Economic Analysis of the Northeast/Mid-Atlantic Low Carbon Fuel Standard: Draft Data and Assumptions, Part I

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LCFS Stakeholder Calls

April 2010

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Objectives of the LCFS Economic Analysis

Key objectives for the economic analysis of the Northeast/Mid-Atlantic LCFS include the following:

- Estimate relative magnitude of potential costs and benefits resulting from LCFS implementation
- Understand which variables and parameters have the most influence on the costs, benefits, and overall impacts of the program
- Identify key issues and tradeoffs of policy options for LCFS decision-makers
- Provide stakeholders with opportunities for review and input
- Adhere to "best practices" in regulatory economic analysis

The LCFS Economic Analysis is <u>not</u> intended to:

- Forecast future economic conditions or the likelihood of any policy outcome
- Limit possible policy options available to decision-makers

Key Steps in the Analysis

Key Steps in the LCFS analysis:

1. Characterize Reference Cases and Policy Scenarios (April)
2. Develop Data and Assumptions: Part I (April-May)
3. Generate LCFS Compliance Scenarios (May-June)
4. Develop Aggregate Cost and Benefit Estimates (June)
5. Develop Data and Assumptions: Part II (June-July)
6. Estimate Regional Economic Impacts (August)

Data

The economic analysis will rely primarily upon published articles and reports which have undergone peer-review and/or public review process.

- Costs and timing of deployment of emerging fuels and technologies
  - highly uncertain, not reflected in literature and public domain yet

- Additional input and information requested from stakeholders on:
  - Production costs of emerging low-carbon fuels (especially MSW-derived fuels);
  - Estimates of technology deployment
  - Costs of related infrastructure (especially EV infrastructure)

Proposed sources include:

- Low carbon fuel production costs: EPA and California Air Resources Board (CARB) estimates (derived from National Renewable Energy Lab estimates)
- Related low C fuel infrastructure: EPA, CARB, and industry sources
- Program costs: EPA, CARB, state estimates
- Benefits estimates: Journal articles, EPA/federal agencies, state estimates

Methods

1. Characterizing the Reference Case(s). The "reference case" is an estimate of what the future might look like in the absence of a regional LCFS, to be used as a basis of comparison for the results of scenarios that characterize the low carbon fuel policy;

- Not a "prediction" of the future, but rather a plausible expectation based on recent trends.

- Includes existing policies, as well as those judged to be "reasonably certain or expected." Relevant policies defined to include federal, regional, and state programs that likely to affect the volume and characteristics of transportation fuels, related infrastructure, and/or vehicles.

- An alternative reference case (Ref Case B) is used to depict a future with higher rate of economic growth and consequently, higher fuel demand and prices.

Methods

2. Characterizing the LCFS Policy Scenarios.

The proposed LCFS policy scenarios are designed to depict the incremental impacts of the program relative to the reference cases, or "world without the regional LCFS."

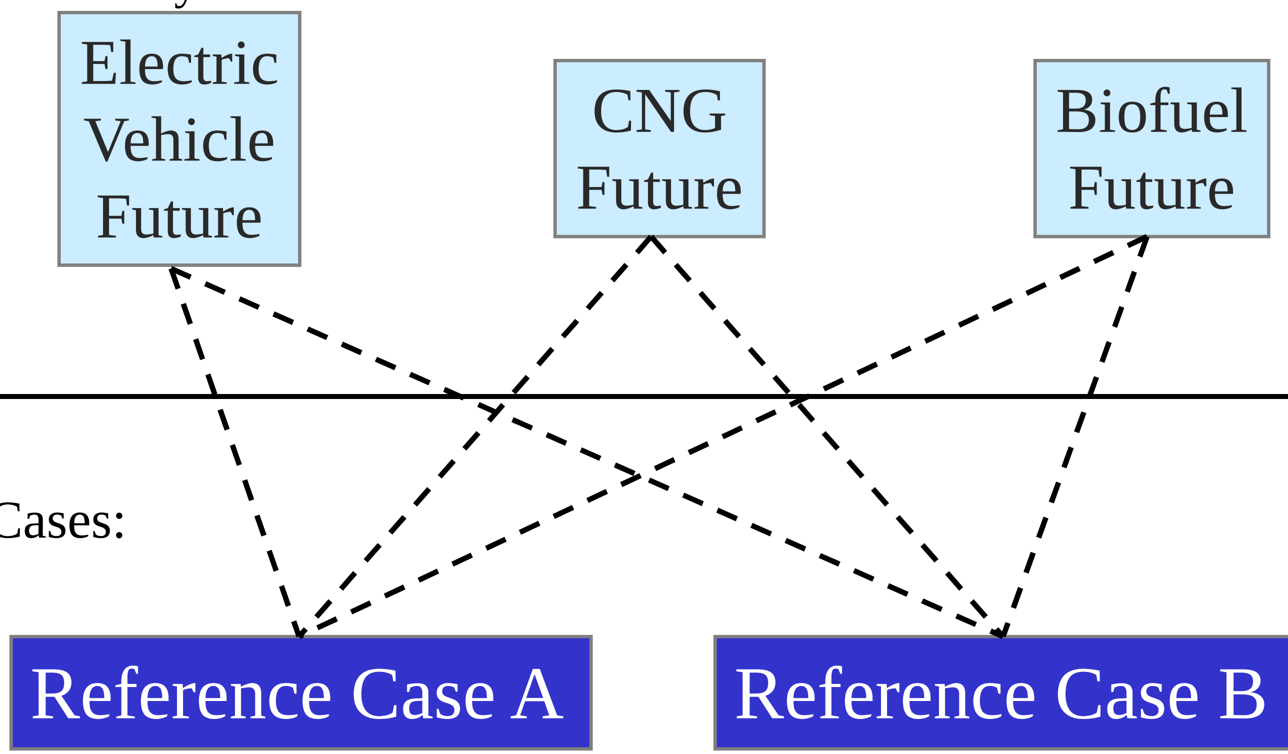
- Goal of LCFS: spur faster development of highly uncertain emerging technologies
- Scenarios are not forecasts; rather "what if" depictions designed to meet the following objectives:
  - Meet a 10% reduction in carbon intensity of transportation fuels over 10 years
  - Capture a broad range of possibilities and uncertainties about the future:
    - Rates of innovation and commercialization of low carbon fuels & technologies
    - Costs of future low carbon fuels and infrastructure
    - Consumer preferences and market penetration
    - General economic conditions
- Recognize the technology-forcing role of LCFS as a performance standard
- Address interests of multiple stakeholders with diverse concerns
- Provide policy insights within given resources and schedule

Methods

Results from the 3 core policy scenarios will be compared to each reference case to understand the incremental impacts of the program.

Policy Scenarios: Start date for all 3 Policy Cases is 2012. Timeframe is 10 years.

Reference Cases:



Methods

3. Assessing LCFS Costs.

- First: Calculate incremental costs associated with regional LCFS by calculating volumes of different low carbon fuels required to meet a 10% LCFS target over 10 years.
  - NE-GREET used to determine various fuels contribution to reductions in carbon intensity (CI) below baseline
  - NE-VISION used to determine fuel volumes required at different CI levels
- Second: Calculate the cost of incremental fuels needed to meet the 10% standard using a range (i.e., low- and high-end) of projected unit costs (i.e., per gallon gasoline equivalent) for low carbon fuels from EPA, CARB, and other sources;
- Third: Calculate infrastructure and program costs using reasonable formulas (e.g., driven by volume of fuels, other cost drivers).

Methods

4. Assessing LCFS Benefits.

- The LCFS benefits assessment will estimate and quantify GHG reductions anticipated from a 10% reduction in carbon intensity in transportation fuels.
  – Range of values from published GHG literature used to evaluate GHG reductions.

- Benefit categories quantified and monetized, using appropriate values from published literature, when possible:
  – Net reductions in criteria pollutants
  – Economic impacts of regional production of low carbon fuels

- Other benefit categories addressed qualitatively

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Methods

4. Accounting for uncertainties through sensitivity analysis.

Goal: Not to forecast the future, but to capture a range of uncertainties and generate useful insights for policymaking;

- Costs and timing of deployment of emerging fuels and technologies highly uncertain, not reflected in literature yet;
- Sensitivity analyses focus - variables expected to have the most significant influence on results:
  - Costs and available volumes of baseline fuels
  - Costs and rate of innovation/market penetration of low carbon fuels
  - Carbon intensity (g CO_2e/MJ) of low carbon fuels

Methods

5. Transparency. An analysis that strives for maximum clarity and transparency will have greater credibility.

In accordance with best practices in economic analysis, the analysis will:

- Provide sufficient opportunities for stakeholder review
- Present full range of uncertainties evaluated and their influence on results
- Avoid overly technical language

II. Reference Case Scenarios

Reference Case A

- Assumes *Annual Energy Outlook 2010* reference case price projections for baseline fuels, and corresponding energy demand/fuel volumes and levels of economic growth;
- Assumes full compliance with existing state, regional, and federal policies (e.g., RGGI, RPS, CAFE);
- Some proportion of low carbon advanced biofuels resulting from RFS2 will be used for compliance with CA LCFS.

Key Variables:	**Reference Case A Assumptions**
Baseline fuel prices (oil, gasoline, NG)	AEO 2010 reference case projections
CI values of baseline fuels	No sig increase in CI
Impact of RFS2	Higher proportion of low C fuels to CA
Fuel volumes	AEO 2010 volume projections
Existing policies (RGGI, RPS, Pavley/CAFÉ, ZEV)	Full compliance

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Reference Case B

- Assumes *Annual Energy Outlook 2010* high price projections for baseline fuels, and corresponding higher energy demand/fuel volumes and levels of economic growth;
- Assumes higher fuel prices will result in greater development of higher CI petroleum resources than REF A;
- Full compliance with existing state, regional, and federal policies (e.g., RGGI, RPS, CAFE);
- Higher proportion of low CI fuels resulting from RFS2 will be used to meet CA LCFS than in REF A.

Key Variables:	**Reference Case B Assumptions**
Baseline fuel prices (oil, gasoline, NG)	AEO 2010 high price projections
CI values of baseline fuels	Increase in CI of baseline fuels
Impact of RFS2	Higher proportion of low C fuels to CA
Fuel volumes	AEO 2010 volumes under high price projections
Existing policies (RGGI, RPS, Pavley/CAFÉ, ZEV)	Full compliance

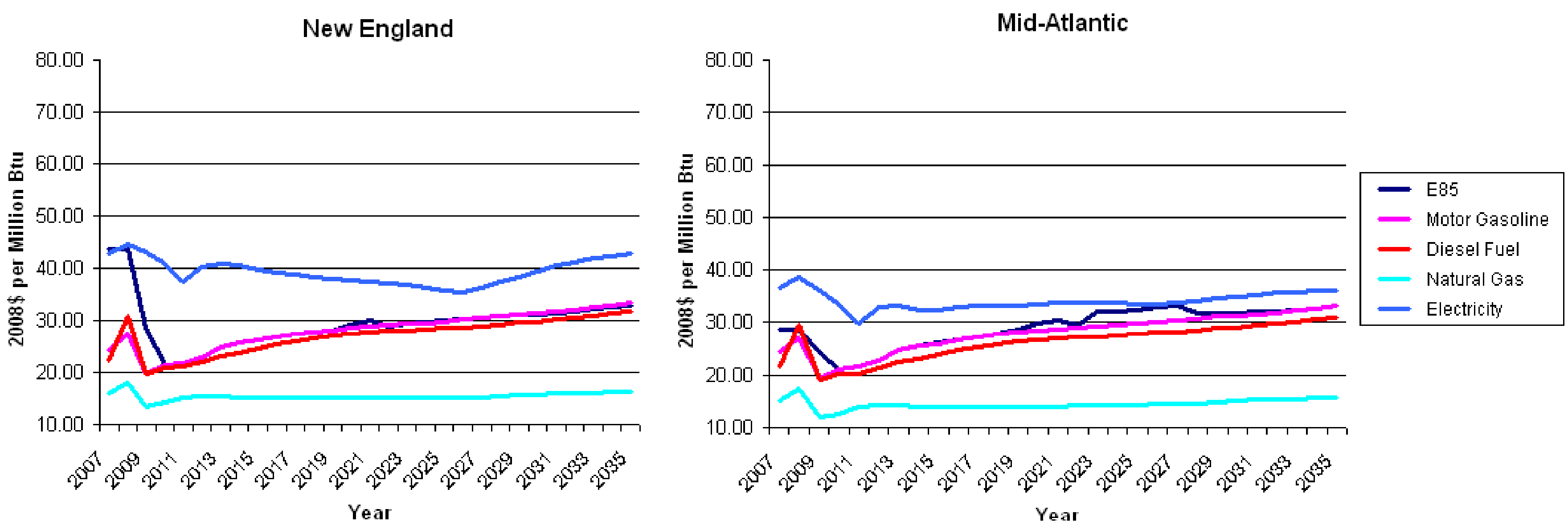
LCFS Reference Cases: Draft Data and Assumptions

- Base Year
- Prices and demand for baseline fuels
- Carbon intensity of baseline fuels
- Role of existing policies
- Existing biofuel, CNG, and EV production and distribution

Base Year: 2006

- LCFS will set a carbon intensity reduction target for fuels relative to emissions intensity in a given Base Year;
- 2006 is the most recent year for which complete datasets are available from all states;
- Consistent with CA baseline year;
- Simplifying assumptions made for baseline fuel blends in Base Year:
  - Assume all gasoline is RFG
  - Assume all distillate fuels are ultra-low sulfur diesel (ULSD)

Ref Case A: Baseline Fuel Prices



Source: Energy Information Administration, Annual Energy Outlook 2010 Early Release.

