RTI International Annual Report

State Fiscal Year 2011–2012 Report of Program Activities, Objectives and Accomplishments; and Itemized Expenditures and Fund Sources

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Table of Contents

Section	Page
Report Overview	**1**
About RTI	**2**
Energy Research at RTI	**2**
Importance of the $500K Grant Appropriated to RTI in the FY 2011–2012 State Budget	**3**
State Fiscal Year 2011–2012 Program Activities, Objectives, and Accomplishments	**5**
State Fiscal Year 2011–2012 Itemized Expenditures and Fund Sources	**7**
Outlook for State Fiscal Year 2012–2013	**8**
Summary	**9**

Appendix

A State of North Carolina Cost Share Funding A-1

REPORT OVERVIEW

- For the 2011–2012 fiscal year (FY), RTI received a nonrecurring State appropriation of $500,000 to match U.S. Department of Energy research and development funds for advancing energy research and creating green jobs.
- The State's investment in the program this year allowed RTI to draw down an additional $4,638,141 in federal energy research funds along with private sector investment.
- As a result, for every $1 in State FY 2012 funds, North Carolina received a return of $9.28 in federal and private investment.
- The State's investment in RTI's energy research began in FY 2010–2011. To date, the State's investment of $982,500 has provided a return of $9,182,128 in energy research funding to North Carolina's economy—or $9.35 in funding for every dollar invested by the State.

As provided in Session Law 2011-145, Section 14.12B, RTI International is pleased to submit this report of State fiscal year program activities, objectives, and accomplishments and prior State fiscal year itemized expenditures and fund sources.

ABOUT RTI

Growing from a handful of scientists in central North Carolina in 1959 to a staff of more than 2,800 in more than 40 countries today, RTI is now one of the world's leading independent, nonprofit research and development (R&D) organizations and one of the largest employers in the Research Triangle region.

Our activities both mirror and support national priorities and policies as well as diverse commercial, industrial, and academic endeavors. For instance, as public and government interest in environmental protection grew in the 1960s, so did related programs at RTI, building on our expertise in statistical, physical, and life sciences.

As our mission affirms, we are dedicated to improving the human condition by turning knowledge into practice through cutting-edge study and analysis in advanced technology, energy and the environment, health and pharmaceuticals, education and training, surveys and statistics, international development, economic and social policy, and laboratory and chemistry services.

We are proud of our scientific stature and our reputation for innovation. By continuing to conduct impartial, reliable, multidisciplinary research and by helping to develop and broker new technologies for our clients, we seek to be the world's preferred resource for turning knowledge into practice.

ENERGY RESEARCH AT RTI

RTI develops advanced energy technologies to address today's significant energy challenges, such as energy security, energy efficiency, sustainability, climate change, and water conservation. Our research supports national and worldwide goals of reliable, sustainable, economically viable, and secure energy supplies.

RTI scientists and engineers conduct applied R&D for a variety of stakeholders in the power, chemical, and petroleum refining industries, as well as for the transportation sector. These stakeholders include the following:

- Process technology licensors
- Gas processing companies
- Oil refiners

- Chemical manufacturers
- Electric utilities
- Clean fuels developers
- Catalyst manufacturers.

In addition to these and other commercial clients, RTI also works with the U.S. Department of Energy (DOE), Department of Defense (DoD), and other government agencies to develop new energy technologies.

Our R&D programs are also directly engaged with the social, political, and economic aspects of energy. Examples include the following:

- RTI energy economists provide detailed, quantitative analyses of the economic benefits derived from new energy technologies.
- RTI experts perform prospective and retrospective studies of technologies and industries and create and present economic return measures for R&D programs as a whole.

