T3**

x. Carbon Sequestration Areas shall be permitted by Warrant as provided on Table AAR-1 Biofuels & Carbon Sequestration and Table 12 Specific Function and Use.

ARTICLE 7. DEFINITIONS OF TERMS

Biofuel: energy derived from a renewable biological source

Cellulosic: comprised of plant material

CO2e: the unit of measurement used to compare the relative climate impact of the different greenhouse gases. The CO2e quantity of any greenhouse gas is the amount of carbon dioxide that would produce the equivalent global warming potential.

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TABLE AAR-1. BIOFUELS & CARBON SEQUESTRATION

This table may be advisory only, or activated as regulatory by the text on the preceding page.

Cellulosic Biofuels Grown on Marginal Crop and Pasture Lands

1. The program consists of market and/or regulatory incentives for the cultivation of dedicated, non-food energy crops in marginal agriculture, pasture, and abandoned public and private land.

2. While biomass energy can be derived from garbage, wood, waste, landfill gases, and alcohol fuels, this program is limited to plants approved, recommended, and/or certified by the Council on Sustainable Biomass Production (CSBP) Standards for dedicated energy products. These may include miscanthus, switchgrass, hemp, poplar, and willow, though the first two contain the highest potential for conversion into a biofuel or biodiesel. The program should not include biomass sources primarily used for the generation of heat, especially those that emit significant amounts of carbon dioxide, methane or nitrous oxide.

2. The market incentives for the landowner / farmer for cellulosic biofuel cultivation consist of the potential revenue stream from harvesting biofuel crops from marginal lands. Public lands may be leased for private cultivation. Additional benefits include an increase in the ecological value of the land and protection from built development.

3. The program anticipates that, over the next ten years, cellulosic biofuel crops [e.g., switchgrass or miscanthus] that don't require deep tilling will begin to replace both corn-based biofuels and fossil-fuel fertilized conventional row crops in the agricultural market place.

4. The jurisdiction can provide both market and regulatory incentives consisting of:

- The development of a biorefinery facility that integrates cellulosic/biomass conversion processes and equipment to produce fuels, power, heat, and value-added chemicals from biomass. Biorefineries will become standard facilities for producing biologically-active chemicals and materials from biomass. The jurisdiction may employ zoning and economic development funding as incentives for the facility, and to create a market for local biofuel crop yields.
- Bio-energy may be generated and supplied in the same area, reducing or eliminating the installation of pipelines. Consolidated Agricultural Settlement (see the v10 SmartCode) may be incentivized through the permitting of such facilities on the landowner's existing farm or ranch.
- The jurisdiction can implement a TDR program to help preserve existing and potential biofuel crop lands.

5. Cellulosic biofuels reduce CO_2e, the unit of measurement used to compare the relative climate impact of the different greenhouse gases. (The CO_2e quantity of any greenhouse gas is the amount of carbon dioxide that would produce the equivalent global warming potential.) On February 3, 2010, the EPA finalized new regulations for the National Renewable Fuel Standard Program for 2010 and beyond. This program will increase the required volumes of renewable fuel to 36 billion gallons per year by 2022.

Carbon Sequestration Program Components

1. The program consists of methodology for sequestering carbon through tree planting on public and private land.

2. The program requires an agreement between a jurisdiction or an independent management entity representing the jurisdiction, and individual private property owners or public property agencies.

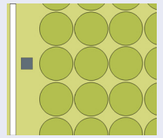
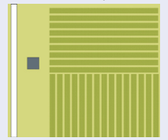
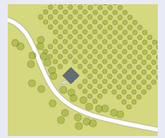
3. Each agreement requires that the landowner plant and maintain tree stands on a designated parcel or parcels pre-approved by the jurisdiction. Each transaction benefits both parties: the landowner receives a revenue stream from the jurisdiction based on the monetized carbon market value of the permanent carbon sequestration, in total CO_2e metric tons. Additional benefits include an increase in the ecological value of the land and protection from built development.

4. Each agreement requires the protection of the land from any type of wood harvesting or adverse uses in perpetuity using one of the following approaches:

- Purchase Carbon/No Harvest: Landowner plants trees and retains responsibility for crop maintenance up to 99 years with a guarantee of no timber harvest. Jurisdiction purchases carbon credits for 99 years, renewable.
- Lease/No Harvest: Jurisdiction's agent leases land for 99 years usage, plants trees and retains responsibility for crop maintenance for 99 years with a guarantee of no timber harvest. Jurisdiction retains carbon rights for 99 years, renewable.

(continued)

Table AAR-1: Biofuels & Carbon Sequestration. This table provides ways of incorporating Cellulosic Biofuel production and Carbon Sequestration orchards and tree farms along the Transect.