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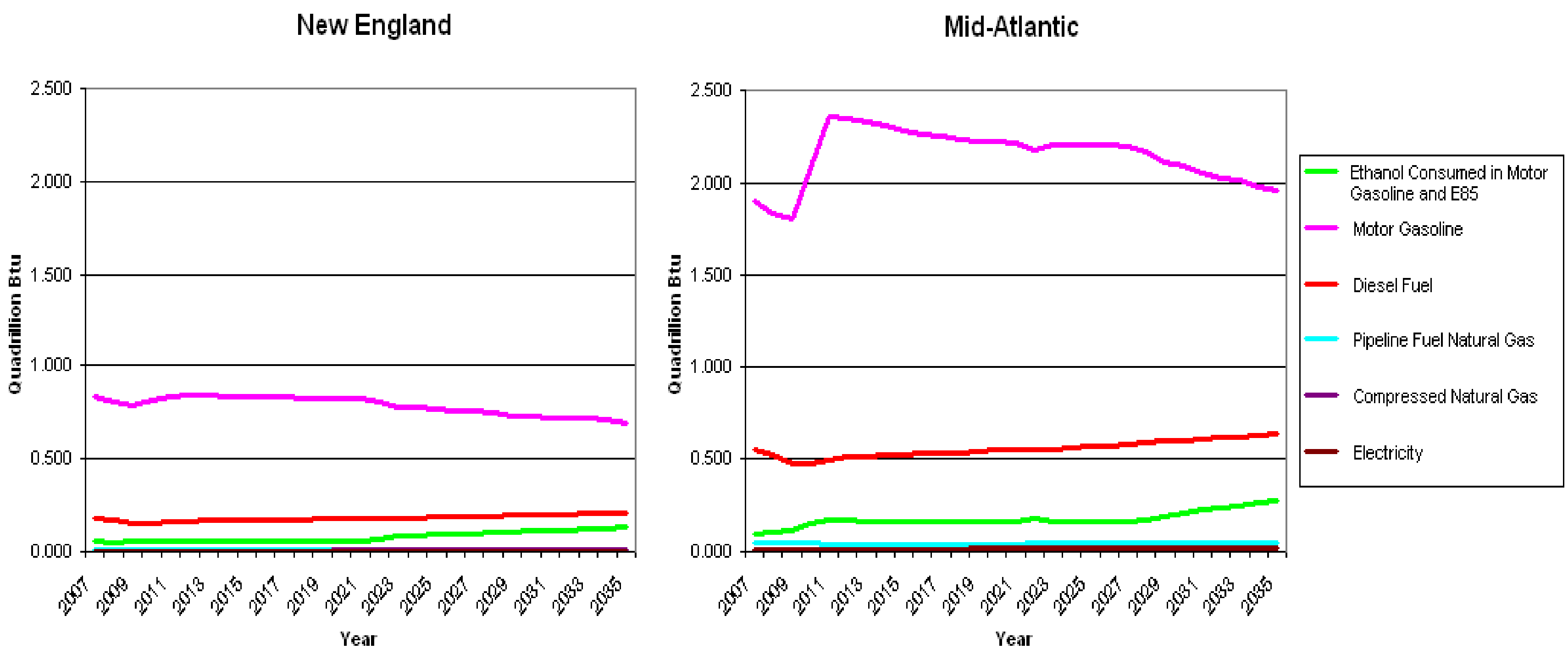
Ref Case A: Baseline Fuel Demand



Source: Energy Information Administration, Annual Energy Outlook 2010 Early Release.

Reference Case B: Baseline Fuel Prices

- *2010 data expected release from AEO: April 28th*

Reference Case B: Baseline Fuel Demand

- *2010 data expected release from AEO: April 28th*

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Carbon Intensity (CI) of Baseline Fuels

Carbon Intensity of baseline fuels will set the reference point for the reductions in carbon intensity required by the LCFS:

- Gasoline CI = 96g/MJ
- Diesel CI = 94g/MJ
- Baseline Ethanol CI = 96g/MJ
- All other baseline fuel volumes assumed negligible

- Electricity CI = TBD
- Based on average CO_2 emissions rates from ISO-New England, NY-ISO, and Mid-Atlantic PJM, weighted by 3-year average of electricity demand (MWh).
- Will examine whether information is available to account for carbon intensity of imports, if information available.

Role of Existing Policies

- The analysis assumes: (1) full compliance with existing GHG and energy regulations and programs at state, regional, and federal level, and (2) maintenance of existing policies, if due to expire during period of analysis.

- Relevant policies include:
  - Federal:
    - *Renewable Fuel Standard* (RFS2)
    - Corporate Average Fuel Economy (CAFÉ)/GHG emissions
  - Regional:
    - Regional Greenhouse Gas Initiative (RGGI)
    - Zero Emission Vehicle (ZEV) program
  - State:
    - Renewable energy standards (i.e., RPS)
    - Massachusetts and Pennsylvania biofuel mandates
    - Various state waste policies

Federal Policy: RFS2

- Reference cases assume advanced biofuels go to CA, remainder of required volumes are proportionally distributed throughout US;
- Reference case B assumes CA demand for low-carbon fuels increases to offset increase in high-carbon feedstocks:
  - Draft boundary assumption: 50% tar-sand share in 10 years at 10% CI penalty → 0.5% annual increase in AFCI
- “Biofuels Future” scenarios: assume that CA and 11 Northeast/Mid-Atlantic (NE-11) states receive greater than proportional shares of RFS2-mandated advanced fuels;
- Assume 10% blend limit for gasoline;
- Use EPA projections for FFV penetration and E85 infrastructure, apportioned to region based on total fuel use.

RFS2 Advanced Ethanol Volumes, Ref A

Reference Case A: Gasoline									NE11 Cellulosic Ethanol			NE11 Non-Cellulosic "Advanced"		
Projection Year	CA Baseline CI (g/MJ)	CA Baseline Gasoliine (Bgal)	CA Target CI (g/MJ)	RFS2 National Cell-EtOH (Bgal)	CA LCFS Demand Cell-EtOH (Bgal)	RFS2 Remaining Cell-EtOH (Bgal)	NE11 Baseline CI (g/MJ)	NE11 Baseline Gasoline (Bgal)	NE11 Share of RFS2 Cell-EtOH (Bgal)	NE11 Average CI (g/MJ)	**NE11 CI Reduction from 2010 Baseline**	NE11 Share of RFS2 Non-Cell EtOH Advanced (Bgal)	NE11 Average CI (g/MJ)	**NE11 CI Reduction from 2010 Baseline**
2010	95.9	16.9	95.9	0.0065	0.00	0.0	96	26.9	0.00	96.0	**0.00%**	0.17	95.8	**0.2%**
2011	95.9	16.9	95.6	0.25	0.11	0.1	96	27.0	0.03	96.0	**0.04%**	0.20	95.7	**0.3%**
2012	95.9	17.0	95.4	0.5	0.22	0.3	96	27.1	0.06	95.9	**0.09%**	0.27	95.6	**0.4%**
2013	95.9	17.1	94.9	1	0.43	0.6	96	27.3	0.12	95.8	**0.17%**	0.32	95.5	**0.6%**
2014	95.9	17.2	94.4	1.75	0.65	1.1	96	27.4	0.22	95.7	**0.33%**	0.36	95.3	**0.8%**
2015	95.9	17.3	93.5	3	1.08	1.9	96	27.5	0.39	95.5	**0.57%**	0.45	94.9	**1.1%**
2016	95.9	17.4	92.5	4.25	1.52	2.7	96	27.7	0.56	95.2	**0.81%**	0.54	94.6	**1.5%**
2017	95.9	17.5	91.1	5.5	2.18	3.3	96	27.8	0.68	95.1	**0.98%**	0.63	94.3	**1.7%**
2018	95.9	17.5	89.6	7	2.85	4.2	96	27.9	0.85	94.8	**1.22%**	0.72	94.0	**2.1%**
2019	95.9	17.6	88.2	8.5	3.52	5.0	96	28.1	1.01	94.6	**1.46%**	0.81	93.7	**2.4%**
2020	95.9	17.7	86.3	10.5	4.42	6.1	96	28.2	1.24	94.3	**1.77%**	0.81	93.4	**2.7%**
2021	95.9	17.8	86.3	13.5	4.44	9.1	96	28.4	1.84	93.5	**2.62%**	0.81	92.6	**3.6%**
2022	95.9	17.9	86.3	16	4.46	11.5	96	28.5	2.35	92.8	**3.33%**	0.90	91.8	**4.4%**

Assumes cellulosic ethanol CI at 38 gCO2e/MJ, “advanced” ethanol CI at 48 gCO2e/MJ.

Assumes all Cell-EtOH not required for CA LCFS is distributed evenly among remaining 49 states (NE11 receives 20% of remaining volume)

For illustrative purposes for the economic analysis, calculations were rounded to tenths of g/MJ

RFS2 Advanced Ethanol Volumes, Ref B

Reference Case B: Gasoline									NE11 Cellulosic Ethanol			NE11 Non-Cellulosic "Advanced"		
Projection Year	CA Baseline CI (g/MJ)	CA Baseline Gasoliine (Bgal)	CA Target CI (g/MJ)	RFS2 National Cell-EtOH (Bgal)	CA LCFS Demand Cell-EtOH (Bgal)	RFS2 Remaining Cell-EtOH (Bgal)	NE11 Baseline CI (g/MJ)	NE11 Baseline Gasoline (Bgal)	NE11 Share of RFS2 Cell-EtOH (Bgal)	NE11 Average CI (g/MJ)	**NE11 CI Reduction from 2010 Baseline**	NE11 Share of RFS2 Non-Cell EtOH Advanced (Bgal)	NE11 Average CI (g/MJ)	**NE11 CI Reduction from 2010 Baseline**
2010	95.9	16.9	95.9	0.0065	0.00	0.0	96	26.9	0.00	96.0	**0.00%**	0.17	95.8	**0.2%**
2011	96.3	16.9	95.6	0.25	0.25	0.0	96.48	27.0	0.00	96.5	**-0.50%**	0.20	96.2	**-0.3%**
2012	96.8	17.0	95.4	0.5	0.50	0.0	96.96	27.1	0.00	97.0	**-1.00%**	0.27	96.6	**-0.7%**
2013	97.3	17.1	94.9	1	1.00	0.0	97.45	27.3	0.00	97.4	**-1.51%**	0.32	97.1	**-1.1%**
2014	97.8	17.2	94.4	1.75	1.46	0.3	97.93	27.4	0.06	97.8	**-1.93%**	0.36	97.4	**-1.5%**
2015	98.3	17.3	93.5	3	2.08	0.9	98.42	27.5	0.19	98.1	**-2.24%**	0.45	97.6	**-1.7%**
2016	98.8	17.4	92.5	4.25	2.70	1.6	98.92	27.7	0.32	98.5	**-2.55%**	0.54	97.8	**-1.9%**
2017	99.3	17.5	91.1	5.5	3.52	2.0	99.41	27.8	0.40	98.8	**-2.93%**	0.63	98.0	**-2.1%**
2018	99.8	17.5	89.6	7	4.33	2.7	99.91	27.9	0.54	99.1	**-3.23%**	0.72	98.2	**-2.3%**
2019	100.3	17.6	88.2	8.5	5.14	3.4	100.41	28.1	0.68	99.4	**-3.53%**	0.81	98.4	**-2.5%**
2020	100.8	17.7	86.3	10.5	6.15	4.4	100.91	28.2	0.89	99.6	**-3.74%**	0.81	98.6	**-2.7%**
2021	101.3	17.8	86.3	13.5	6.34	7.2	101.41	28.4	1.46	99.2	**-3.37%**	0.81	98.2	**-2.3%**
2022	101.8	17.9	86.3	16	6.54	9.5	101.92	28.5	1.93	99.0	**-3.16%**	0.90	97.9	**-2.0%**

Assumes cellulosic ethanol CI at 38 gCO2e/MJ, “advanced” ethanol CI at 48 gCO2e/MJ.