IMPORTANCE OF THE $500K GRANT APPROPRIATED TO RTI IN THE FY 2011–2012 STATE BUDGET

North Carolina State Funding as an Investment in Energy Technology Development

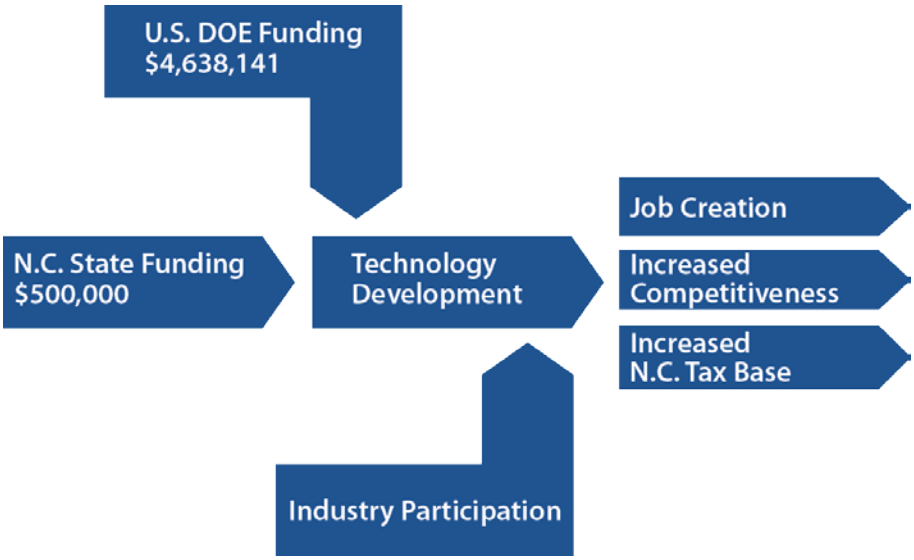
The State Budget approved by the legislature for Fiscal Year (FY) 2011–2012 included a $500,000 grant to assist RTI in winning federal energy research grants that require cost share—or match. The goal of this grant is to help RTI advance energy research in North Carolina and create jobs in this important and growing part of the state's economy. The key points of how RTI utilizes the grant and the benefits to the State can be summarized as follows:

- North Carolina state funding helps RTI to initiate development of three to five additional energy technology concepts per year. With $500,000 funding from the State in FY 11–12, RTI attracted more than $4,638,141 in U.S. DOE funding.

- Together with U.S. DOE funding and in partnerships with leading industrial companies, RTI builds a pipeline of innovative technologies addressing the energy challenges of the nation.

- Technology development moves through scale-up phases, attracting further large-scale investment, such as a recent $4 million award to scale up a technology to make gasoline from cellulosic biomass (this scale-up will be done in North Carolina).

- Commercialization of technologies leads to increased economic competitiveness. It creates high-paying jobs, typically attracting talent from outside of the state and resulting in significant economic input.



Current RTI energy projects in the development phase with industrial partners

Table 1 shows RTI's development pipeline for new energy technologies, our industry partners, and the expected progression to the next scale-up phase toward commercialization.

Table 1. RTI Energy R&D Pipeline

Projects	Funding Level	Industry Partners	Current Scale	Next Step
Warm Syngas Clean-Up	$170 million	Tampa Electric Company, Eastman, Süd-Chemie, AMEC	Large-scale demonstration (50 MW)	Commercial
Biomass Pyrolysis	$9 million	ADM, ConocoPhillips, Haldor Topsoe	Small pilot end of 2012	Demonstration 2014–15
Novel Water Treatment Process	$6 million	Veolia &Duke University)	Lab	Prototype 2015
CO_2 Capture Sorbents	$4 million	Masdar, Foster Wheeler, Süd-Chemie (& Penn State University)	Lab	Pilot 2014
CO_2 Capture from Syngas	$0.8 million	Süd-Chemie	Bench	Pilot 2014
Trace Metals Removal	$0.8 million	Eastman	Small pilot plant	Demonstration 2014
CO_2 Capture Solvents	$2.8 million	BASF	Small pilot late Fall 2012	Demonstration 2014–15

STATE FISCAL YEAR 2011–2012 PROGRAM ACTIVITIES, OBJECTIVES, AND ACCOMPLISHMENTS

In this fiscal year, the funding appropriated to RTI has greatly assisted in further building RTI's technology development pipeline, attracting $4,638,141 in federal research dollars to the state, successfully retaining and creating jobs in the state of North Carolina. **Table 2** below shows the leveraging of federal funds through State funding.