	T1	T2	T3	T4	T5	T6	SD	Specific
Cellulosic Biofuels Circular Crop Plan 	▫	▫						
Cellulosic Biofuels Row Crop Plan 	▫	▫						
Sequestration Orchard Plan 	▫	▫	▫					
Sequestration Green Belt Plan 	▫	▫						

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▫ BY WARRANT

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- Donate/No Harvest: Landowner or jurisdiction's agent plants trees. Landowner donates land in Year 5 to a qualified land management agency or non-profit; jurisdiction retains carbon rights for 99 years, renewable.
- Donate/Thin: Landowner or jurisdiction's agent plants trees. Landowner donates land in Year 5 to a qualified land management agency or non-profit; jurisdiction retains carbon rights at least 99 years, renewable.
- Lease/Harvest: Jurisdiction's agent leases land for 99 years usage, plants trees and retains responsibility for crop maintenance up to 99 years with a guarantee of no timber harvest. Jurisdiction retains carbon rights up to 99 years. Forest is harvested between Year 71-100.
- For landowner of forest land, the "exercise price" for each of these options is the present value of the discounted capital costs associated with conducting the specific activity. The "donate" option only can be exercised in Project Year 5. The "Thin" option only can be exercised in Year 50 at the earliest.

5. The jurisdiction may develop a local mechanism to secure the carbon credits derived from the sequestration. For example, the city could develop a local "carbon bank" for the sale, purchase, and transfer of carbon credits.

6. Transfer of Development Rights (TDR) may be considered to redirect urban growth away from sequestration or "sending" areas and toward "receiving areas" appropriate for sustainable development. The sending area landowners receive compensation for preserving the sequestration land, and receiving area owners or developers experience greater profits; the jurisdiction implements its sequestration goals using little or no community funds.

7. The program requires, for each target region, an estimate of the lands both suitable and available for long-term tree planting, each landowner's commitment to fulfill the program agreement, and the jurisdiction's capacity to set up, administer, and manage the program.

8. A minimum land area threshold of about 20 acres per contract is recommended for accounting purposes, though smaller parcels may be aggregated into larger, single holdings. Tree stands may be grown in linear configurations sufficiently wide to maintain a functional wind break, habitat needs, visual screening, or "blow-over" protection from shallow root species such as Douglas fir.

9. The program requires verification and reporting protocols to assess the continued health and growth or productivity of each eco-parcel and certify periodic estimates of sequestration values.

10. Besides a formal program, trees can be "infilled" or planted along public rights-of-way as part of its urban forest program.

Additional Program Considerations

1. Both programs require customization, beginning with the research of and adaptation to the environmental, economic, political, and social context. They require initial research in biogeochemistry, soil science, range management science, plant ecology and ecosystem ecology to determine the best approach for long-term carbon storage in trees and soil, and for the production of periodic cellulosic biofuel wood, grasses, or non-food plants.

2. The programs can result in the creation and sustaining of multi-function, biologically diverse greenbelts, croplands, orchards, and forests around cities and within counties, while incentivizing the reclamation, enhancement, and protection of marginal agriculture, pasture, and abandoned lands. The sequestration of carbon and the production of non-food biofuels will reduce atmospheric CO2e, while the growing of cellulosic biofuels offers farmers a local rotational or dedicated non-till crop. Combined with the development of a local biorefinery, the program can provide a marketable biofuel product, and/or a source of clean community energy.

3. As a first step, a small demonstration project is recommended to implement a program with minimal risk.

Estimated CO2e Metric Tons Sequestration Values

The values below represent general benefits from each program, and should be locally calibrated for each specific application of this Module. This Appendix is advisory only.

Carbon Sequestration Values

TYPE	UNIT	Mean Annual Seq. CO2e - metric tons per acre per year
vineyard/orchard	per acre	.59 to 1.68 [1]
oak woodlands	per acre	3.71 [2]
coniferous forest	per acre	8.89 [2]
grasslands/shrub	per acre	unknown [3]
urban	per tree	

[1] Source: Kroodsma and Field (2006)
[2] Source: Baldacci et al. (unpublished)
[3] not quantified (no factor) and offset by grazing emissions

EROEI (Energy Return on Energy Invested)

FUEL SOURCE	EROEI
biodiesel	3:1
coal	1:1 to 10:1
ethanol	1.2: 1
natural gas	1:1 to 10:1
hydropower	10:1
hydrogen	0.5:1
nuclear	4:1
oil	1.1 to 100:1
oil sands	2:1
solar PV	1:1 to 10:1
wind	3:1 to 20:1

Source: Dana Visalli, 2006
www.energybulletin.net/node/14745

Cellulosic Biofuel vs. Conventional Fuel Values

CO2 emissions/gallon gasoline = 19.4 pounds/gallon
CO2 emissions/gallon diesel = 22.2 pounds/gallon
CO2 emissions/gallon cellulosic = 5.04 pounds/gallon