Assumes all Cell-EtOH not required for CA LCFS is distributed evenly among remaining 49 states (NE11 receives 20% of remaining volume)

Assumes annual baseline CI increase of 0.5 gCO2e/MJ

For illustrative purposes for the economic analysis, calculations were rounded to tenths of g/MJ.

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"Biofuels Future", Ref A
RFS2 Ethanol Volumes

NE11 Gasoline, Biofuels Future, Ref A

Projection Year	CA Baseline CI (g/MJ)	CA Baseline Gasoliine (Bgal)	CA Target CI (g/MJ)	RFS2 National Cell-EtOH (Bgal)	CA LCFS Demand Cell-EtOH (Bgal)	RFS2 Remaining Cell-EtOH (Bgal)	NE11 Baseline CI (g/MJ)	NE11 Baseline Gasoline (Bgal)	NE11 Cellulosic Ethanol: NE11 Share of RFS2 Cell-EtOH (Bgal)	NE11 Cellulosic Ethanol: NE11 Average CI (g/MJ)	NE11 Cellulosic Ethanol: **NE11 CI Reduction from 2010 Baseline**	NE11 Non-Cellulosic "Advanced": NE11 Share of RFS2 Non-Cell EtOH Advanced (Bgal)	NE11 Non-Cellulosic "Advanced": NE11 Average CI (g/MJ)	NE11 Non-Cellulosic "Advanced": **NE11 CI Reduction from 2010 Baseline**
2010	95.9	16.9	95.9	0.0026	0.00	0.0	96	26.9	0.0	96.0	**0.00%**	0.07	95.9	**0.1%**
2011	95.9	16.9	95.6	0.1	0.04	0.1	96	27.0	0.1	95.9	**0.09%**	0.08	95.8	**0.2%**
2012	95.9	17.0	95.4	0.2	0.08	0.1	96	27.1	0.1	95.8	**0.18%**	0.11	95.7	**0.3%**
2013	95.9	17.1	94.9	0.4	0.15	0.2	96	27.3	0.2	95.7	**0.36%**	0.13	95.5	**0.5%**
2014	95.9	17.2	94.4	0.7	0.27	0.4	96	27.4	0.4	95.4	**0.63%**	0.14	95.2	**0.8%**
2015	95.9	17.3	93.5	1.2	0.46	0.7	96	27.5	0.7	95.0	**1.08%**	0.18	94.8	**1.3%**
2016	95.9	17.4	92.5	1.7	0.66	1.0	96	27.7	1.0	94.5	**1.52%**	0.22	94.3	**1.8%**
2017	95.9	17.5	91.1	2.2	0.85	1.4	96	27.8	1.4	94.1	**1.96%**	0.25	93.8	**2.3%**
2018	95.9	17.5	89.6	2.8	1.08	1.7	96	27.9	1.7	93.6	**2.48%**	0.29	93.3	**2.8%**
2019	95.9	17.6	88.2	3.4	1.31	2.1	96	28.1	2.1	93.1	**3.00%**	0.32	92.7	**3.4%**
2020	95.9	17.7	86.3	4.2	1.62	2.6	96	28.2	2.6	92.5	**3.69%**	0.32	92.1	**4.1%**
2021	95.9	17.8	86.3	5.4	2.08	3.3	96	28.4	3.3	91.5	**4.72%**	0.32	91.1	**5.1%**
2022	95.9	17.9	86.3	6.4	2.47	3.9	96	28.5	3.9	90.7	**5.57%**	0.36	90.2	**6.0%**

Assumes cellulosic ethanol at 38 CI gCO2e/MJ, "advanced" ethanol CI at 48 gCO2e/MJ.

Assumes all RFS volumes are sold proportionally in CA and NE11

RFS2 Volumes scaled by 0.4x (6.4 Bgal in 2022)

For illustrative purposes for the economic analysis, calculations were rounded to tenths of g/MJ

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"Biofuels Future", Ref B RFS2 Ethanol Volumes

NE11 Gasoline, Biofuels Future, Ref B

Projection Year	CA Baseline CI (g/MJ)	CA Baseline Gasoliine (Bgal)	CA Target CI (g/MJ)	RFS2 National Cell-EtOH (Bgal)	CA LCFS Demand Cell-EtOH (Bgal)	RFS2 Remaining Cell-EtOH (Bgal)	NE11 Baseline CI (g/MJ)	NE11 Baseline Gasoline (Bgal)	NE11 Cellulosic Ethanol: NE11 Share of RFS2 Cell-EtOH (Bgal)	NE11 Cellulosic Ethanol: NE11 Average CI (g/MJ)	NE11 Cellulosic Ethanol: **NE11 CI Reduction from 2010 Baseline**	NE11 Non-Cellulosic "Advanced": NE11 Share of RFS2 Non-Cell EtOH Advanced (Bgal)	NE11 Non-Cellulosic "Advanced": NE11 Average CI (g/MJ)	NE11 Non-Cellulosic "Advanced": **NE11 CI Reduction from 2010 Baseline**
2010	95.9	16.9	95.9	0.004778	0.00	0.0	96	26.9	0.0	96.0	**0.00%**	0.13	95.8	**0.2%**
2011	96.3	16.9	95.6	0.18375	0.07	0.1	96.48	27.0	0.1	96.3	**-0.33%**	0.15	96.1	**-0.1%**
2012	96.8	17.0	95.4	0.3675	0.14	0.2	96.96	27.1	0.2	96.6	**-0.66%**	0.20	96.4	**-0.4%**
2013	97.3	17.1	94.9	0.735	0.28	0.5	97.45	27.3	0.5	96.8	**-0.82%**	0.23	96.5	**-0.5%**
2014	97.8	17.2	94.4	1.28625	0.50	0.8	97.93	27.4	0.8	96.8	**-0.81%**	0.27	96.5	**-0.5%**
2015	98.3	17.3	93.5	2.205	0.85	1.4	98.42	27.5	1.4	96.4	**-0.46%**	0.33	96.0	**0.0%**
2016	98.8	17.4	92.5	3.12375	1.21	1.9	98.92	27.7	1.9	96.1	**-0.10%**	0.40	95.6	**0.4%**
2017	99.3	17.5	91.1	4.0425	1.56	2.5	99.41	27.8	2.5	95.7	**0.26%**	0.46	95.2	**0.9%**
2018	99.8	17.5	89.6	5.145	1.98	3.2	99.91	27.9	3.2	95.2	**0.80%**	0.53	94.6	**1.5%**
2019	100.3	17.6	88.2	6.2475	2.41	3.8	100.41	28.1	3.8	94.7	**1.35%**	0.60	94.0	**2.1%**
2020	100.8	17.7	86.3	7.7175	2.98	4.7	100.91	28.2	4.7	93.8	**2.24%**	0.60	93.1	**3.0%**
2021	101.3	17.8	86.3	9.9225	3.83	6.1	101.41	28.4	6.1	92.3	**3.85%**	0.60	91.5	**4.6%**
2022	101.8	17.9	86.3	11.76	4.54	7.2	101.92	28.5	7.2	91.1	**5.11%**	0.66	90.2	**6.0%**

Assumes cellulosic ethanol CI at 38 gCO2e/MJ, "advanced" ethanol CI at 48 gCO2e/MJ.

Assumes all RFS volumes are sold proportionally in CA and NE11

RFS2 Volumes scaled by 0.74x

For illustrative purposes for the economic analysis, calculations were rounded to tenths of g/MJ

DRAFT: Preliminary assumptions for economic analysis 4/15/10

"Biofuels Future", Ref A
RFS2 Ethanol Volumes

NE11 LCFS Gasoline, Biofuels Future, Ref A

									NE11 Cellulosic Ethanol			NE11 Non-Cellulosic "Advanced"		
Projection Year	CA Baseline CI (g/MJ)	CA Baseline Gasoliine (Bgal)	CA Target CI (g/MJ)	RFS2 National Cell-EtOH (Bgal)	CA LCFS Demand Cell-EtOH (Bgal)	RFS2 Remaining Cell-EtOH (Bgal)	NE11 Baseline CI (g/MJ)	NE11 Baseline Gasoline (Bgal)	NE11 Share of RFS2 Cell-EtOH (Bgal)	NE11 Average CI (g/MJ)	**NE11 CI Reduction from 2010 Baseline**	NE11 Share of RFS2 Non-Cell EtOH Advanced (Bgal)	NE11 Average CI (g/MJ)	**NE11 CI Reduction from 2010 Baseline**
2010	95.9	16.9	95.9	0.0065	0.00	0.0	96	26.9	0.00195	96.0	**0.00%**	0.17	95.8	**0.2%**
2011	95.9	16.9	95.6	0.25	0.11	0.1	96	27.0	0.0435	95.9	**0.07%**	0.20	95.7	**0.3%**
2012	95.9	17.0	95.4	0.5	0.22	0.3	96	27.1	0.0855	95.9	**0.13%**	0.27	95.6	**0.5%**
2013	95.9	17.1	94.9	1	0.43	0.6	96	27.3	0.1722	95.8	**0.25%**	0.32	95.4	**0.6%**
2014	95.9	17.2	94.4	1.75	0.65	1.1	96	27.4	0.3315	95.5	**0.49%**	0.36	95.1	**0.9%**
2015	95.9	17.3	93.5	3	1.08	1.9	96	27.5	0.576	95.2	**0.84%**	0.45	94.7	**1.4%**
2016	95.9	17.4	92.5	4.25	1.52	2.7	96	27.7	0.8205	94.9	**1.20%**	0.54	94.2	**1.9%**
2017	95.9	17.5	91.1	5.5	2.18	3.3	96	27.8	0.9975	94.6	**1.45%**	0.63	93.9	**2.2%**
2018	95.9	17.5	89.6	7	2.85	4.2	96	27.9	1.2465	94.3	**1.80%**	0.72	93.4	**2.7%**
2019	95.9	17.6	88.2	8.5	3.52	5.0	96	28.1	1.494	93.9	**2.15%**	0.81	93.0	**3.1%**
2020	95.9	17.7	86.3	10.5	4.42	6.1	96	28.2	1.8255	93.5	**2.61%**	0.81	92.6	**3.6%**
2021	95.9	17.8	86.3	13.5	4.44	9.1	96	28.4	2.718	92.3	**3.87%**	0.81	91.4	**4.8%**
2022	95.9	17.9	86.3	16	4.46	11.5	96	28.5	3.462	91.3	**4.90%**	0.90	90.3	**6.0%**

Assumes cellulosic ethanol CI at 38 gCO2e/MJ, "advanced" ethanol CI at 48 gCO2e/MJ.

Assumes full RFS compliance (16 Bgal in 2022)

Assumes that 30% of non-CA cell-EtOH is sold in NE11

For illustrative purposes for the economic analysis, calculations were rounded to tenths of g/MJ

DRAFT: *Preliminary assumptions for economic analysis 4/15/10*

NESCAUM

"Biofuels Future", Ref B RFS2 Ethanol Volumes

NE11 Gasoline, Biofuels Future, Ref B

									NE11 Cellulosic Ethanol			NE11 Non-Cellulosic "Advanced"		
Projection Year	CA Baseline CI (g/MJ)	CA Baseline Gasoliine (Bgal)	CA Target CI (g/MJ)	RFS2 National Cell-EtOH (Bgal)	CA LCFS Demand Cell-EtOH (Bgal)	RFS2 Remaining Cell-EtOH (Bgal)	NE11 Baseline CI (g/MJ)	NE11 Baseline Gasoline (Bgal)	NE11 Share of RFS2 Cell-EtOH (Bgal)	NE11 Average CI (g/MJ)	**NE11 CI Reduction from 2010 Baseline**	NE11 Share of RFS2 Non-Cell EtOH Advanced (Bgal)	NE11 Average CI (g/MJ)	**NE11 CI Reduction from 2010 Baseline**
2010	95.9	16.9	95.9	0.0065	0.00	0.0	96	26.9	0.0	96.0	**0.01%**	0.17	95.8	**0.2%**
2011	96.3	16.9	95.6	0.25	0.25	0.0	96.48	27.0	0.0	96.5	**-0.50%**	0.20	96.2	**-0.3%**
2012	96.8	17.0	95.4	0.5	0.50	0.0	96.96	27.1	0.0	97.0	**-1.00%**	0.27	96.6	**-0.7%**
2013	97.3	17.1	94.9	1	1.00	0.0	97.45	27.3	0.0	97.4	**-1.51%**	0.32	97.1	**-1.1%**
2014	97.8	17.2	94.4	1.75	1.46	0.3	97.93	27.4	0.2	97.6	**-1.69%**	0.36	97.2	**-1.2%**
2015	98.3	17.3	93.5	3	2.08	0.9	98.42	27.5	0.7	97.4	**-1.48%**	0.45	96.9	**-0.9%**
2016	98.8	17.4	92.5	4.25	2.70	1.6	98.92	27.7	1.2	97.2	**-1.26%**	0.54	96.5	**-0.6%**
2017	99.3	17.5	91.1	5.5	3.52	2.0	99.41	27.8	1.5	97.2	**-1.28%**	0.63	96.4	**-0.5%**
2018	99.8	17.5	89.6	7	4.33	2.7	99.91	27.9	2.0	97.0	**-1.00%**	0.72	96.1	**-0.1%**
2019	100.3	17.6	88.2	8.5	5.14	3.4	100.41	28.1	2.5	96.7	**-0.72%**	0.81	95.7	**0.3%**
2020	100.8	17.7	86.3	10.5	6.15	4.4	100.91	28.2	3.2	96.1	**-0.08%**	0.81	95.1	**1.0%**
2021	101.3	17.8	86.3	13.5	6.34	7.2	101.41	28.4	5.3	93.4	**2.66%**	0.81	92.4	**3.7%**
2022	101.8	17.9	86.3	16	6.54	9.5	101.92	28.5	7.1	91.3	**4.85%**	0.90	90.2	**6.0%**

Assumes cellulosic ethanol CI at 38 gCO2e/MJ, "advanced" ethanol CI at 48 gCO2e/MJ.