Table 2. Leveraging of Federal Funds through State Funding

Federal Dollars Leveraged Through Use of State Funding		
Project/Proposal	**NC Funds Used ($)**	**Federal Dollars Leveraged ($)**
Advanced Biofuels Consortium (Biomass Hydropyrolysis)	100,000	862,538
Syngas Clean-Up (Trace Contaminant Removal and High Temperature Carbon Capture)	323,214	1,292,856
Syngas Clean-Up (50 Megawatt—Analysis and FEED Study)	76,786	2,482,747
Total	**$ 500,000**	**$ 4,638,141**

Specific projects benefiting from State of NC funds and the goals of those projects are highlighted below:

1. **Advanced Biofuels Consortium (Biomass Hydropyrolysis)**. RTI, as a member of the National Advanced Biofuels Consortium, leveraged $100,000 in State of NC funds to win $862,538 from U.S. DOE's National Renewable Energy Laboratory to develop a new technology that can process biomass into a raw crude oil that can be refined to produce transportation fuels. The National Advanced Biofuels Consortium (the Consortium) has been competitively awarded funding from the DOE to conduct cutting-edge research to develop infrastructure-compatible, fungible "drop-in" biomass-based hydrocarbon fuels. The Consortium will develop the technology necessary to deliver processes ready for pilot scale that maximize the use of existing refining and distribution infrastructure. The outcome will be a sustainable, cost-effective advanced biofuels processing sequence with high process efficiency and maximum carbon utilization.

   The Consortium consists of a group of organizations, each chosen for their technical expertise and ability to perform world-class R&D. The industrial partners include 1) refiners, 2) technology developers, 3) a separations expert, and 4) a feedstock technology developer. The university partners bring expertise in bioprocessing, catalysis, and mechanistic and kinetic modeling. The national laboratories offer top experts in biofuels, including bioprocessing, catalysis, computational modeling, and engineering and sustainability analysis. RTI's project team consists of personnel from RTI's Center for Energy Technology with a subcontracted effort from the Department of Chemical and Biomolecular Engineering at North Carolina State University.

   The overall objective of the hydropyrolysis process development effort led by RTI is in the conversion strategy area, specifically to develop catalytic hydropyrolysis

processes to convert biomass to hydrocarbon fuels. RTI used the $100,000 in State of NC funds to design, construct, and commission a new hydropyrolysis reactor system and to develop a comprehensive experimental plan for the program.

2. **Development of multicontaminant and carbon capture components for RTI's warm syngas clean-up technology.** RTI utilized $323,214 of State of NC funds to leverage $1,292,856 in U.S. DOE funds to develop system components that will integrate with RTI's warm syngas clean-up technology (see below).

    a. **Multicontaminant removal.** RTI used and allocated $163,214 in State of NC funds to obtain $652,856 from the U.S. DOE to test a number of materials for removal of heavy metals from a coal-derived syngas. This technology is critical for meeting new regulations for mercury and other heavy metals from coal plants.

    b. **High temperature carbon capture from syngas.** RTI used $160,000 of its State of NC funding to secure $640,000 from the U.S. DOE to develop a technology to separate CO_2 from syngas at elevated temperatures. This process component will significantly reduce CO_2 emissions from the conversion of coal to power, chemicals, fertilizers, and transportation fuels.