Assumes full RFS compliance (16 Bgal in 2022)

Assumes that 75% of non-CA cell-EtOH is sold in NE11

For illustrative purposes for the economic analysis, calculations were rounded to tenths of g/MJ

"Other Future", Ref A RFS2 Ethanol Volumes

NE11 Gasoline, "Other Future", Ref A

									NE11 Cellulosic Ethanol			NE11 Non-Cellulosic "Advanced"		
Projection Year	CA Baseline CI (g/MJ)	CA Baseline Gasoliine (Bgal)	CA Target CI (g/MJ)	RFS2 National Cell-EtOH (Bgal)	CA LCFS Demand Cell-EtOH (Bgal)	RFS2 Remaining Cell-EtOH (Bgal)	NE11 Baseline CI (g/MJ)	NE11 Baseline Gasoline (Bgal)	NE11 Share of RFS2 Cell-EtOH (Bgal)	NE11 Average CI (g/MJ)	**NE11 CI Reduction from 2010 Baseline**	NE11 Share of RFS2 Non-Cell EtOH Advanced (Bgal)	NE11 Average CI (g/MJ)	**NE11 CI Reduction from 2010 Baseline**
2010	95.9	16.9	95.9	0.0065	0.00	0.0	96	26.9	0.00039	96.0	**0.00%**	0.17	95.8	**0.2%**
2011	95.9	16.9	95.6	0.25	0.11	0.1	96	27.0	0.0087	96.0	**0.01%**	0.20	95.8	**0.3%**
2012	95.9	17.0	95.4	0.5	0.22	0.3	96	27.1	0.0171	96.0	**0.03%**	0.27	95.7	**0.4%**
2013	95.9	17.1	94.9	1	0.43	0.6	96	27.3	0.03444	96.0	**0.05%**	0.32	95.6	**0.4%**
2014	95.9	17.2	94.4	1.75	0.65	1.1	96	27.4	0.0663	95.9	**0.10%**	0.36	95.5	**0.5%**
2015	95.9	17.3	93.5	3	1.08	1.9	96	27.5	0.1152	95.8	**0.17%**	0.45	95.3	**0.7%**
2016	95.9	17.4	92.5	4.25	1.52	2.7	96	27.7	0.1641	95.8	**0.24%**	0.54	95.1	**0.9%**
2017	95.9	17.5	91.1	5.5	2.18	3.3	96	27.8	0.1995	95.7	**0.29%**	0.63	95.0	**1.1%**
2018	95.9	17.5	89.6	7	2.85	4.2	96	27.9	0.2493	95.7	**0.36%**	0.72	94.8	**1.2%**
2019	95.9	17.6	88.2	8.5	3.52	5.0	96	28.1	0.2988	95.6	**0.43%**	0.81	94.7	**1.4%**
2020	95.9	17.7	86.3	10.5	4.42	6.1	96	28.2	0.3651	95.5	**0.52%**	0.81	94.6	**1.5%**
2021	95.9	17.8	86.3	13.5	4.44	9.1	96	28.4	0.5436	95.3	**0.77%**	0.81	94.3	**1.7%**
2022	95.9	17.9	86.3	16	4.46	11.5	96	28.5	0.6924	95.1	**0.98%**	0.90	94.0	**2.0%**

Assumes cellulosic ethanol CI at 38 gCO2e/MJ, "advanced" ethanol CI at 48 gCO2e/MJ.

Assumes full RFS compliance (16 Bgal in 2022)

Assumes that 6% of non-CA cell-EtOH is sold in NE11

For illustrative purposes for the economic analysis, calculations were rounded to tenths of g/MJ

"Other Future", Ref B
RFS2 Ethanol Volumes

NE11 Gasoline, Other Future, Ref B

									NE11 Cellulosic Ethanol			NE11 Non-Cellulosic "Advanced"		
Projection Year	CA Baseline CI (g/MJ)	CA Baseline Gasoliine (Bgal)	CA Target CI (g/MJ)	RFS2 National Cell-EtOH (Bgal)	CA LCFS Demand Cell-EtOH (Bgal)	RFS2 Remaining Cell-EtOH (Bgal)	NE11 Baseline CI (g/MJ)	NE11 Baseline Gasoline (Bgal)	NE11 Share of RFS2 Cell-EtOH (Bgal)	NE11 Average CI (g/MJ)	**NE11 CI Reduction from 2010 Baseline**	NE11 Share of RFS2 Non-Cell EtOH Advanced (Bgal)	NE11 Average CI (g/MJ)	**NE11 CI Reduction from 2010 Baseline**
2010	95.9	16.9	95.9	0.0065	0.00	0.0	96	26.9	0.0	96.0	**0.00%**	0.17	95.8	**0.2%**
2011	96.3	16.9	95.6	0.25	0.25	0.0	96.48	27.0	0.0	96.5	**-0.50%**	0.20	96.2	**-0.3%**
2012	96.8	17.0	95.4	0.5	0.50	0.0	96.96	27.1	0.0	97.0	**-1.00%**	0.27	96.6	**-0.7%**
2013	97.3	17.1	94.9	1	1.00	0.0	97.45	27.3	0.0	97.4	**-1.51%**	0.32	97.1	**-1.1%**
2014	97.8	17.2	94.4	1.75	1.46	0.3	97.93	27.4	0.1	97.7	**-1.81%**	0.36	97.3	**-1.3%**
2015	98.3	17.3	93.5	3	2.08	0.9	98.42	27.5	0.4	97.8	**-1.86%**	0.45	97.2	**-1.3%**
2016	98.8	17.4	92.5	4.25	2.70	1.6	98.92	27.7	0.7	97.8	**-1.92%**	0.54	97.2	**-1.2%**
2017	99.3	17.5	91.1	5.5	3.52	2.0	99.41	27.8	0.9	98.0	**-2.12%**	0.63	97.2	**-1.3%**
2018	99.8	17.5	89.6	7	4.33	2.7	99.91	27.9	1.3	98.1	**-2.14%**	0.72	97.1	**-1.2%**
2019	100.3	17.6	88.2	8.5	5.14	3.4	100.41	28.1	1.6	98.1	**-2.15%**	0.81	97.0	**-1.1%**
2020	100.8	17.7	86.3	10.5	6.15	4.4	100.91	28.2	2.0	97.9	**-1.94%**	0.81	96.8	**-0.9%**
2021	101.3	17.8	86.3	13.5	6.34	7.2	101.41	28.4	3.4	96.4	**-0.40%**	0.81	95.4	**0.7%**
2022	101.8	17.9	86.3	16	6.54	9.5	101.92	28.5	4.4	95.3	**0.78%**	0.90	94.1	**2.0%**

Assumes cellulosic ethanol CI at 38 gCO2e/MJ, "advanced" ethanol CI at 48 gCO2e/MJ.

Assumes full RFS compliance (16 Bgal in 2022)

Assumes that 47% of non-CA cell-EtOH is sold in NE11

For illustrative purposes for the economic analysis, calculations were rounded to tenths of g/MJ

NESCAUM

"Other Future", Ref A RFS2 Ethanol Volumes

NE11 Gasoline, Other Future, Ref A

									NE11 Cellulosic Ethanol			NE11 Non-Cellulosic "Advanced"		
Projection Year	CA Baseline CI (g/MJ)	CA Baseline Gasoliine (Bgal)	CA Target CI (g/MJ)	RFS2 National Cell-EtOH (Bgal)	CA LCFS Demand Cell-EtOH (Bgal)	RFS2 Remaining Cell-EtOH (Bgal)	NE11 Baseline CI (g/MJ)	NE11 Baseline Gasoline (Bgal)	NE11 Share of RFS2 Cell-EtOH (Bgal)	NE11 Average CI (g/MJ)	**NE11 CI Reduction from 2010 Baseline**	NE11 Share of RFS2 Non-Cell EtOH Advanced (Bgal)	NE11 Average CI (g/MJ)	**NE11 CI Reduction from 2010 Baseline**
2010	95.9	16.9	95.9	0.002275	0.00	0.0	96	26.9	0.0	96.0	**0.00%**	0.06	95.9	**0.1%**
2011	95.9	16.9	95.6	0.0875	0.11	0.0	96	27.0	0.0	96.0	**-0.03%**	0.07	95.9	**0.1%**
2012	95.9	17.0	95.4	0.175	0.22	0.0	96	27.1	0.0	96.1	**-0.06%**	0.09	95.9	**0.1%**
2013	95.9	17.1	94.9	0.35	0.43	-0.1	96	27.3	-0.1	96.1	**-0.11%**	0.11	96.0	**0.0%**
2014	95.9	17.2	94.4	0.6125	0.65	0.0	96	27.4	0.0	96.0	**-0.05%**	0.13	95.9	**0.1%**
2015	95.9	17.3	93.5	1.05	1.08	0.0	96	27.5	0.0	96.0	**-0.04%**	0.16	95.9	**0.1%**
2016	95.9	17.4	92.5	1.4875	1.52	0.0	96	27.7	0.0	96.0	**-0.04%**	0.19	95.8	**0.2%**
2017	95.9	17.5	91.1	1.925	2.18	-0.3	96	27.8	-0.3	96.3	**-0.36%**	0.22	96.1	**-0.1%**
2018	95.9	17.5	89.6	2.45	2.85	-0.4	96	27.9	-0.4	96.5	**-0.57%**	0.25	96.3	**-0.3%**
2019	95.9	17.6	88.2	2.975	3.52	-0.5	96	28.1	-0.5	96.8	**-0.78%**	0.28	96.4	**-0.4%**
2020	95.9	17.7	86.3	3.675	4.42	-0.7	96	28.2	-0.7	97.0	**-1.06%**	0.28	96.7	**-0.7%**
2021	95.9	17.8	86.3	4.725	4.44	0.3	96	28.4	0.3	95.6	**0.41%**	0.28	95.3	**0.7%**
2022	95.9	17.9	86.3	5.6	4.46	1.1	96	28.5	1.1	94.4	**1.61%**	0.32	94.1	**2.0%**

Assumes cellulosic ethanol CI at 38 gCO2e/MJ, "advanced" ethanol CI at 48 gCO2e/MJ.