3. **Large-scale demonstration of RTI's warm syngas clean-up technology**. The goal of this large-scale $170 million DOE project is to demonstrate the effectiveness of a syngas technology developed by RTI. This process technology will allow coal and other feedstocks such as petroleum coke to be used cleanly and efficiently for production of power, chemicals, fertilizers, and transportation fuels. This 50 Megawatt demonstration is the final precommercial scale-up phase for the technology. RTI used $76,786 in State of NC funds to leverage close to $2.5 million from U.S. DOE for Front End Engineering and Design work (FEED). This work has been critical to prepare for the actual engineering, procurement, and construction phase of the project, which will be performed together with AMEC, a leading process engineering contractor. Successful performance of this large-scale program also allows RTI to further develop its capabilities to manage medium-to-large energy pilot and demonstration projects.

STATE FISCAL YEAR 2011–2012 ITEMIZED EXPENDITURES AND FUND SOURCES

All appropriation funds were applied to labor costs inclusive of indirect overhead charges. See **Appendix A**.

OUTLOOK FOR STATE FISCAL YEAR 2012–2013

For the State fiscal year 2012–2013, RTI plans to continue to utilize State of NC funding to further strengthen its energy program. The funds will be used to leverage federal funds for the following technology development projects:

- **CO_2 Solvent and Capture**. The objective of this ongoing project is to develop novel, non-aqueous CO_2 scrubbing solvents and a capture process that substantially reduces CO_2 emissions from existing and new coal-fired power plants while reducing the parasitic energy penalty and corresponding increase in cost of electricity associated with CO_2 capture. The U.S. DOE is providing additional funds to design, construct, and operate a small pilot plant at RTI.

- **Biomass Pyrolysis**. This technology development for the conversion of biomass to transportation fuels has been funded by U.S. DOE, and State of NC funding allows RTI to receive additional funds from DOE for the operation of a small pilot plant for this technology at RTI. The effort is a step in the further scale-up of the technology.

- **Vehicular Natural Gas Storage Using Advanced Porous Materials**. RTI has teamed with Texas A&M, General Motors, and Lawrence Berkeley National Lab to develop a prototype adsorbed natural gas fuel tank for vehicles. The R&D effort is designed to enhance the economics associated with US use of abundant, domestic natural gas supplies in light-duty vehicles and to reduce harmful energy-related emissions from the combustion of petroleum-based fuel sources. RTI will develop and scale up novel sorbent materials for this application. RTI plans to utilize State of NC funding to leverage significant U.S. DOE funds under this newly awarded program.

- **CO_2 to CO Conversion**. The goal of this project is to demonstrate the feasibility of a carbon dioxide (CO_2) utilization process for producing valuable chemicals based on reduction of CO_2 with abundant low-value carbon sources. Funds will be used to leverage U.S. DOE funding for this ongoing, early-stage technology development.

- **Solid State Lighting**. Working in conjunction with North Carolina-based Cree and SAS, RTI is building a model of the long-term reliability of solid-state lighting (SSL) luminaires. Once completed, the model will overcome a major impediment to the adoption of energy-efficient SSL devices by providing a tool to quantify the return on investment for energy-efficient lighting. The funding provided by the State of North Carolina will be matched by more than $500,000 from the U.S. DOE.

SUMMARY

All of the funds received by RTI have been used for the purposes for which they were granted. Financial data for all listed projects, inclusive of forecasts, have been provided for FY 12 through June 2012. The line item budget for the FY 12 use of funds is attached. We appreciate the State's support of the above projects and the continued opportunity to hire and retain jobs in the State of North Carolina. Please direct any questions to Dr. David Myers, Vice President, Engineering Technology Unit, RTI International, dmyers@rti.org or 919-541-7183.