Assumes 35% RFS compliance (5.6 Bgal in 2022)

Assumes that all non-CA cell-EtOH is sold in NE11

For illustrative purposes for the economic analysis, calculations were rounded to tenths of g/MJ

NESCAUM

"Other Future", Ref B RFS2 Ethanol Volumes

NE11 Gasoline, Other Future, Ref B

									NE11 Cellulosic Ethanol			NE11 Non-Cellulosic "Advanced"		
Projection Year	CA Baseline CI (g/MJ)	CA Baseline Gasoliine (Bgal)	CA Target CI (g/MJ)	RFS2 National Cell-EtOH (Bgal)	CA LCFS Demand Cell-EtOH (Bgal)	RFS2 Remaining Cell-EtOH (Bgal)	NE11 Baseline CI (g/MJ)	NE11 Baseline Gasoline (Bgal)	NE11 Share of RFS2 Cell-EtOH (Bgal)	NE11 Average CI (g/MJ)	**NE11 CI Reduction from 2010 Baseline**	NE11 Share of RFS2 Non-Cell EtOH Advanced (Bgal)	NE11 Average CI (g/MJ)	**NE11 CI Reduction from 2010 Baseline**
2010	95.9	16.9	95.9	0.00455	0.00	0.0	96	26.9	0.0	96.0	**0.01%**	0.12	95.9	**0.2%**
2011	96.3	16.9	95.6	0.175	0.25	-0.1	96.48	27.0	-0.1	96.6	**-0.61%**	0.14	96.4	**-0.4%**
2012	96.8	17.0	95.4	0.35	0.50	-0.2	96.96	27.1	-0.2	97.2	**-1.23%**	0.19	97.0	**-1.0%**
2013	97.3	17.1	94.9	0.7	1.00	-0.3	97.45	27.3	-0.3	97.9	**-1.96%**	0.22	97.6	**-1.7%**
2014	97.8	17.2	94.4	1.225	1.46	-0.2	97.93	27.4	-0.2	98.3	**-2.37%**	0.25	98.0	**-2.1%**
2015	98.3	17.3	93.5	2.1	2.08	0.0	98.42	27.5	0.0	98.4	**-2.49%**	0.32	98.0	**-2.1%**
2016	98.8	17.4	92.5	2.975	2.70	0.3	98.92	27.7	0.3	98.5	**-2.61%**	0.38	98.0	**-2.1%**
2017	99.3	17.5	91.1	3.85	3.52	0.3	99.41	27.8	0.3	98.9	**-3.04%**	0.44	98.4	**-2.5%**
2018	99.8	17.5	89.6	4.9	4.33	0.6	99.91	27.9	0.6	99.1	**-3.19%**	0.51	98.4	**-2.5%**
2019	100.3	17.6	88.2	5.95	5.14	0.8	100.41	28.1	0.8	99.2	**-3.34%**	0.57	98.5	**-2.6%**
2020	100.8	17.7	86.3	7.35	6.15	1.2	100.91	28.2	1.2	99.1	**-3.25%**	0.57	98.4	**-2.5%**
2021	101.3	17.8	86.3	9.45	6.34	3.1	101.41	28.4	3.1	96.8	**-0.80%**	0.57	96.0	**-0.1%**
2022	101.8	17.9	86.3	11.2	6.54	4.7	101.92	28.5	4.7	94.9	**1.12%**	0.63	94.1	**2.0%**

Assumes cellulosic ethanol CI at 38 gCO2e/MJ, "advanced" ethanol CI at 48 gCO2e/MJ.

Assumes 70% RFS compliance (10 Bgal in 2022)

Assumes that all non-CA cell-EtOH is sold in NE11

For illustrative purposes for the economic analysis, calculations were rounded to tenths of g/MJ

RFS2 Biodiesel Volumes, Ref A

Reference Case A: Diesel

Projection Year	CA Baseline CI (g/MJ)	CA Baseline Diesel (Bgal)	CA Target Diesel CI (g/MJ)	RFS2 National Biodiesel (Bgal)	CA LCFS Demand Biodiesel (Bgal)	RFS2 Remaining Biodiesel (Bgal)	NE11 Baseline Diesel CI (g/MJ)	NE11 Baseline Diesel (Bgal)	NE11 Share of RFS2 Biodiesel (Bgal)	NE11 Average Diesel CI (g/MJ)	NE11 CI Reduction from Baseline
2010	94.7	3.8	94.7	0.65	0.00	0.7	94	6.3	0.13	93.1	**0.96%**
2011	94.7	3.9	94.5	0.8	0.02	0.8	94	6.4	0.16	92.9	**1.12%**
2012	94.7	3.9	94.2	1	0.05	1.0	94	6.5	0.19	92.7	**1.35%**
2013	94.7	4.0	93.8	1	0.10	0.9	94	6.6	0.18	92.8	**1.26%**
2014	94.7	4.1	93.3	1	0.15	0.9	94	6.7	0.17	92.9	**1.16%**
2015	94.7	4.1	92.3	1	0.25	0.7	94	6.8	0.15	93.1	**1.00%**
2016	94.7	4.2	91.4	1	0.36	0.6	94	7.0	0.13	93.2	**0.85%**
2017	94.7	4.3	90.0	1	0.52	0.5	94	7.1	0.10	93.4	**0.62%**
2018	94.7	4.4	88.6	1	0.69	0.3	94	7.2	0.06	93.6	**0.40%**
2019	94.7	4.4	87.1	1	0.86	0.1	94	7.3	0.03	93.8	**0.17%**
2020	94.7	4.5	85.2	1	1.10	0.0	94	7.4	0.00	94.0	**0.00%**
2021	94.7	4.6	85.2	1	1.11	0.0	94	7.6	0.00	94.0	**0.00%**
2022	94.7	4.7	85.2	1	1.13	0.0	94	7.7	0.00	94.0	**0.00%**

Assumes biodiesel CI at 47 gCO2e/MJ.

For illustrative purposes for the economic analysis, calculations were rounded to tenths of g/MJ

RFS2 Biodiesel Volumes, Ref B

Reference Case B: Diesel

Projection Year	CA Baseline CI (g/MJ)	CA Baseline Diesel (Bgal)	CA Target Diesel CI (g/MJ)	RFS2 National Biodiesel (Bgal)	CA LCFS Demand Biodiesel (Bgal)	RFS2 Remaining Biodiesel (Bgal)	NE11 Baseline Diesel CI (g/MJ)	NE11 Baseline Diesel (Bgal)	NE11 Share of RFS2 Biodiesel (Bgal)	NE11 Average Diesel CI (g/MJ)	NE11 CI Reduction from Baseline
2010	94.7	3.8	94.7	0.65	0.00	0.7	94	6.3	0.13	93.1	**0.96%**
2011	95.2	3.9	94.5	0.8	0.07	0.7	94.5	6.4	0.15	93.5	**1.06%**
2012	95.7	3.9	94.2	1	0.14	0.9	94.9	6.5	0.17	93.8	**1.23%**
2013	96.1	4.0	93.8	1	0.24	0.8	95.4	6.6	0.16	94.4	**1.08%**
2014	96.6	4.1	93.3	1	0.33	0.7	95.9	6.7	0.14	95.0	**0.93%**
2015	97.1	4.1	92.3	1	0.48	0.5	96.4	6.8	0.11	95.7	**0.72%**
2016	97.6	4.2	91.4	1	0.63	0.4	96.9	7.0	0.08	96.4	**0.51%**
2017	98.1	4.3	90.0	1	0.83	0.2	97.3	7.1	0.04	97.1	**0.23%**
2018	98.6	4.4	88.6	1	1.03	0.0	97.8	7.2	0.00	97.8	**0.00%**
2019	99.1	4.4	87.1	1	1.23	0.0	98.3	7.3	0.00	98.3	**0.00%**
2020	99.6	4.5	85.2	1	1.49	0.0	98.8	7.4	0.00	98.8	**0.00%**
2021	100.1	4.6	85.2	1	1.55	0.0	99.3	7.6	0.00	99.3	**0.00%**
2022	100.6	4.7	85.2	1	1.61	0.0	99.8	7.7	0.00	99.8	**0.00%**

Assumes biodiesel CI at 47 gCO2e/MJ.

For illustrative purposes for the economic analysis, calculations were rounded to tenths of g/MJ

Federal Policy: CAFE

- Assume new 2010 CAFE standards for all states through 2016
- Ref Case A assumes no additional mileage improvements for 2017 and later
- Ref Case B assumes CARB Pavley2 projections for 2017 and later
- Actual fleet average will be slightly lower (real-world) per EIA's *Annual Energy Outlook*

Light-Duty Model-Year Average Fuel Economy (mpg)		
	Ref Case A	**Ref Case B**
2011	27.8	27.8
2012	28.9	28.9
2013	29.8	29.8
2014	30.6	30.6
2015	32.1	32.1
2016	34.1	34.1
2017	34.1	37.7
2018	34.1	40.1
2019	34.1	41.6
2020+	34.1	42.5

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Regional Policy: ZEV Requirements

- 8 states in region have adopted California's Zero-Emission Vehicle requirements: CT, MD, ME, MA, NJ, NY, RI, VT
  - Reference cases assume full ZEV implementation in these states
  - Limited volumes of PHEVs required beginning in 2012
  - "Pure" ZEV (battery-electric or fuel cell vehicles) required starting with model year 2018

	ZEV			PHEV		
	Credit requirement (% of fleet)	Credits per vehicle	Vehicle Requirement (% of fleet)	Credit requirement (% of fleet)	Credits per vehicle	Vehicle Requirement (% of fleet)
2012 - 2014	-	3	-	2.2%	1.5	1.5%
2015 - 2017	-	3	-	3.0%	1.5	2.0%
2018 +	5.0%	3	1.7%	2.5%	1.5	1.7%

  - ZEV program impacts in 2022:
    - Total CI reduction of 0.3 g/MJ
    - 18,000 BEVs, 54,000 PHEVs
    - Total electric demand = 1,900 GWh
- EV/PHEV Technology:
  - Assume energy economy ratio (EER) of 3.0 for BEV and PHEV
  - Assume 22-mi all-electric range (AER) for reference case PHEVs (per CARB ZEV ISOR Table 4.2); higher value or distribution of values for "Electric Future" scenarios
  - Use VISION default method (based on SAE J1711) to calculate electric VMT % based on AER

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Regional Policy: Regional Greenhouse Gas Initiative (RGGI)

- Assume full compliance with regional cap-and-trade program limiting CO_2 emissions from large power plants (>25MW) in 10 LCFS states:
  - Cap limit equals 188.1M short tons of CO_2 from 2009 to 2014; 2.5% reduction in CO_2 emissions each year from 2015 to 2018;

- Assume maintenance of RGGI program after 2018 (i.e., 10% reduction achieved by 2018, no additional reductions required thereafter).

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State Policy: Renewable Energy Standards

- Assume full compliance with goals of mandatory state renewable portfolio standards (RPS);
- Assume no additional requirements for renewables beyond last year of any given state's RPS timeframe.

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State Policy: MA Biofuel Mandate

- Massachusetts requires 2% blend in biodiesel sold in the state, beginning in 2010, with a 50% lifecycle GHG improvement from baseline diesel fuel;

- MA Department of Energy Resources is proposing use of EPA's 2012 values for GHG lifecycle emissions of biodiesel

- Volumes of biodiesel (B100) required to meet mandate:
  - 12M gallons for heating market +
  - <u>8M gallons for transportation market</u>
  - 20M gallons total

Source: MA DOER estimates, 2010.

State Policy: PA Biofuel Mandate

- Pennsylvania: "Act 78 of 2008 – The Biofuel Development and In-State Production Incentive Act" requires 2% biodiesel blend in all diesel sold in PA, starting in May 2010.
- PA's annual market for on-road diesel in 2010 is 1.8B gallons;
- ~36M gallons of biodiesel (B100) is required to meet PA's B2 blending standard in 2010.
- Annual growth in demand for on-road diesel is projected to be 0.57% per year.

Source: PA DEP estimates, 2010.

State Waste Policies

- State policies addressing the treatment and management of municipal solid waste can affect the degree to which municipal solid waste (MSW) feedstocks can be used for low carbon fuel production;
- For example, at least two states (MA and DE) have policies that are effective moratoriums on the use of MSW for additional waste-to-energy (i.e., electricity);
- Other state policies will be reviewed to ensure any restrictions or limitations are considered when estimating MSW available for low carbon fuel production.

Overview of Existing Low Carbon Fuel Development, Production, & Distribution

# of Companies

Sub-Sector	CT	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	Total
Research & Development		2	1			1	3					**7**
Biodiesel Production*	3	1		2	2	2	2	3	11		3	**29**
Biodiesel Distribution	12	1	10	5	2	5	23	26	48	3	1	**136**
Ethanol Production								2	1			**3**
Total	15	4	11	7	4	8	28	31	60	3	4	

*May include facilities that have recently shut down. NESCAUM is verifying this number with the states.

Low Carbon Fuel Research and Development

Company / Institute	State	Sector
Elcriton Inc.	DE	Organic chemical manufacturing
Center for Carbon Free Integration (University of Delaware)	DE	Basic low carbon fuel / technology research
Mascoma	NH	Cellulosic ethanol
DSM Innovation Inc	NJ	Cellulosic ethanol
Rutgers Biotechnology Center for Agg. & Env.	NJ	Basic low carbon fuel / technology research
Transmediair Inc.	NJ	Biomass gasification
New England Community Renewable Energies	MA	Biofuel / solar technology research

Source: Personal communication with State energy and environmental agencies, 2010.