APPENDIX A: STATE OF NORTH CAROLINA COST SHARE FUNDING

Summary

State of NC Funding $500,000

Project/Proposal	Start Date	Total Cost	DOE Award	Cost Share Requirement	Use of NC Funds	Federal Dollars Leveraged
Advanced Biofuels Consortium (Biomass Hydropyrolysis)	6/28/2010	$1,366,279	$1,366,279	$100,000	$100,000	$862,538
Syngas Clean-Up (Trace Contaminant Removal and High Temperature Carbon Capture)	7/20/2009	$4,261,095	$5,326,369	$1,065,274	$323,214	$1,292,856
Syngas Clean-Up (50 Megawatt—Analysis and FEED Study)	10/1/2010	$15,648,407	$16,132,378	$483,971	$76,786	$2,482,747
			TOTAL	**$1,649,245**	**$500,000**	**$4,638,141**

Funding Breakout—by Project by Quarter

7/1/11–6/30/12 = Actuals, 7/1/12–12/31/12 = Forecast	Q1	Q2	Q3	Q4
	7/1/11–9/30/11	10/1/11–12/31/11	1/1/12–3/31/12	4/1/12–6/30/12
Advanced Biofuels Consortium (Biomass Hydropyrolysis)				
Labor (w/Fringe)	$16,817	$6,211	$21,290	$86,772
Travel, Services, etc.	$3,216	$962	$2,331	$5,085
Equipment, Materials, Subcontractors	$7,328	$678	$293	$6,361
Overhead (Indirect) Costs	$23,036	$3,752	$28,384	$125,684
Total	**$50,397**	**$11,603**	**$52,298**	**$223,902**
Labor (fully loaded)	***$38,787***	***$14,325***	***$49,103***	***$200,108***
Labor (fully loaded) toward State Cost Share Funds	**$0**	**$0**	**$22,837**	**$77,163**

Funding Breakout—by Project by Quarter					
7/1/11–6/30/12 = Actuals, 7/1/12–12/31/12 = Forecast	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**
	7/1/11–9/30/11	**10/1/11–12/31/11**	**1/1/12–3/31/12**	**4/1/12–6/30/12**	**7/1/12–9/30/12**
Syngas Clean-Up (Trace Contaminant & Hi Temp CO_2 Capture)					
Labor (w/Fringe)	**$2,591**	**$25,487**	**$36,082**	**$53,428**	**$71,322**
Travel, Services, etc.	**$**	**$7**	**$**	**$**	**$**
Equipment, Materials, Subcontractors	**$7,330**	**$1,579**	**$3,255**	**$6,790**	**$5,000**
Overhead (Indirect) Costs	**$3,692**	**$34,068**	**$47,268**	**$70,071**	**$93,375**
Total	**$13,613**	**$61,141**	**$86,605**	**$130,289**	**$169,697**
Labor (fully loaded)	***$5,976***	***$58,786***	***$67,114***	***$123,228***	***$164,497***
Labor (fully loaded) toward State Cost Share Funds			**$35,489**	**$123,228**	**$164,497**

Funding Breakout—by Project by Quarter				
7/1/11–6/30/12 = Actuals, 7/1/12–12/31/12 = Forecast	**Q1**	**Q2**	**Q3**	**Q4**
	7/1/11–9/30/11	**10/1/11 –12/31/11**	**1/1/12–3/31/12**	**4/1/12–6/30/12**
Syngas Clean-Up (50 Megawatt—Analysis and FEED Study)				
Labor (w/Fringe)	**$109,812**	**$137,159**	**$205,857**	**$221,976**
Travel, Services, etc.	**$44,605**	**$48,573**	**$25,806**	**$21,726**
Equipment, Materials, Subcontractors	**$2,380,000**	**$451,630**	**$1,282,876**	**$987,770**
Overhead (Indirect) Costs	**$249,529**	**$212,463**	**$326,234**	**$335,112**
Total	**$2,783,946**	**$849,825**	**$1,840,773**	**$1,566,584**
Labor (fully loaded)	***$253,270***	***$315,936***	***$474,424***	***$511,943***
Labor (fully loaded) toward State Cost Share Funds	**$0**	**$0**	**$0**	**$76,786**