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Ethanol and Biodiesel Production in LCFS States

Ethanol Producers

Company	Location	State	Feedstock	Nameplate Capacity (mgy)	Operating Production (mgy)
Sunoco	Volney	NY	Corn	114	
Western New York Energy LLC	Shelby	NY	Corn	50	50
Bional Clearfield	Clearfield	PA	Corn	110	110
Total				**274**	**160**

Source: Renewable Fuel Association Statistics

Biodiesel Producers

Company	Location	State	Annual Production Capacity (gal)	Feedstock	Operating Since
MBP Bioenergy, LLC	Attleboro	MA	500,000	Recycled Cooking Oil	November 2006
Eagle Creek Fuel Services,LLC	Baltimore	MD	1,000,000		August 2008
Greenlight Biofuels, LLC	Princess Anne	MD	4,000,000	Multi Feedstock	October 2007
Maryland Biodiesel	Berlin	MD	1,000,000	Soy	June 2006
MBP		NH	1,000,000	Waste vegetable oil	
White Mountian Biodiesel		NH	3,000,000	Waste vegetable oil	
Fuel Bio One, LLC	Elizabeth	NJ	50,000,000	Multi Feedstock	March 2007
Innovation Fuels	Newark	NJ	40,000,000	Multi Feedstock	July 2004
Buffalo Biodiesel, Inc	Tonawanda	NY	1,500,000	Recycled Cooking Oil	June 2008
Northern Biodiesel, Inc.	Ontario	NY			June 2008
Biodiesel of Pennsylvania,Inc	White Deer	PA	1,500,000	Multi Feedstock	March 2007
Keystone BioFuels, Inc.	Shiremanstown	PA		Multi Feedstock	March 2006
Lake Erie Biofuels	Erie	PA	45,000,000	Soy	September 2007
Middletown Biofuels, LLC	Middletown	PA	5,000,000	Soy	June 2007
Soy Energy, Inc.	New Oxford	PA	1,500,000	Soy	February 2007
United Biofuels, Inc.	York	PA	3,000,000	Multi Feedstock	April 2006
United Oil Company	Pittsburgh	PA	5,000,000	Multi Feedstock	December 2005
Mason Biodiesel, LLC	Westerly	RI	2,500,000	Recycled Cooking Oil	June 2007
Newport Biodiesel, LLC	Newport	RI	300,000	Recycled Cooking Oil	January 2008
Bicardel	Swanton	VT	4,000,000		
Total			169,800,000		

Source: National Biodiesel Board Statistics

Existing CNG and Electric Vehicle Infrastructure

- Currently collecting and reviewing data on existing CNG and EV vehicles and infrastructure in 11-state region;
- Will likely assume low to modest no. of CNG and EV vehicles and related infrastructure for both Ref Cases (A and B);
- All infrastructure for the policy scenarios involving these fuels and technologies will be incremental to our Ref Case A and B estimates.

III. LCFS Policy Scenarios

- Definitions of LCFS Policy Scenarios
- Calculating Results for LCFS Policy Scenarios
- LCFS Costs
- LCFS Benefits
- Global Economic Assumptions

Definitions of Proposed LCFS Scenarios

Proposed LCFS policy scenarios were defined to accomplish the following objectives:

- Meet a 10% reduction in carbon intensity of transportation fuels over 10 years
- Account for broad range of possibilities and uncertainties about the future:
  - Rates of innovation and commercialization of low carbon fuels & technologies
  - Costs of future low carbon fuels and infrastructure
  - Consumer preferences and market penetration
  - General economic conditions
- Recognize the technology-forcing role of LCFS as a performance standard
- Have internal consistency
- Address interests of multiple stakeholders with diverse concerns
- Provide policy insights within given resources and schedule

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LCFS Policy Scenario 1: "Biofuels Future"

- Assumes biofuels and biofuel-capable vehicles become dominant fuel and technology, respectively, for meeting LCFS;
- Consistent with high biofuel penetration: relatively fast innovation in biofuels, relatively low feedstocks costs and lower fuel CI, adequate supply of feedstocks from the region
- "Biofuels Future" scenarios: assume CA receives highest proportion of RFS2-mandated advanced fuels; NE-11 states receive proportional share of remainder

Key Variables:	**"Biofuels Future"**
Technology penetration	Hi rate of biofuel innovation
% of LCFS compliance	Biofuels-6%; CNG and EVs-2% each
Prices of low C fuels	Biofuels low, others high
Prices of low C infrastructure	Biofuels low, others high
CI Values	Biofuels low, others high
Target Level	10%
Availability of in-region fuels	Feedstocks for fuels high, others low

LCFS Policy Scenario 2: "CNG Future"

- Assumes that CNG and CNG vehicles become a dominant fuel and technology, respectively, for meeting 10% LCFS;

- Consistent with high CNG penetration are: high consumer acceptance of CNG vehicles, relatively low NG costs and NG CI, adequate supply of NG from the region;

- Smaller proportion of RFS2 advanced biofuels to NE-11 market than in "Biofuel Future"

Key Variables:	**"CNG Future"**
Technology penetration	Hi rate of CNG penetration (vehicles & infrastructure)
% of LCFS compliance	CNG-6%; EV and Biofuels-2% each
Prices of low C fuels	CNG low, others high
Prices of low C infrastructure	CNG low, others high
CI Values	CNG low, others high
Target Level	10%
Availability of in-region fuels	NG avail high, other low

Policy Scenario 3: "Electric Vehicle Future"

- Assumes that electricity and electric vehicles become the dominant fuel and technology, respectively, for meeting the LCFS;
- Consistent with high EV penetration are: high consumer acceptance of EVs, relatively low electricity costs, low electric CI, optimal use of additional grid capacity;
- Smaller proportion of RFS2 advanced biofuels to NE-11 market than in "Biofuel Future"

Key Variables:	**"Electric Vehicle Future"**
Technology penetration	Hi rate of EV penetration/grid innovation
% of LCFS compliance	EVs-6%; CNG and Biofuels-2% each
Prices of low C fuels	Elec low, others med to high
Prices of low C infrastructure	Elec low, others high
CI Values	Elec low, others high
Target Level	10%
Availability of in-region fuels	Elec capacity high, others low

EV/PHEV Scenario Volumes: DRAFT Estimates

- 2% CI reduction could be achieved with (for example):
  - BEVs at 6% market share in 2022
    - Sales share increases linearly from 0.5% in 2012
    - Total 1.5M BEVs, 12000 GWh
  - PHEVs at 15% market share in 2022
    - Sales share increases linearly from 1% in 2012
    - Total 3.7M PHEVs, 9300 GWh

- 6% CI reduction could be achieved with (for example):
  - BEVs at 19% market share in 2022
    - Sales share increases linearly from 1% in 2012
    - Total 4.7M BEVs, 38000 GWh
  - PHEVs at 35% market share in 2022
    - Sales share increases linearly from 1% in 2012
    - Total 8.5M PHEVs, 30000 GWh
    - AER increases from 22 in 2012 to 40 in 2022

Sensitivity Analyses

- **Target level:** 5% and 15% targets will be calculated as linear extrapolation of results from policy scenarios based on 10% target

- **Compliance schedule and/or program duration:** we can vary the "shape" of the compliance schedule, and/or analyze a longer time horizon (e.g., 15 or 20 yrs) for compliance with a 10% LCFS target

  - Either sensitivity approach will analyze the impact of allowing more time for commercialization of low carbon technologies and fuels

- **Heating oil:** as a sensitivity to the "Biofuel Future" scenario, the heating oil sector will face a 0% reduction target and will be assumed to generate credits that can be purchased for compliance by regulated entities

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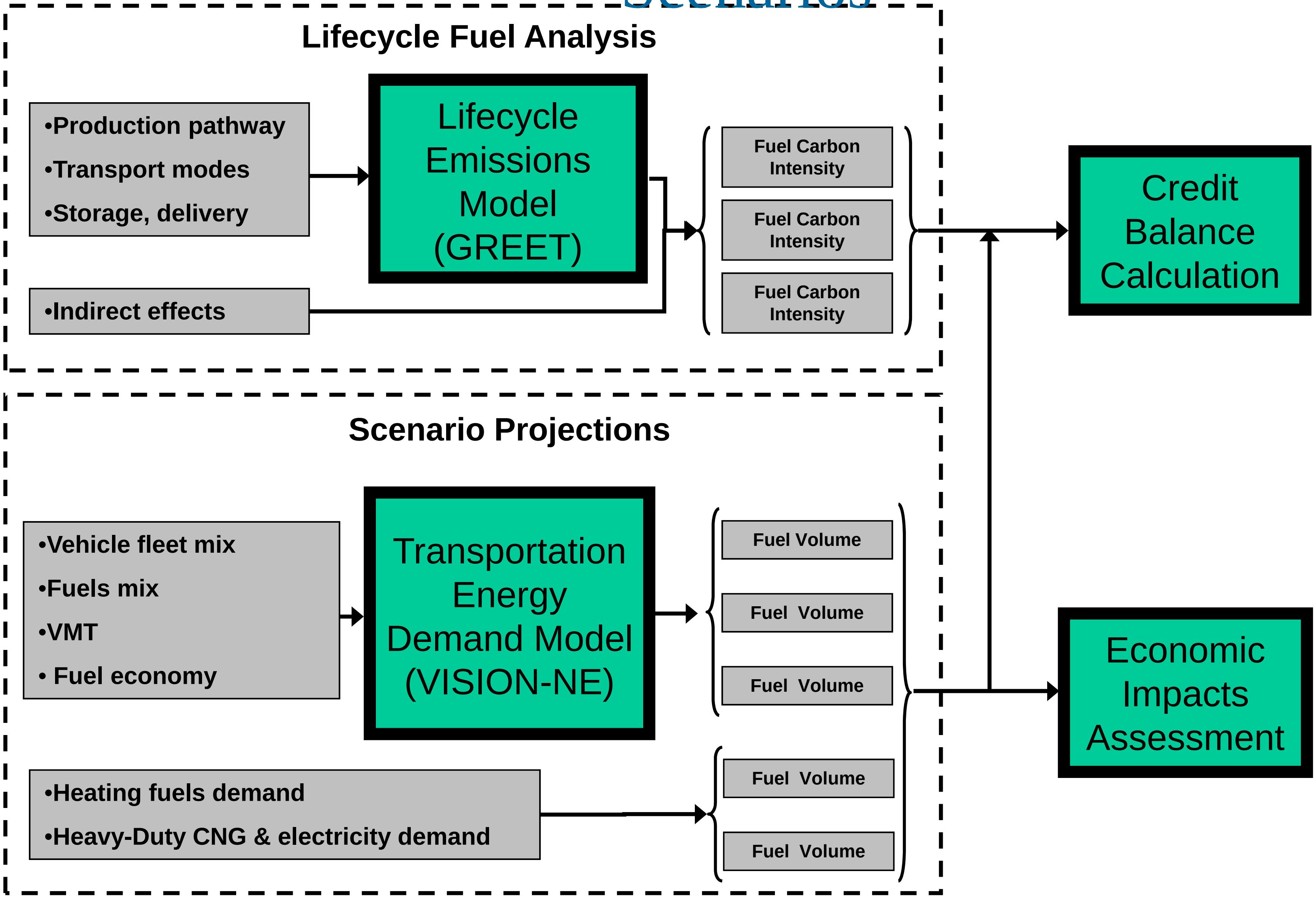
Calculating Results of LCFS Policy Scenarios



Key Assumptions for Calculating Policy Results

- NE-VISION
  - Assume all VISION defaults except where noted
- GREET
  - Use all GREET default values except:
    - » Regional electricity mix
    - » Baseline crude oil mix
- CI values based on EPA, CARB, and LCA estimates
- Diesel baseline includes non-road (Commercial & Industrial)
  - Fuel volumes from EPA NONROAD model and EIA (State Energy Data System)
- Fleet characteristics based on VISION/AEO default, apportioned to states using EIA/SEDS fuel sales volumes
- All fuel specs based on GREET defaults
- All fuel energy density estimates based on lower heating value (LHV)

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Energy Economy Ratio (EER)

- Necessary to account for variation in tank-to-wheel efficiency (miles per MJ) for substitute fuels
- Enables "apples-to-apples" comparison of various fuels based on the utility each fuel provides

$$CI_{electricity} = CI_{grid} / EER$$

- Sensitivity to EER will be captured by varying total electricity CI
- Use CARB Published EER values*:
  - Electricity:Gasoline = 3.0
  - Electricity: Diesel = 2.7
  - CNG:Diesel = 0.9

*CARB LCFS Final Regulation Order, Table 5

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DRAFT: Preliminary assumptions for economic analysis 4/15/10

Proposed Carbon Intensity (CI) Values

Proposed Range of CI Values for LCFS Economic Analysis				
Fuel Pathway	**Carbon Intensity (gCO_2e/MJ)**			**Source(s)**
	Low-end		**High-end**	
Corn Ethanol	48		99	EPA RFS 2022 value for low; CARB 2010 for high
Sugarcane EtOH	36		73	EPA RFS 2022 value for low; CARB 2010 for high
Cellulosic ethanol, residual	-27			EPA RFS 2022 value
Cellulosic ethanol, virgin	-9		EPA direct plus CARB iLUC	EPA RFS 2022 value for low; EPA direct plus CAR
Waste grease biodiesel	13		16	EPA RFS 2022 value for low; CARB 2010 for high
Soy-based biodiesel	40		83	EPA RFS 2022 value for low; CARB 2010 for high
Cellulosic diesel, residual		8		EPA RFS 2022 value
Cellulosic diesel, virgin		27		EPA RFS 2022 value
Natural gas, Marcellus shale		TBD		Lifecycle Associates, under development
Natural gas, Northeast		71		Lifecycle Associates, 2008
LNG		78		Lifecycle Associates, 2008
LNG, biogas		16		CARB 2010
CNG, N. America, compressed in CA		73		Lifecycle Associates, 2008
CNG from landfill gas		11		CARB 2010
Hydrogen, central reforming		142		CARB 2010
Hydrogen on-site reforming w. RE		76		CARB 2010
Electricity, 2012	TBD		TBD	
Electricity, 2022	TBD		TBD	

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Proposed Carbon Intensity (CI) Values: Electricity

- 2012 CI for electricity will be based on CO_2 emissions rate averaged across 3 power grids (ISO-New England, NY-ISO, and PJM), weighted by electricity demand (3-year average) in each respective grid;

- 2022 CI for electricity will be estimated, based on assumptions of full compliance with relevant state and regional policies that will affect the GHG-intensity of electricity production in LCFS states (state RPSs, RGGI).

Costs of Low Carbon Fuels

Proposed Costs for:

- Low Carbon Fuel Production
- Related Fuel Infrastructure
- LCFS Program Costs

LCFS Cost Categories

- ***Costs of Low Carbon Fuel Production:***
  - Cellulosic ethanol
  - Advanced biodiesel
  - Electricity for PHEV/EVs
  - CNG
  - Other
- ***Costs of Related Fuel Infrastructure:***
  - Blending infrastructure
  - Delivery infrastructure (e.g., E85 delivery, CNG stations)
  - PHEV/EV infrastructure (e.g., charging stations)
- ***Program Costs:***
  - Reporting costs (to industry)
  - Program implementation and enforcement costs (to states)

Projected Ethanol Costs, Low-end

- EPA's estimates of ethanol costs for 2022 will be used as low-end of cost range for ethanol:
  - Corn ethanol: $1.69 to $1.73/gal
  - Cellulosic ethanol: $1.46 to 1.50/gal
  - Imported ethanol: $1.69 to $1.73/gal

Average 2022 Production and Distribution Costs for Ethanol Fuels

	Production Cost (c/gal)	Low Ethanol Case		Primary Case Mid Ethanol Case		High Ethanol Case	
		Distribution Cost	Total Cost	Distribution Cost	Total Cost	Distribution Cost	Total Cost
Corn Ethanol	150	23.2	173.2	21.6	171.6	18.8	168.8
Cellulosic Ethanol	127	23.2	150.2	21.6	148.6	18.8	145.8
Imported Ethanol	150	23.2	173.2	21.6	171.6	18.8	168.8

Source: EPA RFS Regulatory Impact Analysis, 2010.

Projected Ethanol Costs, High-end

		Ethanol					
Year	Projected Crude Price ($/bbl)	Midwest Corn (dry mill)	Midwest Corn (wet mill)	Lignocell. (wood chips)	Sugarcane (Brazil)	Lignocell. (corn stover)	Green Wastes
2010	$66	$2.87	$2.87	$2.70	$3.25	$3.19	$2.31
2011	$68	$2.89	$2.90	$2.71	$3.26	$3.20	$2.31
2012	$70	$2.91	$2.92	$2.72	$3.27	$3.22	$2.32
2013	$73	$2.94	$2.96	$2.73	$3.28	$3.23	$2.32
2014	$76	$2.97	$3.00	$2.74	$3.29	$3.26	$2.33
2015	$79	$2.99	$3.03	$2.75	$3.30	$3.27	$2.33
2016	$81	$3.01	$3.05	$2.76	$3.31	$3.28	$2.33
2017	$83	$3.03	$3.07	$2.77	$3.32	$3.29	$2.34
2018	$84	$3.04	$3.09	$2.77	$3.32	$3.30	$2.34
2019	$86	$3.06	$3.11	$2.78	$3.33	$3.31	$2.34
2020	$88	$3.07	$3.13	$2.78	$3.34	$3.32	$2.35

Source: CARB 2009. Note: Sugarcane ethanol price includes $0.54 import tariff.

- CARB estimates prices will be used as high-end of price range for ethanol:
  - Conventional ethanol: $2.87 to over $3/gal
  - Cellulosic ethanol: $2.70 to 3.32/gal (depending on feedstock)
  - Waste-based ethanol: $2.31 to 2.35/gal

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Projected Production Costs: Biodiesel and CNG

- CARB estimates of biodiesel costs in 2012 are:
  - Soybean biodiesel: $3.15/gal
  - Waste oil biodiesel: $1.68/gal
  - Fisher-Tropsch biodiesel: $3.77
- CARB estimates of CNG in 2012 are:
  - $1.86/gal

	Biodiesel				
Year	FAME (Soybean Oil)	FAME, Yellow Grease (waste grease)	F-T (Wood chips)	FAHC (Yellow Grease)	CNG[2]
2010	$3.15	$1.66	$3.74	$1.57	1.81
2011	$3.18	$1.67	$3.76	$1.58	1.83
2012	$3.21	$1.68	$3.77	$1.59	1.86
2013	$3.24	$1.70	$3.79	$1.60	1.87
2014	$3.29	$1.72	$3.82	$1.62	1.90
2015	$3.32	$1.73	$3.84	$1.63	1.92
2016	$3.35	$1.75	$3.85	$1.64	1.96
2017	$3.37	$1.75	$3.87	$1.65	1.97
2018	$3.39	$1.76	$3.88	$1.65	1.99
2019	$3.41	$1.77	$3.89	$1.66	2.02
2020	$3.43	$1.78	$3.90	$1.67	2.04

Source: CARB, 2009.

Projected Biodiesel Costs, 2022

Average 2022 Production and Distribution Costs for Biodiesel Fuels

	Production Cost (c/gal)	Low Ethanol Case		Primary Case Mid Ethanol Case		High Ethanol Case	
		Distribution Cost	Total Cost	Distribution Cost	Total Cost	Distribution Cost	Total Cost
Biodiesel from virgin oils	273	20.0	293	20.0	293	20.0	293
Biodiesel from waste oil	243	20.0	263	20.0	263	20.0	263
Biodiesel from corn oil	190	20.0	210	20.0	210	20.0	210
Biodiesel from algae oil	452	20.0	472	20.0	472	20.0	472
Renewable Diesel Fuel from waste oil	242	15.7	257.7	15.4	257.4	14	256
Cellulosic diesel from BTL	237	15.7	252.7	15.4	252.4	14	251

Source: EPA RFS2 RIA, 2010.

DRAFT: Preliminary assumptions for economic analysis 4/15/10

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State Electricity Price Forecasts (cents/kwh)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
CT															
Residential	16.9	19.1	19.6	18.2	17.0	17.1	17.2	17.3	17.5	17.6	17.7	17.8	18.0	18.1	18.2
Commercial & Industrial[1]	14.8	16.2	17.0	17.6	18.2	18.2	18.6	18.9	19.3	19.7	20.2	20.7	21.1	21.3	21.4
DE															
Residential	11.5	13.2	13.9	13.7	13.5	13.5	13.6	13.7	13.8	13.9	14.0	14.1	14.2	14.3	14.3
Commercial	10.2	11.2	12.1	11.7	11.3	11.3	11.4	11.4	11.5	11.5	11.6	11.6	11.7	11.8	11.8
Industrial	7.7	8.9	10.5	10.1	9.7	9.7	9.8	9.8	9.8	9.9	9.9	10.0	10.0	10.0	10.1
NJ															
Residential	12.6	14.2	15.7	16.1	16.1	16.4	17.1	18.0	19.1	20.2	21.6	23.2	24.7	26.3	28.3
Commercial	11.7	13.1	14.6	13.5	12.9	13.2	13.6	14.3	15.0	15.7	16.7	17.5	18.5	19.7	21.1
Industrial	9.3	11.3	12.6	11.3	10.9	11.0	11.3	11.6	12.0	12.5	13.1	13.6	14.2	15.0	15.9
MA															
Residential	16.6	16.2	17.7	16.5	15.3	15.5	15.6	15.7	15.8	15.9	16.0	16.1	16.3	16.4	16.5
Commercial	15.5	15.2	15.8	14.1	12.6	12.6	12.7	12.8	12.8	12.9	13.0	13.1	13.1	13.2	13.3
Industrial	13.0	13.0	14.9	12.5	10.6	10.6	10.6	10.7	10.7	10.7	10.7	10.8	10.8	10.8	10.9
MD															
Residential	9.7	11.9	13.8	14.2	14.0	14.1	14.3	14.5	14.6	14.8	15.0	15.1	15.3	15.5	15.7
Commercial	10.6	11.6	12.8	11.5	11.1	11.1	11.2	11.2	11.3	11.4	11.4	11.5	11.5	11.6	11.6
Industrial	8.1	9.4	10.4	9.4	9.0	9.1	9.1	9.1	9.2	9.2	9.3	9.3	9.3	9.4	9.4
ME															
Residential	13.8	16.5	16.2	15.1	14.1	14.2	14.3	14.4	14.5	14.6	14.7	14.8	14.9	15.0	15.1
Commercial	12.4	12.9	13.0	11.6	10.3	10.4	10.4	10.5	10.6	10.6	10.7	10.7	10.8	10.9	10.9
Industrial	8.8	14.1	11.7	9.9	8.3	8.3	8.4	8.4	8.4	8.4	8.5	8.5	8.5	8.5	8.6
NH															
Residential	14.7	14.9	15.7	14.6	13.6	13.7	13.8	13.9	14.0	14.1	14.2	14.3	14.4	14.5	14.6
Commercial	14.1	13.9	14.3	12.8	11.4	11.5	11.5	11.6	11.6	11.7	11.8	11.8	11.9	12.0	12.0
Industrial	11.6	12.3	13.2	11.1	9.4	9.4	9.4	9.4	9.5	9.5	9.5	9.6	9.6	9.6	9.6
NY															
Residential[2]	16.9	17.1	18.3	17.8	17.0	16.0	16.6	16.6	16.5	16.5	16.6	16.7	16.7	16.7	16.8
Commercial & Industrial[3]	14.5	14.4	15.7	15.3	14.6	13.8	14.2	14.3	14.2	14.2	14.3	14.4	14.4	14.4	14.5
PA															
Residential[4]	10.2	10.7	11.1	10.0	9.0	9.1	9.2	9.3	9.4	9.5	9.6	9.8	9.9	10.0	10.1
Commercial & Industrial[4]	7.0	7.2	7.2	6.1	5.1	5.2	5.2	5.3	5.4	5.5	5.5	5.6	5.7	5.8	5.8
RI															
Residential	15.1	14.1	17.5	16.3	15.1	15.2	15.4	15.5	15.6	15.7	15.8	15.9	16.0	16.2	16.3
Commercial	13.5	12.7	15.4	13.7	12.2	12.3	12.4	12.4	12.5	12.6	12.6	12.7	12.8	12.8	12.9
Industrial	12.5	12.0	14.2	12.0	10.1	10.1	10.2	10.2	10.2	10.2	10.3	10.3	10.3	10.4	10.4
VT															
Residential[5]	13.3	14.1	14.6	14.8	15.1	15.4	15.7	16.1	16.4	16.7	18.1	19.5	21.1	22.7	24.6
Commercial & Industrial[5]	10.0	10.6	11.1	11.3	11.5	11.7	12.0	12.2	12.4	12.7	13.7	14.8	16.0	17.3	18.7

Blue: Indicates EIA State Electricity Profiles Data
Orange: Indicates NESCAUM projections based on regional AEO 2009 electricity price forecasts
Black: Indicates State provided data
1: VT 2009 Inegrated Resource Plan Price Forecast
2: NYSERDA Patterns & Trends (06-08)
3: 2009 - 2020 indexed by EIA national price projections.
4: PA Public Utilities Commission
5: VT Department of Public Service

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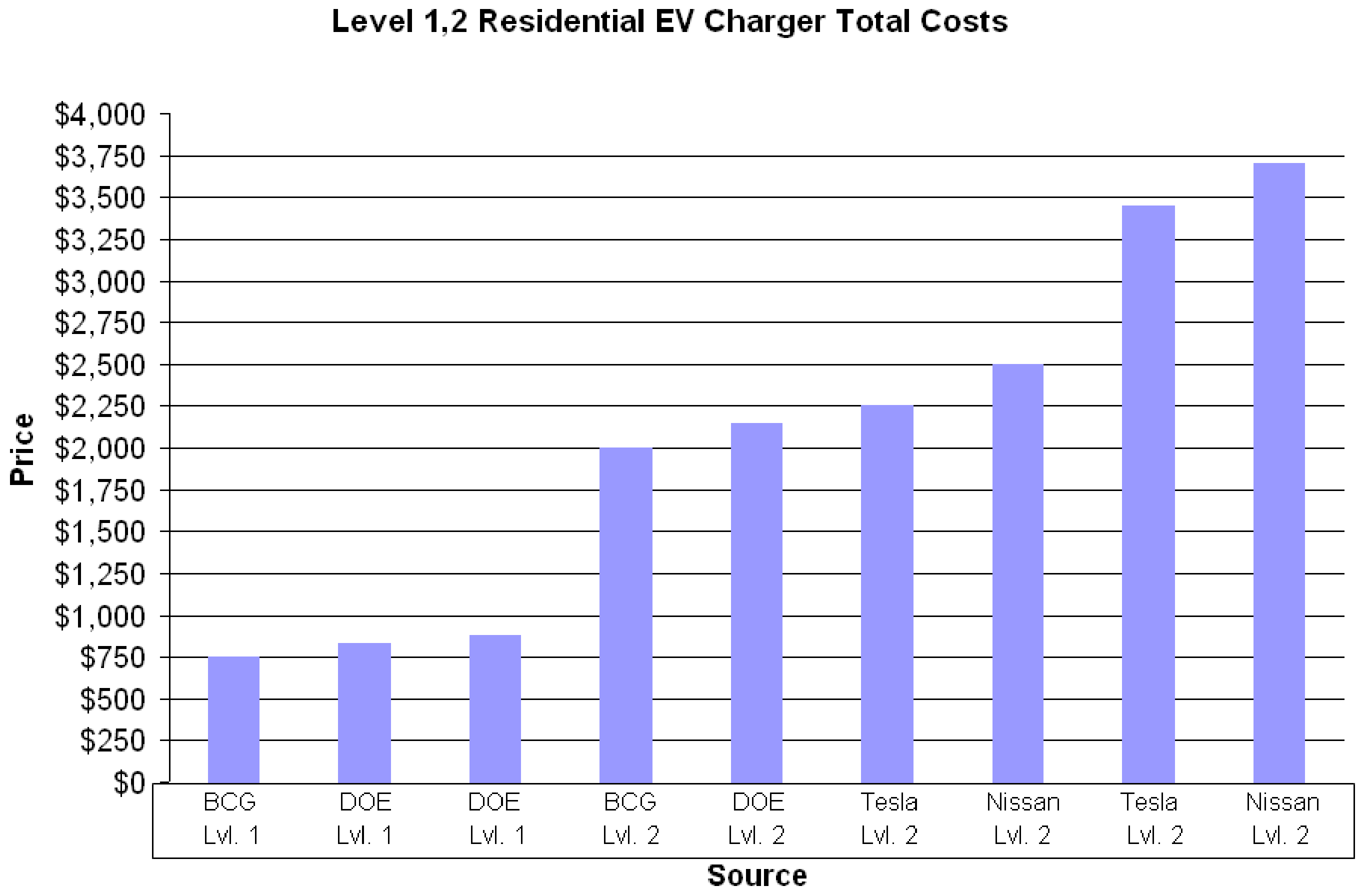
Projected Costs of Level 1 and 2 Residential EV Chargers*



*Includes capital and installation costs. Nissan and Tesla total cost estimates based on their estimated capital costs plus BCG installation cost estimates. Sources: Boston Consulting Group, DOE, Tesla, Nissan.

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Costs of Related Low Carbon Fuel Infrastructure

- Proposed range of EV Infrastructure Costs:
  - Home chargers, Level 1: $750 to ~$850
  - Home charging, Level 2: $2,000 to ~$3,700
  - Public charging stations: $4,500

Sources: Boston Consulting Group, DOE, Tesla, Nissan, California Energy Commission.

- CNG Infrastructure:
  - CNG fueling stations: $370,000 (upgrade existing station) to $1M (new station)

Source: California Air Resources Board, *Initial Statement of Reasons* (Vol.1), 2009.

- E85infrastructure:
  - Ethanol blending equipment: $310K per facility
  - Truck unloading equipment: $500K per facility
  - E85 retail fueling stations: $131K (1 dispenser) to $177K (3 dispensers) per new facility; $130K to upgrade existing pump from 1 to 3 dispensers

Sources: CARB 2009. EPA RFS2 RIA, 2010.

- Biodiesel infrastructure:
  - Biodiesel blending equipment: $400K per terminal
  - Biodiesel piping: $60K per terminal

Sources: CARB 2009. EPA RFS2 RIA, 2010.

LCFS Program Costs

- Reporting costs will be borne by regulated entities.

- Administrative and enforcement costs will be borne by participating LCFS states;

- Both reporting and administrative/enforcement costs will be estimated using simple formulas that account for differences in fuel volumes, staff time requirements, and any other relevant cost drivers.

LCFS Benefits

Proposed estimates for valuation of the following LCFS benefits:

- GHG Reductions
- Other Environmental Benefits
- Innovation Effects
- Other Economic Benefits

LCFS Benefits

- ***GHG Reductions***
  - Reductions in GHG emissions
- ***Other Environmental Benefits***
  - Co-reductions in criteria pollutants
  - *Others….?*
- ***Innovation Effects***
  - Increase in rate of innovation
- ***Other Economic Benefits***
  - Increase in local feedstock and fuel production
  - Potential reduction in fuel price volatility

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LCFS Benefits: GHG Reductions

- GHG benefits of LCFS calculated by multiplying emissions reductions from each LCFS scenario by an estimate (or range of estimates) of the social cost of carbon for each year
- In 2010, Federal interagency task force (EPA, Energy, Ag, Commerce, CEQ, others) developed estimates of the social cost of carbon to allow agencies to value reductions in CO_2 emissions
- Proposed low-end social cost of carbon, 3% discount rate: $21.4 2010 value prorated for 2012
- Will also be calculated at 0% discount rate

Table 15A.1.1 Social Cost of CO_2, 2010 – 2050 (in 2007 dollars)

	Discount Rate			
	5%	3%	2.5%	3%
Year	Avg	Avg	Avg	95th
2010	4.7	21.4	35.1	64.9
2015	5.7	23.8	38.4	72.8
2020	6.8	26.3	41.7	80.7
2025	8.2	29.6	45.9	90.4
2030	9.7	32.8	50.0	100.0
2035	11.2	36.0	54.2	109.7
2040	12.7	39.2	58.4	119.3
2045	14.2	42.1	61.7	127.8
2050	15.7	44.9	65.0	136.2

Source: Federal Interagency Task Force. 2010.

LCFS Benefits: GHG Reductions (con't.)

- High end estimate of value of avoided GHG emissions:
  - Stern *et al.* estimate social cost of carbon at $85 per ton of CO_2 (2000$)
  - Represents the global cost today, assuming a BAU trajectory of a 3.9 degree C increase by 2100 relative to pre-industrial temperatures
- Proposed high-end social cost of carbon: $85/ton (will be adjusted for 2012 dollars)

Sources: 1) Federal Interagency Task Force. 2010. "Social Cost of Carbon (SCC) for Regulatory Impact Analysis Under Executive Order 12866." and 2) Stern, N. *et al.* (2006), *Stern Review: The Economics of Climate Change*, HM Treasury, London.

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LCFS Benefits: Air Quality Impacts

- NESCAUM will estimate calculate changes in criteria pollutant emissions using NE- GREET and apply estimates from the EPA RIA and CARB for each scenario to bound potential impacts on air quality

- RFS2 RIA calculates direct (tailpipe and evaporative) emissions relative to petroleum-based fuels and emissions from production and distribution of renewable fuels:
  - MOVES, Mobile6, and National Mobile Inventory Model (NMIM) used for direct emissions
  - Emission factors for upstream emissions from agriculture taken from GREET and NREL
  - Biofuel production and transportation emissions calculated in GREET
  - Reference case and controls calculated with National Emissions Inventory and other tools
  - 2005 CMAQ modeling platform used to assess air quality impacts

- CARB used data from existing facilities and feedstock production to produce a "tank to wheels" and lifecycle analysis based on data from siting and mitigation regulatory data

LCFS Benefits: Policy-Induced Innovation Effects

- Review of literature on the effects of policy shows significant impact of policy drivers on rate of innovation in energy technologies;
- Analysis will provide qualitative review of potential innovation benefits of LCFS

Sources: Goulder, L. and Matthai, 2000. Optimal CO_2 abatement in the presence of induced technological change, *Journal of Environmental Economics and Management*, ; Pew Center on Global Climate Change, *Induced technological change and climate policy*, Pew Center on Global Climate Change, 2004)

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LCFS Benefits: Regional Economic Impacts

- The regional economic impact analysis will analyze how certain categories of LCFS costs and benefits will be realized by (or accrue to) specific industry and consumer groups (e.g., biofuel mfrs.) in the Northeast.
- Key outputs of the regional economic impact assessment include:
  - Changes in gross state product
  - Changes in employment, by industry group
  - Changes in total economic activity
- Our tool for the regional economic impact analysis will be the REMI© model, a 12-state economic and demographic forecasting model.
- NESCAUM will review literature on energy price volatility as it applies to the Northeast (including documentation from LIHEAP and DOT)

Global Economic Assumptions

- Discount rates are used to reflect the time value of resources by representing future values on a present value basis. The discount rate is critical for evaluating the tradeoffs of incurring costs and benefits in the near-term vs. the longer-term:
  - *Social rates of discount* reflect the time value of investments in public goods and services (e.g., GHG reductions, ecosystem services)
  - *Private rates of discount* reflect the time value of returns to private investments (e.g., new capital or machinery)
- Capital charge rates are used to annualize the costs of capital investments, such as new biofuel plants, based on the costs of financing, taxes, depreciation schedule, book life, and debt life:
  - Capital charge can vary by technology type, depending on the relative risk associated with the technology.

Proposed Discount Rates

- Proposed social discount rate: 0% and 3%
  - 0% reflects (Weitzman *et al.*, 2009) research that the risk of non-linear and irreversible impacts of climate change warrants consideration of a zero discount rate;
  - 3% reflects guidance for federal agencies in evaluating social (public) benefits of regulatory programs

Sources: 1) Weitzman, M. 2009. 2) Executive Order 12866, 2009.

- Proposed private discount rate: 5% and 8%
  - 5% reflects low-end of current returns on private capital
  - 8% reflects higher rate of return on investments in emerging technologies and industries with greater risk

Proposed Capital Charge Rates

- TBD, based on completion of review of state economic analyses.

IV. Next Steps

Next Steps

Steps for completing Part I of the data and assumptions for the LCFS Economic Analysis by late May:

- States and NESCAUM review stakeholder input on Part I (early May)
- States and NESCAUM revise Part I data and assumptions based on input, as appropriate (late May)
- Development of second round of Part II (see next slide), development of data and assumptions already underway
- Revisions to Part I will be reflected in release of draft Part II data and assumptions (late May)

Next Steps

- Part II of data and assumptions will include:
  - Revised Part I data and assumptions
  - Preliminary results (i.e., fuel volumes, nos. of vehicles) for core LCFS policy scenarios
  - Data developed for REMI analysis of regional economic impacts of LCFS
    - Regional biomass supply (MSW, woody& agricultural biomass, and energy crops)
    - Low C fuel production potential for the region
    - State macroeconomic data (e.g., population, employment)
    - Low C fuel industry templates
    - Estimates of program reporting and administrative costs

- Another round of stakeholder calls will be held after release of draft Part II data and assumptions (June)

Conclusion

- Data needs from stakeholders:
  - Production costs for low carbon fuels (especially MSW fuels)
  - Infrastructure costs (especially EV infrastructure needs)
  - Reporting cost estimates
- Deadline for comments: Friday, May 7th
- Send comments and questions to: lcfs@nescaum.org

Thank you!